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United States Nuclear Regulatory Commission
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NUREG-1936, Vol. 1

Environmental Impact Statement for the Combined License (COL) for Calvert Cliffs Nuclear Power Plant Unit 3

Draft Report for Comment

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

U.S. Army Corps of Engineers
U.S. Army Engineer District, Baltimore
Baltimore, MD 21203-1715

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Abstract

This environmental impact statement (EIS) has been prepared to satisfy the requirements of the National Environmental Policy Act of 1969, as amended (NEPA). The EIS has been prepared in response to an application submitted to the U.S. Nuclear Regulatory Commission (NRC) by UniStar Nuclear Development, LLC, on behalf of Calvert Cliffs 3 Nuclear Project, LLC, and UniStar Nuclear Operating Services, LLC, (collectively known as UniStar) for a combined construction permit and operating license (combined license or COL). UniStar also submitted a joint Federal/State Application for the Alteration of Any Floodplain, Waterway, Tidal or Nontidal Wetland in Maryland to the U.S. Army Corps of Engineers (USACE or Corps) and the Maryland Department of the Environment (MDE). The proposed actions related to the UniStar application are (1) NRC issuance of a COL for a new power reactor unit (Unit 3) at the Calvert Cliffs Nuclear Power Plant (CCNPP) in Calvert County, Maryland and (2) Corps permit action on a Department of the Army (DA) Individual Permit application to perform certain activities on the site. The Corps is participating with the NRC in preparing this EIS as a cooperating agency and participates collaboratively on the review team.

This EIS includes the analysis by the NRC and Corps staff that considers and weighs the environmental impacts of constructing and operating a new nuclear unit at the Calvert Cliffs site and at alternative sites and mitigation measures available for reducing or avoiding adverse impacts. This EIS also addresses consultation for Federally listed species, cultural resources, and essential fish habitat (EFH).

This EIS includes the evaluation of the proposed project's impacts to waters of the United States pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899. The Corps will base its evaluation of the DA Individual Permit application on the requirements of Corps regulations, the Clean Water Act Section 404(b)(1) Guidelines, and the Corps public interest review (PIR) process.

After considering the environmental aspects of the proposed NRC action, the NRC staff's preliminary recommendation to the Commission is that the COL be issued as requested. This recommendation is based on (1) the application, including the Environmental Report (ER), submitted by UniStar and responses to requests for additional information (RAI); (2) consultation with Federal, State, Tribal, and local agencies; (3) the staff's independent review; (4) the staff's consideration of comments related to the environmental review that were received during the public scoping process; and (5) the assessments summarized in this EIS, including the potential mitigation measures identified in the ER and this EIS. The Corps permit decision will be made following issuance of the final EIS.

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Executive Summary

By letter dated July 13, 2007, the U.S. Nuclear Regulatory Commission (NRC) received a partial application from UniStar Nuclear Development, LLC, on behalf of Constellation Generation Group, LLC and UniStar Nuclear Operating Services, LLC (collectively known as UniStar), for a combined construction permit and operating license (combined license or COL) for Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 to be located adjacent to the existing Units 1 and 2 in Calvert County, Maryland. Part 1 of the application contained the applicant's Environmental Report (ER) and site suitability information and was accepted on January 25, 2008. Part 2, which contained the balance of information required for a COL application, was received on March 14, 2008 and was accepted on June 3, 2008. On July 7, 2008, Constellation Generation Group, LLC withdrew as an applicant and Calvert Cliffs 3 Nuclear Project, LLC joined as an applicant. The application was supplemented by letters between June 2008 and September 2009. Revision 6 of the application was submitted on September 30, 2009. The NRC staff's review is based on Revision 6 of the application, the applicant's responses to staff's requests for additional information (RAI), and supplemental letters from the applicant.

On May 16, 2008, UniStar submitted a joint Federal/State Application for the Alteration of Any Floodplain, Waterway, Tidal or Nontidal Wetland in Maryland to the U.S. Army Corps of Engineers (USACE or Corps) and the Maryland Department of the Environment (MDE). The Corps application number is NAB-2007-08123-M05 (Calvert Cliffs 3 Nuclear Project, LLC/UniStar Nuclear Operating Service, LLC), on behalf of co-applicants, Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC. The MDE Tidal Application number is Calvert Cliffs 3 Nuclear Project, LLC/200862371/08-WL-1462. The MDE Nontidal Application number is Calvert Cliffs 3 Nuclear Project, LLC/200862335/08-NT-0191.

The proposed actions related to the Calvert Cliffs Unit 3 application are (1) NRC issuance of a COL for construction and operation of a new nuclear unit at the Calvert Cliffs site and (2) Corps permit action on a Department of the Army (DA) Individual Permit application pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899. The U.S. Environmental Protection Agency (EPA) has the authority to review and veto Corps decisions of Section 404 permits. The Corps is participating with the NRC in preparing this environmental impact statement (EIS) as a cooperating agency and participates collaboratively on the review team.

Section 102 of the National Environmental Policy Act of 1969, as amended (NEPA), directs that an EIS be prepared for major Federal actions that significantly affect the quality of the human environment. The NRC has implemented Section 102 of NEPA in Title 10 of the Code of Federal Regulations (CFR) Part 51. Further, in 10 CFR 51.20, the NRC has determined that the issuance of a COL under 10 CFR Part 52 is an action that requires an EIS.

The purpose of UniStar's requested NRC action is to obtain a COL to construct and operate a baseload nuclear power plant. This license is necessary but not sufficient by itself for construction and operation of the unit. A COL applicant must obtain and maintain the necessary permits from other Federal, State, and local agencies and permitting authorities. Therefore, the purpose of the NRC's environmental review of the UniStar application is to determine the impacts on the human environment if one new nuclear power plant of the proposed U.S. EPR design is constructed and operated at the Calvert Cliffs site. The purpose of UniStar's requested Corps action is to obtain a DA permit decision on the Individual Permit application to construct the proposed structures in and under navigable waters and to discharge dredged, excavated, and/or fill material into waters of the United States, including jurisdictional wetlands.

Upon acceptance of the UniStar application, the NRC began the environmental review process described in 10 CFR Part 51 by publishing a Notice of Intent (73 FR 8719) to prepare an EIS and conduct scoping in the *Federal Register* (FR). On March 19, 2008, the NRC held two scoping meetings in Solomons, Maryland, to obtain public input on the scope of the environmental review. To gather information and to become familiar with the proposed and alternative sites and their environs, the NRC and its contractor, Pacific Northwest National Laboratory (PNNL), visited the Calvert Cliffs site in March 2008 and the alternative site, the former Thiokol brownfield site, in October 2008. The NRC, PNNL, and the Corps visited the alternative sites Eastalco and Bainbridge in August 2009. During the site visits, the NRC, PNNL, and Corps staff met with UniStar staff and public officials. During the scoping process, the NRC staff reviewed the comments received and contacted Federal, State, Tribal, regional, and local agencies to solicit comments.

Included in this EIS are (1) the results of the joint NRC/Corps review team's analyses, which consider and weigh the environmental effects of the NRC's proposed action (i.e., issuance of the COL) and of constructing and operating a new nuclear unit at the Calvert Cliffs site; (2) mitigation measures for reducing or avoiding adverse effects; (3) the environmental impacts of alternatives to the proposed action; and (4) the staff's recommendation regarding the proposed action.

To guide its assessment of the environmental impacts of a proposed action or alternative actions, the NRC has established a standard of significance for impacts based on Council on Environmental Quality (CEQ) guidance. Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, provides the following definitions of the three significance levels – SMALL, MODERATE, and LARGE:

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

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

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

Potential mitigation measures were considered for each resource category and are discussed in the appropriate sections of the EIS.

In preparing this EIS, the review team reviewed the applications, including the ER submitted by UniStar; consulted with Federal, State, Tribal, and local agencies; and followed the guidance set forth in NUREG-1555, *Environmental Standard Review Plan* (ESRP). In addition, the review team considered the public comments related to the environmental review received during the scoping process. Comments within the scope of the environmental review are included in Appendix D of this EIS.

The NRC staff's preliminary recommendation to the Commission related to the environmental aspects of the proposed action is that the COL be issued as requested. This recommendation is based on (1) the application, including the ER submitted by UniStar and the applicant's supplemental letters and responses to staff's RAIs; (2) consultation with Federal, State, Tribal, and local agencies; (3) the staff's independent review; (4) the staff's consideration of comments related to the environmental review that were received during the scoping process; and (5) the assessments summarized in this EIS, including the potential mitigation measures identified in the ER. The Corps will base its evaluation of the DA Individual Permit application on the requirements of Corps regulations, the Clean Water Act Section 404(b)(1) Guidelines, and the Corps public interest review (PIR) process. The Corps permit decision will be made following issuance of the final EIS.

A 75-day comment period will begin on the date of publication of the EPA Notice of Availability of the filing of the draft EIS to allow members of the public to comment on the results of the NRC and Corps staffs' review. During this period, the NRC and Corps staff will conduct a public meeting near the Calvert Cliffs site to describe the results of the environmental review, provide members of the public with information to assist them in formulating comments on this EIS, respond to questions, and accept public comment. The public meeting also serves as the Corps public hearing, which means a public proceeding conducted for the purpose of acquiring information or evidence that will be considered in evaluating a proposed DA permit action and affords the public an opportunity to present their views, opinions, and information on such permit actions or Federal projects. After the comment period, the review team will consider all the comments received. The final EIS will include these comments and the review team responses.

The NRC staff's evaluation of the site safety and emergency preparedness aspects of the proposed action will be addressed in the NRC's final Safety Evaluation Report (SER), currently anticipated to be published in July 2012. The reactor specified in the application is the AREVA NP Inc.'s U.S. EPR design, which is currently undergoing a design certification review. The NRC staff's evaluation of the design certification and final rulemaking is currently anticipated to be completed in June 2012.

Abbreviations/Acronyms

χ/Q	dispersion values
°C	degree(s) Celsius
°F	degree(s) Fahrenheit
ac	acre(s)
ADAMS	Agencywide Documents Access and Management System
AEC	U.S. Atomic Energy Commission
ALARA	as low as reasonably achievable
ANC	acid neutralizing capacity
ANSI	American National Standards Institute
APE	Area of Potential Effects
AREVA	AREVA NP Inc.
AQCR	Air Quality Control Region
B&O	Baltimore and Ohio
BA	biological assessment
BACT	best available control technology
BEA	U.S. Department of Commerce Bureau of Economic Analysis
BEIR	Biological Effects of Ionizing Radiation
BGE	Baltimore Gas and Electric Company
B-IBI	Benthic Index of Biotic Integrity
BMP	best management practice(s)
Bq	becquerels
BRAC	base realignment and closure
Btu	British thermal unit
C&O	Chesapeake and Ohio
CAC	Critical Area Commission
CAES	compressed air energy storage
CBCA	Chesapeake Bay Critical Area
CBP	Chesapeake Bay Program
CCNPP	Calvert Cliffs Nuclear Power Plant
CCPS	Calvert County Public Schools
CCWS	component cooling water system
CDC	Centers for Disease Control and Prevention
CDF	core damage frequency
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations

cfs	cubic feet per second (water flow)
Ci	curies
cm	centimeters
CMH	Calvert Memorial Hospital
CO	carbon monoxide
CO_2	carbon dioxide
COL	combined license
COMAR	Code of Maryland Regulations
Constellation	Constellation Energy Nuclear Group, LLC
Corps	U.S. Army Corps of Engineers (also USACE)
CPCN	Certificate of Public Convenience and Necessity
CWMA	Cooperative Wildlife Management Area
CWP	Center for Watershed Protection
CWS	circulating water supply system
CZMA	Coastal Zone Management Act
d	day
D/Q	deposition values
DA	Department of the Army
dB	decibel(s)
dBA	decibel(s) (acoustic)
DBA	design basis accidents
DC	District of Columbia
DE	Delaware
DECOM	decommissioning
DO	dissolved oxygen
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DPS	distinct population segments
D/Q	deposition values
EAB	exclusion area boundary
EDG	emergency diesel generators
EFH	essential fish habitat
EIA	Department of Energy's Energy Information Administration
EIS	environmental impact statement
ELF	extremely low frequency
EMF	electromagnetic field(s)
EMS	Emergency Medical Services
EO	Executive Order
EPA	U.S. Environmental Protection Agency

EPR	Evolutionary Power Reactor
EPRI	Electric Power Research Institute
EPT	Ephemeroptera-Plecoptera-Trichoptera
EPZ	emergency planning zone
ER	Environmental Report
ESA	U.S. Endangered Species Act of 1973, as amended
ESP	Energy Storage and Power LLC
ESRP	*Environmental Standard Review Plan*
ESWS	essential service water system
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FHWG	Fisheries Hydroacoustic Working Group
FIDS	forest interior dwelling species
fps	feet per second
FONSI	finding of no significant impact
FR	*Federal Register*
FSAR	Final Safety Analysis Report
ft	foot/feet
ft^2	square feet
ft^3	cubic feet
FTE	full-time equivalent
FWS	U.S. Fish and Wildlife Service
FY	fiscal year
g	gram(s)
GAI	GAI Consultants, Inc.
gal	gallon(s)
GBq	gigabecquerel
GC	gas centrifuge
GCC	global climate change
GD	gaseous diffusion
GEIS	generic environmental impact statement
GHG	greenhouse gas
GI-LLI	adult lower intestine
GIS	geographical information system
GIT	Georgia Institute of Technology
gpd	gallon(s) per day
gpm	gallon(s) per minute

ha	hectare(s)
HAP	hazardous air pollutants
HAPC	habitat areas of particular concern
HLW	high level waste
HQUSACE	Headquarters, U.S. Army Corps of Engineers
hr	hour
Hz	hertz
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IDAs	Intensely Developed Areas
IGCC	integrated gasification combined cycle
in.	inch(es)
INEEL	Idaho National Engineering and Environmental Laboratory
IRSA	interim resin storage area
ISFSI	independent spent fuel storage installation
Kcal	kilocalorie
kg	kilogram
km	kilometer(s)
km^2	square kilometer(s)
kV	kilovolt(s)
kW(e)	kilowatts electric
kWh	kilowatt hour(s)
L	liter(s)
lb	pound(s)
LDAs	Limited Development Areas
LEAs	Local Educational Agencies
LEDPA	least environmentally damaging practicable alternative
LFAA	Low Flow Allocation Agreement
LLW	low-level waste
LNG	liquefied natural gas
LOS	level of service
LPZ	low population zone
LR	license renewal
LRF	large release frequencies
LWR	light-water reactor
m	meter(s)
m^2	square meter
m^3	cubic meter(s)

mA	milliamperes
MACCS2	MELCOR Accident Consequence Code System
MAPP	Mid-Atlantic Power Pathway
MBq	million becquerels
mCi	millicuries
MBTA	Migratory Bird Treaty Act
MD	Maryland
MBSS	Maryland Biological Stream Survey
MDE	Maryland Department of the Environment
MDNR	Maryland Department of Natural Resources
MDOT	Maryland Department of Transportation
MDP	Maryland Department of Planning
MDSDAT	Maryland State Department of Assessments and Taxation
MEA	Maryland Energy Administration
MEI	maximally exposed individual
mg	milligram(s)
MGD	million gallon(s) per day
mGy	milligray
MHT	Maryland Historical Trust
MHW	mean high water
mi	mile(s)
mi^2	square mile(s)
MISO	Midwest Independent Transmission System Operator, Inc.
MIT	Massachusetts Institute of Technology
mL	millilitres
mm	millimetres
MMS	Minerals Management Service
mo	month
MOA	memorandum of agreement
MOU	memorandum of understanding
mph	mile(s) per hour
MPSC	Maryland Public Service Commission
mR	milliroentgen
mrad	millirad(s)
mrem	millirem(s)
MSA	Metropolitan Statistical Area
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act of 1976
MSL	mean sea level
mSv	millisievert(s)
MSX	Multinucleate Sphere X
MT	metric ton(s) (or tonne[s])

MTU	metric ton of uranium
MVA	motor vehicle accidents
MW	megawatt(s)
MW(e)	megawatt(s) electric
MW(t)	megawatt(s) thermal
MWd	megawatt-day(s)
MWh	megawatt hour(s)
NA	Not Applicable
NAGPRA	Native American Graves Protection & Repatriation Act
NA-NSR	Nonattainment New Source Review
NCES	National Center for Education Statistics
NCI	National Cancer Institute
NCRP	National Council on Radiation Protection and Measurements
NEPA	National Environmental Policy Act of 1969, as amended
NERC	North American Electric Reliability Corporation
NESC	National Electric Safety Code
NETL	National Energy Technology Laboratory
NHPA	National Historic Preservation Act of 1966, as amended
NIEHS	National Institute of Environmental Health Sciences
NIST	National Institute of Standards and Technology
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NOB	Natural Oyster Bar
NO_x	nitrogen oxide(s)
NPCC	Northeast Power Coordinating Council
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRC	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NUREG	NRC publication
NYSDEC	New York State Department of Environmental Conservation
ODCM	Offsite Dose Calculation Manual
OSHA	Occupational Safety and Health Administration
Pa	pascal
PATH	Potomac-Appalachian Transmission Highline Project
PCB	polychlorinated biphenyls
pCi	picocuries

PDCC	Port Deposit Chamber of Commerce
PIR	public interest review
P-IBI	phytoplankton index of biotic integrity
PJM	PJM Interconnection, LLC
PM	particulate matter
PM_{10}	particulate matter with a diameter of 10 microns or less
$PM_{2.5}$	particulate matter with a diameter of 2.5 microns or less
PNNL	Pacific Northwest National Laboratory
PPRP	Power Plant Research Program
ppt	parts per thousand
PRA	probabilistic risk assessment
PSD	prevention of significant deterioration
PWR	pressurized water reactor(s)
rad	radiation absorbed dose
RAI	Request for Additional Information
RCAs	resource conservation areas
RCP	reinforced concrete pipe
RCRA	Resource Conservation and Recovery Act of 1976, as amended
RCS	reactor coolant system
rem	Roentgen equivalent man (a special unit of radiation dose)
REMP	radiological environmental monitoring program
RFC	Reliability*First* Corporation
RIMS	Regional Input-Output Multiplier System
ROD	Record of Decision
ROI	region of interest
ROW	rights-of-way
RSICC	Radiation Safety Information Computational Center
Ryr	reactor year
s	second(s)
SAMA	severe accident mitigation alternative
SAMDA	severe accident mitigation design alternative
SAV	submerged aquatic vegetation
SBO	station blackout
SCR	selective catalytic reduction
SEL	sound exposure level
SER	Safety Evaluation Report
SERC	SERC Reliability Corporation
SHA	State Highway Administration
SHPO	State Historic Preservation Office

SMCMC	St. Mary's County Metropolitan Commission
SNE-MA	Southern New England/Middle Atlantic
SO_2	sulfur dioxide
SO_x	sulfur oxide(s)
SPCC	Spill Prevention Control and Countermeasures
SSC	structures, systems, or components
Sv	sievert(s)
SWPPP	Stormwater Pollution Prevention Plan
TAP	toxic air pollutant(s)
TBq	tera becquerel(s)
TDS	total dissolved solids
TEDE	total effective dose equivalent
TIA	Traffic Impact Analysis
TLD	thermoluminescent dosimeter(s)
TOC	total organic carbon
TRU	Transuranic waste
TSP	total suspended particulates
U.S.	United States
U.S. EPR	U.S. Evolutionary Power Reactor
U_3O_8	triuranium octaoxide ("yellowcake")
UHS	ultimate heat sink
UMTRI	University of Michigan Transportation Research Institute
UniStar	UniStar Nuclear Operating Services, LLC and Calvert Cliffs 3 Nuclear Project, LLC (collective applicant)
UO_2	uranium(IV) oxide
USACE	U.S. Army Corps of Engineers (also Corps)
USBLS	United States Bureau of Labor Statistics
U.S.C.	United States Code
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
VA	Virginia
VIMS	Virginia Institute of Marine Science
VOC	volatile organic compound(s)
WHO	World Health Organization
WNA	World Nuclear Association
WV	West Virginia

yd	yard
yd^3	cubic yards
yr	year(s)

1.0 Introduction

By letter dated July 13, 2007, the U.S. Nuclear Regulatory Commission (NRC) received a partial application from UniStar Nuclear Development, LLC, on behalf of Constellation Generation Group, LLC and UniStar Nuclear Operating Services, LLC (collectively known as UniStar), for a combined construction permit and operating license (combined license or COL) for Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 to be located adjacent to the existing Units 1 and 2 near Lusby, Maryland in Calvert County (UniStar 2007). Part 1 (Revision 0) of the application contained the applicant's Environmental Report (ER) and site suitability information. Revision 1 of the application was submitted on December 14, 2007 and was accepted on January 25, 2008 (73 FR 5877). Revision 2, which was Part 2 of the partial application, contained the balance of information required for a COL application and was received on March 14, 2008 (UniStar 2008a). Revision 2 was accepted on June 3, 2008 (73 FR 32606). Revision 3 of the application was submitted on August 20, 2008, Revision 4 on March 9, 2009, and Revision 5 on June 30, 2009. Revision 6 of the application was submitted on September 30, 2009. The NRC staff's review is based on Revision 6 of the application (UniStar 2009), UniStar's responses to the NRC staff's requests for additional information, and supplemental letters from UniStar.

On July 7, 2008, Constellation Generation Group, LLC withdrew as an applicant and Calvert Cliffs 3 Nuclear Project, LLC joined as an applicant (UniStar 2008b). UniStar Nuclear Operating Services, LLC is designated in the application as the operator, and Calvert Cliffs 3 Nuclear Project, LLC is designated as the owner. The existing facilities at the Calvert Cliffs site are owned by Constellation Energy Nuclear Group, LLC (Constellation).

On May 16, 2008, UniStar submitted a joint Federal/State Application for the Alteration of Any Floodplain, Waterway, Tidal or Nontidal Wetland in Maryland to the U.S. Army Corps of Engineers (USACE or Corps) and the Maryland Department of the Environment (MDE) (UniStar 2008c). The Corps application number is NAB-2007-08123-M05 (Calvert Cliffs 3 Nuclear Project, LLC/UniStar Nuclear Operating Services, LLC) on behalf of co-applicants, Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC. The MDE Tidal Application number is Calvert Cliffs 3 Nuclear Project, LLC/200862371/08-WL-1462. The MDE Nontidal Application number is Calvert Cliffs 3 Nuclear Project, LLC/200862335/08-NT-0191.

The proposed actions related to the Calvert Cliffs Unit 3 application are (1) NRC issuance of a COL for constructing and operating a new nuclear unit at the Calvert Cliffs site and (2) Corps permit action on a Department of the Army (DA) Individual Permit application pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Appropriation Act of 1899 (River and Harbors Act). The Corps, a cooperating agency with the NRC, verifies whether the information presented in this environmental impact statement (EIS) is adequate to fulfill the requirements of Corps regulations and the Clean Water Act Section 404(b)(1)

Guidelines for Specification of Disposal Sites for Dredged or Fill Material (Guidelines) (40 CFR Part 230). The Corps has the authority to issue permits for proposed work or structures in, over, and under navigable waters and for the discharge of dredged of fill material into waters of the United States. The Corps would regulate activities that would temporarily or permanently affect wetlands and waterbodies involved in this project. The U.S. Environmental Protection Agency (EPA) has the authority to review and veto Corps decisions on Section 404 permits.

1.1 Background

A COL is Commission approval for the construction and operation of a nuclear power facility. NRC regulations related to COLs are primarily found in Title 10 of the Code of Federal Regulations (CFR) Part 52, Subpart C.

Section 102 of the National Environmental Policy Act of 1969, as amended (NEPA) (42 U.S.C. 4321 et seq.), requires the preparation of an EIS for major Federal actions that have the potential to significantly affect the quality of the human environment. The NRC has implemented Section 102 of NEPA in 10 CFR Part 51. Further, in 10 CFR 51.20, the NRC has determined the issuance of a COL under 10 CFR Part 52 is an action that requires an EIS.

According to 10 CFR 52.80(b) an application for a COL must contain an ER. The ER provides input that the staff evaluates in preparing the NRC's EIS. NRC regulations related to ERs and EISs are found in 10 CFR Part 51.

The UniStar application references a steam electric system of the AREVA NP Inc.'s (AREVA) U.S. EPR design. Subpart B of 10 CFR Part 52 contains NRC regulations related to standard design certification. AREVA submitted the documentation for design certification to the NRC in December 2007 (AREVA 2007). Revision 1 to the Final Safety Analysis Report for the design certification was submitted in May 2009, and Revision 1 to the ER for the design certification was submitted in September 2009 (AREVA 2009). An application for a standard design certification undergoes an extensive review, usually lasting several years, which may result in a rulemaking certifying the reactor design. Where appropriate, this EIS incorporates the information provided in AREVA's certification submittal that is referenced in the COL application.

1.1.1 Applications and Review

The purpose of UniStar's requested NRC action is to obtain a COL to construct and operate a baseload nuclear power plant. This license is necessary but not sufficient by itself for construction and operation of the unit. A COL applicant must obtain and maintain the necessary permits from other Federal, State, and local agencies and permitting authorities.

The purpose of UniStar's requested Corps action is to obtain a DA permit decision on the Individual Permit application to construct the project that proposes structures and work in, over, and under navigable waters and for the discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands.

1.1.1.1 NRC COL Application Review

UniStar submitted an ER (UniStar 2009) as part of its COL application that focuses on the environmental effects of construction and operation of one new U.S. EPR unit. The NRC regulations setting standards for review of a COL application are listed in 10 CFR 52.81. Detailed direction for the staff to use in conducting its environmental review is found in guidance set forth in NUREG-1555, *Environmental Standard Review Plan* (NRC 2000) and recent updates, hereafter referred to as the ESRP.

In this EIS, the NRC staff evaluates the environmental effects of one new pressurized water reactor (PWR) of the U.S. EPR design with a thermal power rating of 4590 MW(t) at the Calvert Cliffs site. In addition to considering the environmental effects of the proposed action, the NRC considers alternatives to the proposed action, including the no-action alternative and the construction and operation of a new reactor at one of three alternative sites. Also, the benefits of the proposed action (e.g., need for power) and measures and controls to limit adverse impacts are evaluated. The COL application includes several requests for exemptions from the U.S. EPR design certification under 10 CFR 52.93. The environmental impacts of the requested exemptions are considered in this EIS as part of the Federal action. The technical analysis for each DC exemption is included in the NRC's Final Safety Evaluation Report (SER), including a recommendation for approval or denial of each exemption.

Upon acceptance of the UniStar application, the NRC began the environmental review process described in 10 CFR Part 51 by publishing a Notice of Intent to prepare an EIS and conduct scoping in compliance with requirements set forth in 10 CFR Part 51 (73 FR 8719) in the *Federal Register* (FR) on February 14, 2008. On March 19, 2008, the NRC held two scoping meetings in Solomons, Maryland, to obtain public input on the scope of the environmental review and contacted Federal, State, Tribal, regional, and local agencies to solicit comments. A list of the organizations contacted is provided in Appendix B. The staff reviewed the comments received during the scoping process, and responses were developed for each comment. Comments within the scope of the NRC environmental review and their associated responses are included in Appendix D. A complete list of the scoping comments and responses is documented in the *Calvert Cliffs Combined License Scoping Summary Report* (NRC 2008).

To gather information and to become familiar with the proposed and alternative sites and their environs, the NRC and its contractor Pacific Northwest National Laboratory (PNNL) visited the Calvert Cliffs site in March 2008 and the alternative site, the former Thiokol brownfield site, in October 2008. The NRC, PNNL, and the Corps visited the alternative sites Eastalco and Bainbridge in August 2009. During the Calvert Cliffs site visit, the NRC staff met with UniStar staff, a Corps representative, public officials, and the public. Other documents related to the Calvert Cliffs site and alternative sites were reviewed and are listed as references where appropriate.

To guide its assessment of environmental impacts of a proposed action or alternative actions, the NRC has established a standard of significance for impacts based on the Council on Environmental Quality guidance (40 CFR 1508.27). Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, provides the following definitions of the three significance levels established by the NRC – SMALL, MODERATE, or LARGE:

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

This EIS presents the staff's analysis, which considers and weighs the environmental impacts of the proposed action at the Calvert Cliffs site, including the environmental impacts associated with construction and operation of the proposed new reactor at the site, the cumulative effects of the proposed action and other actions, the impacts of construction and operation of a reactor at alternative sites, the environmental impacts of alternatives to granting the COL, and the mitigation measures available for reducing or avoiding adverse environmental effects. This EIS also provides the NRC staff's preliminary recommendation to the Commission regarding the issuance of the COL for the proposed Unit 3.

A 75-day comment period will begin on the date of publication of the EPA Notice of Availability of the filing of the draft EIS to allow members of the public to comment on the results of the review. A public meeting will be held near the Calvert Cliffs site during the public comment period. This meeting will also serve as the Corps public hearing to acquire information or evidence that will be considered in evaluating a proposed DA Individual Permit. During this public meeting, the NRC staff will describe the results of the environmental review, provide members of the public with information to assist them in formulating comments on the EIS, respond to questions, and accept comments. The review team will respond to all the comments received during the draft EIS comment period. The comments and responses will be contained in Appendix E in the final EIS.

1.1.1.2 Corps Permit Application Review

The Corps is part of the review team that makes a determination on the three significance levels established by the NRC. The Corps' independent Record of Decision regarding the aforementioned permit application will reference the analyses in this EIS and present any additional information required by the Corps to support its permit decision. The Corps' role as a cooperating agency in the preparation of this EIS is intended to confirm that the information presented in the EIS is adequate to fulfill the requirements of Corps regulations and the Clean Water Act Section 404(b)(1) Guidelines to construct the preferred alternative identified in the EIS. The EIS is intended to present information adequate to fulfill the requirements of Corps regulations, the Clean Water Act Section 404(b)(1) Guidelines that contains the substantive environmental criteria used by the Corps in evaluating discharges of dredged or fill material into waters of the United States, and the Corps' public interest review process. The Corps' public interest review will be part of its permit decision document and thus, will not be addressed in this EIS.

The Section 404(b)(1) Guidelines stipulate at 40 CFR 230.10(a) that no discharge of dredged or fill material into waters of the United States (including jurisdictional wetlands) shall be permitted if there is a practicable alternative that would have less adverse impact on the aquatic environment, so long as the alternative does not have other significant adverse environmental consequences. Even if an applicant's preferred alternative is determined to be the least environmentally damaging practicable alternative (LEDPA), the Corps must still determine whether the LEDPA is in the public interest. The Corps Public Interest Review (PIR), described at 33 CFR 320.4, directs the Corps to consider a number of factors in a balancing process. A permit will be not be issued for an alternative that is not the LEDPA, nor will a permit be issued for an activity that is determined to be contrary to the public interest.

In this EIS, the Corps evaluates certain construction and maintenance activities proposed in waters of the United States, including wetlands that would be impacted by the proposed project. The Corps decision will reflect the national concern for both protection and utilization of important resources. The benefit, which reasonably may be expected to accrue from the proposal, must be balanced against its reasonably foreseeable detriments. Public interest factors that may be relevant to the proposal will be considered, such as: conservation; economics; aesthetics; general environmental concerns; wetlands; historic and cultural resources; fish and wildlife values; flood hazards; floodplain values; land use; navigation; shore erosion and accretion; recreation; water supply; water quality; energy needs; safety; food and fiber production; mineral needs; and considerations of property ownership, including cumulative impacts thereof and, in general, the needs and welfare of the people. Evaluation of the impact on the public interest will include application of the Guidelines promulgated by the Administrator, EPA, under authority of Section 404(b) of the Clean Water Act. The Corps will address all of these issues in its permit decision document.

As part of the Corps' permit evaluation process, the Corps released a public notice on September 3, 2008 to solicit comments from the public; Federal, State, and local agencies and officials; Indian tribes; and other interested parties in order to consider and evaluate the impacts of UniStar's proposed project (USACE 2008). A list of the organizations contacted by the Corps is included in Appendix B. The Corps will issue a second public notice upon release of the draft EIS, which will include notification for the public hearing.

The timing of the preparation of this EIS is such that the Corps may not have completed its evaluation of the proposed project when this EIS is final. To reach a decision on the permit action, the Corps will consider the recommendations of Federal, State, and local resource agencies; and members of the public; assess the cumulative impact of the total project; and complete the following consultations and coordination efforts: Section 106 of the National Historic Preservation Act, including, as appropriate, development and implementation of any Memorandum of Agreement (MOA); Endangered Species Act; Essential Fish Habitat coordination; State Forest Conservation Plans; State Water Quality Certifications; and State Coastal Zone Consistency determinations.

1.1.2 Preconstruction Activities

In a final rule dated October 9, 2007 (72 FR 57416), the Commission defined "construction" (10 CFR 50.10 and 51.4) as those activities that fall within its regulatory authority. Many of the activities required to construct a nuclear power plant are not part of the NRC action to license the plant. Activities associated with building the plant that are not within the purview of the NRC action are grouped under the term "preconstruction." Preconstruction activities include clearing and grading, excavating, erection of support buildings and transmission lines, and other associated activities. These preconstruction activities may take place before the application for a COL is submitted, during the staff's review of a COL application, or after a COL is granted. Although preconstruction activities are outside the NRC's regulatory authority, many of them are within the regulatory authority of local, State, or other Federal agencies.

Because the preconstruction activities are not part of the NRC action, their impacts are not reviewed as a direct effect of the NRC action. Rather, the impacts of the preconstruction activities are considered in the context of cumulative impacts. In addition, certain preconstruction activities that propose to construct structures or perform work in, over, and under navigable waters and for the discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands that require permits from the Corps, are viewed by the Corps as direct effects related to its Federal permitting action. Chapter 4 of this EIS describes the relative magnitude of impacts related to preconstruction and construction activities.

1.1.3 Cooperating Agencies

NEPA lays the groundwork for coordination between the lead agency preparing an EIS and other Federal agencies that may have special expertise regarding an environmental issue or jurisdiction by law. These other agencies are referred to as "cooperating agencies." Cooperating agencies have the responsibility to assist the lead agency through early participation in the NEPA process, including scoping, by providing technical input to the environmental analysis and by making staff support available as needed by the lead agency.

In addition to a license from the NRC, most proposed nuclear power plants require a permit from the Corps if work is proposed in navigable waters or the activity involves a discharge of dredged or fill material into waters of the United States. The NRC and the Corps decided the most effective and efficient use of Federal resources in the review of new nuclear power projects would be achieved by a cooperative agreement. On September 12, 2008, the NRC and the Corps signed a Memorandum of Understanding (MOU) regarding the review of new nuclear power plant license applications (USACE and NRC 2008), and the Baltimore District of the Corps is participating as a cooperating agency as defined in 10 CFR 51.14.

As described in the MOU, the NRC is the lead Federal agency and the Corps is a cooperating agency in the development of the EIS. Under Federal law, each agency has jurisdiction related to portions of the proposed project as major Federal actions that could significantly affect the quality of the human environment. The goal of this cooperative agreement is the development of one EIS that serves the needs of the NRC's license decision process and the Corps' permit decision process. While both agencies must comply with the requirements of NEPA, they also have independent or individual mission requirements that must be met. The NRC makes license decisions under the Atomic Energy Act, and the Corps makes permit decisions pursuant to the Rivers and Harbors Act and the Clean Water Act.

As a cooperating agency, the Corps is part of the NRC review team, involved in all aspects of the environmental review, including scoping, public meetings, public comment resolution, and EIS preparation. The NRC public meeting with the Corps serves the dual purpose of both agencies, with the Corps referring to the NRC-defined public meeting as its public hearing. The Corps' district engineer or designee may participate in joint public hearings in accordance with 33 CFR Part 327 with other Federal or State agencies, provided the procedures of those hearings meet the requirements of this regulation. In those cases in which the other Federal or State agency allows a cross-examination in its public hearing, the district engineer may still participate in the joint public hearing, but shall not require cross examination as a part of his participation.

The Corps refers to public meetings as hearings to acquire information or evidence that will be considered in evaluating a proposed DA permit, but there is no adjudicatory process involved such as the NRC hearings conducted by the Atomic Safety and Licensing Board.

A cooperating agency may adopt the EIS of a lead Federal agency without re-circulating it when the cooperating agency concludes, after an independent review of the EIS, that its comments and suggestions have been satisfied and issues a Record of Decision. The Corps' goal in this process is to have all the information necessary to make a permit decision when the final EIS is issued. However, it is possible the Corps may still need some information from the applicant to complete the permit documentation – information that the applicant could not make available by the time of final EIS issuance. Also, any conditions required by the Corps, such as compensatory mitigation, will be addressed in the Corps permit (if issued). Mitigation may only be employed after all appropriate and practical steps to avoid and minimize adverse impacts to aquatic resources, including wetlands and streams, have been taken. All remaining unavoidable impacts must be compensated to the extent appropriate and practicable. The Corps permit, if issued, would include special conditions under which UniStar must confirm that the created and enhanced wetlands meet the Federal wetland criteria outlined in the report, "Corps of Engineers Wetlands Delineation Manual," dated January 1987 (Environmental Laboratory 1987), in accordance with Compensatory Mitigation for Losses of Aquatic Resources; Final Rule, as published in April 10, 2008, *Federal Register*, Vol. 73, No. 70, Pages 19594-19705 (33 CFR Parts 325 and 332). If the Corps does not find the wetland and stream mitigation satisfactory, the Corps would determine if any project modifications would be needed to enable a permit decision to be made. Also, UniStar would assume all liability for accomplishing the permitted work including any required mitigation.

1.1.4 Concurrent NRC Reviews

In reviews separate from but parallel to the EIS process, the NRC analyzes the safety characteristics of the proposed site and emergency planning information. These analyses are documented in a Safety Evaluation Report (SER) issued by the NRC. The SER presents the conclusions reached by the NRC regarding (1) whether there is reasonable assurance that one new U.S. EPR unit can be constructed and operated at the Calvert Cliffs site without undue risk to the health and safety of the public; (2) whether the emergency preparedness program meets the applicable requirements in 10 CFR Part 50, 10 CFR Part 52, 10 CFR Part 73, and 10 CFR Part 100; and (3) whether site characteristics are such that adequate security plans and measures as referenced in the above Code of Federal Regulations can be developed. The Final SER for the UniStar COL application is currently anticipated to be published in July 2012.

The reactor design referenced in the application is the U.S. EPR, which is undergoing design certification review separately from the EIS process. If the final design of the U.S. EPR is different from the design considered in this EIS, the NRC staff will determine whether the changes are significant enough to warrant an additional environmental review. The final rulemaking for the U.S. EPR is currently anticipated to be published in June 2012.

1.2 The Proposed Federal Actions

The proposed NRC Federal action is issuance, under the provisions of 10 CFR Part 52, of a COL authorizing the construction and operation at the Calvert Cliffs site of one new U.S. EPR unit. The proposed Corps Federal action is a permit decision on a DA Individual Permit application pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and

Harbors Act. This EIS provides the NRC and Corps analyses of the environmental impacts that could result from building and operating one proposed new unit at the Calvert Cliffs site or at one of the three alternative sites. These impacts are analyzed by the NRC to determine if the proposed site is suitable for the addition of one new unit and whether any of the alternative sites are considered obviously superior to the proposed site.

The site proposed by UniStar is located in Calvert County, Maryland, approximately 40 mi southeast of Washington D.C. and 7.5 mi north of Solomons, Maryland. The proposed Unit 3 would be completely within the confines of the current Calvert Cliffs site and would be located south of the existing CCNPP Units 1 and 2.

1.3 The Purpose and Need for the Proposed Actions

The purpose and need for the proposed NRC and Corps actions is described as follows.

1.3.1 NRC's Proposed Action

The purpose and need for the proposed NRC action is to provide for additional large baseload electrical generating capacity within the State of Maryland. Studies conducted by the State of Maryland have concluded that rolling blackouts could occur as soon as 2011 and that additional capacity is needed in Maryland to provide satisfactory generating reserve (MEA 2008). Chapter 8 of this EIS evaluates the need for power. Chapter 9 of this EIS discusses the alternatives to the proposed action, including the no-action alternative.

A COL license from the NRC is necessary for constructing and operating the proposed power plant. Preconstruction and certain long lead-time activities, such as ordering and procuring certain components and materials necessary to construct the plant, may begin before the COL is granted. UniStar must obtain and maintain permits or authorizations from other Federal, State, and local agencies and permitting authorities prior to undertaking certain activities. The ultimate decision whether or not to build a facility and the schedule for building are not within the purview of the NRC or the Corps and would be determined by the license holder if the authorization is granted.

1.3.2 The Corps' Permit Action

The UniStar permit application to the Corps is for work to prepare the site and construct facilities for a nuclear power generation station at the existing Calvert Cliffs site. As part of the evaluation of permit applications subject to Section 404 of the Clean Water Act, the Corps must define the overall project purpose in addition to the basic project purpose. The overall project purpose establishes the scope of the alternatives analysis and is used for evaluating practicable alternatives under the Guidelines. In accordance with the Guidelines and USACE Headquarters guidance (HQUSACE 1989), the overall project purpose must be specific enough to define the applicant's needs, but not so narrow and restrictive as to preclude a proper evaluation of alternatives. The Corps is responsible for controlling every aspect of the Guidelines analysis. In this regard, defining the Corps' overall project purpose for the Corps' permit action is the sole responsibility of the Corps. While generally focusing on the applicant's statement, the Corps will, in all cases, exercise independent judgment in defining the purpose and need for the Corps' project from both the applicant's alternatives and the public's perspective (33 CFR Part 325 Appendix B (9)(c)(4), see also 53 FR 3136 ([February 3, 1988]).

Where the activity associated with a discharge is proposed for a special aquatic site (as defined in 40 CFR Part 230, Subpart E) and does not require access or proximity to or siting within these types of areas to fulfill its basic project purpose (i.e., the project is not "water dependent"), practicable alternatives that avoid special aquatic sites are presumed to be available, unless clearly demonstrated otherwise (40 CFR 230.10(a)(3)). The basic project purpose for the UniStar project is to generate electricity for additional baseload capacity.

Section 230.10(a) of the Guidelines requires that "no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences." Section 230.10(a)(2) of the Guidelines states that "an alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes. If it is otherwise a practicable alternative, an area not presently owned by the applicant which could reasonably be obtained, utilized, expanded, or managed in order to fulfill the basic purpose of the proposed activity may be considered." Thus, this analysis is necessary to determine which alternative is the LEDPA that meets the project purpose and need. The overall purpose of the project is to construct a nuclear power plant facility to provide for additional baseload electrical generating capacity to meet the growing demand in the State of Maryland. The Corps concurs with the stated project purpose and long-term need to generate electricity to meet the growing demand in Maryland.

1.4 Alternatives to the Proposed Actions

Section 102(2)(C)(iii) of NEPA requires an EIS to include a detailed statement analyzing alternatives to the proposed action. The NRC regulations for implementing Section 102(2) of NEPA provide for including in an EIS a chapter that discusses the environmental impacts of the proposed action and the alternatives (10 CFR Part 51, Subpart A, Appendix A). This EIS addresses five categories of alternatives to the proposed action: (1) the no-action alternative, (2) energy source alternatives, (3) alternative sites, and (4) system design alternatives. The fifth category, which is discussed in Appendix J, is onsite alternatives to reduce impacts to the natural and cultural resources that will be considered in the Corps permit decision.

In the no-action alternative, the action would not go forward. The NRC would deny UniStar's request for a COL. The no-action or permit denial alternatives also are available to the Corps. The "no-action" alternative is one which results in no construction requiring a Corps permit. It may result from (1) the applicant electing to modify its proposal to eliminate work under the jurisdiction of the Corps or (2) the denial of the permit. If the COL and/or permit were denied, the construction and operation of a new nuclear generating unit at the Calvert Cliffs site would not occur, nor would any benefits intended by the approved COL be realized. Energy source alternatives include alternative energy sources, focusing on those alternatives that could meet the purpose and need of the project to generate baseload power. The alternative sites to the proposed Unit 3 at the Calvert Cliffs site are addressed in the following paragraph. System design alternatives include heat dissipation and circulating water systems, intake and discharge structures, and water-use and treatment systems. Finally, onsite alternatives evaluated by the Corps to reduce potential impacts to waters of the United States, including jurisdictional wetlands, as well as potential impacts to cultural and natural resources, are described in Appendix J.

In the ER, UniStar defined a region of interest as the State of Maryland for use in identifying and evaluating potential sites for power generation. The NRC staff evaluated the region of interest, the process by which UniStar selected alternative sites, and the review team evaluated the environmental impacts of construction and operation of a new power reactor at those sites using reconnaissance-level information. Using the process outlined in the ER, UniStar reviewed multiple sites and identified the suite of candidate sites for this project. The alternative sites selected from the candidate sites include three privately owned brownfield sites. The brownfield sites are located near Frederick, Mechanicsville, and Port Deposit, Maryland. The objective of the comparison of environmental impacts is to determine if any of the alternative sites is obviously superior to the Calvert Cliffs site.

As part of the evaluation of permit applications subject to Section 404 of the Clean Water Act, the Corps is required by regulation to apply the criteria set forth in the 404(b)(1) Guidelines (33 U.S.C. 1344; 40 CFR Part 230). These Guidelines establish criteria that must be met in order for the proposed activities to be permitted pursuant to Section 404. Specifically, these Guidelines state, in part, that no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge that would have less adverse impact on the aquatic ecosystem provided the alternative does not have other significant adverse consequences (40 CFR 230.10(a)). If it is otherwise a practicable alternative, an area not presently owned by the applicant that could reasonably be obtained, used, expanded, or managed in order to fulfill the basic purpose of the proposed activity may be considered.

1.5 Compliance and Consultations

Prior to construction and operation of a new unit, UniStar is required to obtain certain Federal, State, and local environmental permits, as well as to meet applicable statutory and regulatory requirements. UniStar (2009) provided a list of environmental approvals and consultations associated with the proposed Unit 3. Potential authorizations, permits, and certifications relevant to the proposed COL are included in Appendix H. The NRC staff reviewed the list and contacted the appropriate Federal, State, Tribal, and local agencies to identify any consultation, compliance, permit, or significant environmental issues of concern to the reviewing agencies that may affect the acceptability of the Calvert Cliffs site for the construction and operation of the proposed Unit 3 reactor. A chronology of the correspondence is provided as Appendix C. A list of the key consultation correspondence is provided as Appendix F, which also contains the biological assessment to the National Marine Fisheries Service (NMFS) and the essential fish habitat assessment.

1.6 Report Contents

The subsequent chapters of this EIS are organized as follows. Chapter 2 describes the proposed site and discusses the environment that would be affected by the addition of the new unit. Chapter 3 describes the power plant layout, structures, and activities related to building and operation to be used as the basis for evaluating the environmental impacts. Chapters 4 and 5 examine site acceptability by analyzing the environmental impacts of construction and operation of the proposed Unit 3. Chapter 6 analyzes the environmental impacts of the uranium fuel cycle, transportation of radioactive materials, and decommissioning, while Chapter 7 discusses the cumulative impacts of the proposed action as defined in 40 CFR Part 1508. Chapter 8 addresses the need for power. Chapter 9 discusses alternatives to the proposed action including energy sources, alternative sites, and system design alternatives, and compares the proposed action with the alternatives. Chapter 10 summarizes findings of the preceding chapters and provides a benefit-cost evaluation. It also presents the NRC staff's preliminary recommendation with respect to the Commission's approval of the proposed site for a COL based on the staff's evaluation of environmental impacts.

The appendices to this EIS provide the following additional information:

- Appendix A – Contributors to the Environmental Impact Statement
- Appendix B – Organizations Contacted
- Appendix C – Chronology of NRC and Corps Environmental Review Correspondence
- Appendix D – Scoping Comments and Responses
- Appendix E – Draft Environmental Impact Statement Comments and Responses (Reserved)

- Appendix F – Key Consultation Correspondence (Includes Biological Assessment and Essential Fish Habitat Assessment)
- Appendix G – Supporting Documentation on Radiological Dose Assessment
- Appendix H – Authorizations, Permits, and Certifications
- Appendix I – Severe Accident Mitigation Alternatives
- Appendix J – UniStar's Least Environmentally Damaging Practicable Alternative (LEDPA) and Onsite Alternative Analysis
- Appendix K – UniStar's Phase I Mitigation Plan for Wetland and Stream Impacts
- Appendix L – Carbon Dioxide Footprint Estimates for a Reference 1000 MWe Reactor
- Appendix M – Supplemental Terrestrial Ecology Information

1.7 References

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

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

10 CFR Part 52. Code of Federal Regulations, Title 10, *Energy,* Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

10 CFR Part 73. Code of Federal Regulations, Title 10, *Energy*, Part 73, "Physical Protection of Plants and Materials."

10 CFR Part 100. Code of Federal Regulations, Title 10, *Energy*, Part 100, "Reactor Site Criteria."

33 CFR Part 320. Code of Federal Regulations, Title 33, *Navigation and Navigable Waters*, Part 320, "General Regulatory Policies."

33 CFR Part 325. Code of Federal Regulations, Title 33, *Navigation and Navigable Waters*, Part 320, "Processing of Department of the Army Permits."

33 CFR Part 327. Code of Federal Regulations, Title 33, *Navigation and Navigable Waters*, Part 327, "Public Hearings."

33 CFR Part 332. Code of Federal Regulations, Title 33, *Navigation and Navigable Waters*, Part 320, "Compensatory Mitigation for Losses of Aquatic Resources."

40 CFR Part 230. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 230, "Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Materials."

40 CFR Part 1508. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 1508, "Terminology and Index."

53 FR 3136. February 3, 1988. "Environmental Quality; Procedures for Implementing the National Environmental Policy Act (NEPA)." *Federal Register.* U.S. Army Corps of Engineers.

72 FR 57416. October 9, 2007. "Limited Work Authorizations for Nuclear Power Plants." *Federal Register*. U.S. Nuclear Regulatory Commission.

73 FR 5877. January 31, 2008. "UniStar Nuclear, LLC; Acceptance for Docketing of a Partial Application for a Combined License for Calvert Cliffs Nuclear Power Plant Unit 3." *Federal Register*. U.S. Nuclear Regulatory Commission.

73 FR 8719. February 14, 2008. "UniStar Nuclear, LLC; Calvert Cliffs Partial Combined License Application; Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process." *Federal Register*. U.S. Nuclear Regulatory Commission.

73 FR 32606. June 9, 2008. "Constellation Generation Group, LLC and UniStar Nuclear Operating Services, LLC; Acceptance for Docketing of an Application for a Combine License for Calvert Cliffs Nuclear Power Plant Unit 3." *Federal Register*. U.S. Nuclear Regulatory Commission.

AREVA NP, Inc. (AREVA). 2007. *AREVA NP Environmental Report, Standard Design Certification*. ANP-10290. Rev. 0. Accession No. ML073530589.

AREVA NP, Inc. (AREVA). 2009. *AREVA NP Environmental Report, Standard Design Certification*. ANP-10290. Rev. 1. Accession No. ML092650775.

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

Clean Water Act. 33 U.S.C. 1251, et seq. (also referred to as the Federal Water Pollution Control Act [FWPCA]).

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

Environmental Laboratory. 1987. *Corp of Engineers Wetlands Delineation Manual.* U.S. Department of the Army, Vicksburg, Mississippi.

Maryland Energy Administration (MEA). 2008. *Maryland Strategic Electricity Plan*. Annapolis, Maryland.

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

National Historic Preservation Act of 1966 (NHPA). 16 U.S.C. 470, et seq.

Rivers and Harbors Appropriation Act of 1899 (Rivers and Harbors Act). 33 U.S.C. 403 as amended.

UniStar Nuclear Development, LLC (UniStar). 2007. Letter from R.M. Krich (UniStar) to U.S. Nuclear Regulatory Commission, "UniStar Nuclear, NRC Project No. 746, Submittal of a Partial Combined License Application for the Calvert Cliffs Nuclear Power Plant, Unit 3, Application for Withholding of Documents, and Request for Exemption." July 13, 2007. Accession No. ML071980292.

UniStar Nuclear Development, LLC (UniStar). 2008a. Letter from G. Vanderheyden (UniStar) to U.S. Nuclear Regulatory Commission, "UniStar Nuclear, NRC Docket No. 52-016 Submittal of Revision 2 to the Partial Combined License Application for the Calvert Cliffs Nuclear Power Plant, Unit 3 and Application for Withholding of Documents." March 14, 2008. Accession No. ML080990114.

UniStar Nuclear Development, LLC (UniStar). 2008b. Letter from G.J. Wrobel (UniStar) to, U.S. Nuclear Regulatory Commission "UniStar Nuclear Energy, NRC Docket No. 52-016 Submittal of Corrected Revision 3 to the Combined License Application for the Calvert Cliffs Nuclear Power Plant, Unit 3." August 20, 2008. Accession No. ML082390786.

UniStar Nuclear Development, LLC (UniStar). 2008c. Letter from D. Lutchenkov (UniStar) to Maryland Department of the Environment, "Joint Federal/State Application to the United States Army Corps of Engineers and the Maryland Department of the Environment for the Alteration of any Floodplain, Waterway, Tidal or Nontidal Wetland in Maryland Calvert Cliffs Nuclear Power Plant - Unit 3 Calvert County, Maryland, USAEC Application Number NAB-2007-08123-M05." May 16, 2008. Accession No. ML081840343.

UniStar Nuclear Development, LLC (UniStar). 2009. *Calvert Cliffs Nuclear Power Plant Unit 3 Combined License Application, Part 3, Environmental Report*. Revision 6, Baltimore, Maryland, September 30, 2009. Accession No. ML092880921.

U.S. Army Corps of Engineers, Headquarters (HQUSACE). 1989. Memorandum from P.J. Kelly (USACE), to Commander, New Orleans (USACE), "Re: Permit Elevation, Plantation Landing Resort, Inc." April 21, 1989. Available at http://www.epa.gov/owow/wetlands/pdf/PlantationLandingRGL.pdf.

U.S. Army Corps of Engineers (USACE or Corps). 2008. *Public Notice in Reply to Application Number CENAB-OP-RMS NAB-2007-01823-M05 (Calvert Cliff's 3 Nuclear Project, LLC/Unistar Nuclear Operating Services, LLC).* September 3, 2008. Accession No. ML082550288.

U.S. Army Corps of Engineers and U.S. Nuclear Regulatory Commission (USACE and NRC). 2008. *Memorandum of Understanding: Environmental Reviews Related to the Issuance of Authorizations to Construct and Operate Nuclear Power Plants*. September 12, 2008. Accession No. ML082540354.

U.S. Nuclear Regulatory Commission (NRC). 2000. *Environmental Standard Review Plan—Standard Review Plans for Environmental Reviews for Nuclear Power Plants.* NUREG-1555, Washington, D.C. Includes 2007 updates.

U.S. Nuclear Regulatory Commission (NRC). 2008. *Calvert Cliffs Combined License Scoping Summary Report.* Washington, D.C. Accession No. ML091690293.

2.0 Affected Environment

The site proposed by Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC (collectively referred to as UniStar) for a combined license (COL) and a U.S. Army Corps of Engineers (referred to as USACE or Corps) action on a U.S. Department of the Army (DA) Individual Permit is located in Calvert County, Maryland. Constellation Energy Nuclear Group currently operates two nuclear units, Calvert Cliffs Nuclear Power Plant (CCNPP) Units 1 and 2, on the site. The site is located approximately 60 mi south of Baltimore, 40 mi southeast of Washington, D.C., 10.5 mi southeast of Prince Frederick, and 7.5 mi north of Solomons, Maryland. The proposed Unit 3 location is described in Section 2.1, followed by descriptions of the land, water, ecology, socioeconomics, environmental justice, historic and cultural resources, geology, meteorology and air quality, nonradiological, and radiological environment of the site and vicinity presented in Sections 2.2 through 2.11, respectively. Section 2.12 discusses related Federal projects and consultations, and references are presented in Section 2.13.

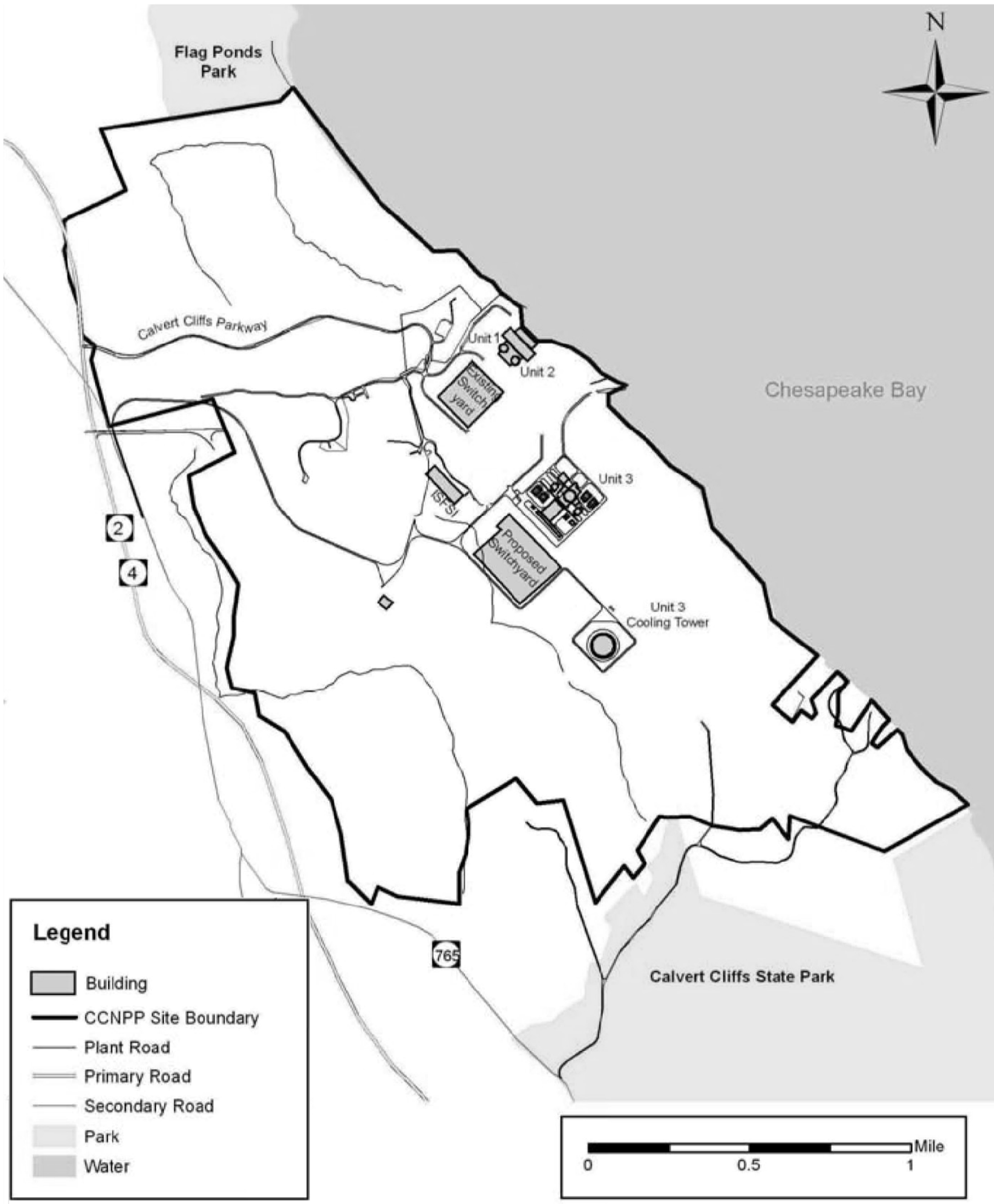
2.1 Site Location

UniStar's selected location for the proposed Unit 3 is wholly within the Calvert Cliffs site and is adjacent to and just south-southeast of the existing units, as shown in Figure 2-1. It is located on the Calvert Peninsula and is bordered on the east by the Chesapeake Bay. Maryland (MD) State Route 2/4 lies to the west of the site, as does the Patuxent River. Flag Ponds Nature Park borders the site to the immediate north, and Calvert Cliffs State Park and MD State Route 765 lie to the south. The Calvert Cliffs site also abuts the Captain John Smith Chesapeake National Historic Trail and the Star-Spangled Banner National Historic Trail. Figure 2-2 shows the 50-mi region in which the site is located.

The Calvert Cliffs site is located in a rural part of southern Maryland within Calvert County. It consists of rolling hills, part of it forested primarily with deciduous trees, with an understory of grasses, herbs, and shrubs. The topography of the site includes relatively flat lands in developed areas and steeply sloped forested valleys. The site also has emergent and forested wetlands, streams, ponds, and tidal waters. The site borders Chesapeake Bay. The Bay frontage consists of approximately 70-ft-high cliffs, stone revetment (embankment support), natural shoreline, and sandy beach.

2.2 Land Use

This section discusses land-related issues for the Calvert Cliffs site. Section 2.2.1 describes the site and the vicinity around the site. Section 2.2.2 discusses the existing transmission line corridors. Section 2.2.3 discusses the region, defined as the area within 50 mi of the site boundary.



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2 **Figure 2-1**. Calvert Cliffs Site and Proposed New Plant Layout (adapted from UniStar 2009a)

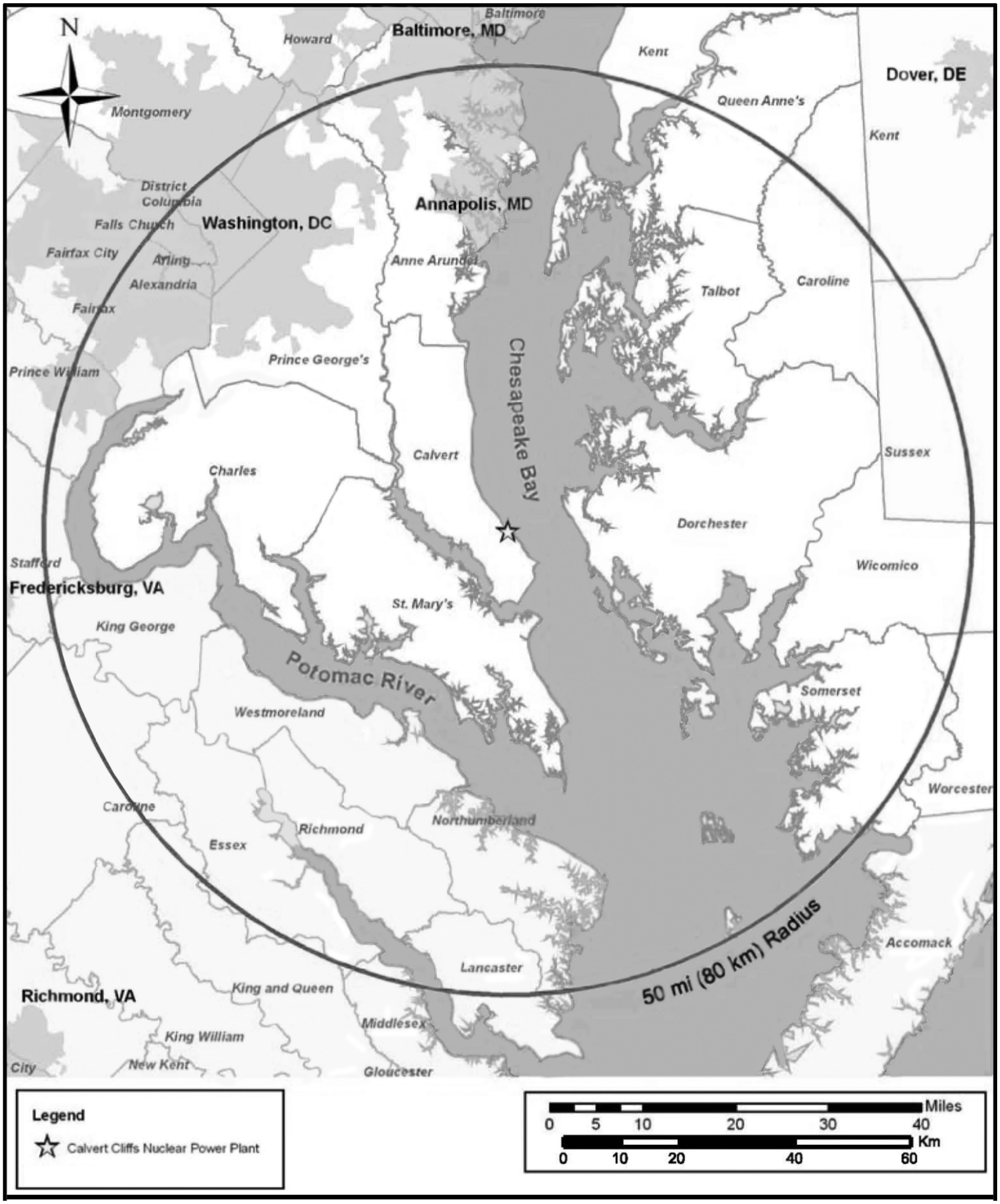

Figure 2-2. The Calvert Cliffs Site and the 50-mi Region (adapted from UniStar 2009a)

2.2.1 The Site and Vicinity

The Calvert Cliffs site comprises approximately 2070 ac adjacent to Chesapeake Bay in an unincorporated area of Calvert County, Maryland. The site is approximately 40 mi southeast of Washington, D.C., and 7.5 mi north of Solomons, Maryland (UniStar 2009a). The site, including the planned footprint for the proposed Unit 3 facilities, is shown in Figure 2-3. Landscape features are shown in Figure 2-4. Within the project site, portions of the project are proposed in the Chesapeake Bay; the Lower Western Shore watershed and its unnamed tributaries to the Chesapeake Bay; in forested nontidal wetlands; and in the St. Leonard Creek watershed, which includes Johns Creek, Goldstein Branch, and some unnamed tributaries. The CCNPP site is planned to be divided since CCNPP Units 1 and 2 will have different owners than Unit 3. The owner of CCNPP Units 1 and 2 would own the north parcel. Calvert Cliffs 3 Nuclear Project, LLC would own the south parcel (UniStar 2009a).

The Calvert Cliffs site contains two existing nuclear generating units, CCNPP Units 1 and 2, which are licensed by the U.S. Nuclear Regulatory Commission (NRC) and have a combined net electric generating capacity of approximately 1700 to 1780 MW(e), depending on plant and Bay conditions. Unit 1 began commercial operation in 1974, and Unit 2 began commercial operation in 1976. Together, the two existing nuclear units; auxiliary facilities, including a barge slip; and onsite transmission line corridors occupy approximately 331 ac of the Calvert Cliffs site. Approximately 1619 ac of the site is forest area, and approximately 106 ac is open land that was previously devoted to agriculture (UniStar 2009a).

Features within an 8-mi radius of the Calvert Cliffs site are shown in Figure 2-5. Access to the site is from MD State Route 2/4. There is no operating rail line within 8 mi of the site, and no natural gas pipelines traverse the site. However, the Dominion Cove Point liquefied natural gas (LNG) pipeline is located south of the Calvert Cliffs site and continues in a northern direction west of MD State Route 2/4. The Dominion Cove Point LNG import facility (a little over 100 ac of industrial land use) is about 3.5 mi southeast of the Calvert Cliffs site within Calvert County (Dominion 2009). Just beyond the 8-mi radius is the Patuxent River Naval Air Station (approximately 6500 ac) to the south of the Calvert Cliffs site in St. Mary's County (DOD 2010).

As described in the Corps' public notice (USACE 2008), the proposed Calvert Cliffs project would permanently affect 343,253 ft^2 (7.88 ac) of forested nontidal wetlands; 52,707 ft^2 (1.21 ac) of emergent nontidal wetlands; 114,563 ft^2 (2.63 ac) of nontidal open water; 33,400 ft^2 (0.77 ac) along 8350 linear ft of streambed portions; and 248,000 ft^2 (5.7 ac) of tidal open waters (approximately 138,500 ft^2 (3.2 ac) of the tidal open water impacts would be from maintenance dredging; approximately 109,000 ft^2 (2.5 ac) would be from new dredging; and approximately 52,500 ft^2 (1.2 ac) of the new dredging would be backfilled). This work includes a total of 3485 ft^2 (0.08 ac) of isolated forested wetland impact.

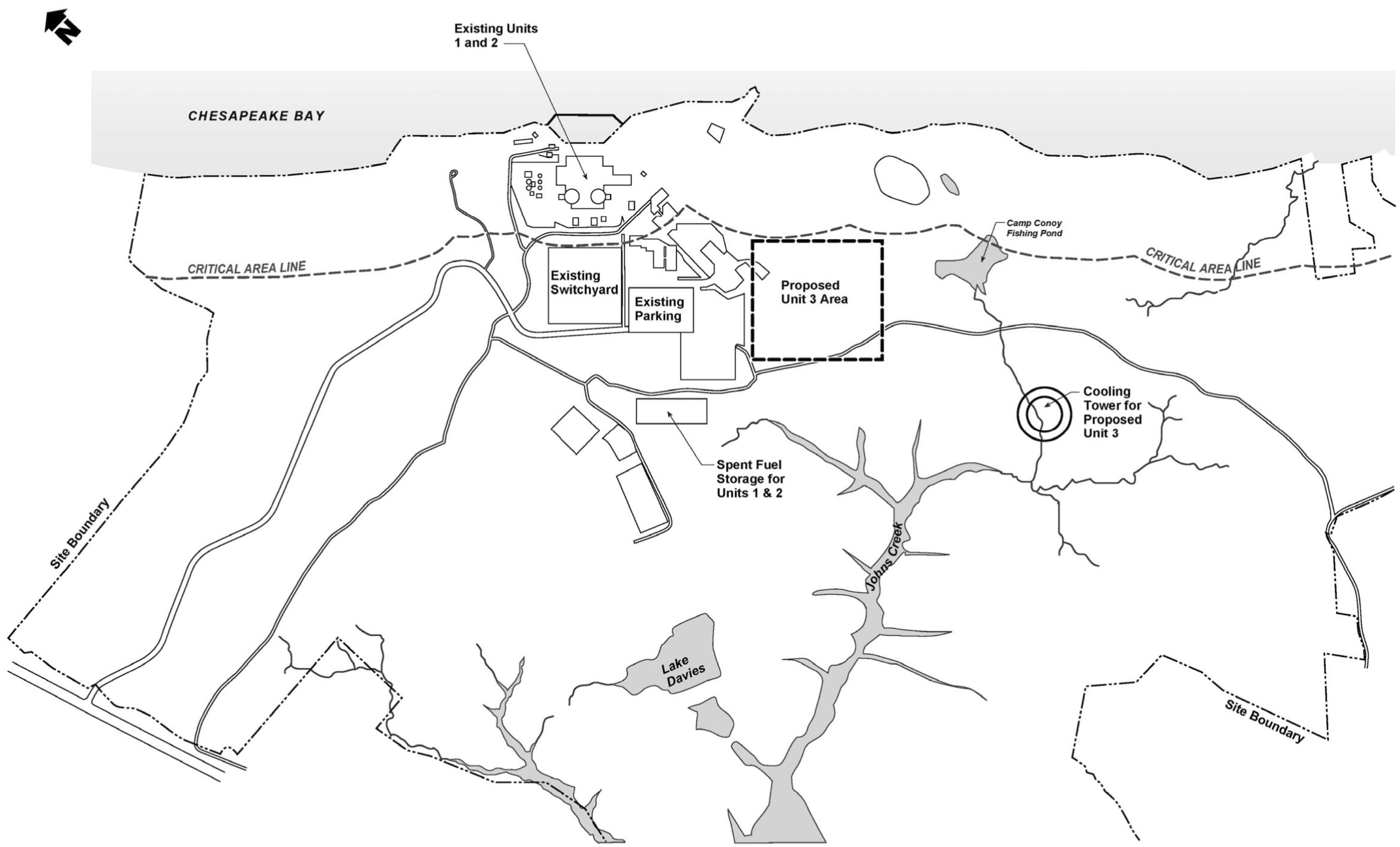

Figure 2-3. Calvert Cliffs Site Map (adapted from UniStar 2009a)

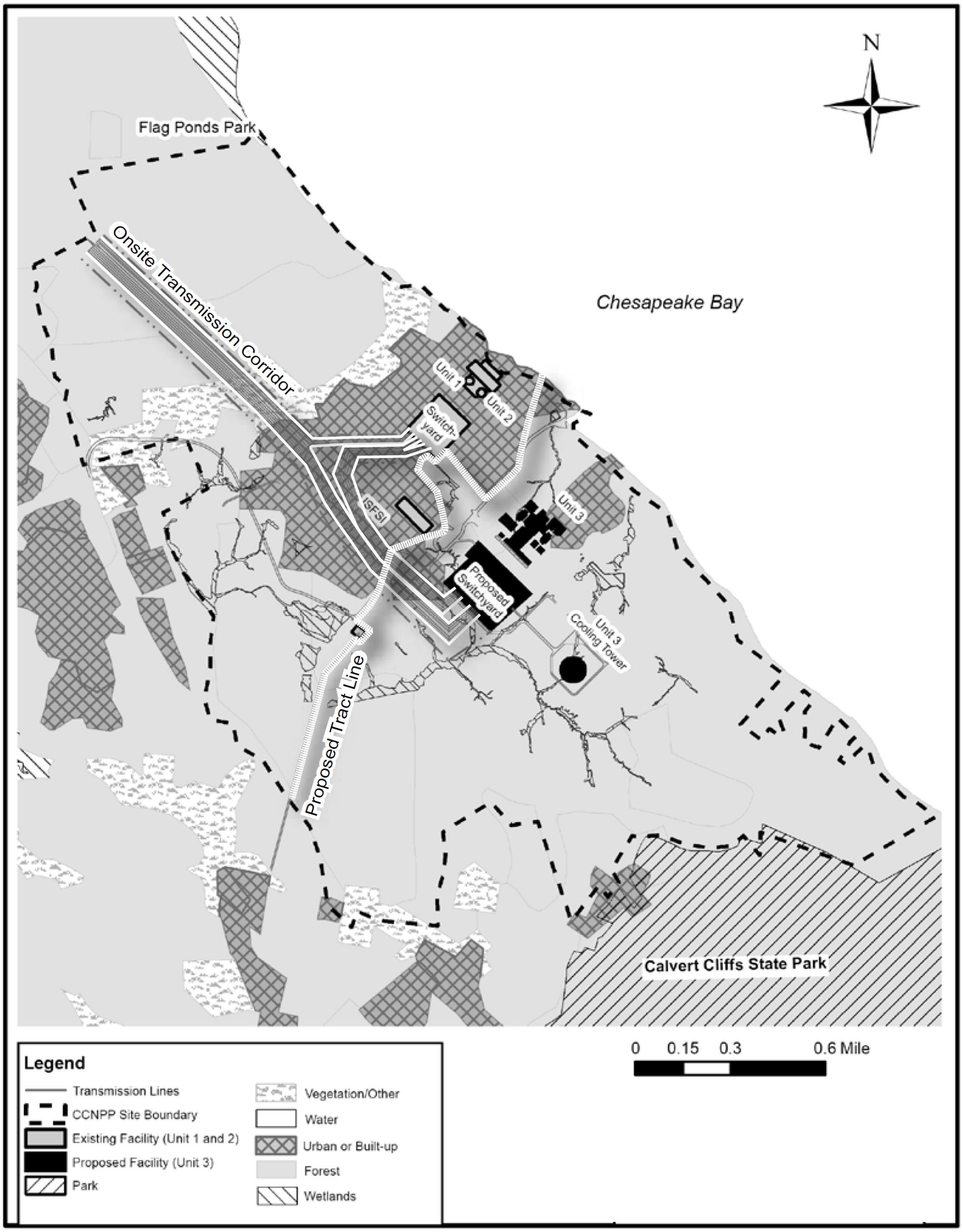

Figure 2-4. Land Use on the Calvert Cliffs Site (adapted from UniStar 2009c)

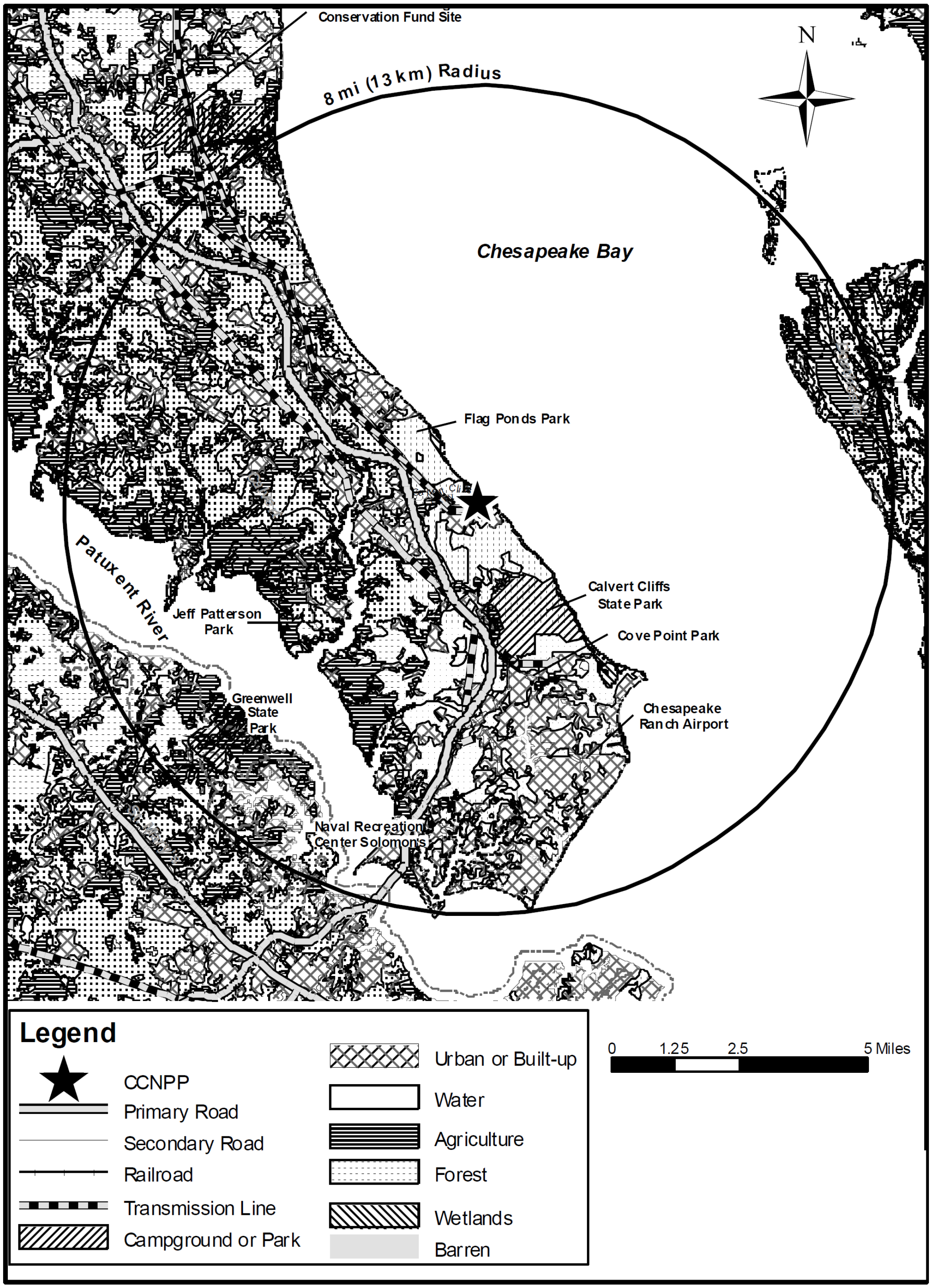

Figure 2-5. Land-Use Classification Within 8 mi of the Calvert Cliffs Site (UniStar 2009a)

The Calvert Cliffs site is subject to zoning by Calvert County. Some portions of the site are zoned light industrial and other portions are zoned farm and forest (UniStar 2009a). However, section 1-2.02 of the Calvert County Zoning Ordinance states that the Ordinance does not apply to a qualified commercial power generating facility (Calvert County 2006). Article 12 of the Zoning Ordinance defines such a facility as a commercial power generating facility as to which a Certificate of Public Convenience and Necessity (CPCN) has been issued under Public Utility Companies Article, section(s) 7-205, 7-207, and/or 7-208, Annotated Code of Maryland. Because a CPCN was issued by the Maryland Public Service Commission (MPSC) for proposed Unit 3 in June 2009 (MPSC 2009), the existing Calvert County zoning designations do not apply to the land that would be occupied by proposed Unit 3.

The Chesapeake Bay Critical Area (CBCA) Protection Act (Critical Area Act) was enacted in 1984 by the Maryland General Assembly to help reverse the deterioration of the Chesapeake Bay and the surrounding environment (CAC 2008a). The Critical Area Act recognizes that the land immediately surrounding the Bay has the greatest potential to affect its water quality and wildlife habitats. The critical area is designated as all land within 1000 ft of the mean high water line of tidal waters or the landward edge of tidal wetlands and all waters of and lands under the Chesapeake Bay and its tributaries (CAC 2008a). The critical area buffer is the land within 100 ft of the mean high water line of tidal waters or the edge of tidal wetlands and tributary streams (CAC 2008a). The Critical Area Act is designed to promote environmentally sensitive stewardship of land in the critical area. It addresses three principal concerns: the accommodation of future growth and development, sensitive use of natural resources, and the preservation of certain resources for future generations. The critical area is classified into Resource Conservation Areas (RCAs), Limited Development Areas (LDAs), and Intensely Developed Areas (IDAs) based on land uses current on December 1, 1985, or June 1, 2002, for the Atlantic Coastal Bays. The regulations associated with each classification are applied in addition to those for the local jurisdiction’s zoning districts. In the case of a conflict, the more restrictive provision usually applies (CAC 2008a). The critical area boundary at the Calvert Cliffs site is shown in Figure 2-4. On August 6, 2008, the Maryland Critical Area Commission approved, with conditions, UniStar’s proposal to the MPSC to construct proposed Unit 3 at the Calvert Cliffs site (CAC 2008b). This decision was affirmed in a subsequent October 22, 2008, letter to the Maryland Power Plant Research Program (CAC 2008c).

The surface landowners own the mineral resources beneath the Calvert Cliffs site (UniStar 2009a). No significant mineral resources within or adjacent to the Calvert Cliffs site have been identified.

Also in the area, the Dominion Cove Point LNG import facility (a little over 100 ac of industrial land use) is about 3.5 mi southeast of the Calvert Cliffs site within Calvert County (Dominion 2009). Additionally, the Patuxent River Naval Air Station (approximately 6500 ac) is about 9 mi south of the Calvert Cliffs site in St. Mary’s County (DOD 2010).

Section 307(c)(3)(A) of the Coastal Zone Management Act (16 U.S.C. 1456 et seq.) requires applicants for Federal permits to conduct an activity in a coastal zone area to provide to the permitting agency a certification that the proposed activity complies with the enforceable policies of the State's coastal zone program. A copy of the certification is also to be provided to the State. The State is to notify the Federal agency whether the State concurs with or objects to the applicant's certification. Calvert County is within Maryland's coastal zone. UniStar's Joint Federal/State Application for the Alteration of Any Floodplain, Waterway, Tidal, or Nontidal Wetland in Maryland was submitted on May 16, 2008, to the State of Maryland and to the Corps. The application provides UniStar's certification that proposed Unit 3 is consistent with the Maryland Coastal Zone Management Plan (UniStar 2008a).

Wetlands near the proposed Unit 3 construction area consist of small headwater streams with narrow floodplains and associated riparian forest in the St. Leonard Creek watershed, minor Chesapeake Bay watershed areas, minor tributary streams, and associated small impoundments (UniStar 2009a).

The topography at the Calvert Cliffs site is gently rolling with steeper slopes along stream banks. Local relief ranges from the sea level up to about 130 ft, with an average relief of approximately 100 ft. The Chesapeake Bay shoreline adjacent to the site consists mostly of steep cliffs with a narrow beach area (UniStar 2009a).

Recreational areas in the immediate area of the Calvert Cliffs site are: Flag Ponds Nature Park, which is operated by Calvert County and located immediately north of the site; Calvert Cliffs State Park, which is located immediately south of the site; the Captain John Smith Chesapeake National Historic Trail, which is operated by the National Park Service and located adjacent to the Calvert Cliffs site in the Chesapeake Bay; and the Star-Spangled Banner National Historic Trail, which is still being defined by the National Park Service, but will likely flank the western and eastern portions of the Calvert Cliffs site (Figure 2-4).

In addition to the historical trails, cultural resources have been identified within the area and are likely to be destroyed by building of proposed Unit 3. These include archaeological sites and architectural resources. Details are provided in Sections 2.7 and 4.6.

2.2.2 Transmission Line Corridors

The existing transmission system for CCNPP Units 1 and 2 consists of two circuits, the north circuit that connects the plant to the Waugh Chapel Substation in Anne Arundel County, Maryland, and the south circuit that connects the plant to the Potomac Electric Power Company Chalk Point Generating Station in Prince Georges County, Maryland. The north circuit is composed of two separate three-phase, 500-kV transmission lines that run through a single corridor from the plant, while the south circuit is a single, three-phase 500-kV line (UniStar 2009a).

2.2.3 The Region

The 50-mi region surrounding the Calvert Cliffs site is shown in Figure 2-6. Within the region, approximately 31 percent of the land is forest, 31 percent is water, 20 percent is devoted to agriculture, 13 percent is developed, and 5 percent is wetlands (UniStar 2009a). There are no lands of Tribal entities recognized and eligible for funding and services from the U.S. Bureau of Indian Affairs within the 50-mi region.

2.3 Water

This section describes the hydrologic processes and water bodies in and around the Calvert Cliffs site, the existing water use, and the quality of water in the proposed Unit 3 environment. Building activities would make use of groundwater. During Unit 3 operations, the Chesapeake Bay would be the only source of water and the only recipient of discharge water.

2.3.1 Hydrology

This section describes the site-specific and regional hydrological features that could impact, or be altered by, development and operation of Unit 3. The hydrologic conditions at the Unit 3 site are described in Section 2.4 of the Final Safety Analysis Report (FSAR) (UniStar 2009b). A summary of the hydrologic conditions of the Unit 3 site is provided in Section 2.3 of the Environmental Report (ER) (UniStar 2009a). Both the FSAR and the ER were informed by the hydrological characterization conducted for the existing CCNPP Units 1 and 2 and the results of investigations performed to support the COL application. The following descriptions are based on information from these sources.

2.3.1.1 Surface-Water Hydrology

Figure 2-7 shows the location of the Calvert Cliffs site within the Maryland portion of the Chesapeake Bay watershed. The site is on Maryland’s Calvert Peninsula, which is bounded by the Chesapeake Bay on the east and the Patuxent River on the west. The Patuxent River flows southeast and empties into the Chesapeake Bay about 8 mi south of the Calvert Cliffs site.

Figure 2-8 shows that the predominant surface-water hydrologic feature of the Calvert Cliffs site is the Chesapeake Bay, which runs along the eastern edge of the site boundary. The Bay is about 195 mi long and anywhere from 3.5 to 35 mi wide. The Bay occupies approximately 4480 mi^2 and nominally holds approximately 1.8×10^{13} gal of water. Between 1951 and 2000, the estimated annual freshwater inflow rate to the Bay averaged 77,500 cfs and varied between 49,000 and 132,000 cfs. On a monthly basis, the rate varied between 7800 and 380,700 cfs.

About 50 percent of the mean annual freshwater inflow into the Chesapeake Bay comes from the Susquehanna River, which enters the Bay more than 60 mi north of the Calvert Cliffs site. In contrast to the Susquehanna River, the Patuxent River contributes only about 1 percent of

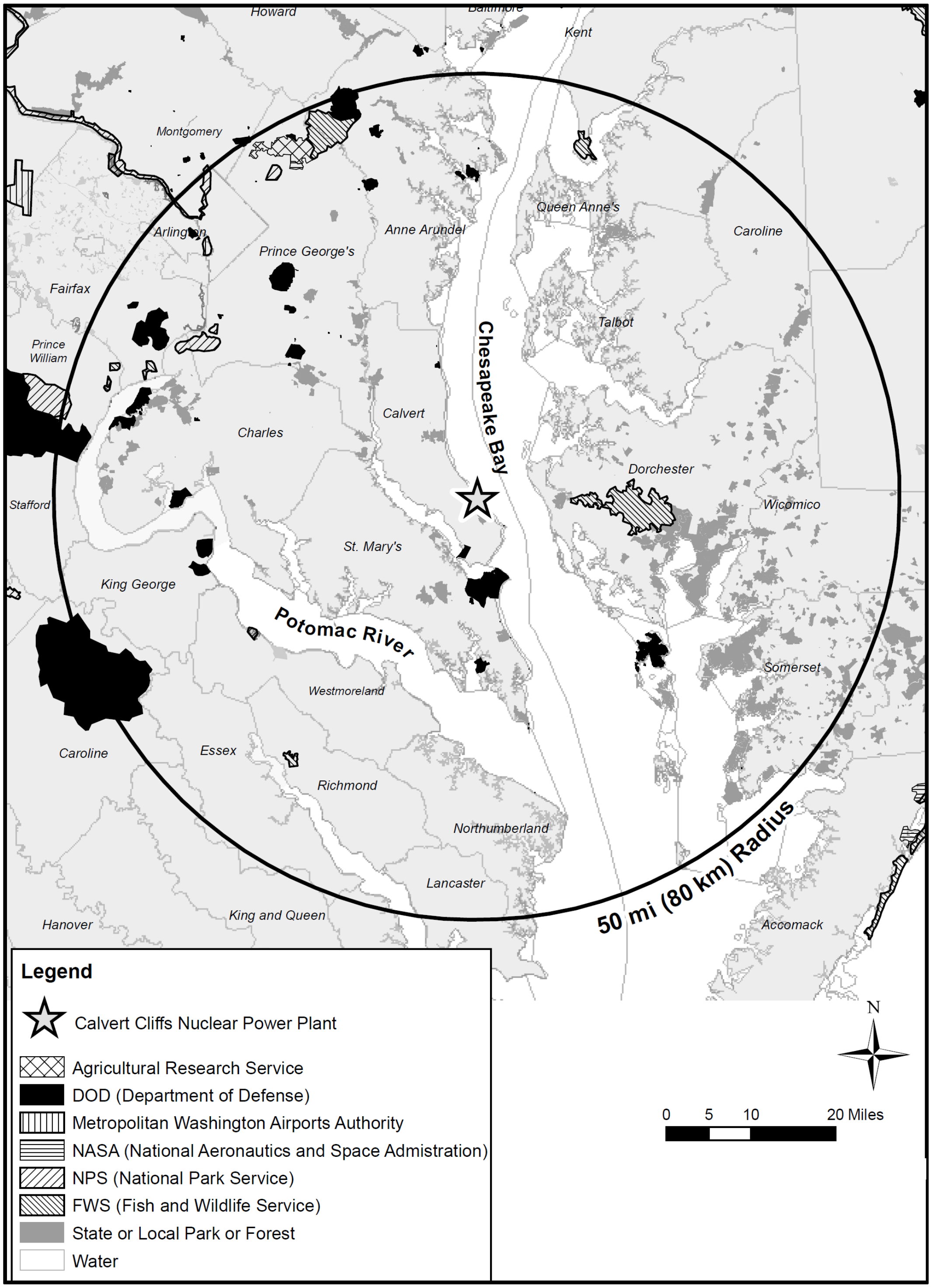

Figure 2-6. Major Public and Trust Lands in the 50-mi Region (UniStar 2009a)

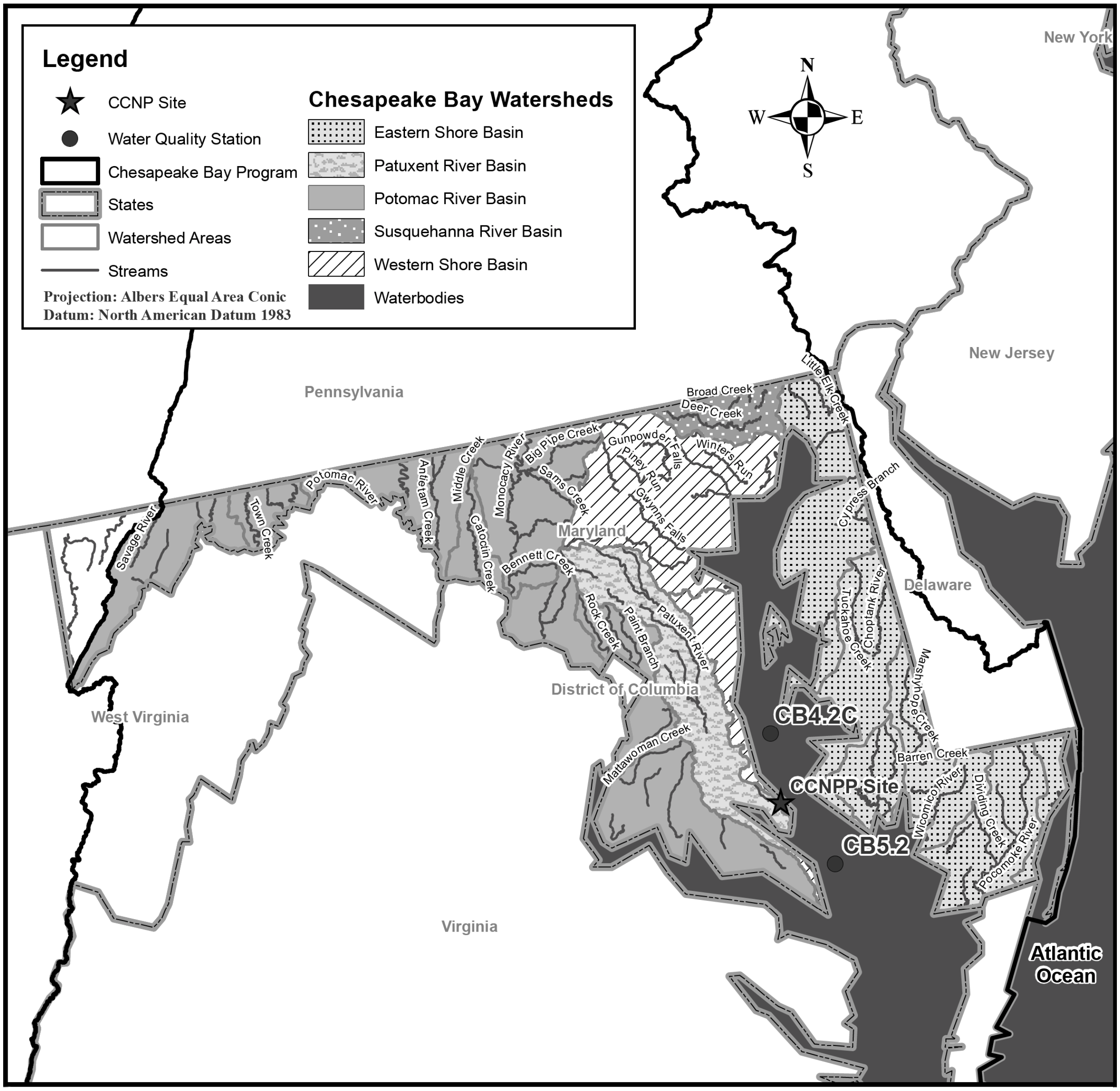

Figure 2-7. Maryland Portion of Chesapeake Bay Watershed (UniStar 2009c)

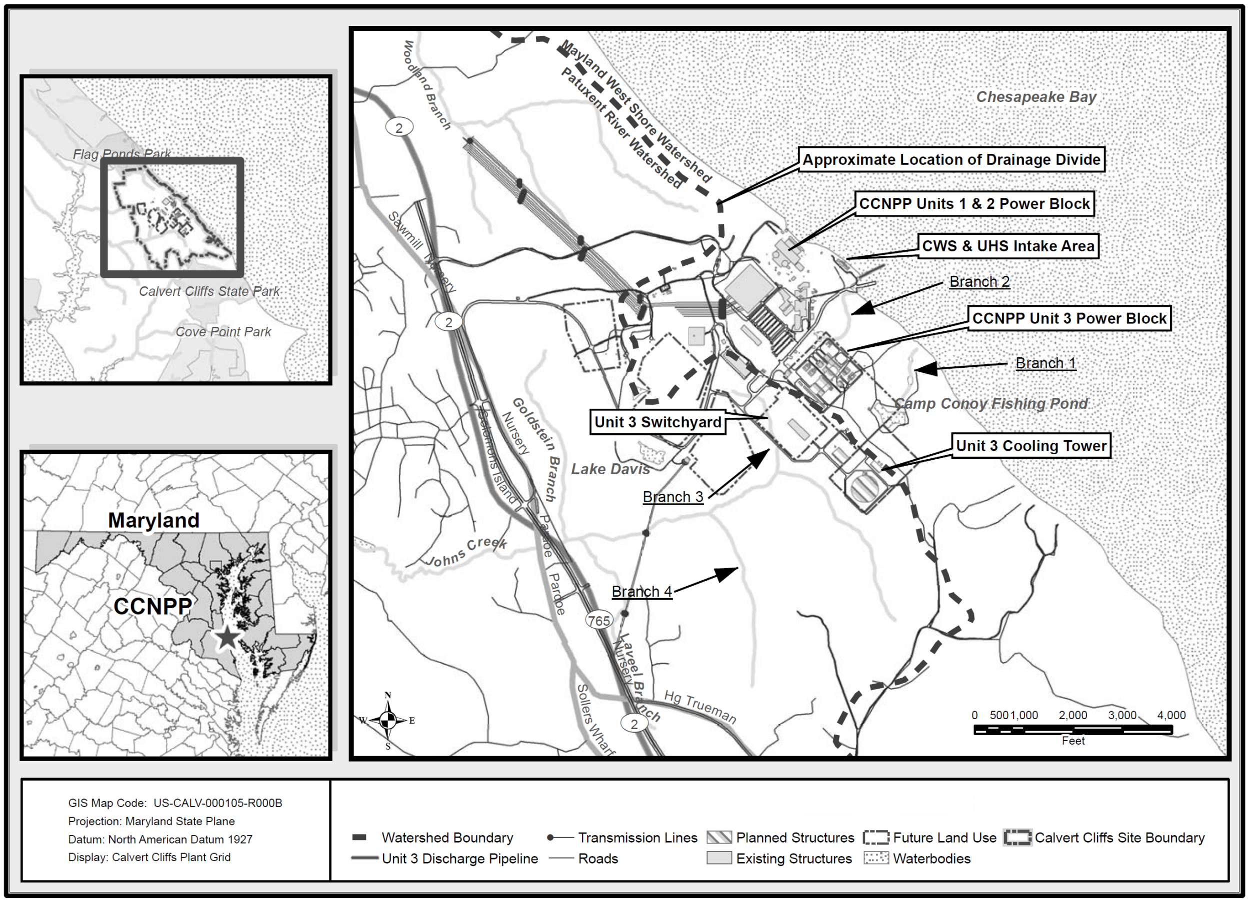

Figure 2-8. Watersheds and Proposed Unit 3 Location at the Calvert Cliffs Site (UniStar 2009a)

the total freshwater inflow to the Bay. Between 1977 and 2005, the average annual inflow rate was 421 cfs. Rocky Gorge Dam is the nearest dam on the Patuxent River and is located more than 70 mi upstream. Hydrologic conditions in the Patuxent River near the Calvert Cliffs site are tidal and have no impact on the site's water bodies.

The Chesapeake Bay experiences tidal forces. The mean tidal range 8 mi south of the Calvert Cliffs site is 1.17 ft. Tidal flow into the Chesapeake Bay is estimated to be about 3,900,000 cfs at the entrance (about 100 mi to the south).

The Chesapeake Bay is monitored in the winter and summer months for temperature and salinity by the Chesapeake Bay Program (CBP), which is a regional partnership that includes Maryland, Pennsylvania, Virginia, the District of Columbia (D.C.), the U.S. Environmental Protection Agency (EPA), and citizen advisory groups. Two of the monitoring stations are near the Calvert Cliffs site; one is to the northwest and one is to the southeast. Between 1984 and 2006, surface temperatures ranged from 32° to 85.5°F, and bottom temperatures ranged from

32.5° to 81.3°F. The nominal thermocline is located between 5 and 15 ft. The vertical temperature profile exhibits seasonal variation as a result of the lag between surface and bottom temperature changes. Salinity measurements at the two CBP stations show that the halocline (strong, vertical salinity gradient) is located between 5 and 15 ft. The vertical temperature profile is seasonally dependent because of the lag between surface and bottom temperature changes. Salinity measurements at the two CBP stations show that the halocline (strong, vertical salinity gradient) is located between 5 and 15 ft. Between 1984 and 2006, surface values ranged from 2.0 to 21.8 parts per thousand (ppt) while bottom values ranged from 11.3 to 25.8 ppt. In general, surface values are expected to be lower due to dilution by freshwater sources. Mean monthly surface salinity varied between 11.6 and 17.0 ppt.

Sea-level rise has been 1.3 ft in the last 100 years and the Tidal Sediment Task Force of the Chesapeake Bay Program estimates that levels may rise by 2 to 3 ft in the next 100 years (UniStar 2009a). Sea-level rise and wave action have caused erosion and buildup (via deposition) of the shoreline near the Calvert Cliffs site. Estimates of shoreline changes north and south of the intake of Units 1 and 2 and barge slip range from +2 ft to -4 ft per year. Erosion has not occurred between the intake of CCNPP Units 1 and 2 and the barge slip because the shoreline is stabilized.

The bathymetry of the Bay near the Calvert Cliffs site differs from the adjacent nearshore bathymetry because of the presence of an intake channel constructed for existing CCNPP Units 1 and 2. Specifically, a 4830-ft-long intake channel was dredged perpendicular to the shoreline and to depths ranging from 40 to 51 ft.

Secondary to the Chesapeake Bay and Patuxent River are the small streams that drain surface water from the site. Figure 2-8 shows that the Calvert Cliffs site is such that surface water is divided between two watersheds. About 20 percent of the surface area, which occupies the eastern side of the site, is in the Lower Western Shore watershed. The manmade Lake Conoy and two small ponds below it are on this side of the divide. Two streams (Branches 1 and 2) drain this eastern portion of the site and flow northeastward to the Chesapeake Bay. The remaining 80 percent of the site surface area is in the St. Leonard Creek watershed, which drains to the Patuxent River. The manmade Lake Davies, which received dredging spoils from the building of the CCNPP Units 1 and 2 intake and discharge facilities, is on the western side of the divide. Several short-lived streams, including Branches 3, 4, Laveel, and Goldstein, drain this western portion of the site into Johns Creek, which flows offsite into St. Leonard Creek. At the confluence with Johns Creek, St. Leonard Creek becomes tidally influenced. St. Leonard Creek empties into the Patuxent River. Within and downstream of the Calvert Cliffs site, wetlands occupy areas along the streams. All streams on the site are non-tidal.

2.3.1.2 Groundwater Hydrology

Groundwater aquifers in the region and the vicinity of the Calvert Cliffs site are described in Section 2.3 of the ER (UniStar 2009a). These aquifers are the result of variations in the geology (see Section 2.8 of this environmental impact statement (EIS)), which allows for more water to flow and be stored in some formations and much less in others. Figure 2-9 shows the major aquifers beneath the Calvert Cliffs site. Three of those aquifers are of interest for building and operation of the proposed Unit 3: Surficial, Piney Point-Nanjemoy, and Aquia.

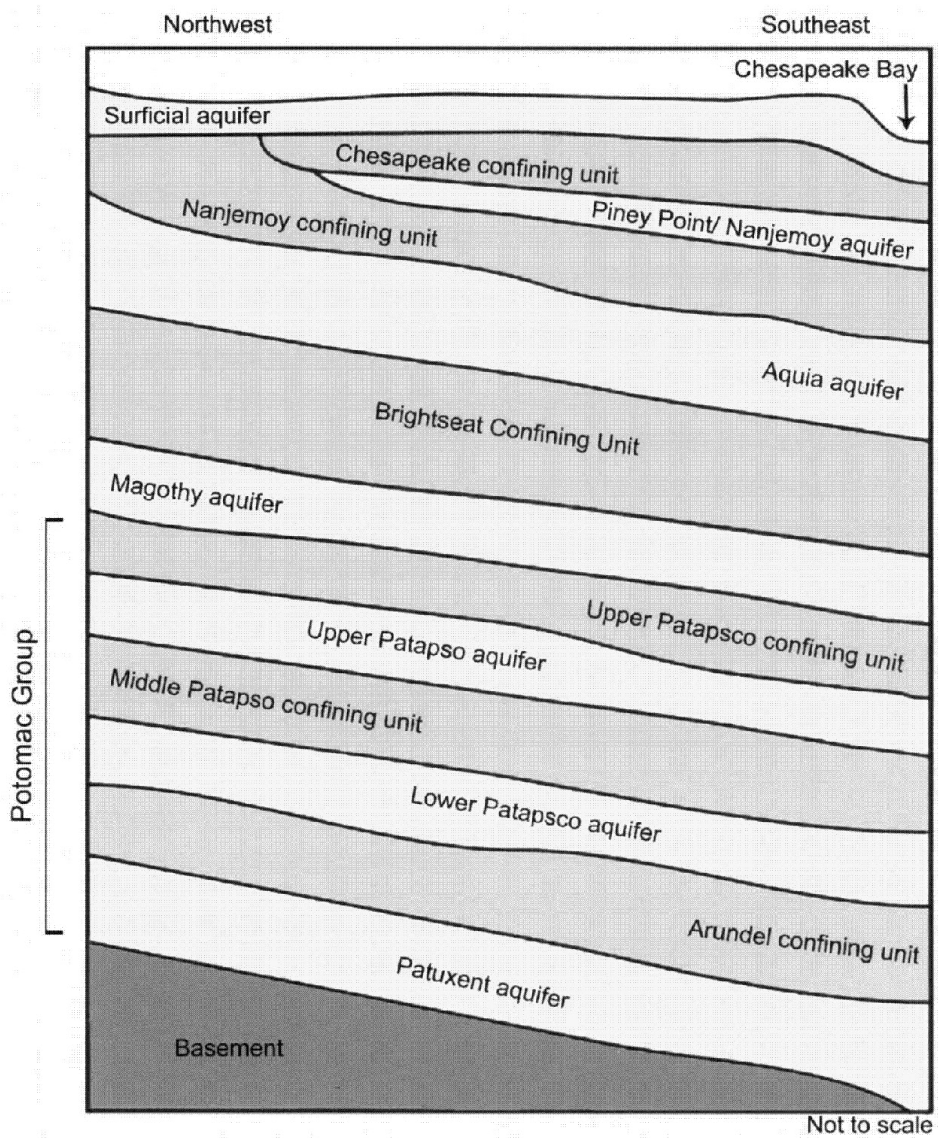

Figure 2-9. Major Aquifers Beneath the Calvert Cliffs Site (UniStar 2009a)

The Surficial aquifer consists of unconsolidated sediments composed of medium-grained sands and silty or clayey sands; occasional intervals of coarse-grained sands have been observed. At the Calvert Cliffs site, the aquifer is present above elevations of 65 to 70 ft and has thickness ranging from 0 ft (where local drainages have dissected the aquifer) to 55 ft at the higher elevations. UniStar determined the geometric mean saturated conductivity of the Surficial aquifer sediments to be 3.2×10^{-4} cm/s based on slug tests in 10 wells and the average total porosity to be 42.7 percent (UniStar 2009b).

Recharge to this aquifer is primarily from precipitation. From 2000 to 2005, the annual average precipitation at the site was 36 in. This amount is partitioned between runoff, evaporation, transpiration, soil water storage, and recharge based on site-specific soil, plant, and topography conditions. Regionally, the Surficial aquifer is not considered to be a reliable source of groundwater due to its thinness and topographic dissections, which lead to local groundwater discharge as springs. At the Calvert Cliffs site, there are no groundwater wells in the Surficial aquifer.

Between the Surficial aquifer and the Piney Point-Nanjemoy aquifer lies the Chesapeake Group, which is a complex series of silty clays, silt, and silty fine-grained sand deposits about 250 ft thick. Two thin and discontinuous water-bearing sand units are present within the upper part of the Group. Both the upper and lower bounds of the Chesapeake Group are considered aquitards.

The Piney Point-Nanjemoy aquifer consists of several geologic formations that include fine- to medium-grained quartz sand, carbonate-cemented sands, sandy silts, clayey sands, and occasional shell fragments, phosphate nodules, and gravel. The thickness of all layers within this water-bearing aquifer is about 115 ft. In a groundwater modeling study that included Calvert County, Maryland, Drummond (2007) used a value of 1.8×10^{-3} cm/s to represent the saturated conductivity of the Piney-Point aquifer beneath the Unit 3 site.

Recharge of this aquifer is assumed to be from precipitation received on exposed surfaces of this unit in northern Calvert County and Anne Arundel County. The possibility exists that some recharge occurs from leakage from overlying aquifers. Discharge from this aquifer is assumed to occur from subaqueous exposures of the aquifer along the Continental Shelf. There are seven wells on the Calvert Cliffs site screened within this aquifer. Four of the wells are in the vicinity of Camp Conoy and would be decommissioned during the building of proposed Unit 3. The other three wells are adjacent to and supply the Visitor's Center, Firing Range, and some onsite trailers. Their combined permit limit is 1100 gpd. There are no plans to use these remaining wells to provide water for building activities or to install new wells in this aquifer.

The lower portion of the Nanjemoy formation contains a higher proportion of clayey sediments and rests on top of the Marlboro clay. Together, the two layers act as a confining layer separating the Piney Point-Nanjemoy aquifer and the lower Aquia aquifer.

The Aquia aquifer consists of quartz sand, cemented sandstones, and shell beds. In a groundwater modeling study that included Calvert County, Maryland, Drummond (2007) used a value of 3.5×10^{-3} cm/s to represent the saturated conductivity of the Aquia aquifer beneath the Unit 3 site. Recharge occurs from precipitation in central Anne Arundel and Prince George's Counties where the aquifer units are exposed at the surface. Discharge is assumed to occur to the southeast from subaqueous exposures of the aquifer along the Continental Shelf. The Aquia aquifer is used extensively throughout southern Maryland. Starting in the 1980s, heavy groundwater pumping for public, commercial, and military uses created a groundwater cone of depression in the Solomons area of Calvert County and in St. Mary's County. Water managers in these areas are seeking to shift groundwater withdrawals from the Aquia aquifer to deeper aquifers.

There are five groundwater wells in the Aquia aquifer that are associated with existing CCNPP Units 1 and 2. The permitted average and maximum withdrawal rates are 450,000 and 865,000 gpd, respectively. The maximum rate applies to the month of maximum groundwater withdrawal; on an annual basis, the 450,000-gpd limit still applies.

Actual annual groundwater use by CCNPP Units 1 and 2 between July 2001 and June 2006 averaged 387,000 gpd (UniStar 2009a). Throughout that time, the monthly average varied between 350,000 and 433,000 gpd, and the lowest and highest monthly withdrawal rates were about 252,000 and 529,000 gpd. Relative to the permitted rate of 450,000 gpd, the overall average withdrawal rate is lower by 63,000 gpd.

Within the Surficial aquifer, the highest elevation of the groundwater lies directly beneath the proposed site for Unit 3. The potentiometric surface is indicative of current soil, vegetation, and topographic conditions but does not necessarily reflect what the surface would look like after the plant is built.

Although there are only a few wells within the Upper and Lower Chesapeake units, the limited potentiometric surfaces show a well-defined gradient from the proposed Unit 3 site toward the Chesapeake Bay. A regional potentiometric map of the Aquia aquifer in 2003 shows a pronounced gradient (approximately 0.001) to the south in the direction of the cone of depression caused by large withdrawals in Solomons Island area at the southern tip of the Calvert Peninsula.

2.3.2 Water Use

Consideration of water use requires estimating the magnitude and timing of consumptive and non-consumptive water uses. Non-consumptive water use does not result in a reduction in the available water supply. For example, water withdrawn from the Chesapeake Bay and used to remove fish from the intake screens would result in no net change in water supply available to other Bay water users if the same volume of water pumped from the Bay would eventually be returned back into the Bay. On the other hand, consumptive water use results in a net reduction of the water supply available for downstream users. For instance, the cooling water system withdraws water for normal cooling. The majority of that water is evaporated in the cooling towers, and that evaporated water would be considered a consumptive loss. The following two sections describe the consumptive and non-consumptive users of surface water and groundwater near the proposed Unit 3 site.

2.3.2.1 Surface-Water Use

The major surface water bodies in Calvert County are the Chesapeake Bay and the Patuxent River. Unit 3 would use only Chesapeake Bay water for all uses during plant operations. Within Calvert County, there are seven permits for withdrawal of Chesapeake Bay water. CCNPP Units 1 and 2 withdraw 3500 MGD, which accounts for nearly 100 percent of the total permitted withdrawals in the county. The nearest permitted surface water withdrawal is by Dominion Cove Point LNG, which is 4 mi from Units 1 and 2.

Consumptive use of Chesapeake Bay water is limited. CCNPP Units 1 and 2 are operated using once-through cooling, which means that all water withdrawn from the Chesapeake Bay is returned and none is consumed within the plant. However, the heated effluent that is returned to the Chesapeake Bay results in induced evaporation and constitutes a decrease in the water supply. If the other Calvert County users of Bay water consumed their entire permitted withdrawal amount, the total consumed would be 0.08 MGD. In contrast, consumption of water by Unit 3 would amount to 28.9 MGD.

There are four permitted surface water discharges to the Chesapeake Bay in Calvert County. The permitted discharge from CCNPP Units 1 and 2 is 3200 MGD, which accounts for nearly 100 percent of the total permitted discharge within Calvert County. The proposed Unit 3 discharge is expected to be 30 MGD.

2.3.2.2 Groundwater Use

Groundwater is the primary source of drinking water in the region. Between the early 1980s and 2005, groundwater use has increased in southern Maryland and the eastern Maryland shore from 42 to 65 MGD in line with increasing population and demand is expected to increase in the future (Soeder et al. 2007). The increase in groundwater pumping has led to a drop in the potentiometric surface within each aquifer. Within the Aquia aquifer beneath the Calvert Cliffs site, the potentiometric surface dropped about 35 ft below sea level in 1985 to about 100 ft in 2005. In contrast, greater groundwater pumping to the south of the Calvert Cliffs site lowered the potentiometric surface from 60 to more than 140 ft below sea level in the same time period.

In Calvert County, there are about 500 permits for groundwater withdrawal. The Surficial aquifer, which is thin, discontinuous, and low-yielding, is primarily used for irrigation and rarely for potable water. None of the Calvert County permits is for withdrawal from the Surficial aquifer. The majority of wells withdraw from the next three deeper aquifers: the Piney Point, the Nanjemoy, and the Aquia. Seven permits allow withdrawals from the deeper Magothy aquifer. None of the aquifers is classified as a sole-source aquifer. The majority of permits allow small withdrawals between 100 to 10,000 gpd, but several are very large. The seven largest permits combined allow for 3.1 MGD of withdrawal, all from the Aquia aquifer. Combined with heavy pumping of the Aquia aquifer in St. Mary's County to the south, withdrawals from the Aquia aquifer have created a large depression in the potentiometric surface centered on the town of Solomons and the Naval Air Station (both south of the Calvert Cliffs site).

UniStar identified 13 production wells on the Calvert Cliffs site. Of those, 12 wells are permitted for groundwater withdrawal and one is an historical Aquia well (the Old Bay Farm well) that is not used. Five permits exist. One permit, Maryland Water Appropriations Permit CA69G010 (05), is for the five Aquia aquifer wells that are used to supply water to existing Units 1 and 2. These wells combined are permitted to withdraw 450,000 gpd annually. In the month of greatest use, the withdrawal rate is allowed to be as high as 865,000 gpd. The other four permits govern withdrawals from the remaining seven wells, all of which are screened in the Piney Point-Nanjemoy aquifer. Altogether, these four permits allow for a total withdrawal of 1600 gpd. UniStar (2009a) plans to decommission four of these wells, which would drop the permitted withdrawal to 1100 gpd.

2.3.3 Water Quality

The following sections describe the water quality of surface-water and groundwater resources in the vicinity of the proposed Unit 3 site.

2.3.3.1 Surface-Water Quality

Surface water bodies whose quality could be affected by proposed Unit 3 include the Chesapeake Bay; Johns Creek; and the lakes, ponds, and streams within the boundaries of the Calvert Cliffs site. The Patuxent River and St. Leonard Creek are downstream of Johns Creek. However, the only plausible impacts to Johns Creek are so minor and localized that the downstream environment of St. Leonard Creek and Patuxent River are not discussed in this section.

Water quality features of the Chesapeake Bay that are of most interest to CCNPP Units 1 and 2 operations are temperature and salinity. In addition, most sections of the Chesapeake Bay, including the reach that encompasses Calvert County, are listed as Clean Water Act Section 303(d) impaired waters, primarily because of low dissolved oxygen and increased nutrients and sedimentation from activities in the watersheds that drain into the Bay.

Regional Chesapeake Bay temperature and salinity data are collected by participants in the CBP, which is a regional partnership that includes Maryland, Pennsylvania, Virginia, the District of Columbia (DC), the EPA, and citizen advisory groups. The CBP oversees monitoring at selected locations throughout the Bay. The CBP monitoring location CB4.4 is closest to the Unit 3 site and is due east of the site. In 2005, the CBP measured water temperature extremes at location CB4.4 with a minimum and maximum of 35.1 and 85.3°F, respectively (UniStar 2009a). On a seasonal basis, the average temperature varied from 42.7°F in winter to 75.4°F in summer. Salinity extremes varied from 4.42 to 22.18 ppt. On a seasonal basis, the average salinity varied from 13.3 ppt in spring to 16.38 ppt in summer. The variations are controlled by the seasonality and efficiency of mixing of freshwater and seawater, which has a nominal salinity of 30 ppt at the mouth of the Chesapeake Bay. The extremes of dissolved oxygen concentration were 0.1 and 13.2 mg/L. The average seasonal concentrations varied from 2.67 in summer to 9.89 mg/L in winter. A dissolved oxygen level of at least 5.0 mg/L is considered optimal for aquatic life. As the dissolved oxygen concentration decreases below 5.0 mg/L and the water becomes more hypoxic, the stress on organisms increases. Between 2.0 and 0.2 mg/L, the water is described as being severely hypoxic. Levels below 0.2 mg/L are considered to be anoxic and unable to support life. The 2005 data show that, on average, the water at CB4.4 has a dissolved oxygen concentration above 5.0 mg/L. However, the data also show that periods of time occur when concentrations fall below 0.2 mg/L, rendering the water anoxic.

Twelve locations in freshwater bodies within the boundaries of the Calvert Cliffs site were sampled in October 2006 as part of a biological study conducted by UniStar (UniStar 2009a). The water bodies included Johns Creek, Goldstein Branch, Lake Conoy (also known as the Camp Conoy fishing pond), the two ponds (1 and 2) below Lake Conoy, and Lake Davies. The water quality analyses of Lake Conoy indicated generally low contaminant levels and good overall water quality. The two ponds below Lake Conoy had similar water quality characteristics with the exception that dissolved oxygen levels were very low. Though not used for drinking water, water quality in Goldstein Branch and the lower part of Johns Creek did not always comply with drinking water standards. For example, total dissolved solids (TDS) were 280 mg/L in the lower part of Johns Creek and 440 mg/L in Goldstein Branch, which meet the drinking water standard of 500 mg/L TDS. However, the TDS levels violated the drinking water standard (500 mg/L TDS) in Lake Davies. In spring 2007, sulfate levels were measured at the same locations (EA Engineering 2007a). Lake Davies and Goldstein Branch had the highest levels; in fact, two samples from Lake Davies had levels just above the drinking water standard of 500 mg/L. The source of the elevated levels of dissolved solids is unknown but may reflect input from the dredging spoils placed in Lake Davies when existing Units 1 and 2 were constructed.

2.3.3.2 Groundwater Quality

Groundwater samples were collected from four wells in May 2007 for water quality determination (UniStar 2009a). Two of the wells were in the Surficial aquifer, one in the Upper Chesapeake unit and one in the Aquia. Water from the Surficial aquifer had lower alkalinity than from the deeper aquifers. The pH in one well was 3.93, which is more acidic than the 6.5 to 8.5 normally expected for groundwater. Sodium in all wells was slightly higher than the drinking water standard of 4 mg/L. Nitrate, sulfate, and chloride were all below the drinking water standard. Groundwater from the Upper Chesapeake unit was much more alkaline (about 190 mg/L) and harder (300 mg/L) than groundwater in the Surficial aquifer. Groundwater from the Aquia had characteristics somewhat between those of the upper aquifers. Nothing in the analyses suggested any unusual chemical conditions or contamination from radionuclides.

Groundwater pumping throughout coastal Maryland, such as the Calvert Cliffs site, has the potential to create conditions that allow saltwater to intrude further into aquifers than would normally occur (Shedlock et al. 2007). If the intruding saltwater reaches aquifer zones where humans currently or in the future might use the freshwater resource, the value of the resource may be diminished considerably. In Maryland, saltwater intrusion problems have been limited to date to coastal areas such as Ocean City and Kent Island, Maryland, where aquifers are close to the surface and near a pumping network. At the Calvert Cliffs site, the Aquia aquifer is approximately 415 ft beneath the surface. More importantly, groundwater pumping of the Aquia aquifer for CCNPP Units 1 and 2 has not lowered the piezometric head nearly as much as it has been lowered by industrial and municipal pumping near Solomons and the Naval Air Station south of the Calvert Cliffs site. To date, saltwater intrusion has not been reported for those more-heavily pumped areas.

2.3.4 Water Monitoring

Regional Chesapeake Bay temperature and salinity data are collected by participants in the CBP. In its ER, UniStar (2009a) describes the onsite hydrological monitoring that occurs in accordance with its existing National Pollutant Discharge Elimination System (NPDES) and Industrial Stormwater Permits. Monitoring locations for CCNPP Units 1 and 2 include the cooling water discharge, wastewater retention basins discharge, sewage treatment plant emergency outflow, and liquid radioactive waste systems discharge.

Pre-application monitoring of the groundwater system underlying the Calvert Cliffs site included monitoring of existing and newly established groundwater wells. The data were collected on nine dates during the period from July 2006 to March 2007. The data appear in tables and contour plots in Section 2.3 of the ER (UniStar 2009a).

UniStar supplements its onsite data collection with regional aquifer data collected by the U.S. Geological Survey (USGS), the Maryland Geological Survey, and other groups. Together, these agencies support the Calvert County Ground Water Level Monitoring Network, which contains data on 42 wells in the deeper aquifers, including the Aquia.

2.4 Ecology

The Calvert Cliffs site is located on the western shore of the Chesapeake Bay, the largest estuary in the United States, which stretches 200 mi from Havre de Grace, Maryland, to Norfolk, Virginia. Diverse terrestrial and aquatic habitats support many species, including mammals, reptiles, amphibians, birds, fish, and invertebrates. This section describes the terrestrial and aquatic environment and biota near the Calvert Cliffs site and other areas likely to be affected by the building, operation, or maintenance of the proposed Unit 3. It describes the spatial and temporal distribution, abundance, and other structural and functional attributes of biotic assemblages that the proposed action could affect, and it identifies “important” or irreplaceable aquatic natural resources and the location of sanctuaries and preserves that might be affected by the proposed action.

2.4.1 Terrestrial and Wetland Ecology

Historically, forests comprised of 50 or more tree species have dominated the terrestrial landscape in the Chesapeake region and still cover about 60 percent of the land area (Chesapeake Bay Program 2008a). Topography, climate, and extensive shorelines contribute to a variety of wetland habitats throughout the Chesapeake Bay region (Chesapeake Bay Program 2008b). To document the diversity present within the Calvert Cliffs site, floral and faunal field surveys as well as wetland delineation were conducted by UniStar contractors. Results from these surveys were used to describe cover types found on the site and the common species within them. Important terrestrial species are discussed in Section 2.4.1.2.

2.4.1.1 Terrestrial Resources – Site and Vicinity

Existing Cover Types

A broad-scale assessment of terrestrial vegetation was conducted by estimating community boundaries using two sets of aerial photographs. The most recent was a set of black-and-white aerial photos of the Calvert Cliffs site dated April 1993, and the other was an undated set of color infrared taken during the 1990s. These efforts were followed by direct observation of the site between May 2006 and April 2007 to delineate boundaries and determine dominant and co-dominant plant species within each type. As documented by the Maryland Department of Natural Resources (DNR, cited as MDNR), surveys for specific plants occurred in July to early August 2006, October 2006, and April 2007 to coincide with flowering periods of Maryland State listed plants known to occur in Calvert County (MDNR 2007a). Eight major cover types were identified and are described in the following sections in order of decreasing areal extent (Figure 2-10).

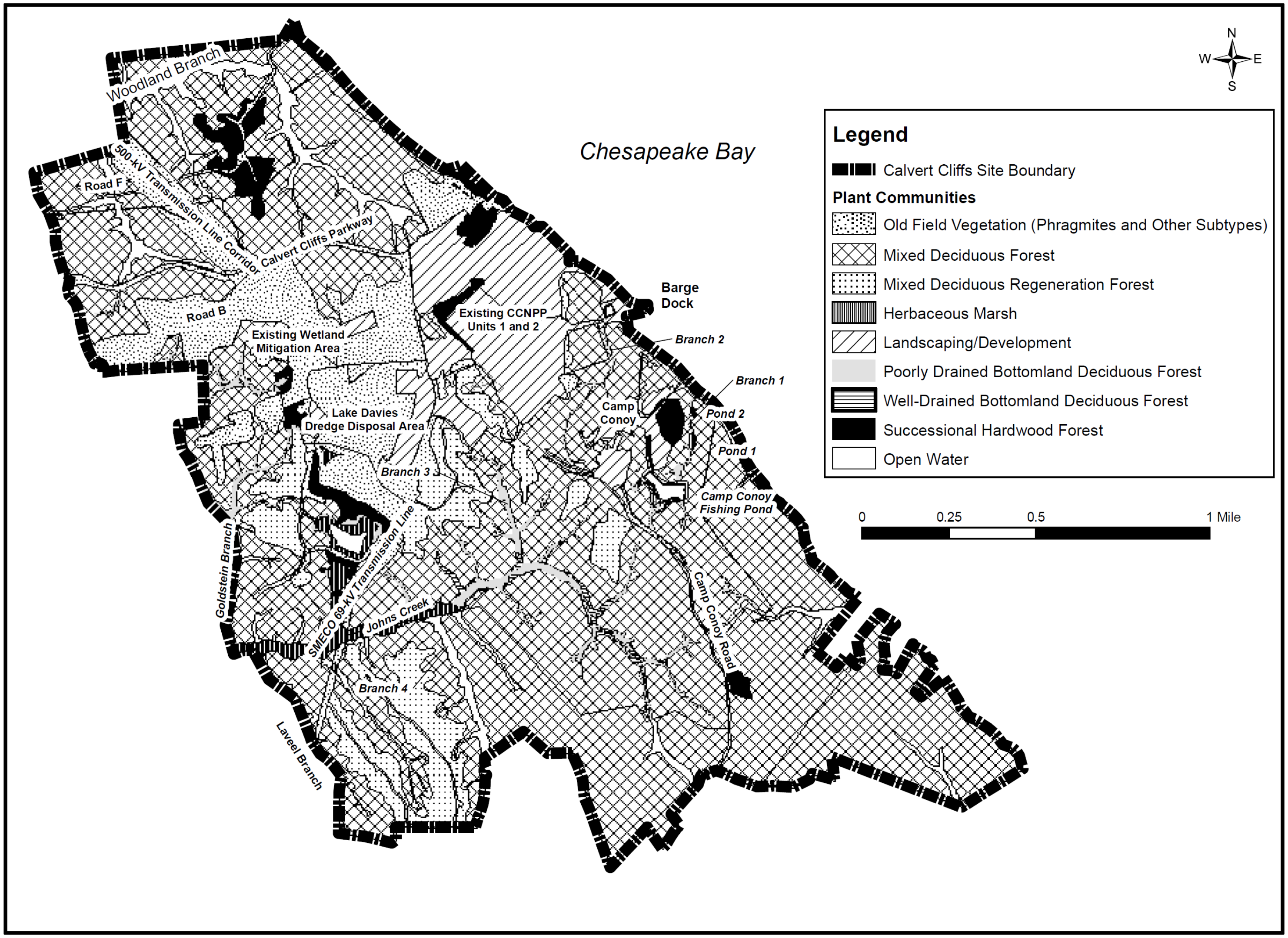

Figure 2-10. Plant Community (Natural Habitat Map) (UniStar 2009d)

In addition to these eight cover types, limited sandy beach and sand cliff habitat are found on the Chesapeake Bay shoreline where previous development has not occurred. The beach is always narrow, approximately 20 ft wide during normal low tide. Although small tidal marshes occur in the Flag Ponds Nature Park and near St. Leonard Creek, cliffs preclude tidal marshes from occurring on the Calvert Cliffs site. Localized forest stands dominated by loblolly pine (*Pinus taeda*) can be found near the Bay, while inland Virginia pine can be locally dominant in disturbed areas allowed to regenerate naturally.

Wildlife inhabiting the Calvert Cliffs site is commonly found in similar cover types within the region. The white-tailed deer (*Odocoileus virginianus*), coyote (*Canis latrans*), red fox (*Vulpes fulva*), eastern cottontail rabbit (*Sylvilagus floridanus*), yellow warbler (*Dendroica petechia*), American crow (*Corvus brachyrhynchos*), northern mockingbird (*Mimus polyglottos*), wild turkey (*Meleagris gallopavo*), worm snake (*Carphophis amoenus*), and the American toad (*Bufo americanus*) are habitat generalists that occur in almost all cover types found on the site (NRC 1996; 1999[a]; Tetra Tech NUS 2007a).

<u>Mixed Deciduous Forest</u>

Virginia pine (*Pinus. virginiana*), mixed in with various broadleaf tree species is the predominant cover type on the Calvert Cliffs site. Dominant broadleaf species include tulip poplar (*Liriodendron tulifera*), chestnut oak (*Quercus prinus*), white oak (*Q. alba*), black oak (*Q. velutina*), southern red oak (*Q. falcata*), and scarlet oak (*Q. coccinia*), and American beech (*Fagus grandifolia*). Also present within the canopies are pignut hickory (*Carya glabra*), bitternut hickory (*C. cordiformis*), red maple (*Acer rubrum*), sweet gum (*Liquidambar styraciflua*), swamp chestnut oak (*Q. michauxii*), and black gum (*Nyssa sylvatica*). Mountain laurel (*Kalmia latifolia*) and pawpaw (*Asimina trilobata*) dominate the local understory, while American holly (*Ilex opaca*) can be quite common. The dense canopy limits understory growth, but where breaks in the canopy allow sunlight to penetrate to the ground, partridgeberry (*Mitchella repens*), Christmas fern (*Polystichum acrostichoides*), common violet (*Viola papilionacea*), and large whorled pogonia (*Isotria verticillata*) are present.

In addition to habitat generalists, wildlife present within mixed deciduous forest include the eastern gray squirrel (*Sciurus carolinensis*), fox squirrel (*S. niger*), eastern chipmunk (*Tamias striatus*), gray fox (*Urocyon cinereoargenteus*), bobcat (*Lynx rufus*), great-horned owl (*Bubo virginianus*), red-shouldered hawk (*Buteo lineatus*), northern cardinal (*Cardinalis cardinalis*), yellow-billed cuckoo (*Cocoyzus americanus*), eastern wood-pewee (*Contopus virens*), pileated woodpecker (*Dryocopus pileatus*), and the blue jay (*Cyanocitta cristata*) (NRC 1996; Tetra Tech NUS 2007a).

(a) NUREG-1437 was originally issued in 1996. Addendum 1 to NUREG-1437 was issued in 1999. Hereafter, all references to NUREG-1437 include NUREG-1437 and its Addendum 1.

Old Field

Natural succession on areas previously disturbed that were not landscaped or maintained has resulted in two types of old field habitats dominated by weedy plant species. The largest old field area is located on the Lake Davies dredge disposal area, southwest of CCNPP Units 1 and 2, and contains dredge spoils deposited during the building of the previous units. This site is dominated by common reed (*Phragmites australis*), also known as *Phragmites*, a widespread invasive species common in moist soils that is considered undesirable (USFS 2008a). Other plants in this area indicative of old fields include blackberry (*Rubus allegheniensis*) and tall fescue (*Festuca arundinacea*).

Other previously disturbed areas represent the second type of old field habitat, which is dominated by old field plant species such as tall fescue, sericea lespedeza (*Lespedeza cuneata*), blackberry, Canada goldenrod (*Solidago canadensis*), and asters (*Aster* spp.). Habitat areas of this type are found scattered throughout the central and northern portions of the Calvert Cliffs site, near the independent spent fuel storage installation (ISFSI), under both existing transmission corridors, and alongside many of the existing roadways.

Wildlife that prefer open habitats including old fields and forest edges include the woodchuck (*Marmota monax*), bobwhite quail (*Colinus virginianus*), American goldfinch (*Carduelis tristis*), turkey vulture (*Cathartes aura*), gray catbird (*Dumetella carolinensis*), and northern black racer (*Coluber constrictor constrictor*) (NRC 1996; Tetra Tech NUS 2007a).

Landscaping/Developed Areas

Previously disturbed areas that have been subsequently landscaped are the primary habitat immediately surrounding Units 1 and 2 as well as the Camp Conoy area (Figure 2-1). Existing buildings, parking lots, and maintained open spaces around these structures are typical of this cover type. Vegetated areas within this cover type are usually lawn grasses containing varied amounts of broadleaf weedy species with planted ornamental trees and shrubs.

In addition to many wildlife species found in old fields and forest edges, the killdeer (*Charadrius vociferous*), American robin (*Turdus migratorius*), and the ruby-throated hummingbird (*Archilochus colubris*) have adapted to use landscaping and developed areas (NRC 1996; Tetra Tech NUS 2007a).

Mixed Deciduous Regeneration Forest

Recent timber harvest activities have altered some of the mixed deciduous stands on the Calvert Cliffs site. Following harvest, regeneration of the forest has produced vigorous and dense stands of Virginia pine, tulip poplar, numerous oak species, sweet gum, and red maple.

Little understory or ground cover is present within these stands, although scattered mountain laurel and American holly can be found.

One wildlife species commonly found in young forest stands is the tufted titmouse (*Baeolophus bicolor*). Wildlife found in other Calvert Cliffs site habitats that would also occur in mixed regeneration forest includes the habitat-generalist white-tailed deer, eastern cottontail rabbit, and eastern wild turkey (NRC 1996; Tetra Tech NUS 2007a).

<u>Well-Drained Bottomland Deciduous Forest</u>

Areas alongside small streams, such as Johns Creek and Goldstein Branch, that lie within the wetland delineation area and small stands of tulip poplar, American beech, sweet gum, black gum, and red maple indicate moist yet well-drained soils. The same understory species, mountain laurel and American holly, are present within this cover type. However, New York fern (*Thelypteris noveboracensis*) dominates a patchily distributed groundcover. This cover type indicates a transition between upland and bottomland cover types and varies in width depending on topography and soils.

Wildlife specific to wetlands, such as the raccoon (*Procyon lotor*), beaver (*Castor canadensis*), red-winged blackbird (*Agelaius phoeniceus*), great blue heron (*Ardea herodias*), Canada goose (*Branta canadensis*), copperhead (*Agkistrodon contortrix*), and the spring peeper (*Hyla crucifer*) could be found in this habitat along with forest species (NRC 1996; Tetra Tech NUS 2007a).

<u>Poorly Drained Bottomland Deciduous Forest</u>

Soils within valley bottoms are seasonally saturated, and red maple, sweet gum, and black gum stands dominate the overstory. Shrubs are sparse to absent, and ground cover plants that can thrive in moist-to-wet soils and deep shade are quite dense in most areas. Forb communities are dominated by New York fern, sensitive fern (*Onoclea sensibilis*), and royal fern (*Osmunda regalis*); sedges and rushes present include tussock sedge (*Carex stricta*), eastern bur-reed (*Sparangium americanum*), and soft rush (*Juncus effusus*); and forbs such as lizard tail (*Saururus cernuus*) and skunk cabbage (*Symplocarpus foetidus*) are quite common. Wildlife would be similar to those found in well-drained bottomland deciduous forest (NRC 1996; Tetra Tech NUS 2007a).

<u>Herbaceous Marsh</u>

Two broad types of herbaceous marsh cover exist within the Calvert Cliffs site. *Phragmites*-dominated marsh occurs in lowlands with flat topography adjacent to Johns Creek in the western portion of the site as well as in small gaps in the canopy surrounding the headwaters of Johns Creek, Goldstein Branch, and other small streams. Areas similar in topography that occur around Lake Conoy and its outflow to the Chesapeake Bay are dominated by sedges, rushes, bulrushes, and lizard tail along with dotted smartweed (*Polygonum punctatum*), Pennsylvania smartweed (*Polygonum pensylvanicum*), jewelweed (*Impatiens capensis*), and halberd-leaved tearthumb (*Polygonum arifolium*).

Similar to other wetlands, the beaver, raccoon, red-winged blackbird, great blue heron, Canada goose, greater yellowlegs (*Tringa melanoleuca*), northern water snake (*Nerodia sipedon*), and the northern cricket frog (*Acris crepitans*) would be common in herbaceous marsh (NRC 1996; Tetra Tech NUS 2007a).

Successional Hardwood Forest

Fast-growing hardwood tree species have recently become established within old field cover types, including black locust (*Robinia pseudoacacia*), black cherry (*Prunus serotina*), and eastern red cedar (*Juniperus virginiana*). The understory is dense and comprised of the same plant species found in the old field cover type. Wildlife found in other deciduous forest types of the Calvert Cliffs site would also be found in successional hardwood forest (NRC 1996; Tetra Tech NUS 2007a).

Open Water

Although not a major cover type, a small amount of open water exists inland of the Chesapeake Bay. The Camp Conoy fishing pond and the Lake Davies dredge disposal areas provide a small amount of open water habitat. Both are manmade waterbodies not present before the building of Units 1 and 2. Although few terrestrial species would be endemic to this habitat, it is used by many and is an important resource.

Existing Natural and Anthropogenic Features

Although forest cover dominates the Calvert Cliffs site, habitat disturbance has occurred in the form of buildings, infrastructure, maintained landscape, logging, and field agriculture. The existing power block, support facilities, roads, parking areas, maintained landscaping, and deposited dredge spoils represent the most obvious disturbance within the central portion of the site. Recreational facilities at Camp Conoy also contribute to this existing disturbance footprint. Although now repopulated with tree cover, logging operations within the last 20 years west of Camp Conoy Road have changed the forest structure from a mature stand of climax forest species to a successional forest stand of more shade-intolerant species. Although no agriculture or farming activities now occur on the Calvert Cliffs site, old field habitats to the north are remnant agricultural fields that have undergone succession, reverting back to a natural state. Transmission line corridor maintenance activities, including mowing and herbicide treatments, prevent these areas from reverting back to forest. Also, small openings in the interior forest canopy are scattered within the proposed Unit 3 construction area, a likely result of windfall from hurricane force winds. The result of these natural and manmade disturbances is a diversification of habitats that is beneficial to edge species such as the white-tailed deer but also a reduction and fragmentation of interior forest that is locally detrimental to the scarlet tanager (*Piranga olivacea*) and other species that rely on this habitat.

2.4.1.2 Terrestrial Resources – Transmission Lines

The existing transmission system for CCNPP Units 1 and 2 consists of a north circuit that connects the plant to the Waugh Chapel Substation in Anne Arundel County, Maryland, and south circuit that connects the plant to the Potomac Electric Power Company Chalk Point Generating Station in Prince Georges County, Maryland. No new transmission corridors would be constructed off the Calvert Cliffs site, as existing transmission corridors would be used for power distribution from the proposed Unit 3.

Offsite Transmission and Access Corridors

Many species of wildlife use both natural and manmade features in the landscape to travel from one environ to another, essentially a corridor. Ground-borne mammals may use roads, trails, levees, streams, strips of forest, or topography features such as ridge tops or valleys depending on their habitat preferences (Atwood et al. 2004; Frey and Conover 2006; Spackman and Hughes 1994). Forest interior birds have used green belts and habitat edges to navigate through less suitable habitat (Levey et al. 2005; Mason et al. 2006). In relatively undisturbed forest tracts like those on the Calvert Cliffs site and throughout Calvert County, stream bottoms and ridge tops marked by slight changes in vegetation likely serve as travel corridors for local fauna, as no large migrations are known to occur within this region. Wildlife that have home ranges larger than the entire site and routinely travel through the site and beyond may use the Goldstein Branch valley bottom or adjoining hilltops for north-south travel, while the Johns Creek drainage may facilitate east-west movement.

2.4.1.3 Important Terrestrial Species and Habitats

Important species are defined as rare, commercially or recreationally valuable, essential to the maintenance of an important species, playing a critical role in the function of an ecosystem, or serving as biological indicators for environmental change (NRC 2000). Rare species are defined as one of the following: listed as threatened or endangered by the U.S. Fish and Wildlife Service (FWS) as defined in Title 50 of the Code of Federal Regulations (CFR) Part 17.11 thru 17.12; proposed for listing as threatened or endangered; published in the *Federal Register* as a candidate for listing; or listed as threatened, endangered, or other species of concern status by the State in which the proposed facility is located. Thirteen important species are known or are likely to occur on the Calvert Cliffs site (Table 2-1).

Migratory birds and their nests and eggs are afforded protection under the Migratory Bird Treaty Act (MBTA). During the site visit, active osprey nests were observed on poles above the existing water intake structure. Eastern bluebirds are also known to nest onsite, and the

Constellation staff maintains nest boxes for this species (NRC 1996; Tetra Tech NUS 2007a). Both osprey and eastern bluebirds are listed as migratory under the MBTA. Forty-five additional migratory bird species were observed within various cover types on the Calvert Cliffs site.

Table 2-1. Important Species Identified as Known or Likely to Occur on the Calvert Cliffs Site

Common Name	Latin Name	Type	Criteria
chestnut oak	*Quercus prinus*	Plant	Ecological Role
mountain laurel	*Kalmia latifolia*	Plant	Ecological Role
New York fern	*Thelypteris noveboracensis*	Plant	Ecological Role
showy goldenrod	*Solidago speciosa*	Plant	State Threatened
Shumard's oak	*Quercus shumardii*	Plant	State Threatened
spurred butterfly pea	*Centrosema virginianum*	Plant	Rare[(a)]
tulip poplar	*Liriodendron tulipifera*	Plant	Ecological Role / Ecological Indicator
northeastern tiger beetle	*Cicindela dorsalis dorsalis*	Insect	Federally Threatened and State Endangered
Puritan tiger beetle	*Cicindela puritana*	Insect	Federally Threatened and State Endangered
eastern narrowmouth toad	*Gastrophryne carolinensis*	Amphibian	State Endangered and Critically Imperiled
bald eagle	*Haliaeetus leucocephalus*	Bird	State Threatened
scarlet tanager	*Piranga olivacea*	Bird	Ecological Indicator
white-tailed deer	*Odocoileus virginianus*	Mammal	Recreationally Valuable

Source: UniStar 2009a; MDNR 2007a
(a) Classified as Rare by the Maryland Natural Heritage Program.

Plants

Seven plant species that occur within the Calvert Cliffs site have met various importance criteria and have been classified as such. Two species, the showy goldenrod (*Solidago speciosa*) and Shumard's oak (*Quercus shumardii*), are listed as threatened in the State of Maryland. The spurred butterfly pea (*Centrosema virginianum*), although not Federally or State-listed, is classified as rare by the Maryland Natural Heritage Program. Chestnut oak (*Quercas prinus*), mountain laurel (*Kalmia latifolia*), New York fern, and tulip poplar are indicative of high-quality habitats and contribute significantly to ecological functions.

<u>Chestnut Oak (*Quercus prinus*)</u>

Chestnut oak is a common and widespread tree species in the eastern United States (USDA 2008d) indicating good ecological health. Unlike tulip poplars, they persist on dry, shallow, and rocky soils (eFloras 2008b) that can be found on the slopes surrounding stream bottoms on the Calvert Cliffs site. Many chestnut oaks are found on the slopes of the Johns Creek and

Goldstein Branch floodplains, providing stability to the steeper slopes. Mast produced by this oak also provides food resources for forest wildlife. Thus, this tree species contributes to the ecological function of Calvert Cliffs site's forest health and ecological stability.

Mountain Laurel (*Kalmia latifolia*)

Mountain laurel is common and widespread throughout the eastern one-third of the United States, from Maine to Florida and west to Louisiana and Indiana (USDA 2008a). It is an upland shrub that dominates the forested understory on the Calvert Cliffs site, including the proposed Unit 3 construction site and steep slopes of Johns Creek and Goldstein Branch. Mountain laurel's predominance in the landscape and widespread use by terrestrial wildlife make it important to the ecological function of the forested portions of the Calvert Cliffs site.

New York Fern (*Thelypteris noveboracensis*)

The New York fern is a common herbaceous plant widespread throughout much of eastern North America (USDA 2008h). Its presence indicates ecologically stable wetland and moist soil communities (USDA 2008h), and its predominance in the landscape contributes to the ecological integrity of the environments in which it occurs. It forms large continuous patches of dense groundcover throughout most of the Calvert Cliffs site forested lowlands and also partially up adjoining slopes, including within the proposed Unit 3 construction area.

Showy Goldenrod (*Solidago speciosa*)

The showy goldenrod, a State of Maryland threatened species, is a perennial forb that typically occurs in open areas where it receives full sun (USDA 2008g; UW 2008). Patches of showy goldenrod were observed in several locations around Camp Conoy during 2006 floral surveys conducted by UniStar contractors (NRC 1996; Tetra Tech NUS 2007a).

Shumard's Oak (*Quercus shumardii*)

Shumard's oak is distributed throughout the southern and eastern United States, west to Texas and north into Michigan (USDA 2008e), but it is not widely distributed in Maryland (USDA 2008f) It is found scattered throughout hardwood forest stands and is often associated with other oak species (USFS 2008b). Shumard's oak is in the red oak family and is very similar in appearance to red oak (*Quercas rubra*). It prefers moist, well-drained loamy soils that typically occur on upland sites. It was observed at multiple locations on the site within the Johns Creek floodplain in 2006 and 2007.

Spurred Butterfly Pea (*Centrosema virginianum*)

The spurred butterfly pea is a climbing forb found throughout the southeastern United States, as far north as southern New Jersey, along the Atlantic Coast. It occurs often in acidic, well-drained soils within forested or more open areas but has a wide tolerance of habitat conditions (USDA 2008b). It was previously reported on the Calvert Cliffs site southwest of the proposed Unit 3 construction area, and more recently observed in the Johns Creek floodplain west of the proposed Unit 3 (UniStar 2009a).

Tulip Poplar (*Liriodendron tulipifera*)

Tulip poplar, a common tree species throughout eastern and southeastern portions of the United States (USDA 2008c), is an indicator species of good ecological condition. The tulip poplar is an integral part of the flora of the Calvert Cliffs site. Tulip poplars establish in openings with moist, deep well-drained soils (USDA 2002). Many large specimens contribute structure to forest communities within the proposed construction area and surrounding areas.

Insects

Two Federally listed insects, the Puritan tiger beetle (*Cicindela puritana*) and the northeastern beach tiger beetle (*Cicindela dorsalis dorsalis*), inhabit sandy beaches and cliffs of the Calvert Cliffs site.

Northeastern Beach Tiger Beetle (*Cicindela dorsalis dorsalis*)

The northeastern beach tiger beetle is a Federally threatened species and endangered in the State of Maryland (55 FR 32088; MDNR 2007a). No critical habitat has been designated for the northeastern beach tiger beetle. Historically, the northeastern beach tiger beetle is a subspecies that occurred along the Atlantic Coast from Cape Cod south to central New Jersey and on the shores of the Chesapeake Bay in Maryland and Virginia. The species has been extirpated from Rhode Island, Connecticut, Long Island, and New Jersey, and the current distribution is limited to two sites in coastal Massachusetts and throughout the Chesapeake shoreline (FWS 1994). Chesapeake Bay populations now constitute a significant portion of the known population of northeastern beach tiger beetles. Additional range-wide distribution and life history information on this species can be found in Appendix M.

Adult northeastern beach tiger beetles have historically occurred on the Calvert Cliffs site on the northernmost 300-ft section of beach that borders Flag Ponds Nature Park, but none were observed during 2006 (Knisley 2006). No suitable breeding habitat, larvae, or burrows have been observed on the Calvert Cliffs site, and Knisley (2006) reports this species is not likely to have an established population on the site. However, it is likely the adults move south from the Flag Ponds population onto the Calvert Cliffs site.

Larvae of the northeastern beach tiger beetles are found in burrows on the beach in the upper intertidal to high drift zone where prey is abundant. Although burrows may be inundated at high tide, larvae have adapted by closing the burrow until water levels drop or may relocate to dig a new burrow in a more suitable location. They emerge as adults in mid June after two years of development, and adult populations peak shortly thereafter and decline through August. Adults are active on wider beach sections near the water's edge on warm, sunny days (FWS 1994). The larvae are parasitized by a wasp and are also susceptible to erosion, flooding, and food availability. Annual population levels of this species fluctuate widely, and localized extirpation and repopulation is likely a survival mechanism as adults are able to disperse widely. Marked individuals have been recovered 5-12 mi away, and some adults have been observed more than 50 mi from known populations. Larvae-to-adult survival may be as low as 5 percent, and causes for the low survival rate have been attributed to beach habitat destruction and direct mortality. Beach alteration resulting from stabilization, recreational beach use, and natural phenomena contribute to habitat destruction, while the latter two may also result in direct mortality (FWS 1994). A five-year review by the FWS is pending for the northeastern beach tiger beetle (73 FR 3991).

<u>Puritan Tiger Beetle (*Cicindela puritana*)</u>

The Puritan tiger beetle was Federally listed as threatened in 1970 due to its limited distribution coupled with threats from habitat loss and degradation, and vulnerability to natural and human threats (55 FR 32088). No critical habitat has been designated for the Puritan tiger beetle. A more recent status review of this species recommended the Puritan tiger beetle be reclassified to Federally endangered, but this finding is still under review (FWS 2007). It is also a State of Maryland endangered species (MDNR 2007b). The Puritan tiger beetle has a very limited distribution, only occurring in three known locations: the Chesapeake Bay shoreline in Calvert County, around the mouth of the Sassafras River in eastern Maryland, and along the Connecticut River in Connecticut and Massachusetts (FWS 1993). Additional range-wide distribution and life history information on this species can be found in Appendix M.

The larvae live in deep burrows excavated into sandy deposits on the high, steep bluffs of the Bay that are eroded and maintained by wave action. Adults prefer narrow, open sandy beaches found below such bluffs and are active both day and night. Adult beetle populations peak in late June to early July as they emerge from burrows after a two-year larval period. Little is known about adult dispersal, although some records indicate long-range dispersal of 25-30 mi may be possible. By August, only a few adults remain. Tiger beetles in general are carnivorous, and both the larvae and adult Puritan tiger beetles prey on invertebrates, with larvae catching prey at the burrow entrance. Adults are prey for other predators, including robber flies and spiders, and larvae are parasitized by a wasp. Larvae may also be susceptible to erosion during winter, the same forces that maintain the habitat they use. Shoreline development is the most serious threat to Puritan tiger beetle populations. Development often requires bank stabilization, and as banks are stabilized plant cover becomes established, reducing or eliminating occupation by this beetle species (FWS 1993). A population has been present on the beach and bluffs of the Calvert Cliffs site since 1997.

Amphibians

Eastern Narrow-Mouthed Toad (*Gastrophryne carolinensis*)

The eastern narrow-mouthed toad (*Gastrophryne carolinensis*) is the sole amphibian that is State-listed as endangered and critically imperiled in Maryland. Maryland is the northernmost state in which this species is known to occur (UMMZ 2008), and it has been found within Calvert County (MDNR 2007a; USGS 2008). Although named a toad, this species is actually a frog known to use a wide variety of habitats that provide adequate moisture and shelter throughout the southeastern United States (UMMZ 2008). The eastern narrowmouth toad finds shelter by burrowing in a wide variety of shaded moist habitats including conifer, hardwood, and mixed forests and woodlands. Breeding ponds can be either permanent or temporary shallow pools or even deep water if floating vegetation is present (UMMZ 2008). Males call from pond edges after adequate rain initiates breeding and eggs are deposited in small floating clusters. Primary prey includes ants, termites, and beetles.

A habitat evaluation was conducted to determine suitability of wetlands on the Calvert Cliffs site for eastern narrow mouthed toads (UniStar 2008c). Most wetlands on site contained moving water, which is unsuitable breeding habitat for this frog (UMMZ 2008). However, the pond at Camp Conoy and a swale in the Lake Davies area of the site were deemed suitable. Surveys were conducted repeatedly during 2008 per a Maryland DNR survey protocol. No eastern narrow-mouthed toad adults or larvae were observed (UniStar 2008c) and it is highly likely this species does not occur within the proposed construction area.

Birds

Important avian species on the Calvert Cliffs site include the bald eagle (*Haliaeetus leucocephalus*) and forest interior dwelling species (FIDS) represented by the scarlet tanager.

Bald Eagle (Haliaeetus leucocephalus)

The bald eagle was delisted by the FWS in 2007 (50 CFR Part 17). It is still afforded Federal protection under the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d) and also classified as threatened by the State of Maryland (MDNR 2007a). Bald eagle pairs defend a core-use area that encompasses a nest site and favored foraging perches (Stinson et al. 2007). Nest trees are usually large super-dominant trees away from human disturbance and within a mile of a large open water habitat, and nest sites are often reused. Foraging perches are prominent locations within sight of an open expanse of water (Stinson et al. 2007), such as along the top of the bluffs along the Chesapeake Bay.

Bald eagles typically lay eggs in March or April, and young fledge 12 weeks after a 35-day incubation period. Ideal nesting habitat is mature forest in close proximity to open water, such as the Chesapeake Bay or the Camp Conoy fishing pond. Bald eagles were observed on the Calvert Cliffs site during 2006 and 2007.

Scarlet Tanager (*Piranga olivacea*)

For the purposes of this EIS the scarlet tanager represents FIDS, a group of birds that function as indicators species because of their sensitivity to land management practices. FIDS require large forest areas to thrive (CAC 2000), and their absence from the landscape has been recognized as an indication of forest fragmentation (Donovan and Flather 2002; Keller and Yahner 2007; Villard et al. 1995). FIDS habitat, as defined by forest characteristics as outlined in the *Guide to the Conservation of Forest Interior Dwelling Birds in the CBCA* (CAC 2000), can be of two types:

1. Forested tracts at least 20.2 ac in size with 10 or more ac of its area greater than 300 ft from the nearest edge, with either a closed canopy or dominated by trees larger than 5 in. in diameter at breast height.
2. Riparian forests at least 50 ac in size with an average width of 300 ft along perennial streams with either a closed canopy or dominated by trees larger than 5 in. in diameter at breast height.

Using these guidelines, it appears Calvert County contains a substantial amount of FIDS habitat (Figure 2-11). The scarlet tanager was the most frequently observed of the 10 FIDS on the Calvert Cliffs site during the 2006 spring breeding season and occurs in the southern, southwestern, and western portions of the site (NRC 1996; Tetra Tech NUS 2007a). Scarlet tanagers nest within the mid story and canopy of extensively forested areas. They lay three to five eggs, which incubate for 13 to 14 days, and young fledge only 9 to 11 days after hatching (SMBC 2008). The scarlet tanager is a neotropical migrant that leaves the site during autumn and winter, which is why they were not recorded in surveys occurring within these seasons during 2006 and 2007. Although quite common, tanager populations have been declining in Maryland, and the cause is attributed to forest habitat fragmentation (CAC 2000).

Mammals

The white-tailed deer was the only terrestrial mammal determined to be an “important species” on the Calvert Cliffs site (UniStar 2009a). Due to extensive hunting in rural Maryland and also in Calvert County, white-tailed deer are a recreationally valuable species. They were observed in all cover types and were observed more frequently than other mammal species. White-tailed

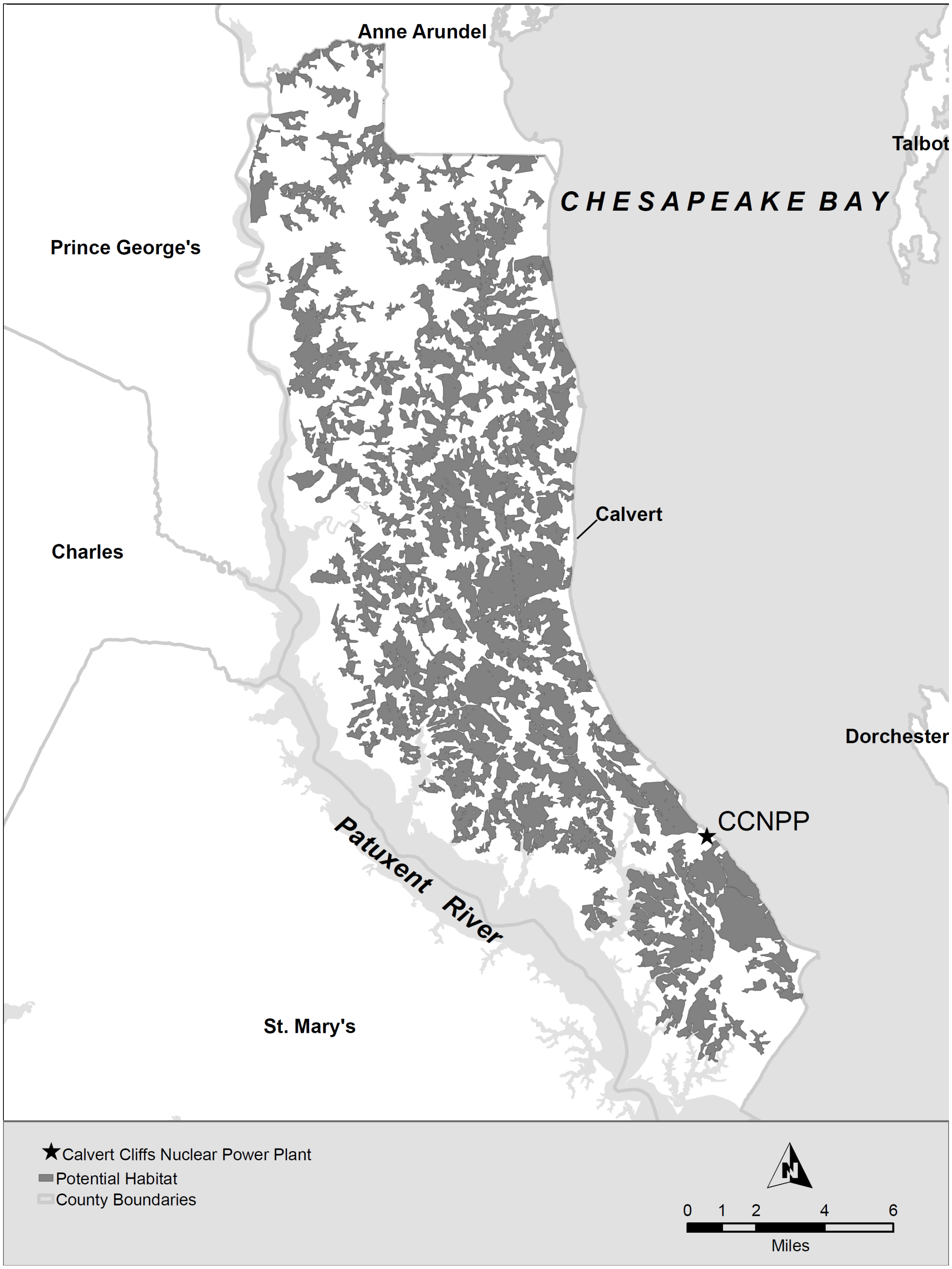

Figure 2-11. FIDS Habitat within Calvert County, Maryland

deer have adapted to many different habitats and are considered habitat generalists. White-tailed deer populations have benefited from landscape scale disturbances and have thrived in edge habitats-places where two or more distinct habitats meet such as where the edge of a forest meets an opening (Cadenasso and Pickett 2000). White-tailed deer breed annually in autumn, with peak activity occurring in November. Single fawns are born 200 to 210 days after conception, with twins and triplets common to does older than 1.5 years of age. Fawns retain their white spots and remain with their mother until the autumn after birth. Female white-tailed deer are sexually mature during their first winter, while males mature the year following birth.

Historically, large carnivores, such as wolves (*Canis lupus*) and cougars (*Puma concolor*), preyed on white-tailed deer and kept populations in balance. However, as a result of the elimination of these predators from much of their range coupled with land management practices that have fragmented the landscape, burgeoning white-tailed deer populations have become a management issue. Locally, some deer herds have exceeded the carrying capacity of their range and have damaged vegetation (Long et al. 2007; Rossell et al. 2007; Taverna et al. 2005), earning the reputation of a nuisance species requiring special management actions.

Habitats of Importance

Habitat is deemed important if it meets one of four criteria and occurs on lands that may be adversely affected by plant or transmission line building, operation, or maintenance. Set-aside lands, habitats designated by State/Federal governments to receive protection priority, wetlands/floodplains (see Section 2.4.1.1), and critical habitat designated as such for species Federally listed as threatened or endangered are all considered “important habitats” (NRC 2000). Although the Calvert Cliffs site does not contain any critical habitat for threatened or endangered species, there are State sanctuaries adjacent to the site, as well as both wetlands and lands that receive priority protections within the Calvert Cliffs site boundary.

Immediately north of the Calvert Cliffs site, the 327-ac Flag Ponds Nature Park managed by the Maryland DNR, has been set aside to preserve the diversity of landforms, natural vegetation, and wildlife habitats. This park contains beach habitat previously occupied by the Puritan tiger beetle and currently occupied by adult northeastern beach tiger beetles; both species are Federally threatened and State endangered. Calvert Cliffs State Park, a 1079-ac wildlands area, borders the Calvert Cliffs site to the south. The state park also contains cliff and beach habitats that host both listed species of tiger beetles.

Although the Calvert Cliffs site does not contain areas designated as critical habitat for threatened or endangered species, the State of Maryland, through the CBCA Act of 1984, established all land within 1000 ft of mean high water line of tidal waters or the landward edge of tidal wetlands and all waters of and lands under the Chesapeake Bay and its tributaries as critical area (CAC 2008d). In addition, regulations that are implemented through the CBCA

Commission establish protections for a 100-ft-wide, naturally vegetated, forested buffer landward from the mean high water line of tidal waters or from the edge of tidal wetlands and tributary streams of the Chesapeake Bay regardless of whether they actually occur within the CBCA (CAC 2008e). Lands within the CBCA are categorized by use and development intensity to prioritize conservation efforts. As mentioned in Section 2.2.1, the three categories are IDAs, LDAs, and RCAs. IDAs are plots at least 20 ac in size resulting from predominantly residential, commercial, institutional, or industrial land-use activities, with little or no natural habitat (CAC 2008f). Conservation of water quality and erosion management is emphasized within LDAs. Also important is forest cover, as conservation measures stipulate forest cover loss must be mitigated and/or created where development takes place in unforested LDA tracts. RCAs are natural environments or resource-utilization areas whereas agriculture, aquaculture, commercial forestry, or fisheries activities occur (CAC 2008f). New development in RCAs is limited to low intensity to preserve the natural character and allow habitat preservation. Best management practices (BMPs) must be employed to manage runoff, erosion, and excessive nutrient loading into wetlands.

The CBCA Commission has also established that interior forest habitat, defined as the area within a forest stand that lies greater than 300 ft from an open area such as pasture, agricultural fields, or lawn (CAC 2000), is an important habitat that must be managed within the Chesapeake Bay watershed. Interior forest habitats are critically important to FIDS and are found within the project area.

Aerial photographs indicate that parts of the Calvert Cliffs site harbor regionally important unfragmented forest tracts, including within the proposed construction area. Therefore, the forested areas on the site, including those close to Johns Creek in the proposed Unit 3 construction area, are valuable in sustaining local FIDS populations.

Each species listed as important in this document has different habitat requirements. As described previously, scarlet tanagers and other FIDS depend on interior forest, while white-tailed deer are habitat generalists and are not reliant on any single habitat component. Bald eagles nest in tall trees near open water, where they forage on fish, birds, and small mammals. Both species of listed tiger beetles, Puritan and northeastern beach, have very specific habitat requirements and limited distributions; these habitats are of very high value for the continued existence of both species. Conversely, all of the plants listed above as important are common, fairly widespread, and do not rely on any specific habitats within the Calvert Cliffs site.

Wetlands

Wetlands are distributed throughout Calvert County, Maryland. Most are associated with the Chesapeake Bay or with the Patuxent River, which forms the western boundary of the county and eventually drains in the Bay. Three cover types within the Calvert Cliffs site boundary are classified as wetlands and qualify as important habitats: well-drained bottomland deciduous forest, poorly drained bottomland deciduous forest, and herbaceous marsh. Boundaries of these habitats, as well as all wetlands, were established during 2006 by UniStar using the Corps

Wetlands Delineation Manual (Figure 2-12) (Environmental Laboratory 1987). The poorly drained forest bottomland deciduous forest and the herbaceous wetlands qualify as wetlands as defined in 33 CFR 328.3 of the Clean Water Act and Code of Maryland Regulations (COMAR) 26.23.01.01(B)(62) for the Maryland Nontidal Wetland Protection Act (COMAR 2007). Well-drained bottomland deciduous forest occurs within valley floodplains, but is not indicative of wetlands (Environmental Laboratory 1987).

UniStar's delineation methods followed Part IV, Section D, Subsection 2 of the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987) and the USACE memorandum on clarification and interpretation of that manual (USACE 1992). UniStar did not delineate any wetlands within the existing power block or the existing 500-kV transmission corridors.

The eastern portion of the Calvert Cliffs site mostly drains into the Chesapeake Bay through a series of unnamed intermittent and first-order perennial streams. Topography of the bluffs along the Chesapeake Bay precludes tidal influence into these streams. The portion of the delineation area west of Camp Conoy Road drains toward the Patuxent River, forming much of the headwaters of Johns Creek, the Goldstein Branch, and to a limited extent the Woodland Branch. Lake Davies, the dredge spoil area created during the building of CCNPP Units 1 and 2 drains into sediment basins that ultimately discharge into both Johns Creek and the Goldstein Branch.

UniStar determined that 58.2 ac of delineated wetlands exist within the Calvert Cliffs site wetland delineation area (State of Maryland 2008). For ease of characterization and discussion, the wetland delineation area was divided by UniStar into nine assessment areas. Each area is a contiguous wetland/aquatic area with a high degree of hydrological interaction and biological similarity. Assessment areas I, II, and III contain the small, unnamed streams that flow into the Chesapeake Bay (Table 2-2). Assessment areas IV, V, and VI form the Johns Creek watershed upgradient from the confluence with the Goldstein Branch. Assessment area VII is the Goldstein Branch watershed. Assessment area VIII is made up of seeps and headwaters that flow north toward the Woodland Branch, while area IX drains into the Calvert Cliffs site storm drain system developed during the building of CCNPP Units 1 and 2.

<u>Assessment Area I</u>

Wetlands in area I consist of three narrow stream channels contained within a poorly drained bottomland deciduous forest cover type defined by steep wooded embankments that are deeply incised and lack adjacent wetlands. Adjoining emergent vegetation patches are less than 3 ft wide; thus, the wetland boundary length is long with respect to the total jurisdictional wetland area. Two of the streams, which join just north of Camp Conoy and flow into the Chesapeake Bay, appear to be perennial, while the third, which also joins the other two, appears to be intermittent. This assessment area also includes an artificial storm water basin near the existing barge dock. This basin appears to have permanent open water as indicated by a narrow surrounding of emergent vegetation.

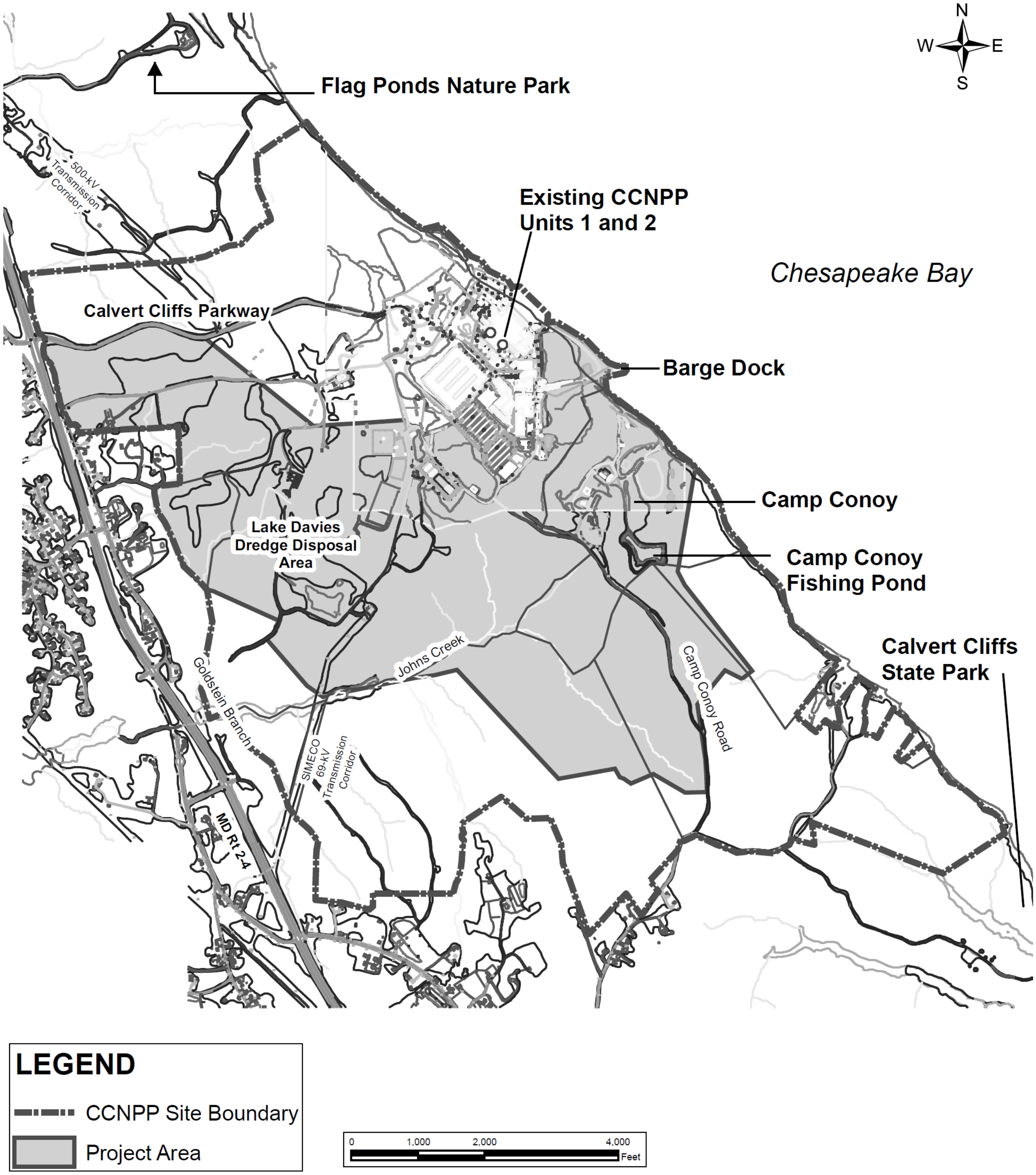

Figure 2-12. Calvert Cliffs Wetland Delineation Area (Tetra Tech NUS 2007a)

Table 2-2. Calvert Cliffs Site Delineated Wetland Summary Table

Assessment Area	Wetland Area (ac)	Wetland Boundary Length (ft)	Description
I	2.2	7500	Streams and bordering wetlands north of Camp Conoy, south of existing power block.
II	6.2	9900	Camp Conoy Fishing Pond and associated streams, seeps, and bordering wetlands.
III	0.8	4100	Stream and bordering wetlands in southeast corner.
IV	12.8	38,700	Headwaters of upper Johns Creek watershed.
V	9.1	12,500	Johns Creek main channel and bordering wetlands.
VI	14.0	6400	Old Lake Davies artificial sediment basins.
VII	11.6	27,200	Goldstein Branch main channel, tributaries, and headwaters.
VIII	0.4	3000	Headwaters on forested slope south of Calvert Cliffs Parkway.
IX	1.1	3000	Seeps, headwaters, and wetlands immediately west of existing Calvert Cliffs site parking lot.
Total	58.2	--	--

Source: State of Maryland 2008

<u>Assessment Area II</u>

This assessment area consists of the Camp Conoy Fishing Pond, three stream channels that feed the pond, the pond outflow stream, and three small isolated wetlands upgradient from the pond. The Camp Conoy Fishing Pond was constructed by excavating and impounding a stream channel with an earthen dam. The pond is a permanent open-water habitat with submergent and emergent wetland vegetation classified as herbaceous marsh cover type. It is fed by three small headwater streams located west and southwest of the pond. Each stream channel has bordering wetlands that range in width from 3 ft to more than 100 ft, classified as poorly drained bottomland deciduous forest. The fishing pond has an outlet stream that flows through an outflow pipe and then northeast to the Chesapeake Bay. The outlet stream also has two small impoundments with herbaceous marsh cover. Tidal influence is blocked by cliffs near the Bay. The three isolated wetlands upgradient of the pond are groundwater seepages that percolate back underground.

Assessment Area III

An unnamed perennial stream fed by four separate seepages and an intermittent stream constitute assessment area III. Four seepages merge to form the perennial stream, which is not sharply defined or confined within distinct banks. The seepages are under a mixed deciduous canopy. The intermittent stream carries surface runoff from land near Camp Conoy Road and is deeply incised and lacks adjacent wetlands. It merges with the perennial stream forming a patch of poorly drained bottomland deciduous cover that gets progressively wider downgradient to more than 50 ft wide.

Assessment Area IV

Two headwater subsystems and the associated wetlands that form the upper portion of the Johns Creek watersheds make up area IV. Assessment area IV is bounded by a ridge that is followed by Camp Conoy Road that separates this area from areas I, II, and III. One headwater stream subsystem is formed from a cluster of seepages near existing Calvert Cliffs site facilities. The other headwaters flow from private land south of the site. These two subsystems merge in a relatively flat area west of Camp Conoy under a mixed deciduous canopy, forming a poorly drained bottomland deciduous forest type surrounded by well-drained bottomland deciduous forest cover type. *Phragmites*, an invasive herbaceous marsh plant, dominates wetland areas where the forest canopy has opened up in area IV.

Assessment Area V

Assessment area V, like area IV, is in the Johns Creek watershed. Although the border between Areas IV and V is arbitrary, assessment area V consists of the main channel of Johns Creek, adjacent wetlands, and a few seepages that form intermittent streams on the slope immediately north of the main channel of Johns Creek. Seepages immediately south of Johns Creek are not included as they are outside the Wetland Delineation Area (Figure 2-12). The width of the Johns Creek floodplain ranges from about 100 to more than 200 ft in this assessment area, and cover types are similar to area IV as poorly drained bottomland deciduous forest is bordered by well-drained bottomland deciduous forest. The forest canopy is open over the wettest portions and herbaceous marsh vegetation dominated by *Phragmites* has become established. Although Johns Creek has tidal influence, this influence is limited to the area west of MD State Route 2/4, downstream of this assessment area.

Assessment Area VI

During the building of CCNPP Units 1 and 2, dredge spoils were deposited in a series of artificial sediment basins known as Lake Davies. These basins allow storm water runoff that accumulates within the dredge spoils to flow into Johns Creek and Goldstein Branch. These basins constitute assessment area VI. Wetland vegetation, classified as herbaceous marsh, is dominated by dense stands of *Phragmites* throughout area VI. The upper basin appears to have been excavated to a level below the water table and provides deep, open water at the center.

Assessment Area VII

The entire Goldstein Branch, including the main channel, seepages, and streams that make its headwaters, and adjacent wetlands make up assessment area VII. Many seepages make up the headwaters originate on steep (15 percent) slopes and flow into a relatively level floodplain of the Goldstein Branch that reaches widths of 150 ft. There is also an isolated depression within the Lake Davies dredge spoil area that is likely hydrologically associated with Goldstein Branch. Since Goldstein Branch is a tributary of Johns Creek, this area is connected to areas IV, V, and VI. Goldstein Branch headwaters occur under a mixed deciduous forest. The floodplain supports poorly drained bottomland deciduous forest and areas of open canopy again support herbaceous marsh dominated by stands of *Phragmites*.

Assessment Area VIII

Assessment area VIII includes small headwaters and adjacent wetlands located on the forested slope immediately south of the Calvert Cliffs Parkway and the stream they form. This stream forms 150 ft south of the Parkway and then flows north under the Parkway to Woodland Branch. The wetlands border is defined by the change from the poorly drained bottomland deciduous forest to the mixed deciduous forest.

Assessment Area IX

Assessment area IX is created by seepages, headwaters, and adjacent wetlands within a mixed deciduous forest stand immediately west of the existing Calvert Cliffs site parking lot. It is a remnant of a stream system that originally flowed into Chesapeake Bay but was graded and filled during building of CCNPP Units 1 and 2. Now storm water runoff around the existing switchyard gathers in a ditch and merges with flow from the seepages and enters a storm drain system discharged into assessment area I. Dense *Phragmites* stands dominate assessment area IX.

Calvert County

Wetlands are distributed throughout Calvert County, Maryland. Most are associated with the Chesapeake Bay or the Patuxent River, eventually draining into the Bay (Figure 2-13). Nontidal wetlands that best represent nontidal wetland habitats classified as nontidal wetlands of Special State Concern often contain threatened or endangered species and unique or rare habitats (MDE 2008). Although the Calvert Cliffs site does not contain any nontidal wetlands of Special State Concern, tidal beaches immediately north of the site host the northeastern beach tiger beetle are of special concern and are protected as such.

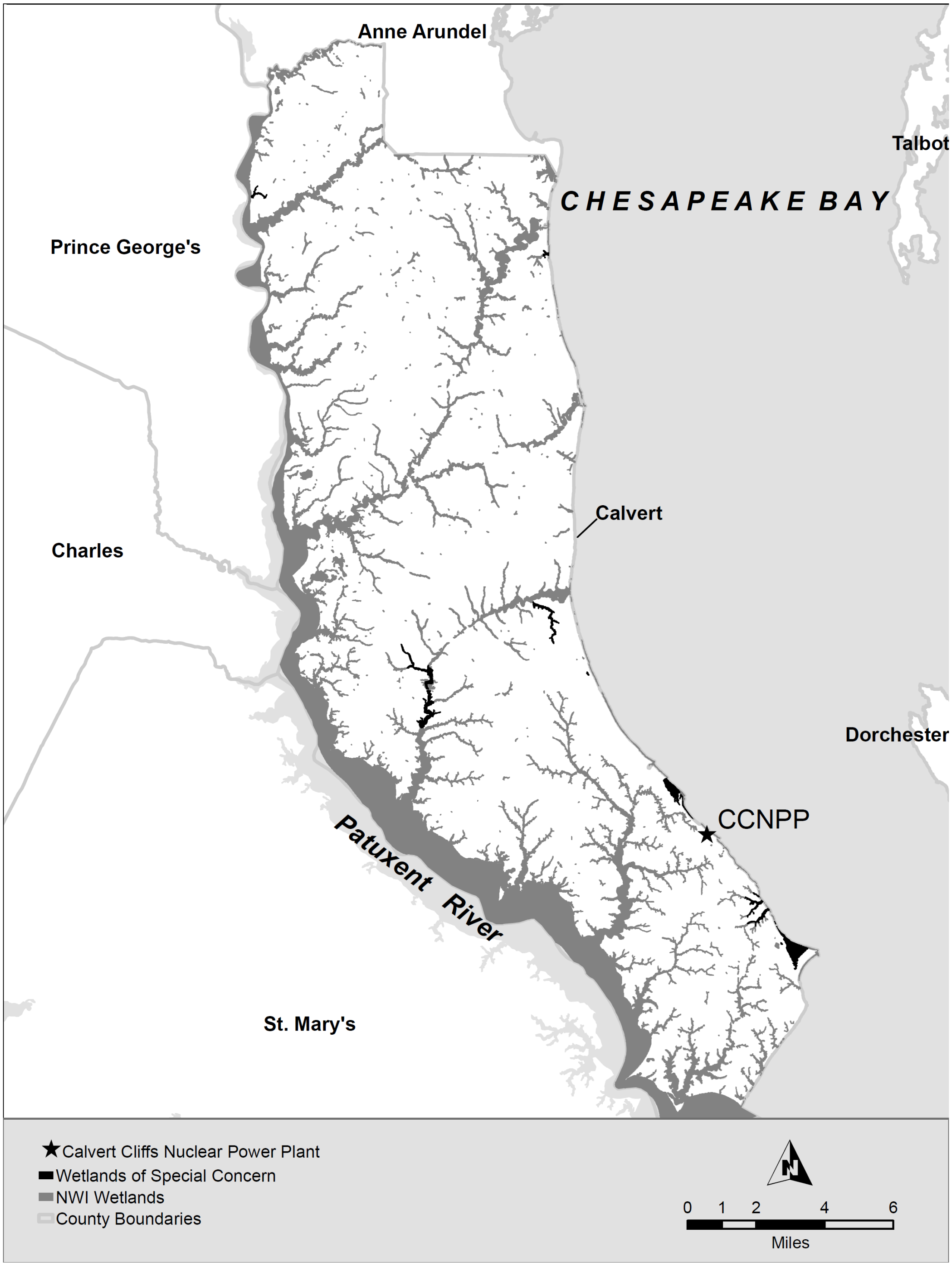

Figure 2-13. Vicinity Wetlands in Calvert County, Maryland

Disease Vector and Pest Species

In epidemiology, a vector does not cause a disease, but instead spreads infection from one host to another. Numerous disease vectors exist in the animal kingdom. Blood-sucking insects such as mosquitoes, ticks, and fleas are widely known to transmit disease to both animals and humans. Mammals such as bats, raccoons, and skunks (*Mephitidae* spp.) have also been implicated in the spread of disease. Although many vector species likely occur on the Calvert Cliffs site, the deer tick (*Ixodes scapularis*) is likely the only one of consequence, spreading the non-fatal yet debilitating Lyme disease. After feeding on an infected host, the deer tick transmits the disease-causing bacterium *Borrelia burgdorferi* through feeding on subsequent hosts (CDC 2008c).

The gypsy moth (*Lymantria dispar*) is the most destructive forest pest in the State of Maryland (MDA 2008). Gypsy moth caterpillars forage on oak leaves and the leaves of other tree species, and high infestations have resulted in defoliated trees and affected large land areas. However, the Maryland Department of Agriculture monitors the presence and severity of infestations, applying treatments when necessary. Evidence of earlier infestations was not observed on the Calvert Cliffs site. However, future infestations of gypsy moths are possible at the site because the habitat is suitable.

Two non-native invasive plant species were observed on the site during 2006: *Phragmites* and Japanese stiltgrass (*Microstegium vimeneum*). The widespread *Phragmites* forms dense monocultures within wetlands and moist soils, eliminating other native wetland plants and changing wetland ecology. Although native, it is believed *Phragmites* monocultures are resultant of non-native genotypes. Japanese stiltgrass is a shade-tolerant invader of forested floodplains (USFS 2008c) and has been found in scattered groundcover patches within the Calvert Cliffs site's forests. It also invades where soil disturbance allows establishment and can displace native floodplain plant species.

2.4.1.4 Terrestrial Ecology Monitoring

There are no known ecological or biological studies ongoing or planned at the Calvert Cliffs site.

2.4.2 Aquatic Ecology

The aquatic habitats associated with the Calvert Cliffs site include several small headwater streams, small ponds, and the Chesapeake Bay. The site is located on the western shore of Chesapeake Bay, which is the largest and most important aquatic resource near the plant. Other primary aquatic habitats near the site include St. Leonard Creek and the Patuxent River.

2.4.2.1 Freshwater Habitats – Site and Vicinity

Most of the freshwater streams on the site are small, intermittent or perennial streams that flow offsite into St. Leonard Creek, which is a subwatershed within the Lower Patuxent River watershed. A few small streams belonging to the Lower Western Shore watershed flow from the site directly into Chesapeake Bay. Several small, artificial ponds exist on the site.

Existing Natural and Anthropogenic Stressors

The Maryland Biological Stream Survey (MBSS) was established to ascertain the status of the biological resources in Maryland's streams (Roth et al. 2005). Data from the MBSS probability-based sampling program provide for general characterization of conditions within each of the 23 counties in the State and Baltimore City, which is considered equivalent to a county. This information was used to consider the conditions of the streams in and around Calvert County, including those on the site. Southerland et al. (2005b) focused on five key stressors – acidification (the process by which the acid balance in a stream changes from neutral towards increasing acidity), nutrients (particularly nitrogen and phosphorus), physical habitat changes (water temperature, sedimentation, channelization, bank erosion), biotic interactions (non-native and invasive aquatic biota), and land use changes (conversion into agricultural or urban areas).

Overall Condition of Calvert County Streams

Some conditions listed in the 2003 Lower Patuxent River characterization report as potential issues for the watershed are relevant to evaluating the ecological conditions of streams on the Calvert Cliffs site. About 42,600 ac of wetlands within the watershed had been lost by about 1998, which is a comparatively large loss relative to other Maryland watersheds (MDNR 2004). Streams in the Lower Patuxent River watershed are generally less buffered by trees than many other watersheds in the State.

Urbanization is one of the major stressors affecting streams in Calvert County (Kazyak et al. 2005). The amount of impervious surface within the St. Leonard Creek subwatershed, which includes Johns Creek (its tributaries Goldstein Branch, Laveel Branch, and Branches 3 and 4) and part of Woodland Branch on the Calvert Cliffs site, is about 0.9 percent (MDNR 2004).

Maryland DNR (2004) defined several kinds of ecologically important areas, including Ecologically Significant Areas (imprecisely defined areas where rare or protected species, or other important natural resources have been identified), Contiguous Forest Areas (large sections of interior forest with at least 250 contiguous ac), and Conservation Areas (lands protected by public and private organizations), that occur on the Calvert Cliffs site. Branch 4 and Laveel Branch (both part of the Johns Creek system) are shown as occurring within an Ecologically Significant Area (MDNR 2004). Johns Creek is in a Contiguous Forest Area (MDNR 2004). The general ecological condition of streams in Calvert County from 2000 to

2004, based on fish, benthic, and combined biotic indices, was poor (Kazyak et al. 2005). Physical habitat was at least partially degraded in 88 percent of the streams in Calvert County (Kazyak et al. 2005). The primary physical habitat issue for Calvert County streams was bank erosion. For key chemical constituents, most streams had phosphorus levels greater than those shown to affect streams (Kazyak et al. 2005). The two most widespread stressors among county streams were invasive plants and areas with urban land use occupying greater than 5 percent of the watershed (Kazyak et al. 2005).

Watersheds

Streams on the Calvert Cliffs site flow into one of two watersheds. The Lower Patuxent River watershed drains about 80 percent of the land area on the site and the Lower Western Shore watershed drains the remaining 20 percent (UniStar 2007).

<u>Lower Patuxent River</u>. Conditions within the Lower Patuxent River watershed can be estimated from the 2000 to 2004 MBSS data from the entire Patuxent River watershed (Southerland et al. 2005c). The Lower Patuxent River rated "good" for the amount of trash in the streams, appropriate pH levels, high acid neutralizing capacity (ANC) values, low nitrate-nitrogen, and high dissolved oxygen content. The system rated "fair" for combined biotic integrity (fish integrity rated poor) and for overall physical habitat quality (partially degraded). Total phosphorus levels in the Lower Patuxent River watershed were high.

<u>Lower Western Shore</u>. The Lower Western Shore watershed rated good in 2000 to 2004 for the amount of trash in the streams, appropriate pH levels, high ANC values, low nitrate-nitrogen, and high dissolved oxygen content (Southerland et al. 2005c). The system rated "fair" for overall physical habitat quality (partially degraded) and poor for combined biotic integrity (fish integrity rated very poor). Total phosphorus levels in the watershed were moderate.

Onsite Streams and Ponds

The Calvert Cliffs site contains the headwaters of several streams that eventually flow offsite. West of Camp Conoy is a system of headwater streams that join to form Johns Creek, which flows west to St. Leonard Creek off the site (Tetra Tech NUS 2007b). Headwater streams are small, intermittent or perennial first- or second-order streams (Freeman et al. 2007) that typically occupy small catchment basins, have small channels, and typically have lower fish diversity and abundance than larger streams (Richardson and Danehy 2007). Headwater streams connect terrestrial and downstream ecosystems by transporting sediment, nutrients, and organic debris (particularly fallen leaves) downstream (Gomi et al. 2002; Freeman et al. 2007). Headwater streams strongly affect the quality and quantity of the water found downstream (Alexander et al. 2007) and provide unique habitats that offer potential refuge from predation for some species, respite from competition for some taxa, and trophic links to some terrestrial animals via the emergence of adult insects from the larval or juvenile stages that inhabit streams (Baxter et al. 2005; Meyer et al. 2007; Richardson and Danehy 2007).

UniStar sampled the fish and invertebrate faunas inhabiting two streams and four freshwater impoundments on the Calvert Cliffs site were sampled during two seasonal surveys, September (i.e., fall) 2006 and March (i.e., spring) 2007 (EA Engineering 2007a). Two locations, one upstream and one downstream, were sampled in Johns Creek. One location each was sampled in Goldstein Branch, Pond 1, and Pond 2. Three locations each were sampled in Lake Davies and Camp Conoy fishing pond. Fish and invertebrate sampling followed standard methods outlined in the Maryland Stream Sampling Manual (MDNR 2001). Stream-dwelling epibenthic invertebrates were grouped into the seven categories used to calculate a Benthic Index of Biotic Integrity (B-IBI) based on criteria established for Maryland Coastal Plain streams (Southerland et al. 2005a). The B-IBI is used to categorize the ecological conditions in Maryland streams as very poor, poor, fair, and good. Habitats in Johns Creek and Goldstein Branch were characterized during the 2006 and 2007 surveys by following standard EPA guidelines and State of Maryland procedures (Barbour et al. 1999; MDNR 2001; EA Engineering 2007a). An additional field survey for benthic invertebrates was conducted in April 2008 at selected locations on the Calvert Cliffs site that were not sampled in the 2006 and 2007 surveys (UniStar 2008a).

<u>Johns Creek</u>

Johns Creek is about 3.5 mi long and is the major freshwater stream on the Calvert Cliffs site (UniStar 2007). Johns Creek is comprised of several tributaries, including Branches 3 and 4, Goldstein Branch, Laveel Branch, and several unnamed tributaries (Figure 2-8). Most of the headwater tributaries of Johns Creek originate on the site and are within or very near the location of the proposed Unit 3 (UniStar 2008a). The Johns Creek headwaters originate via groundwater discharges at distinct seepage areas. Goldstein Branch, which receives runoff from Lake Davies, is a major tributary of Johns Creek, entering the creek near the western boundary of the Calvert Cliffs site. Johns Creek flows west into St. Leonard Creek and is nontidal. The water quality and fauna of Branch 4 and Laveel Branch have not been characterized.

Several water quality parameters (dissolved oxygen, pH, total phosphorus, total nitrogen) measured in Johns Creek in 2006 and 2007 can be evaluated by comparing their values to the low, moderate, and high thresholds used by the MBSS to define conditions in streams (Southerland et al. 2005b). Ammonia nitrogen could not be evaluated because the detection limit used by the aquatic surveys (1.0 mg/L) was greater than the high threshold value (0.07 mg/L) used by the state. Most of the parameters measured in Johns Creek that could be evaluated were rated good (EA Engineering 2007a). Only total phosphorus rated moderate at both steam locations for both surveys. Total nitrogen and pH rated moderate at the upstream location in the fall 2006, but improved by the following spring. Organic contaminants were not detected in Johns Creek water samples (EA Engineering 2007a). Of the five metals detected in the waters of Johns Creek, only barium is considered a pollutant by the EPA, but there are no freshwater criteria for barium (EPA 2002).

The upstream location sampled in Johns Creek had only one fish species, the eastern mudminnow (*Umbra pygmaea*), caught during the fall survey (EA Engineering 2007a). In spring 2007, the least brook lamprey (*Lampetra aepyptera*) and the eastern mudminnow were caught at the upstream station. The downstream location that was sampled had much greater fish abundance and species numbers. Eight species were collected during each survey. Creek chubsucker (*Erimyzon oblongus*) and pumpkinseed (*Lepomis gibbosus*) were the predominant fish caught in the fall, together accounting for about 55 percent of the total catch. In the spring, the American eel (*Anguilla rostrata*) was the predominant species caught, with 45 individuals accounting for about 46 percent of the total catch. Tesselated darter (*Etheostoma olmstedi*), creek chubsucker, and pumpkinseed were also common, together accounting of about 43 percent of the total catch in 2007 (EA Engineering 2007a). The predominant fish species occurring in Johns Creek, except the American eel, are those among the most tolerant of various pollutants, increased acidity, and other stressors (Southerland et al. 2005a, b).

The epibenthic invertebrate community at the upstream location sampled in the fall 2006 was moderately abundant (1628 individuals) and was characterized primarily by midge larvae (Chironomidae), true fly larvae, and oligochaete worms (EA Engineering 2007a). Invertebrate abundance was much lower in the spring 2007 (591 individuals) and was characterized primarily by midge larvae, oligochaete worms, and damselfly larvae (EA Engineering 2007a). The downstream community sampled in the fall was moderately abundant (1414 individuals) and was characterized by the amphipod *Gammarus* sp., which accounted for about 51 percent of the total abundance at the location (EA Engineering 2007a). Several species of midge larvae were also common. Similar to the upstream location, abundance at the downstream location was much reduced in the spring 2007 when only 247 individuals were captured in the dip net. The amphipod *Gammarus* sp. was still the predominant taxon, accounting for about 27 percent of the sampled community (EA Engineering 2007a). Both sites were rated “fair” by the B-IBI in the fall and spring as B-IBI scores ranged from 3.0 to 3.9. Both sites were rated high for numbers of taxa in both seasons, but both were rated low for the percentage of intolerant taxa in the fall 2006 surveys (EA Engineering 2007a). The B-IBI scores calculated for the downstream location in the fall and both locations in the spring were greater than the average Calvert County value of 3.3 calculated for 2000 to 2004 (Kazyak et al. 2005). The B-IBI score for the upstream location in the fall was lower than the Calvert County average value for 2000 to 2004.

The assessments conducted in 2006 and 2007 scored the stream habitat at the downstream location of Johns Creek slightly higher than that at the upstream location. However, the overall habitat at both locations was rated optimal, the highest habitat quality category (EA Engineering 2007a). There were no differences in habitat quality between seasons. Some individual habitat parameters scored less than optimal at both locations. For example, at the upstream location, pool variability was poor, epifaunal substrate was marginal, and sediment deposition was suboptimal in the fall. The downstream location was rated marginal for sediment deposition and suboptimal for pool variability in the fall.

Three additional headwater tributaries on Johns Creek in the area were sampled by UniStar's contractors for invertebrates in April 2008. No fish collections were made. All of these unnamed tributaries were farther upstream than the locations sampled in 2006 and 2007. One headwater stream subsystem (Branch 3) and its associated wetlands originate at a cluster of seeps near existing CCNPP facilities. The stream flows southwest until it meets the Johns Creek mainstem. The other headwater stream subsystem and its associated wetlands originate at seeps on privately owned, forested land south of the Calvert Cliffs site. This stream, which is located near the proposed cooling tower location, flows generally to the northwest. The two stream subsystems merge about 1800 ft west of Camp Conoy (UniStar 2008a).

These three streams were sampled for benthic invertebrates at locations designated as UT-JC-101, UT-JC-102, and UT-JC-103. The two most upstream locations, UT-JC-101 and UT-JC-102, barely met the minimum requirements for benthic invertebrate sampling as specified by MBSS guidelines (MDNR 2001). The location UT-JC-103 was sampled to represent the upstream watershed and stream characteristics of three smaller reaches occurring farther upstream on this tributary. The invertebrate communities at all three locations were similar, rating fair per MBSS guidelines. Key invertebrates were the larvae of stoneflies, mayflies, and caddisflies, although amphipods were common at location UT-JC-103 (UniStar 2008a).

Habitat at each of the three locations was rated suboptimal per EPA guidelines. However, there were differences among the locations. Habitat quality was higher at location UT-JC-102, which scored only one point below the threshold for optimal habitats, than at the other locations. Habitat quality was lower at location UT-JC-101, which rated slightly greater than the threshold for poor habitats (UniStar 2008a).

Two additional locations were sampled in April 2008, both in areas proposed for potential restoration. One location was in the main creek channel just downstream from location UT-JC-103. This invertebrate community was distinguished by amphipods and stoneflies and was rated good by MBSS criteria (UniStar 2009c). The fifth location sampled in Johns Creek was on a downstream tributary. The invertebrate community was characterized by midges and stoneflies and was rated fair by MBSS guidelines.

<u>Goldstein Branch</u>

Goldstein Branch is a tributary of Johns Creek that generally flows from the north along the Calvert Cliffs property boundary entering the creek at the property boundary just east of highway MD State Route 2/4 (UniStar 2007; TetraTech NUS 2007b). Most of the headwaters of

Goldstein Branch originate on the Calvert Cliffs site. This headwater system is distinct from that comprising upper Johns Creek (Tetra Tech NUS 2007b). A tributary flowing from the east carries water from Lake Davies into Goldstein Branch.

Of the water quality parameters measured in Goldstein Branch, only total phosphorus exceeded the high Maryland DNR threshold. All other parameters were lower than the respective Maryland DNR low threshold values (EA Engineering 2007a). Organic contaminants were not detected in Goldstein Branch water samples (EA Engineering 2007a). Of the five metals detected in the waters of Goldstein Branch, only barium is considered a pollutant by the EPA, but there are no freshwater criteria for barium (EPA 2002). Barium levels in Goldstein Branch (33 to 53 mg/L) were higher than in any other onsite waterbody except Lake Davies.

Nine fish species were collected from the single station sampled in Goldstein Branch. The tessellated darter and American eel were the two predominant species collected in both surveys, together accounting for about 66 and 67 percent of the total fish collected in 2006 and 2007, respectively (EA Engineering 2007a). Blacknose dace (*Rhinichthys atratulus*) was also abundant in spring 2007. The predominant fish species occurring in Goldstein Branch, except the American eel, are those among the most tolerant of various pollutants, increased acidity, and other stressors (Southerland et al. 2005a, b).

The epibenthic invertebrate community in Goldstein Branch was moderately abundant in the fall 2006 and was characterized primarily by the snail *Physa* sp., the midge larva *Microtendipes* sp., the amphipod *Gammarus* sp., and oligochaete worms. Abundance decreased by the spring 2007. Characteristic fauna included the amphipod *Gammarus* sp., two species of midge larvae, and the snail *Physa* sp. (EA Engineering 2007a). The B-IBI scores rated the stream as poor in the fall and fair in the spring with B-IBI scores of 2.7 and 3.6, respectively (EA Engineering 2007a). Goldstein Branch was rated high for number of taxa and number of scrapers (animals that scrape small algae off the stream substrates for food) in both seasons. The stream was rated low for percentage of taxa intolerant of chemical contamination in both seasons. The B-IBI score calculated for the Goldstein Branch in the spring was greater than the average Calvert County value of 3.3 calculated for 2000 to 2004 (Kazyak et al. 2005).

The assessments conducted in 2006 and 2007 scored the overall stream habitat in Goldstein Branch as optimal (EA Engineering 2007a). However, some individual habitat parameters scored less than optimal. For example, pool variability was poor and sediment deposition was marginal during both seasons.

Two upstream locations of Goldstein Branch were sampled for benthic invertebrates in April 2008. Invertebrate abundance was relatively low, and the fauna at both locations was characterized by amphipods (UniStar 2008a). The invertebrate communities were rated poor and very poor by MBSS standards (UniStar 2009c).

Woodland Branch

Woodland Branch is a small stream that has three unnamed branches on the northern edge of the Calvert Cliffs site that meet off the site to form the mainstem stream that eventually flows into St. Leonard Creek. Woodland Branch is located within a Contiguous Forest Area (MDNR 2004). The downstream main branch, which is off the site, is listed as an Ecologically Significant Area (MDNR 2004). No recent fish surveys were conducted in Woodland Branch. Two sections of the stream that may be potential restoration sites were sampled for benthic invertebrates in April 2008 (UniStar 2009e). The downstream location was characterized by Ephemeroptera-Plecoptera-Trichoptera (EPT) taxa, which are considered indicators of habitat conditions in streams (Wallace et al. 1996). The upstream location was characterized by amphipods, midge larvae, and mayflies. The invertebrate communities at the two locations were rated good and fair, respectively, by MBSS criteria. Water quality in Woodland Branch was not determined.

Branches 1 and 2

Branch 1, also called Conoy Creek, is a complex of systems that includes Camp Conoy fishing pond and associated wetlands and streams (Figure 2-8) (UniStar 2008a). This stream ultimately discharges into Chesapeake Bay. Ponds 1 and 2 are part of this system. No recent fish or invertebrate surveys included Branch 1. Water quality in Branch 1 was not determined.

Branch 2, also called Lone Creek, is a system of wetlands and streams that drain the area to the north of Camp Conoy fishing pond (Figure 2-8) (UniStar 2008a). One stream, which has short-lived flow upstream and intermittent flow downstream, originates near the northwest corner of Camp Conoy and flows to the north and east. A second, perennial stream originates as the outflow from an existing manmade storm water basin south of CCNPP Units 1 and 2. The two streams meet north of Camp Conoy and flow east, entering Chesapeake Bay just south of the existing CCNPP Units 1 and 2 Barge Dock. A third, small stream originates north of the central part of Camp Conoy and flows north to the main stream. The perennial and intermittent stream channels are deeply incised and generally lack adjacent vegetated wetlands. In April 2008, benthic invertebrates were sampled at one upstream location within the section of Lone Creek that would be affected by the building of the new unit and one downstream location that is being proposed as a potential restoration site. Invertebrates found at the upstream location consisted primarily of amphipods, midge larvae, and true fly larvae. Flatworms (Turbellaria), stoneflies, mayflies, and caddisflies were also found. The invertebrate community at this location was rated fair by MBSS standards (UniStar 2008a). The downstream potential restoration site was characterized primarily by amphipods and midge larvae (UniStar 2009e). The invertebrate community at this location was rated very poor by MBSS standards. Water quality in Branch 2 was not determined.

Ponds 1 and 2

Ponds 1 and 2 are two small impoundments associated with the outflow from Camp Conoy fishing pond (Tetra Tech NUS 2007b). Both ponds are shallow, with water depths generally less than 2 ft.

The dissolved oxygen concentration measured during the fall 2006 survey was moderate (about 3.2 mg/L) in Pond 1 but was extremely low (<1.0 mg/L) in Pond 2. Dissolved oxygen content in both ponds recovered to high levels (>11.0 mg/L) by the following spring (EA Engineering 2007a). Total phosphorus in both ponds exceeded the Maryland DNR high threshold in Pond 1 during both surveys and in Pond 2 in the fall 2006, and was moderate in Pond 2 in the spring 2007. Total nitrogen was low in Pond 2 in both seasons and was moderate in Pond 1 in the fall 2006, but decreased considerably by the following spring. Of the five metals detected in the waters of Ponds 1 and 2, only barium is considered a pollutant by the EPA, but there are no freshwater criteria for barium (EPA 2002). Organic contaminants in Ponds 1 and 2 were not analyzed.

Five fish species were collected from Ponds 1 and 2 during the 2006–2007 surveys. Eastern mosquitofish (*Gambusia holbrooki*) and green sunfish (*Lepomis cyanellus*) were the predominant species in Pond 1 in the fall 2006 survey, accounting for about 84 percent of the fish caught in the pond. Fewer fish were caught in Pond 1 during the spring 2007 survey, and American eel replaced mosquitofish as the numerically dominant species, with green sunfish also common (EA Engineering 2007a). Fish were much less abundant in Pond 2 in fall 2006, with only eight individuals caught. More fish were caught in the spring 2007, with green sunfish and American eel predominant, accounting for about 91 percent of the total catch. Tubificid (oligochaete) worms comprised the most abundant epibenthic invertebrate taxon in both ponds in 2006, accounting for 55 and 28 percent of the fauna in Ponds 1 and 2, respectively (EA Engineering 2007a). The small clam, *Musculium* sp., was also relatively abundant in Pond 2, accounting for 28 percent of the individuals captured. Naidid worms, which were not present in either pond in 2006, were the most abundant fauna in the spring 2007 survey, accounting for 84 and 39 percent of the fauna in Ponds 1 and 2, respectively (EA Engineering 2007a). The numbers of EPT taxa in both ponds were few (0–1 taxon) regardless of season. Invertebrates inhabiting the sediments within Ponds 1 and 2 were less abundant in the fall than in the spring (EA Engineering 2007a). Relatively few taxa comprised either community with 9 to 13 taxa recorded in the fall and 6 to 18 taxa recorded in the spring for the respective ponds. Oligochaete worms, midge larvae, and true fly larvae were predominant in both ponds in the fall with oligochaetes most abundant in Pond 1 and the fly larva *Chaoborus* sp. was most abundant in Pond 2. In the spring, tubificid worms were the most abundant taxon in both ponds, accounting for 85 and 52 percent of the community in Ponds 1 and 2, respectively.

Lake Davies

The Lake Davies area is the site where material dredged from Chesapeake Bay during the building of Units 1 and 2 was placed (UniStar 2008a). Three settling ponds were formed as water was decanted from the dredged material. The larger pond encompasses about 0.53 ac and is vegetated by the invasive reed *Phragmites australis*. Water depth is not known but depends considerably on the amount of recent precipitation.

Surface water dissolved oxygen levels were moderate (3.4–4.0 mg/L) during the fall 2006 survey but were much higher the following spring (EA Engineering 2007a). Total phosphorus levels exceeded the Maryland DNR high high standard in the fall but were moderate the following spring. Total nitrogen was moderate in the fall but very low the following spring. Of the five metals detected in the waters of Lake Davies, only barium is considered a pollutant by the EPA, but there are no freshwater criteria for barium (EPA 2002). The concentrations of calcium, magnesium, potassium, and sodium were much greater than in any other onsite waterbody that was sampled. Organic contaminants in Lake Davies were not analyzed.

Only one fish species, the eastern mosquitofish, was collected from Lake Davies during aquatic surveys conducted on the Calvert Cliffs site. An average of 27 individuals per stations was found in the fall 2006 (EA Engineering 2007a). No fish were collected from Lake Davies in the spring 2007 (EA Engineering 2007a). Fewer invertebrate taxa were captured in samples from Lake Davies in the fall 2006 than in the spring 2007 (EA Engineering 2007a). Epibenthic invertebrate abundance was highly variable among the three samples collected by dip net in the lake during either survey and was lower in the fall than in the spring (EA Engineering 2007a). Chironomid insect larvae (midges) were the most abundant invertebrates in the lake and accounted for the largest number of taxa. Only one EPT taxon was found in Lake Davies. Only three taxa were found inhabiting the sediment within Lake Davies in the fall 2006 with low abundances at the three locations sampled. Eighteen taxa were collected from the sediment in Lake Davies in the spring 2007 when abundances were greater (EA Engineering 2007a). The larvae of one true fly taxon and two midge species were predominant.

Camp Conoy Fishing Pond

The Camp Conoy fishing pond (also known as Lake Conoy) is an artificial impoundment that was probably created for recreational fishing and boating when the land was part of a YMCA camp (UniStar 2008a). One side of the pond, which encompasses about 2.6 ac, consists of a dam over which a paved road traverses. The pond banks are lined with forest and grass; emergent vegetation, including *Phragmites*, occupies the shallow nearshore area. Water depth is not known, but estimated to about 5 ft at the deepest. A corrugated pipe provides the outflow from the pond, which varies in water level by about 2 to 3 ft annually. Water levels in the pond are no longer managed actively. The fish and invertebrate faunas in the pond were sampled in 2006 and 2007.

Water quality within the pond generally was good with only total phosphorus concentrations exceeding the Maryland DNR low threshold value (EA Engineering 2007a). Of the five metals detected in the waters of Camp Conoy fishing pond, only barium is considered a pollutant by the EPA, but there are no freshwater criteria for barium (EPA 2002). The concentrations of these metals in Camp Conoy fishing pond were among the lowest of any of the waterbodies on the site that were sampled. Organic contaminants in Camp Conoy fishing pond were not analyzed.

Aquatic surveys conducted at the fishing pond in fall 2006 and spring 2007 determined that the fish community was comprised of seven species and was numerically dominated by bluegill (*Lepomis macrochirus*), which accounted for about 79 and 82 percent of the fish caught in the pond in the fall and spring, respectively (EA Engineering 2007a). The eastern mosquitofish was the second most abundant species caught in the pond in the fall 2006 survey, accounting for 17 percent of the total abundance, but it was not present in the spring 2007.

More epibenthic invertebrate taxa were found in the dip net samples collected from Camp Conoy fishing pond than any other pond on the Calvert Cliffs site. Averages of 26 and 30 taxa were found in the fall 2006 and spring 2007, respectively. Abundance was variable, was lower in the fall than in the spring (EA Engineering 2007a). Midge larvae were the most abundant taxa in both seasons although oligochaete worms were also abundant in the spring 2007. One to two EPT taxa were found in the Camp Conoy fishing pond, depending on season. The invertebrate fauna inhabiting the sediment within Camp Conoy fishing pond were more diverse and generally more abundant in both surveys than that within the sediments of any other pond sampled (EA Engineering 2007a). Thirty-one taxa were found during the fall survey, and 38 were collected during the spring survey. Midge larvae represented the predominant taxa in the pond in both seasons, although true fly larvae and oligochaete worms were also common (EA Engineering 2007a).

2.4.2.2 Important Freshwater Species – Site and Vicnity

Several criteria, described in the terrestrial ecology section (see Section 2.4.1.3), are used to identify important species that may be affected by the building or operation of a new facility. Ten species and EPT taxa that inhabit the freshwater systems onsite meet these criteria (Table 2-3). Most of these species are discussed by category in the following sections. The State-listed species are discussed in the last subsection within this Section 2.4.2.2. There are no Federally protected species inhabiting the freshwater habitats onsite.

Commercially Important Freshwater Species

Commercial fisheries are not allowed at any of the Calvert Cliffs site's freshwater streams or ponds. However, the American eel is a commercially fished species that occurs in the freshwater habitats on the site and the Chesapeake Bay at the Calvert Cliffs site. The American eel fishery in the U.S. stretches from the Gulf of Mexico to Maine (Secor et al. 2006). The harvest primarily focuses on the yellow-phase eels. Most eels are caught in eel pots, but fyke nets account for at

Table 2-3. Important Freshwater Species at the Calvert Cliffs Site

Common Name	Scientific Name	Type	Category
claspingleaf pondweed	*Potamogeton perfoliatus*	Plant	State Rare
leafy pondweed	*Potamogeton foliosus*	Plant	State Endangered
spiral pondweed	*Potamogeton spirillus*	Plant	Highly State Rare
southern wild rice	*Zizaniopsis miliacea*	Plant	State Endangered
star duckweed	*Lemna trisulca*	Plant	State Endangered
American eel	*Anguilla rostrata*	Fish	Commercial Fishery
Bluegill	*Lepomis macrochirus*	Fish	Ecological Role
Eastern mosquitofish	*Gambusia holbrooki*	Fish	Ecological Role
tessellated darter	*Etheostoma olmstedi*	Fish	Ecological Role
American beaver	*Castor canadensis*	Mammal	Ecological Role
EPT taxa	Ephemeroptera-Plecoptera-Trichoptera	Invertebrate	Ecological Indicator

Source: MDNR 2007b, c

least some of the total catch. There is a relatively small recreational fishery for American eels, primarily for use as bait for game fishing (ASMFC 2006a). The largest commercial landings of American eel occurred between 1974 and 1985, with a gradual decline since then (Secor et al. 2006). About half of the commercial catch comes from the Chesapeake Bay.

American Eel (*Anguilla rostrata*)

The American eel is broadly distributed along the east coast of North America, throughout the Caribbean Sea, and the Gulf of Mexico (Murdy et al. 1997). Eels are abundant in all tributaries in the Chesapeake Bay system (Murdy et al. 1997). American eels live in many habitats, but higher densities occur where there is variety in stream velocity and depth and where non-eel fish abundance is high (Wiley et al. 2004). Eels inhabiting freshwaters are nocturnal predators on invertebrates and small fish (Murdy et al. 1997). The American eel in the western Atlantic is considered to be one population (72 FR 4967), and there is no estimate of its overall abundance (Secor et al. 2006). The FWS evaluated the American eel for possible protection under the U.S. Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.), but concluded that protection under the ESA was not warranted (72 FR 4967) because recruitment was stable and that there were no significant threats at the population level.

Spawning occurs only in the Sargasso Sea, probably beginning in January (Murdy et al. 1997) and peaking in February and March (McCleave 2008). Eel larvae drift around the western Atlantic for about a year then begin to enter coastal waters. The larval eels metamorphose into glass eels, which are about 2.5 in. long, and enter nearshore estuaries. They become pigmented elvers, which may remain in the estuary or travel to streams or rivers. Elvers develop into yellow-phase eels at about two years of age and spend from 5 to 20 years in the Chesapeake system before maturing and migrating to the Sargasso Sea (Murdy et al. 1997; ASMFC 2006a).

The American eel was the most abundant fish collected in Johns Creek during the spring 2007 survey, with 45 individuals accounting for about 46 percent of the fish caught there (EA Engineering 2007a). The species also was among the predominant species in Goldstein Creek and in Ponds 1 and 2. American eels occurred in impingement samples collected from CCNPP Units 1 and 2 in 20 of 21 years from 1975 to 1995 (Ringger 2000). Juvenile American eels were caught in entrainment samples collected from within the intake system for CCNPP Units 1 and 2 in April and May 2006 and February through April 2007 (UniStar 2008d). The estimated juvenile eel density was 0.02 per 100 m^3 in 2006 and 0.04 per 100 m^3 in 2007, with total entrainment during the 19-month study estimated at about 1.6 million juveniles during maximum design flow conditions. Juvenile eels were not found in samples collected in 2006 on the Bay side of the baffle wall separating the CCNPP Units 1 and 2 intake system from the Bay.

Recreationally Important Freshwater Species

The Camp Conoy fishing pond is the main freshwater body onsite with a history of recreational fishing. The primary fish caught was likely the bluegill, which was found in the pond during field surveys conducted in 2006 and 2007 (EA Engineering 2007a). However, the pond is no longer open to fishing (UniStar 2007). The bluegill is discussed as an ecologically important species.

Ecologically Important Freshwater Species

Several ecologically important species or taxa occur in freshwater habitats on the Calvert Cliffs site. Ecologically important species are those that are important to the structure or function of the system or that may be indicators of habitat quality in the system. The bluegill, eastern mosquitofish, and tessellated darter contribute to community structure by being the predominant species in the onsite streams or ponds. The beaver is functionally important because it is an ecological engineer with the ability to strongly modify freshwater habitats. EPT taxa, the nymphs of mayflies and stoneflies and the larvae of caddisflies, are indicators of habitat quality because they are sensitive to anthropogenic disturbance while showing some insensitivity to natural disturbance (Wallace et al. 1996).

Bluegill (*Lepomis macrochirus*)

The bluegill is native to a broad portion of the eastern United States, ranging from Texas and the Mississippi valley to the Great Lakes region and Florida (Murdy et al. 1997). It has been introduced into many areas, primarily for recreational fishing. Bluegill occurs in most Chesapeake area streams (Murdy et al. 1997). Typical habitat includes lakes and ponds and slowly flowing streams. Spawning occurs from April through September. Bluegill feed primarily on insects, crustaceans, and fish but may also consume some plant material. Bluegill comprises an important recreational fishery throughout its range and probably was the primary species caught at the Camp Conoy fishing pond when it was open to fishing. Bluegill was the predominant species collected from Camp Conoy fishing pond fall 2006 and spring 2007 surveys conducted on the Calvert Cliffs site (EA Engineering 2007a). No bluegills were caught in Johns Creek or Goldstein Branch during either survey.

Eastern Mosquitofish (*Gambusia holbrooki*)

The eastern mosquitofish is a small, live-bearing fish with a native distribution that ranges from the northern Gulf of Mexico and Mississippi Valley to Illinois and eastward from New Jersey to Florida (Murdy et al. 1997). The species has been introduced into several U.S. states and many countries, primarily to control mosquitoes. Calvert County provides eastern mosquitofish to residents for mosquito control (Morse 2007). Eastern mosquitofish inhabit freshwater streams and ponds but also tolerate brackish waters. Reproduction occurs from April through September with more than one brood being produced per female. Mosquitofish feed on small invertebrates, including insects and insect larvae, but also include some plant material in their diet (Murdy et al. 1997). These fish are prey for wading birds, fish, amphibians, and larger invertebrates. Eastern mosquitofish was one of the predominant fish species collected in ponds on the Calvert Cliffs site during the fall 2006 aquatic surveys and was the only species collected in Lake Davies (EA Engineering 2007a). Eastern mosquitofish abundance was very reduced in all onsite water bodies in the spring 2007 survey, and none was found in Lake Davies (EA Engineering 2007a).

Tessellated Darter (*Etheostoma olmstedi*)

The tessellated darter is a small freshwater perch that ranges from Florida to the St. Lawrence Seaway and Lake Ontario (Murdy et al. 1997). In the Chesapeake Bay area, the species occurs in all tributaries and may be found in waters having salinities as high as 13 percent. Tessellated darters spawn from April to June and deposit eggs in nests underneath and on the sides of rocks (Murdy et al. 1997). These fish feed on small invertebrates and algae, and in turn may be prey for larger fish. There is no commercial or recreational fishery for tessellated darters.

The tessellated darter was one of the predominant fish species inhabiting surveyed streams on the Calvert Cliffs site. The species was the most abundant fish caught in Goldstein Branch in the fall 2006 and spring 2007 surveys (EA Engineering 2007a). Tessellated darter abundance was lower in Johns Creek, but the species was still among the most commonly collected fish and was the second most abundant in the spring 2007 survey (EA Engineering 2007a). Tessellated darters were not found in any of the ponds on the Calvert Cliffs site.

North American Beaver (*Castor canadensis*)

The North American beaver occurs throughout most of North America from Alaska to eastern Canada and southward to Mexico (Boyle and Owens 2007). Beavers are semi-aquatic mammals that inhabit streams, ponds, and nearshore portions of large lakes (Jenkins and Busher 1979). The beaver is the largest North American rodent, reaching a length of 4 ft, about 30 percent of which consists of a large, flat tail that is used for swimming in the water and for balance when beavers walk on land (Boyle and Owens 2007). Beavers form monogamous pairs and typically breed during January and February. The gestation period lasts about three months after which the young (kits) are born (Boyle and Owens 2007). Kits are able to swim within minutes of birth, but require about 2 years of parental care before they leave the family group. Beavers feed mainly on woody plant bark, shoots, and leaves but also consume herbaceous plants, ferns, and aquatic plants. However, beavers actually consume only about one-third of the plant material harvested. A small fraction of the harvested plants may be used for dam and lodge construction (Rosell et al. 2005).

Beavers, through activities that include felling of trees and building dams across streams, are considered ecosystem engineers that exert significant effects on the physical and biological properties of local ecosystems (Rosell et al. 2005). Beavers build dams to create small impoundments in which they build lodges needed for protection from predators and to survive during cold winters (Boyle and Owens 2007). Beaver impoundments provide valuable habitat that is used by many other organisms, including fish, amphibians, and birds (Häggland and Sjöberg 1999; Aznar and Desrochers 2008; Stevens et al. 2007). Importantly, beavers can control the water levels in their impoundments even during unfavorable weather conditions (Hood and Bayley 2008) and, therefore, may be able to ameliorate some of the effects of climate changes.

The occurrence of beavers on the Calvert Cliffs site was primarily documented indirectly by observations of gnawed vegetation, dead trees, and beaver dams on Johns Creek and Goldstein Branch (TetraTech 2007a; UniStar 2008a). Beavers were observed near the Camp Conoy fishing pond in April 2007. No abundance estimates for the Calvert Cliffs site were made, but the population was said to be substantial (TetraTech NUS 2007a). Beaver activity on the site has changed large areas of forested wetlands to freshwater marsh.

Ephemeroptera-Plecoptera-Trichoptera (EPT) Taxa

Although not one species, the assemblage commonly known as EPT taxa is included because of its widespread use as an indicator of water quality in freshwater ecosystems. The EPT assemblage is based on three insect orders, Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) (Stribling et al. 1998). Adults of species comprising all three orders are terrestrial, but often live near freshwater habitats (Pennak 1978). The developmental stages (nymphs of mayflies and stoneflies, and larvae of caddisflies) occur in aquatic habitats.

Mating typically occurs in spring and summer and more than one generation may be produced in a season. The proportion of EPT taxa often provides a better indication of water quality than more traditional species diversity or biotic indices and is often much less variable (Wallace et al. 1996; Lydy et al. 2000). Southerland et al. (2005b) found that the number of EPT taxa in Maryland streams decreased as total nitrogen/total phosphorus ratio increased and as total phosphorus increased. EPT taxa also showed lower values associated with the lowest and highest pH and ANC class values (Southerland et al. 2005b). EPT taxa were recorded during the surveys conducted onsite in 2006 and 2007. Three to five EPT taxa were found in Johns Creek and Goldstein Branch for both surveys. EPT taxa were less numerous in the onsite ponds, ranging from zero to two taxa (EA Engineering 2007a).

Federally and State-Listed Freshwater Species

This section describes Federally and Maryland State-listed freshwater species and other species of concern. No aquatic critical habitats are proposed or designated near the Calvert Cliffs site. There are no Federally listed freshwater species that occur in Calvert County (MDNR 2007a). State-listed aquatic species that may occur near the Calvert Cliffs site are listed in Table 2-3.

The State of Maryland lists three State-endangered aquatic plants – star duckweed (Lemna trisulca), leafy pondweed (Potamogeton foliosus), and southern wild rice (Zizaniopsis miliacea) – as occurring in Calvert County (MDNR 2007a). It is unlikely that leafy pondweed and southern wild rice occur on the site because of the lack of suitable habitat on the site (Tetra Tech NUS 2007c). The most likely habitat for star duckweed on the site is found at Camp Conoy Fishing Pond and nearby ponds and in beaver-flooded areas along Johns Creek.

The State of Maryland also lists the spiral pondweed (Potamogeton spirillus) and the claspingleaf pondweed (Potamogeton perfoliatus) as State Highly Rare and State Rare, respectively, and as occurring in Calvert County (MDNR 2007a). It is unlikely that claspingleaf pondweed occurs on the site because of the lack of suitable habitat on the site. The most likely habitat for spiral pondweed on the site occurs at Camp Conoy fishing pond and nearby ponds. Neither leafy pondweed nor spiral pondweed was observed during the rare plant survey conducted at these habitats on the site (Tetra Tech NUS 2007c).

2.4.2.3 Non-Native and Nuisance Freshwater Species – Site and Vicinity

The introduction of nonnative plants and animals into streams can affect native aquatic communities by introducing diseases and parasites, and increasing predation on and competition with native species (Southerland et al. 2005b). None of the freshwater aquatic plants and invertebrates of concern in Maryland (MISC 2008a, b) was found on the Calvert Cliffs site during any of the plant, wetlands, or aquatic surveys conducted in 2006 and 2007. One freshwater fish, the western mosquitofish (Gambusia affinis), is listed as an invasive species in

Maryland. That species name was used in the Aquatic Survey Report (EA Engineering 2007a) but was attributed to the eastern mosquitofish, which is correctly named G. holbrooki. Thus, the western mosquitofish was not on the site during the aquatic surveys conducted in 2006 and 2007.

Several nonnative fish species that occur on the Calvert Cliffs site, such as largemouth bass (Micropterus salmoides), green sunfish, bluegill, black crappie (Pomoxis nigromaculatus), and white crappie (P. annularis) are intentionally stocked elsewhere in the State by the Maryland DNR to support recreational fisheries (Southerland et al. 2005b).

One important nonnative aquatic species, also discussed in Section 2.4.1.3, is the common reed Phragmites, which is well-documented as occurring on site. Phragmites successfully colonizes disturbed areas where natural or anthropogenic events have changed marsh plant communities, hydrology, and topography. Phragmites changes marsh habitat as it becomes established (Lathrop et al. 2003). These changes, particularly increased sedimentation and organic matter accumulation, affect marsh function (Lathrop et al. 2003) and may affect resident killifish (Able and Hagan 2003), including the spotfin killifish (Fundulus luciae), which is listed as "Rare?" by the State of Maryland.

On the Calvert Cliffs site, Phragmites covered much of the Lake Davies disposal area, and the exposed marshy areas along Johns Creek, Goldstein Branch, and its tributaries where beaver dams caused stream flooding (Tetra Tech NUS 2007a). Those affected areas have reduced plant cover diversity and their value as food, and cover for wildlife has been adversely affected (Tetra Tech NUS 2007a).

2.4.2.4 Estaurine Habitats – Site and Vicinity

The aquatic species within the Chesapeake Bay include organisms that inhabit the water column (fish, plankton) and the Bay bottom (benthic flora and fauna). A few taxa, for example blue crabs, transcend both habitats. The Chesapeake Bay is the third largest estuary in the world and currently supplies cooling water for CCNPP Units 1 and 2. The Bay, despite significant declines in resources since colonial times, is still very biologically productive and is an important part of the cultural and economic fabric of the area.

Existing Natural and Anthropogenic Stressors

Aquatic habitats in Chesapeake Bay, which is the nation's largest estuary, have faced and continue to face many stresses. The main problems facing the Bay can be linked to one overriding factor – the tremendous growth of the human population surrounding the Bay (USGS 2005). This growth has contributed to poor water quality in the Bay, loss of important habitat, and reduced populations of biological communities. Excess nutrients and sediment in the water caused the Bay to be listed in 1999 as an impaired water body under the Clean Water

Act (USGS 2005). Population growth has led to the alteration of natural forested habitat to agricultural and urban areas. Agricultural lands contribute high levels of nutrients and sediment to receiving streams and subsequently the Bay (Southerland et al. 2005b). Urban areas add contaminants to the mix and, by changing the land from pervious to impervious surfaces, provide a conduit for easy transport to streams and eventually the Bay (Claggett 2007). Increased nutrient (nitrogen and phosphorus) loads in the Bay lead to greater phytoplankton biomass (eutrophication), which then translates to decreased water clarity, subsequent loss of submerged aquatic vegetation (SAV), and eventually depletion of dissolved oxygen in bottom waters as decaying phytoplankton use oxygen stores in the water (Kemp et al. 2005).

Many anthropogenic stressors have caused declines in key biological resources within the Bay. For example, reduced water clarity has contributed to severe reductions in the abundance and extent of SAV in the Bay (Rybicki and Landwehr 2007), and coastal wetlands have been lost because of development of valuable coastal property (Cahoon 2007). One of the strongest factors contributing to living resource loss is overfishing, which has caused declines in populations of several fish species (Murdy et al. 1997) and invertebrates such as blue crabs (Abbe 2002) and eastern oysters (EOBRT 2007). Some of these changes have induced other changes in the Bay, which may make it difficult to completely restore the Bay's ecosystem to previous conditions. For example, reduced oyster populations provide less shell substrate as habitat for developing sea nettle polyps, which may reduce sea nettle abundance, which in turn contributes to increased abundance of sea nettle prey such as comb jellies that feed on oyster larvae (Breitburg and Fulford 2006).

Historically the primary contaminants entering the Bay have been pesticides and herbicides associated with agriculture, particularly on the Delmarva Peninsula (Denver and Ator 2007). Other contaminants emerging as potential issues assaulting the Bay include pharmaceuticals, hormones, detergents, disinfectants, and fire retardants (Denver and Ator 2007). Pharmaceuticals, drugs for human and veterinary use, enter aquatic habitats mainly through ingestion and excretion but also by being flushed down drains and passing through septic systems or treatment plants (Pait et al. 2006). Although pharmaceuticals were developed to have biological effects, the potential effects of these chemicals on aquatic biota are incompletely understood (Halling-Sørensen et al. 1998). In Chesapeake Bay water samples collected near Baltimore and Annapolis, 13 pharmaceutical compounds were detected, although the concentrations were fairly low (Pait et al. 2006).

Episodic natural events also stress resources in the Bay. Hurricanes and other large storms constitute one of the natural disturbances that can affect the Bay ecosystems, albeit the disturbance is unpredictable and periodic. Hurricane Isabel, which passed west of the Bay in September 2003, caused an increase in freshwater flow from the Susquehanna River into the Bay that decreased salinities and contributed to an increase in the number of adult bay anchovy (*Anchoa mitchilli*) and young-of-the-year Atlantic croaker (*Micropogonias undulatus*) in the lower bay (Houde et al. 2005). The storm also induced an unusual fall phytoplankton bloom in the Bay that probably resulted from high winds mixing the water column, which moved nitrogen into the euphotic zone where it fueled the increase in phytoplankton (Miller et al. 2006).

Water Column Habitats

The primary residents of the water column in the Chesapeake Bay are plankton, fish, and sea turtles. Fish and sea turtles are discussed in the sections on important estuarine species and threatened and endangered species because many of the studies of these groups focus on key species rather than on entire assemblages. Designated essential fish habitat (EFH) for several Federally managed fish species exists in Chesapeake Bay. The EFH assessment, included in Appendix F, supports the consultation with the National Marine Fisheries Service (NMFS) in compliance with the Magnuson-Stevens Fishery Conservation and Management Act of 1976 (MSFCMA), as amended, which requires all Federal agencies to consult with NMFS on all actions, or proposed actions, permitted, funded, or undertaken by the agency that may adversely affect EFH.

<u>Plankton</u>

Most plankton are small, free- floating or weakly swimming organisms that drift through the water column. Plankton, despite being small and short-lived, form the base of most of the food chains in oceans, estuaries, and lakes and have key ecosystem roles in the distribution, transfer, and recycling of nutrients and minerals. Plankton are separated into two major functional groups, phytoplankton and zooplankton. The phytoplankton community consists of unicellular plants, such as diatoms and dinoflagellates, and is the major contributor to primary production in most waterbodies. Phytoplankton often rapidly grow into large aggregates or blooms. Subsequent decomposition of the dead phytoplankton can lead to local depletion of oxygen in the water. Some phytoplankton are toxic, and their blooms contribute to fish kills and shellfish poisoning. Zooplankton primarily includes microscopic animals that are consumers of phytoplankton and other zooplankton. Zooplankton are primary prey for many fish species, thus playing a central role in the functioning of aquatic ecosystems. Zooplankton include animals that spend their entire lives in the plankton community (holoplankton) and the larval forms of many species of invertebrates and fish that are planktonic community residents for only a short time (meroplankton). Important zooplankton include unicellular (Foraminifera, Radiolaria) and multicellular animals (copepods). Fish eggs, larvae, and juveniles, called ichthyoplankton, comprise an important part of the larger zooplankton community.

The Chesapeake Bay phytoplankton community off the Calvert Cliffs site was not sampled as part of the aquatic studies conducted in 2006 and 2007. However, phytoplankton are monitored Bay-wide as part of the CBP, which includes one station just north of the site and provides information about the Mid Bay region, the general area that includes the site. The phytoplankton community is evaluated by application of a phytoplankton index of biotic integrity

(P-IBI). The P-IBI is a multi-metric index based on parameters specific to certain salinity regimes and seasons chosen from an overall list of 12 metrics, such as chlorophyll *a* content, diatom biomass, and dinoflagellate biomass, selected to measure various aspects of the community (Lacouture et al. 2006). The P-IBI value calculated in 2007 for the Mid Bay station north of the site was 3.0 to 3.9, which is considered Fair to Fair-Good (Lacouture et al. 2006). Overall, the Mid Bay region received a phytoplankton condition score of 79 percent, which was rated good and represented a 10 percent increase over the 2006 score (Chesapeake EcoCheck 2007).

The Chesapeake Bay zooplankton community off the Calvert Cliffs site was not sampled as part of the aquatic studies conducted in 2006 and 2007. However, zooplankton are monitored Bay-wide, and there is one station just north of the site. The general condition of the zooplankton communities in Chesapeake Bay is suboptimal (UniStar 2009a). Zooplankton abundance levels in many spawning or nursery areas are below those necessary to provide adequate food for migratory fish larvae. Sharp declines in zooplankton abundance have occurred in much of the middle and lower Chesapeake Bay mainstem and in lower tributaries (UniStar 2009a). There was a 32 percent reduction in abundance from 1984 to 2002 at the monitoring station just north of the site. Although the general zooplankton food base for key fish species is declining and shifting to smaller sizes, there are some indications that conditions are improving (UniStar 2009a).

An entrainment study conducted in 2006 and 2007 at the cooling water intake system for CCNPP Units 1 and 2 also included ichthyoplankton sampling from April through December 2006 in Chesapeake Bay waters just outside the baffle wall separating the intake forebay from open bay waters. The highest average densities of ichthyoplankton occurred during May through August with a peak in June (UniStar 2008b). Virtually no ichthyoplankton were collected from October and April. Bay anchovy eggs accounted for about 79 percent of the total ichthyoplankton collected outside the baffle wall during the study. Sciaenid eggs, which could include Atlantic croaker, northern kingfish (*Menticirrhus saxatilis*), silver perch (*Bairdiella chrysoura*), spot (*Leiostomus xanthurus*), and weakfish (*Cynoscion regalis*), comprised about 11 percent of the total ichthyoplankton collected. Atlantic menhaden (*Brevoortia tyrannus*) eggs and larvae were found primarily in May 2007. Other taxa of interest included eggs of an unidentified species of *Fundulus* and juvenile weakfish, each found only in July. Naked goby (*Gobiosoma bosc*) juveniles and larvae were the third most common taxon, but accounted for only about 3 percent of the total ichthyoplankton collected.

Benthic Habitats

Benthic habitats in Chesapeake Bay are inhabited by several major categories of taxa, those that live in sediments (benthic infauna) and SAV. Two key benthic species are the blue crab and the eastern oyster, although each inhabits the water column during some part of its life. Those two species are discussed in the Important Estuarine Species section.

Benthic Sediments and Infauna

It is important to understand the condition of the benthic infaunal communities in the Chesapeake Bay and especially near the Calvert Cliffs site. Benthic animals, largely because of their relative immobility, integrate environmental conditions that have occurred over relatively long time periods and are important contributors to ecosystem function (Bilyard 1987).

The Maryland DNR sponsors a water quality monitoring program throughout the state waters of Chesapeake Bay. Since 1984, sampling the benthic sediments and their constituent fauna have been important components of this program. The program includes sampling at 27 fixed stations within the Bay, two of which (Stations 001 and 006) are relatively close (just to the north) of the Calvert Cliffs site (Llansó et al. 2007a). One fixed station (071) is located in the Patuxent River just upstream from the mouth of St. Leonard Creek. The Maryland DNR program evaluates conditions of the benthic infaunal communities by calculating a B-IBI, which is based on several attributes of the communities compared (Weisberg et al. 1997). The B-IBI provides a validated way to combine several benthic community attributes into a single value that estimates overall benthic community condition (Llansó et al. 2007a).

EA Engineering collected benthic sediments from three nearshore stations near the present CCNPP Units 1 and 2 barge dock in the fall 2006 and the spring 2007 surveys (EA Engineering 2007a). One station was located at the site of the proposed cooling water discharge pipe, and two others were located within 500 ft of the pipe. One of the latter stations was within the approximate area that would be dredged. These sediments were analyzed for sediment grain-size distribution, total organic carbon (TOC) content, nutrients, anthropogenic contaminants, and infaunal community structure (EA Engineering 2007a). Standard sampling and analytical methods were followed.

Sediments at all three stations were comprised primarily of sand (94 to 96 percent) and gravel (2 to 5 percent) with a small percentage of clay (EA Engineering 2007a). TOC in the sediments ranged from 2.36 to 3.07 percent. The sediment type sampled near the barge dock was typical of the region. The two stations sampled under the Maryland DNR program are also very sandy with a very small silt/clay fraction (Llansó et al. 2007b). However, the TOC content of the CCNPP sediments was much higher than that of the two Maryland DNR stations (<1 percent each). Most metals, polynuclear aromatic hydrocarbon compounds, polychlorinated biphenyl congeners, pesticides, semi-volatile organic compounds and volatile organic compounds (VOCs) analyzed in the CCNPP sediments were reported as not detected (EA Engineering 2007a). The few organic compounds that were detected in the sediments occurred at concentrations less than the respective method detection limits. Of the seven metal compounds analyzed, six occurred at levels greater than the method detection limits, but all were substantially less than the threshold effects levels (the concentration below which effects are expected to be rare) (Buchman2008) established for them.

The benthic infaunal community found at each of the three stations was generally sparse and comprised of relatively few taxa. Infaunal abundance varied from 32 to 85 individuals per 0.05 m^2 samples (EA Engineering 2007a). These samples contained from 9 to 13 species. The abundance values for the CCNPP sediments were generally similar to those reported for the two Maryland DNR stations sampled in the summer 2006 (Llansó et al. 2007b). However, species numbers at the CCNPP stations were slightly greater than those for the Maryland DNR stations. The infaunal community at the two CCNPP stations near the site of the proposed cooling water discharge pipe primarily was comprised of the small clam *Gemma gemma* and polychaete worms, such as *Streblospio benedicti* and *Glycinde solitaria*. The small clam was not found at the station south of the barge dock near the area proposed to be dredged. The infaunal community there consisted predominantly of polychaete worms, such as *S. benedicti*. The general infaunal community composition at the Calvert Cliffs site was similar to those at the two Maryland DNR stations. *Gemma gemma* was predominant at both Maryland DNR stations in summer 2006. Polychaete worms, such as *S. benedicti*, were common. Another small clam, *Mulinia lateralis*, was common at the Maryland DNR stations.

The Maryland DNR monitoring program, using the calculated B-IBI scores, rated the two stations north of Calvert Cliffs site as degraded and severely degraded (Llansó et al. 2007a). B-IBI values for the infaunal community at the three CCNPP stations sampled in 2006 are similar to those reported for the Maryland DNR stations and are in the degraded to severely degraded categories. The Maryland DNR program rated the single Patuxent River station as severely degraded and showing a significant downward trend in habitat quality (Llansó et al. 2007a).

<u>Submerged Aquatic Vegetation</u>

SAV in Chesapeake Bay includes 23 species of vascular plants, those plants that have true leaves, stems, and roots, and 3 species of the algal muskgrass family (Family Characeae) (Orth et al. 2007a). Included in this list are several non-native species, such as Hydrilla (*Hydrilla verticillata*), water chestnut (*Trapa natans*), and Eurasian milfoil (*Myriophyllum spicatum*) (MISC 2008a). SAV is important in the diet of waterfowl and serves as important habitat for juvenile fish and shellfish, especially in Chesapeake Bay (Rybicki and Landwehr 2007). SAV provides other services, such as wave attenuation, sediment stabilization, water quality improvement, and primary production, to the Bay ecosystem (Shafer and Bergstrom 2008). Extensive SAV beds historically existed within the coastal bays, lagoons, and estuaries of Chesapeake Bay, but the beds have experienced severe declines in abundance and occurrence (Shafer and Bergstrom 2008). Among the potential causes for the decline are wasting disease, very strong storms, and decreased water clarity caused by higher levels of suspended sediment and long-lasting algal blooms (Rybicki and Landwehr 2007; Shafer and Bergstrom 2008). A non-native waterfowl, the mute swan (*Cygnus olor*), feeds on SAV year-round in Chesapeake Bay and can significantly affect the percent cover, density, and height of SAV (Tatu et al. 2007a, b).

Because of the importance of SAV to the Chesapeake Bay ecosystem, surveys of the nearshore Chesapeake Bay area off the Calvert Cliffs site were conducted in the early fall (September 2006) and spring (May 2007) to identify the presence of any SAV that might be affected by the building and operation of the new unit (EA Engineering 2007b). Sampling for SAV was done by using an iron dethatching rake following a protocol developed by the Maryland Department of the Environment (MDE). The study area included the Bay bottom between the present barge dock and the intake area for Units 1 and 2. Water depths in most of the survey area were 6.6 ft or less, but some stations in isolated pockets of deeper water within the overall study area were included in the survey to provide a more comprehensive understanding of the distribution of SAV within the study area (EA Engineering 2007b). Sixty-five stations were sampled during each survey. No vascular plant SAV species were observed at any of the stations during either surveys, and no SAV species were observed along the shoreline or floating throughout the study area (EA Engineering 2007b). However, unidentified species of muskgrass (*Chara* sp.) and red marine alga (*Chondria* sp.) were collected during the early fall 2006 survey from the stations closest to the shoreline. Two species of muskgrass, *Chara braunii* and *C. zeylanica*, are considered SAV (Orth et al. 2007a). Thus, although the species of *Chara* found off the site in 2006 was not identified, the occurrence of SAV at the site cannot be completely dismissed. Pieces of another type of macrophytic alga were collected during the spring 2007 survey.

The general absence of SAV at the Calvert Cliffs site was checked by examining the records maintained by the Virginia Institute of Marine Science (VIMS). VIMS uses aerial photography and field surveys to document the presence, species composition, and distribution of SAV in the Chesapeake Bay and many of its tributaries. VIMS reported that no SAV occurred along the coast near the study area between 1994 and 2005 (EA Engineering 2007b). The 2006 VIMS aerial SAV survey indicated that there was no SAV in the nearshore area between Cove Point and the area north of Calvert Beach (Orth et al. 2007b).

Shoreline Habitats

The natural portion of the shoreline along the Calvert Cliffs site consists of narrow sandy beach at the foot of steep, sandy cliffs. Adjacent to the barge dock, a small patch of *Phragmites* and small trees exist on the sandy, built-up area at the outlet of the outfall pipe. Between the barge dock and the intake area for CCNPP Units 1 and 2, the shoreline is armored with large boulders. No surveys of the beach or armored shoreline for estuarine fauna were conducted during the 2006 and 2007 sampling. The beach and bluff area south of the barge dock was surveyed for the occurrence of tiger beetles (see Section 2.4.1.3).

2.4.2.5 Important Estuarine Species – Site and Vicinity

Several criteria (see Section 2.4.1.3) identify important species that may be affected by building, operating, or maintaining a new facility. Species meeting these criteria may be commercially or recreationally important fishery species or may have vital roles in estuarine ecosystem dynamics. Species that have designated EFH in the Chesapeake Bay and Federally or State-listed species are also considered important. Thirty species that inhabit the estuarine waters of Chesapeake Bay near the Calvert Cliffs site were identified as important species (Table 2-4). The Federally and State-listed species are discussed in the last subsection within this Section 2.4.2.5. The Biological Assessment completed in support of the ESA Section 7 consultation with NMFS is also presented in Appendix F of this EIS.

The impingement and entrainment by the CCNPP Units 1 and 2 are given for each species based on historical (1975 to 1996) impingement data (Ringger 2000) and more recent (2006 to 2007) entrainment data (UniStar 2008d).

Table 2-4. Important Estuarine Species that May Occur in Chesapeake Bay Near the Calvert Cliffs Site

Common Name	Scientific Name	Type	Category
sea purslane	*Sesuvium maritimum*	Plant	State Endangered
alewife	*Alosa pseudoharengus*	Fish	Federal Species of Concern
American shad	*Alosa sapidissima*	Fish	Ecological Role; Historical Fishery
Atlantic croaker	*Micropogonias undulatus*	Fish	Recreational; Commercial
Atlantic menhaden	*Brevoortia tyrannus*	Fish	Ecological Role; Commercial
Atlantic sturgeon	*Acipenser oxyrinchus*	Fish	Federal Candidate Species
bay anchovy	*Anchoa mitchilli*	Fish	Ecological Role
black sea bass	*Centropristis striata*	Fish	Essential Fish Habitat (EFH)
blueback herring	*Alosa aestivalis*	Fish	Federal Species of Concern
bluefish	*Pomatomus saltatrix*	Fish	Ecological Role; Recreational; EFH
cownose ray	*Rhinoptera bonasus*	Fish	Ecological Role
clearnose skate	*Raja eglanteria*	Fish	EFH
little skate	*Leucoraja erinacea*	Fish	EFH
Butterfish	*Peprilus triacanthus*	Fish	EFH
red drum	*Sciaenops ocellatus*	Fish	EFH
shortnose sturgeon	*Acipenser brevirostrum*	Fish	Federally Endangered; State-Endangered
spot	*Leiostomus xanthurus*	Fish	Recreational; Commercial
spotfin killifish	*Fundulus luciae*	Fish	State “Rare?” (State’s nomenclature)
striped bass	*Morone saxatilis*	Fish	Ecological Role; Recreational
summer flounder	*Paralichthys dentatus*	Fish	Recreational; EFH
weakfish	*Cynoscion regalis*	Fish	Recreational; Commercial
white perch	*Morone americana*	Fish	Ecological Role; Recreational; Commercial
windowpane flounder	*Scophthalmus aquosus*	Fish	EFH

Table 2-4. (contd)

Common Name	Scientific Name	Type	Category
winter skate	*Leucoraja ocellata*	Fish	EFH
green turtle	*Chelonia mydas*	Turtle	Federally Threatened; State-Threatened
Kemp's ridley turtle	*Lepidochelys kempii*	Turtle	Federally Endangered; State-Endangered
leatherback turtle	*Dermochelys coriacea*	Turtle	Federally Endangered; State-Endangered
loggerhead turtle	*Caretta caretta*	Turtle	Federally Threatened; State-Threatened
blue crab	*Callinectes sapidus*	Crustacean	Ecological Role; Recreational; Commercial
eastern oyster	*Crassostrea virginica*	Mollusk	Ecological Role; Recreational; Commercial

Sources: (50 CFR 17.11; MDNR 2007b, c)

Fish

American Shad (*Alosa sapidissima*)

The American shad is an anadromous schooling fish that ranges along the western Atlantic coast from the St. Lawrence River to Florida (Murdy et al. 1997). All American shad from rivers along the Atlantic coast migrate to live in the Gulf of Maine for the summer and fall. The spawning migration generally runs from late winter to late spring. American shad enter Chesapeake Bay from January to June to spawn in low-salinity to freshwater flats in tributaries reaching as far north as the Susquehanna River (Murdy et al. 1997; Hoffman et al. 2008). Eggs are fertilized in the water column of freshwater rivers and tributaries. Some adults die after spawning, whereas others return to the ocean. Most juvenile American shad in Chesapeake Bay, which are about 2 to 3 in. long (Hoffman et al. 2008), leave the freshwater habitats during November and December, ultimately moving into the ocean from February to March (Hoffman et al. 2008). Younger juveniles in the Bay probably feed primarily on planktonic crustaceans but consume more larval fish as they age (Hoffman et al. 2008). Shad spend about 4 to 6 years in the ocean before returning to the Chesapeake Bay to spawn (Murdy et al. 1997).

The American shad was part of the early historical and cultural fabric of the United States, earning the nickname "Founding Fish" (McPhee 2002). The shad fishery was prominent on the northeast U.S. coast from the mid-1700s until its decline because of overfishing and loss of important spawning habitat (Murdy et al. 1997). Maryland placed a moratorium on recreational shad fishing in 1980 (Sadzinski and Jarzynski 2005). The State allows very limited commercial fishing and catch-and-release recreational fishing. Since the mid-1990s, Maryland has undertaken a program to restore the shad to three Chesapeake Bay tributaries, the Patuxent, Choptank, and Nanticoke Rivers (Richardson et al. 2007). From 1996 to 2006, more than 8.3 million larval, early juvenile, and late juvenile American shad were stocked into the Patuxent River. Monitoring in 2006 found that 96 percent of fish caught were of hatchery origin. Richardson et al. (2007) concluded that the number of wild adults returning to the river to spawn is increasing, which indicates that the restoration effort is working. American shad were not found in impingement samples collected from 1975 to 1995 (Ringger 2000), nor in the entrainment samples collected in the CCNPP Units 1 and 2 intake system or baffle wall in 2006 and 2007 (UniStar 2008d).

Shad also contribute ecologically by linking estuarine, freshwater, and terrestrial ecosystems. Spawning migrations of shad and other anadromous herrings transport marine-based nutrients into freshwaters (Garman 1992; MacAvoy et al. 2000). Migrating herrings are among the predominant prey for nesting bald eagles (Watts et al. 2007).

Atlantic Croaker (*Micropogonias undulatus*)

The Atlantic croaker is an inshore demersal fish found from the Gulf of Maine to Florida and throughout the Gulf of Mexico (Murdy et al. 1997; ASMFC 2007a). Adults are found mainly in salinities greater than 5 ppt in Chesapeake Bay. Spawning in the Middle Atlantic Bight region occurs in continental shelf waters, beginning in April and peaking from August through October (Murdy et al. 1997). Larvae, which migrate into Chesapeake Bay at a size of about 0.4 in. (Schaffler et al. 2009), use low-salinity estuaries as nurseries before moving to higher salinity waters as juveniles (Murdy et al. 1997; ASMFC 2007a). The youngest croakers are planktivorous, but juveniles and adults transition to diets of benthic worms, mollusks, and crustaceans (ASMFC 2007a). Adults may occasionally eat other fish. Striped bass, flounder, weakfish, and spotted seatrout prey on Atlantic croakers. Ospreys (*Pandion haliaetus*) occasionally feed on croakers, providing a trophic link from the Bay to terrestrial systems (Watts et al. 2007).

Atlantic croaker was the second most abundant fish caught during trawl surveys conducted throughout the Bay from 1995 to 2000 (Jung and Houde 2003). The species comprises important, yet highly variable, commercial and recreational fisheries in Chesapeake Bay, with the recreational catch exceeding the commercial catch (Murdy et al. 1997). The commercial catch of Atlantic croaker has shown a somewhat cyclical pattern since about 1970 (Meserve 2007a), probably earlier (Hare and Able 2007). Peak catches occurred in the late 1970s followed by reduced catches through the early 1990s. The catch again reached a peak in 1997 and remained high through 2003 before beginning a downward trend that has continued at least through 2006 (Meserve 2007a). The national trend for the recreational fishery has differed, showing a fairly consistent, increasing trend since the early 1980s. Atlantic croaker occurred in the impingement samples collected from the CCNPP Units 1 and 2 intake system in all years from 1975 to 1995 (Ringger 2000), and was among the five most commonly impinged species in 5 of the 21 years. About 19 percent of impinged Atlantic croaker survive. An estimated 19.9 million Atlantic croaker juveniles and larvae were entrained by the intake system for CCNPP Units 1 and 2 under maximum design flow conditions during the 19-month 2006 and 20007 study (UniStar 2008d).

Atlantic Menhaden (*Brevoortia tyrannus*)

Atlantic menhaden are common fish that occur from Nova Scotia to Florida and are abundant throughout Chesapeake Bay from spring to fall (Murdy et al. 1997). Spawning in the Chesapeake Bay region typically occurs in the open ocean in the spring and fall (Murdy et al. 1997). Some spawning activity may occur in bays and sounds. After the pelagic eggs, which are about 0.05 in. in diameter, hatch at sea, larvae (about 0.5 to 1.3 in. long) ride ocean currents into estuaries and grow in fresh to brackish waters before leaving the estuary as juveniles (1.5 to 4.3 in. long) (Murdy et al. 1997; ASMFC 2006b). Menhaden are thought to comprise a single population (ASMFC 2006b). Menhaden migrate south in the winter, although sometimes juveniles overwinter in the Bay (Murdy et al. 1997). Menhaden are commercially harvested primarily for reduction to fish oil, fertilizer, and fish meal, but secondarily for bait (Murdy et al. 1997; ASMFC 2006b). The reduction fishery peaked in the late 1950s and, following a sharp decline through the 1970s, reached a secondary peak in the 1990s (ASMFC 2006b). There has been a steady decline since the 1990s. The general decline since the 1960s may be related to overfishing of adults in the north followed by a shift in fishing to smaller, pre-spawning fish, which has reduced recruitment (CBEF 2006). Atlantic menhaden are very important to the Chesapeake Bay ecosystem where they transform phytoplankton primary productivity to fish biomass that serves as forage for top aquatic predators such as bluefish, striped bass, and weakfish. Menhaden comprise a major part of the diet during the peak period of striped bass and bluefish growth and, therefore, are important to the yearly production of both species (Hartman and Brandt 1995). Menhaden also transfer energy to terrestrial ecosystems, particularly to fish-eating birds such as ospreys and bald eagles (Watts and Paxton 2007; Watts et al. 2007).

Menhaden occurred in impingement samples collected in all years from 1975 to 1995 and were among the five most commonly impinged species in 14 of the 21 years (Ringger 2000). About 52 percent of the impinged Atlantic menhaden survive. About 522 million menhaden eggs, larvae, and juveniles were estimated to be entrained by the intake system for CCNPP Units 1 and 2 under maximum design flow conditions during the 19-month 2006 and 2007 study (UniStar 2008d). Eggs accounted for about 92 percent of the entrained menhaden.

Bay Anchovy (*Anchoa mitchilli*)

The bay anchovy is a common schooling species found from the Gulf of Maine to Florida and throughout the Gulf of Mexico and is most abundant in estuaries (Murdy et al. 1997). Adults may reach a maximum length of about 4 in. This species occurs throughout Chesapeake Bay and the lower reaches of its tributaries. The bay anchovy was the most abundant pelagic fish caught during trawl surveys conducted throughout the Bay from 1995 to 2000 (Jung and Houde 2003), accounting for about 96 percent of the total abundance and 36 percent of the total biomass. Bay anchovies spawn at night from April through September with peak spawning in Chesapeake Bay occurring in July (Luo and Musick 1991; Murdy et al. 1997). A conceptual model of bay anchovy spawning shows the major spawning area is in the lower Bay and size-related migration occurs within Chesapeake Bay (Jung and Houde 2004a). Young juveniles migrate to the upper Bay in summer and remain there until they reach a length of about 1.8 in. and begin to migrate down the Bay. Larger fish, about 2.4 in. long, tend to overwinter around the middle portion of the Bay. This migration of a very abundant fish within the Bay means that a large amount of energy available to predators is dynamic, moving around the Bay (Wang and Houde 1995). Annual recruitment in the Bay is highly variable and can vary as much as nine-fold (Jung and Houde 2004a). The bay anchovy probably is the most abundant fish in Chesapeake Bay. It is planktivorous, feeding on copepods and other planktonic crustaceans (Jung and Houde 2004b). Bay anchovies are important prey for many of the predatory fish in the Bay, including bluefish, striped bass, and weakfish. Young predatory fish feed heavily on bay anchovy juveniles (Scharf et al. 2002). Young anchovies are also eaten by sea nettles (*Chrysaora quinquecirrha*) and comb jellies (*Mnemiopsis leidyi*) (Jung and Houde 2004a).

Bay anchovy was among the five most commonly impinged species in each of the years sampled at CCNPP Units 1 and 2 from 1975 to 1995 (Ringger 2000). It was the most commonly impinged species in 13 of the 21 years. About 68 percent of impinged bay anchovies survive. Bay anchovy eggs and larvae were the most abundant ichthyoplankton component collected in the Bay near the Calvert Cliffs site in 2006 and 2007, accounting for more than 82 percent of the total fauna collected in 2006 (UniStar 2008d). These bay anchovy life stages were also the predominant taxon found in the entrainment samples collected from the CCNPP Units 1 and 2 intake system during the same time period (UniStar 2008d). About 9.17 billion bay anchovy eggs, larvae, juveniles, and adults were estimated to be entrained by the intake system for CCNPP Units 1 and 2 under maximum design flow conditions during the 19-month 2006 and 2007 study (UniStar 2008d). Fertilized eggs accounted for about 76 percent of this total.

Black Sea Bass *(Centropristis striata)*

Black sea bass range from Nova Scotia to Florida (Drohan et al. 2007), occurring in the Chesapeake Bay from spring to late fall. They are common in the middle and lower Bay (Murdy et al. 1997) and migrate offshore in winter. Adults typically live near structured habitats, such as pilings, rocky areas, and shellfish beds (Murdy et al. 1997; Drohan et al. 2007). Juveniles in the Bay live in vegetated areas, and some may overwinter in deeper waters in the Bay during mild years (Drohan et al. 2007). Spawning occurs in late spring to early fall over nearshore continental shelf habitats near large estuaries (Drohan et al. 2007). Development from egg through larval stages occurs in offshore water with juveniles (1.2 to 2.4 in. long) migrating into estuaries during summer. Maturation occurs when fish are about 3 to 6 in. long. The Chesapeake Bay supports a popular sport fishery and a small commercial fishery for black sea bass (Murdy et al. 2007). EFH that includes Chesapeake Bay has been designated for black sea bass juveniles and adults. Additional life history, fishery, and ecological information are provided in the EFH Assessment (Appendix F). Black sea bass occurred in 6 of the 21 yearly impingement samples collected from CCNPP Units 1 and 2 between 1975 and 1995 but only occurred in one year from 1984 to 1995 (Ringger 2000). Black sea bass eggs and larvae do not occur near Calvert Cliffs (Drohan et al. 2007) and, therefore, have not been entrained into the CCNPP Units 1 and 2 intakes. Juvenile black sea bass were not caught in entrainment samples collected at the intake for CCNPP Units 1 and 2 or outside the baffle wall in 2006 and 2007 (UniStar 2008d).

Bluefish (*Pomatomus saltatrix*)

Bluefish occur from Nova Scotia to Brazil (Murdy et al. 1997) and visit the Chesapeake Bay from spring to autumn (Murdy et al. 1997). Bluefish are abundant near the mouth of the Bay and common in the upper Bay in some years, but rarely occur north of Baltimore (Murdy et al. 1997). Spawning takes place in offshore waters during the northward migration, with peak spawning off Chesapeake Bay occurring in July (Murdy et al. 1997). After spawning, smaller fish enter nearshore bays, such as Chesapeake Bay and Delaware Bay, while larger fish swim northward. Juveniles (1.8 to 2.4 in. long) move into estuaries and nearshore environments of the Bay in late summer, and eventually migrate out of the Bay in the autumn (Harding and Mann 2001; Shepherd and Packer 2006). The bluefish is one of the most important recreational and commercial species in Chesapeake Bay with the recreational catch five to six times greater than the commercial catch (ASMFC 2006c). Recreational and commercial catches in Maryland have decreased substantially since peak values in the late 1980s, but have remained relatively stable since the mid-1990s (MDNR 2008b). EFH that includes Chesapeake Bay has been designated for bluefish juveniles and adults. Additional life history, fishery, and ecological information are provided in the EFH Assessment (Appendix F). Bluefish occurred in the impingement samples collected from the CCNPP Units 1 and 2 intake system in 9 of the 21 years from 1975 to 1995 (Ringger 2000), although they occurred in only one year after 1984. Bluefish were not found in the entrainment samples collected at the CCNPP Units 1 and 2 intake system or outside the baffle wall in 2006 and 2007 (UniStar 2008d).

Butterfish (*Peprilus triacanthus*)

Butterfish range from Nova Scotia to Florida and into the Gulf of Mexico (Murdy et al. 1997) but are most abundant between Cape Hatteras and the Gulf of Maine (Cross et al. 1999). Butterfish move into Chesapeake Bay about March and remain until about November. They are most abundant in the lower Bay but occasionally may be common in the upper Bay as far north as the Patapsco River (Murdy et al. 1997). Butterfish overwinter in deep offshore waters. The short-lived species spawns offshore from May to July in the mid-Atlantic area with eggs remaining offshore during the 48-hour incubation period (Cross et al. 1999). Juveniles, which range from 0.6 to 4.7 in. long (Cross et al. 1999), move into nearshore waters, including estuaries (Murdy et al. 1997), and may be associated with jellyfish. Adults may reach a length of about 12 in. and, in the Chesapeake Bay, mature by their third summer (Cross et al. 1999). Commercial catches of butterfish peaked about 1973 along the Atlantic coast and have declined fairly steadily since, with the lowest landings occurring in 2005 (Overholtz 2006). Butterfish were of minor commercial importance in the Chesapeake Bay in the late 1990s, with most of the catch coming from Virginia waters (Murdy et al. 1997). There is little recreational fishing for butterfish. EFH that includes Chesapeake Bay has been designated for butterfish eggs, larvae, juveniles, and adults. Additional life history, fishery, and ecological information are provided in the EFH Assessment (Appendix F). Butterfish occurred in 15 of the 21 yearly impingement samples collected from CCNPP Units 1 and 2 between 1975 and 1995 (Ringger 2000). However, the species only occurred in 5 years from 1984 to 1995. No butterfish life stages were caught in entrainment samples collected from the intake for Units 1 and 2 or outside the baffle wall in 2006 and 2007 (UniStar 2008d).

Clearnose Skate (*Raja eglanteria*)

Clearnose skates live in coastal waters from Massachusetts to Texas, but are rare in the northern parts of the range (Murdy et al. 1997; Packer et al. 2003a). Clearnose skates are primarily summer-to-fall residents of the Chesapeake Bay and are most abundant in the lower Bay (Murdy et al. 1997). These skates move out of the Bay to shallow offshore waters in the fall. Reproduction in waters north of Cape Hatteras occurs in spring and summer, with each fertilized egg being deposited in a benthic egg case (Packer et al. 2003a). Juveniles hatch from the egg cases after about 3 months and may eventually reach a length of about 30 in. at an age of more than 6 years. A relatively small fishery exists for skates (seven species are usually considered and managed together in the fishery) with smaller skates primarily caught for lobster bait (Packer et al. 2003a). Clearnose skates do not contribute much to the total skate catch and are not being overfished (Sosebee 2006). In the Chesapeake Bay, clearnose skates are considered a nuisance catch (Murdy et al. 1997). EFH that includes Chesapeake Bay has been designated for clearnose skate juveniles and adults. Additional life history, fishery, and ecological information are provided in the EFH Assessment (Appendix F). Clearnose skates were not listed in the yearly impingement samples collected from CCNPP Units 1 and 2 between 1975 and 1995 (Ringger 2000). Clearnose skates were not caught in entrainment samples collected from the intake for Units 1 and 2 or outside the baffle wall in 2006 and 2007 (UniStar 2008d).

Cownose Ray (*Rhinoptera bonasus*)

Cownose rays are found from South America to Massachusetts and the Gulf of Mexico (Murdy et al. 1997). They occur in the Chesapeake Bay from about May to October. The Bay is a main nursery area for young-of-the-year rays (Grusha 2005). Cownose rays are large, maturing at about 31- to 35-in. disc width (Grusha 2005) and reaching a maximum disc width of about 3.3 ft (Murdy et al. 1997). Mating occurs in late summer, and females carry the developing young until entering the Bay in May. Young have about 16-in. disc width when born. Cownose rays are ecologically important in Chesapeake Bay because of their occurrence in large schools and their benthic feeding behavior. Cownose rays feed in shallow waters on several species of clams (Smith and Merriner 1985). Feeding involves disruptively excavating the bottom with the pectoral fins and rapidly sucking in and expelling water and sediment with the mouth. This behavior creates large circular pits in the bottom and may disrupt small patches of SAV (Stankelis et al. 2003). Cownose rays occur near the Calvert Cliffs site, and significant fish kills of cownose rays occurred because of impingement on the trash racks of CCNPP Units 1 and 2 in summer 2005 (80 to 100 rays) and 2006 (50 to 200 rays) (NRC 2005, 2006c, 2006d, 2006e, 2006f, 2006g).

Little Skate (*Leucoraja erinacea*)

Little skates range from Nova Scotia to Cape Hatteras and are most abundant between Georges Back and Delaware Bay (Murdy et al. 1997; Packer et al. 2003b). Little skates occasionally occur in the lower Chesapeake Bay in the winter and spring (Murdy et al. 1997). Reproduction may take place throughout the year. Development time varies depending on the season in which the capsule is deposited but typically extends at least 6 months (Packer et al. 2003b). Juveniles are about 4 in. long at hatching. Little skates are fished primarily for use as lobster bait and account for most of the bait fishery, but they are not presently being overfished (Sosebee 2006). EFH that includes Chesapeake Bay has been designated for little skate juveniles and adults. Additional life history, fishery, and ecological information are provided in the EFH Assessment (Appendix F). Little skates were not listed in the yearly impingement samples collected from CCNPP Units 1 and 2 between 1975 and 1995 (Ringger 2000). Little skates were not caught in entrainment samples collected from the intake for Units 1 and 2 or outside the baffle wall in 2006 and 2007 (UniStar 2008d).

Red Drum (*Sciaenops ocellatus*)

Red drum occur from the Gulf of Maine to the northern coast of Mexico but are less abundant along the Atlantic coast than in the Gulf of Mexico (Murdy et al. 1997). Adults reside in Chesapeake Bay from May to November, with highest numbers near the Bay mouth in spring and fall (Murdy et al. 1997). Red drum may reach as far up the Bay as the Patuxent River. Spawning occurs at night in nearshore waters from late summer through autumn, and tidal currents carry larvae to nursery habitats in estuaries where they stay through the juvenile stage (ASMFC 2006d; Rooker et al. 1999). The Chesapeake Bay supports a small red drum fishery (Murdy et al. 1997). EFH that includes Chesapeake Bay has been designated for red drum eggs, larvae, juveniles, and adults. Additional life history, fishery, and ecological information are provided in the EFH Assessment (Appendix F). Red drum occurred in the impingement samples collected from the CCNPP Units 1 and 2 intake system only in 1983 (Ringger 2000). Red drum were not specifically identified in the entrainment samples collected in the CCNPP Units 1 and 2 intake system or outside the baffle wall in 2006 and 2007 (UniStar 2008d). However, sciaenid eggs, which were not identified further, were the second most common organism entrained.

<u>Spot (*Leiostomus xanthurus*)</u>

Spot primarily range from the Gulf of Maine to Florida and are most abundant between North Carolina and the Chesapeake (Murdy et al. 1997; ASMFC 2007b). Spot migrate seasonally between coastal waters and estuaries, entering Chesapeake Bay as adults and juveniles during the spring (Murdy et al. 1997; ASMFC 2007b). Spot were the fourth most abundant pelagic fish caught during trawl surveys conducted throughout the Bay from 1995 to 2000 (Jung and Houde 2003). Peak spawning occurs in February in offshore coastal waters. Larvae, about 0.4 to 0.6 in. long (Phillips et al. 1989), enter the Bay and use the estuarine habitats as nursery grounds until they leave in December (Murdy et al. 1997; ASMFC 2007b). Juvenile spot range from about 3 to 8 in. in length (Phillips et al. 1989) and occupy low salinity areas, tidal creeks, and eelgrass beds in Chesapeake Bay, gradually moving to tidal creeks (ASMFC 2006f). Spot feed on bottom-dwelling invertebrates and are prey for key predators, such as bluefish, striped bass, weakfish, and summer flounder (ASMFC 2007b). The spot commercial and recreational catch in Chesapeake Bay has been declining in recent years, possibly from loss of important estuarine nursery habitat (Murdy et al. 1997; ASMFC 2007b). The national commercial catch has declined gradually since the late 1980s, while the recreational catch has stayed relatively consistent such that it exceeded the commercial catch in 2006 (Meserve 2007b). Spot occurred in impingement samples every year sampled at CCNPP Units 1 and 2 from 1975 to 1995 and was among the five most commonly impinged species in 16 of the 21 years (Ringger 2000). About 80 percent of impinged spot survive. About 13.9 million spot larvae and juveniles were estimated to be entrained by the intake system for CCNPP Units 1 and 2 under maximum design flow conditions during the 19-month 2006 and 2007 study (UniStar 2008d). Juveniles accounted for about 94 percent of this total. They were not found in samples collected outside the intake system baffle wall.

<u>Striped Bass (*Morone saxatilis*)</u>

Striped bass, called rockfish in some areas, occur from the St. Lawrence River in Canada to the St. Johns River in Florida and in the eastern Gulf of Mexico (Murdy et al. 1997). Striped bass occur year-round in all tributaries of Chesapeake Bay. Striped bass reside in deeper channels in the Bay during summer and winter, but move to the lower reaches of rivers in the fall. Chesapeake Bay's tributaries provide spawning area for about 70 to 90 percent of the Atlantic coast striped bass (Phillips 2005), with the spawning migration beginning in March and peaking in April or early May (Murdy et al. 1997; ASMFC 2006d). Striped bass spawn above the salt front in Chesapeake Bay tributaries, such as the Patuxent River (Secor and Houde 1995). Larvae can swim when they reach a length of about 0.3 in. and develop swim bladders. They initially spend some time in nearshore areas or move just downstream to brackish water (Murdy et al. 1997; ASMFC 2006d). Some year-old fish eventually swim into the Bay. Older juveniles and adults form schools in estuarine waters, with some males and many females eventually leaving for open-ocean waters at about age five to eight (Secor and Piccoli 2007). Striped bass comprise important commercial and recreational fisheries in Chesapeake Bay that are tightly regulated because of large population fluctuations that reached very low levels in the 1980s (Murdy et al. 1997; ASMFC 2006d). Maryland placed a moratorium on striped bass fishing in 1985. Fishing resumed in 1990 with a very small catch (534 fish) followed by increasingly larger catches until a peak of more than 780,000 fish was reached in 1998 (NOAA 2008a). From 2000 to 2006, the catch varied between about 300,000 and 656,000 fish, the latter catch occurring in 2006 (NOAA 2008a).

Striped bass are top predators that play a significant role in the Chesapeake Bay ecosystem, interacting with several trophic levels. Younger bass predominantly consume small invertebrates and larger bass primarily feed on fish (Hartman and Brandt 1995; Walter and Austin 2003). Atlantic menhaden are major prey for larger striped bass in most parts of the Bay, but gizzard shad (*Dorosoma cepedianum*) have a larger role in low-salinity areas. Bay anchovy are important prey in waters off the mouth of the Bay (Overton et al. 2008). Striped bass juveniles are prey for bluefish and weakfish (Hartman and Brandt 1995). Striped bass face at least two primary natural threats. Reductions in Atlantic menhaden abundance change the trophic structure of the Bay and may contribute to malnutrition in striped bass (NOAA 2008a). Malnutrition caused by reduced menhaden populations may contribute to increased susceptibility of striped bass to bacterial infections, the most serious of which involves *Mycobacterium* spp. (Jacobs et al. 2006). The incidence of mycobacteriosis in striped bass internal organs may exceed 50 percent with skin lesions often greater than 30 percent of the fish in certain parts of the Bay (Vogelbein et al. 2006). Coincident with this increased incidence of disease has been a detectable increase in the rate of natural mortality (Kahn and Crecco 2006) although a direct link between the two has not been established. Striped bass occurred in impingement samples collected from the CCNPP Units 1 and 2 intake system in 10 of the 21 years from 1975 to 1995 (Ringger 2000). Striped bass were not found in the entrainment samples collected in the CCNPP Units 1 and 2 intake system in 2006 and 2007 or outside the baffle wall (UniStar 2008d).

<u>Summer Flounder (*Paralichthys dentatus*)</u>

Summer flounder range from Nova Scotia to South Florida and only visit Chesapeake Bay from spring to autumn, although some have been known to overwinter in the Bay (Murdy et al. 1997). Summer flounder migrate out of estuaries in late summer to early fall, but some may leave as late as early winter; many return to the same estuary (Sackett et al. 2007). Summer flounder are more common in the lower Chesapeake Bay than in the upper Bay. Spawning occurs during the migration offshore in the autumn, and larvae move into Chesapeake Bay from October through May, remaining in inshore areas for the first year of life (Murdy et al. 1997). Young-of-the-year (about 1 in. long) may reach the Calvert Cliffs site area sometime in spring (Nichols 2008). Juveniles (about 3 to 10 in. long) may occur in the area from spring through fall (Nichols 2008). The summer flounder constitutes a major commercial and recreational fishery and is a highly sought-after food fish (Murdy et al. 1997). The commercial fishery is primarily offshore, whereas the recreational fishery is in estuaries and bays (Latour et al. 2008). Although the summer flounder recreational catch has varied over the years; it approaches the commercial catch because of its popularity with anglers (Murdy et al. 1997). Summer flounder are not yet overfished, but overfishing is occurring (Terceiro 2006). EFH that includes Chesapeake Bay has been designated for summer flounder larvae, juveniles, and adults. Additional life history, fishery, and ecological information are provided in the EFH Assessment (Appendix F). Summer flounder were collected in impingement samples from the CCNPP Units 1 and 2 intake system in 18 of the 21 years from 1975 to 1995 and was the fifth most-impinged species in 1984 (Ringger 2000). About 90 percent of impinged summer flounder survive. Summer flounder were not found in the entrainment samples collected in the CCNPP Units 1 and 2 intake system or outside the baffle wall in 2006 and 2007 (UniStar 2008d).

Weakfish (*Cynoscion regalis*)

Weakfish range from Nova Scotia to Cape Canaveral, Florida, and are most abundant from North Carolina to Long Island (Murdy et al. 1997). Larger weakfish enter the lower Chesapeake Bay in April to May with smaller individuals arriving in summer (Murdy et al. 1997). Adults generally inhabit shallow, sandy parts of the Bay where salinity exceeds 10 ppt. Peak spawning occurs near the Bay mouth and in nearshore waters from May through June (Murdy et al. 1997). Larvae travel to lower salinity riverine habitats to grow until leaving the estuary in winter (Murdy et al. 1997; ASMFC 2007c). Weakfish may mature at an average length of about 6.6 in. (Nye et al. 2008). Weakfish eat many fish and invertebrate taxa, but older individuals consume a greater proportion of fish (Murdy et al. 1997). Although the weakfish is a commercially and recreationally important species in Chesapeake Bay, the fishery has declined since the 1940s (Murdy et al. 1997; ASMFC 2007c). Weakfish stock seriously declined in the late 1980s but rebounded substantially through 1998 (ASMFC 2007c). Weakfish were the fifth most abundant pelagic fish caught during trawl surveys conducted throughout the Bay from 1995 to 2000 (Jung and Houde 2003). However, the stock declined precipitously after 1999. The most likely causes were reduced available forage, resulting from the decline in Atlantic menhaden, and increased predation pressure by striped bass (ASMFC 2006e). Population estimates are not available for the years since 2003, but commercial and recreational landings since 2003 decreased to all-time low values (Meserve 2008). Weakfish occurred in impingement samples collected from the CCNPP Units 1 and 2 intake system in 16 of the 21 years from 1975 to 1995 and was the second most-impinged species in 1984 (Ringger 2000). About 38 percent of impinged weakfish survive. About 3.2 million weakfish larvae and juveniles were estimated to be entrained by the intake system for CCNPP Units 1 and 2 under maximum design flow conditions during the 19-month 2006 and 2007 study (UniStar 2008d). Larvae accounted for about 89 percent of this total but were rare in samples collected outside the intake system baffle wall.

White Perch (*Morone americana*)

White perch occur from Nova Scotia to South Carolina, with the most abundant numbers occurring from the Hudson River to the Chesapeake Bay where it is a year-round resident in all tributaries (Murdy et al. 1997). White perch, which overwinter in deep channels in the Bay, were the third most abundant pelagic fish caught during trawl surveys conducted throughout the Bay from 1995 to 2000 (Jung and Houde 2003). White perch usually inhabit waters with a salinity less than 18 ppt but can tolerate and thrive in salinities ranging from freshwater to 32 ppt (Murdy et al. 1997; King et al. 2004). Spawning occurs in the low-salinity to freshwater reaches of larger rivers, where the demersal eggs attach to the bottom (North and Houde 2001), from April through June. The young use the same area for nursery habitat (Murdy et al. 1997). The upper mainstem of the tidal Patuxent and its tributaries and the upper reach of St. Leonard Creek are known spawning areas (MDNR 2004). Juveniles spend their first summer and fall downstream of their spawning area where they feed on aquatic insects and small crustaceans (MDNR 2008c). In the Patuxent River, juveniles move to tidal freshwaters or brackish habitats for the first year of life (Kraus and Secor 2004). Despite its relatively small size, the brackish part of the Patuxent River yielded much higher juvenile abundance estimates than other larger sub-estuaries in the Bay (Kraus and Secor 2005). Adults feed on shrimp, crabs, and fish. The white perch is an important commercial and recreational fish in Chesapeake Bay, particularly in Maryland waters. The commercial fishery has been in decline in recent years, but the recreational fishery is significant with most of the catch occurring in the spring and autumn (Murdy et al. 1997). White perch populations in Maryland waters appear to be relatively stable (MDNR 2005). White perch is eaten by ospreys (Watts et al. 2007), thus providing a link between estuarine and terrestrial ecosystems. White perch occurred in impingement samples collected from the CCNPP Units 1 and 2 intake system in 19 of the 21 years from 1975 to 1995 (Ringger 2000). About 11.5 million white perch fertilized eggs were estimated to be entrained by the intake system for CCNPP Units 1 and 2 under maximum design flow conditions during the 19-month 2006 and 2007 study (UniStar 2008d). White perch fertilized eggs were not found in samples collected outside the intake system baffle wall.

Windowpane Flounder (*Scophthalmus aquosus*)

Windowpane flounder (or windowpane) range from the Gulf of St. Lawrence to Florida (Murdy et al. 1997) and are most common around Georges Bank (Chang et al. 1999). Windowpane live year-round in Chesapeake Bay and may be common as far north as the Choptank River (Murdy et al. 1997). They can be abundant in the lower Bay. Windowpane spawn from spring to autumn, but may not spawn during the middle of summer (Murdy et al. 1997; Chang et al. 1999). Eggs float and are about 0.06 in. in diameter. Larvae range in length from about 0.08 to 0.8 in., and juveniles reach lengths up to nearly 8 in. (Morse and Able 1995). EFH that includes Chesapeake Bay has been designated for windowpane juveniles and adults although there is no commercial or recreational windowpane fishery in Chesapeake Bay (Murdy et al. 1997).

Additional life history, fishery, and ecological information are provided in the EFH Assessment (Appendix F). Windowpane flounder occurred in 5 of the 21 yearly impingement samples collected from CCNPP Units 1 and 2 between 1975 and 1995 (Ringger 2000). However, the species only occurred in one year from 1981 to 1995. Windowpane flounder were not caught in entrainment samples collected from the intake for Units 1 and 2 in 2006 and 2007, nor were they found in samples collected outside the baffle wall (UniStar 2008d).

Winter Skate (*Leucoraja ocellata*)

Winter skates range from the Gulf of St. Lawrence to Cape Hatteras and are most abundant on Georges Bank and in the northern mid-Atlantic Bight (Packer et al. 2003c). In the lower Chesapeake Bay, winter skates are occasional residents from winter to spring (Murdy et al. 1997). Winter skate may reproduce all year, although peak reproductive activity seems to occur in summer and fall (Packer et al. 2003c). Fully developed juveniles hatch from egg capsules at about 4 to 5 in. in total length. Winter skates are fished as part of the export market for skate wings. Winter skates are considered as being overfished (Sosebee 2006). There are no commercial or recreational winter skate fisheries in the Chesapeake Bay (Murdy et al. 1997). EFH that includes Chesapeake Bay has been designated for winter skate juveniles and adults. Additional life history, fishery, and ecological information are provided in the EFH Assessment (Appendix F). Winter skates were not listed in the yearly impingement samples collected from CCNPP Units 1 and 2 between 1975 and 1995 (Ringger 2000). Winter skates were not caught in entrainment samples collected from the intake for Units 1 and 2 in 2006 and 2007, nor were they found in samples collected outside the baffle wall (UniStar 2008d).

Invertebrates

Blue Crab (*Callinectes sapidus*)

Blue crabs range from Nova Scotia to Argentina and have been recorded from Europe, the Mediterranean, and Japan (Williams 1984). Blue crab habitat ranges from the coastal ocean waters to less saline estuaries and some freshwater systems. Blue crabs can withstand salinities from 0 ppt to 48 ppt (Williams 1984). Blue crabs are opportunistic scavengers consuming plant material, other invertebrates, and fish (Dittel et al. 2006).

Blue crab mating begins in late May in the lower Bay and in June to July in the upper Bay (Carver et al. 2005). Mating continues from July through September. After mating, females in the upper Chesapeake Bay spend the remainder of the summer in the mating area and begin migrating toward the mouth of the Bay in the fall (Aguilar et al. 2005). Females migrate down the eastern side of the main bay channel using the ebb tide flow at night for transport (Tankersley et al. 1998). Some crabs may spawn upon reaching the mouth of the Bay, but others have to overwinter there before completing spawning the next spring. Eggs hatch, releasing planktonic larvae, when females are at the mouth of the Bay or in open ocean waters.

Females tend to live out their lives near the mouth of the Bay (Williams 1984), but the larvae migrate up the Bay after passing through a few developmental stages in the ocean. Newly settled juvenile crabs are about 0.6 in. in body width (Dittel et al. 2006).

The blue crab fishery is the most important in the Chesapeake Bay (Fogarty and Miller 2004). The annual commercial harvest for most years between 1945 and 1980 in the Maryland portion of the Bay ranged from about 45 to 60 million pounds (MDNR 2008d), adjusted for reporting changes instituted in 1981 (Fogarty and Miller 2004). The harvest was about 65 million pounds in 1981, which was the largest harvest recorded in Maryland. The annual harvest generally decreased from 1981 to 2000 when the lowest recorded harvest, about 20 million pounds, occurred (MDNR 2008d). The harvest increased from 2000 to 2004, but has declined steadily since, reaching the second lowest recorded value, about 21.8 million pounds, in 2007. The small 2007 harvest was attributed to low reproduction in 2006, climate-induced crab migration farther north up the Bay, and reduced fishing effort (MDNR 2008d). Maryland instituted emergency crabbing regulations early in 2008, partly in response to the low 2007 harvest (MDNR 2008e).

Blue crab population estimates from 1990 to 1997, based on data from the annual Chesapeake Bay winter dredge surveys (MDNR 2007e), and ranged from about 487 million crabs to 852 million crabs (except for an estimate of 367 million crabs in 1992). Since 1997, the population estimates have been lower, typically less than 352 million crabs.

The historical (1968 to 2000) blue crab population in the CCNPP area has been studied, but blue crabs were not assessed during the field surveys conducted in 2006 and 2007. The historical study, which used commercial peeler crab pots to sample the crabs, was initially conducted from 1968 to 1971 before the Calvert Cliffs plant began operation to establish a baseline that would allow the thermal effects of the cooling water discharge on the crab population to be evaluated (Abbe 1973). Comparison of the first 28 years of the Calvert Cliffs data set (1968 to 1995) with the Maryland DNR fisheries statistics during the same time period showed that the two were highly correlated (Abbe and Stagg 1996). These data also suggested a decline in the percentage of legal size crabs in the 1990s compared to the 1970s and 1980s and that males were becoming smaller. Examination of the entire 33-year data set showed that although the general catch per unit effort was consistent, there was a declining trend in the numbers and sizes of legal size males but not most female size classes (Abbe 2002). This reduction in male size is the result of a fishery that targets larger males, not because of the operation of the Calvert Cliffs plant. This size-selective fishery has been shown to reduce the average size and density of males in a population and to decrease the ratios of males to females (NMFS 2007b). This reduces the number of males available for mating and reduces the amount of sperm produced by males. Because most females typically mate once, the reduced sperm availability limits the maximum number of broods that each female can produce. Blue crabs were not in the entrainment samples collected from the intake for Units 1 and 2 in

2006 and 2007, nor were they found in samples collected outside the baffle wall (UniStar 2008d). Blue crabs were abundant in the impingement samples collected from the CCNPP Units 1 and 2 intake system from 1975 to 1995 (Ringger 2000). The total numbers impinged annually ranged from about 82,000 crabs to about 1.66 million crabs. More than 99 percent of impinged blue crabs survive.

Eastern Oyster (*Crassostrea virginica*)

The eastern oyster, which is sometimes called the American oyster, is one of the species that defines the Chesapeake ecologically and culturally. Ecologically, oysters exert strong effects by constructing living oyster reefs that serve as habitat for themselves and many other species. The importance of the commercial fishery that developed around the eastern oyster in Chesapeake Bay has made the oyster virtually synonymous with the Bay (Ulanowicz and Tuttle 1992).

The NMFS reviewed the status of the eastern oyster in response to a petition to list the species as threatened or endangered (EOBRT 2007). NMFS declined to list the eastern oyster under the ESA (72 FR 35388). Eastern oysters reportedly are distributed from Canada to Florida and into the Gulf of Mexico; records of the species in Central and South America may represent different species (EOBRT 2007). Eastern oysters have inhabited the Chesapeake Bay for about 6000 to 7000 years (Hargis and Haven 1999). Oysters in Chesapeake Bay are generally more common in relatively shallow waters (< 26 ft deep) having low to moderate salinities (5–15 ppt) at temperatures ranging from 68–86°F (Hargis and Haven 1999; EOBRT 2007). Spawning typically occurs in response to environmental conditions, such as temperature greater than 68°F and salinities greater than 10 ppt (EOBRT 2007). In the Chesapeake Bay, spawning occurs between May and October (McCormick-Ray 2005). Males and females broadcast gametes into the overlying water column, in which fertilization occurs. Oysters pass through several larval stages, usually spending about a month as plankton (EOBRT 2007). After this period of planktonic development, larvae seek appropriate habitat, such as the complex habitats provided by oyster reefs, for settlement and metamorphosis to the sessile adult stage. The newly settled oysters are called spat, and the process though which larvae settle to the bottom and attach to hard substrate is called spatfall (Tarnowski 2007). Oyster eggs or larvae were not in the entrainment samples collected from the intake for Units 1 and 2 in 2006 and 2007, nor were they found in samples collected outside the baffle wall (UniStar 2008d).

Oysters contribute to several important ecosystem functions. Oysters feed by straining phytoplankton and organic debris from the water column and large oyster populations filter considerable amounts of phytoplankton, helping to reduce the adverse effects of eutrophication (Ulanowicz and Tuttle 1992, Cerco and Noel 2007). One of the most important oyster contributions is the creation of large, complex reefs constructed of oyster shells that are critical for the settlement of oyster spat and provide valuable habitat for many species of fish and invertebrates (McCormick-Ray 2005; EOBRT 2007).

Oysters in Chesapeake Bay were abundant in the 1600s and early 1700s, and also formed large reefs that extended to the water surface often becoming a hazard to navigation (Kennedy and Breisch 1981). Oyster harvesting in the Bay increased substantially as oysters were overfished in New England. The demand for oysters was such that the Maryland harvest increased almost fivefold from about 1860 to 1875, reaching a peak of about 15 million bushels in the early 1880s (Kennedy and Breisch 1981). Harvests declined very rapidly thereafter. In addition to providing food, oysters were harvested for use as agricultural lime, building roads, and to provide chicken grit (Kennedy and Mountford 2001). The wholesale destruction of oyster reefs made the situation worse because it reduced the source of spat that could replenish oyster populations and removed that exact habitat most needed for successful oyster spat settlement, the oyster reefs themselves. Oyster populations in the 1900s were severely affected by two lethal diseases. Dermo, which caused by the parasitic protozoan *Perkinsus marinus* and affects oyster immune systems, appeared in the late 1940s causing significant oyster mortalities in Virginia (EOBRT 2007). Dermo continues to cause significant oyster mortality in the Bay, and occurred on 93 percent of the Maryland oyster bars surveyed for the disease in the fall of 2007 (Tarnowski 2008). MSX (named for its original description as Multinucleate Sphere X [unknown]) is caused by another protozoan, *Haplosporidium nelsoni*. MSX was discovered in the late 1950s when it caused significant mortalities among adult and young oysters in Delaware Bay and had moved into Chesapeake Bay by 1959 (EOBRT 2007). MSX requires that salinities consistently be greater than 15 ppt for an infection to be maintained within a population. Once infected, oysters live only about 6 weeks. MSX occurs primarily in the southern Bay with about 30 percent of the bars sampled for the disease being infected (Tarnowski 2008). The population issues facing the eastern oyster in Chesapeake Bay led to a 5-year evaluation of several approaches to rebuilding oyster stocks in the Bay, including importing the nonnative Suminoe oyster (*C. ariakensis*) into Bay waters (USACE 2009a). The Record of Decision identified that improving native oyster restoration efforts, placing a moratorium on oyster harvests, and increasing native oyster aquaculture programs were preferable to introducing a nonnative oyster (USACE 2009b).

<u>Flag Pond Oyster Bar/Natural Oyster Bar 19-2</u>

The Calvert Cliffs site is just landward of the Flag Pond oyster bar, an oyster bar available for public use identified and mapped as Natural Oyster Bar 19-2 (NOB 19-2) by the State of Maryland. The bar occupies about 680 ac and is about 2.7 mi long and about 0.7 mi wide at its widest point, which occurs directly off the present area of the cooling water system discharge of CCNPP Units 1 and 2 (Abbe 1988). Most oysters on the bar occur in waters shallower than 26 ft. Baltimore Gas and Electric Company (BGE), in agreement with the State of Maryland, removed the oysters from a 500-ac area of the oyster bar prior to the building of CCNPP Units 1 and 2. Most of the 8756 bushels of oysters removed from the bar by 1969 were from two small sections of the bar located immediately off the location of the proposed Units 1 and 2 intake area. These small patches were about 29 ac in area and had been seeded with spat in 1962 and 1963 (BGE 1971). The oysters were relocated to an oyster bar in the Patuxent River. BGE

(1971) reported that the 500-ac area from which oysters had been removed was closed and taken off the State oyster bar charts. The Maryland DNR began mapping Natural Oyster Bars in the mid-1980s as part of efforts to restore hard-bottom areas to increase potentially successful spatset (MPSC 2008). The former Flag Pond oyster bar was included within a larger area designated as NOB 19-2 during this process. In the region off the Calvert Cliffs site, NOB 19-2 extends about 3300 ft from the shoreline into the Bay (MDNR 2008a, b). Abbe (1988, 1992) stated that about 71 percent of the habitat within the bar was not suitable oyster habitat because it consisted of unstable sand or mud. The oyster population on the bar in 1979 was estimated to be about 7×10^3 bushels, which was considered small (Abbe 1988). The State of Maryland stocked the Flag Pond oyster bar with 102×10^3 bushels of oyster shells in the CCNPP discharge area in 1980 and 197×10^3 bushels off Camp Conoy in 1982 (Abbe 1988). In 1984, another 70×10^3 bushels were placed off Camp Conoy (Abbe 1992). Oyster density on the Flag Pond oyster bar increased from 1983 through 1985 because of the shell planting done by the state, reaching a peak of 243 oysters/m^2 in 1985. However, the number of legal oysters (3 in. or greater in shell length) remained consistent during that period, with about 4.0 to 6.1 legal oysters/m^2 occurring on the bar. The total numbers of oysters on Flag Pond oyster bar decreased steadily after 1985, although the numbers of legal oysters present was consistent with those of the previous years. Abbe (1992) also observed these high occurrences of spatfall.

The State of Maryland conducts an annual fall oyster survey on about 280 oyster bars located throughout the state. The most recent report, which includes spatfall, disease incidence, and mortality data collected from 1985 to 2007, provides an historical overview of conditions on the Flag Pond oyster bar (Tarnowski 2008). Since 1985, spatfall intensity (i.e., the number of spat per bushel of available habitat) has been low, with most years having ten or fewer spat per bushel. The highest spatfall years were 1986, 1987, and 1991, with spatfall intensity ranging from 128 to 330 spat per bushel. Spatfall in 1986 and 1987 was related to the stocking effort that occurred in the early 1980s (Abbe 1992). Spatfall intensity at Flag Pond is consistently one of the lowest in the state, with spatfall being recorded on six surveys since 1995 and only one of the last five (2003 to 2007) surveys (Tarnowski 2008). The prevalence of the oyster disease dermo on the Flag Pond oyster bar was extremely high (88–97 percent of the samples showed the disease) from 1991 to 1993, as it was throughout the state. The disease could not be evaluated during most of 1999 to 2002 when it was again a major problem throughout most of the state. The incidence of dermo increased to 43 percent and 87 percent of the samples evaluated in 2006 and 2007, respectively (Tarnowski 2008). The increase was part of a general bay-wide trend probably associated with reduced streamflow into the Bay. MSX disease has been detected at the Flag Pond oyster bar in only 3 of the years surveyed: 1992, 1995, and 2002 (Tarnowski 2008). Mortality, the proportion of dead oysters collected, varied from 1986 to 1999, ranging from 10 to 77 percent annually. However, mortality has been low since then, with values less than 25 percent since 2002 (Tarnowski 2008).

UniStar sponsored a study of part of the Flag Pond oyster bar in November 2006. The patent-tong survey encompassed an area of about 160,000 m^2 located just north of the present barge dock. EA Engineering (2007a) found that oyster abundance in the surveyed area was low, with an estimated total population in the area of about 9.6 bushels, which implies the bar does not support an oyster population sufficient to be fished or to produce enough new habitat for oyster larval settlement.

Although oyster populations on NOB 19-2 have been relatively low historically and are currently very low, the Maryland DNR emphasizes protection of the bottom habitat within oyster bars and requires replacement of any area of the bay bottom that might be affected by a proposed action (MPSC 2008). Therefore, an acoustic survey of the Bay bottom within a selected portion of NOB 19-2 was conducted in August 2008 to evaluate potential oyster habitat off the Calvert Cliffs site. The survey did not include the entire oyster bar, but focused on the area most likely to be affected by the building of proposed Unit 3 (Conkwright et al. 2008). The survey found that most of the bottom in the oyster bar consists of sand or shell and hard bottom. The only major exception was the muddy bottom of the deep channel that was dredged as the intake channel for CCNPP Units 1 and 2. Conkwright et al. (2008) concluded that there is viable oyster habitat off the Calvert Cliffs site with the primary highest-quality habitats located nearshore at the present barge dock area and extending northward to the dredged intake channel and within a large area extending southeast of the barge dock area. The survey also found that there was old shell material just under the sediment surface that might be used to restore habitat.

Federally and State-Listed Estuarine Species

This section describes Federally and Maryland State-listed estuarine species and other species of concern. No aquatic critical habitats are proposed or designated near the Calvert Cliffs site.

The State of Maryland lists the sea-purslane (*Sesuvium maritimum*) as State Endangered and the spotfin killifish (*Fundulus luciae*) as State “Rare?” (State’s nomenclature) for Calvert County (MDNR 2007a). Federally listed aquatic species known to occur in the Chesapeake Bay near the Calvert Cliffs site include the shortnose sturgeon (*Acipenser brevirostrum*), Atlantic sturgeon (*Acipenser oxyrinchus*), loggerhead turtle (*Caretta caretta*), green turtle (*Chelonia mydas*), Kemp’s ridley turtle (*Lepidochelys kempii*), and leatherback turtle (*Dermochelys coriacea*). The alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*) are considered species of concern by NMFS (NMFS 2007b). Species of concern are not protected under the ESA, but concerns about their status indicate that they may warrant listing in the future.

Sea-purslane *(Sesuvium maritimum)*. Sea-purslane is a small, low-growing annual plant that often may be overlooked in coastal environments. It occurs on sandy beaches and dunes, in brackish marshes, and on coastal banks along the Atlantic coast from New York to Florida and on the Gulf coast from Florida to Texas and has been recorded from Puerto Rico (eFloras 2008a; USDA 2008i). Flowering typically occurs from summer to fall. Although the beach habitat along Chesapeake Bay was not included in the floral studies conducted on the Calvert Cliffs site, the Rare Plant Survey report stated that the correct habitat for the sea-purslane did not occur on the site but that the possible occurrence of sea purslane on the site cannot be completely discounted (Tetra Tech NUS 2007c).

Spotfin Killifish *(Fundulus luciae)*. The spotfin killifish, which is the smallest species of the genus *Fundulus*, reaching a total length of about 2 in., occurs in intertidal marshes from Georgia to Massachusetts (Murdy et al. 1997). In the Chesapeake Bay, spotfin killifish live in small brackish pools and streamlets in the upper parts of intertidal marshes typically associated with saltmarsh cordgrass (*Spartina alterniflora*) (Byrne 1978; Murdy et al. 1997). These habitats are not found at the Calvert Cliffs site. Spotfin killifish occur in waters of widely varying temperature, salinity, and dissolved oxygen content. Spawning occurs primarily in the spring, but may last until early fall. Fertilized eggs are attached to benthic materials and usually hatch within about two weeks, although hatching is delayed in relatively high salinity waters (Byrne 1978). Larvae and juveniles range in length from about 0.2 to 0.7 in. (Byrne 1978). Spotfin killifish are omnivorous, feeding on detritus, diatoms, and small invertebrates, and probably live about one year (Byrne 1978). Wading birds and some fish prey on killifish. There are no fisheries for these killifish. Spotfin killifish were not listed in the yearly impingement samples collected from CCNPP Units 1 and 2 between 1975 and 1995 (Ringger 2000). Spotfin killifish were not caught in entrainment samples collected from the intake for Units 1 and 2 in 2006 and 2007, nor were they found in samples collected outside the baffle wall (UniStar 2008d).

Shortnose Sturgeon *(Acipenser brevirostrum)*. The shortnose sturgeon is a long-lived, Federally and Maryland State-listed endangered species (NMFS 1998; MDNR 2007b) found along the western Atlantic coast from St. John River, New Brunswick to St. Johns River, Florida (Murdy et al. 1997; Wirgin et al. 2005). Shortnose sturgeon live primarily in freshwater or in low-salinity estuaries but may swim into higher salinity coastal waters on occasion (Murdy et al. 1997; NMFS 1998). Females deposit eggs that attach to the bottom substrate and remain there for a few days (Kynard 1997). The eggs hatch into secretive, poorly swimming yolk-sac larvae that develop into feeding larvae within several days. The feeding larvae are able to move downstream, but stop migrating before reaching the estuary. Growth of young-of-the-year fish is fairly rapid with young often reaching lengths of about 6 in. or more during the first season (Dadswell et al. 1984). Adults reach a maximum length of 4.6 ft. Historically, the shortnose sturgeon was found in the Potomac and Susquehanna Rivers and probably in other major Chesapeake Bay tributaries, although historical records apparently were based on few verified records (Dadswell et al. 1984). However, populations have been decimated by loss of critical spawning habitat primarily from damming of rivers and pollution (Murdy et al. 1997). There were few published records of shortnose sturgeon occurrence in the Bay before 1996. In 1979, BGE researchers captured a shortnose sturgeon during trawl studies near the Calvert Cliffs site (UniStar 2008b). Recent studies of the shortnose sturgeon in the Potomac River showed that a reproducing, resident population may eventually be re-established in the Bay. A study conducted from 2004 to 2007 documented the movements of two female shortnose sturgeons in Potomac River (Kynard et al. 2009). A third female was tagged after the completion of the study (FWS 2009). Despite the capture of egg-bearing females in the Potomac, there is no evidence yet that reproduction has been successful in the river, and no Chesapeake Bay tributaries are known to support reproducing populations at this time (FWS 2009). These Potomac River records confirm the presence of suitable habitat for the species and suggest that a breeding population eventually may be established in the river. Shortnose sturgeon were not in the entrainment samples collected from the intake for Units 1 and 2 in 2006 and 2007, nor were they found in samples collected outside the baffle wall (UniStar 2008d). No shortnose sturgeon occurred in the impingement samples collected at CCNPP Units 1 and 2 from 1975 to 1995 (Ringger 2000). NMFS initiated a status review for the shortnose sturgeon in November 2007 to update the biological information on the status of the species and to consider if shortnose sturgeon should be identified and assessed as Distinct Population Segments rather than as a single unit (72 FR 67712). Although a recent study provided genetic evidence for the existence of distinct population segments (Wirgin et al. 2009), no change in the shortnose sturgeon status has been made. A biological assessment that provides life history, population, and ecological information is included in Appendix F.

Atlantic Sturgeon *(Acipenser oxyrinchus)*. The Atlantic sturgeon is a Federal Species of Concern (NMFS 2007a) and a Maryland Highly State Rare Species (MDNR 2007b) that occurs along the western Atlantic coast from Ungava Bay, Quebec, to the Gulf of Mexico (Murdy et al. 1997). Atlantic sturgeon enter Chesapeake Bay in April and May to spawn in tributaries (Murdy et al. 1997). In general, adults migrate upriver in the spring or early summer to spawn, although the specific timing varies with latitude (Murdy et al. 1997; Atlantic Sturgeon Status Review Team 2007). Atlantic sturgeon spawn at depths of 36 to 89 ft between the fall line and salt front in large rivers where flows range from 1.5 to 2.5 ft/s (Atlantic Sturgeon Status Review Team 2007; NMFS 2007a). Tidal tributaries are used as nursery grounds, and juveniles may spend several years in fresh to brackish water areas before moving to coastal waters as 30-in.-long subadults (Murdy et al. 1997; Atlantic Sturgeon Status Review Team 2007; NMFS 2007a). The Atlantic sturgeon is a long-lived species that spends most of its life in marine waters. Adults may reach a maximum size of 14 ft. Dam construction on natal rivers, pollution, and overfishing have dramatically reduced the populations of this once abundant and highly sought after food species (both meat and roe) and conservation efforts are in place to revive the numbers and subsequently the fishery (Murdy et al. 1997). Population data for the Atlantic sturgeon are scarce, and there are only two subpopulations that have size estimates, neither of which includes Chesapeake Bay (NMFS 2007a). Atlantic sturgeon were not caught in the entrainment samples collected from the intake for Units 1 and 2 in 2006 and 2007, nor were they found in samples collected outside the baffle wall (UniStar 2008d). No Atlantic sturgeon occurred in the impingement samples collected at CCNPP Units 1 and 2 from 1975 to 1995 (Ringger 2000).

Alewife *(Alosa pseudoharengus)*. The alewife is a Federal Species of Concern (NMFS 2007b) that occurs in western Atlantic coastal waters, rivers, and estuaries from Newfoundland to northern South Carolina (Murdy et al. 1997). Alewife enter Chesapeake Bay in the spring to spawn with most spawning occurring in March and April (Murdy et al. 1997). Alewife spawn in shallow, low-flowing water, including rivers, streams, and ponds, where the young remain until migration to the sea in early fall (Murdy et al. 1997). Larvae range to about 0.8 in. long and juveniles to about 1.8 in. total length (Fay et al. 1983). Adults, which may reach 15 in. total length, migrate downstream soon after spawning (ASMFC 2007d). Alewife are planktivores feeding on comb jellies, crustaceans, and small fish. Alewife and blueback herring are closely related and together are called river herring. The close physical similarity of the two species has caused them to be fished and managed as a single group (NMFS 2007b).

River herring comprise one of the oldest fisheries in North America (NMFS 2007b) that historically was one of the most valuable in Chesapeake Bay (Murdy et al. 1997). The catch in Maryland peaked at about 8,000,000 lb in the 1930s but dropped to 70,000 lb in recent years (MDNR 2008f). The decline during the last 50 years is mainly because of loss of spawning habitat (Murdy et al. 1997). River herring also comprised a relatively important recreational fishery, but that has also declined considerably. River herring population levels have declined substantially during the last 30 years, probably because of loss of spawning habitat, fishing pressure, and increased predation pressure from growing striped bass populations (NMFS 2007b). These population declines prompted NMFS to identify river herring as species of concern in 2006 (NMFS 2007b).

Alewife and blueback herring provide a connection between ecosystems because their spawning migrations transport marine-based nutrients into freshwaters (Garman 1992; MacAvoy et al. 2000). River herring are important prey for top predators, such as bluefish and striped bass (Hartman and Brandt 1995, MDNR 2008f). Alewife occurred in 13 of the 21 impingement samples collected at CCNPP Units 1 and 2 from 1975 to 1995 but were only caught in two years sampled after 1984 (Ringger 2000). About 2.6 million river herring (*Alosa* spp.) larvae were estimated to be entrained by the intake system for CCNPP Units 1 and 2 under maximum design flow conditions in 2006 and 2007 (UniStar 2008d). No river herring were found in samples collected outside the baffle wall.

Blueback Herring *(Alosa aestivalis)*. The blueback herring is a Federal Species of Concern (NMFS 2007b) that occurs along the western Atlantic coast and in rivers and estuaries from Nova Scotia to Florida (Murdy et al. 1997). Herring enter Chesapeake Bay in April and May to spawn, usually in deeper waters of swift-flowing rivers and streams (Murdy et al. 1997). Blueback herring larvae are slightly smaller than alewife larvae, reaching a length of about 0.6 in. (Fay et al. 1983). Blueback herrings are planktivores feeding on comb jellies, crustaceans, and small fish. Blueback herring are commercially fished but are typically included with alewife in fishery data and management plans. Fishery and population information are discussed in the alewife section. Blueback herring occurred in 20 of the 21 impingement samples collected at CCNPP Units 1 and 2 from 1975 to 1995 and were among the five most abundant species caught in five of those years (Ringger 2000). Potential blueback herring entrainment is discussed as river herring in the alewife section.

Sea Turtles

Four species of sea turtles that are protected under the ESA may occur in Chesapeake Bay during part of the year. A biological assessment that provides life history, population, and ecological information is included in Appendix F. Most of these turtles in the Chesapeake Bay are larger juveniles that use the Chesapeake Bay as feeding habitat (Mansfield 2006). Turtles visit Chesapeake Bay primarily in the spring and summer (VIMS 2000). The two most common species in the Bay are the loggerhead turtle (*Caretta caretta*) and Kemp's ridley turtle (*Lepidochelys kempii*) (Mansfield 2006). Also occurring in the Bay are the green turtle (*Chelonia mydas*) and the leatherback turtle (*Dermochelys coriacea*) (VIMS 2000). Abundances of all four species are typically estimated by counting the number of nesting females or directly counting the number of nests in which eggs have been deposited (Broderick et al. 2006). Abundances of males are often unknown. Recent estimates of turtle occurrence in lower Chesapeake Bay have been made by using aerial surveys (Mansfield 2006). Abundances of turtles within the Bay have decreased substantially since the 1980s. Spring and summer turtle abundances have declined by about 63 percent and 75 percent, respectively (Mansfield 2006). Mansfield (2006) suggested that these decreases could indicate that the Bay might have reached its carrying capacity, in part because of reductions in the forage base, such as blue crabs.

All four sea turtle species face similar threats, with the primary threat being the incidental capture by many types of fishing gear (NOAA 2008a). Additional threats include harvesting of eggs, juveniles, and adults, and disturbance of nesting sites. Predators, other than humans, may also have significant effects on sea turtles. The primary predators on turtle adults include several large shark species, particularly tiger sharks (*Galeocerdo cuvier*) (Heithaus et al. 2008). A search of the event logs maintained by the NRC revealed the occurrence of a fatal sea turtle impingement on the trash racks at the existing CCNPP Units 1 and 2 facility (NRC 2001). The impinged species was not identified.

Loggerhead Turtle *(Caretta caretta)*. The loggerhead turtle is a Federally and State threatened species (MDNR 2007b; NOAA 2008d) that is found in temperate and tropical seas around the world (NOAA 2008d). In the Atlantic Ocean, loggerheads range from Argentina to Newfoundland. Loggerheads in the northwest Atlantic nest primarily on beaches from Alabama to southern Virginia (Conant et al. 2009). Oceanic juveniles, which are about 18 to 25 in. long (Bjorndal et al. 2000), migrate to nearshore waters near estuaries, such as Chesapeake Bay, providing important habitat (NMFS and FWS 2007a). The Chesapeake Bay is used primarily by juveniles but is also frequented by adults in the summer. Loggerheads are known to occur in the Bay off Calvert County (Lutcavage 1981). Loggerheads in the southeastern U.S. may reach a length of 36 in. and weigh as much as 250 lb (NOAA 2008d). In the lower Chesapeake Bay area and coastal Virginia, loggerhead diet has shifted from invertebrates to fish since the 1980s (Seney and Musick 2007). Horseshoe crabs were a prominent prey in the 1980s with blue crabs becoming predominant in the late 1980s and 1990s. After the mid-1990s, menhaden and Atlantic croaker became important prey. The changes probably resulted from declines in the invertebrate populations. Conant et al. (2009) determined that the global loggerhead turtle population can be differentiated into nine distinct population segments (DPS). Conant et al. (2009) concluded that the Northwest Atlantic DPS, which includes all turtles that frequent Chesapeake Bay, was at risk for extinction primarily because of juvenile and adult mortality as bycatch from recreational and commercial fishing.

Green Turtle *(Chelonia mydas)*. The green turtle population occurring in the Chesapeake Bay is Federally and State threatened (MDNR 2007b; NMFS 2007c). On the U.S. Atlantic coast, the green turtle ranges from southern Florida to Massachusetts. In the United States, the major nesting area is in Florida where nesting typically occurs from June to September with most occurring in June and July (NMFS 2007c). Older juveniles migrate to inshore areas where they mature. Adults may reach length of 3 ft and weigh 300 to 350 lb and are the largest of the hard-shelled sea turtles (NMFS 2007c). Estimates have shown that green turtle populations worldwide have been declining for at least 100 years (NMFS 2007c) although a few populations, including the Florida population, have shown small increases in the last few years (NMFS and FWS 2007b).

Leatherback Turtle *(Dermochelys coriacea)*. The leatherback turtle is a Federally and State endangered species (MDNR 2007b; NOAA 2008c) that is found worldwide in many ocean habitats. In the western Atlantic, it ranges from the Gulf of Maine to the Caribbean and is found in the Gulf of Mexico (NOAA 2008c). The primary nesting areas are in South America and west Africa, with minor sites in the Caribbean Sea and southeast Florida. There is some indication that nesting in the Caribbean and Florida has been increasing. Nesting in Florida increased about ten-fold from the late 1980s to the early 2000s, with about 800 to 900 nests found recently (NMFS and FWS 2007c). Little is known about the distribution of juveniles, although they seem to occur in warmer waters (NOAA 2008c). Leatherback turtles are the largest living reptiles with adults reaching lengths of about 6 ft and weighing as much as 1984 lb.

Kemp's Ridley Turtle *(Lepidochelys kempii)*. The Kemp's ridley turtle is a Federally and State endangered species (MDNR 2007b; NOAA 2008b) that occurs along the Atlantic coast from Florida to New England and throughout the Gulf of Mexico (NOAA 2008b). About 95 percent of Kemp's ridley turtles nest in Tamaulipas State, Mexico although some nesting has occurred in within the United States in the Carolinas and Florida. Numbers of nesting females have continued to increase in the 2000s. In 2006, about 100 nests were found in the United States. Nesting occurs from May to July, with females laying two to three clutches. Eggs hatch within about two months, and hatchlings move to offshore waters. Juveniles drift in association with the seaweed *Sargassum* sp. for about two years and return to near coastal areas as subadults. Kemp's ridley turtles are the smallest marine turtles, reaching a maximum length of 28 in. and a weight of 100 lb (NOAA 2008b). A historical record of Kemp's ridley turtle near the Calvert Cliffs site (Hardy 1962) is based on the identification of a beak from a dead turtle. Many young Kemp's ridley turtles inhabit the Chesapeake Bay during the summer, but most live in the lower Bay (UniStar 2008a).

2.4.2.6 Non-Native and Nuisance Estuarine Species – Site and Vicinity

Maryland lists the curly leaved pondweed (*Potamogeton crispus*) as a non-native, invasive estuarine plant species of concern that occurs in the State (MISC 2008a). This species occurs in fresh to brackish waters, where it often forms dense beds. It was not found during the SAV survey conducted in the Bay near the Calvert Cliffs site (EA Engineering 2007b).

Maryland lists the green crab (*Carcinus maenas*) and the Chinese mitten crab (*Eriocheir sinensis*) as non-native, invasive estuarine invertebrate species of concern that occur in the Chesapeake Bay. The green crab is established at the mouth of the Bay (MISC 2006). The Chinese mitten crab has been found off Kent Point and at the mouth of the Patapsco River (MDNR 2008a). Neither was found among the benthic samples collected in the Bay near the Calvert Cliffs site in 2006 and 2007 (EA Engineering 2007a).

Two invasive aquatic vertebrates are of potential concern, the mute swan (*Cygnus olor*) and the nutria (*Myocastor coypus*) (MISC 2008b). Potentially suitable habitat for both species exists on the Calvert Cliffs site (UniStar 2008a). Neither species is known to reside on the site (UniStar 2008a).

Pfiesteria (*Pfiesteria piscicida*) is one of the algal species known to produce toxins. Blooms of *Pfiesteria* may be unusual in that they can generate fish kills at relatively low cell densities (100 to 300 cells/mL). *Pfiesteria* is capable of sexual and asexual reproduction and has a complex life cycle characterized by various flagellated, amoeboid, and cyst stages (UniStar 2008a). *Pfiesteria* is most commonly found low in the water column and close to bottom sediments (Glibert and Burkholder 2006) during the warmer summer months in the mid-Atlantic region but has been detected in the sediments during the cooler months. The alga was first discovered in the Chesapeake Bay in 1992 (Lewitus et al. 1995). A second species, *Pfiesteria shumwayae*, occurs in the Bay but is much less common than *P. piscicida* (Bowers et al. 2006). Water samples collected from the Patuxent River from 2000 to 2002 did not contain either species (Bowers et al. 2006).

Sea nettles range from Cape Cod south along the United States East Coast to the Caribbean and the Gulf of Mexico but occur in Chesapeake Bay in numbers unequaled elsewhere (UniStar 2008a). The sea nettle is most abundant in the tributaries of the middle Bay where salinities are about 10 ppt to 20 ppt. It is considered a nuisance species in part because it has an annoying sting that is not dangerous to swimmers but makes swimming unpleasant. This categorization belies the likely ecological importance of a key predator on zooplankton, fish eggs and larvae, and comb jellies (Purcell et al. 1994, Breitburg and Fulford 2006). Bottom-dwelling polyps are dormant during the winter and become active in spring, releasing tiny sea nettles from May through August. Adult sea nettles may have few natural predators in the middle reaches of Chesapeake Bay (UniStar 2008a).

Comb jellies are related to jellyfish but do not have stinging tentacles. Comb jellies have transparent, jelly-like bodies with bright, iridescent bands of tiny hairs called combs, which are used for limited locomotion. The species occurring in Chesapeake Bay are the sea walnut (*Mnemiopsis leidyi*) and the pink comb jelly (*Beroe ovata*) (Bishop 1972). The sea walnut is probably one of the key water-column species in the Bay because it feeds on large quantities of zooplankton daily and is an important predator of fish eggs (Purcell et al. 2001). Year-to-year variation in sea walnut abundance may be related to variation in abundance of predators. In the Chesapeake Bay, the main predator of the sea walnut is the sea nettle (Purcell et al. 2001). Abundances of the two species appear to be inversely related (Feigenbaum and Kelly 1984) until the comb jellies reach a large size, which gives them a refuge from sea nettle predation. The pink comb jelly also feeds on comb jellies, but it only occurs in higher salinity regions of the Bay and probably has little effect on the sea walnut (Purcell et al. 2001).

2.4.2.7 Aquatic Resources – Transmission Lines

The existing transmission system for CCNPP Units 1 and 2 consists of a north circuit that connects the plant to the Waugh Chapel Substation in Anne Arundel County, Maryland, and south circuit that connects the plant to the Potomac Electric Power Company Chalk Point Generating Station in Prince Georges County, Maryland (Section 2.2.2). No new transmission corridors would be constructed off the Calvert Cliffs site, as existing transmission corridors would be used for power distribution from the proposed Unit 3.

The transmission line leading from the Calvert Cliffs site to the Waugh Chapel Substation is near at least one stream on the site (Woodland Branch, which it crosses offsite) and probably crosses several other small streams in Calvert and Anne Arundel Counties. The conditions in Woodland Branch were described in Section 2.4.2.1. Conditions in the other small streams crossed by the transmission line are unknown but probably are similar to those in Woodland Branch and other small streams in the region. The transmission line that connects the Calvert Cliffs switchyard to the Chalk Point Generating Station crosses small streams in Calvert County and also crosses the Patuxent River at Chalk Point. The reach of the Patuxent River near Chalk Point is at the upper part of the tidal influence in the river where waters are oligohaline (0.5 to 5 ppt) in winter and spring and mesohaline (5 to 19 ppt) in summer and fall (MDNR PPRP 2008). The mainstem of the Patuxent River at Chalk Point is a known white perch spawning area but does not contain historic or current oyster beds (MDNR 2004). The benthic community in the area was rated "good" (B-IBI scores >3.0) during 2003 to 2005 (MDNR 2007f).

2.4.2.8 Aquatic Monitoring

There are no known ecological or biological aquatic studies ongoing at the Calvert Cliffs site, and no surveys are planned.

2.5 Socioeconomics

This section describes the socioeconomic baseline for the proposed Unit 3 to be built by the Calvert Cliffs 3 Nuclear Project, LLC and operated by UniStar Nuclear Operating Services, LLC at the existing Calvert Cliffs site that contains Units 1 and 2. The scope of the review of demographic and community characteristics is guided by the magnitude and nature of the expected impacts that may result from the building, maintenance, and operation of the proposed project.

The discussion of these impacts considers the entire region within a 50-mi radius of the proposed Unit 3 site, with a focus on Calvert and St. Mary's Counties. This is because (1) the construction and operation work forces are expected to be drawn primarily from these two counties, (2) the two counties would receive the majority of any benefits and stresses to community services by these workers, (3) the distribution of population that lies within the 50-mi radius of the proposed unit, and (4) over 90 percent of the current Calvert Cliffs site workforce resides within these two counties.

The region is a 50-mi circle centered on the powerblock and covers all or portion of 14 counties in Maryland (Anne Arundel, Montgomery, Prince George's, Caroline, Dorchester, Kent, Queen Anne's, Somerset, Talbot, Wicomico, Worcester, Calvert, Charles, St. Mary's), two Delaware counties (Kent and Sussex), 13 Virginia counties (Fairfax, Prince William, Stafford, King George, Westmoreland, Northumberland, Lancaster, Richmond, Middlesex, King and Queen, Essex, Caroline, Arlington) and Washington D.C. The population of counties located in or partially in the 50-mi CCNPP radius is shown in Table 2-5 for 2000 and 2006.

The review team examined the possibility that a significant number of workers (numbering up to 4000 during the peak project period) may choose to live in a county within 50 mi of proposed Unit 3, but outside of Calvert and St. Mary's Counties. Geographically, access to the proposed site is limited to the north and northeast because the Chesapeake Bay and its tributaries form physical barriers for most of the remaining counties within the 50-mi radius. This leaves relatively easy access to Washington, D.C., all of Charles County, nearly all of Prince George's County and portions of four other counties (Anne Arundel, Arlington, Fairfax, and Middlesex) as potential areas of residence for proposed Unit 3 construction and operation workers. However, significant socioeconomic impacts are unlikely in these areas because the population of these seven areas is large relative to the size of the workforce needed to support the building and operation of proposed Unit 3 and this impact would be undetectable in each of those counties even if a significant portion of the workforce chose to reside there.

Table 2-5. Total Population for Counties within or partially within the 50-mi Radius of CCNPP in 2000 and 2006

County	2000	2006
Maryland		
Anne Arundel County	489,656	509,300
Montgomery County	873,341	932,131
Prince George's County	801,515	841,315
Caroline County	29,772	32,617
Dorchester County	30,674	31,631
Kent County	19,197	19,983
Queen Anne's County	40,563	46,241
Somerset County	24,747	25,774
Talbot County	33,812	36,062
Wicomico County	84,644	91,987
Worcester County	46,543	48,866
Calvert County	74,563	88,804
Charles County	120,546	140,416
St. Mary's County	86,211	98,854
Delaware		
Kent	126,697	147,601
Sussex	156,638	180,288
Virginia		
Fairfax	969,749	1,010,443
Prince William	280,813	357,503
Stafford	92,446	120,170
King George	16,803	21,780
Westmoreland	16,718	17,188
Northumberland	12,259	12,820
Lancaster	11,567	11,519
Richmond	8809	9142
Middlesex	9932	10,615
King and Queen	6630	6903
Essex	9989	10,633
Caroline	22,121	26,731
Arlington	189,453	199,776
Washington, D.C.	572,059	581,530

Source: USCB 2006a, b, c, g, h

Table 2-6 shows the county of residence for the current CCNPP workforce. Just over 91 percent of the current 833 Calvert Cliffs site employees reside in Calvert County (67.5 percent) and St. Mary's County (23.8 percent) in 2006. The remaining 9 percent are

Table 2-6. Distribution of Current Calvert Cliffs Site Employees by County of Residence in 2006

County	Workforce, 2006	As Percent of Workforce		As Percent of 2006 County Population[a]
		By County	Cumulative	
Calvert	562	67.5	67.5	0.6
St. Mary's	198	23.8	91.2	0.2
Charles	30	3.6	94.8	<0.1
Anne Arundel	27	3.2	98.1	<0.1
Prince Georges	6	0.7	98.8	<0.1
Baltimore[b]	4	0.5	99.3	<0.1
Howard[b]	2	0.2	99.5	<0.1
Allegany[b]	1	0.1	99.6	<0.1
Washington, D.C.	1	0.1	99.8	<0.1
Other Out of State[c]	2	0.2	100.0	--
Total	833			

Source: UniStar 2009a; USCB 2006a, b
(a) County Population data were from USCB 2006a Part 1, 2006a Part 2, 2006b.
(b) Outside the 50-mi radius of the proposed Unit 3.
(c) Undetermined if in or outside the 50-mi radius of the proposed Unit 3.

distributed across seven other Maryland counties (~8.3 percent) and out-of-state locations (~0.3 percent), with less than 4 percent of the employees residing in any one area outside of Calvert and St. Mary's Counties. Also, the current Calvert Cliffs workforce is less than 1 percent of the population in each of the other counties or locations. Accordingly, the review team's focus in this EIS is on impacts in Calvert and St. Mary's Counties.

2.5.1 Demographics

For the purposes of this analysis, the review team divided the total population within the analytical area into three major groups: residents who live permanently in the area, transients who may temporarily live in the area but have a permanent residence elsewhere, and migrant workers who travel into the area to perform seasonal work and then leave after their job is done. Transients and migrant workers are not fully characterized by the U.S. Census, which generally captures only resident populations.

The data used in this section were from the U.S. Census Bureau (USCB), the States of Maryland, Delaware, and Virginia, and the District of Columbia. The most recent data and information are used where possible, with 2000 census data used in some cases to provide comparability between multiple jurisdictions. Population projections to 2030 were obtained from the above sources and extended to 2060 using a trend line. In addition, the NRC SECPOP 2000 code (SECPOP stands for Sector Population, Land Fraction, and Economic Estimation Program) was used to develop the projections for the emergency planning zone (EPZ), as the population and projections data for the EPZ were not available from USCB.

2.5.1.1 Resident Population

The geographic distribution of the estimated 3.2 million residents in 2000 is shown in Figure 2-14. The center of the circle on this map is the proposed Unit 3 site, with concentric circles in 10-mi increments up to 50 mi from the proposed location. The sectors within each circle further show the population distribution by direction.

The area within the emergency evacuation zone, defined by the 10-mi radius of the proposed Unit 3 site, is predominately rural, characterized by farmland and forests, small residential communities, and bounded to the east by the waters of the Chesapeake Bay, and to the south and west by the waters of the Patuxent River. The cities and unincorporated towns within a 10-mi driving distance of the Calvert Cliffs site include California, Calvert Beach-Long Beach, Chesapeake Ranch Estates-Drum Point, Lusby, and Prince Frederick.

In the year 2000, about 10 percent of the resident population lived within 30 mi of the Calvert Cliffs site. Of the remaining 90 percent of the resident population, just over 70 percent lived in the outer 10-mi portion of the radius, with population density being greatest in the segments lying to the north and northwest of the Calvert Cliffs site in the Washington, D.C. area.

Major population centers within about 50 mi of the Calvert Cliffs site are Washington, D.C. (approximately 55 driving miles to the northwest) and Annapolis, Maryland (approximately 50 driving miles to the north). Smaller cities and towns within a 50-mi radius include Glenarden (approximately 50 driving miles to the northwest), North Beach (approximately 26 driving miles to the north), La Plata, approximately 36 driving miles to the west), Leonardtown (approximately 20 driving miles to the southwest), and Seat Pleasant (approximately 49 driving miles to the northwest).

Calvert County is included in the DC-VA-MD-WV Metropolitan Statistical Area, and St. Mary's County is a part of the smaller Lexington Park, Maryland, Micro Area. Select demographic data for the Calvert County and St. Mary's County, in 2000, 2003 and 2004 (UniStar 2009a) and 2007 (MDP 2008a) are presented in Table 2-7. The table shows the combined population in 2000 was 160,774 and grew at an annual rate of 2.47 percent to 2007, with Calvert County's growth rate slightly larger than the growth rate in St. Mary's County. Calvert County is the fastest growing of the 23 counties in the State of Maryland, and St. Mary's County ranks second with annual growth rates of 2.61 percent and 2.35 percent, respectively, from 2000 to 2007 as compared to the State average of 0.85 percent (UniStar 2009a, MDP 2008a).

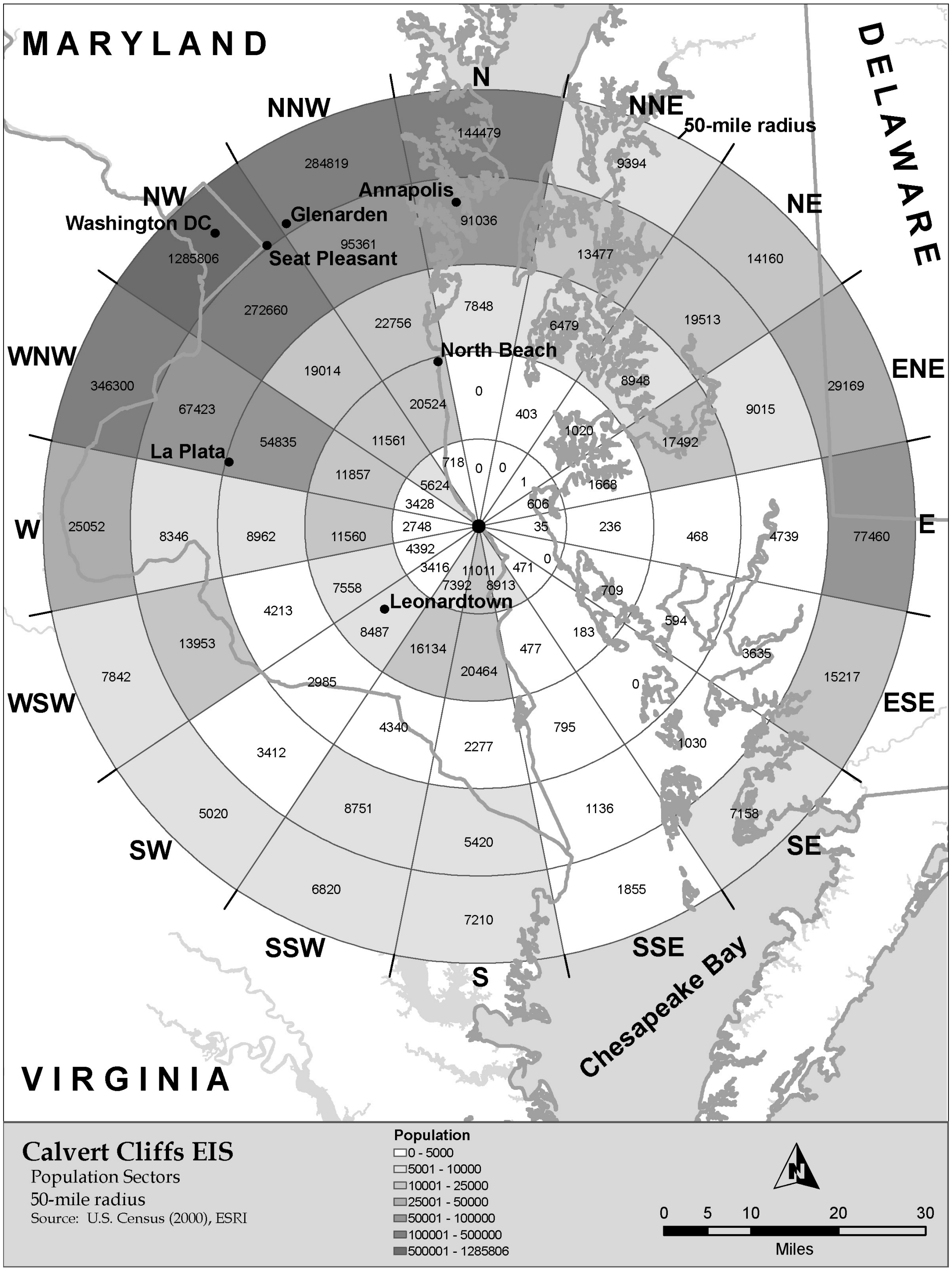

Figure 2-14. Population within the 50-mi Radius of Proposed Unit 3 by 10-mi Increments and Direction (UniStar 2009a)

Table 2-7. Select Demographic Characteristics for the Resident Population in Calvert and St. Mary's Counties

	Calvert County	St. Mary's County	Maryland	UnitedStates
Demographic Characteristics				
Population, 2000	74,563	86,211	5,296,486	281,421,906
Population estimate, 2007	88,223	100,378	5,618,344	301,621,157
Average annual growth rate, 2000-2007	2.61%	2.35%	0.87%	1.00%
Population per square mile, 2000	376.5	238.6	541.9	79.6
Ethnic Composition, 2004				
Caucasians	84.70%	82.10%	64.50%	70.40%
African-American	12.80%	13.90%	29.10%	12.80%
Hispanic	1.90%	2.20%	5.40%	14.10%
Other	0.6%	1.8%	1.0%	2.7%
Income Characteristics, 2003				
Median household income	$71,488	$58,651	$54,302	$43,318
Persons below poverty	5.30%	7.40%	8.80%	12.50%

Source: UniStar 2009a; MDP 2008a

The year 2000 data in Figure 2-14 are summarized by distance in Table 2-8 with projections to the year 2060. The growth rates shown are a composite based on county-level population projections made by the USCB and each state (UniStar 2009a). The aggregate annual growth rate of 0.99 percent, which ranges from a low of 0.75 percent for the period 2050 to 2060 to a high of 1.36 percent for the period 2000 to 2010, results in nearly a doubling of the population in the 60-year period.

2.5.1.2 Transient Population

Transients include people who work in or visit schools, hospitals and nursing homes, correctional facilities, hotels and motels, and recreational areas or special events where there may be seasonal and workday variations in population. In this study, the transient population is defined as persons who live outside the referenced area, but may be predictably expected to be in the area at some point, to include:

- Workers who live permanently outside of the area and commute to a worksite in Calvert and St. Mary's Counties on a regular basis.

Table 2-8. Projection of the Resident Population for Geographic Areas within a 50-mi Radius of the Proposed Unit 3 Site by 10-mi Increments from 2000 to 2060

Year	Population within Radius Distance						10-yr Annual Average Growth Rate
	0-10 mi	10-20 mi	20-30 mi	30-40 mi	40-50 mi	Total	
2000	40,745	112,841	162,006	618,907	2,267,761	3,202,260	--
2010	46,272	128,170	183,991	703,086	2,576,246	3,637,765	1.36%
2015	49,031	135,788	194,909	744,798	2,729,381	3,853,907	--
2020	51,126	141,542	203,279	776,201	2,843,806	4,015,954	1.04%
2030	55,256	152,988	219,647	839,208	3,075,213	4,342,312	0.82%
2040	61,716	170,849	245,359	936,915	3,432,515	4,847,354	1.16%
2050	66,723	184,811	265,321	1,013,675	3,714,072	5,244,602	0.82%
2060	71,812	198,759	285,436	1,090176	3,994,214	5,640,397	0.75%
2000-2060							0.99%

Source: UniStar 2009a
Note: Population projections are provided for 2015 because that is near the year proposed Unit 3 is estimated to start operation.

- Visitors who live outside the area and travel at least 50 mi each way in order to conduct personal business, shop, and/or engage in recreation. Visitors may come to the area for the day or seek overnight accommodations.

Individuals who simply travel through the area from a point outside the area to a destination outside the area are not included.

Because the USCB does not report information about the transient population in this area, the CCNPP Units 1 and 2 Evacuation Time Estimate report (UniStar 2009a) was used to obtain the estimated 2000 transient population in the Calvert Cliffs site vicinity, as shown in Table 2-10. This shows that the total transient population is about 8000 persons in the site vicinity, and that less than 25 percent were within 5 mi of the CCNPP facility.

Recreational use by visitors and tourists is considered to be the primary contributor to the transient population in the area. The Southern Region of Maryland, which includes Calvert County, St. Mary's County, and Charles County, recorded 541,791 visitors in 2004 (UniStar 2009a). Major parks within the 10-mi vicinity include Calvert Cliffs State Park and Flag Ponds Park. Calvert Cliffs State Park had 17,113 day and 2175 overnight visitors from July 2005 to June 2006. The peak month for day users was October (5650 people), the peak month for overnight users was July (875 people), and the month with the most visitors (both day and night users) was October (6035 people). Flag Ponds Park receives approximately 20,000 annual visitors, primarily during the three summer months.

Table 2-9. Projected Population Growth in Calvert and St. Mary's Counties and Maryland from 2000-2030

	Calvert County		St. Mary's County		Maryland	
Year	Population	Average Annual Growth %	Population	Average Annual Growth %	Population	Average Annual Growth %
2000	74,563	--	86,211	--	5,296,486	--
2010	95,450	2.80	107,700	2.49	5,897,600	1.13
2015	98,650	0.67	119,450	2.18	6,176,075	0.94
2020	101,750	0.63	130,750	1.89	6,386,225	0.68
2030	105,850	0.40	151,700	1.60	6,737,750	0.55
2040	128,245	2.12	181,412	1.96	7,110,558	0.55
2050	141,127	1.00	212,317	1.70	7,503,995	0.55
2060	154,009	0.91	246,228	1.60	7,919,200	0.55
2000-2030		1.40		2.53		0.91

Source: MDP 2008b; UniStar 2009a

Table 2-10. Transient Population in the Calvert Cliffs Site Vicinity in 2000

0-1 mi	1-2 mi	2-3 mi	3-4 mi	4-5 mi	5-10 mi	1-10 mi
0	263	741	535	392	6079	8010

Source: UniStar 2009a

2.5.1.3 Agricultural, Seasonal and Migrant Labor

No farm in Calvert County or St. Mary's County employed seasonal or migrant workers in 2004. In addition, it is highly unlikely that seasonal agricultural migrant workers would be hired in the area in the future because the number of farms and the acreage devoted to farming in the region has been declining because the land is increasingly converted to non-farm uses (UniStar 2009a).

2.5.2 Community Characteristics

This section characterizes the communities that may be impacted by the building and operation activities associated with the proposed Unit 3. The characteristics evaluated include the economy, tax based revenue, transportation, aesthetics and recreation, housing, public services (police, fire, and hospitals), healthcare, and education. Information and data for this characterization were drawn from planning agencies within the 50-mi radius of the Calvert Cliffs site, including the Maryland Department of Planning (MDP), the Delaware Economic Development Office, the Virginia Employment Commission, the USCB, and agencies within Calvert and St. Mary's County governments.

While 30 counties and the District of Columbia lie within a 50-mi radius of the Calvert Cliffs site, the discussion in this section focuses on the characteristics in Calvert and St. Mary's Counties that are nearest the site. As stated earlier, over 90 percent of the current CCNPP Units 1 and 2 workforce resides in Calvert and St. Mary's Counties, and it is expected that increases in the workforce for building and operation of the new unit would accrue to the two counties in roughly the same proportion. As a result, any stress to the community infrastructure and services caused by changes in the workforce for building and operation of the proposed plant would be expected to occur primarily in these two counties. The review team realizes some workers may choose to live outside of Calvert and St. Mary's Counties. If that were the case, the review team's analysis may overstate the expected impacts on the two counties. However, as previously stated, any impacts occurring outside of these two counties would be negligible due to the large population of those counties relative to the size of the workforce.

Many of the towns in Calvert and St. Mary's Counties, such as Lusby and Solomons, are considered "designated places" by the USCB but have no political or tax structure independent of the county (UniStar 2009a). This includes Prince Frederick, the Calvert County seat. Incorporated towns include North Beach in Calvert County and Leonardtown in St. Mary's County (UniStar 2009a).

Land use affects a number of community actions that pertain directly to the economy, housing, and schools, and indirectly to a number of other community services. The Maryland Legislature has mandated that each county and municipality adopt a comprehensive land-use plan, per the Economic Growth, Resource Protection, and Planning Act to include Smart Growth initiatives (UniStar 2009a). In addition, the Maryland Master Facilities Plan for schools, coupled with the land-use plans, effectively limit the development of new housing without the construction of accompanying infrastructure so as to avoid straining community services. Thus, development is allowed, but the developer directly bears the costs (UniStar 2009a).

Both counties have adopted land-use plans that guide development and growth. Calvert County has developed two plans, a Comprehensive Plan (CCCP 2004) and a Land Preservation, Parks and Recreation Plan (CCBCC 2006), with benchmarks for economic development, social services, and preservation of resources to maintain and improve the overall quality of life. These plans have and are envisioned to address the rapid growth the County has experienced over the last 20 years. St. Mary's County developed a comprehensive plan in 2002, which was amended in 2003 (SMCBCC 2003). Similar to Calvert County's Comprehensive Plan, the St. Mary's Plan addressed growth through the provision of infrastructure and preservation of resources.

2.5.2.1 Economy

This section provides information on the labor force and income. The labor force is characterized by total employment, employment by occupation, and major type of industry. Income is listed at the total and per capita level. Given that 91 percent of the current CCNPP Units 1 and 2 workforce lives in Calvert and St. Mary's Counties, these two counties represent the economic impact area when discussing employment, income, and other economic impacts.

Table 2-11 provides a breakdown of employment levels by class of employment and occupation for each county in the economic impact area and the State of Maryland. Approximately 30 percent of employed workers in the economic impact area provided civilian government services and 70 percent work in private sector services, with about 11 percent employed in the construction sector.

Table 2-11. Employment by Class and Occupation in Calvert and St. Mary's Counties and Maryland 2006

Labor Force	Economic Impact Area		Maryland
	Calvert County	St. Mary's County	
Civilian Labor Force (persons)	49,575	52,371	3,036,959
Employed	96.7%	95.1%	94.7%
Unemployed	3.3%	4.9%	5.3%
Employed Workers			
Class of worker			
Private wage and salary	66.9%	61.7%	73.0%
Government workers	27.5%	31.8%	21.8%
Self-employed workers	4.7%	6.4%	5.1%
Other	0.9%	0.1%	0.1%
Occupation			
Management and professional	40.5%	40.1%	42.6%
Service	14.8%	15.9%	15.2%
Sales and office	24.3%	22.0%	25.0%
Farming, fishing, and forestry	0.1%	0.9%	0.1%
Extraction, maintenance and repair	1.9%	1.8%	1.3%
Construction	12.2%	11.3%	7.7%
Production, transportation, and material moving	6.3%	7.9%	8.1%

Source: USCB 2006c

Most of the economic impact area's reported 11,000 construction workers in 2006 are not engaged in heavy construction activities and are not suited for the type of construction activities for a nuclear facility. Heavy construction workers include supervisors, boilermakers, brick and stone masons, carpenters, laborers, paving and surfacing, operating engineers, electricians, insulation workers, plumbers and steamfitters, rebar workers, and sheet metal workers. For these trades, the review team identified 117,480 reported workers in Maryland (USBLS 2007a) and 110,640 in the Metropolitan Statistical Area (USBLS 2007b). Some double counting may exist between the two areas, but these numbers indicate the availability of a sufficient number of workers qualified for the building of proposed Unit 3.

At the State level, the construction workforce is projected to increase by approximately 20 percent from 2006 to 2016 (MDLLR 2008a). In the three southern Maryland counties (Calvert, St. Mary's and Charles), the construction workforce is projected to increase by approximately 21 percent from 2004 to 2014, and accounting for new hires to replace those retiring, the construction sector workforce is expected to grow by about 50 percent (MDLLR 2008b).

Calvert County is a bedroom community for the Washington, D.C., area, with North Beach and Chesapeake Beach the principal economic centers, and the unincorporated towns of Calvert Beach-Long Beach, Chesapeake Ranch Estates-Drum Point, Dunkirk, Huntington, Lusby, Ownings, Prince Frederick, St. Leonard, and Solomons the nuclei for residential, commercial, and light industrial activity and development (UniStar 2009a). The approximately 1900 businesses in Calvert County employ 17,500 workers. An estimated 21 businesses employ 100 or more workers, which include Constellation Energy, Calvert Memorial Hospital (CMH), ARC of Southern Maryland, DynCorp International, and Recorded Books (MDBED 2008a).

Leonardtown is the economic hub of St. Mary's County and unincorporated communities include California, Charlotte Hall, Golden Beach, and Lexington Park (UniStar 2009a). There are 1960 businesses in St. Mary's County with employment of 27,000. The major employer is the Patuxent Naval Air Station (over 20,000 civilians and military personnel) and approximately 37 businesses that employ at least 100 people each; many of these jobs are defense related. Most non-defense employers in the county are in the education sector (MDBED 2008b).

According to the MDP, the total and average per capita income in 2005 for the two counties and the State are as shown in Table 2-12.

Table 2-12. Total and Per Capita Income in 2005 ($2000)

	Calvert County	St. Mary's County	Maryland
Total	$2.97 Billion	$2.94 Billion	$211.0 Billion
Per Capita	$33,447	$30,473	$37,616
Source: MDP 2007			

2.5.2.2 Taxes

Tax based revenues are the responsibility of the Maryland State Department of Assessments and Taxation (MDSDAT), and the County Finance and Budget Department. The major tax categories are sales and use, income, and real and personal property. The tax rates for these three categories for Maryland and Calvert and St. Mary's Counties are shown in Table 2-13.

Table 2-13. Sales & Use, Income, and Property Tax Rates (%) for Maryland and Calvert and St. Mary's Counties in 2007

Sales and Use					
Maryland		**Calvert County**		**St. Mary's County**	
6.0		--		--	
Income					
Maryland		**Calvert County**		**St. Mary's County**	
4.75		2.8		3.0	
Property (rate per $100 valuation)					
Maryland		**Calvert County**		**St. Mary's County**	
Real	**Personal**	**Real**	**Personal**	**Real**	**Personal**
0.112	--	0.892	2.230	0.857	2.195

Source: MD Comp 2008a, MD Comp 2008b, and MDSDAT 2008

Personal Income Taxes

The State of Maryland levies a personal income tax of 2 percent on the first $1000 of taxable income up to 6.25 percent on incomes exceeding a million dollars. Nonresidents pay a special tax rate of 1.25 percent in addition to the State income tax rate. Each individual county in Maryland also levies a personal income tax. Calvert County's personal income tax rate is 2.8 percent and St. Mary's County's is 3 percent. According to the Comptroller of Maryland (MD Comp 2007), total and per capita personal income was $247.5 billion and $44,077, respectively, with personal income tax at the State level of $7.462 billion and per capita income tax of $1329. In the economic impact area the per capita personal income taxes was $669 in Calvert County and $583 in St. Mary's County (MDP 2008c).

Sales and Use Taxes

The State sales tax rate for Maryland is 6 percent of the sale price of taxable goods. The sale of a service is usually not taxable. Food sold in grocery stores, prescription medicines and newspapers are generally not taxable. The State level sales and use tax revenue of $3.447 billion translates to $614 on a per capita basis. Any purchases made out of state are subject to Maryland's 6 percent use tax. There are no local sales taxes in the State of Maryland.

Property Taxes

In Maryland, non-utility generators such as CCNPP are subject to three tax rates that cover State real property taxes, county real property taxes, and county personal property taxes. Public utility generators are also subject to local public utility taxes; however, CCNPP is not a public utility. The relevant tax rates are for the three categories for Maryland and Calvert and St. Mary's Counties are as shown in Table 2-13. In the economic impact area, the per capita property tax was $843 in Calvert County and $636 in St. Mary's County (CC DF&B 2007 and SMCBCC 2008a).

For tax assessment purposes, the Calvert Cliffs site is located in Calvert County. UniStar would pay all of its property taxes to Calvert County, which would include levies for Calvert County School District. During the 2000 to 2008 time frame, County property taxes paid in regards to CCNPP Units 1 and 2 have ranged from $12.7 million (2002) to $22.4 million (2008). The 2008 taxes represented 10.14 percent of Calvert County total revenues (UniStar 2009f).

Revenues and Expenditures

The profile of revenues for 2007 that accrued to the State and the two counties in the economic impact area is shown in Table 2-14. With respect to the expected impacts of the proposed power plant, the State would be impacted primarily through the sales and use and personal income taxes, and the two counties through the property and personal income taxes with the largest impact in Calvert County.

2.5.2.3 Transportation

Air

There are three major commercial airports in the 50-mi radius (Baltimore-Washington area): Baltimore/Washington International Thurgood Marshall Airport, Reagan National Airport, and Washington Dulles International Airport (MDBED 2008c). There are no commercial airports in the Calvert and St. Mary's Counties, but there are several private and government airfields, including Chesapeake Ranch Airpark in Calvert County, a helipad on the Calvert Cliffs site that is used for corporate and Medivac flights, and St. Mary's County Airport (Captain Duke Airport). In St. Mary's County, the Patuxent River Naval Air Station, 11 mi south of the Calvert Cliffs site, provides aircraft test and development operations. The St. Mary's County Transportation Master Plan Update suggests determining the needed additional infrastructure to ready the County's airport for future commuter air service (SMC DPW 2006, SMC DPW 2008a, MDBED 2008c).

Table 2-14. Revenues by Major Category for the State of Maryland and Calvert and St. Mary's Counties in 2007

Tax Category	State of Maryland		Calvert County		St. Mary's County	
	Jurisdiction					
			Economic Impact Area			
Property			*(Millions $)*			
Real	$791,643	2.6%	$74,335	38.0%	$63,880	38.3%
Personal	--	--	$236	0.1%	$158	0.1%
Public utilities	--	--	$22,418	11.5%	$2,708	1.6%
All other	--	--	($2,260)	(1.2%)	$3,195	1.9%
Sales and use	$3,447,827	11.4%	--	--	--	--
Personal income	$7,462,097	24.6%	$59,065	30.2%	$58,522	35.0%
Other taxes	$2,649,164	8.7%	$12,574	6.4%	$12,741	7.6%
Shared revenue	--	--	$6,840	3.5%	$7,325	4.4%
Licenses and permits	$606,589	2.0%	$258	0.1%	$894	0.5%
Charges for services	$832,173	2.7%	$3,356	1.7%	$5,970	3.6%
Fines and forfeitures	$374,581	1.2%	$124	0.1%	$275	0.2%
Grants	$6,211,156	20.5%	$10,463	5.4%	$6,375	3.8%
Other	$7,948,277	26.2%	$8,157	4.2%	$4,936	3.0%
Total revenue	$30,323,507	100%	$195,565	100%	$166,978	100%

Source: MD Comp 2007, CC DF&B 2007, and SMCBCC 2008a

Bus

Calvert County provides bus service to individuals that live in the County and work in the Washington, D.C., area (CCOT 2007). This daily service is reportedly well used, with increasing ridership over time (SMCBCC 2003). Calvert County operated 17 passenger buses over 7 routes covering 475,635 mi and carried approximately 113,354 passengers in FY 2005 (UniStar 2009a). In addition, Calvert County's Public Transportation Division operates a courtesy route system and a demand route system to meet the transportation needs of the general public, the elderly, and persons with disabilities (CCOT 2007). The St. Mary's Transit System provides daily service that includes evenings and weekends, with total ridership increasing from approximately 54,395 passengers in FY 2000 to over 300,000 passengers in FY 2006 (SMC DPW 2008b). The St. Mary's County Master Plan indicates that excess capacity existed in 2003 (SMCBCC 2003); however, a more recent transportation plan provides a number of improvements to increase ridership and expand service (SMC DPW 2006).

Roads/Highways

Calvert and St. Mary's Counties are both served by State highways and County roads, with neither county served by interstate highways. As shown in Figure 2-15, the major highway in Calvert County is MD State Route 2/4, which runs on a north-south axis just to the west of the Calvert Cliffs site, and has four lanes (two in each direction). MD State Route 2/4 has turn lanes to ease access at selected intersections and traffic lights at busier intersections. The major State highway in St. Mary's County is MD State Route 235 that runs from northwest to southeast and intersects MD State Route 4 near the town of California.

The road system in Calvert and St. Mary's Counties comprises 672 and 810 road miles in Calvert and St. Mary's Counties, respectively. In each county, the State is responsible for maintenance and upkeep for about 75 percent of the roads, with the remainder under the responsibility of the County and Municipal governments.

The Thomas Johnson Memorial Bridge at the south end of Calvert County connects Calvert and St. Mary's Counties. The four-lane MD State Route 2/4 narrows to two lanes across the bridge where Route 2 exits and continues south, and Route 4 continues across the bridge. The bridge is in need of repair and presents a bottleneck to traffic during peak periods (SMC DPW 2006). A number of alternatives are being considered to upgrade the bridge from a level of service (LOS) rating of an F to a C or better. LOS is on a scale from A to F where A is the best and F is the worst. The Maryland State Highway Administration and the Federal Highway Administration expect to complete the planning process in 2010 and construction by 2020 (SMO 2008).

UniStar reported for 2007 the average daily traffic volume that passed by the Calvert Cliffs site on MD State Route 2/4 was 25,461 (Station ID: B040012) vehicles traveling in both directions (MDOT 2007a), which provides for approximately 12,800 vehicles traveling in each direction on an average day (UniStar 2009a). Based on a nearby MDOT measurement station (Station ID: P0065), the 2007 monthly variation in vehicle traffic to the south before MD State Route 2/4 splits into MD State Route 2 and MD State Route 4 had a comparable volume of traffic to what UniStar reported from a low of 92 percent of the average daily volume to a high of 108 percent (MDOT 2007b).

UniStar commissioned a study of traffic conditions and impacts for the section of MD State Route 2/4 in the area of the Calvert Cliffs site (KLD 2009). The latest revision of the study includes revised assumptions to accommodate comments from the Maryland State Highway Administration. The traffic data used in the study were collected at signalized intersections in 2006 and in 2008 for unsignalized intersections and then projected to 2009 levels for a baseline. The peak hours of traffic were indentified as 6:45 AM to 7:45 AM and 4:30 PM to 5:30 PM. Both signalized intersections are operating well (LOS C or better). The unsignalized intersections operate between an LOS of C to F with a lack of capacity for vehicles turning onto MD 2/4 (KLD 2009). The KLD Engineering study is the basis for impact assessments in Sections 4.4 and 5.4 because it is a more predictable and accurate estimate of traffic near the Calvert Cliffs entrance.

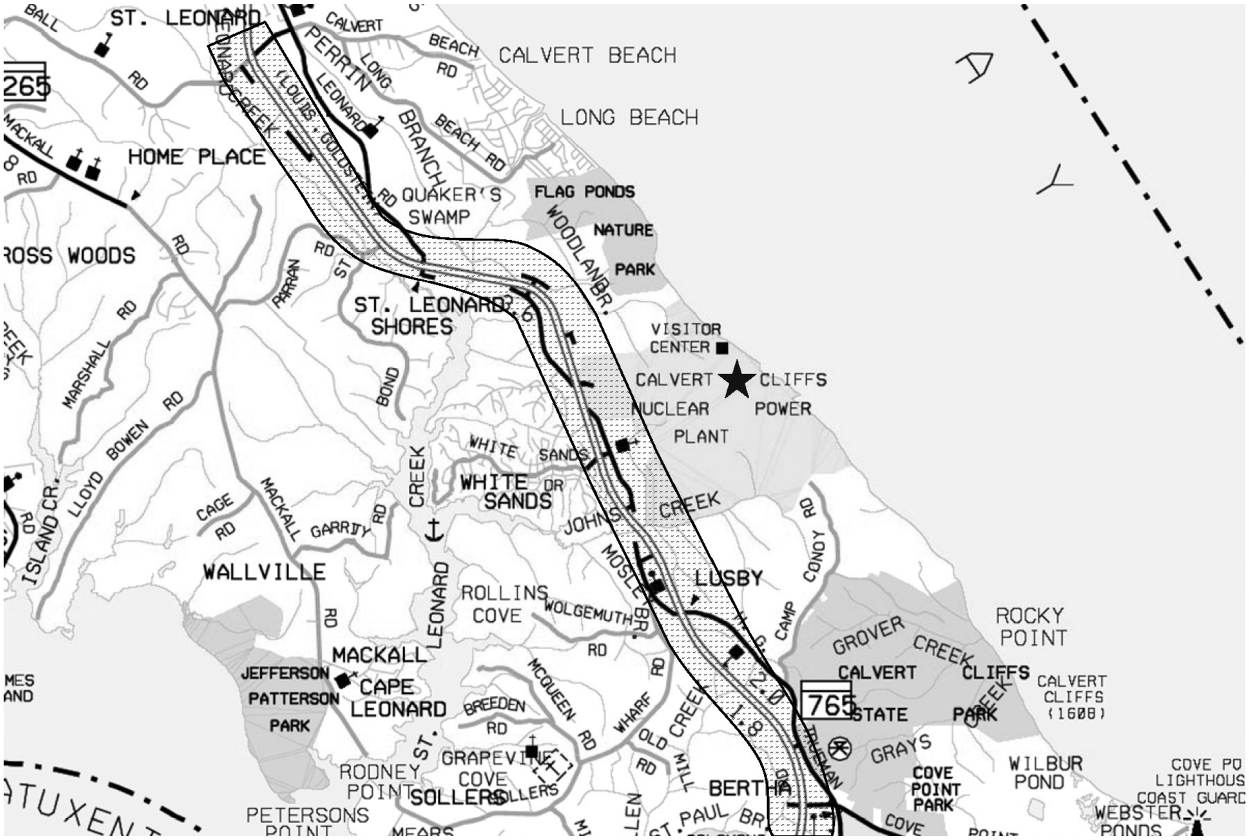

Figure 2-15. Highways and Major Roads within Approximately 10 mi of the Proposed Calvert Cliffs Site (KLD 2009)

Rail

There are no train depots in either Calvert or St. Mary's Counties, with the nearest depots in Prince George's and Waldorf in Charles Counties (MDBED 2008d). The addition of commuter light rail service between Washington, D.C., and La Plata in Charles County by approximately 2018 has been discussed (SMCBCC 2003).

Barge

There are no deep water ports in either Calvert or St. Mary's Counties; both counties are served by the Port of Baltimore (MDBED 2007). The Calvert Cliffs site has a barge dock used to deliver large equipment and large quantities of materials (UniStar 2009a).

2.5.2.4 Aesthetics and Recreation

Physical structures at the Calvert Cliffs site are not visible from points outside the site boundary due to the heavily wooded and rolling topography surrounding it. Recreational users of Chesapeake Bay to the north and east typically cannot see the site because of its elevation above the water and setback distance from the shoreline. Some portions of the site may be visible from certain locations on the Bay or from elevated positions or along the shoreline, such as the locations of intake and discharge equipment. Consequently, the review team has determined that from an aesthetic appearance standpoint, the existing Calvert Cliffs site does not negatively impact the view shed experience of the public.

Recreation opportunities are provided to the populations of Calvert and St. Mary's Counties from properties and facilities owned by Federal, State, and county and local governments, and by private/non-government organizations. The information in this section was primarily drawn from the parks and recreation plans for Calvert and St. Mary's Counties (CCBCC 2006; SMCBCC 2005), which supplement the comprehensive plans for each of the two counties (CCCP 2004; SMCBCC 2003).

Recreation lands for the two counties account for 6.5 percent and 4.4 percent of land area for Calvert and St. Mary's Counties, respectively. The land area ranges from parcels less than 0.1 ac in size to nearly 3000 ac in size, with the smaller parcels predominantly owned by County and local governments.

Major park facilities located within Calvert County include Calvert Cliffs State Park located south of the Calvert Cliffs site and the Flag Ponds Nature Park to the north. The Calvert Cliffs State Park is about 1400 ac in size, with 1.3 mi of Chesapeake Bay shoreline. It contains ponds, creeks, and marshlands, and is 90 percent forested. Recreational activities include bird watching, fishing, fossil hunting, hiking, picnicking, and a playground (MDNR 2007d). Flag Ponds Nature Park, the major park operated by Calvert County, encompasses 327 ac of land area, has 1 mi of shoreline on Chesapeake Bay, and contains woods, ponds, swamps, freshwater marshes, cliffs, and sandy beaches. Activities include hiking, swimming, picnicking, fishing, bird watching and wildlife viewing, and the Park has two freshwater ponds (UniStar 2009a).

Four State park facilities located in St. Mary's County include St. Mary's River State Park, Point, Lookout State Park, St. Clements Island State Park, and Greenwell State Park. These four parks comprise nearly 4000 ac and collectively provide summer camps and special events, horseback riding, camping, fishing, biking, hiking, and picnicking (SMTT 2008; SMCBCC 2005). There are two National Historic Trails located near the Calvert Cliffs site in Calvert County – the Captain John Smith Chesapeake National Historic Trail and the Star-Spangled Banner National Historic Trail. The Captain John Smith Chesapeake National Historic Trail is comprised of a series of water routes along the Chesapeake Bay, and the Star-Spangled Banner National

Historic Trail features land and water routes. Both counties apply the State-recommended goal of 30 ac of recreational land per 1000 people. Because not all land is qualified to be counted toward the goal, both counties were in a deficit situation in 2005 and their need to add recreational land increases with time, as shown in Table 2-15. This shows that Calvert County needed to add 667 ac of recreational land in order to meet the 30-ac goal in 2005, and this increases to 991 ac of additional recreational land in 2020. Similarly for St. Mary's County, the need for additional recreational land increases from 1004 ac in 2005 to 1640 ac in 2020.

Table 2-15. Recreational Acreage Needed in Calvert and St. Mary's Counties to Meet Goal from 2005-2020

Year	Calvert County (Current Qualified Supply = 1889 ac)		St. Mary's County (Current Qualified Supply = 1861 ac)	
	Goal	**Deficit**	**Goal**	**Deficit**
2005	2556	667	2865	1004
2010	2730	841	3081	1220
2015	2820	931	3294	1433
2020	2880	991	3501	1640

Source: CCBCC 2006; SMCBCC 2005

In addition, numerous recreational opportunities are provided in both counties that cover a broad range of activities to include: indoor and outdoor sports (land and water), theater and educational, camping, fishing, hiking, picnicking, and other.

2.5.2.5 Housing

Table 2-16 provides USCB information for the housing markets in Calvert County and St. Mary's County in 2006. Within Calvert and St. Mary's Counties, of the 72,256 total housing units, 92 percent (66,638) were occupied; of these, 84 percent (56,126) were owner occupied. The higher renter occupied share for St. Mary's County probably reflects the shorter tenure of military and civilian residents associated with the Patuxent Naval Air Station. Despite the apparent availability of housing indicated by the USCB data, discussions with county agency representatives indicate that the current availability of new houses or rental houses might be much more limited. The median value of owner-occupied housing in 2006 was $394,700 in Calvert County and $322,000 in St. Mary's County. The median rent in Calvert County was $1021 and $896 in St. Mary's County (USCB 2006d, e).

In addition to the rental housing shown in Table 2-16, there are approximately 24 hotels, motels, and bed and breakfasts totaling nearly 1500 units within 30 mi of Lusby, which is 6 mi due south of the CCNPP. The occupancy rate for hotels and motels is highest during the summer season (April through August), and Mondays through Wednesdays when they are operating at about 80 percent capacity (UniStar 2009a).

Table 2-16. Number of Housing Units in Calvert and St. Mary's Counties in 2006

Housing Units		Calvert County	St. Mary's County
Total		32,106	40,150
Of Which	Occupied	94.3%	90.5%
	Unoccupied	5.7%	9.5%
Of Which	Single family detached including manufactured homes	88.6%	79.7%
	Single family attached	4.8%	5.2%
	2 or more units	6.6%	15.1%
Total Occupied		30,284	36,354
Of Which	Owner	84.9%	71.9%
	Renter	15.1%	28.1%

Source: USCB 2006d, e

The review team determined through analysis of UniStar's ER, interviews, and analysis of other data sources that neither Native American reservations nor any housing reserved for Native Americans exist in Calvert or St. Mary's Counties.

2.5.2.6 Public Services

This section provides information about social services provided to the residents of Calvert and St. Mary's Counties to address public health and safety in the areas of social, water and wastewater, police, fire, and health. Education services are covered in Section 2.5.2.7. The review team expects the public service impacts from the proposed action would be largely proportional to where the workers reside. Therefore, for reasons described previously, Calvert and St. Mary's Counties would likely endure the extent of such impacts, and the review team would not expect any significant public service impacts beyond the two counties. Consequently, the ensuing discussion of baseline conditions is confined to Calvert and St. Mary's Counties. As part of its review, the review team visited the region and Calvert and St. Mary's Counties to meet with local officials regarding the potentially affected public services and to validate UniStar's assertions in the ER (Secrest, Mussatti, and Scott 2010).

Water Supply and Wastewater

Calvert County is served by more than 20 water and sewer district systems, of which 6 provide combined water and sewer services, 14 provide water services, and 5 provide only sewer services (UniStar 2009a). There are approximately 4000 water system accounts with average consumption of 108 thousand gallons per account (UniStar 2009a). The water systems operate at an average capacity of 43 percent, ranging from a low of 5 percent to a high of 70 percent (UniStar 2009a). Households not connected to a water system rely on groundwater from one of seven aquifers (Patapsco, Aquia, Piney Point-Nanjemoy, Magothy, Brandywine, Choptank-St. Mary's, and Brightseat). These aquifers are expected to adequately meet the needs of a growing population in Calvert County (UniStar 2009a). The sewage systems in Calvert County treat an average of 214,479 gallons of sewage per account per year, with average capacity utilization of 54 percent ranging from 33 percent to 57 percent (UniStar 2009a).

According to the 2008 Calvert County Comprehensive Water and Sewerage Plan, which is aligned with the county's Comprehensive Plan, Calvert County is not expecting to have any major water shortages by 2030 (the last year in plan projections) (Calvert County 2008). Residents not serviced by a public sewer district/system rely on septic tanks for wastewater treatment.

The St. Mary's County Metropolitan Commission (SMCMC) provides water and sewer services in St. Mary's County to approximately 41,000 people, with average capacity of 43 percent, ranging from 3 to 75 percent (UniStar 2009a). St. Mary's County water infrastructure includes 27 water systems with 72 wells and 54 pumping stations as well as 12 elevated storage tanks (SMCMC 2005). Households not connected to a water system rely on groundwater from one of four aquifers (Aquia, Piney Point, Nanjemoy, and Magothy). SMCMC provides sewage services to approximately 36,000 people, with an average capacity of 58 percent, ranging from 57 to 85 percent (UniStar 2009a). St. Mary's County sewer infrastructure includes four treatment plants (6.3 mgd capacity), 53 pumping stations and 200 plus miles of sanitary sewers (SMCMC 2005). Residents not serviced by a public sewer district/system rely on septic tanks for wastewater treatment.

Police Services

Law enforcement in Calvert and St. Mary's Counties is provided by Maryland State Police and the Sheriff's Offices from the two counties. The number of officers in the Calvert County and St. Mary's County Sheriffs Offices are 136 and 117, respectively (UniStar 2009a). The number of calls and crime rates for violent and property crimes are provided in Table 2-17 for the State and the two counties.

Table 2-17. Police Activity Levels in 2005 and 2006

Year	Number of Calls		Violent Crime		Property Crime	
	Total	**Rate per 1000**	**Number**	**Rate per 1000**	**Number**	**Rate per 1000**
Maryland						
2005	[a]	[a]	38,369	7.0	198,474	35.5
2006	[a]	[a]	38,119	6.8	195,479	34.9
Calvert County						
2005	71,959	821	231	2.6	1617	18.5
2006	65,454	738	257	2.9	1578	17.8
St. Mary's County						
2005	51,405		360	3.7	1958	20.2
2006	66,006		320	3.3	2396	24.7

Source: CC DF&B 2007; SMCBCC 2007, 2008b; MDP 2008c
(a) Statistics not available on a State level.

Fire Department Services

The seven fire stations in Calvert County are manned by 870 volunteer firemen, with additional support provided by six volunteer rescue squads and one dive rescue team. The fire department has 12 fire engines (attack/pumpers), 3 ladder trucks, 5 tankers, and an assortment of other vehicles. The Calvert County Fire Department has identified a need for staff and equipment. St. Mary's County has nine fire stations and seven volunteer rescue squads manned by approximately 730 volunteer fire fighters. Calvert County and St. Mary's County are part of Region V of the Maryland Emergency Medical Services (EMS) System, and, in most cases, EMS services are provided from the same stations and by many of the same volunteers that staff the fire stations. In addition, the Maryland State Police provide MEDVAC services to both counties in emergency evacuation situations (UniStar 2009a). The number of fire, EMS, and rescue calls responded to by the Calvert and St. Mary's County is provided in Table 2-18.

Table 2-18. Number of Fire, EMS, and Rescue Calls/Responses in 2006 and 2007

	Calvert County			
	2006		2007	
Type of Call	Numbers	Rate per 1000	Number	Rate per 1000
Total	18,337	209.4	20,435	231.6
Fire	3108	35.4	3787	42.9
EMS	13,335	152.2	14,275	161.8
Rescue	1894	21.6	2373	26.9

Source: Secrest, Mussatti, and Scott 2010

Healthcare Services

In 2003, the DC Metropolitan Statistical Area had 22,334 doctors (including private practice) and 39 community hospitals totaling 9342 beds (USCB 2006f), and Calvert and St. Mary's Counties had one hospital each (USCB 2007). Calvert Memorial Hospital (CMH), located in Prince Frederick, is a nongovernmental not-for-profit hospital that provides general medical, emergency, and surgical services and employs approximately 289 medical staff and 1065 support staff. The hospital is licensed for 120 beds and had 8201 admissions in 2006 (UniStar 2009a). CMH's emergency department has 19 beds and 5 triage beds for minor injuries/illness, which treat a patient load of approximately 100 patients each day. In addition, CMH has a 10-bed intensive care unit and a decontamination area capable of treating 10 patients per hour and an additional onsite portable decontamination unit that can handle 50 patients per hour (UniStar 2009a). Recent renovations have expanded CMH's capacities. In addition to the primary facilities in Prince Frederick, CMH also has urgent care centers in Dunkirk and Solomons, and a community health center in North Beach that provides primary care services (UniStar 2009a).

St. Mary's Hospital, located in Leonardtown, is also a nongovernmental not-for-profit hospital that provides general medical and surgical services (UniStar 2009a). In 2007, the hospital employed 252 medical and 1090 support staff and had 9254 patient admissions, 43,222 emergency care visits, and 48,040 outpatient visits. St. Mary's Hospital has 108 beds and, on average, the hospital housed 76.7 patients for an average excess capacity of about 29 percent (UniStar 2009a).

St. Mary's Hospital provides emergency acute care, and an Express Care facility is located in Charlotte Hall to treat minor injuries and illnesses. Under the umbrella of the Chesapeake Potomac Healthcare Alliance, partner facilities include the Chesapeake Potomac Home Health Agency and the Chesapeake Potomac Regional Cancer Center (UniStar 2009a).

St. Mary's County also has 135 physicians practicing in 35 specialties throughout the county and had 3 Nursing and Personal Care facilities with 473 employees in 2000 (UniStar 2009a).

Social Services

Social services in both counties are provided by both County Departments and non-government organizations. The Calvert County Department of Health and Human Services provides and/or coordinates the provision of social services for the county, including coordination with the Department of Social Services, Aging Services, the Calvert Alliance Against Substance Abuse, the Substance Abuse program, the Calvert County Health Department, the Calvert County Memorial Hospital, the Calvert Hospice, the Calvert County Family Network, the Southern Maryland Chapter of the Red Cross, the Department of Community Resources, and the Maryland Cooperation Extension Office. The St. Mary's County Department of Social Services provides for and/or coordinates social services together with the St. Mary's County Public Health Department. These services include Emergency Food Providers, Family to Family Foster Care in Southern Maryland, the Director of Emergency & Transitional Housing Programs, and the Child Care Administration Regional Office for St. Mary's County (UniStar 2009a). Numerous non-government organizations also provide social services, some of which include churches and church organizations, the Salvation Army, and Catholic Charities.

2.5.2.7 Education

Calvert and St. Mary's Counties are served by its own school district and a number of private schools. In combination, the two counties' public schools (CCPS 2008; SMCPS 2008) accounted for an enrollment of 34,117 students in the 2005/2006 school year (MSDE 2005a), and the 33 private schools had an enrollment of 4718 students (MSDE 2005b). Summary data for the public and private school systems in each county are presented in Table 2-19.

Table 2-19. Public and Private School Enrollment in Calvert and St. Mary's Counties in the 2005-06 School Year

School Type	Calvert County		St. Mary's County	
	Public	Private	Public	Private
Prekindergarten	361	402	741	678
Kindergarten	1070	109	1044	208
Elementary (Grades 1-5)	6091	469	5869	1006
Middle School (Grades 6-8)	4155	258	3752	631
High School (Grades 9-12)	5791	159	5243	798
Total Enrollment	17,468	1397	16,649	3321

Source: MSDE 2005a, b

The Calvert County School District employed 2155 people (1560 instructional staff and 595 non-instructional) in the 2005-2006 school year (MSDE 2005c). The district had four high schools, six middle schools, 13 elementary schools (one begin operation in the 2008-09 school year), and six schools tailored for special needs (CCPS 2008). The student/teacher ratios ranged from 14 to 19 students per full-time equivalent (FTE) teacher, with the range centered at 15-17 (GS 2008). Sixteen private schools operated in Calvert County in the 2005-2006 school year (MSDE 2005b).

The Calvert County School District reports that all schools and classrooms are operating at capacity. Despite operating at capacity, the district has indicated that additional classroom equipment is not needed and that modular classrooms will be added in place of additional construction. The greatest need is growth in special education and other specialized teaching programs (UniStar 2009a).

The St. Mary's County School District employed 1931 people (1375 instructional staff and 556 non-instructional) in the 2005-2006 school year (MSDE 2005c). The district had five high schools, four middle schools, 18 elementary schools, and two schools tailored for special needs (SMCPS 2008). The student/teacher ratios ranged from 11 to 21 students per FTE teacher, with the range centered at 16-18 (GS 2008). Thirty-one private schools operated in St. Mary's County in the 2005-2006 school year (MSDE 2005b). The State of Maryland Agency for Public School Construction reported that St. Mary's County public elementary schools had a 98.6-percent utilization rate for the 2005-2006 school year, the middle schools had a 95.4-percent utilization rate, and the high schools had a utilization rate of 102.1 percent (UniStar 2009a). The St. Mary's County Public School district may experience a significant reduction in operating funds if the Impact Aid to Local Educational Agencies (LEAs) initiative is passed. The LEAs reduces educational funds for military children living off base. If the initiative is passed, the district will lose all impact dollars when the Navy moves all families currently living on the Patuxent Naval Air Station to off-base housing (UniStar 2009a).

There are two colleges Calvert and St. Mary's Counties – St. Mary's College of Maryland and The College of Southern Maryland. St. Mary's College of Maryland, located in St. Mary's City, is a public institution and had enrollment of 1908 students in the 2005-2006 school year. The College of Southern Maryland is a public institution and had enrollment of 4961 students in the 2005-2006 school year. It has campuses in Leonardtown (St. Mary's County), Prince Frederick (Calvert County), and La Plata and Waldorf (Charles County). St. Mary's College confers baccalaureate degrees and The College of Southern Maryland confers Associates degrees and Certificates/Diplomas (UniStar 2009a).

2.6 Environmental Justice

Environmental justice refers to a Federal policy established by Executive Order 12898 (59 FR 7629) under which each Federal agency identifies and addresses, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority or low-income populations.[a] The Council on Environmental Quality (CEQ) has provided guidance for addressing environmental justice (CEQ 1997). Although it is not subject to the Executive Order, the Commission has voluntarily committed to undertake environmental justice reviews. On August 24, 2004, the Commission issued its policy statement on the treatment of environmental justice matters in licensing actions (69 FR 52040).

This section characterizes the demographics and geographic characteristics of the proposed site and the surrounding minority and low-income populations that reside within a 50-mi region surrounding the proposed Unit 3. The 50-mi region surrounding the Calvert Cliffs site includes portions of Maryland, Virginia, Washington D.C., and Delaware. The characterization in this section forms the analytical baseline from which potential environmental justice effects would be determined. The characterization of populations of interest includes an assessment of "populations of particular interest or unusual circumstances," such as minority communities exceptionally dependent on subsistence resources or identifiable in compact locations, such as Native American settlements.

2.6.1 Methodology

The review team first examined the geographic distribution of minority and low-income populations within 50 mi of the proposed site, employing a geographic information system (GIS) and the 2000 Census to identify minority and low-income populations. The analysis of the location of minority and low-income populations within the 50-mi radius of the proposed Unit 3 was performed by using the ArcView® GIS software and USCB's 2000 census data at the

(a) Minority categories are defined as: American Indian or Alaskan Native; Asian; Native Hawaiian or other Pacific Islander; Black races; or Hispanic ethnicity; "other" may be considered a separate minority category. Low income refers to individuals living in households meeting the official poverty measure. To see the U.S. Census definition and values for 2000, visit the U.S. Census website at http://ask.census.gov/.

census block level (USCB 2000).[(a)] The review team verified its analysis by conducting field inquiries with numerous agencies and groups (Appendix B). The first step in the review team's environmental justice methodology is to examine each census block group that is fully or partially included within the 50-mi region to determine for each block group whether the percentage of any minority or low-income population is great enough to identify that block group as a minority or low-income population of interest. If either of the two criteria discussed below is met for a census block group, that census block group is considered a minority or low-income population of interest warranting further investigation. The two criteria are whether:

- the population of interest that resides in the census block group exceeds 50 percent of the total population of the census block group, or
- the percentage of the population of interest in the census block group is significantly greater (at least 20 percent) than the minority or low-income population percentage in the respective state.

The identification of census block groups that meet the above two-part criteria is not in and of itself sufficient for the review team to conclude that disproportionately high and adverse impacts exist. Likewise, the lack of census block groups meeting the above criteria cannot be construed as evidence of no disproportionate and adverse impacts. Accordingly, the review team also conducts an active public outreach and on-the-ground investigation in the region of the plant to determine whether minority and low income populations may exist in the region that are not identified in the census mapping exercise. To reach an environmental justice conclusion, starting with the identified populations of interest, the review team must examine impact pathways and investigate all populations in greater detail to determine whether disproportionately high and adverse effects may be present. To do this the review team addresses the following considerations:

Health Considerations

1. Are the radiological or other health effects significant or above generally accepted norms?
2. Is the risk or rate of hazard significant and appreciably in excess of the general population?
3. Do the radiological or other health effects occur in groups affected by cumulative or multiple adverse exposures from environmental hazards?

(a) A census block is the smallest geographic area that the U.S. Census Bureau collects and tabulates decennial census data. A block group is the next level above census blocks in the geographic hierarchy and is a subdivision of a census tract or block numbering area.

Environmental Considerations

4. Is there an impact on the natural or physical environment that significantly and adversely affects a particular group?
5. Are there any significant adverse impacts on a group that appreciably exceed or [are] likely to appreciably exceed those on the general population?
6. Do the environmental effects occur in groups affected by cumulative or multiple adverse exposures from environmental hazards? (NRC 2007b).

If this investigation in greater detail does not yield any potentially high and adverse impacts on populations of interest, the review team may conclude that there are no disproportionately high and adverse effects. If, however, the review team finds any potentially disproportionate and adverse effects, the review team would fully characterize the nature and extent of that impact and consider possible mitigation measures that may be used to lessen that impact. The remainder of this section discusses the results of the search for potentially affected populations of interest.

2.6.1.1 Minority Populations

The racial population is expressed in terms of the number and/or percentage of people that are minorities in an area, and, in this discussion, the sum of the racial minority populations is referred to as the aggregate racial minority population. Persons of Hispanic/Latino origin are considered an ethnic minority and may be of any race; therefore, they are not included in the aggregate racial minority population. The review team did not include Hispanics in its aggregate race estimate because the Federal government considers race and Hispanic origin to be two separate and distinct concepts (USCB 2001).

For each of the 2362 census block groups within the 50-mi radius, the percent of the census block group's population represented by each minority classification (each race, aggregate minority population, and Hispanic/Latino origin) was calculated and compared to the two criteria listed above. The GIS analysis found 658 block groups that have significant African American populations, one with significant American Indian, 38 with significant Asian populations, 42 classified as significant 'other,' and 153 with significant Hispanic populations in the region. There were 758 block groups meeting the aggregate minority population criteria. Using the methodology described in Section 2.6.1, and is discussed further in Section 4.4.2, the review team identified Calvert and St. Mary's Counties as the area that would receive the greatest proportion of all socioeconomic impacts. St. Mary's County had one block group meeting the criteria for African American populations and one meeting aggregate minority populations. Calvert County did not have any block groups meeting the racial criteria. There are no Federally recognized Native American tribes within the 50-mi comparative geographic area, Calvert and St. Mary's Counties, or the State of Maryland.

Table 2-20 shows the overall representation of the populations of interest in the Unit 3 50-mi region. Figure 2-16 shows the geographic locations of the minority populations of significance within the 50-mi radius (UniStar 2009a).

Table 2-20. Regional Minority and Low-Income Populations by Census Block Analysis Results

Category	Number of Blocks (out of 2362 Total)	Percent of Total
African American	728	30.1
Aggregate Minority	826	34.8
Hispanic	153	6.5
American Indian or Alaskan Native	1	0.04
Asian	38	1.61
Native Hawaiian or Other Pacific Islander	0	0.0
Persons Reporting Some Other Race	42	1.8
Low-Income Population	82	3.5

2.6.1.2 Low- Income Populations

The review team used census data to identify low-income households. Table 2-21 shows the number of census block groups within different areas of the 50-mi region. There are 1200 census block groups in the Maryland portion of the 50-mi radius, of which 30 are classified as low income. Of the total of 96 census block groups in Calvert and St. Mary's Counties, there are no low-income census block groups in Calvert County, and there is one low-income census block group in St. Mary's County. Figure 2-17 shows the locations of the low-income populations within the 50-mi radius.

2.6.2 Scoping and Outreach

The review team interviewed local, state, and county officials, business leaders, and key members of minority communities in Calvert and St. Mary's Counties to assess the potential for disproportionate socioeconomic effects that may be experienced by minority and low-income communities during a project with the magnitude of the proposed Unit 3. The review team issued an advanced notice of public hearings for EIS scoping purposes and completed outreach to minority and low-income populations, as evidenced by comments from minority community leaders following the March 19, 2008, public meeting in Solomons, Maryland. Through this outreach process, the review team did not identify any additional groups of minority or low-income persons not already identified in the GIS analysis of Census data.

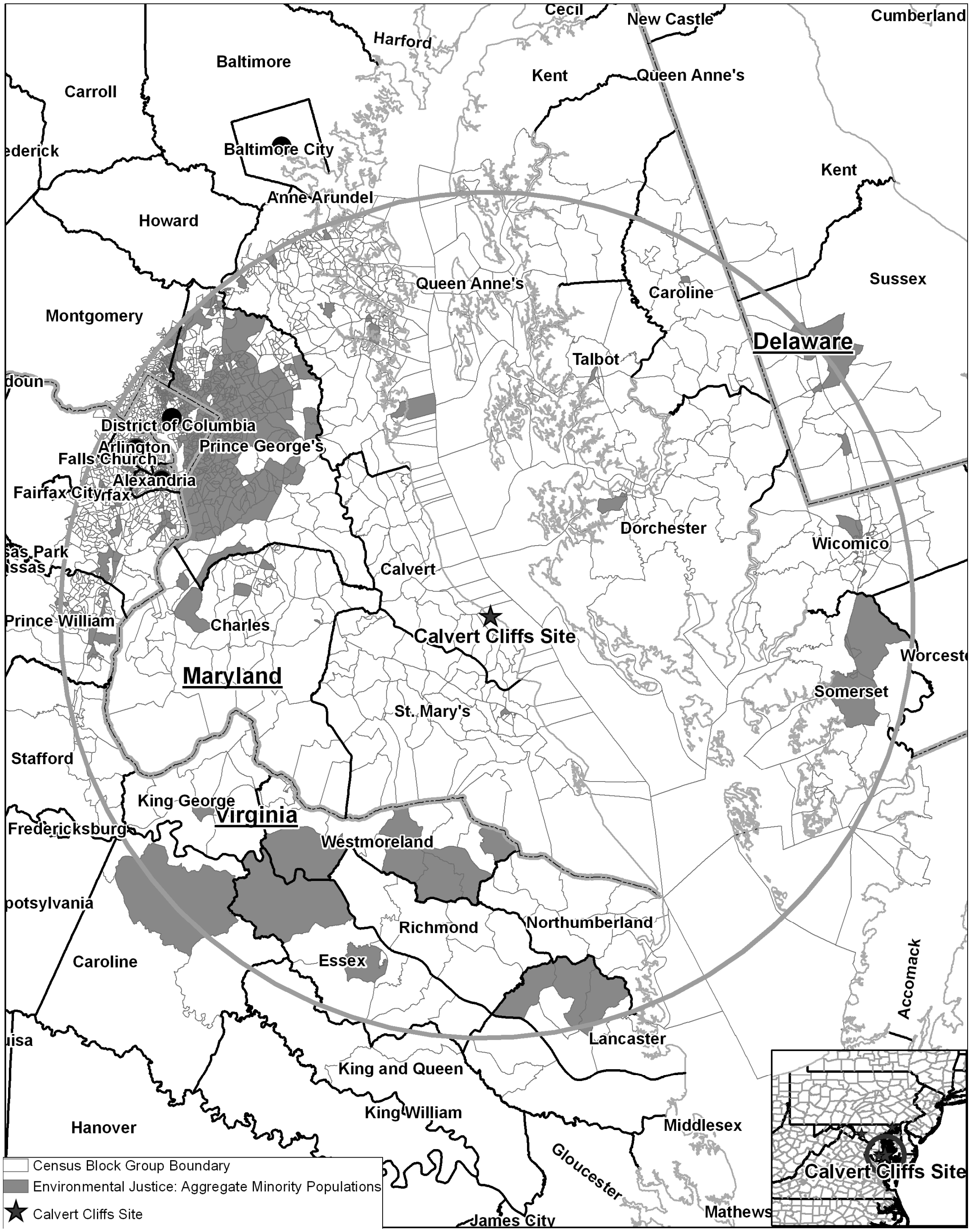

Figure 2-16. Distribution of Aggregate Minority Populations of Significance in 2000

Table 2-21. Low Income Census Block Groups in 2000

State/Area 50-mi Radius	Total Number of Census Block Groups	Number of Low Income Census Block Groups
Maryland	1200	30
Virginia	704	3
Washington, D.C.	433	40
Delaware	25	2
Total	2362	75
Calvert County, MD	41	0
St. Mary's County, MD	55	1
Total	96	1

2.6.3 Subsistence and Communities with Unique Characteristics

For each of the identified low-income and minority populations, it is necessary to determine if any of those populations appears to have a unique characteristic at the population level that would cause an impact to disproportionately affect them. Examples of unique characteristics might include lack of vehicles, sensitivity to noise, close proximity to the plant, subsistence activities, or lack of basic health care, but such unique characteristics need to be demonstrably present in the population and relevant to the potential environmental impacts of the plant. If the impacts from the proposed action would appear to affect an identified minority or low-income population more than the general population because of one of these or other unique characteristics, then a determination is made whether the impact is disproportionate when compared to the general population.

Subsistence uses of natural resources are often to supplement income by providing food or other resources that free up actual earnings for additional store-bought foodstuffs, medications or other needs. Often, subsistence is undertaken for ceremonial and traditional cultural purposes. Subsistence often involves the use of publicly held resources such as rivers (subsistence fishing) or forests (hunting or gathering of vegetation), but also includes the use of privately owned resources, such as home vegetable gardens. Common categories of subsistence uses include gathering plants, fishing, and hunting. Subsistence information is often site specific and difficult to differentiate from the recreational uses of natural resources. Therefore, the review team presents subsistence information in a more qualitative manner based on diverse sources of published and anecdotal information.

About 220 ac of the 2070 ac occupied by the Calvert Cliffs site are currently developed. The general public is not allowed uncontrolled access to the site for safety and security reasons; thus, no ceremonial, culturally significant, or subsistence gathering of vegetation occurs on the site. No information for plant gathering could be found in the vicinity of the Calvert Cliffs site. Therefore, the review team assumes that if collection of plants for ceremonial, cultural, or subsistence purposes is occurring in Calvert or St. Mary's Counties that collection is taking

Figure 2-17. Distribution of the Low-Income Populations of Significance in 2000

place at a de minimis level. As with plant gathering, the review team did not find any available information pertaining to subsistence, cultural, or ceremonial hunting practices of any species within the 50-mi radius.

The review team considered UniStar's process on environmental justice issues and conducted its own interviews with local officials in Calvert and St. Mary's Counties. The review team also considered public comments related to the proposed project. Finally, the review team performed literature reviews for academic studies and performed internet searches for documented subsistence activities by minority and low-income populations. The review team did not find any indications that any populations had unique characteristics or practices that could potentially lead to a disproportionately high and adverse impact in the Calvert County area. However, the review team did review a study (Gibson and McClafferty 2005) with information on subsistence fishing.

The study for three areas (Chesapeake Bay, including the Lower Patapsco and Back Rivers in the Baltimore region, the Lower Potomac and Anacostia Rivers in the Washington, D.C., region, and the Elizabeth and James Rivers in the Tidewater region of Virginia) provides some information on fishing characteristics of minority and low-income populations (Gibson and McClafferty 2005). However, the three areas where the subsistence fishing occurs are around the outer edge of the 50-mi region and not in the near vicinity of the Calvert Cliffs site. This study found that African-Americans constituted the majority of minorities that harvested fish and shellfish in the three regions, ranging from 33 to 49 percent of the total, with the Hispanic/Latino segment the next largest. Minorities and low-income individuals were much more likely to fish from the shore/pier, and low-income individuals are likely to travel less than 10 miles to fish. There was not a clear pattern that minorities traveled shorter or greater distances. Finally, minorities were more likely to consume the fish they caught and tended to do so to help reduce expenditures on food. Individuals making less than $40,000 a year also ate their catch to reduce expenditures on food.

The review team examined whether populations with unique characteristics that would make them susceptible to a disproportionately high and adverse impact would be affected by a physical or environmental pathway of a potential impact from the proposed plant Through its review of the applicant's ER, its own outreach and research, and through scoping meeting comments, the review team did not indentify any communities with potentially unique characteristics for further consideration within the vicinity of the Calvert Cliffs site.

2.6.4 Migrant Populations

The U.S. Census Bureau defines a migrant worker as an individual employed in the agricultural industry in a seasonal or temporary nature and who is required to be absent overnight from their permanent place of residence. From an environmental justice perspective, there is a potential for such groups in some circumstances to be disproportionately affected by emissions in the environment. No farm in Calvert County or St. Mary's County employed seasonal or migrant workers in 2004. Given that the number of farms and acreage devoted to farming in the region has been declining, it is unlikely seasonal agricultural migrant workers would be hired in the future (UniStar 2009a).

2.6.5 Environmental Justice Summary

The review team found low-income, Black, Hispanic, and aggregated minority populations within the 50-mi radius that exceed the percentage criteria established for environmental justice analyses. Consequently, the review team performed additional analyses before making a final environmental justice determination. Based on the information in the UniStar ER, public input, and its own outreach and analysis, the review team determined that because there are minority and low-income populations of interest in the region, impacts to these communities must be considered in greater detail, as discussed in Section 2.6.1. The result of the review team analyses can be found in Section 4.5 of this EIS for construction impacts, and in Section 5.5 for operation impacts.

2.7 Historic and Cultural Resources

In accordance with 36 CFR 800.8(c), the NRC and Corps have elected to use the National Environmental Policy Act of 1969, as amended (NEPA), process to comply with the obligations found under Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA; 16 U.S.C. 470 *et seq.*).

As a cooperating agency, the Corps is part of the NRC review team, involved in all aspects of the environmental review. Assuming a DA permit is granted, the Corps is the primary Federal agency that will review and permit the site preparation activities related to working in wetlands, streams, and the Chesapeake Bay. The NRC will determine whether or not to issue a COL for the new unit. For the purposes of Section 106, the Corps is the lead Federal agency consulting with the State Historic Preservation Office/Officer (SHPO) and UniStar and is a signatory on the Memorandum of Agreement (MOA).

This section discusses the historic and cultural background in the Calvert Cliffs site region. It also details the efforts that have been taken to identify cultural resources within the APE and describes the resources that were identified during this review. A description of the consultation efforts accomplished to date is also provided. The assessments of effects from the proposed building and operation are found in Sections 4.6 and 5.6, respectively.

2.7.1 Cultural Background

The cultural background of the Calvert Cliffs site and its surrounding areas was described in the CCNPP license renewal supplemental EIS (NRC 1996) and is summarized here. The area in and around the Calvert Cliffs site has a rich cultural history and a substantial record of significant cultural resources. The site is located in Calvert County, Maryland, on the west bank of the Chesapeake Bay, which influenced settlement in the area. This part of southern Maryland has a cultural sequence that extends back to about 10,000 B.C. Aboriginal occupation of the area lasted until the early 1600s when European encroachment pushed the remaining Native American groups from the area.

The archaeological record indicates that prehistoric occupation of the area was as follows: Paleo-Indian (10,000 to 7500 B.C.), Archaic (7500 to 1000 B.C.), and Woodland (1000 B.C. to 1600 A.D.) (NRC 1996).

When Euroamericans arrived in the area in the 17th and 18th centuries, the area was occupied by American Indian groups descended from the earlier chiefdoms that populated the southeastern United States. Two Algonkian tribes known as the Nanticokes and the Piscataway occupied the region for several centuries. The Susquehannocks, an Iroquoian group from the area that was to become Pennsylvania, moved into the area just before European contact (NRC 1996).

The European colonization of Maryland began in the early 1600s. The land on which the Calvert Cliffs site is located is believed to have been part of an original land grant of 1000 ac in 1658 from Cecilius Calvert, the Second Lord Baltimore, to Richard Preston. This grant is commonly referred to as “Preston’s Cliff’s or “Charles’ Gift.” In the mid-1700s, the general area was referred to as “Gideon and Cleverlys Right.” By 1782, the acreage where the power plant is located was owned by Andrew Wilson, whose heirs owned the land until 1916, at which time it was sold to Goodman Goldstein. The land was purchased from the Goldstein heirs in May 1967 by BGE to be the site of the CCNPP (NRC 1996).

According to the National Park Service, the closest Native American lands to the site are the Pamunkey and Mattaponi reservations in King William County, Virginia (UniStar 2009a). There are no known Native American Graves Protection & Repatriation Act (NAGPRA) claims by Native Americans on lands within the Calvert Cliffs site boundary (UniStar 2009a).

2.7.2 Historic and Cultural Resources at the Proposed Unit 3 Site

To identify the historic and cultural resources at the COL site, the review team reviewed the following information:

- Calvert Cliffs COL ER (UniStar 2009a) – UniStar's contractor, Tetra Tech NUS, Inc. (Tetra Tech) and MACTEC, contracted with GAI Consultants, Inc., a cultural resource contractor, to identify and evaluate terrestrial cultural resource sites in the area and Panamerican Consultants, Inc. to investigate submerged cultural resources.
- Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Regarding the Calvert Cliffs Nuclear Power Plant (NRC 1996).
- NRC Site Visit March 2008 – NRC staff consulted with the Maryland Historical Trust (MHT) and also conducted an on-the-ground visit of the COL site.
- UniStar RAI Responses – Letters dated June 13, 2008, August 18, 2008, and October 31, 2008 (UniStar 2008a, d, e).
- UniStar Draft Technical Report – CCNPP Phase I and Phase II Cultural Resources Investigations August 2008 (Munford et al. 2008).
- UniStar Draft Technical Report – Submerged Cultural Resources Survey of a Proposed Outfall Pipe, Calvert Cliffs Nuclear Power Plant Unit 3 Construction, Calvert County, Maryland 2008 (Faught 2008).
- Maryland Historical Trust Letter – MHT Review of Phase II National Register Evaluations and Assessment of Effects for Cultural Resources, Calvert Cliffs Nuclear Power Plant Expansion, Calvert County, Maryland February 13, 2009 (MHT 2009). The MHT houses the Maryland SHPO.

Section 106 of the NHPA requires Federal agencies to take into account the effects of their undertakings on historic properties that are listed or eligible for listing on the *National Register of Historic Places* (NRHP). The NRHP is the official list of historic places that have been determined to be worthy of preservation. The list was established by the NHPA and is maintained by the National Parks Service. The eligibility of cultural resources for listing on the NRHP are assessed on four criteria including:

- Criterion A: Associated with events that have made a significant contribution to broad patterns of our history, or
- Criterion B: Associated with the lives of persons significant in our past; or
- Criterion C: Embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
- Criterion D: Have yielded, or are likely to yield, information important to prehistory and history.

There are three Areas of Potential Effect (APEs) for cultural resources for the Corps that may be affected by the proposed project. The APE for archaeological sites is 727 ac based on physical disturbance that may result from project-related building activities, including the site of the reactor and auxiliary buildings and laydown areas (UniStar 2009a). The APE for historic architectural resources and visual effects includes the 727 ac for construction areas and extends 1000 ft beyond the construction boundary. A third APE for submerged cultural resources was defined as a 650 × 1400 ft area centered at the proposed outfall pipeline (UniStar 2009a). The NRC has determined that the APE for the COL review is the area at the power plant site and the immediate environs that may be directly or indirectly impacted by NRC-authorized construction and operation of the proposed new unit. The APE is influenced by the limitation of the scale and nature of the NRC undertaking, which does not include most of the ground disturbing activities which constitute preconstruction activities.

Areas in the Chesapeake Bay near the existing Calvert Cliffs site were previously dredged for the existing discharge conduit and channel, cooling water intake channel, the barge dock and channel, and the shore protection revetment. Building the new intake channel and discharge conduit would occur within areas previously dredged or disturbed by construction activities for Units 1 and 2. (UniStar 2009a).

The NRHP-eligible archaeological sites, structures, buildings and districts located within 10 mi of the proposed Unit 3 site were identified in the ER (UniStar 2009a). A total of 17 archaeological sites, 37 isolated finds, and 5 historic architectural resources were identified. UniStar subcontracted with Tetra Tech, MACTEC, and GAI Consultants, Inc. to identify and evaluate any cultural resources located within the proposed project areas associated with Unit 3. GAI conducted a Phase Ia cultural resources investigation of the proposed Unit 3 site in October 2006 to identify previously recorded or surface-visible archaeological resources and architectural resources and to identify areas with archaeological potential that would require a Phase Ib survey (UniStar 2009a). The Phase Ib cultural resources investigation was conducted in March 2007 to identify subsurface archaeological resources, record all known archaeological and architectural resources in the proposed project area, and to evaluate the recorded resources for eligibility to the NRHP (UniStar 2009a). Supplemental Phase I investigations were conducted at Preston’s Cliffs Wetland Mitigation Area, Camp Conoy Wetland Mitigation Area, and the Old Bay Farm Access Road (UniStar 2009a). Table 2-24 summarizes the results of the Phase I and Phase II archaeological investigations. The survey resulted in the identification of 17 archaeological sites, 14 of which are associated with the historical era, 2 multi-component sites, which are associated with the pre-contact and historic eras, and 1 site associated with the pre-contact era. The cultural resources investigations did not discover any human remains in the proposed project area.

Five archaeological sites (18CV7, 18CV474, 18CV480, 18CV481, and 18CV482) were recommended as potentially eligible for inclusion on the NRHP. Phase II NRHP investigations were not conducted at site 18CV7. Only a small portion of the site extended into the Preston's Cliffs Wetland Mitigation Area and may be impacted by tree planting activities (MHT 2009). The MHT recommended that Phase II investigations were not warranted and requested that the site be avoided. MHT also recommended that if the area is to be reforested that the site be reforested through the hand-planting of seedlings (MHT 2009).

The Phase II NRHP evaluation investigations of the remaining four archaeological sites were completed and UniStar submitted a draft report to the NRC in August 2008 (Munford et al. 2008). Table 2-22 and Table 2-23 summarize the results of the NRHP investigations. Based on the Phase II evaluations, one site (18CV474) is recommended to be NRHP eligible under Criterion D. The remaining three sites subjected to Phase II evaluations (18CV480, 18CV491, and 18CV482) did not meet the minimum criteria for inclusion on the NRHP, and no further archaeological investigations are required.

According to the Phase II NRHP evaluation and the MHT letter dated February 13, 2009, site 18CV474 has been identified as a mid-nineteenth to early-twentieth century domestic site possessing remarkably good archaeological integrity and the potential to yield important information on Maryland's Western Shore Region (UniStar 2009a). A total of 3644 artifacts have been recovered from the site, including a variety of temporally diagnostic ceramics (pearlware, yellowware, and whiteware), bottle glass, cut nails, brick fragments, window glass, lamp chimney glass, buttons, tobacco pipe fragments, and a glass bead. Four intact features have also been identified, including a stone foundation and chimney base, a builder's trench, an area of stone paving, and a possible pier support for a north addition. The temporally diagnostic artifacts and cartographic sources indicate that the site was occupied from ca. 1850 to 1910, and the limited quantity and variety of decorated ceramics suggests that the residents were of a lower socioeconomic status than the landowners, who were likely residing at site 18CV480. The property encompassing these sites was owned and occupied by the Somervell family during the eighteenth and nineteenth centuries, and census data indicates that this locally prominent family relied heavily on enslaved labor throughout the first half of the nineteenth century. The Slave Schedule of the 1860 census identifies Alexander Somervell as the owner of 52 enslaved African Americans, and Charles Somervell (Alexander's son) as the owner of sixteen slaves. Housing for these slaves may have been dispersed throughout the Somervell plantation, and the archaeological investigations conducted at site 18CV474 indicate that the site may represent one such residence for some of the slaves and/or tenants, sharecroppers, or freed African Americans. Site 18CV474 is NRHP eligible under Criterion D. While much of the architecture is not intact, the artifacts, features, and architectural remnants provide irreplaceable information of the lives of African Americans during slavery and during the period after the Civil War.

Table 2-22. Calvert Cliffs Archaeological Sites Identified - Phase I/II Investigations

Site	Site Type	Age	Work Effort	Integrity	Information Potential	GAI/UniStar Recommended NRHP Status	GAI/UniStar Recommendations	SHPO Concurrence
18CV474	Domestic Site	Mid-nineteenth/ Early Twentieth Century	Phase I/II	Good	High	NRHP Eligible/Criterion D	Avoid or Phase III	Concurred 2/13/09 MHT Letter
18CV475	Artifact Scatter/ Foundation	Nineteenth Century	Phase I	Poor	Low	Not Eligible	No Further Work Needed	Concurred 2/13/09 MHT Letter
18CV476	Refuse Dump	Twentieth Century/ Modern	Phase I	Poor	Low	Not Eligible	No Further Work Needed	Concurred 2/13/09 MHT Letter
18CV477	Refuse Dump/ Outbuilding	Mid-late Twentieth Century	Phase I	Poor	Low	Not Eligible	No Further Work Needed	Concurred 2/13/09 MHT Letter
18CV478	Artifact Scatter	Twentieth Century	Phase I	Poor	Low	Not Eligible	No Further Work Needed	Concurred 2/13/09 MHT Letter
18CV479	Lithic Scatter	Indetermined/ Prehistoric	Phase I	Moderate	Low	Not Eligible	No Further Work Needed	Concurred 2/13/09 MHT Letter
18CV480	Domestic Site	Mid-nineteenth/ Early Twentieth Century	Phase I/II	Poor	Low	Not Eligible	No Further Work Needed	Concurred 2/13/09 MHT Letter
18CV481	Domestic Site	Late Nineteenth/ Early Twentieth Century	Phase I/II	Poor	Low	Not Eligible	No Further Work Needed	Concurred 2/13/09 MHT Letter
18CV482	Domestic Site	Late Nineteenth Century	Phase I/II	Poor	Low	Not Eligible	No Further Work Needed	Concurred 2/13/09 MHT Letter
18CV483	Domestic Site/ Artifact Scatter	Mid-nineteenth/ Early Twentieth Century	Phase I	Poor	Low	Not Eligible	No Further Work Needed	Concurred 2/13/09 MHT Letter

Table 2-22. (contd)

Site	Site Type	Age	Work Effort	Integrity	Information Potential	GAI/UniStar Recommended NRHP Status	GAI/UniStar Recommendations	SHPO Concurrence
18CV484	Field Scatter	Twentieth Century	Phase I	Poor	Low	Not Eligible	No Further Work Needed	Concurred 2/13/09 MHT Letter
18CV485	Artifact Scatter	Mid-nineteenth/ Early Twentieth Century	Phase I	Good	Low	Not Eligible	No Further Work Needed	Concurred 2/13/09 MHT Letter
18CV486	Artifact Scatter	Nineteenth/ Twentieth Century	Phase I	Good	Low	Not Eligible	No Further Work Needed	Concurred 2/13/09 MHT Letter
18CV487	Artifact Scatter	Nineteenth Century	Phase I	Good	Low	Not Eligible	No Further Work Needed	Concurred 2/13/09 MHT Letter
18CV489	Artifact Scatter	Nineteenth/ Early Twentieth Century	Phase I	Poor	Low	Not Eligible	No Further Work Needed	Concurred 2/13/09 MHT Letter

Source: Munford and Hyland 2007, Munford et al 2008

Table 2-23. Calvert Cliffs Architectural Structures Identified - Phase I/II Investigations

Resource MHT#	Resource Name	Resource Description	Construction Date	GAI/UniStar Recommended NRHP Status	SHPO Concurrence
CT-58	Parran's Park	Agricultural Outbuildings	Circa 1750 and Early Twentieth Century	NRHP Eligible/Criterion A	Concurred 2/13/09 MHT Letter
CT-59	Preston's Cliff/ Charles' Gift/Wilson Farm	Chimney Stacks, Ruins of House, and Agricultural Outbuildings	1691-1935	NRHP Eligible/Criterion A & C	Concurred 2/13/09 MHT Letter
CT-154	Calvert Cliffs Nuclear Power Plant	Nuclear Power Generation Facility	1975	Not Eligible	Concurred 11/20/06 MHT Letter
CT1295 and CV-172	Baltimore and Drump Point Railroad	Abandoned Railroad Bed	1868-1891	NRHP Eligible/Criterion A & C	Concurred 2/13/09 MHT Letter
CT-1312	Camp Conoy	Recreation Facility	Circa 1930	NRHP Eligible/Criterion A	Concurred 2/13/09 MHT Letter

Source: Munford and Hyland 2007, Munford et al 2008

The Phase II cultural resources investigation identified five architectural resources (Table 5-25). The property types include agricultural outbuildings, ruins, a graded railroad bed, and buildings associated with a seasonal recreation camp established by the Baltimore YMCA (Camp Conoy). Of these, four architectural resources are recommended as eligible for inclusion on the NRHP; CT-58 (Parran's Park), which is associated with tobacco farming and agricultural history and is recommended for NRHP status under criterion A, CT-59 (Preston's Cliff/Charles's Gift/Wilson Farm), which is associated with agricultural history at the local level and is recommended for NRHP status under criteria A and C, and CT-1295 and CV-172 (Baltimore & Drum Point Railroad), which is recommended for NRHP status under criteria A and C, and CT-1312 (Camp Conoy), which is associated with recreational history and is recommended eligible to the NRHP under criterion A.

Panamerican Consultants, Inc., working as a sub-consultant to MACTEC, conducted a cultural resources survey of the submerged cultural resources APE. Nine magnetic anomalies and five sidescan sonar object were identified. None were identified as cultural resources. The draft report documenting the investigation (Faught 2008) was submitted to the MHT. Based on the documentation presented in the report, the MHT concurred that the building of proposed outfall pipe is unlikely to impact any significant cultural resources, and further archaeological investigations are not warranted for Section 106 purposes (MHT 2009).

2.7.3 Consultation

In February, 2008, the NRC initiated consultation on the proposed action by writing the MHT and the Advisory Council on Historic Preservation (NRC 2008a, b). Also in March, 2008, the NRC initiated consultations with three tribes and the Commission on African History and Culture (See Appendix F for complete listing). In the letters, the NRC provided information about the proposed action, indicated that review under the NHPA would be integrated with the NEPA process in accordance with 36 CFR 800.8, invited participation in the identification and possible decisions concerning historic properties, and invited participation in the scoping process. The Corps issued a public notice that initiates consultation and solicits comments from the public; Federal, State, and local agencies and officials; Indian Tribes; and other interested parties in order to consider and evaluate the impacts of this proposed activity. Any comments received will be considered by the Corps to determine whether to issue, modify, condition or deny a permit and to assess impacts on endangered species, historic properties, water quality, general environmental effects, and the other public interest factors (USACE 2008).

To date, literature reviews and consultations with regional American Indian Tribes have not identified any traditional cultural properties in the vicinity of the proposed construction area of the COL unit.

On March 19, 2008, the NRC conducted two public scoping meetings in Solomons, Maryland, at the Holiday Inn Select at 155 Holiday Drive. No comments or concerns regarding historic and cultural resources were made at these public scoping meetings. On February 13, 2009, the Corps received a response from the MHT regarding the review of the Phase II National Register Evaluations and Assessment of Effects for Cultural Resources at the Calvert Cliffs Nuclear Power Plant (MHT 2009). The response letter from the MHT (SHPO) concurred that sites 18CV474, CT-1295 (Drum Point Railroad Bed), and CT-1312 (Camp Conoy) are NRHP eligible and would be adversely affected by the proposed project.

In addition to the response above, the MHT stated that "if site avoidance is not possible, Phase III data recovery investigations would be warranted to mitigate the undertaking's adverse effects on the archaeological property." On April 21, 2009, the Corps and UniStar met with the MHT to begin negotiations and execution of a MOA that stipulates the agreed-upon mitigation measures, including the Phase III investigations, methods of public outreach and interpretation, and the curation of all artifacts and materials generated by the investigations conducted at archaeological site 18CV474. Avoidance, minimization, and/or mitigation for the two historic built environment resources, Drum Point Railroad Bed (CT-1295) and Camp Conoy (CT-1312), are also addressed in the MOA. The parties (Corps, UniStar and SHPO) have negotiated and executed a Memorandum of Agreement (MOA) that stipulates the agreed-upon mitigation measures" including a data recovery plan and an unanticipated discoveries plan (MHT 2010). The Unanticipated Discoveries Plan and the Mitigation Plan prepared by UniStar was signed on March 16, 2010 by the Corps, UniStar and the Maryland SHPO (USACE 2010).

2.8 Geology

A detailed description of the geological, seismological, and geotechnical conditions at the CCNPP site is provided in Section 2.5 of the UniStar FSAR (UniStar 2009b) as part of the COL application. A description of the hydrogeologic setting of the proposed site is addressed in the ER as well (UniStar 2009a). In addition to the site characterization conducted for the Units 1 and 2, results of the UniStar subsurface investigations performed as part of UniStar's safety analysis for this COL application (Section 2.5 of the FSAR) provide further definition of the site geology. These descriptions are based on published geologic reports of the region along with site-specific characterization activities conducted during the building of Units 1 and 2 and characterization activities conducted during preapplication activities for proposed Unit 3 (UniStar 2009b). Considering the geological characteristics of the site and vicinity are essential to the safe design and operation of the plant, but building and operating the plant does not have a significant environmental impact on geological resources (such as, damage to unstable slopes, adjacent utilities, or to nearby structures). The NRC staff's independent assessment of the site safety issues related to the Unit 3 site will consider the applicant's detailed analysis and evaluations of geological, seismic, and geotechnical data. The NRC staff's detailed description of the geological features in the Unit 3 site vicinity will be addressed in the NRC staff's Safety Evaluation Report (in progress).

The Calvert Cliffs site lies within the Coastal Plain Physiographic Province as illustrated in Figure 2-18. The Coastal Plain Province is an extensive sedimentary structure that forms much of the eastern seaboard of the United States. In the vicinity of Maryland, the Coastal Plain is bounded on the west by the Fall Line that separates the Coastal Plain from the Piedmont Physiographic Province; the Calvert Cliffs site is about 40 mi east of the Fall Line. To the east, the Coastal Plain extends out beneath the Atlantic Ocean all the way to the Continental Shelf. The thickness of the Coastal Plain province increases from 0 ft at the Fall Line to about 8000 ft along the Maryland coast.

Figure 2-19 shows the stratigraphic column that represents the geology beneath the Calvert Cliffs site. The surficial sediments consist of alluvium and upland fluvial deposits of sands and gravels. Beneath the surficial sediments is the Chesapeake Group, which consists of alternating silt and clay units with some thin and discontinuous sand layers. In the vicinity of the Calvert Cliffs site, the Chesapeake Group is considered a confining unit with respect to groundwater. The deepest foundations of the plant structures of proposed Unit 3 would be built on structural fill placed within the Choptank formation of the Chesapeake Group.

Below the Chesapeake Group are the 20-ft-thick Piney Point formation and the 180-ft-thick Nanjemoy formation. The Nanjemoy formation is separated from the deeper Aquia formation by the 15- to 20-ft-thick Marlboro clay layer. The base of the 150-ft-thick Aquia formation is bounded by a 10- to 20-ft-thick layer of clay. The sedimentary formations continue downward another 2000 ft or more. However, they do not interact with the building or operation of proposed Unit 3 and, therefore, are not considered further in this EIS.

The surface elevations of the Calvert Cliffs site range from 0 to nearly 130 ft mean sea level (MSL). The terrain consists of gently rolling hills cut by small stream valleys. The topographic high runs approximately north-south and roughly parallels the Calvert peninsula. The proposed Unit 3 would be on the east side of the north-south high and at an elevation of about 85 ft. A few streams flow a short distance east-northeastward to the Chesapeake Bay. The remaining streams flow west into Johns Creek. From there, the water flows into St. Leonards Creek and then into the Patuxent River, which empties into Chesapeake Bay about 10 mi south of the Calvert Cliffs site.

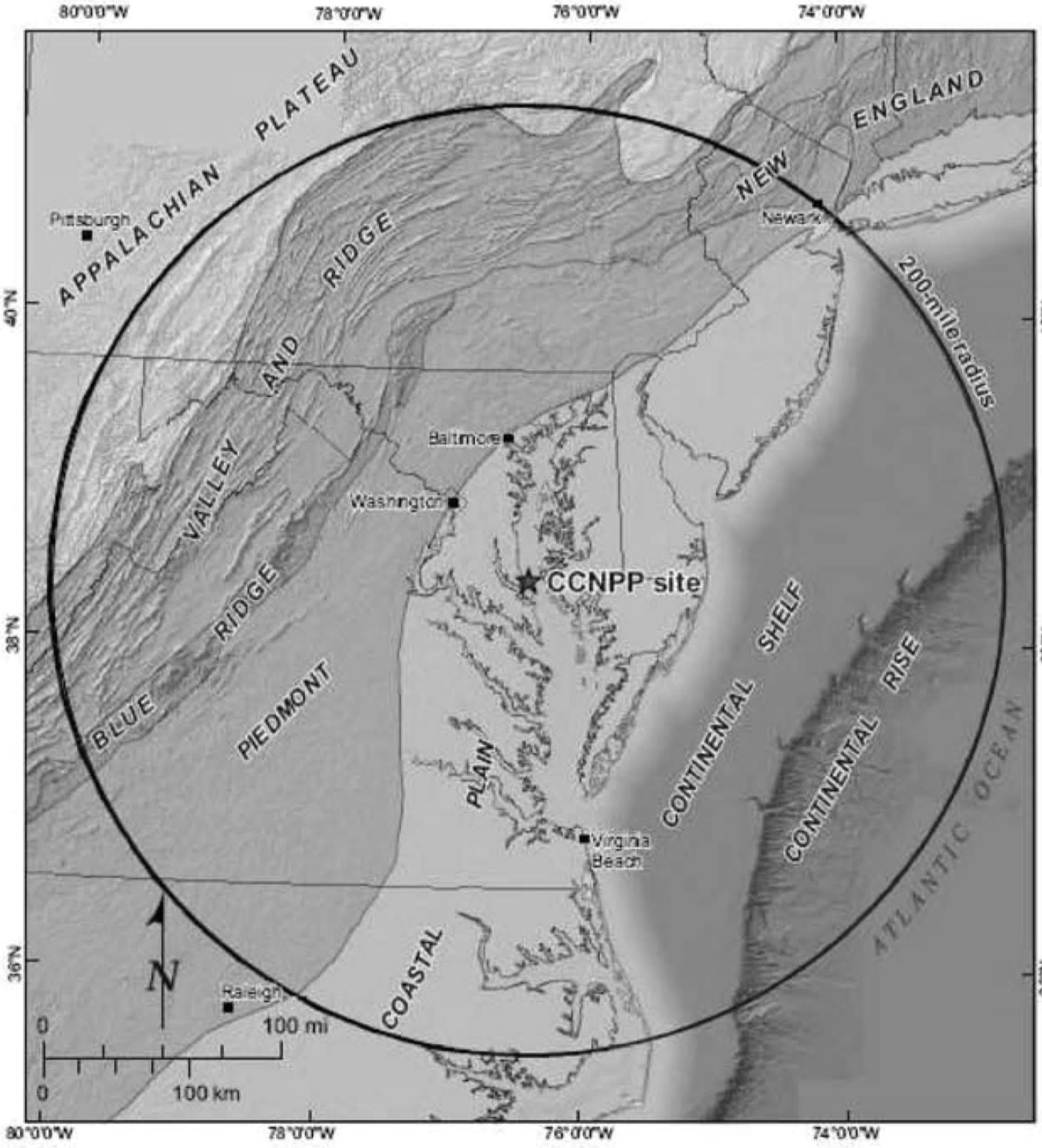

Figure 2-18. Physiographic Map of Maryland and Surrounding Area (the Fall Line separates the Piedmont and Coastal Plains Provinces) (UniStar 2009a)

ERA	PERIOD	EPOCH		AGE(Ma)	UNIT	THICKNESS (FT)
Cenozoic	Quarter-nary	Holocene		0.01	**Alluvium & Beach Deposits**	0-50
		Pleistocene		1.8	**Terrace & Lowland Deposits**	
	Tertiary	Pliocene		5.3	**Upland Deposits**	0-50
		Miocene	Upper	11.2		
			Middle	16.4	**Chesapeake Group** St. Marys Formation Choptank Formation Calvert Formation	245-280
		Eocene	Middle	49	**Piney Point Formation**	
			Lower	54.8	**Nanjemoy Formation**	
		Paleocene	Upper	61	**Marlboro Clay Aquia Formation**	
			Lower	65	**Brightseat Formation**	
Mesozoic	Cretaceous	Upper		99	**Magothy, Monmouth, Matawan Formations undifferentiated**	30?
		Lower		144	**Potomac Group** **Patapsco Formation** **Arundel/Patuxent Formations (undivided)**	1000-1100 750-900
Proterozoic/ Paleozoic				543+	**Metamorphic/igneous**	Not Known

Figure 2-19. Stratigraphic Column for the Calvert Cliffs Site (UniStar 2009a)

On the eastern boundary of the proposed Unit 3 site, a portion of the Chesapeake Bay shoreline consists of a narrow beach at the base of a steep cliff as high as 100 ft. The cliff face is eroding, primarily by wave action at the base. The Maryland DNR estimated rates of shoreline change in the vicinity of the Calvert Cliffs site. The agency estimated the rate of shoreline change south of the barge slip to be erosion on the order of 2 to 4 ft/yr, and north of the intake to be between 2 ft/yr accretion (slow increase to land by the deposition of waterborne sediment) and 4 ft/yr erosion. FSAR Section 2.9 discusses shoreline erosion processes and slope failure along the Chesapeake Bay (UniStar 2009b). Approximately 2500 ft of Calvert Cliffs site shoreline is stabilized to prevent erosion. This section of shoreline encompasses the intake, discharge, and barge structures associated with existing Units 1 and 2. Upslope and away from the Bay, there have been no similar instances of recognizable erosion and deposition processes. The potential for erosion and deposition associated with Units 1 and 2 is minimized through BMPs implemented through a NPDES Stormwater Permit.

Mineral resources at the proposed Unit 3 site are primarily sand and gravel, which are used as aggregate in the construction industry. Clay, which is present in thin layers, can be used for ceramics. Water is abundant in multiple aquifers (MDNR 2008g).

2.9 Meteorology and Air Quality

The following sections describe the climate and air quality of the Calvert Cliffs site. Section 2.9.1 describes the climate of the region and area in the immediate vicinity of the site, Section 2.9.2 describes the air quality of the region, Section 2.9.3 describes atmospheric dispersion at the site, and Section 2.9.4 describes the meteorological monitoring program at the site.

2.9.1 Climate

The Calvert Cliffs site is located in Calvert County in the southern portion of Maryland. Its climate is influenced by the Atlantic Ocean and the Chesapeake Bay to the east, and the Appalachian Mountains to the west. These features give the site a more moderate climate than is found at inland sites at the same latitude. The first-order National Weather Service station at Baltimore, about 50 mi to the north, has long periods of record, which provide a good indication of the general climate at the site because of its proximity and similarities in topography and vegetation.

The following climatological statistics are derived from local climatological data for Baltimore (NCDC 2004) based on a period of record exceeding 50 years. Temperatures are more variable in the winter than in the summer because of the differences in air mass source regions. Daytime maximum temperatures range from about 41°F in January to about 87°F in July, and nighttime minimum temperatures range from about 24°F in January to about 67°F in July. Monthly average wind speeds range from about 8 mph in the summer to more than 10 mph in

March and April. Precipitation is uniformly distributed throughout the year; all months average more than 3 in. of precipitation, with only August having more than 4 in. Snow is generally limited to November through March, although snow has been recorded in April and May.

On a larger scale, climate change is a subject of national and international interest. The recent compilation of the state of knowledge in this area by the U.S. Global Change Research Program (GCRP), a Federal Advisory Committee, (GCRP 2009) has been considered in preparation of this EIS. The GCRP has provided valuable insights regarding the state of knowledge of climate change. The projected change in temperature from "present day" (1993-2008) over the period encompassing the licensing action (i.e., to the period 2040 to 2059 in the GCRP report) in the vicinity of the Calvert Cliffs site is an increase of between 1 to 4°F. While the GCRP has not incrementally forecast the change in precipitation by decade to align with the licensing action, the projected change in precipitation from the "recent past" (1961-1979) to the period 2080 to 2099 was presented; the GCRP report forecasts only minor change (GCRP 2009).

Based on the assessments of the GCRP and the National Academy of Sciences' National Research Council, the EPA determined that potential changes in climate caused by greenhouse gas (GHG) emissions endanger public health and welfare (74 FR 66496). The EPA indicated that, while ambient concentrations of GHGs do not cause direct adverse health effects (such as respiratory or toxic effects), public health risks and impacts can result indirectly from changes in climate. As a result of the determination by the EPA and the recognition that mitigative actions are necessary to reduce impacts, the review team concludes that the effect of GHG on climate and the environment is already noticeable, but not yet destabilizing. In CLI-09-21, the Commission provided guidance to the NRC staff to consider carbon dioxide and other GHG emissions in its NEPA reviews and directed that it should encompass emissions from constructing and operating a facility as well as from the fuel cycle (NRC 2009). The review team characterized the affected environment and the potential GHG impacts of the proposed action and alternatives in this EIS. Consideration of GHG emissions was treated as an element of the existing air quality assessment that is essential in a NEPA analysis. In addition, where it was important to do so, the review team considered the effects of the changing environment during the period of the proposed action on other resource assessments.

2.9.1.1 Wind

UniStar (2009a) provided wind roses for the Calvert Cliffs site for the years 2000 through 2005 and for four other locations (Baltimore-Washington International Airport, Richmond, Norfolk, and Patuxent River Naval Air Station) for different time periods. There are distinct differences in the wind rose that can be attributed to topographical influences. Wind roses for Richmond, Norfolk, Patuxent River, and the Calvert Cliffs site are reasonably similar because they have a prevailing southwest or south-southwest wind. The wind rose for the Baltimore-Washington International Airport is distinctly different than the other four, having a prevailing west wind.

Monthly wind roses for the Calvert Cliffs site show a very predominant offshore (southwest wind) component from May through August and predominant northwest component from December through February. The wind roses for the remaining months show transitional wind patterns. Winds from the east through southeast are infrequent in all months. The annual average 10-m wind speed at the Calvert Cliffs site estimated from the meteorological data provided by UniStar is about 6.4 mph. The annual average wind speeds at Baltimore-Washington International Airport, Richmond, Norfolk, and Patuxent River reported in the ER are 8.9, 10.5, 7.9, and 9.3 mph, respectively. The monthly variation of wind speeds is similar at all four locations, with a maximum in about March and a minimum in the July-August time frame. While the patterns are similar, the differences in monthly average are consistent. Monthly average wind speeds at Richmond are about 30 percent higher than Calvert Cliffs, the wind speeds at Patuxent River are about 50 percent higher, and those at Norfolk are almost 75 percent higher.

2.9.1.2 Temperature

The temperature measured at the 33-ft level of the Calvert Cliffs meteorological tower is considered to be representative of the Calvert Cliffs site. Temperature data from the tower for the 2000 through 2005 time period show the monthly average temperatures range from a low of about 34°F in January to a high of about 75°F in July and August. Monthly-average maximum and minimum temperatures for the Calvert Cliffs site for 2000 through 2005 presented in the ER (UniStar 2009a) are consistent with the long-term climatological values for Baltimore. During the 6-year period, the minimum temperature was about 9°F, and the maximum temperature was 96°F.

2.9.1.3 Atmospheric Moisture

The only atmospheric moisture measurement made at the Calvert Cliffs site is precipitation. Hourly precipitation data are collected near the meteorology tower. The ER presents precipitation data for the years 2000 through 2005. The precipitation data for these years indicate that there is somewhat less precipitation and a larger seasonal variation in precipitation than at Baltimore and other locations in the area.

Neither humidity nor fog (visibility) is measured onsite. The ER lists both monthly mean relative humidity and monthly mean number of days with heavy fog for Baltimore-Washington International Airport, Richmond, and Norfolk. Monthly mean relative humidities for these locations average between 66 and 70 percent and have seasonal variations of about 10 to 15 percent. Monthly average relative humidity minima occur in April, and maxima occur in August and September. It is likely that the relative humidity at the Calvert Cliffs site is similar to the relative humidity presented in the ER.

Fog restricting visibility to less than 1/4 mi typically occurs on about 1 to 3 days per month at Baltimore-Washington International Airport, Richmond, and Norfolk. It is somewhat less frequent at Norfolk than at either of the other locations. Local conditions affect the formation of fog more than they do relative humidity and precipitation.

2.9.1.4 Atmospheric Stability

Atmospheric stability is a meteorological parameter that describes the dispersion characteristics of the atmosphere. It can be determined by the difference in temperature between two heights. A seven-category atmospheric stability classification scheme based on temperature differences is set forth in Regulatory Guide 1.23, Revision 1 (NRC 2007a). When the temperature decreases rapidly with height, the atmosphere is unstable and atmospheric dispersion is greater. Conversely, when temperature increases with height, the atmosphere is stable and dispersion is more limited.

Onsite temperature measurements at the 10- and 60-m level of the Calvert Cliffs meteorological tower are used to determine stability classes for the Calvert Cliffs site. On an annual basis, the atmosphere at the Calvert Cliffs site is unstable about 21.3 percent of the time, neutral about 34.3 percent of the time, and stable about 44.3 percent of the time. These percentages vary seasonally, with a larger frequency of both unstable and stable hours in summer and early fall months and a larger frequency of neutral conditions during the winter and early spring (UniStar 2009a).

2.9.1.5 Severe Weather

The Calvert Cliffs site can experience severe weather in several forms including thunderstorms, ice storms, hurricanes, and tornadoes. Thunderstorms occur on an average of about 28 days per year, with 90 percent of these days in the spring and summer (April through September). On average, hail is associated with several thunderstorms each year. Severe winter weather (heavy snow and ice) typically occurs several times per winter season.

Hurricanes rarely strike the Maryland coastal region. National Climatic Data Center records only list two strikes since 1851. However, on average of about once a year, a hurricane or tropical storm will come within 100 mi of the Maryland coast.

Since 1950, there have been 13 tornadoes reported in Calvert County. Based on statistics of tornadoes reported in the vicinity of the Calvert Cliffs site (Ramsdell and Rishel 2007), the staff estimates the probability of a tornado striking the Calvert Cliffs proposed Unit 3 reactor building to be about 1 in 10,000 (1×10^{-4}) per year.

2.9.2 Air Quality

The discussion on air quality includes the six common “criteria pollutants” for which the EPA has set national ambient air quality standards (ozone, particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxide, and lead). The air quality discussion also includes heat-trapping “greenhouse gases” (primarily carbon dioxide) which have been the principal factor causing climate change over the last 50 years (GCRP 2009).

The Calvert Cliffs site is in Calvert County, Maryland. Calvert County is in the Southern Maryland Intrastate Air Quality Control Region (40 CFR 81.156). With the exception of the 8-hour National Ambient Air Quality Standard for ozone, air quality in Calvert County is in attainment with or better than national standards for criteria pollutants. Emissions from new sources in attainment areas are evaluated by the State of Maryland through the Prevention of Significant Deterioration program. The NRC will comply with the requirements of the Clean Air Act (42 U.S.C. 7506) and air conformity regulation under 40 CFR 93.150 outside of the NEPA process.

Calvert County is in moderate nonattainment of the 8-hour ozone standard. In nonattainment areas, the emissions of pollutants that are precursors to ozone are regulated by the State of Maryland. The primary precursors to ozone are oxides of nitrogen (NO_x) and VOCs. In the State of Maryland, evaluation of new sources in nonattainment areas is through the nonattainment New Source Review Program (COMAR 2000).

There are no mandatory Class 1 Federal Areas where visibility is an important value in either Maryland or Delaware. The Class 1 Federal Areas closest to the Calvert Cliffs site are the Shenandoah National Park about 90 mi west of the site, the James River Face Wilderness Area about 150 mi west-southwest of the site in Virginia, and the Brigantine Wilderness Area about 120 mi northeast of the site in New Jersey.

Carbon dioxide concentration has been building up in the Earth’s atmosphere since the beginning of the industrial era in the mid-1700s, primarily due to the burning of fossil fuels (coal, oil, and natural gas) and the clearing of forests. Human activities have also increased the emissions of other greenhouse gases such as methane, nitrous oxide, and halocarbons. These emissions are thickening the blanket of heat-trapping gases in the Earth’s atmosphere, causing global surface temperatures to rise (GCRP 2009).

2.9.3 Atmospheric Dispersion

Atmospheric dispersion factors (χ/Q values) are used to evaluate the potential consequences of routine and accidental releases. Meteorological data of the period from 2000 through 2006 have been used by UniStar to develop a joint frequency distribution of wind speed, wind direction, and atmospheric stability to calculate the atmospheric dispersion factors for use in evaluating the consequences of normal reactor operations. UniStar used the AREVA NP

AEOLUS3 computer code for calculating both long-term dispersion factors for assessing the consequences of normal reactor operations and short-term dispersion factors for assessing the potential consequences of postulated design basis accidents.

Table 2-24 lists atmospheric dispersion and deposition factors for the location of the nearest residence within 5 mi in each downwind sector. These factors were calculated using the methodology of Regulatory Guide 1.111, Revision 1 (NRC 1977) assuming a mixed-mode release and building wake. Table 2-25 lists dispersion and deposition factors for the closest vegetable gardens within 5 mi. Atmospheric dispersion and deposition factors for all sectors to a distance of 50 mi listed in the ER (UniStar 2009a) are used to estimate potential population doses from normal reactor operations.

The AEOLUS3 code implements the methodology of Regulatory Guide 1.145, Revision 1 (NRC 1982) for calculation of atmospheric dispersion factors for evaluation of potential consequences of postulated design basis accidents. For environmental impact evaluation, realistic atmospheric dispersion factors are calculated for the exclusion area boundary and the outer boundary of the low population zone (LPZ). Realistic atmospheric dispersion factors are dispersion factors that are exceeded no more than 50 percent of the time. Table 2-26 lists the short-term dispersion factors for the Calvert Cliffs site for use in evaluating design basis accidents.

Table 2-24. Annual Average Atmospheric Dispersion and Deposition Factors for the Nearest Residence for Evaluation of Normal Effluents

Downwind Sector	Distance (m)	Undecayed, Undepleted χ/Q (s/m^3)[(a)]	Decayed, Depleted χ/Q (s/m^3)[(b)]	Undecayed, Undepleted Gamma χ/Q (s/m^3)[(c)]	D/Q (1/m2)[(d)]
SE	1574	8.7×10^{-07}	7.9×10^{-07}	6.6×10^{-07}	8.2×10^{-09}
SSE	1969	3.5×10^{-07}	3.2×10^{-07}	2.8×10^{-07}	3.0×10^{-09}
S	2206	3.7×10^{-07}	3.4×10^{-07}	2.9×10^{-07}	4.1×10^{-09}
SW	1945	4.0×10^{-07}	3.7×10^{-07}	3.2×10^{-07}	4.3×10^{-09}
WSW	1634	4.3×10^{-07}	4.0×10^{-07}	3.7×10^{-07}	4.1×10^{-09}
W	2074	2.1×10^{-07}	2.0×10^{-07}	1.9×10^{-07}	1.5×10^{-09}
WNW	2485	1.1×10^{-07}	9.9×10^{-08}	1.0×10^{-07}	6.8×10^{-10}
NW	4097	5.7×10^{-08}	5.2×10^{-08}	4.9×10^{-08}	3.3×10^{-10}

Source: UniStar 2009a
(a) ER Table 2.7-101
(b) ER Table 2.7-105
(c) ER Table 2.7-109
(d) ER Table 2.7-113

Table 2-25. Annual Average Atmospheric Dispersion and Deposition Factors for the Nearest Vegetable Gardens for Evaluation of Normal Effluents

Downwind Sector	Distance (m)	Undecayed, Undepleted χ/Q (s/m^3)[(a)]	Decayed, Depleted χ/Q (s/m^3)[(b)]	Undecayed, Undepleted Gamma χ/Q (s/m^3)[(c)]	D/Q ($1/m^2$)[(d)]
SE	1574	8.7×10^{-07}	7.9×10^{-07}	6.6×10^{-07}	8.2×10^{-09}
SSE	2130	3.1×10^{-07}	2.8×10^{-07}	2.4×10^{-07}	2.5×10^{-09}
S	2206	3.7×10^{-07}	3.4×10^{-07}	2.9×10^{-07}	4.1×10^{-09}
SW	2256	3.0×10^{-07}	2.8×10^{-07}	2.4×10^{-07}	3.1×10^{-09}
WSW	1634	4.3×10^{-07}	4.0×10^{-07}	3.7×10^{-07}	4.1×10^{-09}
W	2529	1.5×10^{-07}	1.4×10^{-07}	1.3×10^{-07}	9.5×10^{-10}
WNW	2795	8.8×10^{-08}	8.2×10^{-08}	8.5×10^{-08}	5.3×10^{-10}
NW	4097	5.7×10^{-08}	5.2×10^{-08}	4.9×10^{-08}	3.3×10^{-10}

Source: UniStar 2009a
(a) ER Table 2.7-102.
(b) ER Table 2.7-106.
(c) ER Table 2.7-110.
(d) ER Table 2.7-114.

Table 2-26. Atmospheric Dispersion Factors for Calvert Cliffs Design Basis Accident Calculations

Time Period	Boundary	χ/Q (s/m^3)
Worst 2 hours[(a)]	Exclusion area boundary	8.08×10^{-5}
Worst 2 hours	Low population zone	1.53×10^{-5}
0 to 8 hours[(b)]	Low population zone	1.18×10^{-5}
8 to 24 hours[(b)]	Low population zone	9.39×10^{-6}
1 to 4 days[(b)]	Low population zone	6.61×10^{-6}
4 to 30 days[(b)]	Low population zone	3.99×10^{-6}

Source: UniStar 2009a
(a) Period of maximum 2-hour release to the environment.
(b) Times are relative to beginning of the release to the environment.

UniStar provided the staff with meteorological data for the 7-year period from January 2000 through December 2006 (UniStar 2009a). The staff used these data to independently estimate atmospheric dispersion factors for the site. Based on its evaluation of the meteorological data and the results of its dispersion calculations, the staff accepts the UniStar dispersion factors listed in Table 2-24, Table 2-25, and Table 2-26.

2.9.4 Meteorological Monitoring

Onsite meteorological measurements began at the Calvert Cliffs site to support the applications for construction permits for CCNPP Units 1 and 2. These measurements, which include wind speed and direction and atmospheric stability, continue in support of operations of the existing units. The meteorological instrumentation was updated in December 2005.

The tower is located in an open field approximately 2900 ft west of the planned location of the proposed Unit 3 reactor building. In the current system, wind and temperature measurements are made at 10 and 60 m above ground on an open-lattice tower. In addition, the precipitation is measured near the tower using a tipping-bucket rain gage, and atmospheric pressure is measured in a meteorological building near the tower. The meteorological measurement system does not include instruments for measuring humidity. According to UniStar (ER Section 6.4.1.3), the tower and meteorological instrument specifications meet the guidance set forth in Revision 1 of Regulatory Guide 1.23 (NRC 2007a).

Signals from the meteorological instruments are routed to two data loggers in the meteorology building for processing. Data processing includes calculation of 15-minute and hourly averages of wind speed, wind direction, and temperature. In addition, the system calculates the standard deviation of wind direction fluctuations and the temperature difference between 10 and 60 m. The meteorological instruments are checked daily and calibrated semi-annually (ER, Section 6.4.2.4).

The review team viewed the meteorological site and instrumentation, reviewed the available information on the meteorological measurement program, and evaluated data collected by the program. Based on this information, the review team concludes that the program provides data that represent the onsite meteorological conditions for the purposes of the review team's environmental review and that the data also provide a reasonable basis for making estimates of atmospheric dispersion for the evaluation of the consequences of routine and accidental releases for the environmental review.

2.10 Nonradiological Health

This section describes aspects of the environment at the Calvert Cliffs site and within the vicinity of the site associated with nonradiological human health impacts. The section provides the basis for evaluation of impacts to human health from building and operation of proposed Unit 3. Building activities have the potential to affect public and occupational health, create impacts from noise, and impact health of the public and workers from transportation of construction materials and personnel to the Calvert Cliffs site. Operation of proposed Unit 3 has the potential to impact the public and workers at the Calvert Cliffs site from operation of the cooling system, noise generated by operations, electromagnetic fields (EMF) generated by transmission systems, and transportation of operations and outage workers to and from the Calvert Cliffs site.

2.10.1 Public and Occupational Health

This section describes public and occupational health at the Calvert Cliffs site and vicinity associated with air quality, occupational injuries, and etiological agents (i.e., disease causing microorganisms).

2.10.1.1 Air Quality

Public and occupational health can be impacted by changes in air quality from activities that contribute to fugitive dust, vehicle and equipment exhaust emissions, and automobile exhaust from commuter traffic (NRC 1996). Air quality for Calvert County is discussed in Section 2.9.2. Fugitive dust and other particulate material (including PM_{10} (particulate matter less than 10 microns in size) and $PM_{2.5}$) can be released into the atmosphere during any site excavations and while grading is being conducted. Most of these activities that generate fugitive dust are short in duration, over a small area, and can be controlled using watering, application of soil adhesives, seeding, and other BMPs (UniStar 2009a). Mitigation measures to minimize and control fugitive dust are required for compliance with all Federal, State, and local regulations that govern such activities (NRC 1996; UniStar 2009a).

Exhaust emissions during normal plant operations associated with onsite vehicles and equipment as well as from commuter traffic can affect air quality and human health. Nonradiological supporting equipment (e.g., diesel generators, fire pump engines) and other nonradiological emission-generating sources (e.g., storage tanks) or activities are not expected to be a significant source of criteria pollutant emissions. Diesel generators and supporting equipment would be in place for emergency-use only but would be started regularly to test that the systems are operational. Emissions from nonradiological air pollution sources were permitted for proposed Unit 3 by the Maryland Public Service Commission on June 26, 2009 (see Appendix H). UniStar will also need to obtain a Clean Air Act Title V permit from the MDE to comply with Code of Maryland Regulations 26.11.03 and 20.79.03.02.B(2)(c). The infrequent emissions from the emergency diesel generators for Unit 3 are not expected to significantly impact ambient air quality levels at the Calvert Cliffs site or in the vicinity of the site.

2.10.1.2 Occupational Injuries

In general, occupational health risks to workers and onsite personnel engaged in activities such as building, maintenance, testing, excavation, and modifications are expected to be dominated by occupational injuries (e.g., falls, electric shock, asphyxiation) or occupational illnesses. Historically, actual injury and fatality rates at nuclear reactor facilities have been lower than the average U.S. industrial rates. According to the U.S. Bureau of Labor Statistics

(USBLS 2007a, b), injury rates drop significantly for large building projects such as nuclear power facilities (e.g., for the years 2003 to 2007, the overall injury-only rate for utility system building activities ranged from 4.6 percent to 6.7 percent compared to 1.2 percent to 3.0 percent for similar projects with 1000 or more workers) (USBLS 2008a, b). These records of statistics are used to estimate the likely number of occupational injuries and illnesses for operation of Units 1 and 2 and predict the likely number of cases for the proposed Unit 3.

Occupational injury and fatality risks are reduced by strict adherence to NRC and Occupational Safety and Health Administration (OSHA) safety standards, practices, and procedures to minimize worker exposures. Appropriate State and local statues also must be considered when assessing the occupational hazards and health risks associated with the Calvert Cliffs site. Currently, the Calvert Cliffs site has programs and personnel to promote safe work practices and respond to occupational injuries and illnesses for Units 1 and 2. Procedures are in place with the objective to provide personnel who work at the Calvert Cliffs site with an effective means of preventing accidents due to unsafe conditions and unsafe acts. They include safe work practices to address hearing protection; confined space entry; personal protective equipment; heat stress; electrical safety; ladders; chemical handling, storage, and use; and other industrial hazards. Personnel are provided training on safety procedures. In addition, UniStar requires contractors to develop and implement safety procedures with the intent of preventing injuries, occupational illnesses, and deaths (UniStar 2009a).

2.10.1.3 Etiological Agents

Public and occupational health can be compromised by activities at the Calvert Cliffs site that encourage the growth of disease causing microorganisms (etiological agents). Thermal discharges from Units 1 and 2 into the Chesapeake Bay have the potential to increase the growth of thermophilic microorganisms. The types of organisms of concern include enteric pathogens (such as *Salmonella* spp. and *Pseudomonas aerugionsa*), thermophilic fungi, bacteria (such as *Legionella* spp. and *Vibrio* spp.), and free-living amoeba (such as *Naegleria fowleri*). These microorganisms could result in potentially serious human health concerns, particularly at high exposures levels. It is important to note that *N. fowleri* is typically found in freshwater systems and is not likely to occur in the saline waters of the Chesapeake Bay.

Available data assembled by the U.S. Centers for Disease Control and Prevention (CDC) for the years 1937 to 2007 report no occurrence of a waterborne disease from exposure to *N. fowleri* or other reported waterborne disease in Maryland (CDC 1998a, 2000, 2002a, 2004a, 2006a, 2007, 2008a, 2008b). Outbreaks of *Legionellosis, Salmonellosis*, or *Shigellosis*, which occurred in Maryland from 1996 to 2006, were within the range of national trends (CDC 1997, 1998b, 1999, 2001, 2002b, 2003, 2004a, 2004b, 2005, 2006b) in terms of cases per 100,000 population or total cases per year, and the outbreaks were associated with recreational waters.

2.10.2 Noise

The State of Maryland regulates the maximum noise level in residential areas. During the day (7 a.m. to 10 p.m.), the maximum noise level is 65 dBA, and, at night, it is 55 dBA. Decibels are the unit of measure of sound. Tipler (1982) lists the following typical sound levels: quiet office 50 dBA, normal conversation 60 dBA, busy traffic 70 dBA, and noisy office with office machines 80 dBA. Changes in noise level of less than 3 dBA are generally not noticeable, and an increase in noise level is generally perceived as doubling the volume.

A noise survey was conducted on and around the Calvert Cliffs site in November 2006 and again in August 2007 to determine ambient noise levels. The results of this survey are presented in the ER (UniStar 2009a). The results of the November 2006 survey and second August 2007 survey are described in a UniStar submission to the Maryland DNR (UniStar 2007). These results establish a background noise level for the area in the vicinity of the proposed Unit 3 site.

In these surveys, measurements were made at eight locations, one location near CCNPP Units 1 and 2, four locations near the site boundary, and three locations farther offsite. The average noise level for the 24-hour period with the lowest wind speed near Units 1 and 2 was about 65 dBA, as was the noise level near MD State Route 2/4, which runs along the western boundary of the site. The noise level near an offsite saw mill averaged about 60 dBA, and the noise level in a residential area averaged about 55 dBA. The noise levels at the remaining, more isolated measurement locations were about 50 dBA.

2.10.3 Transportation

The highway transportation network in the vicinity of the Calvert Cliffs site is shown in Figure 2-1. The sole access road to the Calvert Cliffs site for CCNPP Units 1 and 2 operations workers, construction and operations workers for Unit 3, and construction material deliveries is MD State Road 2/4, approximately 2 mi west of the site. Various feeder roads would be used by construction and operations personnel to access MD State Road 2/4 on the way to the Calvert Cliffs site. According to the ER (UniStar 2009a), a new access road that connects directly to MD State Road 2/4 at Nursery Road, south of the proposed new unit, would be built to ease congestion cause by construction personnel traffic. There is no rail service to the Calvert Cliffs site, and there are no rail depots in Calvert County (UniStar 2009a) where the proposed Unit 3 would be located. The Calvert Cliffs site includes a barge dock that is used for offloading large equipment items.

2.10.4 Electromagnetic Fields

Transmission lines generate both electric and magnetic fields, referred to collectively as EMF. Public and worker health can be compromised by acute and chronic exposure to EMF from power transmission systems, including switching stations (or substations) onsite and transmission lines connecting the plant to the regional electrical distribution grid. Transmission lines operate at a frequency of 60 Hz (60 cycles per second), which is considered to be extremely low frequency (ELF). In comparison, television transmitters have frequencies of 55 to 890 MHz, and microwaves have frequencies of 1000 MHz and greater (NRC 1996).

Electric shock resulting from direct access to energized conductors or from induced charges in metallic structures is an example of an acute effect from EMF associated with transmission lines (NRC 1996). Objects near transmission lines can become electrically charged by close proximity to the electric field of the line. An induced current can be generated in such cases, where the current can flow from the line through the object into the ground. Capacitive charges can occur in objects that are in the electric field of a line, storing the electric charge, but isolated from the ground. A person standing on the ground can receive an electric shock from coming into contact with such an object because of the sudden discharge of the capacitive charge through the person's body to the ground. Such acute effects are controlled and minimized by conformance with National Electrical Safety Code (NESC) criteria. UniStar stated that all new transmission lines would be contained within the Calvert Cliffs property lines. Finally, UniStar stated that the design and building of the proposed Unit 3 substation and transmission circuits would comply with NESC provisions that limit the induced current due to electrostatic effects to 5 milliamperes (mA).

Long-term or chronic exposure to power transmission lines has been studied for a number of years. These health effects were evaluated in the GEIS (NRC 1996) for nuclear power in the U.S., and are discussed in the ER (UniStar 2009a). The GEIS (NRC 1996) reviewed human health and EMF and concluded:

> The chronic effects of electromagnetic fields (EMFs) associated with nuclear plants and associated transmission lines are uncertain. Studies of 60-Hz EMFs have not uncovered consistent evidence linking harmful effects with field exposures. EMFs are unlike other agents that have a toxic effect (e.g., toxic chemicals and ionizing radiation) in that dramatic acute effects cannot be forced and longer-term effects, if real, are subtle. Because the state of the science is currently inadequate, no generic conclusion on human health impacts is possible.

2.11 Radiological Environment

A radiological environmental monitoring program (REMP) has been conducted around the Calvert Cliffs site since before operations began in late 1974. This program measures radiation and radioactive materials from all sources, including existing Units 1 and 2. The REMP includes the following pathways: direct radiation; atmospheric, aquatic, and terrestrial environments; and groundwater and surface water. A pre-operational environmental monitoring program was conducted before 1975 to establish a baseline to observe fluctuations of radioactivity in the environment after operations began. After routine operation of CCNPP Unit 1 and Unit 2 started in 1975 and 1977, respectively, the monitoring program continued to assess the radiological impacts to workers, the public, and the environment.

The results of this monitoring are documented in annual reports entitled *Annual Radiological Environmental Operating Report for the Calvert Cliffs Nuclear Power Plant Units 1 and 2 and the Independent Spent Fuel Storage Installation* (Constellation 2003a, 2004a, 2005a, 2006a, 2007a) and *Radioactive Effluent Release Report and Dose Assessment* (Constellation 2003b, 2004b, 2005b, 2006b, 2007b) for the Calvert Cliffs site. These reports show that exposures or concentrations in air, water, and vegetation are comparable to, if not statistically indiscernible from, pre-operational levels.

Constellation (2005b) reported one event in which tritium was detected in shallow groundwater. In December 2005 during routine monitoring of CCNPP Units 1 and 2, tritium was detected in a groundwater piezometer (#11). On four sampling dates in December 2005, concentrations ranged from 1720 to 2880 pCi/L. On the next seven sample dates, which occurred between January 19 and May 16, 2006, tritium was not detected above the nominal detection limit of about 1500 pCi/L. For context, the drinking water standard for tritium is 20,000 pCi/L (41 FR 28402). The observation of tritium in piezometer #11 in December 2005 was attributed to liquid radioactive waste that was inadvertently discharged through a previously ruptured underground pipe sometime prior to April 2001 when the pipe was repaired to prevent further discharges (NRC 2006a).

The NRC’s Lessons Learned Task Force Report (NRC 2006b) made recommendations regarding potential unmonitored groundwater contamination at U.S. nuclear plants. Constellation Energy Group implemented additional groundwater sampling in various locations that may be a source of groundwater contamination around CCNPP Units 1 and 2. The results of this additional groundwater sampling are summarized in the Annual Radioactive Effluent Release Report for 2007 (Constellation 2007b).

2.12 Related Federal Projects and Consultations

The staff reviewed the possibility that activities of other Federal agencies might impact the issuance of a COL to UniStar for proposed Unit 3. Any such activities could result in cumulative environmental impacts and the possible need for another Federal agency to become a cooperating agency for preparation of the EIS (10 CFR 51.10(b)(2)). After reviewing the Federal activities in the region surrounding the Calvert Cliffs site, the staff determined that it would be advantageous for the Corps to become a cooperating agency for preparation of the EIS.

Given the proximity of the Calvert Cliffs site to Washington, D.C., there are numerous Federal lands within a 50-mi radius of the site including several Department of Defense facilities and the Blackwater National Wildlife Refuge. There are no wilderness areas or rivers included in the national wild and scenic rivers system within the 50-mi region. The closest Native American Tribal reservations are more than 50 mi from the Calvert Cliffs site.

The NRC is required under section 102(2)(C) of NEPA to consult with and obtain the comments of any Federal agency that has jurisdiction by law or special expertise with respect to any environmental impact involved in the subject matter of the EIS. During the course of preparing this EIS, the NRC consulted with various other Federal agencies, Tribal contacts, and State and local agencies. Key consultation correspondence is included in Appendix F.

2.13 References

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

33 CFR Part 328. Code of Federal Regulations, Title 33, *Navigation and Navigable Waters*, Part 328, "Definition of Waters of the United States."

36 CFR Part 800. Code of Federal Regulations, Title 36, *Parks, Forests, and Public Propert*y, Part 800. "Protection of Historic Properties."

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

40 CFR Part 93. Code of Federal Regualtions. Title 40, *Protection of Environment*, Part 93, "Determining Conformity of Federal Actions to State or Federal Implementation Plans."

50 CFR Part 17. Code of Federal Regulations, Title 50, *Wildlife and Fisheries*, Part 17, "Endangered and Threatened Wildlife and Plants."

41 FR 28402. July 9, 1976. "Drinking Water Regulations: Radionuclides." *Federal Register*. U.S. Environmental Protection Agency.

55 FR 32088. August 7, 1990. "Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the Puritan Tiger Beetle and the Northeastern Beach Tiger Beetle." *Federal Register*. U.S. Department of the Interior.

59 FR 7629. February 16, 1994. "Executive Order 12898 of February 11, 1994; Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." Executive Order 12898. *Federal Register*. Office of the President.

69 FR 52040. August 24, 2004. "Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions." *Federal Register*. U.S. Nuclear Regulatory Commission.

72 FR 4967. February 2, 2007. "Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition to List the American Eel as Threatened or Endangered." *Federal Register*. U.S. Department of the Interior.

72 FR 35388. June 27, 2007. "Endangered and Threatened Wildlife and Plants; Finding on Whether to List Eastern Oyster as a Threatened or Endangered Species." *Federal Register*. U.S. Department of Commerce.

72 FR 67712. November 30, 2007. "Endangered and Threatened Species; Initiation of a Status Review for Shortnose Sturgeon." *Federal Register*. U.S. Department of Commerce.

73 FR 3991. January 23, 2008. "Endangered and Threatened Wildlife and Plants; Initiation of 5-year Reviews of 10 Listed Species." *Federal Register.* U.S. Department of the Interior.

74 FR 66496. December 15, 2009. "Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act." *Federal Register.* U.S. Environmental Protection Agency.

Abbe, G.R. 1973. "Catches of the Blue Crab (*Callinectes sapidus*) from 1968 to 1971 in the Area of Calvert Cliffs, Maryland." *Proceedings of the Academy of Natural Sciences of Philadelphia* 125(6):89-120.

Abbe, G.R. 1988. "Population Structure of the American Oysters (*Crassostrea virginica*) on an Oyster Bar in Central Chesapeake Bay: Changes Associated with Shell Planting and Increased Recruitment." *Journal of Shellfish Research* 7(1):33-40.

Abbe, G.R. 1992. "Population Structure of the Eastern Oyster (*Crassostrea virginica*) (Gmelis, 1971), on Two Oyster Bars in Central Chesapeake Bay: Further Changes Associated with Shell Plating, Recruitment and Disease." *Journal of Shellfish Research* 11(2):421-430.

Abbe, G.R. 2002. "Decline in Size of Male Blue Crabs (*Callinectes sapidus*) from 1968 to 2000 near Calvert Cliffs, Maryland." *Estuaries* 25(1):105-114.

Abbe, G.R. and C. Stagg. 1996. "Trends in Blue Crab (*Callinectes sapidus* Rathbun) Catches near Calvert Cliffs, Maryland, from 1968 to 1995 and Their Relationships to the Maryland Commercial Fishery." *Journal of Shellfish Research* 15(3):751-758.

Able, K.W. and S.M. Hagan. 2003. "Impact of Common Reed, *Phragmites australis*, on Essential Fish Habitat: Influence on Reproduction, Embryological Development, and Larval Abundance of the Mummichog (*Fundulus hereoclitus*)." *Estuaries* 26(1):20-50.

Aguilar, R., A.H. Hines, T.G. Wolcott, D.L. Wolcott, M.A. Kramer, and R.N. Lipcius. 2005. "The Timing and Route of Movement and Migration of Post-Copulatory Female Blue Crabs (*Callinectes sapidus Rathbun*) from the Upper Chesapeake Bay." *Journal of Experimental Marine Biology and Ecology* 319(1-2):117-128.

Alexander, R.B., E.W. Boyer, R.A. Smith, G.E. Schwarz, and R.B. Moore. 2007. "The Role of Headwater Streams in Downstream Water Quality." *Journal of the American Water Resources Association* 43(1):41-59.

Atlantic States Marine Fisheries Commission (ASMFC). 2006a. "Species Profile: American Eel, Management Program Seeks to Improve Our Understanding of Species Through Data Collection." *ASMFC Fisheries Focus* 15(9):4-6.

Atlantic States Marine Fisheries Commission (ASMFC). 2006b. *2006 Stock Assessment Report for Atlantic Menhaden.* Prepared by the Atlantic Menhaden Technical Committee for the Atlantic Menahden Management Board, Washington, D.C. Available at: http://www.asmfc.org/speciesDocuments/menhaden/reports/stockAssessments/2006StockAssessmentReport.pdf.

Atlantic States Marine Fisheries Commission (ASMFC). 2006c. "Species Profile Bluefish Joint Plan Seeks to Restore Premier Fighting Fish." *ASMFC Fisheries Focus* 15(4):1-2.

Atlantic States Marine Fisheries Commission (ASMFC). 2006d. "Species Profile: Red Drum Amendment Seeks to Increase Recruitment and Protect Reproductive Adults." *ASMFC Fisheries Focus* 15(1):1-3.

Atlantic States Marine Fisheries Commission (ASMFC). 2006e. *2006 Weakfish Stock Assessment, Terms of Reference and Advisory Report, Technical Committee Supplemental Material*. Prepared by the ASMFC Weakfish Stock Assessment Subcommittee, Washington, D.C. Available at: http://www.asmfc.org/speciesDocuments/weakfish/stockassessmentreports/2006WeakfishStockAssessment.pdf.

Atlantic States Marine Fisheries Commission (ASMFC). 2006f. *Spot* (Leiostomus xanthurus) – *Life History and Habitat Needs*. Available at http://www.asmfc.org.

Atlantic States Marine Fisheries Commission (ASMFC). 2007a. "Species Profile: Atlantic Croaker Amendment Seeks to Maintain Healthy Mid-Atlantic Stock Component." *ASMFC Fisheries Focus* 16(3):1-3.

Atlantic States Marine Fisheries Commission (ASMFC). 2007b. "Species Profile: Spot Popular South Atlantic Stock Benefits from Bycatch Reduction Efforts." *ASMFC Fisheries Focus* 14(4/5):1-2.

Atlantic States Marine Fisheries Commission (ASMFC). 2007c. "Species Profile: Weakfish the Challenge of Managing a Stock Decline When Fishing Is Not the Cause." *ASMFC Fisheries Focus* 16(4):1-3.

Atlantic States Marine Fisheries Commission (ASMFC) 2007d. "Species Profile: Shad and River Herring Atlantic States Seek to Improve Knowledge of Stock Status and Protect Populations Coastwide." *ASMFC Fisheries Focus* 16(8):1-4.

Atlantic Sturgeon Status Review Team. 2007. *Status Review of Atlantic Sturgeon* (Acipenser oxyrinchus oxyrinchus). Prepared for the National Marine Fisheries Service, Northeast Regional Office, Gloucester, Massachusetts. Accession No. ML090780577.

Atwood, T.C., H.P. Weeks, and T.M. Gehring. 2004. "Spatial Ecology of Coyotes Along a Suburban-to-Rural Gradient." *Journal of Wildlife Management* 68(4):1000-1009.

Aznar, J.C. and A. Desrochers. 2008. "Building for the Future: Abandoned Beaver Ponds Promote Bird Diversity." *Ecoscience* 15(2):250-257.

Bald and Golden Eagle Protection Act. 1992. 16 U.S.C. 688 et seq.

Baltimore Gas and Electric Company (BGE). 1971. *Supplement to Environmental Report Calvert Cliffs Nuclear Power Plant*. Baltimore, Maryland.

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition*. EPA 841-B-99-002, U.S. Environmental Protection Agency, Washington, D.C.

Baxter, C.V., K.D. Fausch, and W.C. Saunders. 2005. "Tangled Webs: Reciprocal Flows of Invertebrate Prey Link Streams and Riparian Zones." *Freshwater Biology* 50(2):201-220.

Bilyard, G.R. 1987. "The Value of Benthic Infauna in Marine Pollution Monitoring Studies." *Marine Pollution Bulletin* 18(11):581-585.

Bishop, J.W. 1972. "Ctenophores of the Chesapeake Bay." *Chesapeake Science,* 13(Supplement 1): S98-S100.

Bjorndal, K. A., A.B. Bolten, and H.R. Martins. 2000. "Somatic Growth Model of Juvenile Loggerhead Sea Turtles *Caretta caretta*: Duration of Pelagic Stage." *Marine Ecology Progress Series* 202:265-272.

Bowers, H.A., T.M. Trice, R.E. Magnien, D.M. Goshorn, B. Michael, E.F. Schaefer, P.A. Rublee, and D.W. Oldach. 2006. "Detection of *Pfiesteria* spp. by PCR in Surface Sediments Collected from Chesapeake Bay Tributaries (Maryland)." *Harmful Algae* 5(4):342-351.

Boyle, S. and S. Owens. 2007. *North American Beaver (*Castor canadensis*): A Technical Conservation Assessment.* Prepared by BIO-logic Environmental for the U.S. Department of Agriculture Forest Service, Rocky Mountain Region, Montrose, Colorado. Available at http://www.fs.fed.us/r2/projects/scp/assessments/northamericanbeaver.pdf.

Breitburg, D.L. and R.S. Fulford. 2006. "Oyster-Sea Nettle Interdependence and Altered Control within the Chesapeake Bay Ecosystem." *Estuaries and Coasts* 29(5):776-784.

Broderick, A.C., R. Frauenstein, F. Glen, G.C. Hays, A.L. Jackson, T. Pelembe, G.D. Ruxton, and B.J. Godley. 2006. "Are Green Turtles Globally Endangered?" *Global Ecology and Biogeography* 15(1):21-26.

Buchman, M.F. 2008. *NOAA Screening Quick Reference Tables (SQuiRTs)*. National Oceanic and Atmospheric Administration, Office of Response and Restoration Report 08-1, Seattle, Washington.

Byrne, D.M. 1978. "Life History of the Spotfin Killifish, *Fundulus luciae* (Pisces: cyprinodontidae), in Fox Creek Marsh, Virginia." *Estuaries* 1(4):211-227.

Cadenasso, M.L. and S.T.A. Pickett. 2000. "Linking Forest Edge Structure to Edge Function: Mediation of Herbivore Damage." *Journal of Ecology* 88:31-44.

Cahoon, D.R. 2007. "Chapter 12: Factors Affecting Coastal Wetland Loss and Restoration." In *Synthesis of U.S. Geological Survey Science for the Chesapeake Bay Ecosystem and Implications for Environmental Management*, S.W. Phillips, ed. U.S. Geological Survey Circular 1316, USGS, Reston, Virginia.

Calvert County. 2006. *Calvert County Zoning Ordinance*. Accessed November 3, 2008 at http://www.co.cal.md.us/government/departments/planning/2006zoningordinance/.

Calvert County. 2008. *Calvert County Comprehensive Water & Sewerage Plan 2008*. Accessed on October 26, 2009 at http://www.co.cal.md.us/business/planning/documents/2008watersewerplan/.

Calvert County Board of County Commissioners (CCBCC). 2006. *Calvert County Land Preservation, Parks and Recreation Plan*. Accessed June 19, 2008 at http://www.co.cal.md.us/assets/Planning_Zoning/PDF_Files/AdoptedOpenSpacePlan.pdf.

Calvert County Comprehensive Plan (CCCP). 2004. 2*004 Comprehensive Plan; Calvert County, Maryland*. Accessed August 8, 2008 at http://www.co.cal.md.us/government/departments/planning/comprehensiveplan/.

Calvert County Department of Finance and Budget (CC DF&B). 2007. *Calvert County, Maryland, Comprehensive Annual Financial Report*. Accessed August 8, 2008 at http://www.co.cal.md.us/assets/Finance/2007cafr.pdf.

Calvert County Office of Transportation (CCOT). 2007. *Calvert County Office of Transportation*. Accessed November 19, 2008 at http://www.co.cal.md.us/residents/transportation/.

Calvert County Public Schools (CCPS). 2008. *Calvert County Public Schools*. Accessed December 2, 2008 at http://www.calvertnet.k12.md.us/.

Carver, A. M., T.G. Wolcott, D.L. Wolcott, and A.H. Hines. 2005. "Unnatural Selection: Effects of a Male-Focused Size-Selective Fishery on Reproductive Ppaotential of a Blue Crab Population." *Journal of Experimental Marine Biology and Ecology* 319:29-41.

Centers for Disease Control and Prevention (CDC). 1997. "Summary of Notifiable Diseases, United States 1996." *Morbidity and Mortality Weekly Report* 45(53):1-88.

Centers for Disease Control and Prevention (CDC). 1998a. "Surveillance for Waterborne-Disease Outbreaks – United States, 1995–1996." *Morbidity and Mortality Weekly Report* 47(SS-5):1-72.

Centers for Disease Control and Prevention (CDC). 1998b. "Summary of Notifiable Diseases, United States, 1997." *Morbidity and Mortality Weekly Report* 46(54):1-87.

Centers for Disease Control and Prevention (CDC). 1999. "Summary of Notifiable Diseases, United States, 1998." *Morbidity and Mortality Weekly Report* 47(53):1-93.

Centers for Disease Control and Prevention (CDC). 2000. "Surveillance for Waterborne-Disease Outbreaks – United States, 1997–1998." *Morbidity and Mortality Weekly Report* 49(SS-4):1-36.

Centers for Disease Control and Prevention (CDC). 2001. "Summary of Notifiable Diseases, United States 1999." *Morbidity and Mortality Weekly Report* 48(53):1-104.

Centers for Disease Control and Prevention (CDC). 2002a. "Surveillance for Waterborne-Disease Outbreaks – United States, 1999–2000." *Morbidity and Mortality Weekly Report* 51(SS-8):1-48.

Centers for Disease Control and Prevention (CDC). 2002b. "Summary of Notifiable Diseases – United States, 2000." *Morbidity and Mortality Weekly Report* 49(53):1-102.

Centers for Disease Control and Prevention (CDC). 2003. "Summary of Notifiable Diseases – United States, 2001." *Morbidity and Mortality Weekly Report* 50(53):1-108.

Centers for Disease Control and Prevention (CDC). 2004a. "Surveillance for Waterborne Disease and Outbreaks Associated with Recreational Water – United States, 2001–2002; and Surveillance for Waterborne Disease and Outbreaks Associated with Drinking Water and Water not Intended for Drinking — United States, 2001–2002." *Morbidity and Mortality Weekly Report* 53(SS-8):1-45.

Centers for Disease Control and Prevention (CDC). 2004b. "Summary of Notifiable Diseases – United States, 2002." *Morbidity and Mortality Weekly Report* 51(53):1-84.

Centers for Disease Control and Prevention (CDC). 2005. "Summary of Notifiable Diseases – United States, 2003." *Morbidity and Mortality Weekly Report* 52(54):1-85.

Centers for Disease Control and Prevention (CDC). 2006a. "Surveillance for Waterborne Disease and Outbreaks Associated with Recreational Water – United States, 2003–2004; and Surveillance for Waterborne Disease and Outbreaks Associated with Drinking Water and Water not Intended for Drinking — United States, 2003–2004." *Morbidity and Mortality Weekly Report* 55(SS-12):1-65.

Centers for Disease Control and Prevention (CDC). 2006b. "Summary of Notifiable Diseases – United States, 2004." *Morbidity and Mortality Weekly Report* 53(53):1-79.

Centers for Disease Control and Prevention (CDC). 2007. "Summary of Notifiable Diseases – United States, 2005." *Morbidity and Mortality Weekly Report* 54(53):2-92.

Centers for Disease Control and Prevention (CDC). 2008a. "Summary of Notifiable Diseases – United States, 2006." *Morbidity and Mortality Weekly Report* 55(53):1-94.

Centers for Disease Control and Prevention (CDC). 2008b. "Primary Amebic Meningoencephalitis — Arizona, Florida, and Texas, 2007." *Morbidity and Mortality Weekly Report* 57(21):573-596.

Centers for Disease Control and Prevention (CDC). 2008c. *Learn About Lyme Disease*. Accessed December 29, 2007 at http://www.cdc.gov/ncidod/dvbid/lyme/index.htm. Accession No. ML100490737.

Cerco, C.F. and M.R. Noel. 2007. “Can Oyster Restoration Reverse Cultural Eutrophication in Chesapeake Bay?” *Estuaries and Coasts* 30(2):331-343.

Chang, S., P.L. Berrien, D.L. Johnson, and W.W. Morse. 1999. *Essential Fish Habitat Source Document: Windowpane,* Scophthalmus aquosus*, Life History and Habitat Characteristics*. NOAA Technical Memorandum NMFS-NE-137. National Marine Fisheries Service, Woods Hole, Massachusetts. Accession No. ML072070389.

Chesapeake Bay Ecological Foundation, Inc. (CBEF). 2006. *Chesapeake Bay Ecological Foundation, Inc. – 2008 Ecological Depletion of Atlantic Menhaden Effects on Atlantic Coast Striped Bass*. Accessed February 15, 2008 at http://www.chesbay.org/articles/latest.asp.

Chesapeake Bay Program. 2008a. *Habitats, Forests*. Accessed February 5, 2008 at http://www.chesapeakebay.net/habitats.htm.

Chesapeake Bay Program. 2008b. *Habitats, Wetland*s. Accessed February 5, 2008 at http://www.chesapeakebay.net/habitats.htm.

Chesapeake EcoCheck. 2007. *Reporting Region Summary: 2007, Mid Bay, Health Report Card*. Accessed September 29, 2008 at http://www.eco-check.org lreportcard/chesapeake/2007/summaries/mid _bay.

Claggett, P.R. 2007. “Chapter 2: Human Population Growth and Land-Use Change.” In *Synthesis of U.S. Geological Survey Science for the Chesapeake Bay Ecosystem and Implications for Environmental Management*, S.W. Phillips, ed. U.S. Geological Survey Circular 1316, USGS, Reston, Virginia.

Clean Air Act. 42 U.S.C. 7401 et seq.

Clean Water Act. 33 U.S.C. 1251, et seq. (also referred to as the Federal Water Pollution Control Act [FWPCA]).

Coastal Zone Management Act (CZMA) of 2006. 16 U.S.C. 1451 et seq.

COMAR 20.19.03.02.b(2)(c) 2010. “Federal or State Emission Standards.” Code of Maryland Regulations.

COMAR 26.11.03. 2010. “Permits, Approvals, and Registration – Title V Permits.” Code of Maryland Regulations.

COMAR 26.11.17. 2000. "Nonattainment Provisions for Major New Sources and Major Modifications Authority." Code of Maryland Regulations.

COMAR 26.23.01.01. 2007. "Nontidal Wetlands." Code of Maryland Regulations.

Conant, T.A., P.H. Dutton, T. Eguchi, S.P. Epperly, C.C. Fahy, M.H. Godfrey, S.L. MacPherson, E.E. Possardt, B.A. Schroeder, J.A. Seminoff, M.L. Snover, C.M. Upite, and B.E. Witherington. 2009. *Loggerhead sea turtle* (Caretta caretta) *2009 status review under the U.S. Endangered Species Act*. Report of the Loggerhead Biological Review Team to the National Marine Fisheries Service, Silver Spring, Maryland. Available at: http://www.seaturtle.org/PDF/ConantTA_2009_NMFSTechReport.pdf.

Conkwright, R.D., K.A. Offerman, and S.V. Ryswick. 2008. *Appendix G, Calvert Cliffs Acoustic Bottom Survey*. Maryland Department of Natural Resources, Annapolis, Maryland.

Constellation Energy Group, LLC (Constellation). 2003a. *Annual Radiological Environmental Operating Report for the Calvert Cliffs Nuclear Power Plant Units 1 and 2 and the Independent Spent Fuel Storage Installation, January 1 - December 31, 2002*. Accession No. ML031400478.

Constellation Generation Group, LLC (Constellation). 2003b. Letter from Mark Tonacci (Constellation) to the NRC dated July 16, 2003, "Subject: Calvert Cliffs Nuclear Power Plant Unit Nos. 1 and 2; Docket Nos. 50-317 & 50-318; 2002 Radioactive Effluent Release Report and Dose Assessment." Accession No. ML032030050.

Constellation Energy Group, LLC (Constellation). 2004a. *Annual Radiological Environmental Operating Report for the Calvert Cliffs Nuclear Power Plant Units 1 and 2 and the Independent Spent Fuel Storage Installation, January 1 - December 31, 2003*. Accession No. ML041380033.

Constellation Generation Group, LLC (Constellation). 2004b. Letter from Mark Tonacci (Constellation) to the NRC dated July 15, 2004, "Subject: Calvert Cliffs Nuclear Power Plant Unit Nos. 1 and 2; Docket Nos. 50-317 and 50-318; 2003 Radioactive Effluent Release Report and Dose Assessment." Accession No. ML042020066.

Constellation Energy Group, LLC (Constellation). 2005a. *Annual Radiological Environmental Operating Report for the Calvert Cliffs Nuclear Power Plant Units 1 and 2 and the Independent Spent Fuel Storage Installation, January 1 - December 31, 2004.* Accession No. ML051370609.

Constellation Generation Group, LLC (Constellation). 2005b. Letter from Mark Tonacci (Constellation) to the NRC dated July 14, 2005, "Calvert Cliffs Nuclear Power Plant Unit Nos. 1

and 2; Docket Nos. 50-317 & 50-318; 2004 Radioactive Effluent Release Report and Dose Assessment." Accession No. ML052020232.

Constellation Energy Group, LLC (Constellation). 2006a. *Annual Radiological Environmental Operating Report for the Calvert Cliffs Nuclear Power Plant Units 1 and 2 and the Independent Spent Fuel Storage Installation, January 1 – December 31, 2005*. Accession No. ML061440213.

Constellation Generation Group, LLC (Constellation). 2006b. Letter from Steven Sanders (Constellation) to the NRC dated July 13, 2006, "Subject: Calvert Cliffs Nuclear Power Plant Unit Nos. 1 and 2; Docket Nos. 50-317 and 50-318, Independent Spent Fuel Storage Installation, Docket No. 72-8; 2005 Radioactive Effluent Release Report and Dose Assessment." Accession No. ML061980021.

Constellation Energy Group, LLC (Constellation). 2007a. *Annual Radiological Environmental Operating Report for the Calvert Cliffs Nuclear Power Plant Units 1 and 2 and the Independent Spent Fuel Storage Installation, January 1 - December 31, 2006*. Accession No. ML071590393.

Constellation Generation Group, LLC (Constellation). 2007b. Letter from Steven Sanders (Constellation) to the NRC dated July 11, 2007, "Subject: Calvert Cliffs Nuclear Power Plant Unit Nos. 1 and 2; Docket Nos. 50-317 & 50-318, Independent Spent Fuel Storage Installation, Docket No. 72-8; 2006 Radioactive Effluent Release Report and Dose Assessment." Accession No. ML072050475.

Cross, J.N., C.A. Zetlin, P.L. Berrien, D.L. Johnson, and C. McBride. 1999. *Essential Fish Habitat Source Document: Butterfish,* Peprilus triacanthus*, Life History and Habitat Characteristics*. NOAA Technical Memorandum NMFS-NE-145. National Marine Fisheries Service, Woods Hole, Massachusetts.

Council on Environmental Quality (CEQ). 1997. T*he 1997 Annual Report of the Council on Environmental Quality*. Washington, D.C. Accession No. ML093280365.

Dadswell, M.J., B.D. Taubert, T.S. Squiers, D. Marchette, and J. Buckley. 1984. *Synoposis of Biological Data on Shortnose Sturgeon,* Acipenser brevirostrum *LeSueur 1818*. NOAA Technical Report NMFS 14, National Marine Fisheries Service, Washington, D.C.

Denver, J.M. and S.W. Ator. 2007. "Chapter 8: The Occurrence of Pesticides in the Bay Watershed." In S*ynthesis of U.S. Geological Survey Science for the Chesapeake Bay Ecosystem and Implications for Environmental Management*, S.W. Phillips, ed. U.S. Geological Survey Circular 1316, USGS, Reston, Virginia.

Dittel, A.I., C.E. Epifanio, and M.L. Fogel. 2006. "Trophic Relationships of Juvenile Blue Crabs *(Callinectes sapidus)* in Estuarine Habitats." *Hydrobiologia* 568(1):379–390.

Dominion. 2009. *Dominion Cove Point LNG.* Accessed December 16, 2009 at http://www.dom.com/business/gas-transmission/cove-point/index.jsp.

Donovan, T.M. and C.H. Flather. 2002. "Relationships Among North American Songbird Trends, Habitat Fragmentation, and Landscape Occupancy." *Ecological Applications* 12(2):364-374.

Drohan, A.F., J.P. Manderson, and D.B. Packer. 2007. *Essential Fish Habitat Source Document: Black Sea Bass,* Centropristis striata, *Life History and Habitat Characteristics. Second Edition*. NOAA Technical Memorandum NMFS-NE-200. Woods Hole, Massachusetts.

Drummond, D.D. 2007. "Water-Supply Potential of the Coastal Plain Aquifers in Calvert, Charles, and St. Mary's Counties, Maryland, with Emphasis on the Upper Patapsco and Lower Patapsco Aquifers." *Report of Investigations No. 76*, Department of Natural Resources, Resource Assessment Service, Maryland Geological Survey, Maryland.

EA Engineering Science and Technology Inc. (EA Engineering). 2007a. *Aquatic Field Studies for UniStar Calvert Cliffs Expansion Project May 2007*. Prepared for UniStar Nuclear Development, LLC by EA Engineering Science and Technology, Sparks, Maryland. Accession No. ML090690170.

EA Engineering Science and Technology Inc. (EA Engineering). 2007b. *Submerged Aquatic Vegetation Surveys for UniStar Calvert Cliffs Expansion Project June 2007*. Prepared for UniStar Nuclear Development, LLC by EA Engineering Science and Technology Sparks, Maryland. Accession No. ML100040305.

Eastern Oyster Biological Review Team (EOBRT). 2007. *Status Review of the Eastern Oyster* (Crassostrea virginica). Report to the National Marine Fisheries Service, Northeast Regional Office, Gloucester, Massachusetts.

eFloras. 2008a. *Flora of North America*. Accessed March 13, 2008 at http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=242415129.

eFloras. 2008b. *Mountain Chestnut Oak, Rock Chestnut Oak*. Accessed February 15, 2008 at http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=233501064.

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

Environmental Laboratory. 1987. *Corp of Engineers Wetlands Delineation Manual.* Wetlands Research Program Technical Report Y-87-1, Department of the Army, Vicksburg, Mississippi. Accession No. ML042790476.

Faught, M.K. 2008. *Final Report, Submerged Cultural Resources Survey of a Proposed Outfall Pipe, Calvert Cliffs Nuclear Power Plant Unit 3 Construction, Calvert County, Maryland*. Prepared for MACTEC Federal Programs, Inc., by Panamerican Consultants, Inc., Memphis, Tennessee. Accession No. ML100040309.

Fay, C.W., R.J. Neves, and G.B. Pardue. 1983. *Species Profiles Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic)—Alewife/Blueback Herring*. FWS/OBS-82/11.9,TR EL-82-4, Prepared by U.S. Army Corps of Engineers and U.S. Fish and Wildlife Service for U.S. Fish and Wildlife Service. Slidell, Lousiana. Accession No. ML073460154.

Feigenbaum, D. and M. Kelly. 1984. "Changes in the Lower Chesapeake Bay Food Chain in Presence of the Sea Nettle *Chrysaora quinquecirrha* (Scyphomedusa)." *Marine Ecology Progress Series* 19:39-47.

Fogarty, M.J. and T.J. Miller. 2004. "Impact of a Change in Reporting Systems in the Maryland Blue Crab Fishery." *Fisheries Research* 68(1-3):37-43.

Frey, S.N. and M.R. Conover. 2006. "Habitat Use by Meso-Predators in a Corridor Environment." *The Journal of Wildlife Management* 70(4):1111-1118.

Freeman, M.C., C.M. Pringle, and C.R. Jackson. 2007. "Hydrologic Connectivity and the Contribution of Stream Headwaters to Ecological Integrity at Regional Scales 1." *Journal of the American Water Resources Association* 43(1):5-14.

Garman, G.D. 1992. "Fate and Potential Significance of Postspawning Anadromous Fish Carcasses in an Atlantic Coastal River." *Transactions of the American Fisheries Society* 121:390-394.

Gibson, J.C. and J.A. McClafferty. 2005. *Chesapeake Bay Angler Interviews, Identifying Populations at Risk for Consuming Contaminated Fish in Three Regions of Concern*. CMI-HDD-05-01, prepared for the Chesapeake Bay Program by Conservation Management Institute, Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Accessed December 2, 2008 at http://www.nbii.gov/images/uploaded/155729_1170437308921_2004_ConsumptionAdvisories_AnglerSurvey.pdf.

Glibert, P.A. and J.M. Burkholder. 2006. "Toward an Emerging Consensus on the Ecology of *Pfiesteria*." *Harmful Algae* 5(4):339–341.

Gomi, T., R.C. Sidle, and J.S. Richardson. 2002. "Understanding Processes and Downstream Linkages of Headwater Systems." *BioScience* 52(10):905-916.

Great Schools (GS). 2008. *Great Schools*. Accessed September 4, 2008 at http://www.greatschools.net/.

Grusha, D.S. 2005. *Investigation of the Life History of the Cownose Ray,* Rhinoptera bonasus *(Mitchill 1815). A Thesis Presented To: The Faculty of the School of Marine Science, the College of William and Mary*. MS Thesis, College of William and Mary, Williamsburg, Virginia.

Häggland, A. and G. Sjöberg. 1999. "Effects of Beaver Dams on the Fish Fauna of Forest Streams." *Forest Ecology and Management* 115(2-3):259-266.

Halling-Sørensen, B., S. Nors Nielsen, P.F. Lanzky, F. Ingerslev, H.C. Holten Liitzhofl, and S.E. Jorgensen. 1998. "Occurrence, Fate, and Effects of Pharmaceutical Substances in the Environment - A Review." *Chemosphere* 36(2):357-393.

Harding, J.M. and R. Mann. 2001. "Diet and Habitat Use by Bluefish (*Pomatomus saltatrix*) in a Chesapeake Bay Estuary." *Environmental Biology of Fishes* 60(4):401–409.

Hardy, J.D. 1962. "Comments on the Atlantic Ridley Turtle, *Lepidochelys olivacea kempi*, in the Chesapeake Bay." *Chesapeake Science* 3(3):217-220.

Hare, J.A. and K.W. Able. 2007. "Mechanistic Links Between Climate and Fisheries Along the East Coast of the United States: Explaining Population Outbursts of Atlantic Croaker *(Micropogonias undulatus)*." *Fisheries Oceanography* 16(1):31–45.

Hargis Jr., W.J. and D.S. Haven. 1999. "Chesapeake Oyster Reefs, Their Importance, Destruction and Guidelines for Restoring Them." Chapter 23 in *Oyster Reef Habitat Restoration: A Synopsis and Synthesis of Approaches*. M.W. Luckenbach, R. Mann, and J.A. Wesson, eds. Virginia Institute of Marine Science Press, Gloucester Point, Virginia.

Hartman, K.J. and S.B. Brandt. 1995. "Trophic Resource Partitioning, Diets, and Growth of Sympatric Estuarine Predators." *Transactions of the American Fisheries Society* 124:520-537.

Heithaus, M.R., A.J. Wirsing, J.A. Thomson, and D.A. Burkholder. 2008. "A Review of Lethal and Non-Lethal Effects of Predators on Adult Marine Turtles." *Journal of Experimental Marine Biology and Ecology* 356(1-2):43-51.

Hoffman, J.C., L.E. Limburg, D.A. Bronk, and J.E. Olney. 2008. "Overwintering Habitats of Migratory Juvenile American Shad in Chesapeake Bay." *Environmental Biology of Fishes* 81(3):329–345.

Hood, G.A. and S.E. Bayley. 2008. "Beaver *(Castor canadensis*) Mitigate the Effects of Climate on the Area of Open Water in Boreal Wetlands in Western Canada." *Biological Conservation* 141(2):556-567.

Houde, E.D., J. Bichy, and S. Jung. 2005. "Effects of Hurricane Isabel on Fish Populations and Communities in Chesapeake Bay." In *Hurricane Isabel in Perspective: Proceedings of a Conference*, K.G. Sellner, ed. Chesapeake Research Consortium, CRC Publication 05-160, Edgewater, Maryland.

Jacobs, J.M., A. Baya, M. Rhodes, R. Reimschuessel, and R.M. Harrell. 2006. "The Influence of Dietary Intake on the Progression and Severity of Mycobacteriosis in Striped Bass *(Morone saxatilis)*." In *USGS/NOAA Workshop on Mycobacteriosis in Striped Bass, May 7-10, 2006, Annapolis, Maryland*. USGS Scientific Investigations Report 2006-5214, USGS, Reston, Virginia.

Jenkins, S.H. and P.E. Busher. 1979. "*Castor canadensis*." *Mammalian species, American Society of Mammalogists* 120:1-8.

Jung, S., and E.D. Houde. 2003. "Spatial and Temporal Variabilities of Pelagic Fish Community Structure and Distribution in Chesapeake Bay, USA." *Estuarine, Coastal and Shelf Science* 58(2):335-351.

Jung, S. and E.D. Houde. 2004a. "Recruitment and Spawning-Stock Biomass Distribution of Bay Anchovy (*Anchoa mitchilli*) in Chesapeake Bay." *Fishery Bulletin* 102(1):63–77.

Jung, S. and E.D. Houde. 2004b. "Production of Bay Anchovy *Anchoa mitchilli* in Chesapeake Bay: Application of Size-based Theory." *Marine Ecology Progress Series* 281:217-232.

Kahn, D.M. and V. Crecco. 2006. "Tag-Recapture Data from Chesapeake Bay Striped Bass Indicate that Natural Mortality has Increased." In *USGS/NOAA Workshop on Mycobacteriosis in Striped Bass, May 7-10, 2006, Annapolis, Maryland*. USGS Scientific Investigations Report 2006-5214, USGS, Reston, Virginia.

Kazyak, P., J.V. Kilian, S.A. Stranko, M.K. Hurd, D.M. Boward, C.J. Millard, and A. Schenk. 2005. *Maryland Biological Stream Survey 2000-2004, Volume 9: Stream and Riverine Biodiversity*. Maryland Department of Natural Resources, Annapolis, Maryland.

Keller, G.S. and R.H. Yahner. 2007. "Seasonal Forest-Patch Use by Birds in Fragmented Landscapes of South-Central Pennsylvania." *The Wilson Journal of Ornithology* 119(3):410-418.

Kemp, W.M., W.R. Boynton, J.E. Adolf, D.F. Boesch, W.C. Boicourt, G. Brush, J.C. Cornwell, T.R. Fisher, P.M. Glibert, J.D. Hagy, L.W. Harding, E.D. Houde, D.G. Kimmel, W.D. Miller, R.I.E. Newell, M.R. Roman, E.M. Smith, and J.C. Stevenson. 2005. "Eutrophication of Chesapeake Bay: Historical Trends and Ecological Interactions." *Marine Ecology Progress Series* 303:1-29.

Kennedy, V.S. and L.L. Breisch. 1981. *Sixteen Decades of Political Management of the Oyster Fishery in Maryland's Chesapeake Bay*. University of Maryland Center for Environmental Science, Cambridge, Maryland.

Kennedy, V.S. and K. Mountford. 2001. "Human Influences on Aquatic Resources in the Chesapeake Bay Watershed." Chapter 10 in *Discovering the Chesapeake, The History of an Ecosystem*. P.D. Curtin, G.S. Brush, and G.W. Fisher, eds., Johns Hopkins University Press, Baltimore, Maryland.

King, R.S., J.R. Beaman, D.F. Whigham, A.H. Hines, M.E. Baker, and D.E. Weller. 2004. "Watershed Land Use Is Strongly Linked to PCBs in White Perch in Chesapeake Bay Subestuaries." *Environmental Science & Technology* 38(24):6546-6552.

KLD Engineering, P.C. (KLD). 2009. *Traffic Impact Study at the Calvert Cliffs Nuclear Power Plant, Draft Final Report, Rev. 2.* TR-427, Hauppauge, New York. Accession No. ML093570407.

Knisley, C.B. 2006. *Current Status of Two Federally Threatened Tiger Beetles at Calvert Cliffs Nuclear power Plant*. Letter report to Carla Logan, Constellation Generation Group, October 26, 2006. Glen Allen, Virginia. Accession No. ML090690159.

Kraus, R.T. and D.H. Secor. 2004. "Dynamics of White Perch *Morone americana* Population Contingents in the Patuxent River Estuary, Maryland, USA." *Marine Ecology Progress Series* 279:247-259.

Kraus, R.T. and D.H. Secor. 2005. "Application of the Nursery-Role Hypothesis to an Estuarine Fish." *Marine Ecology Progress Series* 291:301-305.

Kynard, B. 1997. "Life History, Latitudinal patterns and Status of the Shortnose Sturgeon, *Acipenser brevirostrum."* *Environmental Biology of Fishes* 48:319-334.

Kynard, B., M. Breece, M. Atcheson, M. Kieffer, and M. Mangold. 2009. "Life History and Status of Shortnose Sturgeon (*Acipenser brevirostrum*) in the Potomac River." *Journal of Applied Ichthyology* 25 (Supplement 2):34-38.

Lacouture, R.V., J.M. Johnson, C. Buchanan, and H.G. Marshall. 2006. "Phytoplankton Index of Biotic Integrity for Chesapeake Bay and its Tidal Tributaries." *Estuaries and Coasts* 29(4):598–616.

Lathrop, R.G., L. Windham, and P. Montesano. 2003. "Does *Phragmites* Expansion Alter the Structure and Function of Marsh Landscapes? Patterns and Processes Revisited." *Estuaries* 26(2B):423-435.

Latour, R.J., J. Gartland, C.F. Bonzek, R.A. Johnson. 2008. "The Trophic Dynamics of Summer Flounder (*Paralichthys dentatus*) in Chesapeake Bay." *Fishery Bulletin* 106:47-57.

Lewitus, A.J., R.V. Jesien, and T.M. Kana. 1995. "Discovery of the 'Phantom' Dinoflagellate in Chesapeake Bay." *Estuaries* 18(2):373-378.

Levey, D.J., B.M. Bolker, J.J. Tewksbury, S. Sargent, and N.M. Haddad. 2005. "Effects of Landscape Corridors on Seed Dispersal by Birds." *Science* 309(146):146-148.

Llansó, R.J., J. Dew, and L.C. Scott. 2007a. *Chesapeake Bay Water Quality Monitoring Program, Long-Term Benthic Monitoring and Assessment Component, Level I Comprehensive Report, July 1984-December 2006 (Volume 1)*. Prepared by Versar, Inc., for Maryland DNR, Annapolis Maryland.

Llansó, R.J., J. Dew, and L.C. Scott. 2007b. *Chesapeake Bay Water Quality Monitoring Program, Long-Term Benthic Monitoring and Assessment Component, Level I Comprehensive Report, July 1984-December 2006 (Volume 2)*. Prepared by Versar, Inc., for Maryland DNR, Annapolis Maryland.

Long, Z.T., T.H. Pendergast IV, and W.P. Carson. 2007. "The Impact of Deer on Relationships between Tree Growth and Mortality in an Old-Growth Beech-Maple Forest." *Forest Ecology and Management* 252:230-238.

Luo, J. and J.A. Musick. 1991. "Reproductive Biology of the Bay Anchovy in Chesapeake Bay." *Transactions of the American Fisheries Society* 120:701-710.

Lutcavage, M. 1981. *The Status of Marine Turtles in Chesapeake Bay and Virginia Coastal Waters. A Thesis Presented To: The Faculty of the School of Marine Science, the College of William and Mary*. MA Thesis, College of William and Mary, Williamsburg, Virginia.

Lydy, M.J., C.G. Crawford, J.W. Frey. 2000. "A Comparison of Selected Diversity, Similarity, and Biotic Indices for Detecting Changes in Benthic-Invertebrate Community Structure and Stream Quality." *Archives of Evironmental Contamination and Toxicology* 39:469–479.

MacAvoy, S.E., S.A. Macko, S.P. McIninch, and G.C. Garman. 2000. "Marine Nutrient Contributions to Freshwater Apex Predators." *Oecologia* 122:568–573.

Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA). 16 U.S.C. 1801 et seq.

Mansfield, K.L. 2006. *Sources of Mortality, Movements and Behavior of Sea Turtles in Virginia-A Dissertation Presented To: The Faculty of the School of Marine Science, the College of William and Mary*. PhD Dissertation, College of William and Mary, Williamsburg, Virginia.

Maryland Comptroller (MD Comp). 2007. *State of Maryland, Comprehensive Annual Financial Report*. Accessed August 15, 2008 at http://www.marylandtaxes.com/publications/fiscalrprts/cafr2007.pdf.

Maryland Comptroller (MD Comp). 2008a. *Comptroller of Maryland, Sales and Use Tax*. Accessed November 18, 2008 at http://individuals.marylandtaxes.com/usetax/default.asp.

Maryland Comptroller (MD Comp). 2008b. *Comptroller of Maryland, Income Tax Information*. Accessed November 18, 2008 at http://individuals.marylandtaxes.com/incometax/default.asp.

Maryland Critical Area Commission for the Chesapeake and Atlantic Coastal Bays (CAC). 2000. *A Guide to the Conservation of Forest Interior Dwelling Birds in the Chesapeake Bay Critical Area.* Annapolis, Maryland.

Maryland Critical Area Commission for the Chesapeake and Atlantic Coastal Bays (CAC). 2008a. *Critical Area Commission for the Chesapeake and Atlantic Coastal Bays*. Accessed on August 4, 2008 at http://www.dnr.state.md.us/criticalarea/index.html.

Maryland Critical Area Commission for the Chesapeake and Atlantic Coastal Bays (CAC). 2008b. Letter from Amber Widmayer (CAC, Natural Resource Planner) to Susan Gray (Maryland Department of Natural Resources, Maryland Power Plant Research Program), “Re: Notification of Critical Area Commission Action on Request for Approval of Calvert Cliffs Nuclear Power Plant Expansion Project,” August 8, 2008.

Maryland Critical Area Commission for the Chesapeake and Atlantic Coastal Bays (CAC). 2008c. Letter from Margaret G. McHale (Critical Area Commission, Chair) to Susan Grey (Maryland Department of Natural Resources, Power Plant Research Program), “Re: Revised Initial Conditions for CPCN Case 9127 – Proposed Calvert Cliffs Unit 3,” October 22, 2008. Accessed November 3, 2008 at http://webapp.psc.state.md.us/Intranet/CaseNum/submit.cfm?DirPath=C:\Casenum\9100-9199\9127\Item_80\&CaseN=9127\Item_80.

Maryland Critical Area Commission for the Chesapeake and Atlantic Coastal Bays (CAC). 2008d. *Critical Area Commission for the Chesapeake and Atlantic Coastal Bays*. Accessed August 4, 2008 at http://www.dnr.state.md.us/criticalarea/index.html.

Maryland Critical Area Commission for the Chesapeake and Atlantic Coastal Bays (CAC). 2008e. *Preserving Our Precious Natural Resources*. Accessed February 19, 2008 at http://www.dnr.state.md.us/criticalarea/preserving.html.

Maryland Critical Area Commission for the Chesapeake and Atlantic Coastal Bays (CAC). 2008f. *Categories of Land within the Critical Area*. Accessed February 19, 2008 at http://www.dnr.state.md.us/criticalarea/section2a.html.

Maryland Department of Agriculture (MDA). 2008. *Gypsy Moth Program*. Accessed February 20, 2008 at http://www.mda.state.md.us/plants-pests/forest_pest_mgmt/gypsy_moth/gypsy_moth_program_policy.php.

Maryland Department of Business and Economic Development (MDBED). 2007. *Maryland Department of Business and Economic Development. Facts and Figures, Transportation*. Accessed at www.choosemaryland.org/factsandfigures/transportation/transportationindex.html.

Maryland Department of Business and Economic Development (MDBED). 2008a. *Calvert County*. MDBED – Regions and Counties – County Profiles – Calvert County. Accessed November 18, 2008 at http://www.choosemaryland.org/regionsandcounties/southernregion/CalvertCounty.html.

Maryland Department of Business and Economic Development (MDBED). 2008b. *St. Mary's County*. MDBED – Regions and Counties – County Profiles – St. Mary's County. Accessed November 18, 2008 at http://www.choosemaryland.org/regionsandcounties/southernregion/StMarysCounty.html.

Maryland Department of Business and Economic Development (MDBED). 2008c. *Air*. MDBED – Facts & Figures – Transportation – Air. Accessed November 18, 2008 at http://www.choosemaryland.org/factsandfigures/transportation/airdata.html.

Maryland Department of Business and Economic Development (MDBED). 2008d. *Rail*. MDBED – Facts and Figures – Transportation – Rail. Accessed November 19, 2008 at http://www.choosemaryland.org/factsandfigures/transportation/raildata.html.

Maryland Department of Environment (MDE). 2008. *Nontidal Wetlands of Special State Concern*. Accessed October 2, 2008 at www.mde.state.md.us/assets/document/wetlandswaterways/ssc.pdf.

Maryland Department of Labor, Licensing, and Regulation (MDLLR). 2008a. *Career and Workforce Information, Occupational Projections – C – Maryland Occupational Projections – 2006-2016*. Accessed November 18, 2008 at http://www.dllr.state.md.us/lmi/iandoproj/occc.shtml.

Maryland Department of Labor, Licensing, and Regulation (MDLLR). 2008b. *Career and Workforce Information, Occupational Projections – C – Southern Maryland WIA Occupational*

Projections – 2004-2014. Accessed November 18, 2008 at http://www.dllr.state.md.us/lmi/iandoproj/southern/occc.shtml.

Maryland Department of Natural Resources (MDNR). 2001. *Maryland Biological Stream Survey Sampling Manual, Monitoring and Non-Tidal Assessment*. Monitoring and Non-Tidal Assessment Division, Annapolis, Maryland.

Maryland Department of Natural Resources (MDNR). 2004. *Lower Patuxent River in Calvert County Watershed Characterization December 2003*. Annapolis, Maryland.

Maryland Department of Natural Resources (MDNR). 2005. *2002-2004 Fishery Management Plans Legislative Report*. Fisheries Service; Fishery Management Plan Program, Annapolis, Maryland.

Maryland Department of Natural Resources (MDNR). 2007a. *Current and Historical Rare, Threatened, and Endangered Species of Calvert County, Maryland*. Wildlife and Heritage Service, Annapolis, Maryland.

Maryland Department of Natural Resources (MDNR). 2007b. *Rare, Threatened, and Endangered Animals of Maryland*. Wildlife and Heritage Program, Annapolis, Maryland.

Maryland Department of Natural Resources (MDNR). 2007c. *Rare, Threatened, and Endangered Plants of Maryland*. Wildlife and Heritage Program, Annapolis, Maryland.

Maryland Department of Natural Resources (MDNR). 2007d. *Calvert Cliffs State Park*. Accessed November 19, 2008 at http://www.dnr.state.md.us/publiclands/southern/calvertcliffs.html.

Maryland Department of Natural Resources (MDNR). 2007e. *Fisheries Service, Bay-wide Blue Crab Winter Dredge Survey 2007*. Accessed March 7, 2008 at http://www.dnr.state.md.us/fisheries/crab/winter_dredge.html.

Maryland Department of Natural Resources (MDNR). 2007f. *Maryland Tributary Strategy Patuxent River Basin Summary Report for 1985-2005 Data*. Annapolis, Maryland.

Maryland Department of Natural Resources (MDNR). 2008a. *Chinese Mitten Crab Watch*. Accessed March 13, 2008 at http://www.dnr.state.md.us/dnrnews/infocus/mitten_crab.asp.

Maryland Department of Natural Resources (MDNR). 2008b. *A Chesapeake Bay Fishery Management Update, Section 8. Bluefish*. Accessed September 26, 2008 at http://www.dnr.state.md.us/fisheries/FMP/FMPBluefish04.pdf.

Maryland Department of Natural Resources (MDNR). 2008c. *A Chesapeake Bay Fishery Management Update, Section 19. White Perch*. Accessed September 26, 2008 at http://www.dnr.state.md.us/fisheries/FMP/FMPWhitePerch04.pdf.

Maryland Department of Natural Resources (MDNR). 2008d. *DNR Announces Estimated 2007 Blue Crab Harvest Numbers*. Accessed February 6, 2008 at http://www.dnr.state.md.us/dnrnews/pressrelease2008/020408.html.

Maryland Department of Natural Resources (MDNR). 2008e. *Summary of Maryland's 2008 Emergency Crabbing Regulation Changes*. Accessed October 26, 2008 at www.dnr.state.md.us/fisheries/crab/SummaryofCrabChanges08.pdf.

Maryland Department of Natural Resources (MDNR). 2008f. *A Chesapeake Bay Fishery Management Update, Section 1. Alosines (Shad and River Herring)*. Accessed September 26, 2008 at http://www.dnr.state.md.us/fisheries/management/FMP/FMPAlosines04.pdf.

Maryland Department of Natural Resources (MDNR). 2008g. *Maryland Geological Survey, A Brief Description of the Geology of Maryland*. Accessed September 12, 2008 at http://www.mgs.md.gov/esic/brochures/mdgeology.html.

Maryland Department of Natural Resources, Power Plant Research Program (MDNR PPRP). 2008. *Environmental Review of Proposed Unit 3 at Calvert Cliffs Nuclear Power Plant*. PSC Case No. 9127. Maryland Power Plant Research (PPRP).

Maryland Department of Planning (MDP). 2007. *Historical and Projected Total Personal Income for Maryland's Jurisdictions (in thousands of constant 2000 $)*. Accessed November 18, 2008 at http://www.mdp.state.md.us/msdc/projection/income/TotalPersInc_2007.pdf.

Maryland Department of Planning (MDP). 2008a. *Table 1A. Total Resident Population for Maryland's Jurisdictions, 2000 – 2007*. Accessed October 24, 2008 at http://www.mdp.state.md.us/msdc/Pop_estimate/Estimate_07/county/table1a.pdf.

Maryland Department of Planning (MDP). 2008b. *Historical and Projected Total Population for Maryland's Jurisdictions (Revisions, October 2007)*. Accessed October 24, 2008 at http://www.mdp.state.md.us/msdc/popproj/TOTPOP_PROJ07.pdf.

Maryland Department of Planning (MDP). 2008c. *2007 Maryland Statistical Handbook*. Accessed August 28, 2008 at http://www.mdp.state.md.us/msdc/md_statistical_handbook07.pdf.

Maryland Department of Transportation, State Highway Administration (MDOT). 2007a. *Traffic Monitoring System Report Module, Annual Average Daily Traffic (AADT) for Calvert County*. Accessed November 19, 2008 at http://www.sha.state.md.us/tmsreports/report_date.asp?rdoReportType=traffic&reportfullname=AADT.rpt.

Maryland Department of Transportation, State Highway Administration (MDOT). 2007b. *Traffic Trends System Report Module, Monthly Variation in ATR Stations*. Accessed November 19, 2008 at http://www.sha.state.md.us/traffictrends2/.

Maryland Historic Trust (MHT), Maryland Department of Planning. 2009. Letter from J. Rodney Little (Maryland Historical Trust) to William Seib (U.S. Army Corps of Engineers), Re: MGT Review of Phase II National Register Evaluations and Assessment of Effects for Cultural Resources, Calvert Cliffs Nuclear Power Plant Expansion, Calvert County, Maryland. February 13, 2009. Acession No. ML090570416.

Maryland Invasive Species Council (MISC). 2006. *Invasive Species of Concern in Maryland, Invader of the Month: Archived Invaders – Little Green Invaders, Green Crab*. Accessed October 13, 2008 at http://www.mdinvasivesp.org/archived_invaders/archived_invaders_2006_02.html.

Maryland Invasive Species Council (MISC). 2008a. *Invasive Species of Concern in Maryland: Aquatic Plants*. Accessed March 13, 2008 at http://www.mdinvasivesp.org/list_aquatic_plants.html.

Maryland Invasive Species Council (MISC). 2008b. *Invasive Species of Concern in Maryland: Vertebrates*. Accessed March 13, 2008 at http://www.mdinvasivesp.org/list_vertebrates.html.

Maryland Public Service Commission (MPSC). 2008. *Appendix G, Calvert Cliffs Acoustic Bottom Survey. Oyster Report, Case No. 9127*. Accessed October 28, 2008 at http://webapp.psc.state.md.us/Intranet/CaseNum/submit.cfm?DirPath=C:\Casenum\9100-9199\9127\Item_78\&CaseN=9127\Item_78.

Maryland Public Service Commission (MPSC). 2009. *In the Matter of the Application of UniStar Nuclear Energy, LLC and UniStar Nuclear Operating Services, LLC for a Certificate of Public Convenience and Necessity to Construct a Nuclear Power Plant at Calvert Cliffs in Calvert County, Maryland*. Case Number 9127. Order Number 82741.

Maryland State Department of Education (MSDE). 2005a. *Maryland State Department of Education, Maryland Public School Enrollment by Race/Ethnicity and Gender and Number of Schools, September 30, 2005*. Accessed December 2, 2008 at http://www.marylandpublicschools.org/NR/rdonlyres/85E7723B-CB82-46B0-AD4B-EAD45A69B4F2/8628/enroll05.pdf.

Maryland State Department of Education (MSDE). 2005b. *Maryland State Department of Education, Nonpublic School Enrollment, State of Maryland, September 30, 2005*. Accessed December 2, 2008 at http://www.marylandpublicschools.org/NR/rdonlyres/85E7723B-CB82-46B0-AD4B-EAD45A69B4F2/8776/nonpub05.pdf.

Maryland State Department of Education (MSDE). 2005c. *Maryland State Department of Education, Staff Employed at School and Central Office Levels October 2005*. Accessed December 2, 2008 at http://www.marylandpublicschools.org/NR/rdonlyres/726B3C64-BD92-456A-8B3C-2D0ADE555862/9461/stfemp06.pdf.

Maryland State Department of Assessments & Taxation (MDSDAT). 2008. *State Department of Assessments & Taxation, Origin & Functions*. Accessed November 18, 2008 at http://www.msa.md.gov/msa/mdmanual/25ind/html/06assesf.html.

Mason, J., C. Moorman, G. Hess, and K. Sinclair. 2006. "Designing Suburban Greenways to Provide Habitat for Forest-Breeding Birds." *Landscape and Urban Planning* 80(2007):153-164.

McCleave, J.D. 2008. "Contrasts Between Spawning Times of Anguilla Species Estimated from Larval Sampling at Sea and from Otolith Analysis of Recruiting Glass Eels." *Marine Biology* 155:240-262.

McCormick-Ray, J. 2005. "Historical Oyster Reef Connections to Chesapeake Bay - a Framework for Consideration." *Estuarine, Coastal and Shelf Science* 64:119-134.

McPhee, J. 2002. *The Founding Fish*. Farrar, Straus and Giroux, New York.

Meserve, N. 2007a. *2007. Review of the Atlantic States Marine Fisheries Commission Fishery Management Plan for Atlantic Croaker (*Micropogonias undulatus*), 2006 Fishing Year*. Atlantic States Marine Fisheries Commission, Raleigh, North Carolina.

Meserve, N. 2007b. 2007 *Review of the Atlantic States Marine Fisheries Commission Fishery Management Plan for Spot (*Leiostomus xanthurus*), 2006 Fishing Year*. Atlantic States Marine Fisheries Commission, Raleigh, North Carolina.

Meserve, N. 2008. *2007 Review of the Atlantic States Marine Fisheries Commission Fishery Management Plan for Weakfish (*Cynoscion regalis*), 2006 Fishing Year*. Atlantic States Marine Fisheries Commission, Raleigh, North Carolina.

Meyer, J.L., D.L. Strayer, J.B. Wallace, S.L. Eggert, G.S. Helfman, and N.E. Leonard. 2007. "The Contribution of Headwater Streams to Biodiversity in River Networks." *Journal of the American Water Resources Association* 43(1):86-103.

Migratory Bird Treaty Act (MBTA) of 1918. 16 U.S.C. 703 et seq.

Miller, W.D., L.W. Harding, Jr., and J.E. Adolf. 2006. "Hurricane Isabel Generated an Unusual Fall Bloom in Chesapeake Bay." *Geophysical Research Letters* 33:L06612, doi:10.1029/2005GL025658.

Morse, D. August 9, 2007. "Putting the Bite on Mosquitoes, Some Public and Private Control Efforts Rely on a Ravenous Little Fish." *The Washington Post* Accessed August 28, 2008 at http://www.washingtonpost.com/wp-dyn/content/article/2007/08/08/AR2007080802205.html.

Morse, W.W. and K.W. Able. 1995. "Distribution and life history of windowpane, *Scophthalmus aquosus*, off the northeastern United States." *Fishery Bulletin* 93:675-693.

Munford, B.A. and M.G. Hyland. 2007. *Draft Interim Report Phase Ib Cultural Resources Investigation.* Prepared for UniStar Nuclear, LLC. by GAI Consultants, Inc., Homestead, Pennsylvania. Accession No. ML100040308.

Munford, B.A., L.A. Frye, and M.G. Hyland. 2008. *2008 Phase I Cultural Resources Investigations and Phase II National Register Evaluations for Calvert Cliffs Nuclear Power Plant, Calvert County, Maryland*. Prepared for UniStar Nuclear, LLC, by GAI Consultants, Inc., Homestead, Pennsylvania. Accession No. ML100970243.

Murdy, E.O., R.S. Birdsong, and J.A. Musick. 1997. *Fishes of the Chesapeake Bay*. Smithsonian Institution Press, Washington, D.C.

National Climatic Data Center (NCDC). 2004. *2003 Local Climatological Data Annual Summary with Comparative Data – Baltimore, Maryland (BWI)*. NCDC, Asheville, North Carolina.

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

National Historic Preservation Act of 1966 (NHPA). 16 U.S.C. 470, et seq.

National Marine Fisheries Service (NMFS). 1998. *Final Recovery Plan for the Shortnose Sturgeon (*Acipenser brevirostrum*)*. Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland. Accession No. ML070170263.

National Marine Fisheries Service (NMFS). 2007a. *Species of Concern, Atlantic sturgeon,* Acipenser oxyrinchus oxyrinchus. Accessed October 7, 2008 at www.nmfs.noaa.gov/pr/pdfs/species/atlanticsturgeon_detailed.pdf.

National Marine Fisheries Service (NMFS). 2007b. *Species of Concern, River herring (Alewife and Blueback herring),* Alosa pseudoharengus *and* A. aestivalis. Accessed October 7, 2008 at www.nmfs.noaa.gov/pr/pdfs/species/riverherring_detailed.pdf. Accession No. ML100481337.

National Marine Fisheries Service (NMFS). 2007c. *Green Turtle (Chelonia mydas).* Accessed September 30, 2008 at http://www.nmfs.noaa.gov/pr/species/turtles/green.htm. Accession No. ML093270453.

National Marine Fisheries Service and U.S. Fish and Wildlife Service (NMFS and FWS). 2007a. *Loggerhead Sea Turtle (*Caretta caretta*), 5-Year Review: Summary and Evaluation*. National Marine Fisheries Service, Silver Spring, Maryland and U.S. Fish and Wildlife Service, Jacksonville, Florida.

National Marine Fisheries Service and U.S. Fish and Wildlife Service (NMFS and FWS). 2007b. *Green Sea Turtle (*Chelonia mydas*) 5-Year Review: Summary and Evaluation*. National Marine Fisheries Service, Silver Spring, Maryland, and U.S. Fish and Wildlife Service, Jacksonville, Florida.

National Marine Fisheries Service and U.S. Fish and Wildlife Service (NMFS and FWS). 2007c. *Leatherback Sea Turtle (*Dermochelys coriacea*) 5-Year Review: Summary and Evaluation*. National Marine Fisheries Service, Silver Spring, Maryland, and U.S. Fish and Wildlife Service, Jacksonville, Florida.

National Oceanic and Atmospheric Administration (NOAA). 2008a. *46th Northeast Regional Stock Assessment Workshop (46th SAW) Part A. Assessment Report*. Ref Doc. 08-03a; 252 p., Northeast Fisheries Science Center, Woods Hole, Massachusetts.

National Oceanic and Atmospheric Administration (NOAA). 2008b. *Kemp's Ridley Turtle (*Lepidochelys kempii*)*. Accessed September 30, 2008 at http://www.nmfs.noaa.gov/pr/species/turtles/kempsridley.htm. Accession No. ML093270433.

National Oceanic and Atmospheric Administration (NOAA). 2008c. *Leatherback Turtle (*Dermochelys coriacea*)*. Accessed September 30, 2008 at http://www.nmfs.noaa.gov/pr/species/turtles/leatherback.htm. Accession No. ML093270442.

National Oceanic and Atmospheric Administration (NOAA). 2008d. *Loggerhead Turtle (*Caretta caretta*)*. Accessed September 30, 2008 at http://www.nmfs.noaa.gov/pr/species/turtles/loggerhead.htm. Accession No. ML093270448.

Nichols, J. 2008. Email from J. Nichols (NOAA) to H. Nash (NRC), "Summer Flounder Size Range." December 24, 2008. Accession No. ML093070050.

North, E.W. and E.D. Houde. 2001. "Retention of White Perch and Striped Bass Larvae: Biological-Physical Interactions in Chesapeake Bay Estuarine Turbidity Maximum." *Estuaries* 24(5):756-769.

Nye, J.A., T.E. Targett, and T.E. Helser. 2008. "Reproductive Characteristics of Weakfish in Delaware Bay: Implications for Management." *North American Journal of Fisheries Management* 28:1-11.

Orth, R.J., D.J. Wilcox, L.S. Nagey, A.L. Owens, J.R. Whiting, and A.K. Kenne. 2007a. *2006 Monitoring – 2006 Report, Distribution of Submerged Aquatic Vegetation in Chesapeake Bay and Coastal Bays. Virginia Institute of Marine Science (VIMS) Special Scientific Report Number 150. Final report to U.S. EPA, Chesapeake Bay Program, Annapolis, Maryland*. Accessed September 19, 2008 at http://www.vims.edu/bio/sav/sav06/sav_species_text.html.

Orth, R.J., D.J. Wilcox, L.S. Nagey, A.L. Owens, J.R. Whiting, and A.K. Kenne. 2007b. *Monitoring – 2006 Report, Cove Point, Md. (61) (No SAV), 2006 Distribution of Submerged Aquatic Vegetation in Chesapeake Bay and Coastal Bays. Virginia Institute of Marine Science Special Scientific Report Number 150*. *Final report to U.S. EPA, Chesapeake Bay Program, Annapolis, MD*. Accessed February 13, 2008 at http://www.vims.edu/bio/sav/sav06/quads/cv061th.html.

Overholtz, W. 2006. *Butterfish*. National Marine Fisheries Service, Woods Hole, Massachusetts.

Overton, A.S., C.S. Manooch III, J.W. Smith, and K. Brennan. 2008. "Interactions Between Adult Migratory Striped Bass (*Morone saxatilis*) and Their Prey During Winter Off the Virginia and North Carolina Atlantic Coast from 1994 Through 2007." *Fishery Bulletin* 106(2):174-182.

Packer, D.B., C.A. Zetlin, and J.J. Vitaliano. 2003a. *Essential Fish Habitat Source Document: Clearnose Skate,(*Raja eglanteria*) Life History and Habitat Characteristics*. NOAA Technical Memorandum NMFS-NE-174. National Marine Fisheries Service, Woods Hole, Massachusetts. Accession No. ML072080214.

Packer, D.B., C.A. Zetlin, and J.J. Vitaliano. 2003b. *Essential Fish Habitat Source Document: Little Skate,* Leucoraja erinacea*, Life History and Habitat Characteristics*. NOAA Technical Memorandum NMFS-NE-175. National Marine Fisheries Service, Woods Hole, Massachusetts. Accession No. ML072080217.

Packer, D.B., C.A. Zetlin, and J.J. Vitaliano. 2003c. *Essential Fish Habitat Source Document: Winter Skate,* Leucoraja ocellata*, Life History and Habitat Characteristics*. NOAA Technical Memorandum NMFS-NE-179. National Marine Fisheries Service, Woods Hole, Massachusetts. Accession No. ML072070390.

Pait, A.S., R.A. Warner, S.I. Hartwell, J.O. Nelson, P.A. Pacheco, and A.L. Mason. 2006. *Human Use Pharmaceuticals in the Estuarine Environment: A Survey of the Chesapeake Bay, Biscayne Bay and Gulf of the Farallones*. NOS NCCOS 7, National Oceanic and Atmospheric Administration, Silver Spring, Maryland.

Pennak, R.W. 1978. *Freshwater Invertebrates of the United States*. John Wiley and Sons, New York.

Phillips, J.M., M.T. Huish, J.H. Kerby, and D.P. Moran. 1989. *Species profiles life histories and environmental requirements of coastal fishes and invertebrates (mid-Atlantic)--spot*. U.S. Fish Wildlife Service Biological Report 82(11.98). TR EL-82-4. U.S. Army Corps of Engineers, Washington, D.C.

Phillips, S.W. 2005. *U.S. Geological Survey Chesapeake Bay Science Plan, 2006-2011*. Open-File Report 2005-1440, USGS, Reston, Virginia.

Purcell, J.E., D.A. Nemazie, S.E. Dorsey, E.D. Houde, and J.C. Gamble. 1994. "Predation Mortality of Bay Anchovy *Anchoa mitchilli* Eggs and Larvae Due to Scyphomedusae and Ctenophores in Chesapeake Bay." *Marine Ecology Progress Series* 114:47-58.

Purcell, J.E., T.A. Shiganova, M.B. Decker, and E.D. Houde. 2001. "The Ctenophore *Mnemiopsis* in Native and Exotic Habitats: U.S. Estuaries versus the Black Sea Basin." *Hydrobiologia* 451:145-176.

Ramsdell, J.V. and J.P. Rishel. 2007. *Toronado Climatology of the Contiguous United States.* NUREG/CR-4461, Rev. 2; PNNL-15112, Rev. 1. Washington, D.C.

Richardson, B.M., R.P. Morin, C.P. Stence, and M.W. Baldwin. 2007. *Restoration of American Shad and Hickory Shad in Maryland's Chesapeake Bay, 2006 Final Progress Report*. Maryland Department of Natural Resources, Annapolis, Maryland.

Richardson, J.S. and R.J. Danehy. 2007. "A Synthesis of the Ecology of Headwater Streams and Their Riparian Zones in Temperate Forests." *Forest Science* 53(2):131-147.

Ringger, T.G. 2000. "Investigations of Impingement of Aquatic Organisms at the Calvert Cliffs Nuclear Power Plant, 1975-1995." *Environmental Science and Policy* 3:S261-S273.

Rooker, J.R., S.A. Jolt, G.J. Holt, and L.A. Fuiman. 1999. "Spatial and Temporal Variability in Growth, Mortality, and Recruitment Potential of Postsettlement Red Drum (*Sciaenops ocellatus*) in a Subtropical Estuary." *Fishery Bulletin* 97(3):581-590.

Roth, N.E., M.R. Southerland, G.M. Rogers, and J.H. Vølstad. 2005. *Maryland Biological Stream Survey 2000-2004; Volume IV: Ecological Assessment of Watersheds Sampled in 2003*. Publication # DNR-12-0105-0038, prepared by Versar, Inc., for Maryland Department of Natural Resources, Annapolis, Maryland.

Rosell, F., O. Bozser, P. Collen, and H. Park. 2005. "Ecological Impact of Beavers (*Castor fiber* and *Castor canadensis)* and Their Ability to Modify Ecosystems." *Mammal Review* 35(3-4):248-276.

Rossell Jr., C.R., S. Patch, and S. Salmons. 2007. "Effects of Deer Browsing on Native and Non-Native Vegetation in a Mixed Oak-Beech Forest on the Atlantic Coastal Plain." *Northeastern Naturalist* 14(1):61-72.

Rybicki, N.B. and J.M. Landwehr. 2007. "Chapter 11: Submerged Aquatic Vegetation and Water Clarity." In *Synthesis of U.S. Geological Survey Science for the Chesapeake Bay Ecosystem and Implications for Environmental Management*. S.W. Phillips, ed. U.S. Geological Survey Circular 1316, USGS, Reston, Virginia.

Sackett, D.K., K.W. Able, and T.M. Grothues. 2007. "Dynamics of Summer Flounder (*Paralichthys dentatus*) Seasonal Migrations Based on Ultrasonic Telemetry." *Estuarine, Coastal and Shelf Science* 74:119-130.

Sadzinski, B. and T. Jarzynski. 2005. *Maryland's 2004 American Shad (*Alosa sapidissima*), Alewife Herring (*Alosa pseudoharengus*) and Blueback Herring (*Alosa aestivalis*) Compliance Report*. Maryland Department of Natural Resources, Stevensville, Maryland.

Schaffler, J.J., C.S. Reiss, and C.M. Jones. 2009. "Patterns of Larval Atlantic Croaker Ingress Into Chesapeake Bay, USA." *Marine Ecology Progress Series* 378:187-197.

Scharf, F.S., J.A. Buckel, and F. Juanes. 2002. "Size-Dependent Vulnerability of Juvenile Bay Anchovy (*Anchoa mitchilli*) to Bluefish Predation: Does Large Body Size Always Provide a Refuge?" *Marine Ecology Progress Series* 233:241-252.

Secor, D., G. Chaput, J. Collie, and J. Hightower. 2006. *Terms of Reference and Advisory Report to the American Eel Stock Assessment Peer Review*. Assessment Report No. 06-01 of the Atlantic States Marine Fisheries Commission, Washington, D.C.

Secor, D.J. and E.D. Houde. 1995. "Temperature Effects on the Timing of Striped Bass Egg Production, Larval Viability, and Recruitment Potential in the Patuxent River (Chesapeake Bay)." *Estuaries* 18:527-544.

Secor, D.J. and P.M. Piccoli. 2007. "Oceanic Migration Rates of Upper Chesapeake Bay Striped Bass (*Morone saxatilis*), Determined by Otolith Microchemical Analysis." *Fishery Bulletin* 105(1):62–73.

Secrest, T.J., D.C. Mussatti, and M.J. Scott. 2010. *Calvert Cliffs Unit 3 COL Discussions Regarding Socioeconomic and Environmental Justice—Interviews with the Public.* Accession No. ML100050174.

Seney, E.E. and J.A. Musick. 2007. "Historical Diet Analysis of Loggerhead Sea Turtles (*Caretta caretta*) in Virginia." *Copeia* 2:478-489.

Shafer, D.J. and P. Bergstrom. 2008. *Large-Scale Submerged Aquatic Vegetation Restoration in Chesapeake Bay, Status Report, 2003-2006*. ERDC/EL TR-08-20, U.S. Army Corps of Engineers, Washington, D.C.

Shedlock, R.J., D.W. Bolton, E.T. Cleaves, J.M. Gerhart, and M.R. Nardi. 2007. *A Science Plan for a Comprehensive Regional Assessment of the Atlantic Coastal Plain Aquifer System in Maryland.* United States Geological Society, Open-File Report 2007–1205. U.S. Geological Survey, Reston, Virginia.

Shepherd, G.R. and D.B. Packer. 2006. *Essential Fish Habitat Source Document: Bluefish,* Pomatomus saltatrix, *Life History and Habitat Characteristics, Second Edition.* NOAA Technical Memorandum NMFS-NE-198. Woods Hole, Massachusetts.

Smith, J.W. and J.V. Merriner. 1985. "Food habits and feeding behavior of the cownose ray, *Rhinoptera bonasus*, in Lower Chesapeake Bay." *Estuaries* 8(3):305-310.

Smithsonian Migratory Bird Center (SMBC). 2008. *Scarlet Tanager Life History*. Accessed February 7, 2008 at http://nationalzoo.si.edu/ConservationAndScience/MigratoryBirds/Life_History/default.cfm?Commonname=Scarlet%20Tanager.

Soeder, D.J., J.P. Rafensperger, and M.R. Nardi. 2007. *Effects of Withdrawals on Ground-Water Levels in Southern MD and the Adjacent Eastern Shore, 1980–2005*. United States Geological Society Scientific Investigations Report 2007–5249. U.S. Geological Survey, Reston, Virginia. Accession No. ML093220802.

Sosebee, K. 2006. *Skates*. NOAA National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, Massachusetts. Available at http://www.nefsc.noaa.gov/sos/spsyn/op/skate/archives/27_Skates_2006.pdf.

Southerland, M.T., G.M. Rogers, M.J. Kline, R.P. Morgan, D.M. Boward, P.F. Kazyak, R.J. Klauda, and S.A. Stranko. 2005a. *Maryland Biological Stream Survey 2000-2004, New Biological Indicators to Better Assess the Condition of Maryland Streams*. Volume XVI, Publication # DNR-12-0305-0100, Maryland Department of Natural Resources, Annapolis, Maryland.

Southerland, M., L. Erb, G. Rogers, R. Morgan, K. Eshleman, M. Kline, K. Kline, P. Kazyak, J. Kilian, J. Ladell, and J. Thompson. 2005b. *Maryland Biological Stream Survey 2000-2004, Stressors Affecting Maryland Streams*. Volume XIV, Publication # DNR-12-0305-0101, Maryland Department of Natural Resources, Annapolis, Maryland.

Southerland, M.T., L.A. Erb, G.M. Rogers, and P.F. Kazyak. 2005c. *Maryland Biological Stream Survey 2000-2004, Statewide and Tributary Basin Results*. Volume VII, Publication # DNR-12-0305-0109, Maryland Department of Natural Resources, Annapolis, Maryland.

Southern Maryland Online (SMO). 2008. *Plans Unveiled for MD4, Thomas Johnson Bridge Plans*. Accessed November 19, 2008 at http://somd.com/news/headlines/2008/7796.shtml.

Spackman, S.C. and J.W. Hughes. 1994. "Assessment of Minimum Stream Corridor Width for Biological Conservation: Species Richness and Distribution Along Mid-Order Streams in Vermont, USA." *Biological Conservation* 71(3):325-332.

St. Mary's County Board of County Commissioners (SMCBCC). 2003. *Quality of Life in St Mary's County – A Strategy for the 21st Century*. Accessed November 19, 2008 at http://www.co.saint-marys.md.us/planzone/docs/CompPlanamendedMarch03.pdf.

St. Mary's County Board of County Commissioners (SMCBCC). 2005. *St. Mary's County 2005 Land Preservation, Parks, and Recreation Plan*. Accessed November 19, 2008 at http://www.co.saint-marys.md.us/recreate/docs/2005R&PLandPreservationPlan.pdf.

St. Mary's County Board of County Commissioners (SMCBCC). 2007. *St. Mary's County, Maryland, Approved Budget, Fiscal Year 2007*. Accessed November 19, 2008 at http://www.co.saint-marys.md.us/finance/documents/2007%20Budget%20Book.pdf.

St. Mary's County Board of County Commissioners (SMCBCC). 2008a. *St. Mary's County, Maryland, Recommended Budget, Fiscal Year 2009*. Accessed August 15, 2008 at http://www.co.saint-marys.md.us/finance/documents/RecommendBudgetFY09.pdf.

St. Mary's County Board of County Commissioners (SMCBCC). 2008b. *St. Mary's County FY08 Approved Budget*. Accessed November 19, 2008 at http://www.co.saint-marys.md.us/finance/documents/FY08BudgetComplete.pdf.

St. Mary's County Department of Public Works (SMC DPW). 2006. *St. Mary's County Transportation Plan, August 200*6. Accessed August 11, 2008 at http://www.co.saint-marys.md.us/dpw/docs/tranposrtationplan/LongTermReport-Adopted.pdf.

St. Mary's County Department of Public Works (SMC DPW). 2008a. *Airport Operations Division*. Accessed November 18, 2008 at http://www.co.saint-marys.md.us/dpw/dpwtemplate.asp?content=airportoverviewcontent.asp.

St. Mary's County Department of Public Works (SMC DPW). 2008b. *Transportation Services Division, Other Program Information*. Accessed November 19, 2008 at http://www.co.saint-marys.md.us/dpw/dpwtemplate.asp?content=stsotherprograminfocontent.asp.

St. Mary's County Public Schools (SMCPS). 2008. *St. Mary's County Public Schools*. Accessed December 2, 2008 at http://www.smcps.k12.md.us/.

St. Mary's Travel and Tourism (SMTT). 2008. *State Parks*. Accessed November 19, 2008 at http://tour.co.saint-marys.md.us/tourismtemplate.asp?content=stateparkscontent.asp.

Stankelis, R.M., M.D. Naylor, and W.R. Boynton. 2003. "Submerged Aquatic Vegetation in the Mesohaline Region of the Patuxent Estuary: Past, Present, and Future Status." *Estuaries* 26:186-195.

State of Maryland. 2008. *Recommended Licensing Conditions – Revised 24 October 2008*. *Maryland Public Service Commission (PSC) Case No. 9127, UniStar Nuclear Energy, LLC.*

Stevens, C.E., C.A. Pazkowski, and A.L. Foote. 2007. "Beaver (*Castor canadensis*) as a Surrogate Species for Conserving Anuran Amphibians on Boreal Streams in Alberta, Canada." *Biological Conservation* 134(1):1-13.

Stinson, D.W., J.W. Watson, and K.R. McAllister. 2007. *Washington State Status Report for the Bald Eagle*. Washington Department of Fish and Wildlife, Olympia, Washington. Available at http://wdfw.wa.gov/wlm/diversty/soc/status/baldeagle/baldeagle_status07.pdf.

Stribling, J.B., B.K. Jessup, J.S. White, D. Boward, and M. Hurd. 1998. *Development of a Benthic Index of Biotic Integrity for Maryland Streams*. CBWP-EA-98-3, Maryland Department of Natural Resources, Annapolis, Maryland.

Tankersley, R.A., M.G. Wieber, M.A. Sigala, and K.A. Kachurka. 1998. "Migratory Behavior of Ovigerous Blue Crabs (*Callinectes sapidus*): Evidence for Selective Tidal-Stream Transport." *The Biological Bulletin* 195(2):168-173.

Tarnowski, M., ed. 2007. *Maryland Oyster Population Status Report, 2006 Fall Survey*. Maryland Department of Natural Resources, Annapolis, Maryland.

Tarnowski, M., ed. 2008. *Maryland Oyster Population Status Report, 2007 Fall Survey*. Maryland Department of Natural Resources, Annapolis, Maryland.

Tatu, K.S., J.T. Anderson, L.J. Hindman, and G. Seidel. 2007a. "Diurnal Foraging Activities of Mute Swans in Chesapeake Bay, Maryland." *Waterbirds* 30(1):121-128.

Tatu, K.S., J.T. Anderson, L.J. Hindman, and G. Seidel. 2007b. "Mute Swans' Impact on Submerged Aquatic Vegetation in Chesapeake Bay." *Journal of Wildlife Management, Research Library Core* 71(5):1431.

Taverna, K., R.K. Peet, and L.C. Phillips. 2005. "Long-Term Change in Ground-Layer Vegetation of Deciduous Forests of the North Carolina Piedmont, USA." *Journal of Ecology* 93:202-213.

Terceiro, M. 2006. *Summer Flounder Assessment and Biological Reference Point Update for 2006*. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Woods Hole, Massachusetts.

Tetra Tech NUS. 2007a. *Final Faunal Survey Report for Proposed UniStar Nuclear Project Area, Calvert Cliffs Nuclear Power Plant Site, Calvert County, Maryland*. Germantown, Maryland. Accession No. ML090690114.

Tetra Tech NUS. 2007b. *Final Wetland Delineation Report for Proposed UniStar Nuclear Project Area, Calvert Cliffs Nuclear Power Plant Site, Calvert County, Maryland*. Germantown, Maryland. Accession No. ML100040304.

Tetra Tech NUS. 2007c. *Final Rare Plant Survey Report for Proposed UniStar Nuclear Project Area, Calvert Cliffs Nuclear Power Plant Site, Calvert County, Maryland*. Tetra Tech NUS, Germantown, Maryland. Accession No. ML090690117.

Tipler, PA. 1982. *Physics.* Worth Publishers, New York.

Ulanowicz, R.E. and J.H. Tuttle. 1992. "The Trophic Consequences of Oyster Stock Rehabilitation in Chesapeake Bay." *Estuaries* 15(3):298-306.

UniStar Nuclear Development, LLC (UniStar). 2007. *Technical Report in Support of Application of UniStar Nuclear Energy, LLC and UniStar Nuclear Operating Services, LLC for Certificate of Public Convenience and Necessity Before The Maryland Public Service Commission for Authorization to Construct Unit 3 at Calvert Cliffs Nuclear Power Plant and Associated Transmission Lines*. November 6, 2007. Accession No. ML100960624.

UniStar Nuclear Energy (UniStar). 2008a. Letter from G. Vanderheyden (UniStar) to U.S. Nuclear Regulatory Commission in response to NRC letter dated May 13, 2008, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Submittal of Response to Requests for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3 and Request for Withholding of Documents." June 12, 2008. Accession No. ML100040300.

UniStar Nuclear Energy (UniStar). 2008b. Letter from G. Gibson (UniStar) to U.S. Nuclear Regulatory Commission in response to NRC letters dated May 13, 2008, June 12, 2008, and August 29, 2008, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Submittal of Response Requests for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3 – Supplemental Aquatic RAIs." September 29, 2008. Accession No. ML082760508.

UniStar Nuclear Energy (UniStar). 2008c. Letter from G. Gibson (UniStar) to U.S. Nuclear Regulatory Commission in response to NRC letter dated September 10, 2008, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Submittal of Response to Calvert Cliffs Nuclear Power Plant, Unit 3, COLA, Request for Additional Information Terrestrial Ecology." October 17, 2008. Accession No. ML082960400.

UniStar Nuclear Energy (UniStar). 2008d. Letter from G. Gibson (UniStar) to U.S. Nuclear Regulatory Commission in response to NRC letter dated October 14, 2008, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Calvert Cliffs Nuclear Power Plant, Unit 3, Submittal of Response to Requests for Additional Information, Environmental Impact Statement (EIS) Issues." October 31, 2008. Accession No. ML083110676.

UniStar Nuclear Energy (UniStar). 2008e. Letter from G. Vanderheyden (UniStar) to U.S. Nuclear Regulatory Commission in response to NRC letter dated May 13, 2008, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Submittal of Supplemental Response to Requests for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3." August 18, 2008. Accession No. ML100970387.

UniStar Nuclear Energy (UniStar). 2009a. *Calvert Cliffs Nuclear Power Plant Unit 3 Combined License Application, Part 3, Environmental Report*. Revision 6, September 30, 2009, Baltimore, Maryland. Accession No. ML092880921.

UniStar Nuclear Energy (UniStar). 2009b. *Calvert Cliffs Nuclear Power Plant Unit 3 Combined License Application, Part 2, Final Safety Analysis Report*. Revision 6, September 30, 2009, Baltimore, Maryland. Accession No. ML092880897.

UniStar Nuclear Energy (UniStar). 2009c. Letter from G. Gibson (UniStar) to U.S. Nuclear Regulatory Commission, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016 Calvert Cliffs Nuclear Power Plant, Unit 3 Follow-up Responses to Environmental Report RAIs 1001 through 1011, dated March 5, 2009, and RAI 1011 dated July 17, 2009." July 31, 2009. Accession No. ML092190627.

UniStar Nuclear Development, LLC (UniStar). 2009d. Letter from G. Gibson (UniStar) to U.S. Nuclear Regulatory Commission in response to NRC letter dated February 3, 2009, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Calvert Cliffs Nuclear Power Plant, Unit 3, Environmental RAIs No. 1001 through 1011." March 5, 2009. Accession No. ML090710146.

UniStar Nuclear Energy (UniStar). 2009e. Letter from G. Gibson (UniStar) to U.S. Nuclear Regulatory Commission in response to NRC letter dated February 3, 2009, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016 Calvert Cliffs Nuclear Power Plant, Unit 3 Follow-up Responses to Environmental Report RAI NO.1 003-2, Aquatic Ecology and RAI NO.1 008-4, Ecological Impacts (Fish Return System)." July 24, 2009. Accession No. ML092150728.

UniStar Nuclear Energy (UniStar). 2009f. Letter from G. Gibson (UniStar) to U.S. Nuclear Regulatory Commission, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016 Calvert Cliffs Nuclear Power Plant, Unit 3 Follow-up Responses to Environmental Report RAI No. 124, Estimated Tax Benefit, and Application for Withholding of Documents. September 17, 2009. Accession No. ML092640126.

University of Michigan Museum of Zoology (UMMZ). 2008. Gastrophryne carolinensis*, Eastern Narrow-Mouthed Toad*. Accessed April 29, 2008 at http://animaldiversity.ummz.umich.edu/site/accounts/information/Gastrophryne_carolinensis.htm.

University of Wisconsin (UW). 2008. *Robert W. Freckmann Herbarium, Freckmann Family Asteraceae* Solidago speciosa *Nutt, showy goldenrod*. Accessed February 8, 2008 at http://wisplants.uwsp.edu/scripts/detail.asp?SpCode=SOLSPE2. Accession No. ML093210616.

U.S. Army Corps of Engineers (USACE). 1992. Memorandum from A.E. Williams (USACE, Major General, USA, Director of Civil Works), "Subject: Clarification and Interpretation of the 1987 Manual." March 6, 1992. Available at http://www.wetlands.com/pdf/wdm0225e.pdf.

U.S. Army Corps of Engineers (USACE). 2008. *Public Notice in Reply to Application Number CENAB-OP-RMS NAB-2007-01823-M05 (Calvert Cliff's 3 Nuclear Project, LLC/Unistar Nuclear Operating Services, LLC).* September 3, 2008. Accession No. ML082550288.

U.S. Army Corps of Engineers (USACE). 2009a. *Final Programmatic Environmental Impact Statement for Oyster Restoration in Chesapeake Bay Including the Use of a Native and/or Nonnative Oyster, Volumes I and 2*. Norfolk, Virginia.

U.S. Army Corps of Engineers (USACE). 2009b. *Record of Decision. Final Programmatic Environmental Impact Statement for Oyster Restoration in Chesapeake Bay Including the Use of a Native and/or Nonnative Oyster*. Norfolk, Virginia.

U.S. Army Corps of Engineers (USACE). 2010. Letter from K.B. Anderson (USACE) to R.J. Nelson (Office of Federal Agency Programs, Advisory Council on Historic Preservation), Review of US Army Corps of Engineers and Maryland State Historic Preservation Officer regarding Calvert Cliffs 3 Nuclear Plant (CENAB-OP-RMS) effect on historic properties and Memorandum of Agreement. March 16, 2010. Accession No. ML100810272.

U.S. Bureau of Labor Statistics (USBLS). 2007a. *May 2007 State Occupational Employment and Wage Estimates, Maryland*. Accessed October 29, 2008 at http://stats.bls.gov/oes/current/oes_md.htm. Accession No. ML100490592.

U.S. Bureau of Labor Statistics (USBLS). 2007b. *May 2007 Metropolitan and Nonmetropolitan Area Occupational Employment and Wage Estimates, Washington-Arlington-Alexandria, DC-VA-MD-WV*. Accessed November 18, 2008 at http://www.bls.gov/oes/current/oes_47900.htm. Accession No. ML100780174.

U.S. Bureau of Labor Statistics (USBLS). 2008a. *TABLE 1. Incidence Rates of Nonfatal Occupational Injuries and Illnesses by Industry and Case Types, 2007*. Accessed December 30, 2009 at http://www.bls.gov/iif/oshwc/osh/os/ostb1917.pdf. Accession No. ML093210629.

U.S. Bureau of Labor Statistics (USBLS). 2008b. *TABLE 6. Incidence Rates of Nonfatal Occupational Injuries and Illnesses by Industry and Case Types, 2007 – Maryland*. Accessed December 30, 2009 at http://www.bls.gov/iif/oshwc/osh/pr076md.pdf. Accession No. ML093210629.

U.S. Census Bureau (USCB). 2000. *Race [71] – Universe: Total Population, Census 2000 Summary File 1 (SF 1)*. Accessed February 12, 2010 at http://factfinder.census.gov. Accession No. ML100740438.

U.S. Census Bureau (USCB). 2001. *Overview of Race and Hispanic Origin 2000.* Accessed on February 3, 2010 at http://www.census.gov/prod/2001pubs/c2kbr01-1.pdf. Accession No. ML100890583.

U.S. Census Bureau (USCB). 2006a. *Maryland County Population Estimates 2000-2006, Parts 1 and 2*. Accessed November 18, 2008 at http://factfinder.census.gov (USCB – Census 2000 – American FactFinder – Data Sets, Annual Population Estimates – 2006 Population Estimates – Detailed Tables). Accession Nos. ML093270583, ML093270584.

U.S. Census Bureau (USCB). 2006b. *Washington, D.C. Population Estimates 2000-2006*. Accessed October 24, 2008 at http://factfinder.census.gov (USCB – Census 2000 – American FactFinder – Data Sets, Annual Population Estimates – 2006 Population Estimates – Detailed Tables). Accession No. ML093270589.

U.S. Census Bureau (USCB). 2006c. *Calvert County, Maryland, Selected Economic Characteristics: 2006*. Accessed October 24, 2008 at http://factfinder.census.gov (USCB - Census 2000 – American FactFinder – Calvert County, Maryland – Economic Characteristics). Accession No. ML093270591.

U.S. Census Bureau (USCB). 2006d. *Calvert County, Selected Housing Characteristics: 2006*. Accessed November 19, 2008 at http://factfinder.census.gov (USCB – Census 2000 – American FactFinder – Calvert County, Maryland – Housing Characteristics). Accession No. ML093270592.

U.S. Census Bureau (USCB). 2006e. *St. Mary's County, Selected Housing Characteristics: 2006*. Accessed November 19, 2008 at http://factfinder.census.gov (USCB – Census 2000 – American FactFinder – Calvert County, Maryland – Housing Characteristics). Accession No. ML093270597.

U.S. Census Bureau (USCB). 2006f. *Extracted from State and Metropolitan Area Data Book: 2006 on Healthcare*. Accessed November 19, 2008 at http://www.census.gov/prod/2006pubs/smadb/smadb-06tableb.pdf. Accession No. ML10490598.

U.S. Census Bureau (USCB). 2006g. Delaware County Population Estimates 2000-2006. Accessed October 24, 2008 at USCB – Census 2000 – American FactFinder – Data Sets, Annual Population Estimates – 2006 Population Estimates – Detailed Tables.

U.S. Census Bureau (USCB). 2006h. Virginia County Population Estimates 2000-2006, Parts 1 and 2. Accessed October 24, 2008 at USCB AFF 2006b P2. Maryland County Population Estimates 2000-2006. At USCB – Census 2000 – American FactFinder – Data Sets, Annual Population Estimates – 2006 Population Estimates – Detailed Tables.

U.S. Census Bureau (USCB). 2007. *County and City Data Book, Table B-6. Counties – Physicians, Community Hospitals, Medicare, Social Security, and Supplemental Security Income, Maryland*. Accessed November 19, 2008 at http://www.census.gov/prod/2008pubs/07ccdb/tabb6.pdf. Accession No. ML093270598.

U.S. Department of Agriculture (USDA). 2002. *USDA Plant Fact Sheet; Tulip Poplar,* Liriodendron tulipifera *L., Plant Symbol = LITU*. Accessed on February 15, 2008 at http://plant-materials.nrcs.usda.gov/intranet/pfs.html. Accession No. ML093270599.

U.S. Department of Agriculture (USDA). 2008a. *Plants Profile,* Kalmia latifolia*, L., mountain laurel*. Accessed February 19, 2008 at http://plants.usda.gov/java/nameSearch?keywordquery=Kalmia+latifolia&mode=sciname&submit.x=15&submit.y=10. Accession No. ML093210630.

U.S. Department of Agriculture (USDA). 2008b. *Plants Profile,* Centrosema virginianum *(L.) Benth., spurred butterfly pea*. Accessed February 15, 2008 at http://plants.usda.gov/java/nameSearch. Accession No. ML093270601.

U.S. Department of Agriculture (USDA). 2008c. *Plants Profile,* Liriodendron tulipifera *L. tuliptree*. Accessed February 14, 2008 at http://plants.usda.gov/java/profile?symbol=LITU. Accession No. ML093210632.

U.S. Department of Agriculture (USDA). 2008d. *Plants Profile,* Quercus prinus*, L., chestnut oak*. Accessed February 15, 2008 at http://plants.usda.gov/java/profile?symbol=QUPR2. Accession No. ML093210633.

U.S. Department of Agriculture (USDA). 2008e. *Plants Profile,* Quercus shumardii *Buckley Shumard's oak*. Accessed February 14, 2008 at http://plants.usda.gov/java/profile?symbol=QUSH. Accession No. ML093210634.

U.S. Department of Agriculture (USDA). 2008f. *Flora of North America, Taxon*: Quercus shumardii. Accessed December 14, 2008 at http://www.efloras.org/. Accession No. ML09270604.

U.S. Department of Agriculture (USDA). 2008g. *Plants Profile,* Solidago speciosa *Nutt, showy goldenrod*. Accessed February 8, 2008 at http://plants.usda.gov/java/profile?symbol=SOSP2. Accession No. ML093220804.

U.S. Department of Agriculture (USDA). 2008h. *Plants Profile,* Thelypteris noveboracensis *(L.) Nieuwl., New York fem*n. Accessed February 19, 2008 at http://plants.usda.gov/java/nameSearch. Accession No. ML093210638.

U.S. Department of Agriculture (USDA). 2008i. *Plants Profile,* Sesuvium maritimum *(Walter) Britton, Sterns & Poggenb. Slender Seapurslane*. Accessed March 13, 2008 at http://plants.usda.gov/java/profile?symbol=SEMA3. Accession No. ML100481397.

U.S. Department of Defense (DOD). 2010. *CNIC--Naval Air Station Patuxent River*. Accessed January 29, 2010 at https://www.cnic.navy.mil/Patuxent/AboutCNIC/index.htm. Accession No. ML100760365.

U.S. Environmental Protection Agency (EPA). 2002. *National Recommended Water Quality Criteria: 2002*. EPA-822-R-02-047, Washington, D.C.

U.S. Fish and Wildlife Service (FWS). 1993. *Puritan Tiger Beetle (*Cicindela puritana *G. Horn) Recovery Plan*. Northeast Region, Hadley, Massachusetts.

U.S. Fish and Wildlife Service (FWS). 1994. *Northeastern Beach Tiger Beetle (*Cincindela dorsalis dorsalis *Say), Recovery Plan*. Accession No. ML071970332.

U.S. Fish and Wildlife Service (FWS). 2007. *Puritan Tiger Beetle (*Cicindela puritana*), Draft 5-Year Review: Summary and Evaluation*. Annapolis, Massachusetts.

U.S. Fish and Wildlife Service (FWS). 2009. *Shortnose Sturgeon in the Potomac River*. U.S. Fish and Wildlife Service Update. Maryland Fishery Resources Office, Annapolis, Maryland.

U.S. Forest Service (USFS). 2008a. *Weed of the Week, Common Reed,* Phragmites australis *Cav. Trin. ex Steud*. Accessed October 2, 2008 at http://www.na.fs.fed.us/fhp/invasive_plants/weeds/common-reed.pdf. Accession No. ML093270607.

U.S. Forest Service (USFS). 2008b. *Index of Species Information, Species:* Quercus shumardii. Accessed February 8, 2008 at http://www.fs.fed.us/database/feis/plants/tree/queshu/all.html. Accession No. ML093270606.

U.S. Forest Service (USFS). 2008c. *Nepalese Browntop*. Accessed February 21, 2008 at http://www.invasive.org/browse/subject.cfm?sub=3051. Accession No. ML093270608.

U.S. Geological Survey (USGS). 2005. *U.S. Geological Survey Chesapeake Bay Science Plan, 2006-2011*. Open-File Report 2005-1440, Reston, Virginia.

U.S. Geological Survey (USGS). 2008. *ARMI National Atlas for Amphibian Distributions, Eastern Narrow-Mouthed Toad*. Accessed February 7, 2008 at http://www.pwrc.usgs.gov/armiatlas/species.cfm?recordID=173467. Accession No. ML093210639.

U.S. Global Change Research Program (GCRP). 2009. *Global Climate Change Impacts in the United States.* T.R. Karl, J.M. Melillo, and T.C. Peterson, eds. Cambridge University Press, New York. Available at http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf.

U.S. Nuclear Regulatory Commission (NRC). 1977. *Regulatory Guide 1.111 - Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors*. Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1982. *Regulatory Guide 1.145 - Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants*. Revision 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, *Main Report.* NUREG-1437, Vols. 1 and 2, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report,* NUREG-1437, Addendum 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2000. *Environmental Standard Review Plan—Review Plans for Environmental Reviews for Nuclear Power Plants.* NUREG-1555, NRC, Washington, D.C. Includes 2007 updates.

U.S. Nuclear Regulatory Commission (NRC). 2001. *Event Notification Report for June 5, 2001.* Calvert Cliffs Nuclear Power Plant Impingement Incidents Event Number: 38049. Available at at http://www.nrc.gov/reading-rm/doc-collections/event-status/event/2001/20010605en.html.

U.S. Nuclear Regulatory Commission (NRC). 2005. *Event Notification Report for July 18, 2005.* Calvert Cliffs Nuclear Power Plant Impingement Incidents Event Number: 41845. Available at http://www.nrc.gov/reading-rm/doc-collections/event-status/event/2005/20050718en.html.

U.S. Nuclear Regulatory Commission (NRC). 2006a. Letter from B. McDermott (NRC) to J.A. Spina (Constellation Generation Group, LLC.), “Subject: Calvert Cliffs Nuclear Power Plant – NRC Integrated Inspection Report 05000317/2006003 and 05000318/2006003.” July 21, 2006. Accession No. ML062060024.

U.S. Nuclear Regulatory Commission (NRC). 2006b. *Liquid Radioactive Release Lessons Learned Task Force Final Report*. Accessed at www.nrc.gov/reactors/operating/ops-experience/tritium/lr-release-lessons-learned.pdf. Accession No. ML083220312.

U.S. Nuclear Regulatory Commission (NRC). 2006c. *Event Notification Report for July 12, 2006.* Calvert Cliffs Nuclear Power Plant Impingement Incidents Event Numbers: 42699 and 42700. Available at http://www.nrc.gov/reading-rm/doc-collections/event-status/event/2006/20060712en.html.

U.S. Nuclear Regulatory Commission (NRC). 2006d. *Event Notification Report for July 13, 2006.* Calvert Cliffs Nuclear Power Plant Impingement Incidents Event Number: 42702. Available at http://www.nrc.gov/reading-rm/doc-collections/event-status/event/2006/20060713en.html.

U.S. Nuclear Regulatory Commission (NRC). 2006e. *Event Notification Report for July 14, 2006.* Calvert Cliffs Nuclear Power Plant Impingement Incidents Event Number: 42704. Available at http://www.nrc.gov/reading-rm/doc-collections/event-status/event/2006/20060714en.html.

U.S. Nuclear Regulatory Commission (NRC). 2006f. *Event Notification Report for August 16, 2006.* Calvert Cliffs Nuclear Power Plant Impingement Incidents Event Number: 42776. Available at http://www.nrc.gov/reading-rm/doc-collections/event-status/event/2006/20060816en.html.

U.S. Nuclear Regulatory Commission (NRC). 2006g. *Event Notification Report for September 6, 2006.* Calvert Cliffs Nuclear Power Plant Impingement Incidents Event Number: 42827. Available at http://www.nrc.gov/reading-rm/doc-collections/event-status/event/2006/20060906en.html.

U.S. Nuclear Regulatory Commission (NRC). 2007a. *Regulatory Guide 1.23 - Meteorological Monitoring Programs for Nuclear Power Plants*. Revision 1, Washington D.C.

U.S. Nuclear Regulatory Commission (NRC). 2007b. *Dominion Nuclear North Anna, LLC. (Early Site Permit for North Anna ESP Site).* CLI-07-27, Docket No. 52-008-ESP.

U.S. Nuclear Regulatory Commission (NRC). 2008a. Letter from R. Raione (NRC) to D. Klima (Advisory Council on Historic Preservation), “Subject: Request for Participation in the Scoping Process for the Calvert Cliffs Nuclear Plant, Unit 3 Combined License Application Review. February 29, 2008. Accession No. ML080430649.

U.S. Nuclear Regulatory Commission (NRC). 2008b. Letter from R. Raione (NRC) to J.R. Little (Maryland Historical Trust), “Subject: Request for Participation in the Scoping Process for the Calvert Cliffs Nuclear Plant, Unit 3 Combined License Application Review.” February 29, 2008. Accession No. ML080430656.

U.S. Nuclear Regulatory Commission (NRC). 2009. *Duke Energy Carolinas, LLC and Tennessee Valley Authority.* CLI-09-21, Docket No. 52-018-COL, 52-019-COL, 52-014-COL, 52-015-COL.

Villard, M., G. Merriam, and B.A. Maurer. 1995. "Dynamics in Subdivided Populations of Neotropical Migratory Birds in a Fragmented Temperate Forest." *Ecology* 76(1):27-40.

Virginia Institute of Marine Science (VIMS). 2000. *Help Virginia's Sea Turtles! Support the VIMS Sea Turtle Stranding Program Brochure*. Gloucester Point, Virginia.

Vogelbein, W.K., J.M. Hoenig, and D.T. Gauthier. 2006. "Epizootic Mycobacteriosis in Chesapeake Bay Striped Bass: What is the Fate of Infected Fish?" In *USGS/NOAA Workshop on Mycobacteriosis in Striped Bass, May 7-10, 2006, AnnPiperapolis, Maryland*. USGS Scientific Investigations Report 2006-5214, USGS, Reston, Virgina.

Wallace, J.B., J.W. Grubagh, and M.R. Whiles. 1996. "Biotic Indices and Stream Ecosystem Processes: Results form an Experimental Study." *Ecological Applications* 6(1):140-151.

Walter III, J.F., and H.M. Austin. 2003. "Diet Composition of Large Striped Bass (*Morone saxatilis*) in Chesapeake Bay." *Fishery Bulletin* 101(2):414–423.

Wang, S. and E.D. Houde. 1995. "Distribution, Relative Abundance, Biomass and Production of Bay Anchovy (*Anchoa mitchilli*) in the Chesapeake Bay." *Marine Ecology Progress Series* 121:27-38.

Watts, B.D., G.D. Therres, and M.A. Byrd. 2007. "Status, Distribution, and the Future of Bald Eagles in the Chesapeake Bay Area." *Waterbirds* 30(Special Publication 1):25-38.

Watts, B.D. and B.J. Paxton. 2007. "Ospreys of the Chesapeake Bay: Population Recovery, Ecological Requirements, and Current Threats." *Waterbirds* 30 (Special Publication 1):39-49.

Weisberg, S.B., L.C. Sciiappner, J.A. Ranasinghe, R.J. Dial, D.M. Dauer, and J.B. Frithsen. 1997. "An Estuarine Benthic Index of Biotic Integrity (B-IBI) for Chesapeake Bay." *Estuaries* 20(1):149-158.

Wiley, D.J., R.P. Morgan II, R.H. Hilderbrand, R.L. Raesly, and D.L. Shumway. 2004. "Relations between Physical Habitat and American Eel Abundance in Five River Basins in Maryland." *Transactions of the American Fisheries Society* 133:515-526.

Williams, A.B. 1984. *Shrimps, Lobsters, and Crabs of the Atlantic Coast of the Eastern United States, Maine to Florida*. D.C. Fisher, ed. Smithsonian Institution Press, Washington, D.C.

Wirgin, I., C. Grunwald, E. Carlson, J. Stabile, D.L. Peterson, and J. Waldman. 2005. "Range-Wide Population Structure of Shortnose Sturgeon *Acipenser brevirostrum* Based on Sequence Analysis of the Mitochondrial DNA Control Region." *Estuaries* 28(3):406-421.

Wirgin, I., C. Grunwald, J. Stabile, and J.R. Waldman. 2009. "Delineation of discrete population segments of shortnose sturgeon *Acipenser brevirostrum* based on mitochondrial DNA control region sequence analysis." *Conservation Genetics* doi: 10.1007/s10592-009-9840-1.

3.0 Site Layout and Plant Description

The proposed Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 (referred to as the proposed Unit 3) site is located in Calvert County in rural Maryland. Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC (collectively referred to as UniStar) applied to the U.S. Nuclear Regulatory Commission (NRC) for a combined construction permit and operating license (combined license or COL) for the proposed Unit 3. In addition to the COL application, UniStar applied for a Department of Army (DA) permit from the U.S. Army Corps of Engineers (USACE or Corps) to conduct activities that result in alteration of waters of the United States, including wetlands. The proposed new unit would be situated wholly within the existing Calvert Cliffs site and adjacent to existing CCNPP Units 1 and 2. The site is situated on the western shore of the Chesapeake Bay, approximately 40 mi southeast of Washington, D.C.

This chapter describes the key plant characteristics that are used to assess the environmental impacts of the proposed actions. The information is drawn from UniStar's Environmental Report (ER) (UniStar 2009a), its Final Safety Analysis Report (FSAR) (UniStar 2009b), UniStar's joint application to the Corps and the Maryland Department of the Environment (UniStar 2008a), the Corps Public Notice (USACE 2008), and supplemental documentation from UniStar as referenced.

Whereas Chapter 2 of this environmental impact statement (EIS) describes the existing environment of the proposed site and its vicinity, this chapter describes the physical layout of the proposed plant. This chapter also describes the physical activities involved in building and operating the plant and associated transmission lines. The environmental impacts of building and operating the plant are discussed in Chapters 4 and 5 of this EIS, respectively. This chapter is divided into five sections. Section 3.1 describes the external appearance and layout of the proposed plant. Section 3.2 describes the major plant structures and distinguishes structures that interface with the environment from those that do not interface with the environment or that interface with the environment temporarily. Section 3.3 describes the activities involved in building or installing each of the plant structures. Section 3.4 describes the operational activities of the plant systems that interface with the environment. References cited are listed in Section 3.5.

3.1 External Appearance and Plant Layout

The 2070-ac Calvert Cliffs site currently contains two pressurized water reactors (PWRs) and their associated facilities, which occupy approximately 220 ac. These facilities, along with auxiliary facilities including the barge slip and onsite transmission line corridors, occupy 331 ac of the Calvert Cliffs site. The two units share a turbine building and other support structures. The service building and intake and discharge system are located east of the turbine building.

An independent spent fuel storage installation is located near the center of the site. An abandoned summer camp, Camp Conoy, is located on the site south of the existing units. The land that would be disturbed for Unit 3 is estimated at 460 ac, approximately 320 ac of which would be permanently converted to structures, pavement, or intensively maintained grounds. The balance of 140 ac would be disturbed only temporarily to accommodate the concrete batch plant and construction offices, warehouses, laydown areas, and parking associated with facilitating site preparation and building activities. The site, including the planned footprint of the proposed Unit 3 facilities, is shown in Figure 3-1. A conceptualization of the proposed Unit 3 superimposed on the site is shown in Figure 3-2.

The location for proposed Unit 3 is south of CCNPP Units 1 and 2, in the vicinity of the former Camp Conoy. Unit 3 would have a separate protected area and plant access road. The Unit 3 reactor building would be surrounded by the fuel pool building, four safeguard buildings, two emergency diesel generator buildings, the reactor auxiliary building, the radioactive waste processing building, and the access building (UniStar 2009a). The vent stack for Unit 3 would be the tallest new structure at approximately 211 ft above grade or about 7 ft above the reactor building. Unlike existing CCNPP Units 1 and 2, which use once-through cooling systems, the Unit 3 design would consist of a closed-cycle cooling system with a single, circular, mechanical draft cooling tower. At an approximate height of 164 ft, this 528-ft diameter tower (at the base) would be the second largest structure on the site and is to be outfitted with plume abatement to minimize visible water vapor plume (UniStar 2009a). Unit 3 buildings would be built of concrete or steel with metal siding. The exterior finishes for Unit 3 buildings would be similar in color and texture to those of the Unit 1 and 2 buildings (UniStar 2009a).

Forested areas, surrounding the facilities, obscure most views of the existing and proposed Calvert Cliffs units. Units 1 and 2 are visible from the Chesapeake Bay to the east. From the Bay, views of Unit 3 would be limited because of elevation differences between the Chesapeake Bay, the site, and the forested 1000-ft setback. Onsite forested areas and gently rolling hills and valleys would screen views so that only the tops of taller structures are likely to be visible from the nearest residential properties at a distance of 3000 to 4000 ft. The intake forebay and structure, pump house, and associated discharge piping at the shoreline for Unit 3 would likely have limited visual impact considering their proposed locations in proximity to the existing CCNPP Unit 1 and 2 intake structure and barge slip facility (UniStar 2009a).

3.2 Proposed Plant Structures

This section describes each of the major plant structures: the reactor power system, structures that would have a significant interface with the environment during operation, and the balance of plant structures. All of these structures are relevant in the discussion of the impacts of building the proposed Unit 3 in Chapter 4. Only those structures that interface with the environment are relevant to the operational impacts discussed in Chapter 5.

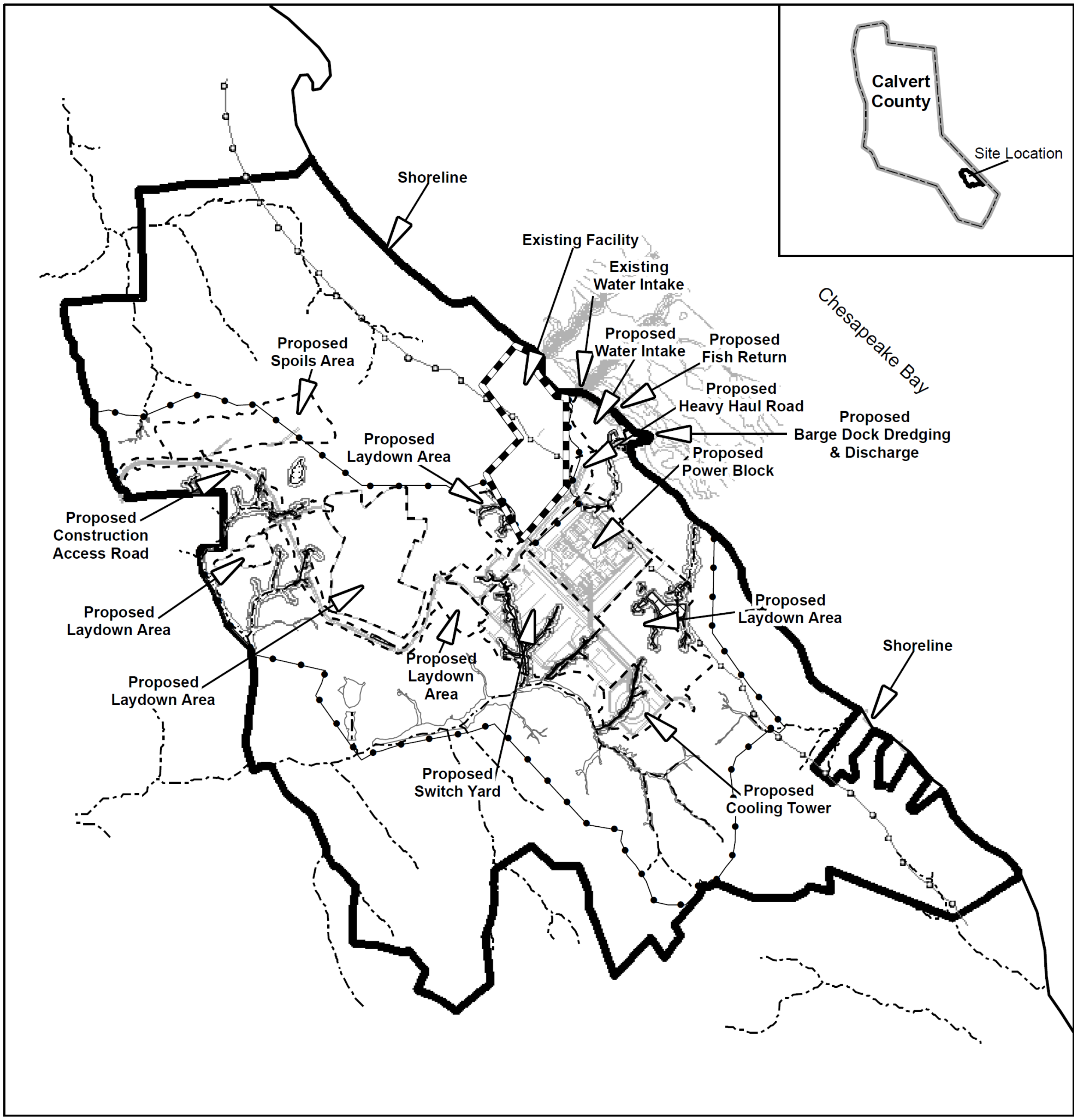

Figure 3-1. Calvert Cliffs Site and Layout of Proposed Unit 3 (UniStar 2008a)

Figure 3-2. Calvert Cliffs Site with Existing Units 1 and 2 at Left and Superimposed Illustration of Proposed Unit 3 at Right, Looking to the Southeast (UniStar 2009a)

3.2.1 Reactor Power Conversion System

UniStar has proposed building and operating a one-unit PWR steam electric system using the AREVA NP Inc.'s (AREVA) U.S. EPR design. AREVA submitted the Standard Design Certification Application for the U.S. EPR on December 11, 2007 (AREVA 2007) to the NRC. AREVA submitted changes to the U.S. EPR design information in Revision 1 of its Design Control Document (AREVA 2009). The NRC staff is performing a detailed review of that application. The four-loop PWR is rated at 4590 MW(t) with a design gross electrical output of approximately 1710 MW(e) and a net output of 1562 MW(e). The reactor coolant system (RCS) consists of the reactor pressure vessel; a pressurizer; one reactor coolant pump per loop; one steam generator per loop; and ancillary systems, piping, and control systems. The pressure vessel contains the fuel assemblies consisting of zirconium alloy clad uranium dioxide fuel rods that produce heat through a sustained criticality reaction. Heat created in the reactor core is transferred to the steam generators, and conversion of water to steam in the secondary side of the generators drives the turbine generator, creating electricity. The reject heat from the plant to the environment, principally the atmosphere, is calculated to be 3238 MW(t) (UniStar 2009a). Figure 3-3 provides an illustration of the reactor power conversion system.

3.2.2 Structures with a Major Plant-Environmental-Interface

The review team divided the plant structures into two primary groups: those that interface with the environment and those that are internal to the reactor and associated facilities but without direct interaction with the environment. Examples of interfaces with the environment are withdrawal of water from the environment at the intake structures, release of water to the environment at the discharge structure, and release of excess heat to the atmosphere. The structures or locations with environmental interfaces are considered in the review team's assessment of the environmental impacts of facility construction and preconstruction and facility operation in Chapters 4 and 5, respectively. The power-production processes that would occur within the plant itself and that do not affect the environment are not relevant to a National Environmental Policy Act (NEPA) review and are not discussed further in this EIS. However, such internal processes are considered by the NRC in the AREVA design certification documentation and in NRC safety review of the UniStar COL application. This section describes the structures with a significant plant-environment interface. The remaining structures are discussed in Section 3.2.3, inasmuch as they may be relevant in the review team's consideration of impacts discussed in Chapter 4.

Figure 3-4 illustrates the Calvert Cliffs site layout with a grid overlay used to reference the locations of various plant structures and activity areas as they are described in the following sections. Existing CCNPP Units 1 and 2 are located primarily in the 1C to 4D quadrants. Proposed Unit 3 structures are located primarily in the 3E to 5H quadrants.

3.2.2.1 Landscape and Stormwater Drainage

Landscaping and the stormwater drainage system affect both the recharge to the subsurface and the rate and location that precipitation drains into adjacent creeks and streams. Impervious areas eliminate recharge to aquifers beneath the site. Pervious areas managed to reduce runoff and maintained free of vegetation would experience considerably higher recharge rates than adjacent areas with local vegetation. The stormwater management system, including site grading, drainage ditches, swales, and stormwater retention ponds, provides a safety function to keep locally intense precipitation from flooding safety-related structures. Figure 3-4 illustrates the site drainage for proposed Unit 3 in quadrants 3:5E:H. The grading of the surface topography directs water away from safety structures and into ditches that drain away from the site into creeks and stormwater basins.

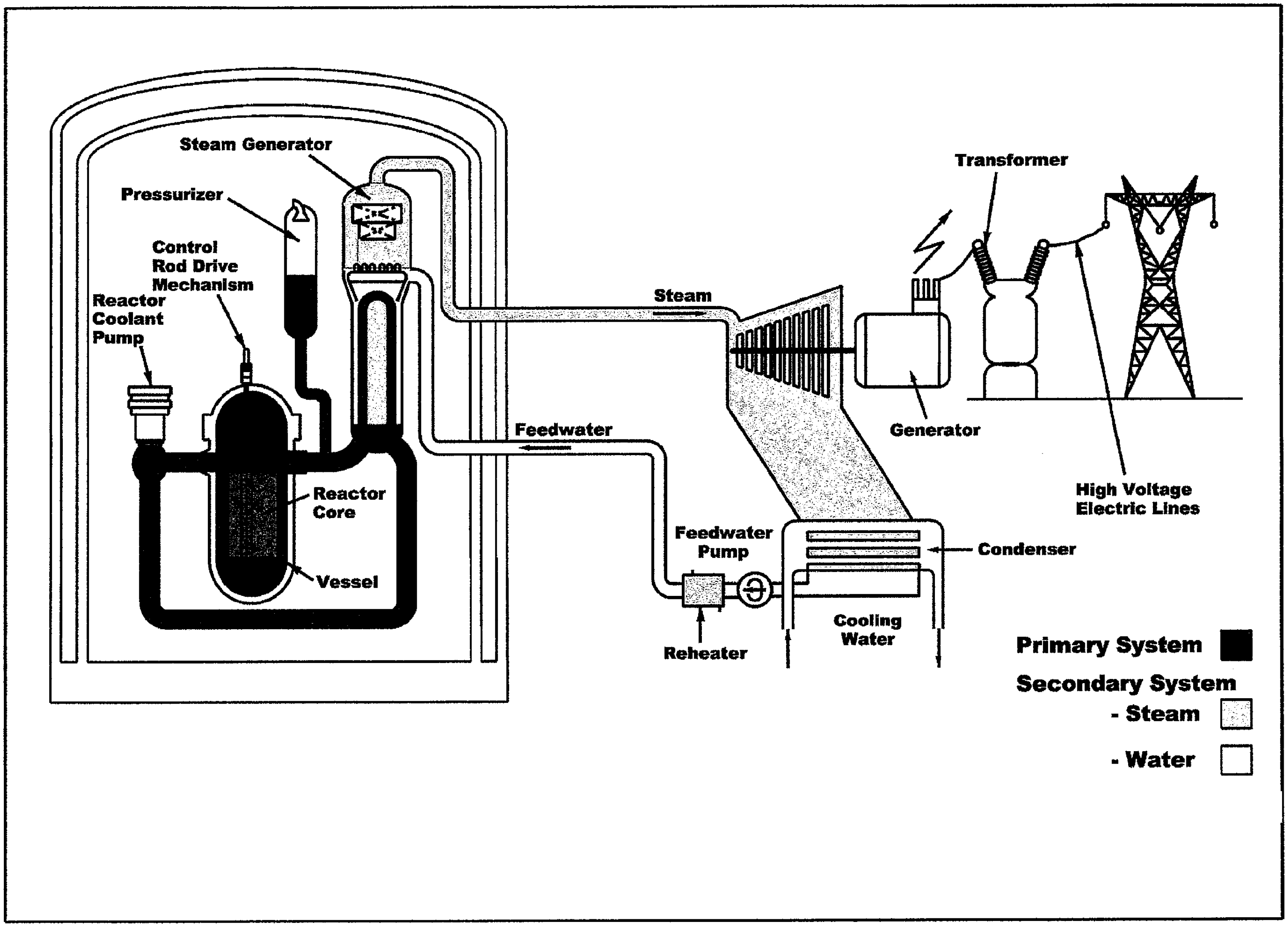

Figure 3-3. Simplified Flow Diagram of the Reactor Power Conversion System (UniStar 2009a)

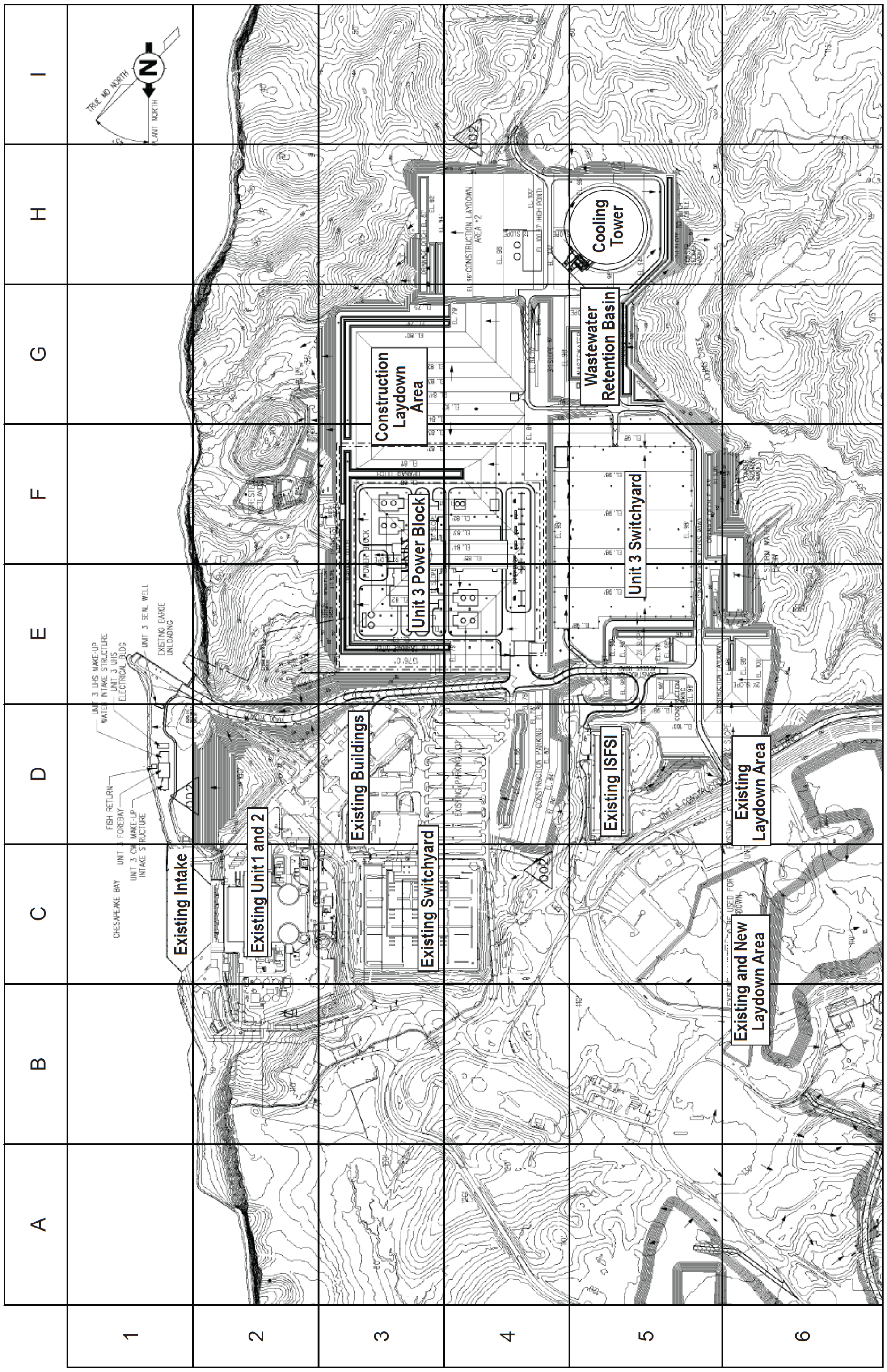

Figure 3-4. Grid Overlay of the Calvert Cliffs Site Layout Showing Major Structure and Activity Areas (Modified from UniStar 2009a)

3.2.2.2 Cooling-Water System

The cooling-water system represents the largest interface from the plant to the environment. Proposed Unit 3 is designed to use two cooling systems, a circulating water supply system (CWS) and an essential service water system (ESWS). The planned CWS, which cools the reactor circulating water, is a closed-cycle cooling system that uses a single mechanical draft cooling tower, drawing water from and discharging a portion of it into the Chesapeake Bay. The remaining portion of the water is released to the atmosphere via evaporative cooling through the mechanical draft cooling tower. The ESWS is a safety system to provide cooling water to heat exchangers located in the safeguards building and the cooling system for the emergency diesel generators located in the emergency power generating buildings. The ESWS would be used for normal operations, refueling, shutdown and cooldown, anticipated operational events, design basis accidents, and severe accidents. The planned ESWS is a closed-looped system with four, two-cell mechanical draft cooling towers for heat dissipation. UniStar's proposed desalination plant (see Section 3.2.3), which uses water withdrawn from the Bay and is designed to use seawater reverse osmosis technology, would supply water to the ESWS for normal operations. However, during accidents, the makeup water for the ESWS would be supplied from the Chesapeake Bay through a safety-related ultimate heat sink (UHS) intake structure (UniStar 2009a). These components represent interfaces between the plant and the environment.

Cooling-Water Intake Structures

For the proposed Unit 3, a 9000-ft^2 (0.21-ac), wedge-shaped pool would be built adjacent to the southern end of the existing forebay shared by CCNPP Units 1 and 2 intakes. Water would enter the wedge-shaped pool directly from the CCNPP Units 1 and 2 forebay. Two 60-in.-diameter safety-related intake pipes would extend from the wedge-shaped pool 550 ft to a common forebay (shared by CWS and UHS intakes) that would measure 100-ft-long by 80-ft-wide by about 12-ft-deep. No screens or fish-return system would be installed at the pipe openings, but there would be trash racks (without an associated fish-return system). The bars on the trash racks would be spaced 3.5 in. apart. The CWS and safety-related UHS intake structures would be located adjacent to each other in quadrant 1D (Figure 3-4) in the common forebay landward of the nearby Chesapeake Bay shoreline. Both the CWS and UHS intake structures would have trash racks (with 3.5-in. bar spacing) and traveling screens. The traveling screens for each system would be dual-flow type screens with a double entry-center exit flow pattern. The screen panels would be metallic or plastic mesh with a mesh size of 0.079 to 0.118-in. square (UniStar 2009a). The proposed CWS intake structure is a concrete structure 78-ft long and 55-ft wide. The CWS intake would have individual pump bays housing makeup pumps and a wash system to provide a pressurized spray to remove fish, crabs, and debris from the screens and transfer them to the fish-return system. Although the design is not complete, the fish-return system would be similar to those for CCNPP Units 1 and 2 (UniStar 2008b). To build the proposed fish-return outfall, an 18-in.-diameter pipe would be installed in a mechanically excavated trench east of the common forebay. Any bends in the pipes would be greater than 90° to facilitate fish passage. The pipes would be smooth-walled and smooth-jointed to reduce potential fish abrasion (UniStar 2009c). The proposed UHS intake structure is a concrete structure 75-ft long and 60-ft wide. It would have individual pump bays housing water makeup pumps (UniStar 2009d). The UHS portion of the intake system provides a safety-related function and would not be connected to a fish-return system.

Discharge Structure

Water released from the retention basin would flow through the discharge pipes that release the discharge water into a seal well and then into the Chesapeake Bay. The seal well is located between quadrants 1D and 1E in Figure 3-4. The top of the seal well rises 5 ft above ground surface, and the bottom of the seal well rests 20 ft below ground. A 30-in.-diameter pipe exits the bottom of the seal well and extends 550 ft into Chesapeake Bay about 1151 ft south and 650 ft east of the intake piping suction point for Unit 3 (relative to plant north) (UniStar 2009a). UniStar proposes to use a three port diffuser, which, at 550 ft from the shoreline, would rise 3 ft above the bed of the Chesapeake Bay. Each diffuser port would direct water out of the pipe at an angle of 22.5° above horizontal. This would be the only discharge into the Chesapeake Bay from Unit 3 other than stormwater runoff and the fish-return outfall (see Section 3.3.1.5 for a description of the fish-return outfall).

Cooling Towers

Proposed Unit 3 would use closed-cycle, mechanical draft cooling towers to dissipate heat from the CWS and the ESWS. As described in Section 3.1, Unit 3 requires one cooling tower for the CWS; it is 164 ft tall and 528 ft in diameter at the base. The Unit 3 CWS cooling tower, located in quadrant 5H of Figure 3-4, would be a round concrete structure. In addition, the ESWS consists of four two-cell cooling towers. The ESWS towers are located near the reactor building in quadrants 3F and 4E. The ESWS cooling towers provide heat rejection for the UHS in emergency conditions and, therefore, are also safety-related structures.

3.2.2.3 Other Permanent Plant-Environment Interfacing Structures

Roads, groundwater wells, and buildings are additional permanent plant-environment interfacing structures that would be built on the proposed site.

Roads

The workforce and some building materials would enter and exit the site via roads. Solid waste and radioactive waste are expected to be transported offsite via roadways. A new access road for Unit 3 would allow the flow of traffic from Unit 3 to Maryland State Route 2/4.

Groundwater Wells

Water is withdrawn from subsurface aquifers via wells for Units 1 and 2. Groundwater would be used during the building of Unit 3 but is not proposed to be used for the operation of Unit 3. However, supply wells used as a backup to the desalination plant are permanent structures.

Diesel Generator Building

Diesel generators would be installed on the site to provide a backup source of power when the normal power source is disrupted. Combustion emissions would be released to the atmosphere from the generators only during emergency operations and periodic testing. The diesel generators would be located in the power block region of the site.

Radioactive Waste Facility

The radioactive waste facility would house the holding and processing systems for low-level liquid radioactive waste and solid radioactive waste. It also would house the collection and processing system for gaseous radioactive waste. Radioactive waste management is described in more detail in Section 3.4.3. Packaged solid wastes and liquid mixed wastes would be stored in the radioactive-waste building until shipment offsite for further processing or disposal. The environmental interfaces for the radioactive-waste treatment facility would be liquid effluent discharges to the blowdown discharge line, gaseous effluent venting, and solid-waste handling for offsite shipment.

Sanitary Waste Treatment Plant

UniStar plans to build a new wastewater treatment facility to treat sanitary waste for proposed Unit 3. Wastes from Units 1 and 2 would not be treated by this facility.

Barge Facility

An existing barge dock located in quadrant 1E of Figure 3-4 would be refurbished and the navigation access channel extended to allow transport of large components by barge to the site. Two existing pile-cap crane supports and one mooring bollard would be removed (UniStar 2008b; UniStar 2008c). Once the barge dock area has been refurbished, it would be used by barges that may be as large as 200 ft long and 50 ft wide. More typically, the barges used are about 35 ft wide. Barge drafts range from 2 ft to 11 ft, depending on the load.

3.2.2.4 Other Temporary Plant-Environment Interfacing Structures

Some temporary plant-environment interfacing structures would need to be removed before proposed Unit 3 operation commences; for example a concrete batch plant. The impacts from the operation and installation of these structures are discussed in Chapter 4.

Dewatering wells

Groundwater wells can be used to dewater areas that would otherwise be flooded by the influx of groundwater and are planned to dewater deep excavations in the power block region in quadrants 3E and 3F of Figure 3-4.

Concrete Batch Plant

The temporary concrete batch plant and material storage would occupy 26.2 ac. This area would house the equipment and facilities needed for delivery, materials handling and storage, and preparation of concrete.

3.2.2.5 Power Transmission System

The purpose of the proposed plant is to provide baseload power to the regional electrical power grid. The electrical power would be routed from the Calvert Cliffs site using the existing CCNPP Units 1 and 2 transmission lines. The review team considers the transmission lines between Unit 3 and the switchyard for Units 1 and 2 as the plant-environment interface for electrical transmission. The Unit 3 switchyard is shown in quadrants 5E and 5F of Figure 3-4.

Two existing transmission system routes operated for CCNPP Units 1 and 2 would be used for proposed Unit 3. The north route consists of two 500-kV lines that connect the Calvert Cliffs site to the Waugh Chapel substation in Anne Arundel County. The south route consists of three 500-kV lines that connect to the Mirant Corporation Chalk Point Generating Station in Prince George's County (Figure 3-5).

To accommodate the proposed Unit 3, UniStar has determined the following new facilities and upgrades to the existing power transmission system would be needed (UniStar 2009a):

- One new 500-kV, 16 breaker, breaker-and-a-half substation that would be located approximately 100 ft southeast of Unit 3. The substation would occupy approximately 20 ac. This 700 ft by 1200 ft tract of land would be located about 1000 ft southwest of the power block.
- Two new 500-kV, 3500 megawatt ampere circuits connecting Unit 3 to the existing substation serving Units 1 and 2. The circuits would be approximately 1 mi long on individual transmission towers.
- Breaker upgrades at the Waugh Chapel, Chalk Point, and other affected substations.

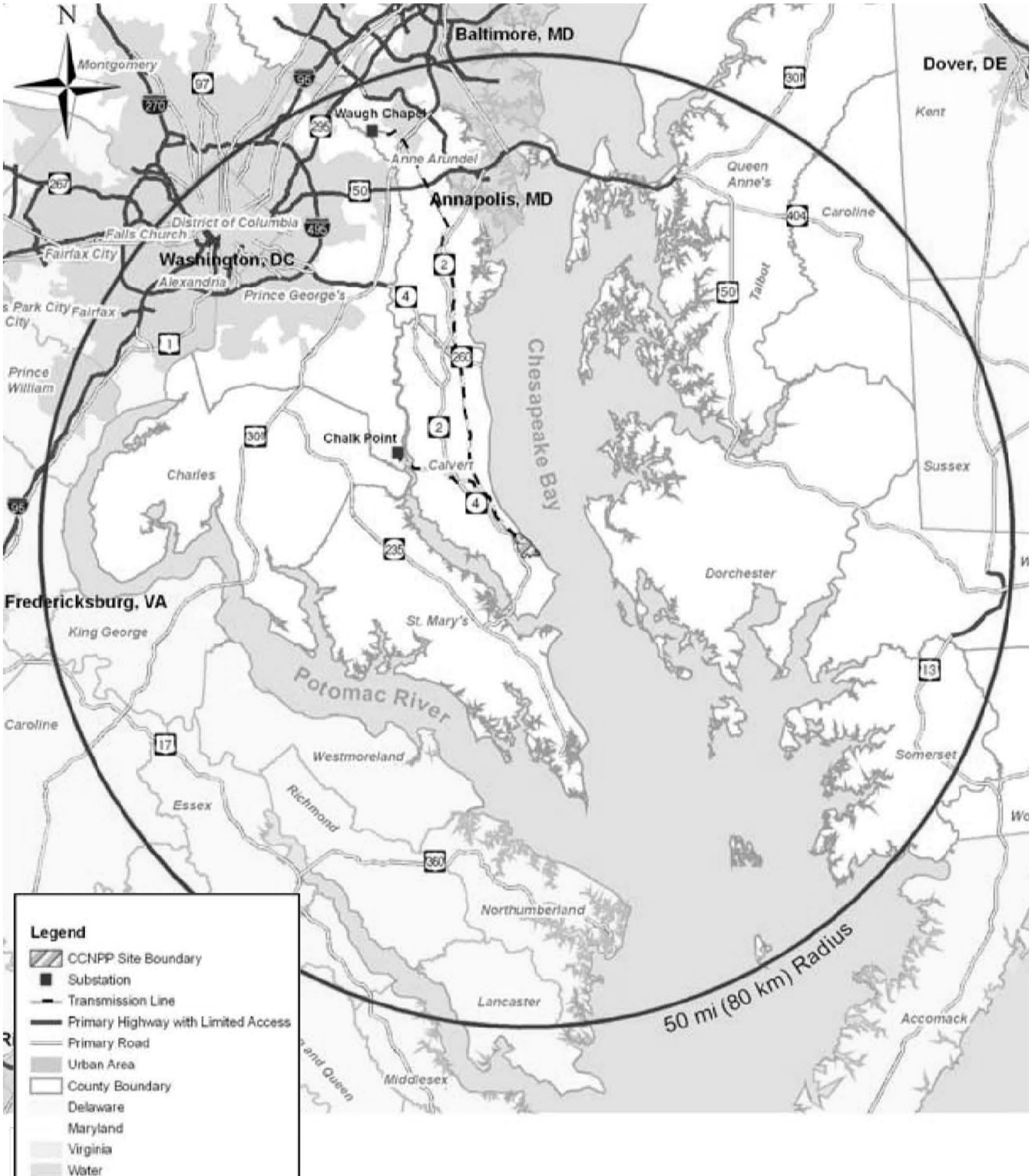

Figure 3-5. Existing Transmission System to Support Operation of Proposed Unit 3 (UniStar 2009a)

3.2.3 Structures with a Minor Environmental Interface

The structures described in the following sections would have minimal plant-environment interface during plant operation.

3.2.3.1 Power Block

The power block refers to the reactor building, the control building, the turbine building, the radioactive waste building, service buildings, and associated structures. As described previously, the Unit 3 reactor building would be surrounded by the fuel pool building, four safeguard buildings, two emergency diesel generator buildings, the reactor auxiliary building, the radioactive waste processing building, and the access building (UniStar 2009a). The vent stack for Unit 3 would be the tallest new structure at approximately 211 ft above grade or about 7 ft above the reactor building. The power block contains many safety-related structures.

3.2.3.2 Pipelines

The review team assumed that pipelines would follow existing roads or roads created when building Unit 3. Therefore, the installation of pipelines would be limited to areas already disturbed. Major pipelines include pipes running from the wedge-shaped pool in the Chesapeake Bay to the common forebay, from the CWS makeup intake to the CWS cooling tower basin, from the UHS intake to the ESWS cooling towers basins, and from the discharge retention basin to the Chesapeake Bay discharge. Pipelines associated with the UHS, including the intake pipelines from the wedge-shaped pool to the common forebay, are safety related.

3.2.3.3 Wastewater Retention Basin

A shallow 200-ft by 300-ft basin would receive and mix discharges of CWS cooling tower blowdown, ESWS cooling towers blowdown, brine discharge from the desalination plant, reverse osmosis system waste discharge, and sanitary wastes. A pipeline connects the wastewater retention basin to the seal well near the shoreline. The retention basin is shown in quadrant 5G of Figure 3-4.

3.2.3.4 Miscellaneous Buildings

A variety of small miscellaneous buildings would exist throughout the site to satisfy worker needs, building activities, and operational requirements. Some miscellaneous buildings may be temporary and would be removed after startup.

3.2.3.5 Parking

The existing parking area would be expanded to support construction. Another smaller parking area would also be built. These parking areas would be located in quadrants 4D, 5D, and 5E of Figure 3-4, respectively.

3.2.3.6 Laydown Areas

Multiple laydown areas would be established to support fabrication and installation activities and may be maintained as laydown areas for future maintenance and refurbishment of the plant. Laydown areas are graded relatively level and covered with crushed stone or gravel. Normally only limited vegetation is allowed in laydown areas. The locations of two new laydown areas are shown in Figure 3-4 in the region of quadrants 3:4F:G and 4H. Another laydown area is located in quadrants 6D:E. UniStar plans to use an existing laydown area for Units 1 and 2 (quadrants 5:6B:C of Figure 3-4) when building Unit 3.

3.2.3.7 Seal Well

The last structure encountered before the water released from the cooling tower retention basin enters the Chesapeake Bay is a seal well. The seal well is located between quadrants 1D and 1E (Figure 3-4). The top of the seal well rises 5 ft above ground surface, and the bottom of the seal well rests 20 ft below ground. A 30-in. pipe exits the bottom of the seal well.

3.2.3.8 Desalination Plant

UniStar plans to build a desalination (also called desalinization or desal) plant to supply all Unit 3 freshwater needs including potable and sanitary water, demineralized water, and fire protection system water. The plant would use reverse osmosis technology to purify seawater from the CWS intakes. Seawater entering the osmosis equipment would be pretreated with a membrane filtration system. The desalination plant would be used to improve the quality of Chesapeake Bay water to provide a freshwater supply for several functions, including supplying ESWS cooling water and potable water needs. The desalination plant would be located in quadrant 4H of Figure 3-4.

3.3 Construction and Preconstruction Activities

The NRC's authority is limited to activities that have a reasonable nexus to radiological health and safety or common defense and security (72 FR 57416). The NRC has defined "construction" according to the bounds of its regulatory authority. Examples of construction (defined at 10 CFR 50.10(a)) activities for safety-related structures, systems, or components include driving of piles; subsurface preparation; placement of backfill, concrete, or permanent retaining walls within an excavation; installation of foundations or in-place assembly, erection, fabrication, or testing.

Other activities related to building the plant that do not require NRC approval (but may require a DA permit from the Corps) may occur before, during, or after NRC-authorized construction activities. These activities are termed “preconstruction” in 10 CFR 51.45(c) and are typically regulated by other local, State, Tribal, or Federal agencies. Preconstruction includes activities such as site preparation (e.g., clearing, grading, erosion control, and other environmental mitigation measures); erection of fences; excavation; erection of support buildings or facilities; building service facilities (e.g., roads, parking lots, railroad lines, barge slips, transmission lines); and procurement or fabrication of components occurring at other than the final, in-place location at the facility. Further information about the delineation of construction and preconstruction activities is presented in Chapter 4.

This section describes the structures and activities associated with building Unit 3, providing an overall characterization of the major activities for the principal structures and furnishing a framework for the activities involved in building the proposed nuclear power plant. Table 3-1 provides general definitions and examples of activities that would be performed in building the new unit.

Table 3-1. Descriptions and Examples of Activities Associated with Building Proposed Unit 3

Activity	Descriptions	Examples
Clearing	Removing vegetation or existing structures from the land surface.	Cutting planted pines from an area to be used for construction laydown.
Excavation dewatering	Pumping water from wells or pumping water directly to keep excavations from flooding with groundwater or surface runoff.	Pumping water from excavation of base for reactor building.
Deep excavation	Digging an open hole in the ground. Deep excavation requires equipment with greater vertical reach than a backhoe. Deep excavation generally requires dewatering systems to keep the hole from flooding.	Excavating to support fabrication of basemat for the reactor.
Dredging	Removing substrates and sediment in navigable waters including wetlands.	Enlarging of the barge slip.
Erection	Assembling all modules into their final positions, including all connection between modules.	Using a crane to assemble reactor modules.
Fabrication	Creating an engineered material from the assembly of a variety of standardized parts. Fabrication can include conforming native soils to some engineered specification (e.g., compacting soil to meet some engineered fill specification).	Preparing and pouring concrete; laying rebar for basemat.
Grubbing	Removing roots and stumps by digging.	Removing stumps and roots of pines logged from the construction laydown area.
Grading	Reforming the elevation of the land surface to facilitate operation of the plant and drainage of precipitation.	Substantially leveling the site from its current profoundly more rugged terrain.

Table 3-1. (contd)

Activity	Descriptions	Examples
Hauling	Transporting material and workforce along established roadways.	Driving on new access road by construction workforce.
Paving	Laying impervious surfaces, such as asphalt and concrete, to provide roadways, walkways, parking areas, and site drainage.	Paving parking area.
Well drilling	Drilling and completing wells.	Drilling wells for dewatering or water supply.
Shallow excavation	Digging holes or trenches to depths reachable with a backhoe. Shallow excavation may not require dewatering.	Placing pipelines; setting foundations for small buildings.
Dredge placement	Placing fill material in areas not designated as wetlands. These materials can come from dredging wetlands.	Placing sediments removed from the barge slip and navigation channel in an existing, upland (non-wetland) disposal area or as sound bedding for underground pipe installation.
Vegetation management	Thinning, planting, trimming, and clearing vegetation.	Maintaining switchyard free of vegetation during building.
Filling of a wetland or waterbody	Discharging of dredge and/or fill material into waters of the United States including wetlands.	Placement of a culvert for a roadway.
Rock Armoring	Placing rocks on the Bay bottom to protect in-water structures	Placing rock armoring on the Bay side of the baffle wall for the new intake, at the CWS discharge diffuser, and at the fish-return system discharge.
Pile Driving	Driving sheet-metal baffle wall components and support pilings into the Bay bottom	Installing sheet-pile wall to separate the new intake area from the Bay

3.3.1 Major Activity Areas

UniStar has stated (UniStar 2008c) that building activities for the new unit would permanently affect 343,253 ft^2 (7.88 ac) of forested nontidal wetlands; 52,707 ft^2 (1.21 ac) of emergent non-tidal wetlands; 114,563 ft^2 (2.63 ac) of nontidal open water; 33,400 ft^2 (0.77 ac) along 8350 ft of stream bed portions; and 248,000 ft^2 (5.7 ac) of tidal open waters. Approximately 138,500 ft^2 (3.2 ac) of the tidal open water impacts are from maintenance dredging, whereas approximately 109,000 ft^2 (2.5 ac) is from new dredging (USACE 2008). Approximately 52,500 ft^2 (0.9 ac) of the new dredging would be backfilled. UniStar also has stated this work includes 3485 ft^2 (0.08 ac) of isolated forested wetland impacts (UniStar 2008c).

3.3.1.1 Landscape and Stormwater Drainage

Preparing to build and operate proposed Unit 3 would require land to be cleared and graded for the main reactor buildings and support facilities and additional space for material and equipment laydown areas. After the site is graded, a stormwater drainage system would be created around the facilities to direct stormwater away from the operational areas. Drainage ditches and pipes would route surface water to water-retention and/or infiltration ponds.

3.3.1.2 Power Block

The power block, the area where the reactor, turbine, and associated structures are to be located would require clearing and grading an area that would permanently affect 2470 ft^2 (0.06 ac) along 617 linear feet of stream bed and create impervious surfaces of most of this area (UniStar 2008c, USACE 2008). Deep excavations would be required for some of the deeper foundations. These deep excavations are expected to require installation of dewatering wells. An onsite concrete batch plant would fabricate concrete for numerous pours. The structures would be erected with many components delivered as large modules installed via crane.

3.3.1.3 Cooling Tower

Clearing and grading the area for erection of the circulating water system mechanical draft cooling tower would permanently affect 32,670 ft^2 (0.75 ac) of non-tidal forested wetlands and 5780 ft^2 (0.13 ac) along 1445 linear feet of stream bed (UniStar 2008b, USACE 2008). The tower would be fabricated onsite.

3.3.1.4 Cooling-Water Intake Structures

The site plan for the Unit 3 intake structure is illustrated in Figure 3-6. UniStar plans to build a 9000-ft^2, wedge-shaped pool for Unit 3 by building a sheet-pile wall extending 180 ft from the shoreline to the existing baffle wall for the embayment for CCNPP Units 1 and 2 (UniStar 2008b; USACE 2008). The proposed sheet-pile wall would extend about 90 ft channelward of the approximate mean high water (MHW) shoreline. The new baffle wall would not have an opening connecting the wedge-shaped pool directly with the Chesapeake Bay. The steel sheet piling would be supported by 30-in.-diameter soldier piles placed on 10-ft centers. A 50-ft section of existing shoreline armor protection would be removed prior to the sheet-pile wall installation. Building the sheet-pile wall is expected to take about 2 months.

Once the sheet-pile wall is in place, about 60 ft of shoreline armor within the wedge-shaped pool would be removed and a temporary sheet-pile wall would be installed upland along the intake water pipeline route. The temporary upland sheet-pile wall would extend about 30 ft channelward into the wedge-shaped pool to facilitate dewatering and installation of intake pipes and associated trash racks. The area within the wedged-shaped pool surrounded by the

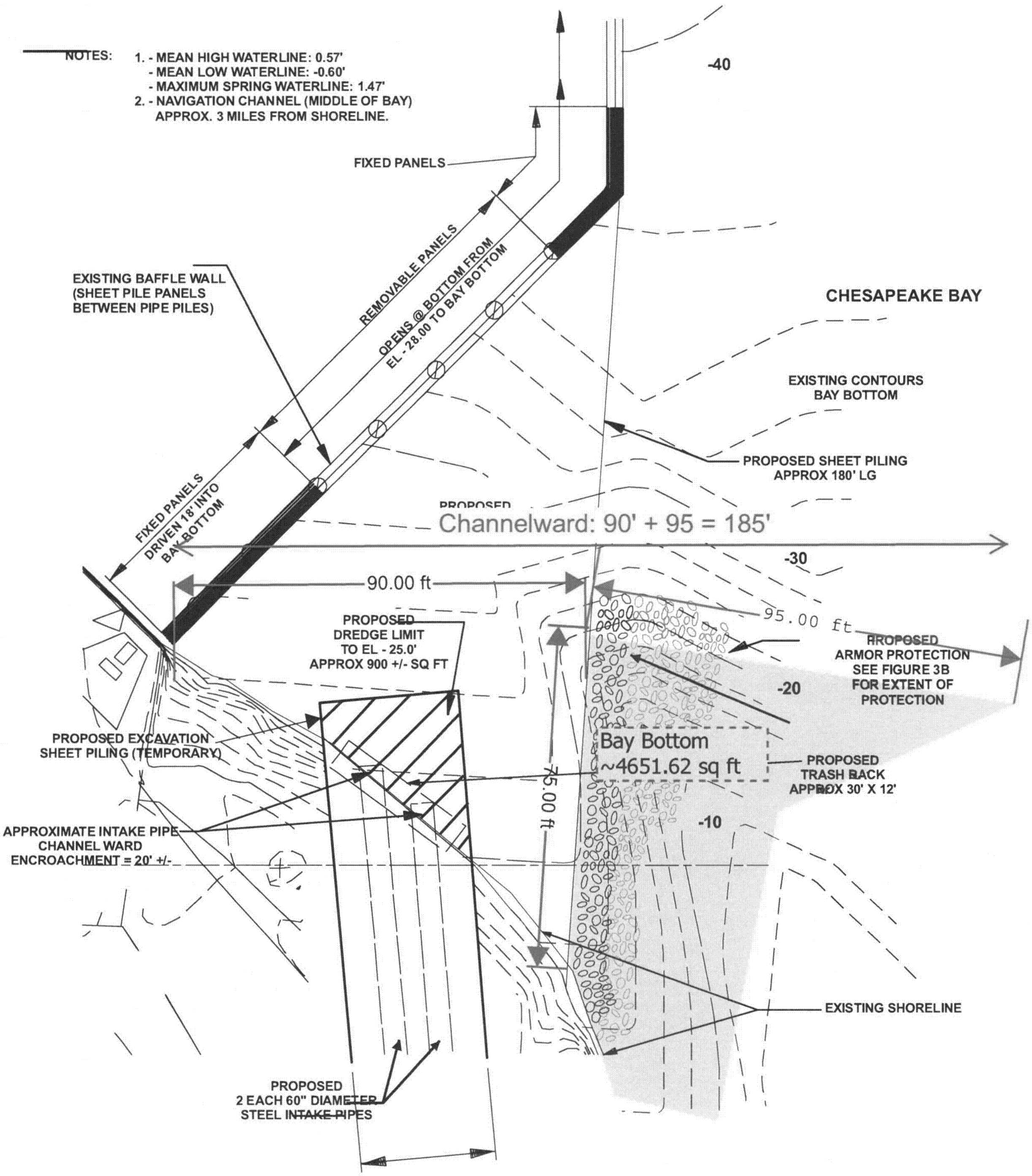

Figure 3-6. Site Plan at Unit 3 Intake Structure (UniStar 2009e)

pipeline sheet piling would be dewatered and dredged by mechanical method to create an approximately 30-ft-wide by 30-ft-long by 25-ft-deep area. This would result in about 900 yd^3 of sand and gravel that would be deposited at an existing environmentally controlled upland area at Lake Davies. After dredging, two 60-in.-diameter intake pipes would be installed with trash racks at the pipe openings, extending approximately 20 ft channelward of the approximate MHW shoreline to a bottom elevation of −25 ft mean low water. About 80 ft of the shoreline within the pool would be armored, with the armoring extending about 10 ft from shore.

After installation of the pipes and associated trash racks, approximately 80 ft of shoreline armor protection extending 10 ft channelward of the approximate MHW shoreline would be emplaced within the wedged-shaped pool. Armor protection would be extended out beyond the new sheet-pile wall approximately 75 ft, extending about 25 to 95 ft channelward (UniStar 2009f). The armoring would be added to the Bay bottom as a series of four overlying layers, ranging from washed gravel on the bottom to large quarry rock (averaging about 2 tons each) on the top (UniStar 2009c). The overall thickness of the armoring would vary according to the water depth. About 4650 ft^2 (0.11 ac) of the Bay bottom would be armored. Finally, the temporary sheet-pile wall around the intake pipes would be removed, allowing the area to flood and submerge the pipes. Building of the intake system is expected to take about 4 months.

3.3.1.5 Fish-return System

A fish-return system similar to those for CCNPP Units 1 and 2 would be built for Unit 3 (UniStar 2008b). The fish return would be located on the east (Bay) side of the Unit 3 intake forebay. The CWS intake pump system would have traveling screens with a wash system to provide a pressurized spray to remove fish, crabs, and debris from the screens and transfer them to the fish-return system. The traveling screens for each system would be dual-flow type screens with a double entry-center exit flow pattern. The screen panels would be metallic or plastic mesh with a mesh size of 0.079 to 0.118-in. square (UniStar 2009a). The separate UHS pump system would not be connected to the fish-return system because the UHS makeup system operates infrequently or in the case of a design-basis accident (UniStar 2009e).

To build the proposed fish-return outfall, a pipe would be installed in a mechanically excavated trench. Any bends in the pipes would be greater than 90° to facilitate fish passage. The pipes would be smooth-walled and smooth-jointed to reduce potential fish abrasion (UniStar 2009c). The pipe would be installed 4.0 ft below the Bay bottom and would emerge from the Bay bottom 40 ft channelward of the approximate MHW shoreline directly off the common forebay. The outfall location would be protected with a 10-ft by 10-ft riprap apron. About 40 ft of the existing shoreline revetment would be removed, and approximately 500 yd^3 of material would be dredged within the work area to install the pipe (UniStar 2008c; USACE 2008). The trench would be about 5 ft wide at the bottom and about 65 ft wide at the level of the Bay floor as shown in Figure 3-7 (UniStar 2008b). An area of about 2600 ft^2 would be directly disturbed by

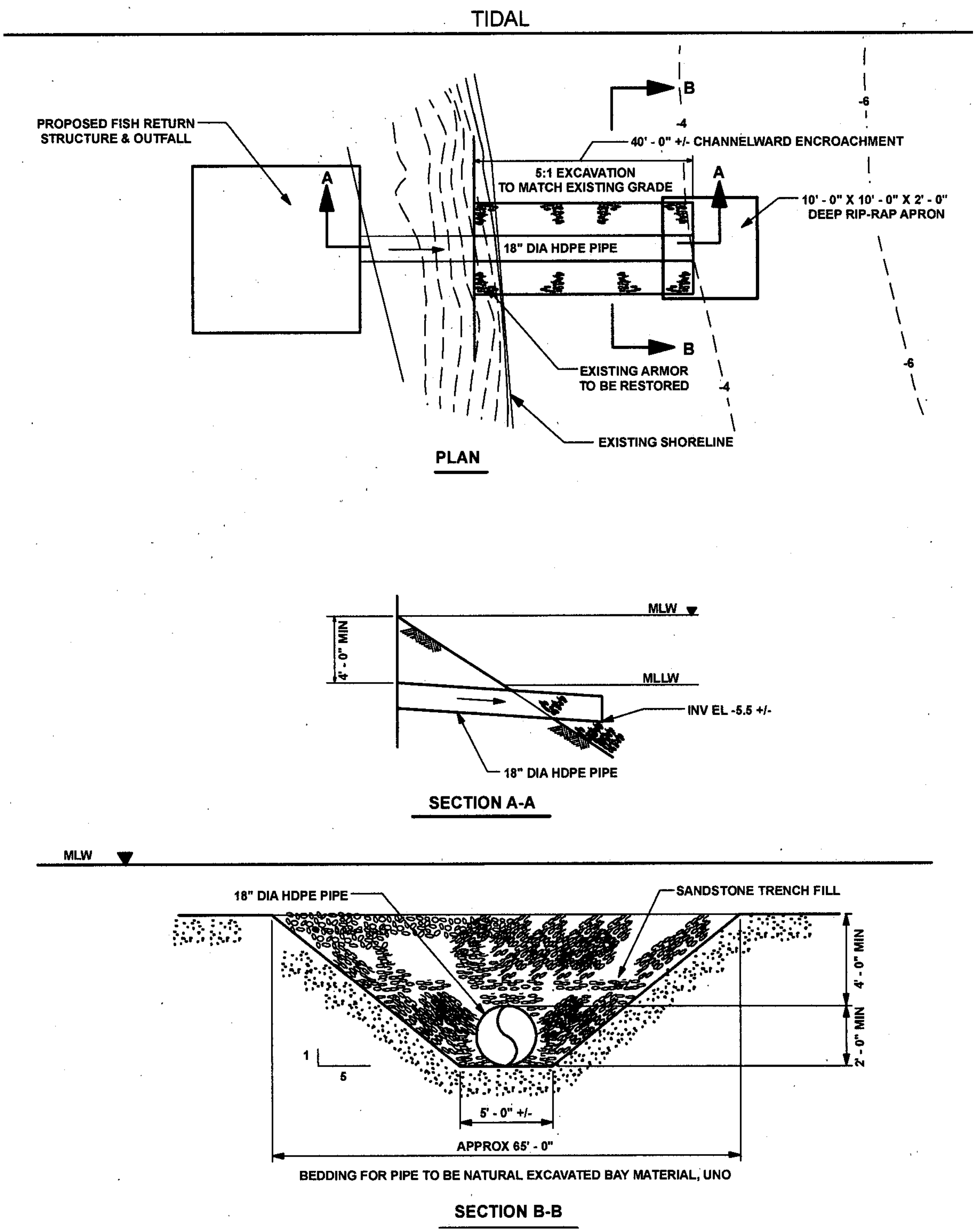

Figure 3-7. Fish-return System (UniStar 2008b)

the dredging (UniStar 2008b). The dredged material would be returned to the trench after the pipe is placed, and the existing shoreline revetment restored to its original design after pipe installation.

3.3.1.6 Discharge Structure

UniStar would use mechanical dredging methods to install a cooling water discharge pipe with a three single-port diffuser outfall structures approximately 550 ft from the shoreline out into the Chesapeake Bay about 1151 ft south and 650 ft east of the intake piping suction point for proposed Unit 3 (relative to plant north) (UniStar 2009a). The trench bottom width would range from 3 to 6 ft wide, and the maximum width of the trench at the level of the Bay bottom would be about 70 ft (Figure 3-8).

The discharge point would be elevated 3 ft above the Bay bottom. This installation would temporarily affect approximately 38,500 ft^2 (0.9 ac), along 550 ft of the Bay bottom. In addition, a 20-ft by 40-ft riprap scour pad would be installed at the diffuser outfall, permanently affecting 800 ft^2 (0.02 ac). Approximately 7000 yd^3 of material would result from dredging for the pipe installation. Approximately 5800 yd^3 would be reused as trench fill with the remainder, about 1200 yd^3, deposited at an existing, upland (non-wetland), environmentally controlled area at the Lake Davies laydown area onsite (UniStar 2008c; USACE 2008). The pipe would be installed with a minimum of 4 ft of cover to protect it from storms and snagging by small-boat anchors. Riprap with a median diameter of 12 in. and filter fabric would be placed on top of the back-filled material to provide the minimum 4-ft cover over the pipe. The riprap would be placed within the discharge pipe trench to the top of the trench at the original grade of the Bay bottom, but would not extend above the existing Bay bottom.

3.3.1.7 Barge Facility

To facilitate receipt of equipment and materials, the existing CCNPP Units 1 and 2 barge slip would be restored and extended to reestablish use when building proposed Unit 3. Two existing pile-cap crane supports and one mooring bollard would be removed (UniStar 2008a; UniStar 2008b) (Figure 3-9 and Figure 3-10). An area approximately 1500-ft-long by 130-ft-wide (average width), covering 195,000 ft^2, would be dredged to a bottom elevation of 16 ft below mean low water (UniStar 2008b). This would require the mechanical dredging of about 50,000 yd^3 of bottom substrates (UniStar 2008b, UniStar 2008c). UniStar considers the removal of sediment from about 1065 ft of the total length, about 45,000 yd^3, as maintenance dredging (UniStar 2008b; UniStar 2008c). Sediment removal from the remaining 435-ft length, about 5000 yd^3, is an extension beyond the original dredging limits and is required to reach the bottom elevation of 16 ft below mean low water. UniStar has requested permission from the Corps to conduct maintenance dredging for 10 years (UniStar 2008c). The dredged material removed from the barge slip either would be used during plant development as sand bedding for

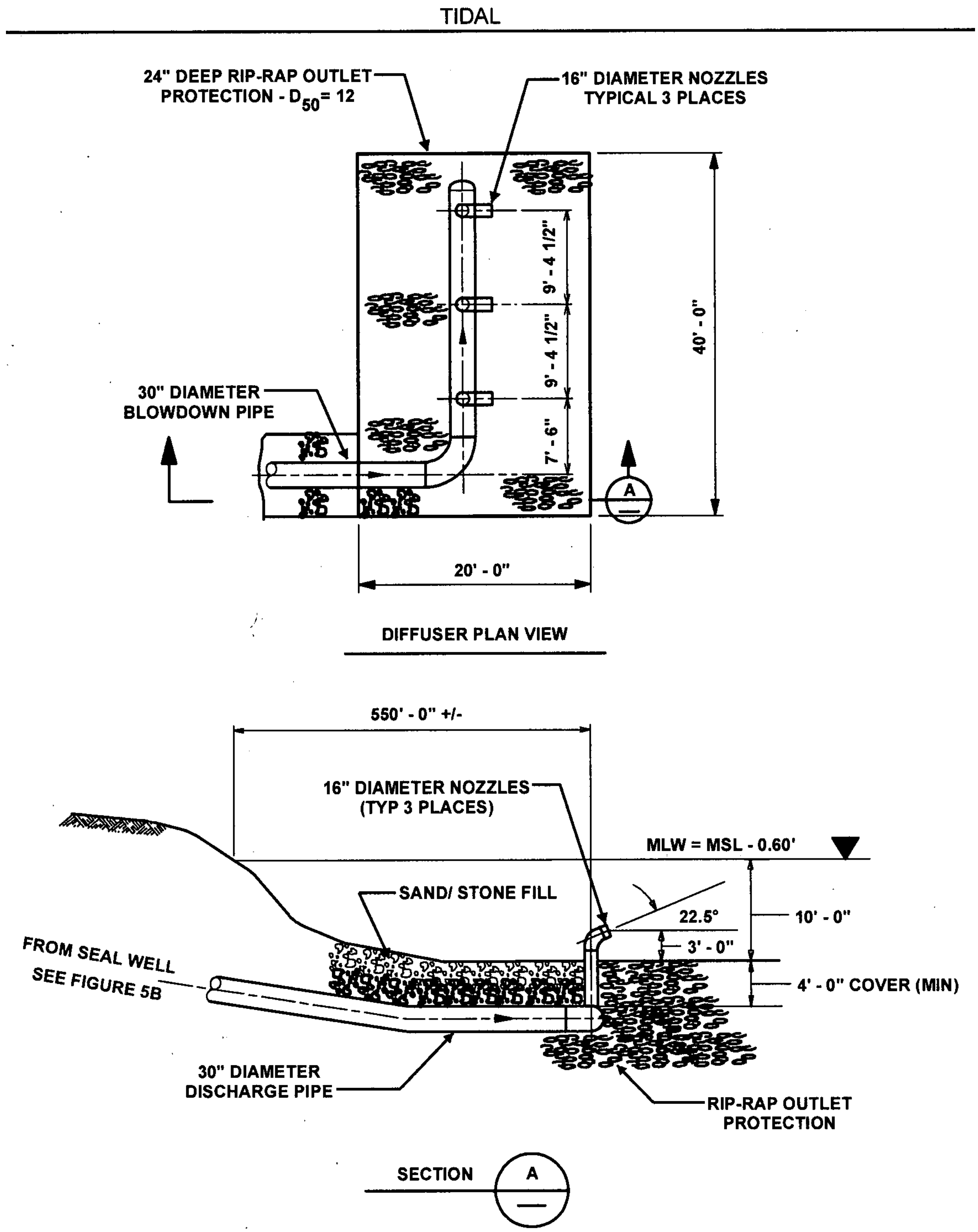

Figure 3-8. Discharge Outfall Details (UniStar 2008b)

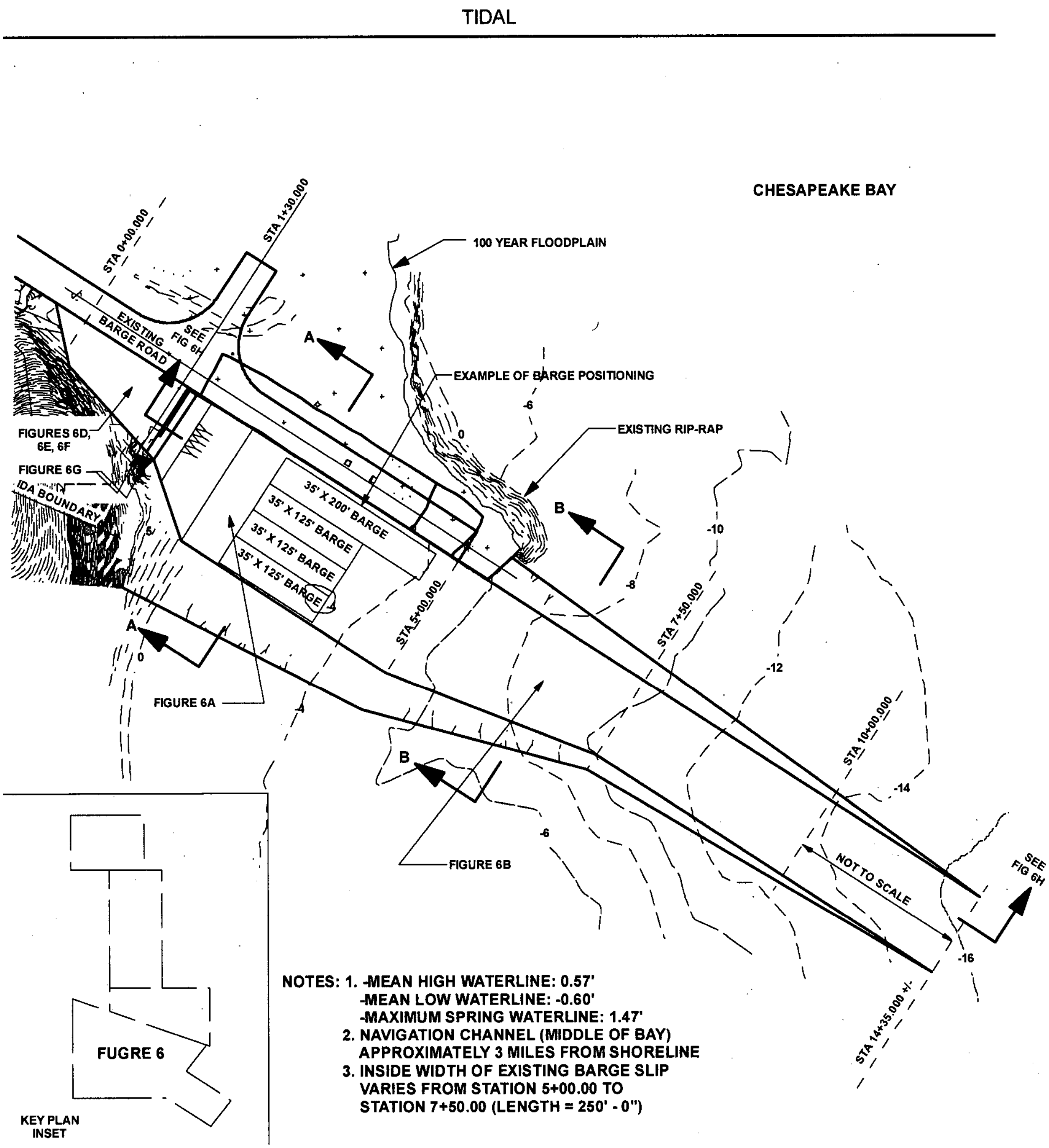

Figure 3-9. Proposed Restoration of Barge Slip (UniStar 2008b)

TIDAL

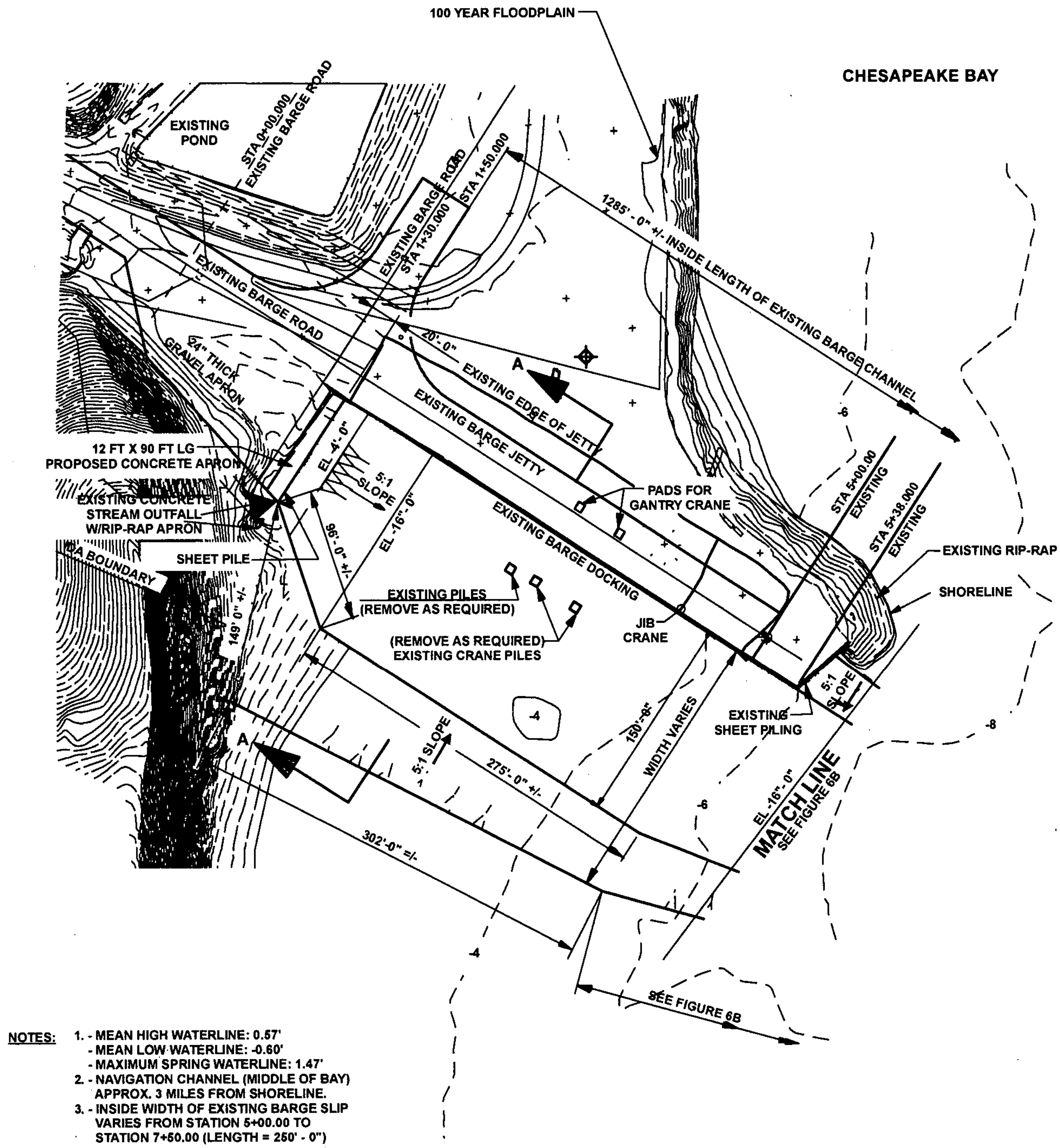

Figure 3-10. Modifications at Existing Barge Unloading Facility (UniStar 2008b)

underground pipe installation or deposited at an existing upland (non-wetland), environmentally controlled area at the Lake Davies laydown area onsite. The dredged material would be characterized prior to use.

As a part of the refurbishment, a new sheet-pile wall would be installed along the shoreline in front of the existing bulkhead, which was built as a part of the original dock design. The bulkhead would consist of a new sheet-pile wall driven immediately in front of the existing bulkhead. The new bulkhead would be about 90-ft-long, starting from the barge slip and extending south to an existing outfall culvert (UniStar 2008b; USACE 2008). The sheet-pile wall would be supported by 30-in.-diameter soldier piles. On the land side of the new sheet-pile bulkhead, a concrete apron would be placed, along with a gravel apron, to allow equipment to be offloaded from barges with wheeled-mounted transporters.

Additional nearshore maintenance dredging would be required to remove silt that has accumulated in the shoreward portion of the barge dock area over the past 30 years, altering the normal flow pattern from an existing culvert outfall. Silt build-up over the years has caused the discharge from the culvert outfall to meander in a north-south direction prior to discharging into the barge slip area. Restoration activities in this area would include the emplacement of a 40-ft by 40-ft by 2-ft-deep riprap apron extending approximately 40 ft channelward of the approximate MHW shoreline directly in front of the existing outfall, allowing the discharge to flow directly into the Bay as originally designed. The existing waterway depths range from approximately the mean low water level to 16.0 ft below mean low water level within the proposed work area.

Refurbishment is expected to take about 2 weeks. Once the barge dock area has been refurbished, it would be used by barges that may be as large as 200 ft long and 50 ft wide. More typically, the barges used are about 35 ft wide. Barge drafts range from 2 ft to 11 ft, depending on the load. UniStar expects that the barge dock would be in use for about 5 years but stated, although there are no specific plans for maintenance dredging, eventual replacement of major components could require dredging in the future. UniStar has requested permission from the Corps to conduct maintenance dredging for 10 years (UniStar 2008c).

3.3.1.8 Construction Support and Laydown Areas

Building materials are brought to the site and stored in what are called laydown areas. UniStar expects to clear and grade five laydown areas in various areas onsite. These laydown areas would permanently affect 95,832 ft^2 (2.20 ac) of nontidal forested wetlands; 52,708 ft^2 (1.21 ac) of emergent wetlands; 114,563 ft^2 (2.63 ac) of open water; and 1535 ft^2 (0.04 ac) along 384 linear feet of stream bed (UniStar 2008c, USACE 2008). Laydown areas would be covered with gravel or crushed rock to prevent erosion. Vegetation would be suppressed.

3.3.1.9 Switchyard and Onsite Transmission Corridor

UniStar proposes to build one new 500-kV substation that would be located on a 700-ft by 1200-ft tract of land approximately 1000 ft southwest of the Unit 3 power block and 2000 ft west-southwest of the existing switchyard. Two new 500-kV, 3500-megawatt ampere circuits would connect Unit 3 to the existing substation serving Units 1 and 2. These additions to the existing switchyard would require clearing and grading an area permanently affecting 179,903 ft^2 (4.13 ac) of nontidal forested wetlands and 16,710 ft^2 (0.38 ac) along 4178 linear feet of stream bed (UniStar 2008c; USACE 2008). The switchyard would be covered with gravel or crushed rock and would remain vegetation free.

The circuits would be approximately 1 mi long on individual transmission towers. The new towers are expected to use tubular or lattice designs and would conform to the criteria of the National Electric Safety Code and site standards.

3.3.1.10 Roadways

A heavy haul road leading from the barge slip to the construction site in nontidal areas would need to be created, permanently affecting 2570 ft^2 (0.06 ac) along 642 linear feet of stream bed (UniStar 2008b, USACE 2008).

A new access road with three separate stream crossings would be required to bring personnel and material to the construction site. Clearing and grading of this access road would require: (1) 200 linear feet of 30-in.-diameter reinforced concrete pipe (RCP) and emplacement of a 15-ft by 15-ft riprap scour pad; (2) 100 linear feet of 36-in.-diameter RCP and emplacement of a 15-ft by 15-ft riprap scour pad; and (3) 520 linear feet of two 54-in.-diameter RCP and emplacement of a 40-ft by 40-ft riprap scour pad. The invert of each pipe would be depressed to match the slope and invert of the stream or wetland being crossed. This roadwork would permanently affect a 31,363-ft^2 (0.72-ac) area of forested wetlands and 4336 ft^2 (0.10 ac) along 1084 linear feet of stream bed (UniStar 2008b; USACE 2008).

3.3.1.11 Pipelines

Laying pipelines would occur in several areas on the site as described related to stormwater drainage, intake, and discharge structures. They would generally be buried in trenches. Pipeline installation would require the clearing of land along the pipeline corridor and shallow excavation (trenching).

3.3.1.12 Concrete Batch Plant

Erecting the temporary concrete batch plant would occur on a cleared, graded area.

3.3.1.13 Parking

Parking areas would be graded and paved.

3.3.1.14 Miscellaneous Buildings

Excavation for shallow foundations would be required prior to fabrication and erection of miscellaneous buildings.

3.3.1.15 Cranes and Crane Footings

Fabricating footings and erecting cranes would be necessary to build the larger plant structures.

3.3.2 Summary of Resource Parameters During Construction and Preconstruction

Table 3-2 provides a list of the significant resource commitments of construction and preconstruction. The values in this table combined with the affected environment described in Chapter 2 provide the basis for the construction and preconstruction impacts assessed in Chapter 4. These values were stated in the ER (UniStar 2009a), and the review team determined that the values are not unreasonable.

Table 3-2. Summary of Resource Commitments Associated with Building Proposed Unit 3

Resource Areas	Value	Description
All Resource Areas	68 to 86 months	Upper limit of duration of construction and combined construction and preconstruction activities, respectively, for one U.S. EPR unit
Land Use, Terrestrial Ecology, Aquatic Ecology, Cultural and Historic Resources (Site and Vicinity)	460 ac	Disturbed area footprint, 320 ac permanently dedicated to Unit 3 and supporting facilities
Land Use, Terrestrial Ecology, Cultural and Historic Resources (Offsite, Transmission Lines)	1 mi	Existing circuits from Units 1 and 2 to be extended onsite to Unit 3 substation; no new offsite transmission lines
Hydrology-Groundwater	100,000 gpd	Normal annual groundwater withdrawal; 180,000 gpd maximum withdrawal during month of maximum use
Terrestrial and Wetland Resources	11.7 ac	Loss of wetland habitat

Table 3-2. (contd)

Resource Areas	Value	Description
Aquatic Ecology	8350 linear ft 2.7 ac 0.16 ac 4.5 ac 0.88 ac 177 to 208 dB	Stream channels, filling Conoy Fishing Pond, filling Bay bottom, armoring Bay bottom, dredging Bay bottom, trenching Bay waters, pile driving noise
Socioeconomics, Transportation, Air Quality	3950 workers 790–1383 workers	Peak onsite workforce In-migrating workforce
Terrestrial Ecology Nonradiological Health, Socioeconomics	83–108 dBA 73–102 dBA	Peak noise level Noise level 50 ft from activity

Source: UniStar 2009a

3.4 Operational Activities

The operational activities considered in the review team's environmental review are those associated with structures that interface with the environment, as described in Section 3.2.2. Examples of operational activities are withdrawing water for the cooling system, discharging blowdown water and sanitary effluent, and discharging waste heat to the atmosphere. Safety activities within the plant are discussed by the applicant in the FSAR portion of its application (UniStar 2009b) and are reviewed by the NRC as part of its safety evaluation report (SER) (in progress).

The following sections describe the operational activities, including operational modes (Section 3.4.1), plant-environment interfaces during operations (Section 3.4.2), the radioactive and nonradioactive waste management systems (Sections 3.4.3 and 3.4.4), and summarize the values of parameters likely to be experienced during operations (Section 3.4.5).

3.4.1 Description of Operational Modes

The operational modes for proposed Unit 3 considered in the assessment of operational impacts on the environment (Chapter 5) are normal operating conditions and emergency shutdown conditions. These are the nominal conditions under which maximum water withdrawal, heat dissipation, and effluent discharges occur. Cooldown, refueling, and accidents are alternative modes to normal plant operation during which water intake, cooling tower evaporation water discharge, and radioactive releases may change from nominal conditions. The primary plant cooling shifts from the CWS to the ESWS during these alternate modes.

3.4.2 Plant-Environment Interfaces During Operation

This section describes the operational activities related to structures with an interface to the environment.

3.4.2.1 Circulating Water System – Intakes, Discharges, Cooling Tower

Waste heat is a byproduct of normal power generation at a nuclear power plant. The CWS for the proposed Unit 3 is a closed-cycle wet cooling system that is used to transfer heat from the main condenser and the closed cooling water system to a single plume-abated mechanical draft cooling tower. During normal plant operation, the CWS would dissipate up to 1.108×10^{10} Btu/hr (2.792×10^{9} Kcal/hr) of waste heat (UniStar 2009a).

Excess heat in the cooling water is transferred to the atmosphere by evaporative and conductive cooling in the cooling tower. In addition to evaporative losses, a small percentage of water is also lost in the form of droplets (drift) from the cooling tower; air impacts from cooling tower operation would also include visible plumes. The water not evaporate or drift from the tower is routed back to the cooling tower basin; this water is known as blowdown water.

Evaporation of CWS water from the cooling tower increases the concentration of dissolved solids in the cooling water system. To limit the concentration of dissolved solids, a portion of the blowdown water is removed and replaced with makeup water from the Chesapeake Bay. The blowdown water would be directed to a common retention basin that receives waste input from several sources. Time spent in the basin allows for settling of suspended solids and chemical treatment, if required, prior to discharging to the Chesapeake Bay.

UniStar provided the following bounding rates for the CWS:

- The maximum makeup water flow rate would be 44,320 gpm, with a flow velocity along the new intake channel less than 0.5 fps.
- The maximum consumptive water use rate (evaporation and drift) would be 22,199 gpm.
- The maximum blowdown rate would be 22,121 gpm.

For the potable and sanitary water system, UniStar would treat desalinated water to meet all Federal and State release requirements. For the demineralized water system, UniStar would treat desalinated water to meet requirements specified in guidance from the Electric Power Research Institute. The treatment would include the addition of a corrosion inhibitor. For the fire water distribution system, UniStar would use untreated desalinated water.

3.4.2.2 Essential Service Water System

The ESWS is a closed-loop system that provides cooling water to the component cooling water system (CCWS) heat exchangers and the cooling jackets of the emergency diesel generators (UniStar 2009a). The ESWS dissipates waste heat during normal operations; operational events, such as refueling and shutdown; and accidents. The ESWS consists of four safety-related mechanical draft cooling towers, each with a dedicated CCWS heat exchanger and water storage basin. A fifth, non-safety-related tower is available for use during severe accident conditions. During normal operation, the basins would be supplied with non-safety-related makeup water from the desalination plant. During a design basis accident, the basins would be supplied with safety-related makeup water from the Chesapeake Bay via the UHS intake structure.

Within each ESWS tower, excess heat in the cooling water is transferred to the atmosphere via conduction, evaporation, and drift. The evaporation process increases the concentration of dissolved solids in the cooling water. To limit the concentration of dissolved solids, a portion of the water is continuously discharged from the system as blowdown water, which is routed using gravity to the common retention basin. After solids settlement and chemical treatment (if required), the water from the common retention basin would ultimately be discharged to the Chesapeake Bay. UniStar provided the following bounding rates for the ESWS:

- The maximum makeup water flow rate would be 1490 gpm.
- The maximum consumptive water use rate (evaporation and drift) would be 1368 gpm.
- The maximum blowdown rate would be 122 gpm.

3.4.2.3 Power Transmission System

Inspections and maintenance of the transmission line corridors (to include maintenance of the transmission line hardware and tree trimming and application of herbicide) would be performed periodically on an as-needed basis.

3.4.2.4 Emergency Diesel Generators

Unit 3 would have six standby diesel generators and two Station Blackout diesel generators. When operated, the generators would produce gaseous emissions that would comply with all emissions standards, including U.S. Environmental Protection Agency (EPA) Tier 4 requirements governing diesel emissions being phased in over the 2008-2015 period. For safety and maintenance purposes, the generators would be run for about 100 hours per year.

3.4.3 Radioactive Waste Management System

Liquid, gaseous, and solid radioactive waste-management systems would be used to collect and treat the radioactive materials produced as byproducts of operating proposed Unit 3. These systems would process radioactive liquid, gaseous, and solid effluents to maintain releases within regulatory limits and to levels as low as is reasonably achievable (ALARA) before releasing them to the environment. Waste-processing systems would be designed to meet the design objectives of 10 CFR Part 50, Appendix I ("Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents"). The radioactive waste-management systems would not be shared between the existing Units 1 and 2 and proposed Unit 3. Radioactive materials in the reactor coolant would be the primary source of gaseous, liquid, and solid radioactive wastes in an U.S. EPR. Radioactive fission products build up within the fuel as a consequence of the fission process. These fission products would be contained in the sealed fuel rods, but small quantities could escape the fuel rods into the reactor coolant. Neutron activation of the primary coolant system would also add radionuclides to the coolant.

The offsite dose calculation manual (ODCM) for CCNPP Units 1 and 2 (Constellation 2005) describes the methods and parameters used for calculating offsite radiological doses from liquid and gaseous effluents. The ODCM also describes the methodology for calculation of gaseous and liquid monitoring alarm/trip set points for release of effluents from CCNPP. Operational limits for releasing liquid and gaseous effluents are also specified in the ODCM to ensure compliance with NRC regulations.

Summary descriptions of the liquid, gaseous, and solid radioactive waste management systems for the proposed Unit 3 are presented in the following sections. A more detailed description of these systems can be found in Chapter 11 of the U.S. EPR Design Control Document (AREVA 2009).

3.4.3.1 Liquid Radioactive Waste Management System

The liquid radioactive waste-management system functions to collect, segregate, process, handle, store, and dispose of liquids containing radioactive material such that any discharged liquid effluents are below concentration levels specified in 10 CFR Part 20, Appendix B, Table 2 (UniStar 2009b). This is managed using evaporation, centrifugal separation, demineralization, and filtration in several process trains consisting of tanks, pumps, ion exchangers, and filters. The system is designed to handle both normal and anticipated operational occurrences. Normal operations include processing of (1) RCS effluents, (2) floor drain effluents and other wastes with potentially high suspended solid contents, and (3) chemical wastes. In addition, the radioactive waste-management system can handle effluent streams that typically do not contain radioactive material, but that may, on occasion, become radioactive (e.g., steam generator blowdown as a result of steam generator tube leakage). With two exceptions, liquid effluents processed through the liquid radioactive waste-management system are discharged to the environment. The exceptions are (1) steam generator blowdown that is normally returned to the condensate system after processing and (2) reactor coolant that can be degassed prior to reactor shutdown and returned to the RCS.

Liquid effluent discharges are monitored to confirm release levels are not exceeded. The total liquid radioactive source term estimated for liquid effluents is listed in the ER, Table 3.5-7 (UniStar 2009a). Calculated doses to the maximally exposed individual (MEI) and the population within 50 mi are presented in Section 5.9.2.

3.4.3.2 Gaseous Radioactive Waste Management System

The gaseous radioactive waste-management system functions to collect, process, and discharge radioactive or hydrogen-bearing gaseous wastes. This is managed using a once-through, ambient-temperature, activated-carbon delay system. Radioactive isotopes of iodine and the noble gases xenon and krypton are created as fission products within the fuel rods during operation. Some of these gases that escape to the RCS through cladding defects and subsequently decay to stable isotopes are released to the environment via plant ventilation or are captured and then released by the gaseous radioactive waste-management system.

All gaseous effluents from the gaseous waste processing system, the containment ventilation purge system, the main condenser exhaust and ventilation from the radioactive waste building, the fuel pool building, the nuclear auxiliary building, and the safeguards and access controlled areas are released via the plant stack. Gaseous effluent discharges are monitored to verify release levels are not exceeded. The total gaseous radioactive source term estimated for gaseous effluents is listed in Table 3.5-8 of the ER (UniStar 2009a). Calculated doses to the MEI from gaseous effluents are evaluated in Section 5.9.2.

3.4.3.3 Solid Radioactive Waste Management System

The solid radioactive waste-management system functions to treat, temporarily store, package, and dispose of dry or wet solids. The system is a three-part system, the radioactive concentrates processing system, the solid waste processing system, and the solid waste storage system. This is managed with the same process used to treat, store, and dispose of solid radioactive waste at currently operating CCNPP Units 1 and 2. The solid radioactive wastes include spent ion exchange resins, deep bed filtration media, spent filter cartridges, dry active wastes, and mixed wastes. The system is designed to handle both normal and anticipated operational occurrences. There are no onsite facilities for permanent disposal of solid wastes; therefore, packaged wastes would be temporarily stored in the auxiliary and radwaste buildings prior to being shipped to a licensed disposal facility.

The estimated annual solid radwaste volume produced by an U.S. EPR is estimated to be 7933 ft^3. This solid radwaste would include an estimated 1990 Ci of radioactive material (UniStar 2009a). The storage and transportation of used reactor fuel is discussed in Chapter 6, "Fuel Cycle, Transportation, and Decommissioning," of this EIS.

3.4.4 Nonradioactive Waste Systems

The following sections provide descriptions of the nonradioactive waste systems proposed for Unit 3. This category of nonradioactive effluent includes gaseous emissions, liquids, hazardous waste, mixed wastes, and solids. All discharges to surface waters would be regulated by a National Pollutant Discharge Elimination System (NPDES) permit that would limit the volume and constituent concentrations.

3.4.4.1 Solid Waste Management

When building Unit 3, solid effluents that could be disposed in a landfill include clays, sand, gravels, silts, topsoil, tree stumps, root mats, brush and limbs, vegetation, and rock. Such a landfill for land-clearing debris does not require a permit but must comply with regulations issued by the State of Maryland for solid waste facilities.

Because the CCNPP Units 1 and 2 operations currently recycle, recover, or send off for disposal its solid wastes, it does not release solid waste as effluent. Based on this experience, UniStar expects to have nearly zero solid waste effluent during operation of Unit 3 (UniStar 2009a).

3.4.4.2 Liquid Waste Management

Water withdrawn from Chesapeake Bay for cooling and other operation purposes would be released as liquid effluent discharges back to the Chesapeake Bay. Cooling water from the CWS and ESWS would contain both biocides and chemicals. The biocides would be used to control biofouling of the CWS, and chemicals would be used to control scaling, corrosion, foaming, and solids deposition. UniStar states that water entering the CWS from the Chesapeake Bay would be treated in a manner similar to water treatment for Units 1 and 2 (UniStar 2009a). The intake water would be treated with sodium hypochlorite, which acts as a biocide to minimize marine growth and control fouling on the heat exchangers. Depending on the water chemistry within the internal cooling systems, the cooling water may receive biocide, dechlorination (sodium hydroxide), scale inhibitor (a dispersant), and possibly an antifoaming agent. UniStar may elect to prevent *Legionella* sp. growth using hyperchlorination in combination with intermittent chlorination, biocide, and scale inhibitor. Discharges of liquid effluents would be controlled by Maryland Department of the Environment (MDE) via the NPDES permit.

All sanitary wastes generated during preconstruction and construction activity would be transported and treated offsite by a private contractor. A wastewater treatment plant would be built and used to treat sanitary wastes during operation of Unit 3. The plant would not treat wastes from the existing CCNPP Units 1 and 2. UniStar would use a private contractor to manage sanitary waste handling. Waste sludge from the sanitary system would be removed and transported to a waste processing plant.

The Potable and Sanitary Water Distribution System is expected to supply drinking water at a rate of 93 gpm during operations and 216 gpm during shutdown and cooldown conditions. Effluent discharges, which would go directly to the seal well prior to discharge to Chesapeake Bay, would be regulated by MDE via the NPDES permit. The effluent limits are expected to be similar to those for existing Units 1 and 2 (e.g., Table 3.6-3 of the ER) (UniStar 2009a). Proposed Unit 3 would discharge no wastes to groundwater.

Volumetrically, the liquid effluent streams would be predominantly CWS blowdown water with various other waste streams mixed in. One of those would be the reject stream from the desalinization plant. The salt concentration of that stream would be about twice that of Chesapeake Bay salinity and somewhat less than that of CWS blowdown water. Therefore when the two are mixed, the concentration in the blowdown water would determine the upper boundary of the salinity of the mixture.

The potential release of nonradioactive liquid effluents to the Chesapeake Bay would be controlled by the Unit 3 NPDES permit. Three permitted outfalls are anticipated:

- Plant effluents (e.g., treated sanitary wastes, desalinization reject stream, cooling tower blowdown)
- Stormwater from various drainages across the proposed Unit 3 site
- Intake screen backwash.

Other nonradioactive liquid wastes that would be generated would be collected and processed using various physical, chemical, and biological means. Only if testing demonstrates that the liquid wastes are within the limits for discharge would the wastes be released.

3.4.4.3 Gaseous Waste Management

The operation of Units 1 and 2 currently has gaseous emissions, primarily from diesel generators and the combustion turbine generator, that are subject to air permits issued by MDE. The addition of Unit 3 would require additional diesel and combustion turbine generators with attendant emissions regulated under an amended or new MDE permit. No other sources for gaseous emissions are currently planned at the Calvert Cliffs site (UniStar 2009a).

3.4.4.4 Hazardous and Mixed Waste Management

Table 3.6-6 of the ER lists the types of hazardous wastes generated by existing Units 1 and 2 at the Calvert Cliffs site, including paint, lead, mercury, and acids. Similar wastes are expected to be generated from the operation of proposed Unit 3 (UniStar 2009a). The generation, treatment, storage, and disposal of hazardous wastes are governed by the Federal Resource Conservation and Recovery Act (RCRA) regulations. UniStar addresses the RCRA requirements for existing Units 1 and 2 and would manage hazardous wastes from proposed Unit 3 in a similar manner.

Mixed waste is a combination of hazardous waste and low-level radioactive material, special nuclear material, or byproduct material. Mixed waste can be created during activities such as routine maintenance, refueling, and radiochemical laboratory work. NRC (in 10 CFR) and EPA (in 40 CFR) regulations govern generation, management, handling, storage, treatment, disposal, and protection requirements associated with these wastes. Management of these wastes would conform to the EPA requirements and the Memorandum of Understanding (MOU) with the State of Maryland. The quantities expected from proposed Unit 3 are small, similar to those from other nuclear power plants. Mixed wastes from Units 1 and 2 are infrequently shipped to offsite permitted facilities. UniStar expects to do the same for mixed wastes generated by operation of proposed Unit 3.

3.4.5 Summary of Resource Parameters during Operation

Table 3-3 provides a list of the significant resource commitments involved in operating Unit 3 that are relevant to more than one resource evaluation. The values in this table, combined with the affected environment described in Chapter 2, provide part of the basis for the operational impacts assessed in Chapter 5. These values were stated in the ER (UniStar 2009a), and the review team has determined that the values are reasonable.

Table 3-3. Resource Parameters During Operation

Resource	Value	Description
Site (land)	320 ac	Permanently dedicated to Unit 3 and supporting facilities
Electrical Output	1710 MW(e) 1562 MW(e) 4590 MW(t)	Total output Net output Thermal output
Structure Heights	211 ft above grade 164 ft above grade	Vent stack, tallest new structure Cooling tower
Water Use (CWS)	30,032 gpm 44,320 gpm	Normal plant operations Maximum rate

Table 3-3. (contd)

Resource	Value	Description
Chesapeake Bay Water Use	41,095 gpm normal 47,383 gpm maximum	Normal withdrawal Maximum withdrawal
Effluent Discharge to Chesapeake Bay from Seal Well	21,019 gpm normal 24,363 gpm	Normal release Maximum release
CWS and ESWS/UHS Cooling Tower Evaporation	19,582 gpm 23,524 gpm	Normal rate Maximum rate
CWS and ESWS/UHS Cooling Tower Drift	41 gpm 43 gpm	Normal rate Maximum rate
Operation Workforce	363 workers 182 workers	Normal operating workforce In-migrating workers

Source: UniStar 2009a

3.5 References

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

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

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

72 FR 57416. October 9, 2007. "Limited Work Authorizations for Nuclear Power Plants." Federal Register. U.S. Nuclear Regulatory Commission.

AREVA NP Inc. (AREVA). 2007. *AREVA NP Environmental Report, Standard Design Certification*. ANP-10290. Rev. 0. Accession No. ML073531265.

AREVA NP, Inc. (AREVA). 2009. *AREVA NP Environmental Report, Standard Design Certification*. ANP-10290. Rev. 1. Accession No. ML092650775.

Constellation Generation Group, LLC (Constellation). 2005. *Offsite Dose Calculation Manual for Calvert Cliffs Nuclear Power Plant*. Revision 8. Lusby, Maryland. Accession No. ML052020232.

Resource Conservation and Recovery Act (RCRA). 42 U.S.C. 6901 et seq.

UniStar Nuclear Development, LLC (UniStar). 2008a. Letter from D. Lutchenkov (UniStar) to Maryland Department of the Environment, "Joint Federal/State Application to the United States Army Corps of Engineers and the Maryland Department of the Environment for the Alteration of any Floodplain, Waterway, Tidal or Nontidal Wetland in Maryland Calvert Cliffs Nuclear Power Plant - Unit 3 Calvert County, Maryland, USAEC Application Number NAB-2007-08123-M05." May 16, 2008. Accession No. ML081840343.

UniStar Nuclear Development, LLC (UniStar). 2008b. Letter from G. Gibson (UniStar) to U.S. Nuclear Regulatory Commission in response to NRC letter dated May 13, 2008, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Submittal of Response Requests for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3 – Supplemental Aquatic RAIs." September 29, 2008. Accession No. ML082760508.

UniStar Nuclear Development, LLC (UniStar). 2008c. Letter from R.D. Leone (UniStar) to T.J. Romine (Maryland Public Service Commission), "Re: In the Matter of the Application of UniStar Nuclear Energy, LLC and UniStar Nuclear Operating Services, LLC for a Certificate of Public Convenience and Necessity to Construct a Nuclear Power Plant at Calvert Cliffs in Calvert County, Maryland—Case No. 9127." August 1, 2008. Accession No. ML091671372.

UniStar Nuclear Development, LLC (UniStar). 2009a. *Calvert Cliffs Nuclear Power Plant Unit 3 Combined License Application, Part 3, Environmental Report*. Revision 6, Baltimore, Maryland. Accession No. ML092880921.

UniStar Nuclear Development, LLC (UniStar). 2009b. *Calvert Cliffs Nuclear Power Plant Unit 3 Combined License Application, Part 2, Final Safety Analysis Report*. Revision 6, Baltimore, Maryland. Accession No. ML092880897.

UniStar Nuclear Development, LLC (UniStar). 2009c. Letter from G. Gibson (UniStar) to U.S. Nuclear Regulatory Commission in response to NRC letter dated February 3, 2009, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Calvert Cliffs Nuclear Power Plant, Unit 3, Environmental RAIs No. 1001 through 1011." March 5, 2009. Accession No. ML090710146.

UniStar Nuclear Development, LLC (UniStar). 2009d. Letter from G. Gibson (UniStar) to U.S. Nuclear Regulatory Commission, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Calvert Cliffs Nuclear Power Plant, Unit 3, Intake Structure Relocation Changes for Environmental Report." January 14, 2009. Accession No. ML090220368.

UniStar Nuclear Development, LLC (UniStar). 2009e. Letter from G. Gibson (UniStar) to U.S. Nuclear Regulatory Commission in response to NRC letter dated February 3, 2009, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Calvert Cliffs Nuclear Power Plant, Unit 3, Follow-up Responses to Environmental Report RAI No.1003-2, Aquatic Ecology and RAI No. 1008-4, Ecological Impacts (Fish Return System)." July 24, 2009. Accession No. ML092150728.

UniStar Nuclear Development, LLC (UniStar). 2009f. Letter from G. Gibson (UniStar) to U.S. Nuclear Regulatory Commission dated July 29, 2009. "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Calvert Cliffs Nuclear Power Plant, Unit 3, Follow-up Response to Requests for Additional Information Nos. 1001-14 and 1008-6." In response to NRC's Request for Additional Information dated February 3, 2009. Accession No. ML092120061.

U.S. Army Corps of Engineers (USACE or Corps). 2008. Public Notice in Reply to Application Number CENAB-OP-RMS NAB-2007-01823-M05 (Calvert Cliff's 3 Nuclear Project, LLC/Unistar Nuclear Operating Services, LLC). September 3, 2008. Accession No. ML082550288.

4.0 Construction Impacts at the Proposed Site

This chapter examines the environmental issues associated with the building of proposed new Unit 3 at the Calvert Cliffs site as described in the application for a combined license (COL) submitted by UniStar to the U.S. Nuclear Regulatory Commission (NRC). As part of its application, UniStar submitted an Environmental Report (ER) (UniStar 2009a), which discusses the environmental impacts of building, operating, and decommissioning proposed Unit 3, and a Final Safety Analysis Report (FSAR) (UniStar 2009b), which addresses safety aspects of construction and operation. UniStar also submitted a Joint Federal/State Application for the Alteration of Any Floodplain, Waterway Tidal, or Nontidal Wetland in Maryland to the U.S. Army Corps of Engineers (USACE or Corps) and to the Maryland Department of the Environment (MDE) (UniStar 2008c).

In addition, UniStar submitted an application to the Maryland Department of Natural Resources (DNR, cited as MDNR) in support of an application for a Certificate of Public Convenience and Necessity (CPCN) (UniStar 2007). A CPCN is required by the State of Maryland before UniStar can start construction activities. In response to the CPCN application, Maryland DNR's Power Plant Research Program (PPRP) conducted an extensive review of the UniStar submittal (MDNR PPRP 2008), and the Maryland Public Service Commission (PSC) issued a CPCN for proposed Unit 3 on June 26, 2009 (MPSC 2009).

As discussed in Section 3.3 of this environmental impact statement (EIS), the NRC's authority related to building new nuclear generating units is limited to construction "activities that have a reasonable nexus to radiological health and safety and/or common defense and security" (72 FR 57416). Many of the activities required to build a nuclear power plant do not fall within the NRC's regulatory authority and, therefore, are not "construction" as defined by the NRC. Such activities are referred to as "preconstruction" activities in Title 10 of the Code of Federal Regulations (CFR) Part 51.45(c). The NRC staff evaluates the direct, indirect, and cumulative impacts of the construction activities that would be authorized with the issuance of a COL. The environmental effects of preconstruction activities (e.g., clearing and grading, excavation, and erection of support buildings) are included as part of this EIS in the evaluation of cumulative impacts.

As described in Section 1.1.3 of this EIS, the Corps is a cooperating agency on this EIS consistent with the updated Memorandum of Understanding (MOU) signed with the NRC (USACE and NRC 2008). The NRC and the Corps established this cooperative agreement because both agencies have concluded it is the most effective and efficient use of Federal resources in the environmental review of a proposed new nuclear power plant. The goal of this cooperative agreement is the development of one EIS that provides all the environmental information and analyses needed by the NRC to make a license/permit decision and all the information needed by the Corps to perform analyses, draw conclusions, and make a permit decision in the Corps' Record of Decision (ROD) documentation. To accomplish this goal, the environmental review described in this EIS was conducted by a joint NRC/Corps team. The review team was composed of NRC staff and its contractors and staff from the Corps.

The Corps is responsible for ensuring that the information presented in this EIS is adequate to fulfill the requirements of Corps regulations, the Clean Water Act Section 404(b)(1) "Guidelines," which contains the substantive environmental criteria used by the Corps in evaluating discharges of dredged or fill material into waters of the United States, and the Corps public interest review process. The Corps will decide whether to issue a permit based on an evaluation of the probable impact including cumulative impacts of the proposed activity on the public interest. In accordance with the Guidelines, no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge that would have less adverse impact on the aquatic ecosystem, provided the alternative does not have other significant adverse consequences. The Corps permit decision will reflect the national concern for both protection and utilization of important resources. The benefit which reasonably may be expected to accrue from the proposal must be balanced against its reasonably foreseeable detriments. Factors that may be relevant to the proposal,including the cumulative effects thereof, will be considered;among those factors are conservation, economics, aesthetics, general environmental concerns, wetlands, historic and cultural resources, fish and wildlife values, flood hazards, floodplain values, land use, navigation, shore erosion and accretion, recreation, water supply, water quality, energy needs, safety, food and fiber production, mineral needs, considerations of property ownership, and in general, the needs and welfare of the people.

Many of the impacts the Corps must address in its analysis are the result of preconstruction activities. Also, most of the activities conducted by a COL applicant that would require a permit from the Corps would be preconstruction activities. On May 16, 2008, UniStar submitted an application to the Corps for a permit to conduct the following activities: filling, dredging, grading, and building structures (UniStar 2008c).

While both the NRC and the Corps must meet the requirements of the National Environmental Policy Act of 1969, as amended (NEPA), both agencies also have mission requirements that must be met in addition to the NEPA requirements. The NRC's regulatory authority is based on the Atomic Energy Act of 1954, as amended (42 U.S.C. 2011 et seq.). The Corps' regulatory authority related to the proposed action is based on Section 10 of the Rivers and Harbors Appropriation Act of 1899 (Rivers and Harbors Act) (33 U.S.C. 403), which prohibits the obstruction or alteration of navigable waters of the United States without a permit from the Corps, and Section 404 of the Clean Water Act (33 U.S.C. 1344), which prohibits the discharge of dredged or fill material into waters of the United States without a permit from the Corps. Therefore, the applicant may not commence preconstruction or construction activities in jurisdictional waters, including wetlands, without a Corps permit. The Corps will complete its evaluation of the proposed project after it fully considers the recommendations of Federal, State, and local resource agencies and members of the public; assesses the cumulative impact of the total project; and after the following consultations and coordination efforts are completed: Section 106 of the National Historic Preservation Act, including, as appropriate, development and implementation of any Memorandum of Agreement (MOA); Endangered Species Act; Essential Fish Habitat coordination; State Forest Conservation Plans; State Water Quality Certifications; and State Coastal Zone Consistency determinations. Because the Corps is a cooperating agency under the MOU for this EIS, the Corps' decision of whether to issue a permit will not be made until after public comment has been received on this NRC/Corps draft EIS and the final EIS is issued.

The collaborative effort between the NRC and the Corps in presenting their discussion of the environmental effects of building the proposed project, in this chapter and elsewhere, must serve the needs of both agencies. Consistent with the MOU, the staffs of the NRC and the Corps collaborated in the (1) review of the COL application and information provided in response to requests for additional information (developed by the NRC and the Corps) and (2) development of the EIS. Section 10 CFR 51.45(c) requires that the impacts of preconstruction activities be addressed by the applicant as cumulative impacts in its ER. Similarly, the NRC's analysis of the environmental effects of preconstruction activities on each resource area would be addressed as cumulative impacts, normally presented in Chapter 7. However, because of the collaborative effort between the NRC and the Corps in the environmental review, the combined impacts of construction activities that would be authorized by the NRC with its issuance of a COL and the preconstruction activities are presented in this chapter. For each resource area, the NRC also provides an impact characterization solely for construction activities that meet the NRC's definition of construction at 10 CFR 50.10(a). Thereafter, both the assessment of the impacts of 10 CFR 50.10(a) construction activities and the assessment of the combined impacts of construction and preconstruction are used in the description and assessment of cumulative impacts in Chapter 7 of this EIS.

For most environmental resource areas (e.g., aquatic ecology), the environmental impacts are not the result of either solely preconstruction or solely construction activities. Rather, the impacts are attributable to a combination of preconstruction and construction activities. For most resource areas, the majority of the impacts would occur as a result of preconstruction activities.

This chapter is divided into 12 sections. In Sections 4.1 through 4.9, the review team evaluates the potential impacts on land use, meteorology and air quality, water use and quality, terrestrial and aquatic ecosystems, socioeconomics, environmental justice, historic and cultural resources, nonradiological and radiological health effects, and applicable measures and controls that would limit the adverse impacts of station construction. An impact category level – SMALL, MODERATE or LARGE – of potential adverse impacts has been assigned by the review team for each resource area using the definitions for these terms established in Chapter 1. In some resource areas, for example in the socioeconomic area where the impacts of taxes are analyzed, the impacts may be considered beneficial and would be stated as such. The review team's determination of the impact category levels is based on the assumption that the mitigation measures identified in the ER or activities planned by various state and county governments, such as infrastructure upgrades (discussed throughout this chapter), are implemented. Failure to implement these upgrades might result in a change in the impact category level. Possible mitigation of adverse impacts, where appropriate, is presented in Section 4.10. A summary of the construction impacts and the proportional distribution of impacts based on construction and preconstruction is presented in Section 4.11. Citations for the references cited in this chapter are listed in Section 4.12. The technical analyses provided in this chapter support the results, conclusions, and recommendations presented in Chapters 7, 9, and 10 of this EIS.

The review team's evaluation of the impacts of construction of Calvert Cliffs proposed Unit 3 draws on information presented in UniStar's ER and supplemental documents, the PPRP review of the proposed project and the CPCN (MPSC 2009), and the Corps' permitting documentation, as well as other government and independent sources.

4.1 Land-Use Impacts

This section provides information on land-use impacts associated with building proposed Unit 3 at the Calvert Cliffs site. Topics discussed include land-use impacts at the Calvert Cliffs site, in the vicinity of the Calvert Cliffs site, and in transmission line corridors and other offsite areas.

4.1.1 The Site and Vicinity

Proposed Unit 3 would be located southeast of existing Calvert Cliffs Nuclear Power Plant (CCNPP) Units 1 and 2. The proposed location for Unit 3 is entirely within the existing Calvert Cliffs site. Approximately 460 ac would be disturbed during construction (UniStar 2009a). Unit 3 and auxiliary facilities would occupy approximately 320 ac at the site (UniStar 2009a). Approximately 36 ac would be used to permanently store excavated material from the power block, circulating water supply system cooling tower and other construction areas that are not suitable for construction backfill (UniStar 2009a). Approximately 134 ac of land that is currently zoned Forest and Farm District by Calvert County would be permanently affected, and 13 ac would be temporarily affected by building activities (UniStar 2009a). Some wetlands on the Calvert Cliffs site would be affected by Unit 3 building activities. Wetland impacts are discussed in Section 4.3.3.

The location of proposed Unit 3 and supporting facilities is not currently farmed and does not possess any prime farmland soils (UniStar 2009a). The proposed building activities would result in the permanent loss, through filling, of approximately 11.7 ac of non-tidal wetland habitat and approximately 30.7 ac of non-tidal wetland buffer (UniStar 2009a).

Heavy equipment and reactor components would be barged up the Chesapeake Bay to the existing barge slip on the Calvert Cliffs site. The slip area would be dredged, and the existing heavy haul road from the barge slip would be modified and extended to the proposed Unit 3 construction site and laydown areas. A new access road, approximately 2.5 mi long, would be built from Maryland (MD) State Road 2/4 to the Unit 3 construction site, providing access to the construction areas without impeding traffic to Units 1 and 2 (UniStar 2009a). A site perimeter road system and access road around the cooling tower area to the power block would be built. Another road would be built to the proposed water intake structure.

The new intake, discharge, and barge facilities would be located in the 100-year coastal floodplain.[a] In addition, some mitigation activities, including wetland enhancement and creation and stream restoration and enhancement, would occur at and south of the area of the barge slip within the 100-year coastal floodplain (see Section 4.3). With those exceptions, facility development activities would be outside the 500-year floodplain in areas designated as areas of minimal flooding (UniStar 2009a).

Building Unit 3 would affect approximately 33.4 ac within the Chesapeake Bay Critical Area (CBCA), including approximately 14.35 ac within the CBCA buffer zone that extends 100 ft landward of mean high tide (UniStar 2009a). The proposed intake and discharge pipelines; the intake forebay and structure; the heavy haul road; stormwater retention basins; bio-retention drainage ditches; wetland enhancement and creation and stream restoration and enhancement; and security fencing would be within the buffer zone. Critical and buffer areas are discussed further in Section 2.2.1 of this EIS.

The intake structure, pipelines, and common forebay; barge slip; and heavy haul road would be located in the intensively developed area (IDA) adjacent to existing Units 1 and 2. Development in the more highly protected resource conservation area (RCA) would include the eastern edge of the power block and stormwater management structures and some stream and wetlands creation, restoration, and enhancement (see Section 4.3). UniStar states in its COL application that all applicable State and County regulations and ordinances pertaining to the CBCA Protection Act would be complied with when building and operating Unit 3 (UniStar 2009a).

(a) A one-hundred-year floodplain would be covered by floodwaters in the event of a 100-year flood. A 100-year flood is a flood having a one percent chance of being equaled or exceeded in magnitude in any given year.

Small portions of the currently proposed Captain John Smith Chesapeake National Historic Trail and the Star-Spangled Banner National Historic Trail would be converted from recreational land use to industrial land use with the expansion of the in-water exclusion area to comply with security measures for the proposed Unit 3. However, because most portions of the water trails would still be available for recreational use, the impact would be negligible.

Several facilities associated with Camp Conoy and the Eagle's Den conference center would be demolished. Adjacent pavement would also be removed. From an ecological perspective, the demolition would result in a beneficial increase in pervious surface area. Cultural aspects of demolition are addressed in Section 4.6.

Offsite land-use changes in the vicinity of the Calvert Cliffs site would be expected as a result of building activities. Information on roads, housing, and construction-related infrastructure impacts is discussed in Section 4.4.

Within the Calvert Cliffs site boundary, one new 500-kV substation to transmit power from proposed Unit 3 and two new 500-kV circuits connecting the proposed new unit's substation to the existing Units 1 and 2 substation would be needed. The two existing 500-kV circuits that are currently connected to Units 1 and 2 substation would be disconnected from the substation and extended 1 mi to the proposed Unit 3 substation (UniStar 2009a). The new circuits would require new onsite transmission towers. The new transmission towers would not be located in waters of the United States, including jurisdictional wetlands.

Based on information provided by UniStar and the review team's independent evaluation, the review team concludes that the land-use impacts of construction and preconstruction activities would be SMALL, and mitigation measures would not be warranted. The review team's conclusion reflects the following important considerations: (1) proposed Unit 3 would be built on an industrial site containing other nuclear facilities, (2) the State of Maryland has granted the applicant a CPCN for the proposed project, and (3) the Maryland Critical Area Commission approved, with conditions, UniStar's proposal to build proposed Unit 3 at the Calvert Cliffs site. Based on the above analysis, and because NRC-authorized construction activities represent only a portion of the analyzed activities, the NRC staff concludes that the land-use impacts of NRC-authorized construction activities would be SMALL. This project also requires certification from the State of Maryland that the proposed plant would be consistent with Maryland's coastal zone management program (see Section 2.2.1).

4.1.2 Transmission Line Corridors and Offsite Areas

As mentioned above, there would be a 1-mi extension of two existing 500-kV circuits onsite. Because the Calvert Cliffs site currently has industrial land use for the operation of Units 1 and 2 and because much of the land in the 1-mi onsite transmission corridor was previously disturbed, impacts to land use as a result of the transmission connection between the existing and proposed switchyards would be minor. No new offsite transmission corridors are planned for proposed Unit 3 (UniStar 2009a). Breaker upgrades and associated modifications would be required at the Waugh Chapel, Chalk Point, and other substations, but all of the changes would be implemented within the boundaries of the existing substations and no new land would be needed (UniStar 2009a). However, some offsite land use changes in the vicinity of the Calvert Cliffs site would be expected as a result of building activities. These changes are expected to be minor and temporary; information on transportation, recreation, and housing-related infrastructure impacts is discussed in Section 4.4.4. The review team concludes that the land-use impacts of construction and preconstruction activities of offsite transmission line corridors and other offsite areas would be SMALL, and no mitigation would be warranted.

10 CFR 50.10(a)(2) specifically states that the transmission lines are not construction activities. There would be no transmission corridor impacts from construction activities. The NRC staff concludes the land-use impacts from NRC-authorized construction activities would be SMALL, and no mitigation would be warranted.

4.2 Water-Related Impacts

Water-related impacts involved in building a nuclear power plant are similar to impacts that would be associated with any large industrial facility development project and similar to those realized while building Units 1 and 2. Prior to initiating onsite activities, including any site-preparation work, UniStar would be required to obtain the appropriate authorizations regulating alterations to the hydrological environment. These authorizations would likely include:

- Clean Water Act Section 401 Certification. This certification would be issued by the MDE and verifies that the project does not conflict with State water-quality management programs.
- Coastal Zone Management Consistency. This concurrence of consistency with the State costal program's policies would be issued by the MDE and applies to any activity that is in, or affects land use, water use, or any natural resource in the coastal zone, if the activity requires a Federal license or permit.
- Clean Water Act Section 402(p) National Pollutant Discharge Elimination System (NPDES) Construction and Industrial Stormwater Permits. These permits regulate limits of pollutants in liquid discharges to surface water and point source stormwater discharges. U.S. Environmental Protection Agency (EPA) stormwater regulations established requirements for stormwater discharges from various activities, including construction and preconstruction activities. The EPA has delegated the authority for administering the NPDES program in the State of Maryland to the MDE.

- Section 10 of the Rivers and Harbors Act. This section prohibits the obstruction or alteration of navigable waters of the United States without a permit. Permits for related activities in the Chesapeake Bay are obtained from the Corps.

4.2.1 Hydrological Alterations

Building the proposed Unit 3 would impact several surface water bodies and some of the aquifers underlying the site. Surface water bodies that would be altered by site preparation and building activities include the Chesapeake Bay, Camp Conoy Fishing Pond, Lake Davies, existing debris and sediment basins, wetlands, and the streams and creeks that drain the watersheds. The Camp Conoy Fishing Pond and Lake Davies are both man-made. Lake Davies was the location that received the dredge spoils during excavation of the intake and discharge structures for Units 1 and 2.

UniStar plans to construct a water-intake structure, water discharge pipe, heavy haul road, and upgraded and enlarged barge slip near and in the Chesapeake Bay. Within the proposed Unit 3 site boundary, about 320 ac would be permanently altered to build the proposed unit and another 140 ac would be temporarily disturbed. Water bodies such as Camp Conoy Fishing Pond and several streams would be filled in. Lake Davies would receive sediments dredged for the barge slip. Several stormwater impoundments would be created and their outlets routed to either Johns Creek on the west or the unnamed streams on the east. The excavation for the power block would extend down to as much as 40 ft below plant grade. To facilitate emplacement of below-grade elements, the excavation would likely require dewatering to remove water that enters from surface drainage and groundwater infiltration.

The local groundwater aquifers that could be impacted by proposed activities are the Surficial aquifer, the Piney Point-Nanjemoy aquifers, and the Aquia aquifer. Surface modifications during site preparation would alter the thickness of the Surficial aquifer and the nature and location of recharge and discharge zones. Water for construction and preconstruction purposes would be obtained from wells screened within the Aquia aquifer.

In summary, the hydrological alterations associated with building the proposed unit are limited to dredging for the intake and discharge structures, altering the surface topography and hydrology (e.g., site grading, laydown yards, stormwater collection trenches and basins), dewatering the excavation for installation of the nuclear facilities, and withdrawing groundwater from the Aquia aquifer for construction and preconstruction purposes.

4.2.2 Water Use Impacts

To support all the activities prior to completion of proposed Unit 3, UniStar (in collaboration with Maryland DNR's PPRP), has identified the water requirements for purposes such as worker needs, concrete mixing and curing, and dust control (UniStar 2009a). The water requirements would be met using groundwater from onsite wells, water from excavation dewatering, and water trucked in from offsite sources. After the desalination plant becomes operational, some of the water needs would be provided by desalinated Chesapeake Bay water.

Together with the Maryland DNR, UniStar identified three sources to supply water for construction and preconstruction (MDNR PPRP 2008). The primary source would be groundwater obtained from the Aquia aquifer from one or two new wells to be installed within the boundary of the Unit 3 site. The PPRP recommended that UniStar be granted an 8-year groundwater appropriation to provide water at an average rate of 100,000 gpd during each year and a maximum rate of 180,000 gpd during the month of maximum use. The PPRP recommendation of 8 years exceeds the UniStar estimate of time to complete the project to provide additional time should delays occur in building schedules. The other two sources of water would be excavation dewatering and treated effluent from local wastewater treatment plants. The water from both sources would be used (if appropriate) for dust control.

One of the sources of water is the Surficial aquifer, which would be dewatered to permit foundation installation. Extensive pumping of the Surficial aquifer may reduce or eliminate the springs and seeps that feed the ephemeral streams and wetlands that immediately surround the powerblock. UniStar (2009a) conducted a modeling study to determine the impact of these activities on water flow into Johns Creek. Because the precise nature of the revised surfaces and associated stormwater retention basins is unknown, UniStar considered three recharge rates: 2.5, 5.0 (the expected value), and 10.0 in./yr. The results showed that, relative to predisturbance conditions, groundwater flow to Johns Creek could drop by 50 percent under the low recharge rate, drop by 20 percent under the expected rate, and increase by 20 percent under the high rate. Discussions between UniStar and the PPRP suggested that the dewatering period may extend for only two years rather than the entire site preparation and building period (MDNR PPRP 2008). The review team identified no water users that rely on these small creeks.

The impacts of this water-use plan are discussed in the next sections.

4.2.2.1 Surface Water Use Impacts

According to the ER, UniStar expected to use water from the desalination (also called desalinization) plant when it became operational (UniStar 2009a). During discussions with the Maryland PPRP, UniStar acknowledged that the desalination plant would not be operational until the last two quarters of the last year of construction and preconstruction (MDNR PPRP 2008). When the desalination plant comes online, UniStar plans to use it primarily for plant commissioning rather than completing the buildings. Any Chesapeake Bay water that was desalinated and used prior to operation would be undetectable to the resource given the volume of water the Chesapeake Bay represents.

The impacts to surface water are limited to the immediate vicinity of the construction area and excavations. The impacts are limited to the first two years of the construction period, and Chesapeake Bay water would not be used for the planned activities. During dry periods, flow in the small local creeks may be reduced due to changes in the magnitude and distribution of groundwater recharge onsite caused by land-cover changes. Those creeks flow into Johns Creek before it leaves the site. However, the review team identified no water users that rely on Johns Creek.

Based on these factors, the information provided by UniStar, and the review team's independent evaluation, the review team concludes that the surface water use impacts of construction and preconstruction activities would be SMALL, and no mitigation would be warranted. Based on the above analysis, and because NRC-authorized construction activities represent only a portion of the analyzed activities, the NRC staff concludes that the surface water use impacts of NRC-authorized construction activities would be SMALL. The NRC staff also concludes that no further mitigation measures would be warranted.

4.2.2.2 Groundwater Use Impacts

Surficial Aquifer

UniStar plans to pump water from the Surficial aquifer to dewater those areas where foundations must be built. Once the foundations are completed, the dewatering can be discontinued. Within a few years, the water levels in the Surficial aquifer should return to levels close to their predisturbance levels. There are no nearby users of water from this aquifer, and the impact would be limited to the dewatering period.

Piney Point-Nanjemoy Aquifer

UniStar has seven wells screened within this aquifer. Four of these wells are in the vicinity of Camp Conoy and would be removed. The other three wells supply the Visitor's Center, Firing Range, and some trailers. Their combined permit limit is 1100 gpd. There are no plans to use these remaining wells to provide water for construction and preconstruction activities or to install new wells in this aquifer.

Aquia Aquifer

Bechtel (2008a) evaluated the impact of increasing the groundwater pumping rate from the 2002 rate of 392,000 gpd to 738,000 gpd to provide water for building Unit 3. Its results suggested that the maximum effect to the closest water user would be a 14-ft decline in Aquia aquifer piezometric level and that the decline would dissipate within 3 years of ceasing the increased pumping. The 2008 piezometric level of the Aquia aquifer at Calvert Cliffs was about -90 ft (90 ft below ground surface). The top of the Aquia aquifer at Calvert Cliffs is about -415 ft, so a temporary decline in piezometric level of 14 ft is relatively small and would not lead to desaturation of the aquifer. Because the Aquia aquifer would remain saturated during these temporary declines in water level, wells completed in this formation would still have piezometric levels well above the top of the Aquia aquifer and would be able to continue functioning normally.

As noted, UniStar proposes to use water from one or two new Aquia aquifer wells that would be installed within the boundary of the Unit 3 site. The permitted average withdrawal would be about 100,000 gpd during a 365-day period. During the month of maximum withdrawal, the permitted rate would be 180,000 gpd. That withdrawal rate is significantly less than the current rate of 392,000 gpd and the higher rate of 738,000 gpd evaluated by Bechtel (2008a). Therefore, the decline in the Aquia aquifer would be less than the 14-ft decline estimated by Bechtel. Because additional pumping is only needed during site preparation and building Unit 3 and because the quantity to be pumped is only 26 percent of what is currently pumped for Units 1 and 2, the change to the Aquia aquifer's piezometric surface is limited, temporary, and localized. The PPRP evaluated the impact and reached a similar conclusion (MDNR PPRP 2008).

The impact to the Surficial aquifer is localized, and there are no nearby users of water from that aquifer. Water from the Piney Point-Nanjemoy aquifer would not be used. The permitted Aquia aquifer pumping rate would be smaller than the withdrawal rate for Units 1 and 2 and would occur for no more than 86 months. Based on these factors, the information provided by UniStar, and the review team's independent evaluation, the review team concludes that the groundwater use impacts of construction and preconstruction activities for proposed Unit 3 would be SMALL, and no mitigation would be warranted. Based on the above analysis, and because NRC-authorized construction activities represent only a portion of the analyzed activities, the NRC staff concludes that the groundwater use impacts of NRC-authorized construction activities would be SMALL. The NRC staff also concludes that no mitigation measures would be warranted.

4.2.3 Water Quality Impacts

Impacts to the quality of the water resources of the site are expressed for surface-water (the streams, creeks, and Chesapeake Bay) and groundwater (i.e., the Surficial and Aquia aquifers) conditions that are most directly affected by construction and preconstruction.

4.2.3.1 Surface Water Quality Impacts

While building the proposed Unit 3, the potential exists for soil erosion to degrade the water quality of surface-water bodies such as Johns Creek, associated branches and unnamed streams, and the nearshore environment of Chesapeake Bay. In addition, installation of intake, discharge, and barge slip structures in and along the shoreline of the Chesapeake Bay will disturb sediments, potentially increasing turbidity both near and downstream of the sites of these facilities. To build and operate the proposed unit, UniStar must obtain multiple approvals from regulatory and State agencies, including a Section 404 permit from the Corps, a NPDES general construction permit from the MDE, a Section 401 Certification from the State of Maryland, and a Coastal Zone Management Act (CZMA) consistency determination from the State of Maryland. In addition, UniStar is required by MDE to develop a Sediment and Erosion Control Plan and Stormwater Pollution Prevention Plan (SWPPP). Together, the approvals, the SWPPP, and the CPCN conditions (MSPC 2009) will confirm that UniStar follows best management practices (BMPs) to minimize the impacts to surface waterbodies.

Because hydrological alterations resulting from site preparation and building activities, including dredging for the intake, discharge, and barge slip, would be localized and temporary; disturbed land would be stabilized to prevent erosion; and permits, certifications, and SWPPP require the implementation of BMPs to minimize impacts, the review team concludes that the surface water quality impacts of construction and preconstruction activities for proposed Unit 3 would be SMALL, and no mitigation beyond the BMPs would be warranted. Based on the above analysis, and because NRC-authorized construction activities represent only a portion of the analyzed activities, the NRC staff concludes that the surface water quality impacts of NRC-authorized construction activities would be SMALL. The NRC staff also concludes that no further mitigation measures beyond the BMPs would be warranted.

4.2.3.2 Groundwater Quality Impacts

During site preparation and building activities of proposed Unit 3, the potential exists for spills to transport pollutants (e.g., gasoline) to the Surficial aquifer. As noted, UniStar would be subject to a multitude of permit requirements that serve to prevent and promptly mitigate any spills. Another potential mechanism that could degrade water quality is the disposal of dredged sediments from Chesapeake Bay in Lake Davies. However, there is no evidence that disposal of sediments dredged while building Units 1 and 2 in Lake Davies caused a discernible degradation of water quality. Furthermore, the quantity of sediments dredged for Unit 3 would be less than the quantities for Units 1 and 2 because Unit 3 would use the existing intake channel. With less sediment being disposed, the impact to water quality from building Unit 3 would likely not be discernible.

Increased pumping in the Aquia aquifer has the potential to reduce potentiometric surfaces and induce saltwater intrusion. However, Maryland CPCN-permitted pumping rate for Unit 3 is only 22 percent of the permitted pumping rate for Units 1 and 2, and the CPCN-permitted duration of pumping for Unit 3 is only 8 years. The temporary groundwater withdrawal is unlikely to be sufficient to induce intrusion. Withdrawals elsewhere on the Calvert Peninsula are much higher and have yet to show evidence of saltwater intrusion.

Because of the BMP protection and the lack of observed impacts from previous activities related to building Units 1 and 2, the review team concludes that the groundwater quality impacts of construction and preconstruction activities for proposed Unit 3 would be SMALL, and no further mitigation beyond the BMPs for spills would be warranted. Based on the above analysis, and because NRC-authorized construction activities represent only a portion of the analyzed activities, the NRC staff concludes that the groundwater quality impacts of NRC-authorized construction activities would be SMALL. The NRC staff also concludes that no further mitigation measures beyond the BMPs would be warranted.

4.2.4 Water Monitoring

UniStar states in the ER that it will prepare an Erosion, Sedimentation and Pollution Control Plan in support of the NPDES Construction Stormwater Permit. This permit is required before site preparation can commence on the proposed Unit 3.

Some of the observation wells would be impacted by site preparation and building activities and would be taken out of service prior to the start of work. UniStar states that the monitoring network would be evaluated to identify any groundwater data gaps and determine whether additional wells are needed to fill those gaps. UniStar also states that revisions to the monitoring network would be implemented to identify the impacts of preoperational activities. UniStar would continue to monitor groundwater levels.

4.3 Ecological Impacts

This section describes the potential impacts to ecological resources from the construction of proposed Unit 3. This section is divided into two subsections: terrestrial and wetland impacts and aquatic impacts.

4.3.1 Terrestrial and Wetland Impacts

This section provides information on the site-preparation activities and construction of proposed Unit 3 at the Calvert Cliffs site and the impacts to the terrestrial ecosystem. Topics discussed include terrestrial resource impacts at the site, erosion and sedimentation control, sensitive resources, spill prevention and response, and noise. The detailed acreage estimates used for analysis in this section are taken from Table 4.3-1 of UniStar's ER (UniStar 2009a). Although acreage sums do not match revised totals describing the same disturbance areas cited earlier in the ER, the discrepancies in the total amounts of area disturbed are not expected to change the outcome of this analysis.

4.3.1.1 Terrestrial Resources – Site and Vicinity

Wildlife Habitat

All activities related to building the proposed Unit 3, including ground-disturbing activities, would occur within the existing Calvert Cliffs site boundary. Although impacts could not be avoided, the footprint of the Unit 3 area was designed to minimize impacts to high-quality terrestrial habitats. Approximately 460 ac of terrestrial wildlife habitat would be disturbed while building Unit 3 (Table 4-1). Approximately 320 ac of habitat, including 33.4 ac in the CBCA, would be permanently lost as it would be cleared, grubbed, and graded to develop the power block, cooling tower, switchyard, roadways, parking lots, permanent construction laydown area, borrow area, and retention basins (Figure 4-1). Temporary impacts to 169 ac of wildlife habitat would occur to accommodate a batch plant and temporary construction laydown areas, construction offices, warehouses, and parking (Table 4-1). No area within CBCA limited development areas (LDAs) would be disturbed, and all temporary impacts would occur outside the CBCA.

Habitat loss would occur within all nine cover classes (Table 4-1, Figure 4-1). Most of this loss would be in mixed deciduous forest cover, which is the most abundant cover type within the site boundary. Loss of approximately 12 ac of wetlands, a valuable and important resource in the Chesapeake Bay region, would also occur (see Wetlands section for detailed analyses). About 253 ac of forest would be lost. Merchantable timber would be removed, and stumps, shrubs, saplings, groundcover, and leaf litter would be grubbed and cleared. Although individual trees may be retained for aesthetic purposes, habitats and their ecological functions within the proposed clearing and building area would be lost.

The State of Maryland has determined that the amount of forest retained after the proposed construction would exceed thresholds defined in the Maryland Forest Conservation Act (Natural Resources Article 5-1601-1612) and would not require mitigation for forest loss (MDNR PPRP 2008). However, to minimize the impacts of forest loss, UniStar has prioritized forest stands for future permanent preservation based on age, successional stage, and ease of replacement. Priority is given to forest types indicative of mature, stable, forested wetlands. Mature, late-successional deciduous forest types are given second priority for preservation. Sweetgum (*Liquidambar styraciflua*)-tulip poplar (*Liriodendron tulipifera*) forest occupies flatter, richer soils and is ranked third. Forest stands dominated by fast-growing, early-successional tree species are given lowest priority for preservation.

The power block and adjoining permanent laydown yard were placed in the Camp Conoy area to minimize impacts to the CBCA and interior forest. Previous development had fragmented the local forest and precluded its use by forest interior dwelling species (FIDS). In addition, the width of the proposed entrance road has been narrowed, and temporary staging areas are proposed in old field cover types in the western part of the Calvert Cliffs site. Also, the concrete batch plant location would become the proposed permanent laydown area just southeast of the proposed power block.

Table 4-1. Areal Extent of Disturbance to Cover Types on the Calvert Cliffs Site

Cover Type	CBCA IDA[a] (ac)	CBCA RCA[b] (ac)	CBCA Total (ac)	Permanent Impacts (outside CBCA (ac)	Temporary Impacts outside CBCA (ac)	Total (ac)
Lawns/Developed Areas	3.09	5.21	8.30	19.33	24.30	51.93
Old Field	1.22	0.23	1.45	27.35	96	124.8
Mixed Deciduous Forest	14.76	5.20	19.96	133.81	26.44	180.21
Mixed Deciduous Regeneration Forest	0	0	0	36.28	12.00	48.28
Well-Drained Bottomland Deciduous Forest	0	0	0	1.37	0.05	1.42
Poorly Drained Bottomland Deciduous Forest	0.15	0.50	0.65	8.87	0.31	9.83
Herbaceous Marsh	0.05	0.02	0.07	1.74	1.63	3.44
Successional Hardwood	0	1.71	1.71	3.5	7.82	13.03
Open Water	0.02	0.01	0.03	2.66	0	2.69
Total	19.29	12.88	32.17[c]	234.91	168.55	435.63[d]

Source: UniStar 2009a

(a) IDA = intensely developed area

(b) RCA = resource conservation area

(c) UniStar's revised total CBCA area disturbed is 33.4 ac; however, the cover type(s) of the additional 1.2 ac of disturbance was not identified. Regardless of cover type or habitat of the additional 1.2 ac, the conclusion in this EIS is unlikely to change.

(d) UniStar's revised total area disturbed is 460 ac; however, the cover type(s) of the additional 25 ac of disturbance was not identified. Regardless of cover type or habitat of the additional 25 ac, the conclusion in this EIS is unlikely to change.

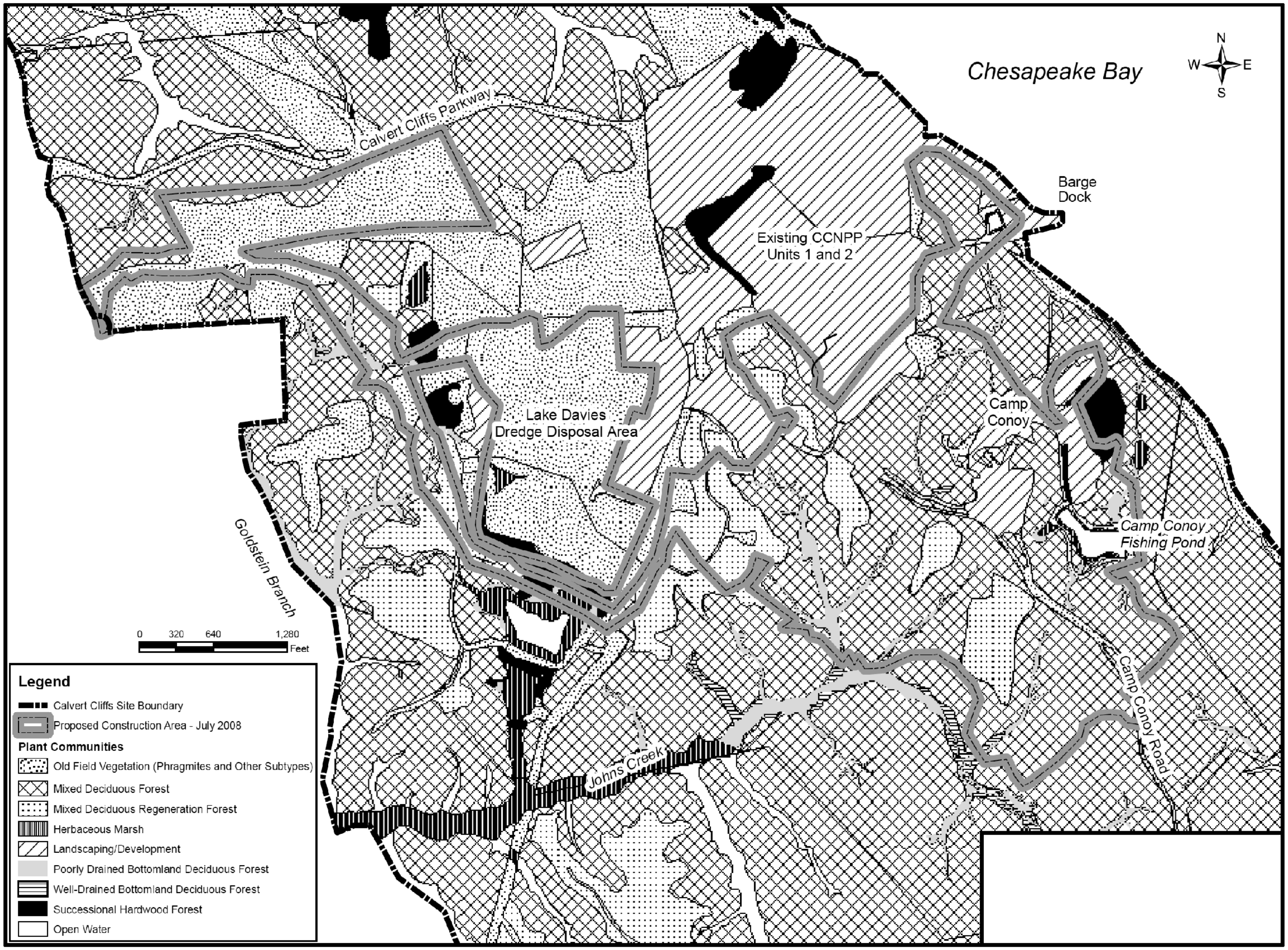

Figure 4-1. Locations of Impacts within Vegetation Cover Types of the Calvert Cliffs Site (UniStar 2009b)

BMPs would be employed to minimize impacts to areas surrounding the disturbance footprint. For example, silt fences, as specified in an erosion and sedimentation plan that would have to be approved by the MDE prior to site disturbance, would be erected. Exposed soil would be covered or bermed until backfilling and final grading activities would be completed.

Chesapeake Bay Critical Area

The proposed Unit 3 disturbance footprint would affect the CBCA, including forested habitat, and tidal and non-tidal wetlands in the IDA and the RCA. Approximately 33.4 ac within the CBCA would be affected by the proposed disturbance. Activities that would occur within the CBCA include installation of a new water intake structure and pump houses, installation of a fish-return system, terracing of the forested hill just west of the new intake and fish-return, building the heavy haul road, grading and filling areas for the power block and laydown area, and altering the existing barge dock. About 19 ac of this would occur within the IDA, and almost 13 ac would occur in the RCA. Although IDAs are plots that contain little or no natural habitat as a result of previous development and land use activities, 15 ac of forest cover within the IDA would be affected. There would be no disturbance in the LDA. Dredging to enhance the barge slip would affect a small amount of tidal wetland, and an even smaller amount of forest. Impervious surfaces within the CBCA would increase by 2.8 ac as a result of the proposed actions.

Mitigation for these impacts, as well as loss of interior forest/FIDS habitat and wetlands, is proposed to occur within the CBCA (Figure 4-2). The applicant proposes to create 7.2 ac of forested wetland in the Camp Conoy area. Tulip poplar, sweetgum, green ash (*Fraxinus pennsylvanica*), black locust (*Robinia pseudoacacia*), Virginia pine (*Pinus virginiana*), and loblolly pine (*P. taeda*) would also be planted to recreate a 16.4 ac stand of mixed deciduous forest in a disturbed area north of the existing Units 1 and 2 (MDNR PPRP 2008). It is expected that mitigation plantings would provide FIDS habitat within 20 to 30 years, with natural succession ultimately reproducing the forest structure that now exists within the proposed Unit 3 area. In addition, 3.2 ac of upland forest would be planted where existing buildings and associated impervious surfaces would be removed from the Eagle's Den site (UniStar 2008d).

The specified portions of the CBCA would be adversely affected by the proposed construction. However, impacts would mainly occur in the IDA. The primary conservation concern within IDAs is impacts to water quality. Impervious surfaces increase stormwater runoff, which adversely affects water quality, and impervious surface area would increase (see Sections 4.2.3.1 and 4.3.2 for additional discussion). A total of 22 ac of forest would be lost within the CBCA. Although mitigation would create 26.4 ac of forest, adverse impacts to the CBCA are significant. Adverse impacts to non-tidal wetlands (including within CBCA) are discussed in the wetlands section.

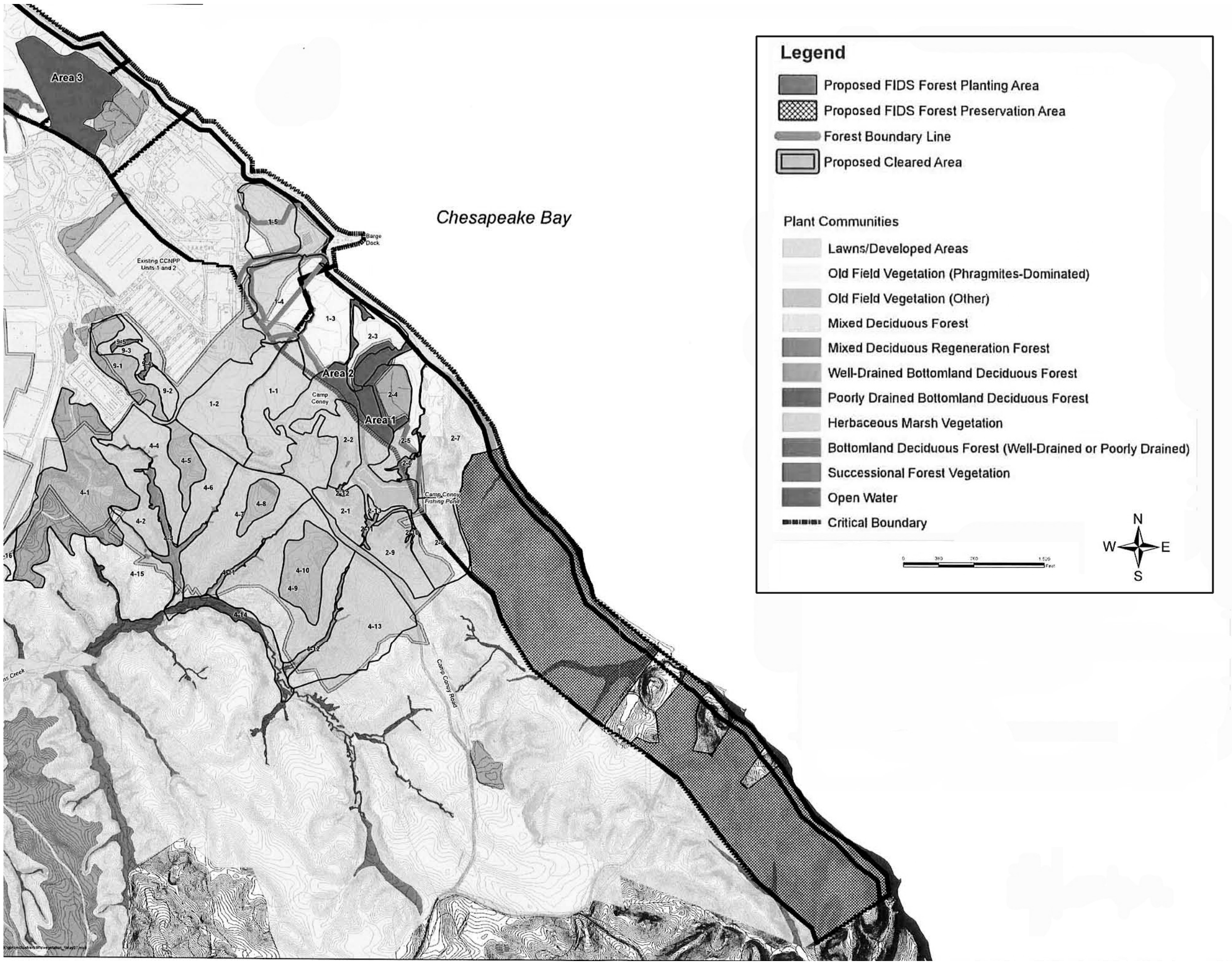

Figure 4-2. Proposed Mitigation Actions on the Calvert Cliffs Site (MDNR PPRP 2008)

Wildlife Habitat Summary

Impacts from building the proposed Unit 3 and supporting facilities to wildlife habitat would be unavoidable. Approximately 460 ac of habitat would be affected, and 320 ac would be permanently lost. Forested cover would be reduced by about 253 ac, and 13 ac of wetland habitat would be lost. The remaining forest area satisfies the Maryland Forest Conservation Act breakeven point; therefore, mitigation of forest removal is not planned.

Interior forest, a habitat relied upon by FIDS, would be adversely affected. The disturbance footprint would affect 16.3 ac of interior forest habitat within the CBCA on the Calvert Cliffs site. Increased forest fragmentation and additional impacts to riparian forest (amounting to about 19 ac in addition to the lost interior forest), the other key FIDS habitat, would result in a total of about 35 ac, or 56 percent, of onsite FIDS habitat being lost (MDNR PPRP 2008).

Fragmentation of forest could also result in lower productivity by allowing invasive species a foothold into previously undisturbed habitats. For example, the brown-headed cowbird (*Molothrus ater*), a nest parasite that thrives along forest edges, lays its eggs in the nests of other birds. Cowbird eggs hatch quicker than eggs of the host species, and the young cowbird either ejects other eggs from the nest or out competes other nestlings for food. This could affect FIDS such as the scarlet tanager (*Piranga olivacea*), with the end result being decreased FIDS productivity. However, post-disturbance riparian forest mitigation actions could partially offset forest fragmentation because plantings are expected to result in a net gain of more than 15 ac of FIDS habitat over time.

The CBCA would be adversely affected at the locations described above by the proposed building of Unit 3. A sum of 22.3 ac of forest would be lost within the CBCA onsite, but post-disturbance mitigation actions should create an additional 26.4 ac of forest, including forested wetlands, to partially offset impacts to the CBCA, Calvert Cliffs site wetlands, and FIDS habitat loss. Impacts would primarily occur in the IDA surrounding the existing barge dock and water intake structure. The primary conservation concern within IDAs is decreased water quality, which would result from the increase in impervious surface area would increase. Some existing impervious surfaces would be removed elsewhere in the CBCA, and UniStar must have an MDE-approved erosion and sedimentation plan before ground-disturbing activities commence. This plan would contain BMPs, such as silt fences and berming that address water quality issues during and after building Unit 3. MDE would determine the need, if any, for further mitigation measures.

Flora and Fauna

Direct mortality would occur to wildlife inhabiting the proposed disturbance footprint. Commonly occurring arboreal, fossorial, and less mobile wildlife that would be affected during land-clearing activities such as timber harvest, grubbing, and grading include the beaver (*Castor canadensis*), woodchuck (*Marmota monax)*, eastern gray squirrel (*Sciurus carolinensis*), eastern chipmunk (*Tamias striatus*), eastern cottontail rabbit (*Sylvilagus floridanus*), American toad (*Bufo americanus*), and various snakes, frogs, and small mammals. Larger and more mobile species would likely flee. None of these species is of conservation concern in the State of Maryland and all are common in suitable habitats throughout the region. The review team concludes that direct mortality is not expected to depress local populations at detectable levels.

During site field surveys, 46 migratory bird species were recorded within various cover types of the Calvert Cliffs site (Tetra Tech NUS 2007). Land-clearing activities conducted during the nesting season would result in lost or decreased habitat for migratory birds nesting with the work zone. The U.S. Fish and Wildlife Service (FWS) would not place any time-of-year restrictions on land clearing due to Migratory Bird Treaty Act (MBTA) consideration and has deemed proposed mitigation sufficient for offsetting impacts to migratory birds (FWS 2009).

Therefore, the review team concludes that loss of migratory bird productivity would be localized and is not expected to destabilize regional populations. Mortality from avian collision with existing transmission lines and new permanent structures, including cooling towers, is discussed in Chapter 5.

Activities including the presence of humans, machinery, construction lighting, traffic, noise, and fugitive dust would likely displace wildlife in habitats surrounding the proposed disturbance footprint. Sufficient habitat exists in the vicinity of the proposed construction area and elsewhere on the Calvert Cliffs site to allow avoidance behavior from high noise levels. As animal density increases within these habitats, increased competition may displace individuals into sub-optimal habitats, potentially predisposing individuals to higher mortality rates. Habitat displacement and increased traffic from building activities would increase wildlife mortality on roadways areas as animals flee disturbance areas. Mammals that may suffer increased roadside mortality include the white-tailed deer (*Odocoileus virginianus*), eastern cottontail rabbit, eastern gray squirrel, eastern chipmunk, raccoon (*Procyon lotor*), and woodchuck. Most turtle, snake, and amphibian species are also at risk for roadway mortality. However, displacement of individuals and subsequent competition and roadway mortality would occur to mostly common and abundant species. The review team concludes that these impacts would not be detectable beyond the local vicinity and would not destabilize regional populations.

Refueling stations, fuel storage, oil storage, and storage of other fluids also pose a risk to surface waters that some wildlife species rely upon. However, activities and spill countermeasures would be conducted in a way to minimize the potential for spill and limit the spread, thereby limiting mortality and morbidity of wildlife. BMPs related to the management of effluent and stormwater runoff as required by the Storm Water Management Plan and NPDES permit would also limit these impacts.

In summary, impacts to flora and fauna include direct mortality from land clearing, increased traffic, and chemical spills. Displacement of individuals, increased competition, and lost productivity could also result. However, the review team does not expect that the sum of these activities would be measurable at a population level beyond the project footprint and immediate vicinity.

4.3.1.2 Terrestrial Resources – Transmission Lines

Impacts related to building new transmission lines onsite for proposed Unit 3 are incorporated in the discussion of onsite impacts in the preceding section. No new offsite transmission lines would be installed.

4.3.1.3 Important Terrestrial Species and Habitats

This section describes the potential impacts to important species, including Federally threatened or endangered terrestrial species or terrestrial species proposed for Federal listing, State-listed species, and other ecologically important species, resulting from construction of the new unit at the Calvert Cliffs site and the onsite 500-kV transmission lines. The potential impacts of construction activities on these species are described in the following sections. There are no areas designated as critical habitat in the vicinity of the Calvert Cliffs site.

Chestnut Oak (Quercus prinus)

Chestnut oak is important as a mast-producing tree that contributes to the structural integrity and ecosystem health of the Calvert Cliffs site's forested tracts. Although its removal from a forest stand could affect wildlife food resources, impacts on the regional population would be negligible as it is common within mixed deciduous stands of the site and is widely distributed across the eastern United States (USDA 2008a).

Mountain Laurel (Kalmia latifolia)

Mountain laurel is a common shrub in the forest understory on the Calvert Cliffs site and throughout the eastern United States. It contributes to forest structure and is not a significant food source for wildlife (USDA 2008b). Although this species would be removed from the disturbance footprint, impacts to mountain laurel would be negligible as it is ubiquitous on the site.

New York Fern (Thelypteris noveboracensis)

New York fern is a widespread and abundant ground cover plant under forest canopies of the Calvert Cliffs site and the eastern United States and Canada (USDA 2008c). It contributes to forest structure. Although this species would be removed from the disturbance footprint, impacts to New York fern would be negligible as it also is ubiquitous on the site.

Showy Goldenrod (Solidago speciosa)

The State of Maryland lists the showy goldenrod as a threatened species that prefers open areas in full sun. Large patches of showy goldenrod observed within the proposed power block area at several locations around Camp Conoy would be removed or transplanted. Adverse impacts could be avoided, but UniStar chose to build components of Unit 3 within previously disturbed old field areas, which are showy goldenrod habitat, to limit impacts to forests and wetlands. The applicant has proposed a mitigation and monitoring plan to mitigate the impacts, and the plan would be conducted in accordance with the Maryland Department of Natural Resources guidelines for rare, threatened, and endangered plant reintroductions (MDNR 2008). Showy goldenrod rhizomes (root structure) and seeds would be collected from at least 10 locations within the disturbance footprint and replanted/resewn in an attempt to preserve local genetic diversity. A survey of the mitigation planting site would occur before mitigation and annually in September–October for five continuous years (MDNR PPRP 2008). A baseline report and five annual reports, including transplant results, photo-documentation, site maps, problem descriptions, and actions taken, would be submitted to the Maryland DNR (2008a). The Maryland DNR generally discourages transplanting as a means of avoiding impact to a listed plant species. Although success of the proposed mitigation actions cannot be determined, showy goldenrod is a plant commonly and successfully sewn into plantings, gardens, and prairie restorations (Kentucky Native Plant Society 2005). Therefore, some level of success is likely to result from the proposed mitigation actions. Net effects to the showy goldenrod would be noticeable but would not jeopardize the continued existence of this species on the site, assuming some transplants are successful.

Shumard's Oak (Quercus shumardii)

Shumard's oak is another State threatened species that occurs on the Calvert Cliffs site and throughout the southeastern United States (USDA 2008d). Although no individual trees were observed within the proposed disturbance footprint, several were observed immediately adjacent to the switchyard, laydown area 1, and cooling tower construction areas. These trees would not be removed, but clearing and grubbing may affect the root zones of the trees nearest the construction zone. The applicant has proposed to retain as much of the existing vegetation as possible in the vicinity of the Shumard's oaks to serve as a buffer from disturbance. As a result of the buffer, adverse impacts to Shumard's oak are expected to be negligible.

Spurred Butterfly Pea (Centrosema virginianum)

Although not listed as threatened or endangered, the State of Maryland does classify the spurred butterfly pea as rare. The presence of the spurred butterfly pea has not been confirmed, and the location where it is most likely to occur is outside the proposed disturbance area. Therefore, it would not likely be affected by the proposed activities related to building a new nuclear unit at Calvert Cliffs.

Tulip Poplar (Liriodendron tulipifera)

The tulip poplar was identified as important because it is a common tree throughout the Calvert Cliffs site and vicinity, it contributes to the local forest structure, and it indicates good ecological health. Removal of tulip poplar trees would reduce the number present on the site, but impacts to the tulip poplar's regional abundance (USDA 2008e) would be negligible.

Northeastern Beach Tiger Beetle (Cicindela dorsalis dorsalis)

The northeastern beach tiger beetle is a Federally threatened species (55 FR 32088) that uses sandy beach habitats and has been observed on the Calvert Cliffs site. However, none were observed during 2006 surveys (Knisley 2006). Historically, this beetle has been confined to the northernmost 300-ft section of beach on the site that borders Flag Ponds Natural Area. In 2004, four adult northeastern beach tiger beetles were observed on the beach approximately 3 mi northwest of the existing Calvert Cliffs water intake structure, but none were observed from 2006 to 2008 in annual surveys (Knisley 2006, 2009). The location of the 2004 observation is the nearest known occurrence of this species to the proposed activity. No suitable breeding habitat, larvae, or burrows have been observed on the Calvert Cliffs site, and it is believed this species does not have an established population on the site (Knisley 2006).

There are no areas designated as critical habitat for the northeastern beach tiger beetle in the vicinity of the Calvert Cliffs site. Proposed activities would not take place within approximately 5000 ft of the northernmost section of beach where this beetle has been observed. Therefore, adverse impacts to northeastern beach tiger beetles from building proposed Unit 3 would be negligible.

Puritan Tiger Beetle (Cicindela puritana)

The Puritan tiger beetle has been listed as Federally threatened since 1970 (55 FR 32088). Success of subsequent recovery efforts has been inadequate, and the known distribution of this beetle is extremely limited (FWS 1993). Puritan tiger beetles are known to occur at only three locations, one being the Chesapeake Bay shore in Calvert County, Maryland (FWS 1993). Puritan tiger beetles thrive on steep, unvegetated bluffs with a narrow beach below, and this habitat is found along with these beetles on the southern end of the Calvert Cliffs site where it borders the Chesapeake Bay. Proposed activities, including mitigation activities, have the potential to affect the Puritan tiger beetle (MACTEC 2009). Such activities would occur in two areas where beetles have been observed. Alteration of the barge slip, including dredging, removal of existing structures, restoration of the bulkhead and a stream outfall culvert and widening of the heavy haul road to the barge dock would affect a small beach where a small number of adult Puritan tiger beetles have been observed on occasion (Knisley 2009; UniStar 2008d). The bluff has been removed near the barge slip, and the wide beach was described as marginal to poor habitat for Puritan tiger beetles (Knisley 2006). Further south, the beach narrows as rocks become more numerous. Although the habitat is not optimal, adult Puritan tiger beetles have been observed using this portion of the Calvert Cliffs site (Knisley 2006, 2009). The beach habitat near the barge slip that would be affected is likely used by adults during foraging only, and densities there were noted to be low (Knisley 2006, 2009). Adult tiger beetles are quick and agile and would hastily move away from disturbance. UniStar committed to a time-of-year restriction from June 1 to August 31 when adult Puritan tiger beetles are active (UniStar 2009c). The restriction is for work at the barge dock area and would only apply to activities from mean low water landward to the sheet pile bulkhead. Such restriction is expected to adequately minimize adult beetle mortality near the barge dock during construction.

The second area where proposed activity has potential to affect the Puritan tiger beetle involves stream enhancement where an unnamed stream empties into the Chesapeake Bay south of the existing barge dock (Figure 4-2). This activity includes prevention of the upstream migration of a headcut, minor bank grading, and riparian and native plant re-vegetation. Suitable tiger beetle habitat, including bare, steep bluffs and narrow, sandy beach, exists at the mouth of this stream. UniStar has committed to the same time-of-year restriction, June 1 to August 31, for this stream enhancement activity as for the activities in the barge dock area (UniStar 2009c). UniStar has also committed to limiting the physical extent of the stream enhancement activities associated with the unnamed stream to a segment of 100-ft-wide section centered at the outlet into Chesapeake Bay. The Corps permit, if issued, would require physical demarcation of the work area while work is being conducted. This restriction would minimize disturbance of nearby larval tiger beetle habitat.

Another activity that has the potential to affect the Puritan tiger beetle is the demolition of the building and removal of impervious surfaces at the Eagle's Den location. The Eagle's Den is located at the immediate top of the bluff that faces Chesapeake Bay. The bluff face is where Puritan tiger beetle larvae live. The beach immediately below the Eagle's Den is mapped as beetle habitat but described as rocky and marginally suited, although the nearby beach habitat is mapped as optimal tiger beetle habitat. (Knisley 2006). A geotechnical evaluation would be conducted to determine stability of the Eagle's Den area, and used to determine appropriate construction loads and methods. Work activities within the CBCA are pending approval from the CBCA Commission, and mitigation may be warranted.

There are no areas designated as critical habitat for the Puritan tiger beetle in the vicinity of the Calvert Cliffs site. However, UniStar committed to time-of-year work restrictions and delimited beach work-zones to minimize impacts to adult and larval beetles. Therefore, impacts to Puritan tiger beetles and their habitats from the proposed project would be minimal.

In accordance with Section 7 of the U.S. Endangered Species Act of 1973, as amended (ESA), the NRC and the Corps plan to jointly consult with the FWS regarding Federally listed species.

Eastern Narrow-mouthed Toad (Gastrophryne carolinensis)

The eastern narrow-mouthed toad is a State of Maryland endangered species. It is technically not a toad species, but a toad-like frog that requires shelter and moisture to survive (University of Michigan Museum of Zoology 2008). They occur in a wide variety of habitats, including Calvert County (USGS 2008; MDNR 2007). Surveys indicated it is highly unlikely they occur within the proposed disturbance area and, therefore, it is unlikely that they would be affected.

Bald Eagle (Haliaeetus leucocephalus)

Four active bald eagle nests are known to occur on the Calvert Cliffs site, three of which were occupied in 2007. Proposed activities do not encroach within 1500 ft of the three nests, well beyond the 660-ft buffer recommended for commercial building activities that would occur within sight of active bald eagle nests (FWS 2007). Therefore, the potential to disturb eagles using these three nest sites would be minimal. However, a fourth nest would have to be removed.

The fourth eagle nest is located within the proposed power block site, and the tree containing the nest would have to be removed. The applicant would have to obtain an authorization under the Bald and Golden Eagle Protection Act for taking of eagles from the FWS (73 FR 29075). An incidental take permit is also required from the State of Maryland, and an application for this permit was submitted to the Maryland DNR in July 2008 (MDNR PPRP 2008). The permit would also allow take of any additional eagle nests within the proposed disturbance area and within 0.25 mi of the disturbance boundary, although none are known to occur within this area.

The applicant has proposed to protect a 100-ac tract of forested habitat on the south portion of the Calvert Cliffs site that has had an active eagle nest site since 2000 and was occupied by an eagle pair in 2008 (MDNR PPRP 2008). No tree harvesting would occur within the protected 100-ac tract, and human activity would be limited for 15 years (MDNR PPRP 2008). Although mitigation measures would be taken, bald eagle productivity on the site would be adversely affected by proposed Unit 3 because at least one nest would be removed, noise and other construction and preconstruction activities would disturb eagles protecting nests, and trees suitable for future nests would be removed. Regional eagle populations are stable and have been increasing as evidenced by the Federal delisting of the bald eagle, but further mitigation may be required by FWS or Maryland DNR.

Scarlet Tanager (Piranga olivacea)

The scarlet tanager is a small bird that relies upon interior forest for nesting habitat. This species is migratory, has been observed and is believed to nest on the Calvert Cliffs site, and represents other FIDS within this EIS. Clearing and fragmentation of forests could result in FIDS habitat loss and degradation. As discussed in the wildlife habitats section of this chapter, impacts to interior forest and FIDS habitat are unavoidable. Proposed locations for the switchyard, cooling tower, offices, and warehouses occur within forested tracts that have not been previously fragmented during past development of the site. These activities would result in the loss of interior forest that FIDS rely upon.

As stated in Chapter 2, there are two types of FIDS habitats: interior forest and riparian forest. Both FIDS habitat types must have either a closed canopy or dominant trees greater than 5 in. in diameter. Forested stands meeting the criteria for FIDS habitat can be found on the Calvert Cliffs site and throughout Calvert County (Table 4-2). Unfragmented riparian FIDS habitat is present along the Patuxent River, especially in southwestern Calvert County. Upland interior forest is also present throughout the county, although more fragmented in the northern quarter.

Currently about 63 ac of FIDS habitat exists within the CBCA on the Calvert Cliffs site (Table 4-2). Proposed grubbing and grading related to building the switchyard, cooling tower, construction offices, and warehouses would occur within forested tracts that have not been previously fragmented, resulting in the loss of about 16 ac of interior forest and a loss of almost 35 ac of FIDS habitat.

Table 4-2. FIDS Habitat Impact Table

Project Phase	Forest Cover (ac)	Forest Interior (ac)	FIDS Habitat (ac)
Existing	70.3	30.9	62.5
Post-disturbance	49.3	14.6	27.7
Post-mitigation	75.7	14.6	77.8
Net Result	+5.4	-16.3	+15.3

Source: MDNR PPRP 2008

Proposed post-disturbance mitigation actions (see preceding CBCA section) is expected to increase the amount of riparian forest habitat, resulting in a net gain of about 15 ac of FIDS habitat in 20 to 30 years. However, the impacts of permanently losing just over 16 ac of interior forest are significant.

White-tailed Deer (Odocoileus virginianus)

White-tailed deer were identified as an important species because they are recreationally valuable. The primary impact to white-tailed deer from Unit 3 is habitat loss and increased roadway mortality due to displacement. Displaced deer would temporarily redistribute to adjacent habitats following land clearing. Competition would increase in those areas, and some deer may relocate offsite and be exposed to hunting mortality. However, white-tailed deer are widespread and abundant, and the net effect of these activities on the local white-tailed deer population would be minimal.

Important Species Summary

Direct mortality during ground-clearing activities may occur to small, slow-moving, burrowing, and cavity-dwelling species. Increased mortality of mobile and immobile species may result from increased traffic volume on nearby roadways. Land clearing during nesting would lower or eliminate local migratory bird productivity during that year. Noise related to building Unit 3 may displace wildlife, increasing resource demand in adjacent habitats that may exceed carrying capacity ultimately resulting in higher mortality rates. Accidental toxicant spills could affect wildlife, especially aquatic wildlife in adjacent wetlands, but BMPs should minimize the potential effects of accidental spills. The chestnut oak, mountain laurel, New York fern, and tulip poplar are common and widespread on the site, and losses of these due to disturbance would not alter site ecology. Showy goldenrod populations within the disturbance area would be affected, but mitigation actions could partially compensate for local impacts. The spurred butterfly pea likely does not occur within the proposed construction zone and would be unaffected. The northeastern beach tiger beetle also does not occur in the proposed construction zone and would be unaffected. Puritan tiger beetle adults occasionally occur on a small beach area affected by alteration of the barge dock. However, adult tiger beetles are mobile predators that would likely flee during high activity periods. Optimal habitat for this species would be unaffected by the building of Unit 3, the applicant has committed to mitigation actions, and impacts to suitable habitat and individuals would be minimal. Mitigation activities would occur adjacent to suitable Puritan tiger beetle habitat, but these activities would not occur when adult beetles are active. The eastern narrow-mouthed toad is unlikely to occur within the proposed disturbance area and would not be affected by building activities. Bald eagle productivity would be adversely affected, as an active nest would be removed to accommodate the power block. Some mitigation measures are proposed (MDNR PPRP 2008), but further mitigation may be warranted. Although much of the building would occur in previously fragmented forest, activities related to building Unit 3 would remove and fragment forest cover and adversely affect habitat for the scarlet tanager and other FIDS. FIDS habitat is regulated within the CBCA, and mitigation would result in a net gain of FIDS habitat on site within the CBCA over time (MDNR PPRP 2008). The white-tailed deer population on the Calvert Cliffs site may experience habitat loss and increased mortality on local roadways or from hunting in offsite habitats if they are displaced. However, deer are abundant and highly adaptable.

Activities related to building Unit 3 are not expected to increase mortality rates enough to destabilize site wildlife populations, and changes in abundance would not be detectable at a regional population level. Interior forest and a bald eagle nest would be adverselyaffected. Mitigation measures are proposed that could moderate these impacts. Further mitigation measures may be warranted.

Wetlands

Non-tidal wetlands would be affected during building the proposed Unit 3 (Table 4-3, Figure 4-3). Although impacts cannot be avoided entirely, the proposed disturbance footprint has been designed to limit impacts to wetlands to the extent possible. There are no Wetlands of Special Concern on the Calvert Cliffs site, and tidal beaches immediately north of the site in the Flag Ponds Nature Park that are classified by the State of Maryland as of Special Concern would not be affected by the proposed activities.

Approximately 12 ac of non-tidal wetlands with 8350 ft of intermittent and upper perennial stream channels would be graded and permanently lost within the CCNPP Wetlands Delineation Area (MDNR PPRP 2008). This loss represents approximately 20 percent of all non-tidal wetlands on the Calvert Cliffs site. The proposed activities would also affect 30.8 ac of non-tidal wetland buffer. Impacts to wetlands within the CBCA are included in this discussion.

Table 4-3. Areal Extent of Impacts to Non-tidal Wetlands of the Calvert Cliffs Site

Wetland Assessment Area	Existing Wetlands (ac)	Wetland Losses (ac)	Buffer Losses (ac)	Wetland Remaining (ac)	Impact (%)
I	2.2	0.03	2	2.17	1
II	6.18	4.84[(a)]	6.79	1.34	78
III	0.77	0	0	0.77	
IV	12.79	4.97	15.84	7.82	39
V	9.13	0	0	9.13	
VI	14.01	0	0	14.01	
VII	11.55	0.72	3.41	10.83	6
VIII	0.45	0	0	0.45	
IX	1.12	1.1	2.81	0.02	98
Totals	58.20	11.66	30.85	46.54	20

Source: MDNR PPRP 2008

(a) Includes 0.05 ac of isolated wetland that is Maryland jurisdictional only.

Assessment Area I

Proposed activities within area I include building the power block, heavy haul road, and security-related structures. These activities would fill 0.03 ac of wetlands. Almost all of the impacts result from the filling of intermittent and upper perennial stream channels and adjacent wetlands that have been degraded by past development and are narrow and deeply scoured. Approximately 0.02 ac of open water habitat within an existing stormwater retention basin would also be filled for the heavy haul road. About 2.0-ac of non-tidal, forested wetland buffer would be affected in this area. No wetland impacts in area I occur within 100 ft of the Chesapeake Bay mean high tide line, the most sensitive part of the CBCA.

Wetlands in area I are not of high value relative to other Calvert Cliffs wetlands. Past erosion events have degraded wetlands in area I and limit their function to groundwater recharge/discharge and wildlife habitat.

Assessment Area II

A permanent laydown yard is proposed to be constructed within area II and would result in the filling of almost 4.8 ac of wetlands. This includes 2.7 ac of open water within the Camp Conoy Fishing Pond, 0.7 ac of emergent wetlands, 1.5 ac of forested wetlands that border the pond, and 1152 ft of intermittent and upper perennial stream channels that flow into and out of the pond. In addition, 6.8 ac of non-tidal wetland buffer would be filled. Although no areas within 800 ft of the Chesapeake Bay would be affected, 0.2 ac of wetlands would be filled in the outermost 200 ft of the CBCA 1000-ft buffer zone.

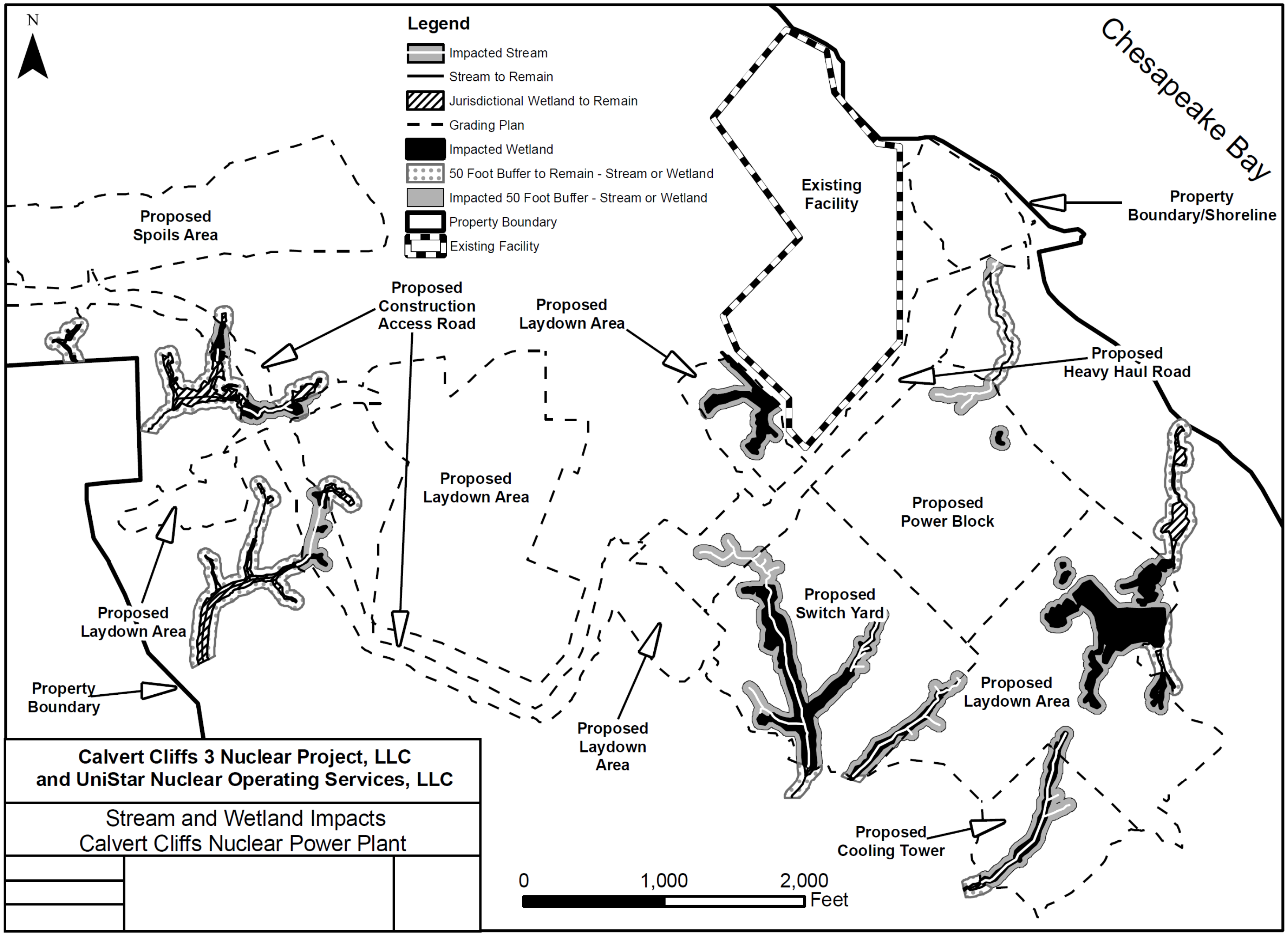

Figure 4-3. Location and Extent of Non-tidal Wetlands of the Calvert Cliffs Site (UniStar 2009b)

Wetlands in area II are relatively valuable. These wetlands primarily provide wildlife habitat, groundwater recharge/discharge, aquatic habitat, particle retention, nutrient removal, production export, and shoreline stabilization. The Camp Conoy Fishing Pond has been valued for recreation, uniqueness, and aesthetics. However, heightened security concerns have eliminated use of the pond in recent history. The uniqueness and high quality of Area II wetlands means the loss of these wetland resources would be noticeable.

<u>Assessment Area III</u>

Wetlands in area III would not be graded, filled, or otherwise directly affected by the proposed activities.

<u>Assessment Area IV</u>

The areal extent of affected wetlands in area IV would be greater than in any other assessment area. Activities related to building the switchyard and 500-kV transmission line would fill 5 ac of wetlands. This impact includes filling 5387 ft of intermittent and perennial streams, forested wetlands, and forested springs that feed Johns Creek headwaters. Activities would also affect 15.8 ac of non-tidal wetland buffer covered in forest.

Wetlands in area IV form a portion of the headwaters for Johns Creek and primarily provide wildlife habitat while also functioning as groundwater recharge/discharge, particle retention, nutrient removal, and production export. Area IV wetlands are also valued for their uniqueness, recreation, and educational opportunities. Loss of these wetlands would also affect local wildlife habitat and result in fragmentation of interior forest. In addition, Johns Creek would be affected by the activities in area IV (see Section 4.3.3.2 for further discussion).

<u>Assessment Area V</u>

Wetlands in area V would not be graded, filled, or otherwise directly affected by the proposed activities.

<u>Assessment Area VI</u>

Wetlands in area VI would not be graded, filled, or otherwise directly affected by the proposed activities.

<u>Assessment Area VII</u>

Building the access road and temporary laydown yard would affect 0.7 ac of wetlands, including 2000 ft of intermittent and perennial stream channel, and 3.4 ac of non-tidal wetland buffer in area VII. These wetlands are characterized as forested wetlands and springs that contribute to the headwaters of the Goldstein Branch. The portion of the wetlands in area VII consists of

0.25 of 2.07 ac of non-tidal wetland buffer. BMPs, such as the use of a super silt fence, would limit further impact to emergent herbaceous wetlands and buffer adjacent to the laydown yard.

Area VII wetlands are valuable because they function primarily as nutrient removal and wildlife habitat and contribute to groundwater recharge/discharge, aquatic habitat, particle retention, and production export. Although these wetlands receive runoff from landscaped areas, MD State Route 2/4, and adjacent private lands, the wetlands are not degraded. Loss of wetlands in area VII would increase nutrient loads to Goldstein Branch and decrease local wildlife habitat availability.

Assessment Area VIII

Wetlands in area VIII would not be graded, filled, or otherwise directly affected by the proposed activities.

Assessment Area IX

All wetlands in area IX, including 1.12 ac of emergent herbaceous wetland, 0.64 ac of forested wetland, 2.8 ac of non-tidal wetland buffer, and 1200 ft of intermittent stream channels containing multiple springs, would be filled during activities related to grading and filling of the parking lot.

Wetlands within area IX are located adjacent to the existing Calvert Cliffs site parking lot and have been affected by past development as part of the non-tidal wetland buffer is mowed grass along roadways. They contribute the least in terms of wetland function (wildlife habitat only) and value (aesthetics only) when compared to all other Calvert Cliffs wetland assessment areas. Since area IX wetlands do not contribute substantially to ecosystem function, loss of these wetlands would not be significant.

Wetland Permits and Mitigation

The Corps has the authority to issue permits for the discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands. For Corps permitting purposes, the applicant is required to obtain a Water Quality Certification in accordance with Section 401 of the Clean Water Act from the MDE. A permit is also required from the MDE under the Maryland Nontidal Wetlands Protection Act. Permits, if issued, would include a final mitigation plan that meets the requirements of the respective agencies. BMPs would be employed to minimize impacts to adjacent wetlands near and down-gradient from the disturbance zone. For example, silt fences, as specified in an erosion and sedimentation plan that would have to be approved by the MDE prior to site disturbance, would be erected. Exposed soil would be covered or bermed until backfilling and final grading. Construction effluent and stormwater runoff would be monitored as required by the Storm Water Management Plan, NPDES permit, and other applicable construction permits.

UniStar has committed to actions that would mitigate wetland impacts (Table 4-4), including stream enhancement, stream restoration, and wetland habitat creation (MACTEC 2008). A total of 24.9 ac of non-tidal wetlands would be created or enhanced (MDNR PPRP 2008).

Table 4-4. UniStar Proposed Wetland Mitigation Actions within the Calvert Cliffs Site

Site	Action	Impact Area (ac)
Lake Davies Dredge Disposal Area	Eradicate *Phragmites* in the central basin	2.4
Lake Davies Dredge Disposal Area	Create open water habitat	0.9
Lake Davies Dredge Disposal Area	Plant herbaceous wetland vegetation	1.3
Johns Creek	*Phragmites* eradication and plant forested wetland vegetation	15.7
Camp Conoy	Grade and plant forested wetland vegetation	4.6
Totals		24.9

Source: MDNR PPRP 2008.

Mitigation standards set forth by the MDE Wetlands and Waterways Program require at least a 2:1 replacement ratio and sometimes 3:1 for forested non-tidal wetlands (MDE 2008). Emergent wetlands are replaced at a 1:1 ratio. To mitigate for the filling of approximately 8350 ft of intermittent and perennial stream channels, the applicant proposed to conduct stream restoration and enhancement to 10,429 ft of existing streams on the Calvert Cliffs site (Figure 4-4) (MDNR PPRP 2008). Restoration, involving reestablishment of physical, biological, and riparian functions of five stream segments totaling 6283 ft would involve installing instream structures, vegetative and bioengineered bank stabilization, and riparian enhancement. Stream enhancement to 4146 ft of stream in five segments would include stream channel alteration, planting of native riparian vegetation, aquatic habitat improvement, and bank stabilization.

Creation, restoration, and enhancement would not result in the net gain in the areal extent of wetlands on the Calvert Cliffs site. However, these activities would likely increase the functional value of wetlands restored or enhanced, an important component of wetland mitigation (USACE 2002). The MDE would also require a monitoring program for five years following the mitigation actions. Remedial actions could then be implemented if mitigation actions are not successful.

Summary of Impacts to Wetland Resources

Although no Maryland wetlands of Special Concern would be affected by building Unit 3, impacts to non-tidal wetlands from building the proposed Unit 3 and supporting facilities would be unavoidable. Non-tidal wetlands would be graded and filled, contributing to wildlife mortality and habitat loss. However, proposed mitigation would create new wetlands and enhance or restore other wetlands and streams. As part of these proposed measures, native-forested wetland trees would be planted within forest gaps to reduce fragmentation, and invasive plants

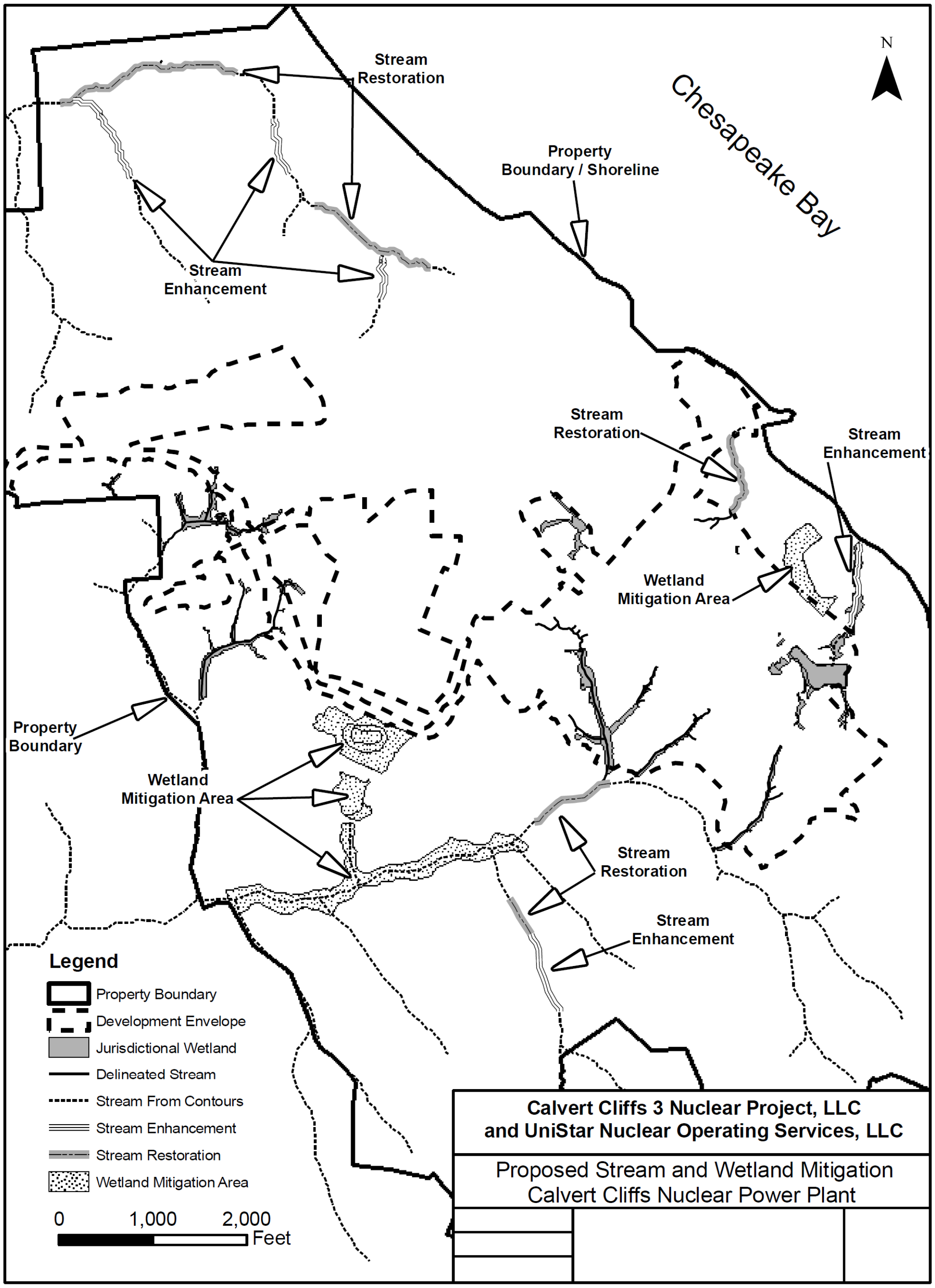

Figure 4-4. Proposed Wetland and Stream Mitigation Actions on the Calvert Cliffs Site (MDNR PPRP 2008)

would be removed to increase wetland function. The Corps requires mitigation only be employed after all appropriate and practical steps to avoid and minimize adverse impacts to aquatic resources, including nontidal wetlands and streams, have been taken. Further, the Corps requires all remaining unavoidable impacts to be compensated to the extent appropriate and practicable.

4.3.1.4 Terrestrial Monitoring

UniStar has not proposed terrestrial monitoring when building Unit 3, but the Corps would monitor or require monitoring for compliance with a Corps permit, if issued. The State and other Federal agencies may also require monitoring associated with compliance of permits issued to assure compliance and assess success.

4.3.1.5 Summary of Impacts to Terrestrial and Wetland Resources

Impacts from building the proposed Unit 3 and supporting facilities to wildlife habitat, non-tidal wetlands, and important species are unavoidable. All habitat types on the site would be affected; several habitats would be noticeably altered. Forest cover would be lost, and fragmentation would result in loss of interior forest, adversely affecting FIDS on the Calvert Cliffs site. Non-tidal wetlands would also be graded and filled, resulting in degradation and loss of wetland function downstream. Areas within the CBCA would also be lost or degraded. Ground-clearing and other subsequent activities when building Unit 3 would result in the removal of an active bald eagle nest, and populations of showy goldenrod would be lost. Mitigation proposed by UniStar may partially offset some of these impacts through time.

Based on information provided by UniStar and the review team’s independent evaluation, the review team concludes that the impacts from the combined construction and preconstruction activities for proposed Unit 3 to terrestrial ecosystems of the Calvert Cliffs site would be MODERATE for important species, including Federally and State-listed species, and wildlife habitats, including wetlands.

The Corps, FWS, and the State of Maryland may require further avoidance, minimization, and mitigation measures. If issued, the Corps permit would include special conditions that would require UniStar to confirm the created and enhanced wetlands meet the Federal wetland criteria outlined in the report entitled, “Corps of Engineers Wetlands Delineation Manual” (USACE 1987). If the Corps does not find the wetlands and stream mitigation satisfactory, the Corps would determine if adverse impacts to the waterway and wetlands are more than minimal and if any project modifications would be warranted. Also, the Corps would require UniStar to assume all liability for accomplishing the corrective work in accordance with Compensatory Mitigation for Losses of Aquatic Resources (73 FR 19594) (33 FR Parts 325 and 320).

NRC-authorized construction activities with the potential to affect terrestrial species and habitats include the use of cranes and the erection of safety-related structures; movement of construction vehicles and heavy equipment around the site; the noise associated with construction, machinery, and testing of diesel and combustion turbine generators; fugitive dust; overhead lighting; and minor changes in the surface water drainage. Construction-related activities are not expected to increase wildlife mortality rates enough to destabilize site wildlife populations, and changes in abundance would not be detectable at a regional population level. In addition, BMPs discussed in Chapter 3 would mitigate the effects of construction activities on wetlands and important terrestrial species such that they would not be detectable. Based on this information, the NRC staff concludes that the terrestrial ecology impact from NRC-authorized construction activities would be SMALL.

4.3.2 Aquatic Impacts

Aquatic resources in Johns Creek and its unnamed tributaries, Laveel Branch, Goldstein Branch, Branch 1, Branch 2, Branch 3, Camp Conoy Fishing Pond, Pond 1, and Pond 2 would be affected mainly by building the power block, the cooling tower, switchyard, construction access road, heavy haul road, temporary and permanent laydown areas, spoils area, borrow area, permanent parking lots, various stormwater retention basins, and the batch plant. Woodland Branch, located on the north part of the Calvert Cliffs site, could be indirectly affected, but its general geographic separation from the main construction area reduces the likelihood of impacts.

Aquatic resources in Chesapeake Bay would be impacted mainly by building the new water intake and discharge systems, installing a new fish-return system, and refurbishing the existing barge dock area, including dredging, in Chesapeake Bay.

4.3.2.1 Aquatic Resources – Site and Vicinity

Onsite Ponds and Streams

The activities that would affect the freshwater aquatic resource on the Calvert Cliffs site include clearing and grading the land, building or refurbishing roads, installing temporary utilities and facilities, and creating parking and construction equipment preparation areas. These activities would eliminate some onsite aquatic resources, may increase erosion, and would increase runoff into downstream resources.

<u>Aquatic Resource Elimination</u>

Clearing and grading of about 460 ac of mostly forested uplands would have the greatest effect on the freshwater aquatic resources on the Calvert Cliffs site. Some of this land would be replaced with impervious surfaces. The major impacts would be the elimination of the Camp

Conoy Fishing Pond, the removal of the upper reaches of Branches 2 and 3 and an unnamed tributary to Johns Creek, the isolation of parts of the upper reach of Branch 1, and the disruption of the drainage in the Lake Davies dredge spoils disposal area (UniStar 2009a).

The alteration of headwater tributaries, such as those that would be eliminated during the building of Unit 3, would have important effects on downstream water quality and ecosystem functions, such as increased turbidity and reduced transport of organic material (Section 2.4.2). Although the specific downstream effects of removing three of the headwater streams that flow into Johns Creek are not quantifiable, the overall effects on the creek watershed may be somewhat ameliorated because there are several tributaries that would not be affected by building the new unit.

Increased Erosion

Clearing and grading activities disturb vegetation and expose newly bare soils to erosion, significantly increasing the sediment loads in nearby streams. Increased sedimentation is one of the primary stressors to streams in Maryland reducing habitat quality for fish and invertebrates (Southerland et al. 2005). UniStar proposes to install berms and use plants to stabilize exposed soils to reduce the risk of sediments washing into streams and other onsite water bodies (UniStar 2009a). UniStar would install sand filters around the power block margin, the cooling tower area, the switchyard, and laydown areas to catch water from storms. The sand filters would consist of base materials that promote infiltration of runoff from small rainstorms (UniStar 2009a). However, the base materials' infiltration capacity would be exceeded during large storms, and the runoff would be routed through overflow pipes to the stormwater retention basins. The stormwater retention basins would be unlined, planted with wetland grasses and herbs that occur in the area, have simple earth-fill closure on the downstream end, and would include discharge piping to nearby streams. UniStar has prepared a SWPPP that specifies the soil control measures that would be followed to reduce sediment entry into aquatic habitats (Bechtel 2008b).

Increased Runoff

The activity of building Unit 3 would also change the watershed by adding about 130 ac of impervious surfaces for the power block, cooling tower, switchyard, laydown areas, other work areas, and roads (UniStar 2009a). These surfaces keep rainfall from penetrating directly into the ground, increasing runoff that may adversely change stream hydrography and transfer pollutants into streams and ponds. This runoff would be directed through the storm retention basins as previously described.

The amount of impervious surface added by Unit 3 would increase the developed portion of the site. About 16 percent (331 ac) of the total site acreage (2070 ac) is classified as urban (Section 2.1). The impervious surface to be added by Unit 3 would increase the developed acreage (about 461 ac) to approximately 22 percent of the site. Maryland studies indicate that watersheds covered with greater than 15 percent impervious surfaces usually do not have good quality stream habitats (MDNR 2004). The increased amount of impervious surfaces may worsen the already somewhat degraded conditions of the streams on the Calvert Cliffs site (Section 2.4.2). Most of the drainage on the site flows into the St. Leonard Creek subwatershed, which comprises about 22,792 ac of land and water (MDNR 2004). Impervious surfaces comprise about 0.9 percent (205 ac) of the subwatershed (MDNR 2004). The process of building Unit 3 would raise the percentage of impervious surface in the subwatershed to about 1.5 percent (335 ac), which approaches the threshold (2 percent) at which stream habitat begins to deteriorate (MDNR 2004). Increased impervious surface on the site could lead to increased use of chemicals to remove ice from roads and other impervious surfaces during the winter. Ice removal can increase salinity in nearby streams and ponds (Kaushal et al. 2005; Ramakrishna and Viraraghavan 2005), which can significantly affect aquatic plants and animals (Blasius and Merritt 2002; Karraker et al. 2008).

Chesapeake Bay

The process of building the intake and discharge structures, fish-return system, and improvement of the barge dock access channel would cause temporary and permanent loss or conversion of aquatic habitat in the Chesapeake Bay.

The major events associated with building proposed Unit 3 that would affect aquatic resources in the Chesapeake Bay share certain activities, such as dredging, pile driving, and armoring the Bay bottom. All work would be conducted in accordance with Federal, State, and local permits (Appendix H). The aquatic resources in Chesapeake Bay likely would not be adversely affected by the installation of new transmission facilities for the Unit 3 because the facilities would be built on the uplands part of the Calvert Cliffs site. The primary activities associated with each structure to be built would be:

- Cooling Water Intake Structure—pile driving associated with installation of the new sheet-pile walls, dewatering and dredging for the intake pipe installation, removal and replacement of shoreline armoring, and armoring the Bay bottom near the new permanent sheet-pile wall.
- Fish-return System—dredging for the return pipe installation, removing and replacing shoreline armoring, and armoring the Bay bottom at the discharge point.
- Cooling Water Discharge Structure—dredging for the discharge pipe installation and armoring the Bay bottom at the discharge point; some impacts associated with vessel use would be possible because a barge-mounted clamshell dredge would be used to dig the trench for the pipeline (UniStar 2008a).

- Barge Dock Improvements—removal of existing crane piles, dredging the barge dock channel and nearshore area, installing a sheet-pile wall in the nearshore, and armoring the nearshore Bay bottom; vessel movements during construction would also affect aquatic resources.

Dredging and Pipeline Trenching

Dredging involves the physical removal of native Bay-bottom sediment to create a channel deep enough for vessels to use. Dredging the Bay bottom would be done on the south side of the CCNPP Units 1 and 2 barge dock by using a shore-based clamshell dredge (UniStar 2008a). Mechanical dredging uses a crane and bucket to excavate and transfer bottom sediments to a barge for transport to the disposal area. Some dredged material and water can be lost from the bucket as it is raised and deposited into the barge. The amount of material re-entering the water column as it is transferred from the barge to trucks would be small. Dredging or pipeline trenching causes major impacts to the localized benthos because both remove the entire benthic community from within the dredged or trenched area. At least 195,000 ft^2 (18,116 m^2 or about 4.5 ac) of Bay bottom would be affected during the barge dock channel dredging (UniStar 2008b). In addition to the physical removal of Bay bottom, dredging increases the suspended sediment load in the water column. The extent and duration of increased sediment loads depend on the nature of the sediment (e.g., sandy versus silty) and the prevailing water currents in the area. The surficial sediments in the area that would be dredged are sandy (Section 2.4.2) and would likely settle out of the water column relatively quickly. The nature of the deeper sediment layers is not known, but it may consist of hard-packed clay such as that uncovered by the scouring of the bottom near the cooling water discharge for CCNPP Units 1 and 2 (UniStar 2009a). Fine material has the potential to remain in the water column much longer than coarse material. Suspended sediment decreases light penetration, which decreases phytoplankton photosynthesis. Suspended sediment also may affect fish by clogging the gills and may affect filter-feeding invertebrates and fish. The dredging or trenching for Unit 3 would not resuspend contaminants because the contaminant loads in the sediments in the barge dock area recently were shown to be very low (Section 2.4.2).

The effects of digging a pipeline trench on estuarine resources are similar to those from dredging. The trench for the cooling water discharge pipeline would be dug using a barge-mounted clamshell dredge (UniStar 2008b). The minimum area of Bay bottom that would be disturbed by this dredging is 38,500 ft^2 (3577 m^2, or about 0.88 ac). About 5800 yds^3 of 7000 yds^3 of sediment that would be removed for the trench would be stored and used to backfill the trench. The backfilling method was not specified, but presuming that the barge-mounted clam dredge would be used, some of the native Bay-bottom sediment next to the trench may be covered during the process. The trench would be covered by filter fabric and imported rock riprap. The riprap would not extend above the natural Bay bottom topography. Thus, the area of disturbance to the benthos would be slightly larger than the specified dimensions of the trench, although the extent is not known. The trenching and backfilling would also cause some sediment to become suspended in the water column. Suspended sediment typically settles out of the water column quickly and the effects from the increased turbidity are temporary. Other potential impacts associated with the discharge pipeline are armoring that would be placed near the diffuser and the use of vessels to move the dredge barge. Both are discussed in following sections.

Installation of the proposed Unit 3 intake pipes and trash rack may include the fabrication of a sheet-pile cofferdam and dewatering system to minimize some of the effects of dredging (UniStar 2009a). The area that would be included within the cofferdam is about 900 ft^2 (about 0.02 ac).

Measures UniStar suggests can be used to reduce the potential impacts from dredging include:

- Restricting dredging to certain times of the year. The State of Maryland placed a condition on UniStar's CPCN permit that specifies dredging should occur at appropriate times of the year (MPSC 2009).
- Installing a silt curtain around each dredge or active dredge area to minimize sediment release
- Confirming clam-shell dredges are fully closed and hoisted slowly to limit spillage
- Not filling spoils barges to levels that would cause sediment to overflow
- Not washing vessel decks so that sediment and other material are not released overboard
- Performing water-quality monitoring according to permit requirements.

UniStar has not committed to these measures, except the CPCN permit condition, and the review team has not relied on them being done in its assessment of potential dredging impacts.

Benthic recolonization after dredging or trenching depends on the nature of the substrate that remains after dredging, the fauna present in the surrounding area, and the timing of the dredging or trenching. Sediment recolonization would occur via adult emigration from undisturbed areas and seasonal reproduction and larval recruitment by animals living in undisturbed areas (Maurer et al. 1986). Thus, recolonization rates depend on natural reproductive cycles and active or passive transport to the affected sediments. In the case of dredging, it is possible that the resulting substrate at the barge slip area would consist of hard clay, which is difficult for infauna to colonize. Eventually softer material, such as sands or muds, would deposit onto the dredged area making it more suitable to recolonization. This process probably would take years, depending on sediment depositional rates in the area and the degree to which the barge dock is used. The substrate used to backfill the pipeline trench is likely to be a mix of materials that differs from the native material that was removed. This material eventually would be colonized by infaunal organisms, although the time frame for this colonization is not predictable. In one documented case, installation of a pipeline that was generally similar in size to the Unit 3 discharge pipeline caused complete loss of benthic fauna in the pipeline corridor (Lewis et al. 2002a) that was followed by substantial recolonization within one year (Lewis et al. 2002b). The fauna found in the area of the Unit 3 discharge pipe includes relatively widespread species that are likely to provide offspring for recolonization or are able to directly recolonized new habitat. Recolonization is affected by the timing of dredging or trenching, which determines when the substrate is suitable to be inhabited, and the timing of reproduction, which determines the availability of larvae.

The benthic infaunal community in the areas proposed for dredging or trenching for Unit 3 is not unique or rare as it is similar to the communities elsewhere in the region and also to the community type that has been in the area for many years. The community is also moderately degraded to degraded (Section 2.4.2). Although this community probably provides some forage for fish and crabs, the area is not one of high benthic productivity. Although the dredging and trenching in the project area would have a major, localized effect on the benthos, these activities are not expected to seriously affect the benthos in the CCNPP general area or in the region along this coast of the Chesapeake Bay.

Pile Driving

Pile driving would be used in three project areas, all involving the installation of sheet-pile walls. The installation would use a vibratory hammer to install the sheet-piling and a conventional pile-driving hammer to install the 30-in. soldier piles placed on 10-ft centers to support the sheet-piling. Pile driving generates noise at levels that may be harmful to estuarine organisms, particularly fish. Additional impacts would result if vessels are used to place and drive the piling and soldier piles. The vessel-associated impacts are described in a following section.

The harmful effects of the noise occur because sound is transmitted in water as pressure waves that may cause temporary hearing loss and damage auditory tissue (generally, sensory hair cells of the ear) and non-auditory tissue (UniStar 2008b). The specific effects often depend on the physiology of individual fish species. The Fisheries Hydroacoustic Working Group (FHWG), established by three western states to improve understanding of fishery impacts from underwater sound pressure caused by pile driving, set interim guidelines to assess the potential for projects that involve in-water pile driving to affect fish. The FHWG established two criteria to estimate the sound and vibration levels from pile driving that would injure fish. Both are measured at a standard distance of 10 m (32.8 ft) from the pile-driving activity. The peak sound-pressure level (peak pressure or peak) is maximum excursion of pressure associated with the sound (Popper et al. 2006) and is measured as decibels (dB) relative to reference level of one micropascal (dB re 1 μPa_{peak}). Peak pressure determines the likelihood that the swim bladder and ear are exposed to extreme mechanical stress (Popper et al. 2006). The sound exposure level (SEL) is the constant sound level of 1-second duration that would contain the same acoustic energy as the originally produced sound and is measured as dB re 1 μPa^2•s.

The interim criteria (Popper et al. 2006) specified a peak level of 206 dB and a cumulative SEL level of 187 dB for fish weighing 2 grams (0.004409 lb) and heavier or a cumulative SEL of 183 dB for fish lighter than 2 grams (<0.004409 lb). UniStar estimated the noise levels for the pile driving conducted during the building activities for Unit 3 by applying FHWG compilations of measurements of noise and vibration impacts associated with various methods of pile driving, types of materials, and water depth. The estimated peak and cumulative SEL values for driving a 24- or 36-in. steel pile with a conventional pile-driving hammer in about 16 ft water depth are about 203 to 208 dB and 177 to 180 dB, respectively. These values suggest that the sound impacts from driving 30-in. steel piles with conventional hammers at the Calvert Cliffs site may produce sound impacts that approach or exceed the interim peak pressure guidance criterion of 206 dB, but probably would not exceed the minimum SEL criterion of 183 dB for fish lighter than 2 grams (<0.004409 lb) (UniStar 2008b). Sheet-pile driving produces peak pressures ranging from 175 dB to 180 dB and cumulative SEL values ranging from 160 dB to 165 dB, which are below the respective interim criteria values (UniStar 2008b).

Sounds from pile driving also could affect sea turtles, but the effects are difficult to estimate. There has been little work done to determine the hearing sensitivity of sea turtles at various sound frequencies (Viada et al. 2007), and most of the inference about the potential for injury due to sound is based on studies of turtle anatomy. There is some evidence that sea turtles initially might avoid sounds ranging from about 170 to 179 dB, but eventually can become habituated to the noise (Bartol and Musick 2003).

Armoring

The benthic substrate near key underwater structures in the project area would be armored by importing rocks. The largest area, about 7125 ft^2 (0.16 ac), that would receive rock armor is next to the new sheet-pile wall that would be installed to create the intake embayment for Unit 3 (UniStar 2009b). Armor would also be added to the Bay bottom at the openings of the intake pipes within the wedge-shaped pool, end of the fish-return system, the cooling water discharge diffuser, and the nearshore area of the barge dock. Although some sediment suspension would occur during installation of the rock armor, the most noticeable effect would be the conversion of the benthic community from a soft-bottom infaunal community to a hard-bottom epifaunal community, which eventually should colonize the rocks. The epifaunal community that eventually colonizes the rock armor probably would include oysters, barnacles, mussels, and sea anemones, all of which colonized new hard-bottom habitat near the CCNPP Units 1 and 2 discharge diffuser (Abbe 1987). The loss of soft-bottom habitat would reduce the potential forage area for some fish species (e.g., flounder) and blue crabs. However, the area is not one of high benthic productivity, and the area that would be lost is small relative to the size of similar habitat available in the vicinity.

Vessel Movements

Vessel use during the dredging or the installation of the in-water structures as well as delivery of heavy components for proposed Unit 3 would affect the aquatic resources of the area, particularly the benthos. The main effects from using vessels would include turbulence from propellers (prop wash), anchor cable scraping across the Bay bottom, and accidental spill of materials overboard. Vessels would be used during the installation of the cooling water discharge pipeline, during the offloading of materials from barges, and probably during the installation of the sheet-pile wall at the new intake area. Prop wash can significantly disturb benthic habitats if the turbulence is strong or long lasting. The primary occurrence of vessels would be during the operation of the barge dock, which is expected to last about 5 years. The barge docking procedures would minimize the potential impacts from prop wash (UniStar 2008b). Docked barges would not be maneuvered within the barge facility. Tow tugs would push barges toward the dock and remove unloaded barges by slowly pulling them away from the dock. The water depth (16 ft) at the barge dock relative to the draft of the tugs maneuvering the barges should also reduce the potential for prop wash disturbance.

Anchor cables would affect the benthos by disrupting the upper layers of the sediment as they sweep across it. This type of damage is most likely to occur during the installation of the cooling water discharge pipeline and during the installation of the sheet-pile wall for the new intake system. This disturbance should be localized and temporary. Benthic fauna can be expected to recolonize the swept areas.

Accidental spills of materials from vessel decks would introduce contaminants into the Bay. The potential for this occurrence can be minimized by not allowing decks to be washed during vessel operation. As mentioned above, UniStar has not committed to these measures, except the CPCN permit condition, and the review team has not relied on these measures in its assessment of potential dredging impacts (MPSC 2009).

Vessel operations during the placement of in-water structures for Unit 3 would cause short-term, localized impacts to the aquatic resources at the Calvert Cliffs site. These impacts should not affect the general resources in the area of the site or the region along this coast of the Chesapeake Bay. Transporting heavy components to Calvert Cliffs by barge would increase vessel traffic in the Bay, which could increase the potential for strikes of slowly moving animals.

4.3.2.2 Important Aquatic Species

This section describes the potential impacts to important aquatic species including Federally threatened or endangered species, State-listed species, and ecologically important or fisheries species resulting from building the new unit at the Calvert Cliffs site and the onsite 500-kV transmission line.

Important Freshwater Species

No State-listed freshwater species is likely to be affected by building proposed Unit 3. The State of Maryland lists the freshwater plants star duckweed (*Lemna trisulca*), leafy pondweed (*Potamogeton foliosus*) and southern wildrice (*Zizaniopsis miliacea*) as State endangered and spiral pondweed (*Potamogeton spirillus*) and the claspingleaf pondweed (*Potamogeton perfoliatus*) as State Highly Rare and State Rare, respectively (Section 2.4.2). None of the species were reported on the site during the flora and rare plant surveys conducted in 2006 and 2007, although suitable habitat for them exists onsite (Section 2.4.2).

The American eel (*Anguilla rostrata*) occurs within several freshwater habitats, including Johns Creek, Goldstein Branch, Camp Conoy fishing pond, Pond 1, and Pond 2 that would be directly or indirectly affected by Unit 3 (Section 2.4.2). Habitats that would be removed (Camp Conoy pond, upper headwaters of Johns Creek) contained no or few American eels during the 2006 and 2007 aquatic surveys (Section 2.4.2). The largest numbers of American eels were found at the downstream station in Johns Creek (near the confluence with Laveel Branch) and the Goldstein Branch station. Both stream sections would most likely experience the indirect effects of building the new unit that would occur farther upstream. The State of Maryland placed a condition on UniStar's CPCN permit that requires UniStar to include a stream restoration and enhancement program in its wetland mitigation plan that would allow the passage of the American eel and other migratory fish species (MPSC 2009). A recent entrainment study showed that American eel juveniles might occur in the area of the Chesapeake Bay intake system for CCNPP Units 1 and 2 from February through May (EA Engineering 2008). Any construction activities occurring during that time frame could affect American eel juveniles. Three other fish species, the bluegill (*Lepomis macrochirus*), eastern mosquitofish (*Gambusia holbrooki*), and tessellated darter (*Etheostoma olmstedi*), were listed as important to the freshwater habitats on site because of their ecological roles. Bluegill occurred in Camp Conoy fishing pond in 2006 and 2007 and in Pond 1 and Pond 2 in fall 2006 (Section 2.4.2). The lack of bluegill in Pond 1 and Pond 2 during the spring 2007 survey likely means there are no resident populations in the ponds. Therefore, the filling of Camp Conoy fishing pond would most likely eliminate the species from the Calvert Cliffs site. The bluegill is a commonly stocked species in Maryland (Section 2.4.2), so the elimination of the small population from the Calvert Cliffs site is not expected to adversely affect other stocked bluegill populations in the region.

The eastern mosquitofish was most abundant in the Camp Conoy fishing pond, Pond 1, Pond 2, and Lake Davies during the fall 2006 survey (Section 2.4.2). It occurred in low numbers in Johns Creek and Goldstein Branch. The lack of eastern mosquitofish in the ponds during the spring 2007 may mean that the species cannot establish resident populations in them. Therefore, activities that affect these waterbodies should not adversely affect the regional population of eastern mosquitofish.

The tessellated darter occurred only in the downstream Johns Creek and the single Goldstein Branch station (Section 2.4.2). These two stations would most likely experience the indirect effects of building activities that would occur farther upstream. Because the effects would occur upstream of the areas where the tessellated darter was found, no overall adverse effects to the population of the species in the St. Leonard Creek watershed are expected.

One mammal, the North American beaver, was listed as an important freshwater species (Section 2.4.2). The occurrence of beavers on the Calvert Cliffs site was documented by observations of beaver activities (gnawed trees, dams) and individuals at Camp Conoy fishing pond in April 2007. No estimates of the population size on the site were made. Beavers on the site primarily inhabit portions of Johns Creek and parts of Goldstein Branch (Section 2.4.2). If beavers reside within the freshwater habitats that would be eliminated by building the new unit, it is likely that they may be able to migrate to less disturbed areas, although it is possible that some individuals may be killed. Beavers living in the downstream reaches of Johns Creek and Goldstein Branch would likely experience the indirect effects of building activities that would occur farther upstream. Despite these potential effects on the beavers living onsite, beaver populations have been increasing in Maryland (Tetra Tech NUS 2007), and overall adverse effects to the regional beaver populations are not expected.

The developmental stages of the insect orders Ephemeroptera, Plecoptera, and Trichoptera are grouped (as EPT taxa) and used as ecological indicators. More EPT taxa occurred in Johns Creek and Goldstein Branch than in any of the ponds sampled on the site in 2006 and 2007. No more than two EPT taxa occurred in any single sample collected from the onsite ponds. Because EPT taxa live in aquatic habitats only part of the year, the disruption of the habitat by building activities is probably of greater concern than direct mortality. The elimination of some of the headwaters of Johns Creek and the filling of Camp Conoy Fishing Pond will remove habitat available for occupancy by EPT taxa. However, the generally low numbers of EPT taxa in these waterbodies indicates that the habitat is not optimal for EPT taxa, and its loss should not adversely affect regional populations of these insects.

Important Estuarine Species

Two State-listed estuarine species could occur on the site (Section 2.4.2). Sea purslane (*Sesuvium maritimum*) and the spotfin killifish (*Fundulus luciae*) are listed as State endangered and State "Rare?" respectively. Neither have been found on the site (Section 2.4.2), and neither are expected to be adversely affected by building activities associated with proposed Unit 3.

Several Federally listed species may occur near the Calvert Cliffs site. The shortnose sturgeon (*Acipenser brevirostrum*), leatherback turtle (*Dermochelys coriacea*), and Kemp's ridley turtle (*Lepidochelys kempii*) are endangered. The loggerhead turtle (*Caretta caretta*) and green turtle (*Chelonia mydas*) are threatened. The Atlantic sturgeon (*A. oxyrinchus*) is a Federal candidate species. The alewife (*Alosa pseudoharengus*) and blueback herring (*A. aestivalis*) are Federally listed species of concern. In accordance with Section 7 of the ESA, the NRC and the Corps are jointly consulting with National Marine Fisheries Service (NMFS) regarding Federally listed estuarine species. The biological assessment is provided in Appendix F.

The shortnose sturgeon and Atlantic sturgeon are benthic fish that feed primarily on bottom-dwelling invertebrates (Section 2.4.2). Therefore, the primary impacts from building activities would be loss of habitat for feeding because of dredging or armoring. However, the soft-bottom sediment at the Calvert Cliffs site is not highly productive and does not represent a major feeding resource for these species. Chesapeake Bay populations of shortnose sturgeon and Atlantic sturgeon are not expected to be adversely affected by the building activities in the Bay because neither species is common in the Calvert Cliffs site area (Section 2.4.2).

The primary impacts to all four turtle species would be from interactions with vessels transiting through the Bay and operating in the Calvert Cliffs area. Only two protected sea turtle species, the loggerhead and Kemp's ridley, may typically occur near the Calvert Cliffs site area (Section 2.4.2), although both are much more common in the lower Bay (UniStar 2008b). Activities at the site would not be expected to directly affect green and leatherback turtles because they do not typically occur there. Noise from pile driving in the Chesapeake Bay could affect sea turtles in the area, but the severity is difficult to determine because of the lack of information regarding sea turtle susceptibility to noise. The Corps and U.S. Minerals Management Service (MMS) considered the potential effect of pile-driving noise on sea turtles in its evaluation of potential impacts from the Cape Wind Farm project and concluded that significant adverse effects were unlikely because turtles probably would avoid the area where building activities were occurring (MMS 2009).

Alewife and blueback herrings are relatively small planktivorous fish that occur in the Calvert Cliffs site area (Section 2.4.2). The primary effect of site preparation and construction activities on these species would be interruption of feeding because of increased suspended sediment from dredging, but this interruption would occur in a relatively small area and would be temporary. Pile-driving sounds may also affect these species, but fish are mobile and may avoid the area. Neither dredging nor pile driving is expected to adversely affect Chesapeake Bay alewife or blueback herring populations.

Other planktivorous fish or water-column-feeding fish, such as American shad (*Alosa sapidissima*), Atlantic menhaden (*Brevoortia tyrannus*), bay anchovy (*Anchoa mitchilli*), butterfish (*Peprilus triacanthus*), bluefish (*Pomatomus saltatrix*), striped bass (*Morone saxatilis*), and weakfish (*Cynoscion regalis*), primarily would be affected by the interruption of feeding because of suspended sediments from dredging. This interruption would occur in a relatively small area and would be temporary. Pile-driving sounds may also affect these species, but fish are mobile and may avoid the area. Neither suspended sediment from dredging nor pile-driving noise would adversely affect Chesapeake Bay populations of these species.

Benthic-feeding fish, such as Atlantic croaker (*Micropogonias undulatus*), black sea bass (*Centropristis striata*), red drum (*Sciaenops ocellatus*), spot (*Leiostomus xanthurus*), summer flounder (*Paralichthys dentatus*), white perch (*Morone americana*), windowpane flounder (*Scophthalmus aquosus*) clearnose skate (*Raja eglanteria*), little skate (*Leucoraja erinacea*), and winter skate (*Leucoraja ocellata*), primarily would be affected by loss of feeding habitat through the removal of soft sediments during dredging and the addition of rock armoring to the Bay bottom. However, the soft-bottom sediment at the Calvert Cliffs site is not highly productive and does not represent a major feeding resource for these species. Pile-driving sounds also could affect these species, but fish are mobile and may avoid the area. Neither loss of the small area of feeding habitat nor pile-driving noise is likely to adversely affect Chesapeake Bay populations of these species.

Blue crabs (*Callinectes sapidus*) occupy water column and benthic habitats. Blue crabs use the water column primarily to move from place to place within the Bay and would not be adversely affected by the relatively small area likely to be disturbed by suspended sediments from dredging or trenching activities. Blue crabs spend considerable time on benthic habitats, which make them susceptible to activities that disturb the sediments. Some blue crabs likely would get trapped within the clamshell dredge as it excavates benthic substrates. However, mortality from this entrapment would likely be too small to adversely affect regional blue crab populations. Loss of a small area of soft-bottom habitat would not adversely affect blue crabs.

The eastern oyster (*Crassostrea virginica*) is one important species over which the State of Maryland has expressed its concern about potential impacts from building Unit 3. The State of Maryland has determined that eastern oyster habitat near the plant is valuable and is to be protected to the extent possible. Oysters would be affected by suspended sediments in the water column that would interfere with filter feeding. The area affected by increased turbidity likely would be small because of the steps UniStar proposes to limit suspended sediment loads. The primary impacts to oysters and their habitat would result from the dredging of the barge dock area and the trenching for placement of the cooling water discharge pipe. These activities would disturb habitat within Natural Oyster Bar 19-2 (NOB 19-2), also known as the Flag Pond Oyster Bar. Oyster abundances within NOB 19-2 were found to be very low during a survey conducted by UniStar in late 2006 and in several surveys conducted by the State of Maryland (summarized in Section 2.4.2). Although direct impacts to oysters would, therefore, be relatively minor, the oyster bar is considered valuable habitat for potential restoration by the State of Maryland. Most of the dredging proposed by UniStar would be maintenance dredging of the area next to the barge dock that has been dredged previously. This area was not included in the 2008 survey of NOB 19-2 (Section 2.4.2), but presumably is no longer viable oyster habitat. However, the Bay bottom just bayward of the barge dock was found to be high-quality oyster habitat, some of which would be disturbed by dredging or digging the trench for the cooling water discharge pipe. The dredged area would be lost as future oyster habitat. Even though the discharge pipe trench would be covered with native Bay material, it is likely that this would not constitute good quality oyster habitat. Some disturbance of oyster habitat is unavoidable, and the State of Maryland has specified that UniStar should use appropriate time-of-year dredging restrictions to minimize impacts to the oyster bar and should fund the cost of moving, creating, or restoring oyster habitat equal to the area of bottom in NOB 19-2 that would be directly, adversely affected by building Unit 3 (MPSC 2009). The State's conditions imposed on activities affecting the oyster bed would, if followed, minimize direct effects to oysters and would be expected to result in no net loss of potential oyster habitat.

4.3.2.3 Aquatic Resources – Transmission Lines

Placement of new transmission lines onsite for proposed Unit 3 would not likely affect the freshwater aquatic resources on the Calvert Cliffs site because the new lines would not cross any waterbodies (UniStar 2009a). No new offsite transmission lines would be installed. Therefore, no offsite aquatic resources would be affected.

4.3.2.4 Aquatic Monitoring

UniStar does not plan to conduct any monitoring of aquatic resources during activities related to building the proposed Unit 3 other than that required in Chesapeake Bay for the operation of the CCNPP Units 1 and 2 (UniStar 2009a). The SWPPP developed by UniStar includes regular (daily and after major rainstorms) monitoring of stormwater discharges and the conditions of the engineered erosion control measures to determine they are effective in minimizing silt runoff. The plan also requires evaluation of the need to repair or replace the installed controls, which may include silt fences, hay bales, berms, and settling ponds. The Corps and the State of Maryland may require monitoring for compliance with their respective Federal and State permits, if issued.

4.3.2.5 Summary of Impacts to Aquatic Resources

Freshwater Aquatic Resources

The review team evaluated the proposed construction and preconstruction activities related to the building of proposed Unit 3 and the potential impacts to aquatic biota, including State-listed species, in the onsite freshwater habitats and the Chesapeake Bay. Activities affecting onsite freshwater habitats include clearing and grading the land, building or refurbishing roads, installing temporary and permanent utilities and facilities, and creating parking and construction equipment preparation areas. These activities would eliminate some onsite aquatic resources, increase erosion, and increase runoff into downstream resources. Building Unit 3 would also change the watershed permanently by adding about 130 ac of impervious surfaces.

Based on the information provided by UniStar and the review team's evaluation, the review team concludes that the impacts from the combined construction and preconstruction activities for proposed Unit 3 to the freshwater aquatic biota, including State-listed species, and habitats within the St. Leonard Creek and Lower Western Shore watersheds would be MODERATE, primarily because of the loss of an onsite pond, the headwaters of small tributaries, and the addition of 130 ac of impervious surfaces to the watershed. Such impacts would noticeably alter the St. Leonard Creek subwatershed, which is the largest component of the Lower Patuxent River watershed. UniStar proposes to restore or enhance two small streams in the Lower Western Shore watershed and portions of the Woodland Branch and Johns Creek in the St. Leonard Creek watershed. Further mitigation measures, such as time-of-year work restrictions, may be warranted and are being considered by the Corps and the State of Maryland. The Corps requires that mitigation may only be employed after all appropriate and practical steps to avoid and minimize adverse impacts to aquatic resources, including nontidal wetlands and streams, have been taken. Further, the Corps requires all remaining unavoidable impacts to be compensated to the extent appropriate and practicable. Most of the impacts to freshwater resources would be from preconstruction activities, such as clearing and grading forested land, eliminating streams and ponds, and adding impervious surfaces to the watersheds. Therefore, the NRC staff concludes that the impacts to freshwater aquatic biota, including State-listed species, and habitats from NRC-authorized construction activities would be SMALL, and no further mitigation specific to NRC-authorized construction would be warranted.

Chesapeake Bay Aquatic Resources

Similarly, the review team evaluated the impacts to the Chesapeake Bay's aquatic biota, including Federally and State-listed species, and habitats. Activities affecting the nearshore habitats in Chesapeake Bay include the installation of the cooling water intake and discharge system and the refurbishing of the barge dock area. These activities would temporarily increase suspended sediment loads in the area and subject organisms to increased noise and potential interactions with vessels. Some soft-bottom habitat would be temporarily disturbed by the activities, and at least 0.16 ac would be permanently converted to rocky habitat by the armoring at the intake and discharge structures, thus noticeably altering the benthic habitat in the wedge-shaped pool and surrounding the discharge structure.

Based on the information provided by UniStar and the review team's evaluation, the review team concludes that the impacts from construction and preconstruction activities for proposed Unit 3 to the Chesapeake Bay aquatic biota, including Federally and State-listed species, and habitats would be MODERATE. Further mitigation measures for preconstruction and construction activities, such as time-of-year work restrictions, may be warranted and are being considered by the Corps and the State of Maryland. The Corps requires that mitigation may only be employed after all appropriate and practical steps to avoid and minimize adverse impacts to estuarine aquatic resources have been taken. Further, the Corps requires all remaining unavoidable impacts to be compensated to the extent appropriate and practicable.

The only NRC-authorized construction activity that would affect aquatic resources, including Federally and State-listed species, in the Bay is building part of the safety-related makeup water system, specifically installing and armoring the two intake pipelines. The two pipelines would extend a short distance into the wedge-shaped pool affecting a small part of the benthic habitat. Therefore, the NRC staff concludes that the impacts to the aquatic biota, including Federally and State-listed species, and habitats of the Chesapeake Bay from NRC-authorized construction activities would be SMALL.

4.4 Socioeconomic Impacts

Socioeconomic impacts may occur in the 50-mi region surrounding the proposed Unit 3. This evaluation assesses the impacts of project-related activities and of the peak workforce on the region. Unless otherwise specified, the primary source of information for this section is the ER (UniStar 2009a).

The planned project activities would differ significantly from those activities required to construct CCNPP Units 1 and 2.[a] Based on review team interviews with local officials and discussions with the applicant, the review team identified the following differences between the construction phase of the current Units 1 and 2, and the building strategy for the proposed new unit. Although many activities would be similar, Units 1 and 2 were constructed simultaneously and almost entirely onsite. For the single Unit 3, many of the components of the AREVA NP Inc. (AREVA) U.S. EPR nuclear unit would be built at dedicated fabrication facilities outside the Calvert Cliffs site region and would be delivered to the Unit 3 site ready to assemble, reducing onsite labor requirements. UniStar estimates the peak onsite labor force for Unit 3 to be 3950 workers (specific assumptions are discussed in following sections). Because fewer onsite workers would be needed to build Unit 3 than were needed for CCNPP Units 1 and 2 and because impacts are related to the number of construction workers in-migrating, the review team expects the physical, social, and economic impacts on the region would be less than the impacts experienced during the construction of CCNPP Units 1 and 2. The remainder of this section provides support for this assertion, based upon a detailed assessment of each socioeconomic impact area, employing baseline conditions described in Section 2.5 of this EIS.

Although the review team considered the entire region within a 50-mi radius of the Calvert Cliffs site when assessing socioeconomic impacts, the discussion is limited to the two-county area of Calvert County and St. Mary's Counties, which is approximately the western half of the 20-mi radius. Based on commuter patterns, the distribution of residential communities in the area, and the nature of the likely socioeconomic impacts of construction and preconstruction activities, the review team found negligible impacts on other counties within the 50-mi radius in Maryland,

(a) CCNPP Unit 1 began operation in 1975, and Unit 2 began operation in 1977 (Constellation Website at http://www.constellation.com/portal/site/constellation/menuitem.0275303d670d51908d84ff10025166a0/; also available on the NRC website at htt://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1350).

Virginia, Delaware, and Washington, D.C. Access to the two Delaware counties and eight Maryland counties to the west is limited by the Chesapeake Bay, and access to 11 of the 13 Virginia counties is limited by the Potomac River. Potential impacts to the remaining four Maryland counties, two Virginia counties, and Washington, D.C. that lie to the north and northwest of the Calvert Cliffs site are limited by the size of these areas relative to the workforce. And, while the highway system is good, access is limited by the absence of interstate highways.

4.4.1 Physical Impacts

Construction and preconstruction activities can cause temporary and localized physical impacts such as noise, odors, vehicle exhaust, and dust. Vibration and shock impacts are not expected because of the strict control of blasting and other shock-producing activities. This section addresses potential impacts that may affect people, buildings, and roads.

4.4.1.1 Workers and the Local Public

The land surrounding the Calvert Cliffs site is zoned for a combination of light industrial, farm, forest, and residential uses, and is bounded by the Chesapeake Bay and to the west by forested land. No significant industrial or commercial facilities other than the Calvert Cliffs site exist or are planned in the vicinity. The recreational areas closest to the plant include the Flag Ponds Nature Park to the north and the Calvert Cliffs State Park to the south, both of which are adjacent to the plant site. Most construction and preconstruction activities take place during the work week and most visitors use these parks on weekends. Also, the heavy forest cover of the large Calvert Cliffs site itself is expected to buffer many effects of traffic, noise, and dust, and therefore the increase in these attributes from construction and preconstruction activities is not expected to significantly affect either Flag Ponds or Calvert Cliffs State Park (UniStar 2009a).

All construction and preconstruction activities would occur within the Calvert Cliffs site boundary and would be performed in compliance with all Occupational Safety and Health Administration (OSHA) standards, BMPs, and other applicable regulatory and permit requirements. While approximately 41,000 people live within 10 mi of the site (see Section 2.5.1.1), the only people likely to be vulnerable to noise, fugitive dust, and gaseous emissions resulting from project activities include construction workers and, to a lesser extent, other personnel working onsite at the existing adjacent operating units. People working or living immediately adjacent to the site and transient populations, such as recreational visitors, tourists, or temporary employees for other businesses in the area, would be impacted significantly less than construction workers because of access and distance, which would limit exposure to construction and preconstruction activities (UniStar 2009a).

Construction workers would have adequate training and personal protective equipment to minimize the risk of potentially harmful exposures. Emergency first-aid care would be available at the site, and regular health and safety monitoring would be conducted. People working onsite or living near the Calvert Cliffs site would not experience any physical impacts greater than those that would be considered an annoyance or nuisance. Construction and preconstruction activities would be performed in compliance with Federal, State, and local regulations and site-specific permit conditions (UniStar 2009a).

4.4.1.2 Noise

Construction and preconstruction activities are inherently noisy, and noise is an environmental concern because it can cause adverse health effects, annoyance, and disruption of social interactions. Noise would result from clearing, earthmoving, foundation preparation, pile driving, concrete mixing and pouring, steel erection, and various stages of facility equipment fabrication, assembly, and installation. Non-routine activities such as blasting, if needed, would only be conducted during weekday business hours. The Calvert Cliffs site's relative isolation from populated areas and the wooded areas surrounding the site would provide natural noise abatement. In addition, good practices such as maintenance of equipment, controlling access to high noise areas, duration of emission and shielding high noise sources close to their origin would be used (UniStar 2009a). All project activities would also be subject to regulations stemming from the Noise Control Act of 1972, Federal regulations for noise from construction equipment (40 CFR Part 204), OSHA regulations (29 CFR 1910.95), and State regulations (COMAR 2007). The review team expects noise impacts on recreation and the general public would be minimal with the use of good practices described above and because noise attenuates with distance.

4.4.1.3 Air Quality

As of 2006, Calvert County was in attainment for all the National Ambient Air Quality Standards,[a] except for the 8-hour ozone standard due to Calvert County's proximity to Washington, D.C. Calvert County is part of the Southern Maryland Intrastate Air Quality Control Region (40 CFR 81.156), for which the attainment status is listed as better than national standards for total suspended particulates, sulfur dioxide, and nitrogen dioxide, and unclassifiable/attainment for carbon monoxide (see Section 2.9). Temporary and minor effects on local ambient air quality may occur as a result of normal industrial activities. Emissions of fugitive dust and particulate matter (PM) smaller than 10 micrometers (PM_{10}) in size are generated during earth-moving and material-handling activities. Construction equipment and offsite vehicles also produce emissions. The pollutants of primary concern include PM_{10} fugitive dust, reactive organic gases, oxides of nitrogen, carbon monoxide, and, to a lesser extent, sulfur dioxides. Mitigation measures (e.g., paving or stabilizing disturbed areas, water suppression, reduced material handling) would minimize such emissions. Odors could result from exhaust

(a) Areas of the United States having air quality as good as or better than the National Ambient Air Quality Standards are designated by EPA as "attainment areas."

emissions, but odors dissipate onsite and would have no discernible impact on the local air quality. All equipment would be serviced regularly, and all industrial activities would be conducted in accordance with Federal, State, and local emission requirements.

UniStar stated that specific mitigation measures to control fugitive dust would be identified in a dust-control plan or a similar document prepared prior to starting the project in accordance with all applicable State and Federal permits and regulations (UniStar 2009a). These mitigation measures could include but are not limited to the following:

- stabilizing access roads and spoils piles
- limiting speeds on unpaved access roads
- periodically watering unpaved access roads to control dust
- performing housekeeping (e.g., remove dirt spilled onto paved roads)
- covering haul trucks when loaded or unloaded
- minimizing material handling (e.g., drop heights, double-handling)
- ceasing grading and excavation activities during high winds and during periods of extreme air pollution
- phasing grading to minimize the area of disturbed soils
- re-vegetating road medians and slopes.

4.4.1.4 Buildings

Construction and preconstruction activities would not affect any offsite buildings. The Camp Conoy structure and the Eagle's Den conference center would be demolished. Onsite safety related buildings associated with CCNPP Units 1 and 2 have been built to safely withstand any possible impact from natural phenomena such as earthquakes and, therefore, can withstand shock and vibration from activities associated with development at the Calvert Cliffs site (10 CFR Part 50, Appendix A). Other onsite buildings were built according to building codes and standards, which includes consideration of seismic loads (UniStar 2009a). Information about historic properties and the impacts of construction on a number of peripheral onsite buildings that will be removed is provided in Sections 2.7 and 4.6. Offsite buildings are not expected to be affected by project activities due to their distance from the site. The nearest residence is approximately 3000 ft from the site, and, as discussed earlier, project-related activities would comply with all regulations pertaining to offsite vibrations.

4.4.1.5 Transportation

This EIS assesses the impact of transporting workers and materials to and from the Calvert Cliffs site from three perspectives: the socioeconomic impacts, the air quality impacts of dust and particulate matter put into the air by vehicle traffic, and the potential health impacts caused by additional traffic-related accidents. The socioeconomic impacts are addressed here and in Section 4.4.4.1. The air quality impacts are addressed in Section 4.4.1.1, and the human health impacts are addressed in Section 4.8. Public roads would be used to transport construction materials and equipment. Calvert County has a well-developed transportation system and would not be significantly impacted as a result of the proposed project-related activities. A new site access road from MD State Route 2/4 would be built, and an existing heavy haul road near the barge slip would be upgraded and extended. Construction workers would access the site through MD State Route 2/4, which is clearly marked with signs and maintained clear of debris.

The barge facility would be refurbished to transport large components and equipment, and the existing onsite heavy-haul road would be refurbished and extended. The review team expects neither the refurbishment activities, nor the use of the barge facility and heavy-haul road, to impact the public because these activities would occur within a restricted access area.

4.4.1.6 Aesthetics

The proposed footprint for Unit 3 is in a light industrial area, surrounded primarily by forested land. With the exception of elevated activities involving cranes, construction and preconstruction activities will generally not be visible from points outside the Calvert Cliffs site boundary due to the surrounding heavily wooded area. Limited project activities may be visible from locations in the Chesapeake Bay, including elevated activities, activities conducted along the shoreline, barge unloading, installation of intake/discharge equipment, and refurbishment of the heavy-haul road, but the elevation and setback would limit general visibility.

Water turbidity may be present during dredging operations to refurbish the barge facility. Mitigation measures include implementing the SWPPP, transporting excavated and dredged material to an onsite spoils area, and complying with required Federal and State regulations and permits (Section 4.2.3.1) (UniStar 2009a). Therefore, the aesthetic impact of turbidity is expected to be insignificant and temporary.

4.4.1.7 Summary of Physical Impacts

All construction and preconstructon activities would occur within the site boundary. The review team has evaluated information provided by UniStar, visited the site and its environs, and performed an independent review of the potential physical impacts of construction and preconstruction activities on the local area and region of the proposed Unit 3 site. The review team concludes that the expected physical impacts of construction and preconstruction activities would be SMALL, and no further mitigation beyond the strategies outlined by the applicant in its ER would be warranted.

4.4.2 Demography

UniStar estimated the peak project workforce for Unit 3 would be 3950 workers. UniStar further assumed the proposed project schedule would last approximately 86 months, which includes site development activities, with peak employment occurring within the last quarter of fourth year through the first quarter of the fifth year of the project. While there are enough construction workers in absolute numbers in the socioeconomics impact area, not all workers have the skills necessary to build a nuclear plant. Consequently, the review team determined through review of the ER (UniStar 2009a) and interviews with labor officials in the area that between 20 and 35 percent of the skilled workforce would need to come from outside the two-county economic impact area of Calvert and St. Mary's Counties. The actual percentage of in-migrating workers would depend on the level of competition for those particular skills from other nuclear and non-nuclear related projects occurring at the same time.

The review team assumes, for the purpose of this study, that:

- The number of workers that would move their place of residence (in-migrate) to the region and the economic impact area would range from 20 to 35 percent of the 3950 peak project workforce.
- The U.S. Census Bureau average household size of 2.61 persons would be representative of worker households.
- Each in-migrating construction worker at the proposed Unit 3 would generate an additional 0.6855 indirect jobs as a result of his or her economic activity in the economic impact area.
- The place of residence for in-migrating construction workers within the economic impact area would follow the same distribution as the distribution of current CCNPP Units 1 and 2 operations and maintenance workforce.

The result of these assumptions means a peak increase in the economic impact area's population of 1876 to 3284 persons, distributed between the two counties, as shown in Table 4-5.

The review team estimated the demographic consequence of this increase in population would range from 0.8 percent to 1.5 percent for the entire economic impact area based on population projected for 2015 (Table 2-9), when the construction workforce is expected to be near its peak. The increase for Calvert County ranges from 1.4 to 2.5 percent and 0.4 to 0.7 percent for St. Mary's County. Given that in-migrating workforce would represent a small percentage of the economic impact area's total population, the review team determined this effect would not be significant on the economic impact area and the remainder of the region.

Table 4-5. Potential Peak Increase in Population During Peak Construction and Preconstruction Activities of Proposed Unit 3

	Total	Economic Impact Area		Locations Outside Economic Impact Area
		Calvert County	St. Mary's County	
Peak Direct Workforce	3950	--	--	--
Percent of Current CCNPP Units 1 & 2 Workforce Distribution	--	68%	23%	--
Workers that In-Migrate (20-35%)	790-1383	537-940	182-318	71-124
Indirect Jobs Created (20-35%)	542-948	368-644	125-218	49-85
Total In-Migrant Household Population	2062-3608	1402-2454	474-830	186-324

Source: UniStar 2009a

4.4.3 Economic Impacts on the Community

This section evaluates the economic impacts of construction and preconstruction on the area within 50 mi of the Calvert Cliffs site, focusing primarily on the two-county economic impact area. The evaluation assesses the impacts of building proposed Unit 3 and demands placed by the larger workforce on the surrounding region.

4.4.3.1 Economy

The impacts of construction and preconstruction activities on the local and regional economy depend on the region's current and projected economy and population. For this analysis, the review team based its analysis upon the latest information provided by UniStar and assumes construction and preconstruction activities would last approximately 86 months with commercial operations beginning in 2016 (UniStar 2009e).

New indirect jobs are created through a process called the "multiplier effect," whereby a new (direct) job in a given area stimulates spending on goods and services that results in the economic need for a fraction of a new (indirect) job, typically in service-related industries. The cumulative effect of a new direct job workforce being added to an economy induces the creation of a number of new indirect jobs. The ratio of new indirect jobs to the number of new direct jobs is called the "employment multiplier." The U.S. Department of Commerce Bureau of Economic Analysis (BEA), Economics and Statistics Division, provides regional multipliers for industry employment and earnings and a custom set of multipliers was provided by BEA to UniStar for the two county economic impact area (UniStar 2009a). The BEA employment multiplier is applied to only in-migrating workers because the BEA model assumes the income effect from construction workers that already live in the area will have no additional impact on the economy.

For every construction worker, BEA estimates an additional 0.6855 jobs would be created (UniStar 2009a). Only the in-migrating direct jobs are counted so that a net impact can be estimated. Other indirect and induced jobs are assumed to be allocated to area residents who would be leaving other jobs to take Unit 3-related employment. Considering this multiplier effect, the construction and preconstruction activities could create approximately 790 to 1383 additional indirect jobs. Table 4-6 shows the annual average number of directly employed construction workers and the associated indirect employment.

Table 4-6. Proposed Unit 3 Direct and Indirect Employment During Construction and Preconstruction Activities from 2011–2016

	Total CCNPP 3 Employment		
Year	**Direct[a]**	**Indirect (20-35%)[b]**	**Total**
2011	1000	137-240	1137-1240
2012	2350	322-564	2672-2914
2013	3275	449-786	3724-4061
2014	3863	530-927	4392-4789
2015	3742	513-898	4255-4639
2016	1928	264-463	2193-2391

(a) Source: UniStar 2009a.
(b) Review team assessment.

The employment of a large workforce for up to 86 months would have positive economic impacts on the surrounding region, providing additional income to the regional economy, reducing unemployment, and creating business opportunities for housing and service-related industries. UniStar estimates the peak workforce of 3950 would earn an average of $70,720 annually for a total of $279 million. The review team concludes, based on its own independent review of the likely economic effects of the proposed action, that beneficial economic impacts could be experienced throughout the region. The review team expects economic impacts to beminimal but beneficial, both within and outside the economic impact area, due to the size of the economies and the expected distribution of residences.

4.4.3.2 Taxes

The tax structure of the region is discussed in Section 2.5 of this EIS. Several tax revenue categories would be affected by the building of proposed Unit 3. These include taxes on wages and salaries, sales and use taxes on construction-related purchases, workforce expenditures, property taxes related to the new units, and personal property taxes on owned real property.

This section provides an estimate of the personal income tax revenues that would accrue to the two counties in the economic impact area and the State of Maryland. The review team considers the wages of Maryland residents who would work at the proposed site to be a net transfer with no analytical worth. For workers in-migrating outside of Maryland, the review team considers the full value of their Unit 3-based earnings as applicable to this analysis.

Because the number of new income tax payers in Maryland resulting from the Unit 3 project would not change noticeably in the context of the State's income tax base, income tax revenue attributable to the Unit 3 project would be minimal. Determining the exact amount of income tax revenue relies on a number of factors such as income tax rates, residency status, deductions taken and other factors. Assuming an in-migrating worker earns a representative annual salary of approximately $70,720 (UniStar 2009a), and using Calvert County's income tax rate of 2.8 percent, Calvert County revenue attributable to construction and preconstruction during peak years of activity would be $1 to $1.9 million. In St. Mary's County income tax revenues at the peak would be approximately $386,000 to $675,000. Given the large income tax base in the State of Maryland and the economic impact area, this increase would only represent a minimal but beneficial impact.

As discussed in Section 2.5.2.2, the State of Maryland obtains revenues based on sales and use taxes generated by retail expenditures on goods and services. The State would receive sales tax revenue from all Unit 3-related purchases (i.e., materials or equipment). Given the difficulty in estimating spending patterns, it is not possible to estimate the sales and use tax revenue for Maryland attributed to the development of Unit 3. However, because this revenue would be paid to the State rather than local jurisdictions, the impact to the two-county economic impact area would be minimal and beneficial.

Individuals and businesses in Maryland pay taxes on real property to the State and on real and personal property to the counties (see Table 2-13 for the tax rates by jurisdiction). In 2006, Constellation Energy paid about $16.2 million in Calvert County property taxes (including $10.3 million in personal property and $5.5 million in operating real property taxes) for Units 1 and 2, and, in 2007, it paid about $16.2 million in property taxes (including $10.6 million in personal property and $5.6 million in operating real property taxes) (UniStar 2009a). As the assessed value of property increases each year during the project so would the taxes paid to Calvert County. These incremental increases in taxes would have a significant impact on Calvert County's annual property tax revenues. UniStar estimated tax payments to be $1.1 million (2009), $3.5 million (2010), $8.5 million (2011), $18.8 million (2012), $40.7 million (2013), $61.6 million (2014), and $71.3 million (2015) (UniStar 2009d). In 2015 when tax payments are expected to be $71.3 million, this would represent a 32.2 percent increase in the 2009 Calvert County revenue.

Another source of revenue from property taxes would be from housing purchased by the long-term construction workforce. In-migrating workers may have new housing built for them, which would add to the county's taxable property base; or they could purchase existing houses, which would drive housing demand and housing prices up, slightly increasing values (and property taxes levied). The increased housing demand would have little effect on tax revenues in the heavily populated two-county economic impact area. Therefore, the impact from property taxes on housing for the State and the two-county economic impact area would be minimal and beneficial. However, the impact of the site-related property taxes paid to Calvert County would likely be significant and beneficial.

4.4.3.3 Summary of Economic Impacts on the Community

Based on its independent analysis, the review team concludes that the economic impacts of building activities would be SMALL and beneficial in Calvert County and the rest of the 50-mi region. The tax revenue that accrues to the County and State governments over the approximately 86-month construction period would constitute a slight increase in total taxes collected by the State of Maryland and St. Mary's County. However, the impact would be significant in Calvert County. Consequently, the review team concludes that the tax revenue impacts from construction and preconstruction activities to the region would be SMALL and beneficial, except for Calvert County for which the impact would be LARGE and beneficial.

4.4.4 Infrastructure and Community Service Impacts

This section provides the estimated impacts on infrastructure and community services to include transportation, recreation, housing, public services, and education.

4.4.4.1 Transportation

Public roads and waterways would be used to transport construction materials and equipment because the nearest operating rail line is 8-mi from the Calvert Cliffs site. Project-related impacts on traffic are determined by five elements:

1. the number and timing of construction worker vehicles on the roads per shift
2. the number of shift changes for the workforce per day
3. the number and timing of truck deliveries to the site per day
4. the projected population growth rate in Calvert County
5. the capacity and usage of the roads.

The major transportation routes described in Section 2.5.2.3 would be used by construction workers to commute to and from work and to transport a majority of the construction materials and equipment to the Calvert Cliffs site. As a result, traffic flows would increase substantially on MD State Route 2/4 during the peak project period and would be highest during shift changes, with impacts decreasing with distance, as vehicles would travel to the site via alternate routes. It is possible that there would be noticeable impacts on rural roads that connect to MD State Route 2/4.

A Traffic Impact Analysis (TIA) was conducted (KLD 2009) on the roadways in the site vicinity with input from Maryland State Highway Administration and Calvert County. The TIA Study shown in Figure 2-16 extended 4 mi in each direction (8-mi total) from the Calvert Cliffs site entrance and included five intersections:

- Calvert Beach Road (signalized)
- Calvert Cliffs Parkway (signalized)
- Nursery Road (unsignalized)
- Pardoe Road (unsignalized)
- Cove Point Road (unsignalized).

There are no planned highway improvements, so the TIA analyzed two scenarios regarding the ability of the MD State Route 2/4 to accommodate expected future traffic volumes using the existing highway network (KLD 2009). The baseline scenario was for a 'no-build' situation to account for normal growth in traffic volumes of 4 percent per year and an increase in traffic given a 'build' situation to accommodate a peak of 2067 vehicles during the morning peak and 3009 during the evening peak. For a maximum calculation, the TIA included not only construction workers, operations staff, and deliveries, but also outage workers. Increased traffic due to an outage would be temporary, only lasting a few weeks each year. Construction workers were distributed in 3 shifts a day with 60 percent in the first shift, 35 percent in the second shift and 5 percent in the third shift.

The TIA results for the baseline 4 percent growth without Unit 3 indicated the unsignalized intersections and the Calvert Beach Road/Ball Road intersection would not function properly by 2018, indicating upgrades would be needed regardless of the development of Unit 3. The results of the TIA analysis for the peak site development period indicate the existing intersections would fail under the traffic load even if all the intersections were signalized. The recommendation from the TIA study was the addition of a new signalized intersection on MD 2/4 for construction worker access. Other recommendations included adding turning lanes on MD 2/4 at the Calvert Beach Road/Ball Road; lane reconfiguration at Calvert Cliffs Parkway; and signalizing and adding lanes at the Nursery Road, Pardoe Road, and Cove Point Road intersections. The study concludes that if the above recommendations are implemented, all intersections will operate at acceptable levels at peak periods (LOS D or better).

A critical area not addressed by the TIA is access from the south over the Thomas Johnson Memorial Bridge that connects Calvert and St. Mary's Counties, where the four-lane MD State Route 2/4 narrows to two lanes across the bridge. As reported in Section 2.5.2.3, the Maryland State Highway Administration and the Federal Highway Administration expect to complete the planning process for bridge expansion in 2010 and construction by 2020. The State expects to begin bridge renovations after completion of proposed Unit 3 (KLD 2009). Currently, access is limited from the west, to St. Mary's and Charles Counties, which will channel traffic flow to the

North and South in Calvert County, thus increasing the need to implement the mitigation measures discussed in the TIA to help alleviate the choke point at the Thomas Johnson Memorial Bridge.

Based on the information provided by UniStar, interviews with local planners and officials, and the review team's independent evaluation, the review team concludes that the offsite impacts on road transportation of building Unit 3 would be temporary and noticeable but not destabilizing during the peak project period for roads in the vicinity of the site, and minimal elsewhere. However, UniStar, in coordination with the State, commissioned a traffic study that identified mitigating strategies that would mitigate the traffic to a manageable level.

Large components and equipment would be transported to the site via barge and the heavy-haul road (UniStar 2009a). This would mean the barge facility would have to be upgraded and the heavy-haul road to be upgraded and extended. The review team determined the refurbishment of the barge facility and extension of the heavy-haul road would be confined to an access-restricted area, thus imposing a minimal and temporary impact on the public.

4.4.4.2 Recreation

Impacts on recreation may result from increased demand/use of existing and planned resources and from aesthetic/visual and noise impacts, which were discussed earlier in Section 4.4.1. The increase in demand on existing/planned resources would result from usage by the increased population in the two counties. Recreational users near the site may experience traffic congestion on the roads at shift change; however, most recreational activities occur on the weekends and not during normal weekday business hours when shift changes would occur. Given the relatively small number of people in-migrating relative to the large surrounding population and the fact that recreational users would likely not be on the road at shift change, the review team concludes that recreational impacts from construction and preconstruction would be minimal.

4.4.4.3 Housing

The assumptions behind the review team's estimated in-migration of workers was established in Section 4.4.2 of this chapter, with the number of in-migrating households resulting from construction and preconstruction activities for Unit 3 ranging from 537 to 940 for Calvert County and 182 to 318 for St. Mary's County (Table 4-5). The Census Bureau estimates that in 2006 there were 1830 and 3814 unoccupied housing units in Calvert and St. Mary's Counties, respectively (Table 2-21).

The Calvert County Department of Economic Development has indicated the housing market in Calvert County might be tight (UniStar 2009a), despite an annual average issuance of 648 construction permits for single family and multifamily units from 2000 through 2007 (MDP 2008). St. Mary's County Government indicates there is an adequate supply of housing (UniStar

2009a), and an annual average of 974 construction permits were issued for single family and multifamily units from 2000 through 2007 (MDP 2008). The Calvert County Department of Economic Development also indicated a larger number of the in-migrants associated with the project workforce may seek housing in St. Mary's County due to the differential in housing prices in the two counties (UniStar 2009a; MDP 2008).

Some of the workforce may choose to stay in rental housing, apartments, or in one of the 28 hotels/motels/bed and breakfast facilities in Calvert and St. Mary's Counties, which offer approximately 1500 rooms (UniStar 2009a). Given the supply of 1500 hotel/motel/bed and breakfasts rooms and a peak summer occupancy rate of 80 percent (Section 2.5.2.5), approximately 300 rooms remain available for construction workers. Based on these assumptions, the review team believes that additional hotel/motel/bed and breakfasts facilities may be needed. Thirty-three apartment and townhouse complexes in Calvert and St. Mary's Counties provide one- to three-bedroom rental units, of which 28 are located in St. Mary's County. St. Mary's County government officials indicated that a number of apartment units currently used by a major employer for temporary housing may become available (UniStar 2009a).

The boom-and-bust nature of large-scale construction projects aggravates the housing impacts in local communities. The typical pattern begins when in-migrating workers and their families (along with local residents with enhanced economic resources because of project- and worker-related jobs and expenditures) increase the demand for housing. Increased demand creates upward pressure on both the housing supply and prices in the local area. When construction ends, most in-migrating workers leave, and local indirect jobs also are lost. Because a considerable construction workforce already lives locally, many of these impacts could be avoided. In addition, the high population growth rate in the region would mitigate much of the economic decline after the completion of construction.

Housing supply is a dynamic process that can respond relatively quickly to changes in demand. Based on housing construction permit information from Maryland discussed above, which shows approximately 1622 permits issued from 2000 to 2007 for single and multi-family homes and the review team's expert opinion, the supply of housing in Calvert and St. Mary's Counties could be adapted in a relatively short time period to meet the projected change in demand associated with the proposed project. Based on the information provided by UniStar, the review team's interviews with local real estate agents and City and County Planners, and the review team's independent evaluation, the review team expects the housing-related impacts of construction and preconstruction on Unit 3 would be minimal and temporary.

4.4.4.4 Public Services

This section describes the public services available and discusses the impacts of construction and preconstruction at the proposed Unit 3 site on water supply and waste treatment; police, fire and medical services; education; and social services in the region.

Water Supply Facilities

Project-related water requirements and their impacts are discussed in Section 4.2 of this EIS. The impact to the local water supply systems from project-related population growth can be estimated by calculating the amount of water that would be needed by the total population increase in Calvert and St. Mary's Counties. According to a 2003 EPA report on potable water usage, the average person in the United States uses about 90 gpd (EPA 2003). For an assumed project-related population increase of 1402 to 2454 people in Calvert County and 474 to 830 people in St. Mary's County, the increased water consumption would be 126,188 gpd to 220,829 gpd in Calvert County and 42,681 gpd to 74,692 gpd in St. Mary's County, respectively. This increase is well within the excess capacity of 2.4 MGD in the Calvert County water systems and 4.8 MGD in the St. Mary's County water systems. This would leave sufficient unused capacity to meet base growth of less than 1 percent in Calvert County and approximately 2 percent in St. Mary's County if all of the growth (base plus Unit 3) is connected to a water supply system. The review team concludes that the impacts of construction and preconstruction activities on community water systems would be minor and temporary.

Wastewater Treatment Facilities

Section 2.5.2.6 describes the public wastewater treatment systems in Calvert and St. Mary's Counties, their permitted capacities, and current utilization. Wastewater treatment facilities in the two counties have excess capacities. In 2005, the seven sewage treatment plants in Calvert and St. Mary's Counties operated at an average capacity of 54 percent and 58 percent, respectively. Assuming that 100 percent of the water consumed by in-migrating workers would be disposed of through the wastewater treatment facilities, the project-related population increase in Calvert and St. Mary's Counties would need 126,188 gpd to 220,829 gpd of additional wastewater treatment capacity in Calvert County and 42,681 gpd to 74,692 gpd in St. Mary's County. Currently, Calvert County has approximately 700,000 gpd of excess wastewater treatment capacity, while St. Mary's County has 2.9 million gpd of excess capacity. Residents not serviced by a public sewer district/system rely on septic tanks for wastewater treatment. The review team concludes that the impacts of building Unit 3 on wastewater treatment facilities would be temporary and well below the excess capacity levels of each local wastewater treatment facility.

Police, Fire, and Medical Facilities

A temporary increase in population from the site construction workforce for a new nuclear facility can increase the burden on local fire and police departments, but this increase is temporary. Based on police and fire activity levels shown in Tables 2-18 and 2-19 in Section 2.5.2.6, the expected increase in police and fire services are shown in Table 4-7.

Table 4-7. Expected Increase in Police and Fire Services Related to Proposed Unit 3[(a)]

	Calvert County		St. Mary's County	
	Number	**% Increase**	**Number**	**% Increase**
Police				
Total Calls	2998	≤3.3%	854	≤1%
Violent Crime	11		4	
Property Crime	70		30	
Fire [based on 2006 only]				
Total Calls	794	≤3.3%		
Fire	135			
EMS	577			
Rescue	82			

Note: The baseline numbers above include the projected population by 2015 (Table 2-7) and the average annual police and fire service levels in Tables 2-17 and 2-18. The increase is based upon peak population increases shown in Table 4-5.

The Calvert and St. Mary's County Sheriff's Departments believe that the increase in population due to building Unit 3 would increase the demand for police services, but they would not need additional staffing or equipment (UniStar 2009a). Similarly, representatives of the Calvert and St. Mary's Counties Fire Departments felt there would be additional needs that would be met by the existing level of staff and equipment. Based on the number of healthcare facilities in Calvert and St. Mary's Counties and their capacity and usage as discussed in Section 2.5.2.6, the review team determined local healthcare services could accommodate a similar increase in demand.

Once the project has been completed, many of the construction workers would leave the area, relieving those burdens. During construction and preconstruction activities, the temporary increase in demand for community resources could be mitigated in several ways. First, the more communities that host new workers, the less pressure each individual community would experience on its infrastructure. Consequently, any incentives UniStar can provide its employees to move into the area in an organized manner instead of all at once would mitigate (but not remove) this short-term demand. Next, communities can avoid the long-term commitment to the maintenance and operation of infrastructure purchases to fulfill short-term demand increases. Instead of purchasing new fire or police equipment, affected communities could lease vehicles or building space.

Based on the magnitude of the expected impacts, the response of police and fire department representatives, and the capabilities of the healthcare systems in the two counties, the review team determined that the construction- and preconstruction-related impact on these services would be temporary and not noticeable within each community's anticipated growth.

Social Services

Social services in both counties are provided by the County governments and non-government organizations as described in Section 2.5.2.6. The social services include health, aging, substance abuse, shelter, family services (food, clothing, temporary shelter, and foster care). To the extent UniStar's contractors hire individuals who use the services provided by the Department of Human Resources or nonprofit organizations, building Unit 3 could reduce the burden on some social service providers, such as unemployment offices and income assistance programs. However, new families moving into a community would bring new demand for both state- and privately-provided social services, such as child and family services, substance abuse centers, and legal services. The enhanced employment opportunities created by the multiplier effect during the project may provide some benefits to the disadvantaged population. As the project winds down and direct and indirect jobs are lost, demands on social services may increase. Impacts to social services would be mitigated by tax revenue forecasts discussed in Section 4.4.3.2 from Unit 3 activities. The review team concludes that the impact on social services within any given county in the local area would not be significant.

4.4.4.5 Education

The review team expects the increase in school-age children to reach a peak of approximately 280 to 491 students in Calvert County and 81 to 141 students in St. Mary's County associated with the workforce increase resulting from the construction and preconstruction activities of proposed Unit 3 (Section 4.4.2). This represents an increase in the student population of 1.5 percent to 2.6 percent in Calvert County's public and private schools and 0.4 percent to 0.7 percent in St. Mary's County public and private schools. The remaining school-age children outside of Calvert and St. Mary's Counties would be distributed throughout the remaining counties in the region, but in such limited numbers that they are not considered in this analysis.

The public school districts in both counties are operating at or near capacity. The increase represents the normal/base increase of the school-age population in Calvert County over a period of about 4 years and a normal/base increase of the school-age population in St. Mary's County over a period of about 2 years. The Calvert County Public School District reports that growth will be met by the use of modular classrooms. The tax revenues received by Calvert County would include levies for the public school system to meet needs for special services, teacher recruitment, and modular classrooms. St. Mary's schools would not receive tax revenue for Unit 3. Of greater significance is the pending issue of the potential curtailment of Impact Aid funds to the St. Mary's schools, as discussed in Chapter 2. This would impact the provision of educational services whether or not the proposed Unit 3 is built. The review team concluded the expected impacts to the Calvert County and St. Mary's County Public School systems would be temporary and not beyond levels already anticipated from normal population growth in Calvert and St. Mary's Counties.

4.4.4.6 Summary of Infrastructure and Community Services Impacts

Based on the information provided by UniStar, interviews with staff from County departments and non-governmental social service providers in Calvert and St. Mary's Counties, and the review teams' evaluation, the review team concludes that the impact of construction and preconstruction activities on regional infrastructure and community services, including recreation; housing; water and wastewater facilities; police, fire, and medical facilities; social services; and education would be SMALL and adverse. The estimated peak workforce of 3950 would have a MODERATE temporary and adverse impact on transportation on MD State Route 2/4 next to the plant, and a SMALL and adverse impact elsewhere. These transportation-related impacts could be made more manageable with proper planning and mitigation measures similar to those discussed by UniStar in its TIA analysis. These conclusions are predicated on the specific assumptions about the size, composition, and behavior of the project workforce discussed in detail in Section 4.4.2 of this EIS.

4.4.5 Summary of Socioeconomic Impacts

The review team has assessed the proposed construction and preconstruction activities related to building Unit 3 and the potential socioeconomic impacts in the region. Physical impacts on workers and the general public include impacts on existing buildings, roads, aesthetics, noise levels, and air quality. Social and economic impacts span issues of demographics, economy, taxes, infrastructure, and community services. The review team concludes all physical impacts from construction and preconstruction would be SMALL in the region and in the local area. Based on the above analysis, and because NRC-authorized construction activities represent only a part of the analyzed activities, the NRC staff concludes that the physical impacts of NRC-authorized construction activities would be SMALL, and no mitigation beyond the applicant's commitments would be warranted.

Social and economic impacts span issues of demographics, economy, taxes, infrastructure, and community services. Infrastructure and community services include transportation; recreation; housing; water supply and wastewater facilities; police, fire, and medical facilities; social services; and education. Based on information supplied by UniStar and the review team interviews conducted with public officials in Calvert and St. Mary's Counties, the review team concludes impacts from construction and preconstruction activities on the affected local economies for proposed Unit 3 would be beneficial and SMALL in the 50-mi radius region with two exceptions. The first exception is property tax revenues in Calvert County, which would be beneficial and LARGE, and the second is a potential MODERATE and temporary traffic-related impact on MD State Route 2/4 next to the Calvert Cliffs site, which could be mitigated by the implementation of traffic-related strategies similar to those discussed by UniStar.

Based on the above analysis, and because NRC-authorized construction activities represent only a portion of the analyzed activities, the NRC staff concludes that the impacts of NRC-authorized construction activities on socioeconomics would be SMALL with two exceptions, which are outlined below. The NRC staff also concludes that no further mitigation measures beyond the actions outlined by the applicant in its ER would be warranted.

To determine the portion of the MODERATE and temporary transportation impact attributable to NRC-authorized construction activities, the NRC staff assumes, based on UniStar's characterization of construction-related labor hours (UniStar 2009a), 77 percent of traffic related impacts would be associated with NRC-authorized construction activities. Using this allocation, the NRC staff concludes the transportation impact from Unit 3 NRC-authorized construction activities would be MODERATE and temporary based on the increased traffic on MD State Route 2/4. UniStar may choose to implement traffic mitigation activities noted in Section 4.4.4.1, which would make the traffic impacts more manageable.

To determine the portion of the LARGE beneficial tax impact in Calvert County impact attributable to NRC-authorized construction activities, the NRC staff assumes, based on UniStar's characterization of construction-related labor hours (UniStar 2009a), 77 percent of tax related impacts would be associated with NRC-authorized construction activities. Using this allocation, the NRC staff concludes the tax impact on Calvert County from NRC-authorized construction activities would be beneficial and LARGE based on the significant increase in tax revenues for Calvert County attributable to Unit 3.

4.5 Environmental Justice Impacts

The review team evaluated whether the health or welfare of minority and low-income populations at those census blocks identified in Section 2.6 of this EIS could be disproportionately affected by the potential impacts of building proposed Unit 3 at the Calvert Cliffs site. To perform this assessment, the review team (1) identified all potentially significant pathways for human health, environmental, physical, and socioeconomic effects, (2) determined the impact of each pathway for populations within the identified census blocks, and (3) determined whether or not the characteristics of the pathway or special circumstances of the minority and low-income populations would result in a disproportionate impact on minority or low-income people within each census block. To perform this assessment, the review team followed the methodology described in Section 2.6.1. In the context of construction and pre-construction activities at the Calvert Cliffs site, the review team considered the questions outlined in Section 2.6.1.

As discussed in Section 2.6.3, the review team did not find any evidence of unique characteristics or practices in the region that could lead to a disproportionate impact on any minority or low-income population.

4.5.1 Health Impacts

For all three health-related considerations described in Section 2.6.1, the review team determined through literature searches and consultations with NRC staff health experts that the expected building-related level of environmental emissions is well below the protection levels established by NRC and EPA regulations and cannot impose a disproportionately high and adverse radiological health effect on any identified minority or low-income populations. From the review team's investigation, no project-related potential pathways to adverse health impacts were found to occur in excess of the safe levels stipulated by NRC and EPA health and safety standards. The NRC staff determined that the maximum annual radiological dose rate to construction workers during construction would be approximately 38.8 mrem/yr. This dose is much smaller than the 100 mrem annual dose limit to an individual member of the public (see Section 4.9.5). The NRC staff determined that the offsite dose rate would also be well below regulatory limits and impacts would be small. Furthermore, there are no radiological components from construction or preconstruction activities and, therefore, such activities cannot contribute to a cumulative radiological effect to either workers or to members of nearby communities (the nearest residence to the site is about 3000 ft away). The review team's investigation and outreach did not identify any unique characteristics or practices among any minority or low-income populations that would result in disproportionate adverse impacts on those populations (Secrest, Mussatti, and Scott 2010). Though no migrant farm workers exist near the site, no impacts would be expected on migrant farm worker populations even if they were employed near the Calvert Cliffs site.

As described in Section 4.5.2, the potential environmental and physical effects of construction and preconstruction are generally confined within the site boundaries, leading to no offsite health impacts on any identified population from those effects. Where there are potential offsite non-radiological health effects, the review team did not identify any studies, reports, or anecdotal evidence that would indicate any environmental pathway that would physiologically impact minority or low-income populations differently from other segments of the general population during construction and preconstruction activities. Moreover, the review team's regional outreach provided no indication in either the location or practices of minority and low-income populations in the 50-mi region that suggests they would experience non-radiological impacts any differently than the general population. In addition, the review team determined that the non-radiological health effects of construction and preconstruction activities and other past, present, and reasonably foreseeable future actions that could contribute to cumulative impacts to non-radiological health would be localized and minimal (see Sections 4.8.4 and Section 7.7). The review team's investigation and outreach did not identify any unique charateristics or practices among minority and low-income populations that would result in disproportionate adverse impacts on them (Secrest, Mussatti, and Scott 2010). No impacts would be expected on migrant farm workers if they were to exist near the Unit 3 site.

Any increase in traffic accidents due to heavier traffic is unlikely to have a disproportionate impact on any particular population subgroup in the 50-mile region or Calvert County. The roads nearest the plant would be more crowded and more traffic accidents may occur, but these increases are likely to be located on the principal commuting routes, which are not located in communities with disproportionately large minority or low-income populations. There is no information to suggest that nearby minority or low-income communities would be disproportionately vulnerable to hazards while on the road. Finally, as discussed in Section 2.6.2 of this EIS, the review team did not identify any evidence of unique characteristics or practices in any minority or low-income population that may result in different non-radiological health impacts compared to the general population. Therefore, non-radiological health effects would not have a disproportionate impact on minority or low-income populations.

4.5.2 Physical and Environmental Impacts

Building a nuclear power plant is similar in environmental effects to building any large-scale industrial project. For the three environmental considerations identified in Section 2.6.1, the review team determined that the physical impacts from onsite construction and preconstruction activities at the proposed Unit 3 would attenuate rapidly with distance. In addition, the review team did not find any evidence of unique characteristics or practices among any minority or low-income populations of interest and expect there would be no disproportionately high and adverse physical or environmental impact on any minority or low-income population. There are four primary exposure media in the environment: soil, water, air, and noise. The following four subsections discuss each of these pathways in greater detail.

4.5.2.1 Soil

Construction and preconstruction activities on the Calvert Cliffs site represent the largest source of soil-related environmental impacts. Soil disturbance activities are localized to the site, are sufficiently distant from surrounding populations, and have little migratory ability, resulting in no noticeable offsite impacts. Soil migration will be prevented by adherence to regulations and permits and the use of BMPs. In addition, the site is well defined, access is restricted, and no minority or low-income communities or individuals would be relocated (UniStar 2009a). As discussed in Section 2.6 of this EIS, the staff did not identify any evidence of unique characteristics or practices in the minority or low-income populations that may result in different soil-related impacts compared to the general population. The review team concludes soil-related environmental impacts during the building of Unit 3 would pose no disproportionate and adverse impact on any minority or low-income populations within the 50-mi region.

4.5.2.2 Water

Surface water from the Chesapeake Bay would not be used for construction and preconstruction activities. Instead, UniStar would use groundwater from one or two new Aquia aquifer wells to be installed. Any necessary dewatering of the excavation would be localized and temporary and would impact only the Surficial Aquifer. Both surface water and groundwater impacts have been evaluated as SMALL (see Section 4.2.2). Water-related environmental impacts from erosion-related degradation of surface water and the introduction of anthropogenic substances into surface and groundwater would occur but would be mitigated through adherence to permit requirements and BMPs. Impacts to the shoreline waters may result from increased water turbidity during dredging activities and would also be minimized through adherence to permit requirements and BMPs.

Increased water turbidity from construction and preconstruction activities could temporarily disturb any subsistence catch rates at the Calvert Cliffs site shoreline where impacts would occur. As discussed in Section 2.6.3, the review team has indentified subsistence fishing practices within the 50-mi region, however, none near the Calvert Cliffs shoreline. Consequently, the water-related impacts of the proposed action would be of limited magnitude, localized, and temporary. Given the distance between the location of these effects and the locations of identified minority and low-income populations, the review team determined the potential negative offsite environmental effects from impacts to water sources would be minimal, and there would be no water-related disproportionate or adverse impacts on minority and low-income populations.

4.5.2.3 Air

Air emissions are expected from increased vehicle traffic, construction equipment, and fugitive dust from construction and preconstruction activities. Emissions from vehicles and construction equipment are unavoidable, but would be localized, minor, and not disproportionately located in the vicinity of identified minority and low-income populations. As discussed in Section 2.6, the review team did not identify any evidence of unique characteristics or practices in the minority and low-income populations that may result in different air quality-related impacts compared to the general population. Emissions from fugitive dust would be localized within the site boundary, and dust control measures would be implemented to maintain compliance with national ambient air quality standards. Therefore, the review team determined the negative environmental effects from construction-related reductions in air quality would be small, localized, short-lived and would affect all populations in the same proportion. Therefore, the review team determined the negative environmental effects from construction- and preconstruction-related reductions in air quality would be minor, localized, and short-lived for any population in the vicinity. Consequently, the review team found no disproportionate and adverse impacts on minority and low-income populations because of changes in air quality.

4.5.2.4 Noise

In addition to the findings in Section 4.8 that noise impacts from construction and preconstruction activities are temporary in nature, the distance between the site and minority and low-income populations is large. In addition, with the interposing terrain and other characteristics of the Calvert Cliffs site, noise impacts are lessened. As discussed in Section 2.6 of this EIS, the review team did not identify any evidence of unique characteristics or practices in the minority and low-income populations that may result in different noise-related impacts compared to the general population, so there would be no disproportionate or adverse impact on minority or low-income populations.

4.5.2.5 Summary of Physical and Environmental Impacts

Based on information provided by UniStar and the review team's independent review, the review team found no pathways from soil, water, air, and noise that would lead to disproportionate and adverse impacts on minority or low-income populations.

4.5.3 Socioeconomic Impacts

Socioeconomic impacts in Section 4.4 were reviewed to evaluate if there would be any construction and preconstruction-related activities that could have a disproportionate effect on minority or low-income populations. Calvert and St. Mary's Counties have sufficient housing available and have experienced levels of growth such that in-migrating workers would not have a significant impact on housing prices or availability. The review team expects that traffic would increase significantly along MD 2/4 and transportation impacts would be MODERATE. While there likely would be adverse impacts on traffic, the review team did not identify any unique characteristics or practices in the low-income and minority populations that would cause a disproportionate impact.

As discussed in Section 2.6, there are no minority and low-income block groups in the vicinity of the Calvert Cliffs site. The review team expects that all other potential adverse socioeconomic impacts from construction and preconstruction-related activities for Unit 3 would not affect the low-income and minority populations in the region disproportionately because there are no unique characteristics or practices among those communities that would be affected by socioeconomic impact pathways. Consequently, the review team found no disproportionate and adverse impacts on minority and low-income populations because of changes in socioeconomic conditions.

4.5.4 Subsistence and Special Conditions

NRC's environmental justice methodology includes an assessment of populations of particular interest or unusual circumstances, such as minority communities exceptionally dependent on subsistence resources or identifiable in compact locations, such as Native American settlements.

4.5.4.1 Subsistence

As discussed in Section 2.6.1, access to the Calvert Cliffs site is restricted, which reduces any impact on plant gathering, hunting, and fishing activities at the site. Both UniStar and the NRC review team interviewed community leaders in Calvert and St. Mary's Counties in regard to subsistence practices and no such practices were found in the two counties. Though there is documented subsistence fishing on parts of the Chesapeake Bay, these areas are not in the vicinity of the Calvert Cliffs site. Also documented in the study is that minorities and low-income people are more prone to fish from the shoreline than other demographic groups. Consequently, because access is restricted to the shoreline near proposed Unit 3 where impacts would occur, the review team expects there would be no disproportionate adverse impacts on minority and low-income populations. The review team determined there were no construction- and preconstruction-related disproportionate and adverse impacts on minority or low-income populations related to subsistence.

4.5.4.2 High-Density Communities

Based on the analysis in Section 2.6, the minority and low-income populations are sparsely scattered throughout Calvert and St. Mary's Counties. Although there are several towns near the Calvert Cliffs site, there are not any block groups with a significant minority population and no low-income block groups. St. Mary's County has one census block group with aggregate minority populations, one African American census block group, and only one low-income block group. These settlement patterns were confirmed for the review team through a series of interviews with minority leaders and social service agency representatives in Calvert and St. Mary's Counties. Based on information provided by UniStar and the review team's independent review, the review team found no impact pathways from subsistence practices or to high-density communities. Consequently, the review team found no disproportionate and adverse impacts on minority and low-income populations because of affects on high-density communities.

4.5.5 Summary of Environmental Justice Impacts

The review team has evaluated the proposed construction and preconstruction activities related to building proposed Units 3 and the potential environmental justice impacts in the vicinity and region. The review team determined there are no environmental pathways by which the identified minority or low-income populations in the 50-mi region would be likely to suffer disproportionate and adverse environmental or health impacts as a result of construction and preconstruction activities; therefore, environmental justice impacts would be SMALL, and no additional mitigation would be warranted beyond which UniStar has outlined in its ER. Based on the above analysis, and because NRC-authorized construction activities represent only a portion of the analyzed activities, the NRC staff concludes there are no environmental pathways by which the identified minority or low-income populations in the 50-mi region would be likely to suffer disproportionate and adverse environmental or health impacts as a result of the NRC-authorized construction activities. Therefore, environmental justice impacts would be SMALL.

4.6 Historic and Cultural Resources

The National Environmental Policy Act of 1969, as amended (NEPA) requires Federal agencies to take into account the potential effects of their undertakings on the cultural environment, which includes archaeological sites, historic buildings, and traditional places important to local populations. The National Historic Preservation Act of 1966, as amended (NHPA), also requires Federal agencies to consider impacts to those resources if they are eligible for listing on the National Register of Historic Places (NRHP) (such resources are referred to as "Historic Properties" in NHPA). As outlined in 36 CFR 800.8, "Coordination with the National Environmental Policy Act of 1969," the NRC coordinated compliance with Section 106 of the NHPA in meeting the requirements of NEPA.

Building, operation, and decommissioning of new power units can affect either known or undiscovered cultural resources. Therefore, in accordance with the provisions of NHPA and NEPA, the review team must make a reasonable and good faith effort to identify historic properties in the Area of Potential Effects (APE) and, if present, determine if any significant impacts are likely to occur. Identification is to occur in consultation with the State Historic Preservation Officer (SHPO), American Indian Tribes, interested parties, and the public. If significant impacts are possible, efforts should be made to mitigate them. As part of the NEPA/NHPA integration, if no historic properties (i.e., places eligible for listing on the NRHP) are present or affected, the NRC staff must notify the SHPO before proceeding. If it is determined that historic properties are present, the NRC is required to assess and resolve adverse effects of the undertaking.

For specific historic and cultural resource information on the Calvert Cliffs site, see Section 2.7. As explained in Section 2.7, previous cultural resource identification efforts indicated the presence of 17 archaeological sites, one of which is eligible for listing in the NRHP under criteria D (18CV474). Five architectural resources were also identified, four of which are considered eligible for the NRHP listing under criteria A or A and C.

Having received Phase I and Phase II archaeological investigations of the proposed area to be disturbed, the Maryland Historical Trust (MHT) wrote to the Corps on February 13, 2009, with its review of the Phase II cultural investigations (MHT 2009). Based on information in the Phase II cultural investigations report, the MHT concurred with the recommendation of GAI Consultants, Inc. (GAI) that sites 18CV481, 18CV482, and 18CV480 do not meet the criteria for eligibility in the National Register given their loss of integrity and inability to yield additional information.

Archaeological site 18CV474 has retained much of its integrity and has the potential to yield significant information regarding domestic agricultural sites in nineteenth century southern Maryland. UniStar and GAI have recommended site 18CV474 as eligible for listing in the National Register under Criterion D, and, if possible, the site should be preserved in place. The MHT concurred with UniStar and GAI that site 18CV474 is eligible for inclusion in the National Register (MHT 2009).

In its letter dated, February 13, 2009, the MHT stated "the expansion of Calvert Cliffs Nuclear Power Plant, as currently proposed, would result in the destruction of site 18CV474 and would constitute an adverse effect on this significant archaeological resource." The MHT recommended that the Corps and UniStar continue to coordinate with the Trust on ways to avoid or mitigate the adverse effect. If site avoidance is not possible, UniStar would need to provide the Trust with documentation detailing the constraints and providing justification as to why site 18CV474 cannot be avoided during project activities. If site avoidance is not possible, the SHPO indicated that Phase III data recovery investigations would be warranted to mitigate the undertaking's adverse effect on the archaeological property (MHT 2009). The parties (Corps, SHPO and UniStar) would then need to execute the Memorandum of Agreement (MOA) that stipulates the agreed-upon mitigation measures, including the Phase III investigations, methods of public outreach and interpretation, and the curation of all artifacts and materials generated by the investigations conducted at site 18CV474 (USACE 2010).

The MHT reviewed the recommendations in the Phase II report for the historic built environment. In its letter dated February 13, 2009, the Trust concluded that the proposed power plant would not adversely affect Parran's Park (CT-58) or Preston's Cliffs (CT-59). The report also finds that the proposed work would require the alteration and demolition of portions of the Drum Point Railroad Bed (CT-1295) and Camp Conoy (CT-1312). The Trust agrees that these changes would constitute an adverse effect to historical properties CT-1295 and CT-1312 (MHT 2009).

In a letter dated May 22, 2009, UniStar provided a draft mitigation summary for NRHP eligible historical properties, and on June 25, 2009, draft mitigation plans for Camp Conoy (CT-1312) and the Baltimore & Drum Point Railroad (CT-1295) were submitted to the Corps and the MHT. Mitigation of adverse effects in the draft mitigation summary for CT-1312 consisted of archival research, fieldwork that will contain a site plan map, measured drawings of each of Camp Conoy's contributing buildings, and photographic and written documentation of the contributing buildings, as well as the preparation of a separate reader-friendly report and public outreach. Mitigation of adverse effects in the draft mitigation summary for CT-1295 consisted of archival research and fieldwork that will contain topographic surveys of the rail bed within the project APE, measured drawings of the rail bed, and photographic and written documentation, as well as the preparation of a separate reader-friendly report and public outreach.

On July 8, 2009, UniStar submitted the Data Recovery Plan for Site 18CV474. The data recovery study will include archival research, archaeological fieldwork that will consist of metal detector survey, site contour mapping, recordation of the house foundation, unit excavations, and mechanical and/or hand-stripping of excavation blocks, as well as preparing the Phase II data recovery technical report and a public outreach component such as public speaking and/or artifact exhibits.

In September 2009, the MHT drafted a MOA among the U.S. Army Corps of Engineers, the Maryland State Historic Preservation Officer and UniStar Nuclear Development, LLC, Pursuant to 36 CFR 800 and 33 CFR Part 325 Appendix C regarding the Calvert Cliffs Nuclear Power Plant, Calvert County, Maryland (MHT 2009). The MOA stipulates the mitigation requirements for the CCNPP Unit 3 expansion project. The Maryland SHPO specifically stated that for historic buildings/structures, mitigation measures may include use of vegetative buffers to minimize visual effects, moving, rather than demolishing, historic buildings, or study, survey, and repair of historic resources that are similar to those that must be demolished. For archaeological sites, mitigation measures stipulated in the MOA include Phase III (data recovery) investigations, methods of public outreach and interpretation, and the curation of all artifacts and materials generated by the investigation. The Corps will verify that UniStar implements the measures in order to mitigate the project's adverse effects on archaeological site 18CV474, the Drum Point Railroad Bed (CT-1295), and Camp Conoy (CT-1312) in accordance with the time frames and stipulations established in the MOA. The MOA was signed by the Corps, UniStar and MHT on March 16, 2010 (USACE 2010).

The MHT reviewed UniStar's plans for a proposed outfall pipe related to Unit 3 and concurred that the proposed outfall pipe project is unlikely to impact any significant cultural resources. The MHT believes that the portion of the CCNPP that includes the proposed outfall pipe possesses no archaeological research potential, and further archaeological investigations are not warranted for Section 106 purposes (MHT 2009).

4.6.1 Summary of Impacts to Historic and Cultural Resources

For the purposes of NHPA Section 106 consultation (36 CFR Section 800), based on (1) the measures that UniStar would take to avoid adverse impacts to significant cultural resources during construction and preconstruction activities, (2) the review team's cultural resource analysis and consultation, and (3) UniStar's commitment to follow its procedures should ground-disturbing activities discover cultural or historic resources, the review team concludes a finding of historic properties are affected, and mitigation is required to resolve adverse effects. Unit 3 building activities would adversely affect three National Register listed/eligible historic properties including two historic buildings/structures (Baltimore & Drum Point Railroad (CT-1259) and Camp Conoy (CT-1312)) and one archaeological site (18CV474). The SHPO requested a MOA be prepared between UniStar, the Corps, and the Maryland SHPO that stipulates agreed-upon mitigation measures appropriate to each property (MHT 2009) and that MOA was signed on March 16, 2010 (USACE 2010) by the Corps, Unistar, and MHT.

The process of clearing and excavating the site for the proposed Unit 3 would demolish historic and archaeological resources, which would adversely affect the intrinsic attributes that contribute to their cultural significance and eligibility for the NRHP as significant historic properties, rendering them ineligible for listing. However, even though the resources would be adversely affected, the process identified in the MOA would ensure that the adverse impacts would be mitigated through data recovery investigations and documentation of artifacts and other archaeological data recovered from site 18CV474 and appropriate archival research, mapping, and photographic documentation of the significant architectural resources at Camp Conoy and the Baltimore & Drum Point Railroad. The MOA defines the appropriate mitigation for each historic property based on the unique attributes that contribute to that property's NRHP eligibility. Preconstruction activities would have adverse impacts on Baltimore & Drum Point Railroad and Camp Conoy, and 18CV474.

For the purposes of NHPA 106 consultation, based on the loss of three eligible NRHP properties within the APE and the Corps' cultural resource analysis and consultation, the Corps' concludes with a finding of historic properties adversely affected (36 CFR Section 800.5(d)(2)). For the purposes of NHPA 106 consultation pursuant to 36 CFR 800.8, the NRC concludes with a finding of historic properties adversely affected based on the loss of archaeological site 18CV474 within the APE from construction activites.

To ensure it meets its obligation to comply with NHPA through the NEPA process as described in 36 CFR 800.8, the NRC staff has reviewed the mitigation plans identified in the MOA, particularly the Data Recovery Plan for the 18CV474 site, and determined that no additional mitigation is necessary beyond the conditions of the MOA signed by the Corps, MHT, and UniStar (USACE 2010). In the event of that an unanticipated discovery is made, site personnel would be instructed to notify NRC and consult with the Corps and MHT in conducting an assessment of the discovery to determine if additional coordination is warranted (USACE 2010).

For the purposes of the review team's NEPA analysis, based on information provided by UniStar, and the review team's independent evaluation, the review team concludes that the impacts from the construction and preconstruction activities of proposed Unit 3 to cultural resources at the Calvert Cliffs site and vicinity would be LARGE because the work associated with the proposed project would have an adverse effect on Baltimore & Drum Point Railroad

(CT-1259) by demolition, Camp Conoy (CT-1312) by destruction of contributing buildings, and archaeological site 18CV474 by destruction.

The NRC staff concludes that almost all the impact on cultural resources would be the result of preconstruction activities. Based on the this information, the NRC staff concludes that the cultural resources impacts of NRC-authorized construction would be SMALL. The impacts on historic and cultural resources will be discussed by the NRC staff in the cumulative impacts analysis in Chapter 7 of this EIS.

4.7 Meteorological and Air Quality Impacts

Section 2.9 describes the meteorological characteristics and air quality of the Calvert Cliffs site. The primary impacts of building a new unit on local meteorology and air quality would be from dust from land-clearing and building activities, open burning, emissions from equipment and machinery, concrete batch plant operations, and emissions from vehicles used to transport workers and materials to and from the site.

UniStar includes a brief discussion of the impacts of construction of proposed Unit 3 on air quality in the ER (UniStar 2009a). A more extensive discussion of the impacts of construction on air quality was provided in its submission to the Maryland DNR in support of the application for a CPCN (UniStar 2008c), which is required before UniStar can start construction. In response to the CPCN application, the Maryland PPRP conducted an extensive review for Maryland DNR of the UniStar submittal (MDNR PPRP 2008). The review team's review of the impacts of construction of proposed Unit 3 draws from the UniStar submittal and the PPRP draft review of that submittal, as well as from the ER.

4.7.1 Construction and Preconstruction Activities

The UniStar submittal to Maryland DNR (UniStar 2008c) includes a listing of activities and equipment used in building the plant by construction year. From this listing, UniStar estimates equipment emissions for the year of maximum emissions. The PPRP reviewed the UniStar activity and equipment usage estimates and performed an independent assessment of the emissions using current EPA emissions factors and models. The second year of the project is expected to result in the most emissions.

Table 4-8 lists the PPRP estimates of annual emissions for criteria pollutants during the second year of the project period. The PPRP emissions estimates are consistent with the emissions estimated by UniStar. The PPRP concluded that the sum of air quality monitoring data and modeling of projected emissions did not show any exceedance of National Ambient Air Quality Standards (MDNR PPRP 2008). The review team has reviewed both the UniStar and PPRP emissions estimates and concludes that the estimates are reasonable for the purposes of the environmental review.

Table 4-8. Worst Year (Year Two) Annual Construction Emissions (Tons/yr)

Source	Total PM[a]	PM_{10}[b]	$PM_{2.5}$[c]	NO_x[d]	CO[e]	VOC[f]	SO_2[g]
Construction Vehicles	4.9	4.9	4.9	165.3	54.9	12.3	6.6
Vehicle Travel–Unpaved and Paved Roads	59.3	14.6	1.5				
Disturbed Earth Movement	10.9	5.2	1.5				
Wind Erosion	6.6	6.6	6.6				
Aggregate Movement	0.3	0.2					
Concrete Batch Plant	2.3	1.4					
Total	84.3	32.8	16.1	165.3	54.9	12.3	6.6

(a) particulate matter
(b) particulate matter less than 10 microns in diameter
(c) particulate matter less than 2.5 microns in diameter
(d) oxides of nitrogen
(e) carbon monoxide
(f) volatile organic compounds
(g) sulfur dioxide

In making the emissions estimates, UniStar and the PPRP assumed that a number of measures would be taken to minimize emissions. These measures include:

- Using gravel to stabilize construction roads, parking lots, and laydown areas
- Applying water to unpaved and exposed areas daily
- Using a high-efficiency baghouse or equivalent technology at the concrete batch plant
- Using equipment with EPA-compliant diesel engines.

Emissions associated with building Unit 3 would be similar to emissions associated with any large building project. The emissions include dust from a variety of activities, emissions from equipment, emissions from painting and similar operations, and emissions from workers' vehicles. These emissions and any potential impact from them are generally localized and temporary. Section 4.4.1.3 of the ER (UniStar 2009a) discusses measures that UniStar intends to implement to mitigate the impacts of construction on air quality. These measures include compliance with air quality control regulations, emissions monitoring, dust control programs, and routine vehicle inspection and maintenance programs. In addition, the CPCN issued by the Maryland PSC contains general air quality requirements related to construction.

Preoperational activities will also result in greenhouse gas emissions, principally carbon dioxide (CO_2). Assuming a 7-year construction period and typical construction practices, the review team estimates that the total construction equipment CO_2 emission footprint for building one nuclear power plant at the Calvert Cliffs site would be of the order of 35,000 metric tons, as compared to a total United States annual CO_2 emission rate of 6,000,000,000 metric tons (EPA 2009). Appendix L provides the details of the review team estimate for a reference 1000 MW(e) nuclear power plant. Based on its assessment of the relatively small construction equipment carbon footprint as compared to the United States annual CO_2 emissions, the review team concludes that the atmospheric impacts of greenhouse gases from construction and preconstruction activities would not be noticeable, and additional mitigation would not be warranted.

In general, emissions from construction and preconstruction activities (including greenhouse gases) would vary based on the level and duration of a specific activity, but the overall impact is expected to be temporary and limited in magnitude. Considering the information provided by UniStar, the analysis of potential impacts of proposed Unit 3 conducted by Maryland DNR's PPRP, and measures that UniStar intends to implement to mitigate the impacts of construction on air quality, the review team concludes that the impacts from Unit 3 construction and preconstruction activities on air quality would not be noticeable because appropriate mitigation measures would be adopted.

4.7.2 Transportation

In the ER, UniStar (2009a) estimates the maximum construction workforce for proposed Unit 3 would be about 3950 workers during the peak 12-month period, which would occur at the end of the fourth year and beginning of the fifth year of construction. Combined with the workers for existing Units 1 and 2 and outage workers, the total work force onsite could temporarily reach a maximum of about 5800 workers. While many of these workers would be doing shift work, there would be a significant increase in traffic during this period.

The primary access roads to the Calvert Cliffs site would be likely to experience a significant increase in traffic during shift changes that could lead to periods of congestion. Stopped vehicles with idling engines would lead to increased emissions beyond what would occur from normal vehicle operation alone. However, the overall impact caused by increased traffic volume and congestion is difficult to estimate because timing of construction activities, shifts, and exact worker residence locations is largely unknown.

UniStar (2009a) has proposed several measures, such as installing new site perimeter and access roads, conducting a traffic impact assessment (TIA), and developing a traffic management plan to limit the adverse impacts of increased traffic due to construction. Additional measures that are typically used to reduce traffic include encouraging car pools, establishing central parking and shuttling services to and from the construction site, and staggering shift changes for operating personnel, outage workers, and construction workers.

Construction workforce transportation will also result in greenhouse gas emissions, principally carbon dioxide (CO_2). Assuming a 7-year construction period and a typical workforce, the review team estimates that the total construction workforce CO_2 emission footprint for building one nuclear power plant at the Calvert Cliffs site would be of the order of 150,000 metric tons; again, this is compared to a total United States annual CO_2 emission rate of 6,000,000,000 metric tons (EPA 2009). Appendix L provides the details of the review team estimate for a reference 1000 MW(e) nuclear power plant. Based on its assessment of the relatively small construction workforce carbon footprint as compared to the United States annual CO_2 emissions, the review team concludes that the atmospheric impacts of greenhouse gases from construction workforce transportation would not be noticeable, and additional mitigation would not be warranted.Based on UniStar's proposed mitigation measures, including conducting a TIA and developing a traffic management plan and other measures that are available to reduce traffic; the results of the PPRP analysis of the air quality impacts of Unit 3 construction; and the review team's evaluation, the review team concludes that the impact on the local air quality (and greenhouse gas emissions) from the increase in vehicular traffic related to construction and preconstruction activities would be temporary and would not be noticeable because appropriate mitigation measures would be adopted.

4.7.3 Summary of Meteorological and Air Quality Impacts

The review team evaluated potential impacts on air quality associated with criteria pollutants and greenhouse gas emissions during Unit 3 site development activities. The review team determined that the impacts would be minimal. On this basis, the review team concludes that the impacts of Unit 3 site development on air quality from emissions of criteria pollutants and CO_2 emissions would be SMALL. Because NRC-authorized construction activities represent only a portion of the analyzed activities, the NRC staff concludes that the air quality impacts of NRC-authorized construction activities would also be SMALL. Notwithstanding these SMALL impacts to air quality, the NRC staff will perform a Clean Air Act Section 176 air conformity applicability analysis pursuant to 40 CFR Part 93, Subpart B, to determine whether additional mitigation may be warranted.

4.8 Nonradiological Health Impacts

Nonradiological health impacts to the public and workers from construction and preconstruction activities include exposure to dust and vehicle exhaust, occupational injuries, and noise, as well as the transport of materials and personnel to and from the site. The area around the proposed Unit 3 site is predominantly rural with a large tourism base and a population of approximately 41,000 people within 10 mi of the site (UniStar 2009a). The nearest accessible area is approximately 1 mi from the site preparation and development area for proposed Unit 3, and the nearest residence is approximately 1.1 mi from existing Units 1 and 2 (Constellation 2007). The land surrounding the Calvert Cliffs site is zoned residential, rural community, farm, and forest, as well as commercial and light industrial depending on the direction. The Chesapeake Bay is adjacent to the site to the east (UniStar 2009a). People who are vulnerable to nonradiological health impacts from construction and preconstruction activities include construction workers and personnel working at the proposed Unit 3 site; people working or living in the vicinity or adjacent to the site; and transient populations in the vicinity (i.e., temporary employees, recreational visitors, tourists).

4.8.1 Public and Occupational Health

This section discusses the impacts of building proposed Unit 3 on public nonradiological health and the impacts from site preparation and development on worker nonradiological health. Section 2.10 provides background information on the affected environment and nonradiological health at and within the vicinity of the proposed Unit 3 site.

4.8.1.1 Public Health

UniStar stated in its ER that the physical impacts to the public from development activities at the Calvert Cliffs site would include inhalation of dust and vehicle exhaust as sources of air pollution during site preparation (UniStar 2009a). Operational controls would be imposed to mitigate fugitive dust emissions, such as stabilizing roads and spoils piles, periodically watering unpaved roads, and re-vegetating road medians and slopes (UniStar 2009a).

Engine exhaust would be minimized by maintaining fuel-burning equipment in good mechanical order. UniStar (2009a) stated that applicable Federal, State, and local emission requirements would be followed to as they relate to open burning or the operation of fuel-burning equipment. The appropriate Federal, State, and local permits and operating certificates would be obtained as required.

There would be no general public access to the proposed Unit 3 site, and as discussed in Section 2.10, the nearest residence is approximately 3000 ft from the site (UniStar 2008a). Given the fugitive dust suppression and vehicle exhaust emission mitigation measures discussed above and the general public's distance away from the site, the review team expects that the impacts to nonradiological public health from construction and preconstruction activities would be negligible.

4.8.1.2 Construction Worker Health

As discussed in Section 2.10, human health risks for construction workers and personnel working onsite to build the proposed unit and associated onsite transmission lines are expected to be dominated by occupational injuries (e.g., falls, electrocution, asphyxiation) to workers engaged in activities such as building, maintenance, and excavation. Historically, actual injury and fatality rates at nuclear reactor facilities have been lower than the average U.S. industrial rates.

According to the U.S. Bureau of Labor Statistics (USBLS 2007), injury rates drop significantly for large building projects such as nuclear power facilities. The reports take into account occupational injuries and illnesses as total recordable cases, which include those cases that result in death, loss of consciousness, days away from work, restricted work activity or job transfer, or medical treatment beyond first aid. The review team estimated the annual number of recordable cases based on U.S. recordable rates for the years 2003 to 2007, the overall injury-only rate for utility construction (the number of injuries and illnesses per 100 full-time workers) ranged from 4.6 to 6.7 compared to 1.2 to 3.0 for similar projects with 1000 or more workers (USBLS 2008a, b). UniStar (2009a) reports that the average construction workforce for Unit 3 would be approximately 3000 workers during a 86-month period with a peak workforce of approximately 4000. Based on this assessment, an estimated 200 occupational illnesses or injuries could occur each year.

Occupational injury and fatality risks are reduced by strict adherence to NRC and OSHA safety standards, practices, and procedures. Appropriate State and local statutes also must be considered when assessing the occupational hazards and health risks associated with building. The review team expects that UniStar would fully adhere to NRC, OSHA, and State safety standards, practices, and procedures during any activities related to site preparation/excavation or building the proposed facility. UniStar states that a safety and medical program will be provided for workers, and all contractors and site staff must comply with site safety, fire, radiation, security policies, procedures, safe work practices, and State and Federal regulations (UniStar 2009a). These actions would help minimize or prevent injury, illness, and death.

Other nonradiological impacts to workers who are clearing land or building the facility discussed in this section include noise, fugitive dust, and gaseous emissions resulting from site preparation and development activities. Operational controls and practices discussed in the previous section are mitigation measures that also reduce impacts to worker health. Onsite impacts to workers would be mitigated through training and use of personal protective equipment to minimize the risk of potentially harmful exposures. Emergency first-aid care and regular health and safety monitoring of personnel also could be undertaken.

4.8.1.3 Summary of Public and Construction Worker Health Impacts

Based on mitigation measures identified by UniStar in its ER, adherence to permits and authorizations required by State and local agencies, and the review team's independent evaluation, the review team concludes that the nonradiological health impacts to the public and to workers would be minimal, and no further mitigation would be warranted.

4.8.2 Noise Impacts

Development of a nuclear power plant is similar to other large industrial projects and it involves many noise-generating activities. Regulations governing noise from activities are generally limited to worker health. Federal regulations governing construction noise are found in 29 CFR Part 1910 and 40 CFR Part 204. The regulations in 29 CFR Part 1910 address noise exposure in the construction environment, and the regulations in 40 CFR Part 204 generally govern the noise levels of compressors. The State of Maryland's noise regulations govern the time periods when noises can occur and the vibration intensity beyond the site preparation and development site boundaries (COMAR 2007). Calvert County does not have specific noise regulations.

The ER (UniStar 2009a) indicates that activities associated with development of proposed Unit 3 at the Calvert Cliffs site would have peak noise levels in the 93- to 108-dBA range. A 10-dBA decrease in noise level is generally perceived as cutting the volume in half. At a distance of 50 ft from the source, these peak noise levels would generally decrease to the 73- to 102-dBA range and, at distance of 3000 ft, the noise levels would generally be in the 38- to 67-dBA range. UniStar notes that the nearest resident lives about 3000 ft from the construction footprint (UniStar 2008a). For context, Tipler (1982) lists the sound intensity of a quiet office as 50 dBA, normal conversation as 60 dBA, busy traffic as 70 dBA, and a noisy office with machines or an average factory as 80 dBA. Construction noise (at 10 ft) is listed as 110 dBA, and the pain threshold is 120 dBA.

Site preparation and development activities would be expected to take place 24 hours per day, 7 days per week during peak building periods. UniStar has stated that it will comply with Federal and State regulations. In addition, the ER (UniStar 2009a) lists a number of measures and good practices that could be taken to reduce potential adverse effects of noise. Among the measures are use of hearing protection, inspection and maintenance of equipment, noise limiting devices on vehicles and equipment, shielding high noise sources near their origin, restriction of noise-related activities to daylight hours, and restriction of delivery times to daylight hours.

According to NUREG-1437 (NRC 1996, 1999)[a], noise levels below 60 to 65 dBA are considered to be of small significance. As discussed in Section 2.10, it is unlikely that noise levels would be greater than 60 dBA at the nearest residence. More recently, the impacts of noise were considered in NUREG-0586, Supplement 1 (NRC 2002). The criterion for assessing the level of significance was not expressed in terms of sound levels, but was based on the effect of noise on human activities and on threatened and endangered species. The criterion in NUREG-0586, Supplement 1 (NRC 2002), is stated as follows:

> The noise impacts of decommissioning ... are considered detectable if sound levels are sufficiently high to disrupt normal human activities on a regular basis. The noise impacts ...
>
> are considered destabilizing if sound levels are sufficiently high that the affected area is essentially unsuitable for normal human activities, or if the behavior or breeding of a threatened and endangered species is affected.

Based on the temporary nature of peak construction activities, good noise control practices, limiting of most noise-producing activities to daylight hours, the location and characteristics (terrain and vegetation) of the Calvert Cliffs site that provide sound attenuation, and the distance

(a) NUREG-1437 was originally issued in 1996. Addendum 1 to NUREG-1437 was issued in 1999. Hereafter, all references to NUREG-1437 include NUREG-1437 and its Addendum 1.

to the nearest residence, the review team concludes that the noise impacts from building proposed Unit 3 would be minimal, and no further mitigation would be warranted.

4.8.3 Transporting Construction Materials and Personnel to the Proposed Site

This EIS assesses the impact of transporting workers and construction materials to and from the proposed Unit 3 site from the perspective of three areas of impact: the socioeconomic impacts, the air quality impacts of fugitive dust and particulate matter emitted by vehicle traffic, and the potential health impacts due to additional traffic-related accidents. The human health impacts are addressed in this section, while the socioeconomic impacts are addressed in Section 4.4.1, and the air quality impacts are addressed in Section 4.7.2.

The general approach used to calculate nonradiological impacts of fuel and waste shipments is the same as that used for transportation of construction materials and construction personnel to and from the proposed Unit 3 site. The assumptions made to provide reasonable estimates of the parameters needed to calculate nonradiological impacts are discussed below.

UniStar estimated that building a new 1300-MW unit requires up to 182,900 yd^3 of concrete 20,500 tons of structural steel and rebar; 6.5 million linear ft of cable: and 275,000 linear ft of piping (UniStar 2009a). These quantities were used to estimate the nonradiological impacts of shipping the necessary materials to the proposed Unit 3 site. Additional information needed to develop the nonradiological impact estimates are as follows:

- The review team assumed that shipment capacities are approximately 13 yd^3 of concrete per shipment, 11 tons of structural steel, and 3300 linear ft of piping and cable per shipment. It was assumed that these materials would be transported to the site in a levelized manner over a 6-year period based on the schedule outlined in the ER (UniStar 2009a).
- The applicant estimated the number of workers to peak at 3950 (UniStar 2009a). This value represents the peak workforce for the single unit. At an average of 1.8 persons per vehicle, consistent with assumed vehicle occupancies used in a previous site evaluation (NRC 2008), there would be about 2200 vehicles per day. Each person was assumed to travel to and from the proposed Unit 3 site 250 days per year.
- Average shipping distances for building materials were assumed by the review team to be 50 mi one way based on the region of influence. The average commute distance for construction workers was assumed by the review team to be 20 mi one way. This is based on U.S. DOT data that estimates the typical commute distance is 16 mi. (DOT 2003).
- The review team assumed the average shipping distance for construction materials to be 50 mi one way, and the average commuting distance for construction workers to be 20 mi one way.

- Accident, injury, and fatality rates for transporting building materials were taken from Table 4 in ANL/ESD/TM-150 *State-level Accident Rates for Surface Freight Transportation: A Reexamination* (Saricks and Tompkins 1999). Rates for the State of Maryland were used for material shipments, typically conducted in heavy-combination trucks. The data provided in Saricks and Tompkins (1999) are representative of heavy-truck accident rates and do not specifically address the impacts associated with commuter traffic (i.e., workers traveling to and from the site). However, a single source that provided all three rates to estimate the impacts from worker transportation to/from the site was not available. To develop representative commuter traffic impacts, data from the U.S. Department of Transportation (DOT) (DOT 2008a) was accessed to provide a Maryland-specific fatality rate for all traffic from 2001 through 2006. This average fatality rate was used as the base for estimating Maryland-specific injury and accident rates. Adjustment factors were developed using national-level traffic accident statistics in *National Transportation Statistics 2007* (DOT 2007). The adjustment factors are the ratio of the national injury rate to the national fatality rate and the ratio of the national accident rate to the national fatality rate. These adjustment factors were multiplied by the Maryland-specific fatality rate to approximate the injury and accident rates for commuters in Maryland.
- The DOT Federal Motor Carrier Safety Administration evaluated the data underlying the Saricks and Tompkins (1999) rates, which was taken from the Motor Carrier Management Information System, and determined that the rates were under-reported. Therefore, the accident, injury, and fatality rates in Saricks and Tompkins (1999) were adjusted using factors derived from data provided by the University of Michigan Transportation Research Institute (UMTRI) (UMTRI 2003). The UMTRI data indicate accident rates for 1994 to 1996, the same data used by Saricks and Tompkins (1999), were under-reported by about 39 percent. Injury and fatality rates were under-reported by 16 percent and 36 percent, respectively. As a result, the accident, injury, and fatality rates were increased by factors of 1.64, 1.20, and 1.57, respectively, to account for the apparent under-reporting. These adjustments were applied to the materials, which are transported by heavy truck shipments similar to those evaluated by Saricks and Tompkins (1999), but not to commuter traffic accidents.

The estimated nonradiological impacts of transporting materials to the proposed Unit 3 site and of transporting workers to/from the site are illustrated in Table 4-9. Based on Table 4-9, the nonradiological transportation impacts are dominated by the transportation of construction workers to and from the proposed Unit 3 site. The estimated total annual fatalities related to building the facility represents about a 1 percent increase above the 21 traffic fatalities that occurred in Calvert County, Maryland, in 2006 (DOT 2008b). This increase is minor relative to the current traffic fatality risks in the area surrounding the Calvert Cliffs site.

Based on the information provided by UniStar, the review team's independent evaluation, and considering the number of shipments of building materials and the number of workers that would be transported to the site, the review team concludes that the total nonradiological health impacts from transporting building materials and personnel to the proposed Unit 3 site would be minimal, and no further mitigation would be warranted.

Table 4-9. Estimated Impacts of Transporting Workers and Materials to and from the Proposed Unit 3 Site

	Accidents per Yr Per Unit	Injuries per Yr Per Unit	Fatalities per Yr Per Unit
Workers	$3.7 \times 10^{+1}$	$1.7 \times 10^{+1}$	2.5×10^{-1}
Materials			
Concrete	2.9×10^{-1}	2.4×10^{-1}	7.9×10^{-3}
Rebar, Structural Steel	3.9×10^{-2}	3.2×10^{-2}	1.0×10^{-3}
Cable	4.1×10^{-2}	3.4×10^{-2}	1.1×10^{-3}
Piping	1.8×10^{-3}	1.4×10^{-3}	4.7×10^{-5}
Total - Construction	$3.8 \times 10^{+1}$	$1.7 \times 10^{+1}$	2.6×10^{-1}

4.8.4 Summary of Nonradiological Health Impacts

As part of its evaluation on nonradiological health impacts, the review team considered the mitigation measures identified by UniStar in its ER and relevant permits and authorizations required by State and local agencies for building proposed Unit 3. The team evaluated impacts to public health and to the construction workers from fugitive dust, occupational injuries, noise, and transport of materials and personnel to and from the proposed Unit 3 site. No significant impacts related to the nonradiological health of the public or workers were identified during the course of this review. Based on information provided by UniStar and the review team's independent evaluation, the review team concludes that the nonradiological health impacts of construction and preconstruction activities associated with proposed Unit 3 would be SMALL, and no further mitigation would be warranted. Based on the above analysis, and because NRC-authorized construction activities represent only a portion of the analyzed activities, the NRC staff concludes that the nonradiological health impacts of NRC-authorized construction activities would be SMALL. The NRC staff also concludes that no further mitigation measures, beyond the UniStar's commitments, would be warranted.

4.9 Radiological Exposure to Construction Workers

The sources of radiation exposure for construction workers include direct radiation exposure, exposure from liquid radioactive effluents, and exposure from gaseous radioactive effluents from the existing Units 1 and 2 during site preparation and construction of proposed Unit 3. For the purposes of this discussion, construction workers are assumed to be members of the public rather than occupational workers; therefore, the dose estimates are compared to the dose limits for the public, pursuant to 10 CFR Part 20, Subpart D. UniStar (2008a) noted that all major building activities are expected to occur outside the CCNPP Units 1 and 2 protected area boundary, but inside the site boundary.

4.9.1 Direct Radiation Exposures

In its ER (UniStar 2009a), UniStar identified three sources of direct radiation exposure from nuclear facilities within the Calvert Cliffs site: (1) the reactor buildings for existing Units 1 and 2, (2) the independent spent fuel storage installation (ISFSI), and (3) the interim resin storage area (IRSA). The ISFSI and the IRSA are identified as the primary sources of direct radiation exposure to proposed Unit 3 construction workers. Any direct radiation from existing Units 1 and 2 would be included in the estimates from the ISFSI and IRSA, which are closer to the proposed Unit 3 construction workers. Direct radiation from the old steam generator storage facility was determined to not be a significant source of dose to the construction workers. The review team did not identify any additional sources of direct radiation during the site visit or during document reviews.

UniStar used fenceline thermoluminescent dosimeters (TLDs) and environmental TLDs to measure direct radiation levels at locations in and around the Calvert Cliffs site protected area (UniStar 2009a). TLDs were placed at the protected area fences for the ISFSI and IRSA. Environmental TLDs are located in two rings around the Calvert Cliffs site, an inner ring near the site boundary, and an outer ring (3.7 to 5 mi) from the plant (Constellation 2005; 2007). These TLDs are read quarterly and measure the contribution to dose from any source, including natural background, the current reactor buildings, ISFSI, IRSA, and the old steam generator storage facility.

UniStar estimated the maximum direct radiation dose a construction worker would receive. The location with the highest direct radiation dose rate a construction worker would receive is the road adjacent to the ISFSI and IRSA. The estimated dose at this location for a 2200-hour work year (2000-hour work year plus 10 percent overtime) would be 38.2 mrem. This dose rate was based on the ISFSI loading for the year 2015. This also conservatively assumes that the construction worker is at this location for the entire work year. No other area where building occurs would receive a higher direct radiation dose rate.

4.9.2 Radiation Exposures from Gaseous Effluents

Gaseous radioactive effluents from CCNPP Units 1 and 2 are released at the plant stacks (UniStar 2009a). They consist of effluents from the waste gas processing system; the containment purge and vents and the main condenser air evacuation exhaust; and discharges from the fuel pool building, the radwaste building, and the nuclear auxiliary building (UniStar 2009a; Constellation 2005). UniStar estimated the dose to construction workers using 2006 gaseous effluent data. The estimated maximum annual total effective dose equivalent to a construction worker from gaseous effluents was 1.55 mrem/yr for a worker at the shoreline near the barge slip (shoreline/tunnel/barge/in-out-flow worker). The dose from gaseous effluents to the worker at the location for the highest direct radiation dose would be 0.53 mrem. Therefore, the estimated dose to a construction worker from gaseous effluents would be small compared to the dose from direct radiation.

4.9.3 Radiation Exposures from Liquid Effluents

Liquid radioactive effluents discharged to the Chesapeake Bay were evaluated for their contribution to the total effective dose equivalent to construction workers (UniStar 2009a). The principal exposure pathway to a construction worker would be direct exposure to the Bay water and shoreline sediments. UniStar analyzed the maximum dose to a construction worker, assuming the liquid effluents were released at the shoreline. The estimated total effective dose equivalent for a worker spending 2200 hours at the shoreline would not exceed 0.08 mrem in that scenario. The liquid effluents are actually discharged 850 ft away from the shoreline, and the effective dilution was not considered for conservatism. Therefore, the estimated dose to construction workers from liquid effluents would be negligible compared to the dose from direct radiation exposure.

4.9.4 Total Dose to Construction Workers

The maximum annual dose to a construction worker was estimated to be 38.8 mrem, which is the sum of three pathways—(1) direct radiation (38.2 mrem), (2) gaseous effluents (0.53 mrem), and (3) liquid effluents (< 0.08 mrem). This estimated maximum dose would occur at the road near the ISFSI and assumes a presence at that location of 2200 hours per year. Therefore, the dose is primarily the result of direct radiation. The annual dose limit to an individual member of the public is 100 mrem total effective dose equivalent.

A power uprate of 1.38 percent was granted to CCNPP Units 1 and 2 in July 2009. This uprate will be implemented by the time site preparation and construction on Unit 3 could begin. The uprate may increase the maximum annual dose to a construction worker by as much as 1.38 percent; however, the annual dose would still be well below 100 mrem total effective dose equivalent.

To obtain the collective dose, UniStar calculated the dose rates for each year when building occurs prior to operation, using a matrix of job descriptions, number of full-time workers and their locations, and TLD readings. The total estimated collective dose equivalent for construction workers over the 6-year building period was 17.2 person-rem (UniStar 2009a). The average construction worker dose rate was approximately 1 mrem/yr. This average dose rate is much smaller than the approximately 311 mrem/yr each worker would receive from natural background radiation (NCRP 2009).

4.9.5 Summary of Radiological Health Impacts

The NRC staff concludes that the estimate of doses to construction workers during building of the new unit is well within NRC annual exposure limits (i.e., 100 mrem) designed to protect the public health. Based on information provided by UniStar and the NRC staff's independent evaluation, the NRC staff concludes that the radiological health impacts to construction workers for proposed Unit 3 would be SMALL, and no further mitigation would be warranted. Radiation exposure from all NRC-licensed activities including operation of CCNPP Units 1 and 2 is regulated by the NRC. Therefore, NRC staff concludes the radiological health impacts for NRC-authorized construction activities would be SMALL, and no further mitigation would be warranted.

4.10 Nonradioactive Waste Impacts

The following sections provide descriptions of the potential environmental impacts from the generation, handling, and disposal of nonradioactive waste during the building activities for proposed Unit 3 at the Calvert Cliffs site. Potential types of nonradioactive waste expected to be generated, handled, and disposed include construction debris, spoils, stormwater runoff, municipal and sanitary waste, dust and air emissions. The assessment of potential impacts resulting from these types of wastes is presented in the following subsections.

4.10.1 Impacts to Land

Building activities related to the proposed Unit 3 could result in solid waste materials like construction debris and spoils. The State of Maryland will require environmental compliance in the removal and disposal of these solid wastes from the site. UniStar plans to dispose of acceptable construction debris such as earthen materials (e.g. topsoil, clay, or brush) offsite at a proper disposal facility. Other solid waste generated such as office wastes would be disposed and recycled as appropriate (UniStar 2009a).

Excavated materials from the proposed construction areas not suitable for offsite disposal or construction backfill would be permanently stored in an existing open field north of the proposed construction access road. This approximately 36-ac site would be graded and stabilized with vegetative cover. All spoils resulting from dredging would comply with the Department of the Army, Clean Water Act Section 404 permit. Dredge spoils from site preparation would likely be transported and deposited at an existing spoils area located at Lake Davies (UniStar 2009a). The dredged material would be characterized prior to use.

All potential wastes generated while building proposed Unit 3 would be handled according to county, State, and Federal regulations. All county and State permits and regulations for handling and disposal of solids and the Corps' permit for disposal of dredged spoils would be obtained and implemented.

Based on the effective practices for recycling and minimizing waste already in place for CCNPP Units 1 and 2, and the plans to manage solid and liquid wastes in accordance with all applicable State and local requirements and standards, the review team expects the impacts to land from nonradioactive waste generated during the building activities of proposed Unit 3 would be minimal, and no further mitigation would be warranted.

4.10.2 Impacts to Water

Surface water and groundwater have the potential to be impacted due to the building activities of proposed Unit 3. UniStar plans to minimize these potential impacts by implementing the MDE BMPs. Some of the BMPs that would be implemented include implementation of SWPPP, NPDES permit for stormwater associated with building activities, and erosion and sediment control plan. In addition, the CPCN conditions would apply (MSPC 2009). Surface and groundwater quality during the development of proposed Unit 3 are discussed further in Section 4.2.3.

Onsite sanitary wastes generated during the building activities would be accommodated with the construction of temporary facilities. Waste facilities from CCNPP Units 1 and 2 would not be used. UniStar has filed a permit application with the State of Maryland to use groundwater wells to withdraw freshwater from the Aquia aquifer. Construction personnel use is included in the request. Freshwater for sanitation use would come from the groundwater wells. The groundwater wells are anticipated to be used during the first four years of construction. The desalination plant is anticipated to be operational by years five and six, thereby supplying freshwater as needed when building proposed Unit 3 (UniStar 2009a).

Offsite, both the Calvert and St. Mary's County wastewater treatment systems have the excess capacity to meet the increased generation of wastewater by the project workforce. Calvert County is expected to have the larger increase in population as more of the labor force is expected to reside in this county.

Based on the regulated practices for managing liquid discharges, including wastewater, the CPCN conditions, and the BMPs that UniStar plans to implement for managing surface and groundwater, the review team expects that impacts to water from nonradioactive effluents when building proposed Unit 3 would be minimal, and no further mitigation would be warranted.

4.10.3 Impacts to Air

As discussed in Sections 4.4.1 and 4.8.1, fugitive dust and other generated emissions during site development activities would be managed. UniStar plans to control these emissions through several BMPs and applicable regulatory laws. UniStar will incorporate a dust control plan into the SWPPP to control fugitive dust emissions. Equipment and vehicles used for site preparation and the increase in vehicle traffic of construction workers involved in building proposed Unit 3 would result in increased emissions. Mitigation of increased emissions will be accomplished through applicable permits for National Ambient Air Quality Standards and the National Emission Standards for Hazardous Air Pollutants. In addition, lowering of maximum speed limits, inspection of emission control equipment for construction vehicles and a traffic management plan would be employed (UniStar 2009a).

Based on the regulated practices for managing air emissions from construction equipment and temporary sources and the use of BMPs, the review team expects that impacts to air from nonradioactive emissions when building proposed Unit 3 would be minimal, and no further mitigation would be warranted.

4.10.4 Summary of Nonradiological Waste Impacts

Solid, liquid, and gaseous wastes generated when building proposed Unit 3 would be handled according to County, State, and Federal regulations. County and State permits and regulations for handling and disposal of solid waste, and the Corps' permit for disposal of dredged spoils, would be obtained and implemented. The State of Maryland BMPs, which include a SWPPP for surface water runoff and groundwater quality, NPDES permit for facilities releases, and the use of temporary facilities for sanitary waste systems during the construction period, would ensure compliance with the Clean Water Act and State of Maryland standards. Air emissions from fugitive dust and vehicles used when building and developing proposed Unit 3 would be managed using regulated practices, BMPs, and traffic management plans. Based on the information provided by UniStar and the review team's independent evaluation, the review team concludes that nonradioactive waste impacts to land, water, and air would be SMALL and that additional mitigation would not be warranted. Because NRC-authorized construction activities represented only a portion of the analyzed activities, the NRC staff concludes that the nonradioactive waste impacts of NRC-authorized construction activities would also be SMALL, and no further mitigation would be warranted.

Cumulative impacts to water and air from nonradioactive emissions and effluents are discussed in Sections 7.2 and 7.6, respectively. For the purposes of Chapter 9, the review team expects that there would be no substantive differences between the impacts of nonradioactive waste for proposed Unit 3 and the alternative sites and no substantive cumulative impacts that warrant further discussion beyond those discussed for the alternative sites in Section 9.3.

4.11 Measures and Controls to Limit Adverse Impacts During Construction and Preconstruction

In its evaluation of environmental impacts when building proposed Unit 3, the review team relied on UniStar's compliance with the following measures and controls that would limit adverse environmental impacts:

- compliance with applicable Federal, State, and local laws, ordinances, and regulations intended to prevent or minimize adverse environmental impacts (e.g., solid waste management, erosion and sediment control, air emissions, noise control, stormwater management, spill response and cleanup, hazardous material management)
- compliance with applicable requirements of permits or licenses required for construction of the new units (e.g., USACE Section 404 Permit, NPDES, Maryland's CPCN)
- compliance with existing CCNPP Unit 1 and 2 processes and/or procedures applicable to proposed Unit 3 construction environmental compliance activities for the Calvert Cliffs site (e.g., solid waste management, hazardous waste management, and spill prevention and response)
- incorporation of environmental requirements into construction contracts
- identification of environmental resources and potential impacts during the development of the ER and the COL process.

Table 4-10 summarizes the measures and controls to limit adverse impacts when building proposed Unit 3 based on the table supplied by UniStar (2009a), as adjusted by the review team when considered to be appropriate. Some measures apply to more than one impact category.

4.12 Summary of Construction Impacts

The impact category levels determined by the review team in the previous sections are summarized in Table 4-11. The impact category levels for NRC-authorized construction discussed in this chapter are denoted in the table as SMALL, MODERATE, or LARGE as a measure of their expected adverse environmental impacts, if any. Construction and preconstruction building activities are similarly noted. Some impacts, such as the addition of tax revenue from UniStar for the local economies, are likely to be beneficial impacts to the community. UniStar has received a CPCN from the State of Maryland that contains conditions that could potentially reduce the impacts discussed in this chapter.

Table 4-10. Summary of Measures and Controls Proposed by UniStar to Limit Adverse Impacts When Building Proposed Unit 3

Affected Environment/ Resource Area	Specific Measures and Control
Land-Use Impacts	
The Site and Vicinity	• Comply with NPDES Construction General Permit, including EPA effluent limitations. • Use site Resource Management Plan and BMPs to protect resources such as wetlands and streams in vicinity. • Comply with individual Corps of Engineers 404 Permit. • Comply with Maryland Non-Tidal Wetlands Protection Act permit. • Restore wetlands and wetland buffers temporarily disturbed during construction. • Construct new wetlands and enhance others. • Implement Storm Water Pollution Prevention Plan (SWPPP), including sediment and erosion control. • Use site Resource Management Plan and comply with BMP requirements; on-site land is not used for farmland nor is it considered prime or unique. • Unmerchantable trees and slash will be chipped and spread as wood chips or disposed of at an offsite landfill. • Acreage will be restored following land-disturbing activities to the extent possible. • Construction footprint would be wholly contained on an existing dedicated nuclear power plant site. • Implement Spill Prevention Control and Countermeasures (SPCC) Plan.
Transmission Line Rights-of-Way and Offsite Areas	• Use existing transmission corridor maintenance policies and practices to protect terrestrial and aquatic ecosystems.
Historic Properties and Cultural Resources	• Perform Phase III Cultural Resource Survey. • Follow Data Recovery Plan. • Follow Mitigation Plan. • Follow MOA that stipulates agreed-upon mitigation measures. • In consultation with the SHPO, develop plan and procedures to manage identified/unidentified historic/cultural resource. • Take appropriate actions (e.g., stop work) following discovery of potential historic/cultural resource.

Table 4-10. (contd)

Affected Environment/ Resource Area	Specific Measures and Control
Water-Related Impacts	
Water Use	• Comply with existing Groundwater Water Appropriations and Use Permit Withdrawal Limit. • Use offsite water supply. • Install Desalinization Plant. • Install bio-retention ditches to allow runoff to infiltrate. • Comply with COMAR 26.17.06 for dewatering activities or obtain Water Appropriation and Use Permit, as needed. • Comply with individual Corps of Engineers 404 Permit. • Comply with BMP requirements. • Use site Resource Management Plan and BMPs to protect resources such as wetlands and streams in vicinity. • Comply with Maryland Non-Tidal Wetlands Protection Act permit. • Comply with BMP requirements. • Restore wetlands and wetland buffers temporarily disturbed during construction. • Develop new wetlands. • Use site Resource Management Plan and BMPs to protect resources such as wetlands and streams in vicinity.
Water Quality	• Implement Spill Prevention, Control, and Countermeasures (SPCC) Plan. • Implement Storm Water Pollution Prevention Plan (SWPPP), including sediment and erosion control, as part of the NPDES Construction General Permit requirements. • Comply with Corps of Engineers 404 Permit requirements.
Ecological Impacts	
Terrestrial Ecosystems	• Use site Resource Management Plan and BMPs to protect resources. • To the extent practicable, design construction footprint to account for CBCA and other important habitat, including bald eagles nests. • Obtain permits from the Maryland Department of Natural Resources and U.S. Fish and Wildlife Service to allow removal of any unoccupied bald eagle nests within the construction area and for approval of the required mitigating actions. • Minimize cooling tower lighting, as practicable and allowed by regulation. • Create new habitats (i.e., unforested uplands to ultimately generate a mixed deciduous forest). • Maintain remaining unforested upland as old field habitat. • Restore acreage following land-disturbing activities to the maximum extent possible.

Table 4-10. (contd)

Affected Environment/ Resource Area	Specific Measures and Control
	• Use site Resource Management Plan and BMPs to protect resources such as wetlands and streams in vicinity. • Comply with Maryland Nontidal Wetlands Protection Act Permit. • Comply with BMP requirements. • Comply with individual Corps of Engineers 404 Permit. • Preserve aesthetically outstanding tree clusters, as practical; harvest merchantable timber; use or recycle other woody material, as appropriate; develop reforestation plan. • Use site Resource Management Plan and BMPs to protect resources.
Aquatic Ecosystems	• Use site Resource Management Plan and BMPs to protect resources. • Implement Spill Prevention, Control, and Countermeasures (SPCC) Plan. • Comply with Maryland Nontidal Wetlands Protection Act Permit. • Comply with individual Corps of Engineers 404 Permit. • Comply with BMP requirements. • Restore wetlands and wetland buffers temporarily disturbed during construction. • Construct new wetlands. • Implement Storm Water Pollution Prevention Plan (SWPPP), including sediment and erosion control and the construction of new impoundments, as appropriate. • Comply with BMPs, including intercepting and retaining sediment before it reaches streams.
Socioeconomic Impacts	
Physical Setting	• Comply with applicable MDE noise limits. • Comply with applicable OSHA noise-exposure limits. • Comply with applicable EPA and MDE air quality regulations. • Implement routine vehicle/equipment inspection and maintenance program. • Install new site perimeter and access road. • Conduct Phase 2 Traffic Impact Analysis (TIA). • Develop Traffic Management Plan using Phase 2 TIA results.

Table 4-10. (contd)

Affected Environment/ Resource Area	Specific Measures and Control
Socioeconomics	• Small aggregate socioeconomic impacts anticipated, mitigation not required. • Large beneficial impact to county property tax revenues; small beneficial impact for other types of tax revenues. No mitigating measures or controls required.
Environmental Justice	• No mitigating measures or controls required.
Radiation Exposure to Construction Workers	• Doses to construction workers would be maintained below NRC public dose limits (10 CFR Part 20). • Implement ALARA practices at construction site.
Nonradiological Health	• Implement site-wide Safety and Medical Program, including safety policies, safe work practices, as well as general and topic-specific training.

Table 4-11. Summary of Impacts from Construction of Proposed Unit 3

Category	Comments	NRC-Authorized Construction Impact Level	Construction and Preconstruction Impact Level
Land-Use Impacts			
The Site and Vicinity	Construction activities would take place within the existing site boundaries.	SMALL	SMALL
Transmission Line Corridors and Offsite Areas	No offsite corridors to be developed.	SMALL	SMALL
Water-Related Impacts			
Water Use			
Surface Water	Surface water not used.	SMALL	SMALL
Groundwater	Temporary use of groundwater will remain a localized impact.	SMALL	SMALL
Water Quality			
Surface Water	BMPs will be used to limit construction stormwater impacts.	SMALL	SMALL
Groundwater	BMPs will prevent or mitigate spills.	SMALL	SMALL

Table 4-11. (contd)

Category	Comments	NRC-Authorized Construction Impact Level	Construction and Preconstruction Impact Level
Ecological Impacts			
Terrestrial Ecosystems and Wetlands	Forest loss and fragmentation would reduce FIDS habitat. Wetlands and streams would be filled and graded. Proposed wetland and wildlife habitat mitigation would offset some impacts.	SMALL	MODERATE
Aquatic Ecosystems Freshwater	Impacts to freshwater systems occur from the elimination of stream headwaters and small pond, increased erosion from the removal of forested areas, and increased runoff from the addition of impervious surfaces.	SMALL	MODERATE
Chesapeake Bay	Estuarine aquatic resources would be affected by dredging and trenching of the bay bottom, noise from baffle wall installation, and habitat conversion by adding rock armoring to the Bay bottom.	SMALL	MODERATE
Socioeconomic Impacts			
Physical Impacts	Construction would take place within existing site boundaries, so impact on the public would be minimal. Impact on workers would be mitigated with training and protective equipment. Construction would not affect any offsite buildings, and onsite buildings were constructed to withstand vibration from construction activities. Local traffic increase in vicinity of MD SR 2/4 would be MODERATE and temporary.	SMALL	SMALL
Demography	Percentage of construction workers relocating to the region likely would be SMALL relative to the existing population base.	SMALL	SMALL
Economic Impacts to the Community	Economic impact would be beneficial to local economies in Calvert County.	SMALL	SMALL to LARGE BENEFICIAL
Infrastructure and Community Services	Housing, public services and education are generally adequate for the influx of construction workers.	SMALL to MODERATE	SMALL to MODERATE
Environmental Justice Impacts	No environmental pathways or preconditions exist that could lead to and disproportionate adverse impacts on minorities or low-income populations.	SMALL	SMALL

Table 4-11. (contd)

Category	Comments	NRC-Authorized Construction Impact Level	Construction and Preconstruction Impact Level
Historic and Cultural Resource Impacts	DRAFT MOA and DRAFT Mitigation Plan – 9/09; NHPA Section 106 Findings - 2/13/09 Letter from Maryland Historical Trust - adverse effect on historic properties (CT-1312, CT-1295) and archaeological site (18CV474); visual impacts within 1 mi to resources within Architectural APE.	SMALL	LARGE
Meteorological and Air Quality Impacts	Construction would be conducted in accordance with applicable State requirements. Dust emissions would be minimized through a dust-control plan.	SMALL	SMALL
Nonradiological Health Impacts	Emission controls and remote location would minimize nonradiological health impacts. Adherence to Federal and State Regulations assumed to protect occupational workers.	SMALL	SMALL
Radiological Health Impacts	Doses to construction workers would be maintained below NRC public dose limits (10 CFR Part 20).	SMALL	SMALL
Nonradioactive Waste	Solid, liquid, and gaseous wastes generated when building proposed Unit 3 would be handled according to county, State, and Federal regulations.	SMALL	SMALL

4.13 References

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

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

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

29 CFR Part 1910. Code of Federal Regulations, Title 29, *Labor,* Part 1910, "Occupational Safety and Health Standards."

33 CFR Part 320. Code of Federal Regulations, Title 33, Navigation and Navigable Waters, Part 320, "General Regulatory Policies."

33 CFR Part 325. Code of Federal Regulations, Title 33, *Navigation and Navigable Waters,* Part 325, "Processing of Department of the Army Permits."

36 CFR Part 800. Code of Federal Regulations, Title 36, *Parks, Forests, and Public Property*, Part 800, "Protection of Historic Properties."

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

40 CFR Part 93. Code of Federal Regulations, Title 40, *Protection of Environment,* Part 93, "Determining Conformity of Federal Actions to State or Federal Implementation Plans."

40 CFR Part 204. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 204, "Noise Emission Standards for Construction Equipment."

55 FR 32088. August 7, 1990. "Determination of Threatened Status for the Puritan Tiger Beetle and the Northeastern Beach Tiger Beetle." *Federal Register.* U.S. Fish and Wildlife Service.

72 FR 57416. October 9, 2007. "Limited Work Authorizations for Nuclear Power Plants." *Federal Register*. U.S. Nuclear Regulatory Commission.

73 FR 19594. April 10, 2008. "Compensatory Mitigation for Losses of Aquatic Resources." *Federal Register*. U.S. Army Corps of Engineers.

73 FR 29075. May 20, 2008. "Authorizations Under the Bald and Golden Eagle Protection Act for Take of Eagles." *Federal Register*. U.S. Department of the Interior.

Abbe, G.R. 1987. "Thermal and Other Discharge-Related Effects on the Bay Ecosystem." Chapter 9 in *Ecological Studies in the Middle Reach of Chesapeake Bay, Calvert Cliffs.* K. L. Heck Jr., ed., Springer-Verlag, New York.

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

Bartol, S.M., and J.A. Musick. 2003. "Sensory Biology of Sea Turtles." Volume II of *The Biology of Sea Turtles.* P.L. Lutz, J.A. Musik., ed., CRC Press, Boca Raton, Florida.

Bechtel Power Corporation (Bechtel). 2008a. "Evaluation of Potential Impacts of Construction Pumping On Declining Potentiometric Levels in the Aquia Aquifer." Document No. 25237-000-30R-KO0 G-00001-000, provided in UniStar Letter UN#09-001 to NRC*,* January 9, 2009. Accession No. ML090220482.

Bechtel Power Corporation (Bechtel). 2008b. "Calvert Cliffs Unit 3 Storm Water Management Plan Document No: 25237-209-30G-KO3G-00001 Revision A," provided in UniStar Letter UN#08-037, to NRC, September 29, 2008. Accession No. ML090220702.

Blasius, B.J. and R.W. Merritt. 2002. "Field and Laboratory Investigations on the Effects of Road Salt (NaCl) on Stream Macroinvertebrate Communities." *Environmental Pollution* 120(2):219-231.

Clean Air Act. 42 U.S.C. 7401 et seq.

Clean Water Act. 33 U.S.C. 1251, et seq. (also referred to as the Federal Water Pollution Control Act [FWPCA]).

Coastal Zone Management Act of 2006 (CZMA). 16 U.S.C. 1451 et seq.

Constellation Generation Group, LLC (Constellation). 2005. Letter from Mark Tonacci (Constellation) to the NRC dated July 14, 2005, "Calvert Cliffs Nuclear Power Plant Unit Nos. 1 and 2; Docket Nos. 50-317 & 50-318; 2004 Radioactive Effluent Release Report and Dose Assessment." Accession No. ML052020232.

Constellation Energy Group, LLC (Constellation). 2007. *Annual Radiological Environmental Operating Report for the Calvert Cliffs Nuclear Power Plant Units 1 and 2 and the Independent Spent Fuel Storage Installation, January 1 - December 31, 2006*. Accession No. ML071590393.

COMAR 26.02.03.00. 2007. "Control of Noise Pollution." *Code of Maryland Regulations*.

EA Engineering, Science, and Technology (EA Engineering). 2008. *Entrainment Characterization Data Report for Calvert Cliffs Nuclear Power Plant*. Prepared for Constellation Energy. Accession No. ML083110678.

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

Karraker, N.E., J.P. Gibbs, and J.R. Vonesh. 2008. "Impacts of Road Deicing Salt on the Demography of Vernal Pool-Breeding Amphibians." *Ecological Applications* 18(3):724-734.

Kaushal, S.S., P.M. Groffman, G.E. Likens, K.T. Belt, W.P. Stack, V.R. Kelly, L.E. Band, and G.T. Fisher. 2005. "Increased Salinization of Fresh Water in the Northeastern United States." In *Proceedings of the National Academy of Sciences of the United States of America* 102(38):13517–13520.

Kentucky Native Plant Society. 2005. "2005 Wildflower of the Year, Showy Goldenrod (*Solidago speciosa*)." *The Lady-Slipper* 20:1 / Spring 2005. Available at http://www.knps.org.

KLD Engineering, P.C. (KLD). 2009. *Traffic Impact Study at the Calvert Cliffs Nuclear Power Plant, Draft Final Report, Rev. 2.* TR-427, Hauppauge, New York. Accession No. ML093570407.

Knisley, C.B. 2006. *Current Status of Two Federally Threatened Tiger Beetles at Calvert Cliffs Nuclear Power Plant*. Letter report to Carla Logan, Constellation Generation Group, October 26, 2006. Glen Allen, Virginia. Accession No. ML090690159.

Knisley, C.B. 2009. Email from C. Barry Knisley (Randolph-Macon College, Professor) to Corey A. Duberstein (Pacific Northwest National Laboratory, Ecology Scientist), "Subject: RE: Calvert Cliffs tiger beetles." January 13, 2009. Accession Nos. ML090920737 and ML100050568.

Lewis, L.J., J. Davenport, and T.C. Kelly. 2002a. "A Study of the Impact of a Pipeline Construction on Estuarine Benthic Invertebrate Communities." *Estuarine, Coastal and Shelf Science* 55(2):213-221.

Lewis, L.F., J. Davenport, and T.C. Kelly. 2002b. "A Study of the Impact of a Pipeline Construction on Estuarine Benthic Invertebrate Communities. Part 2. Recolonization by Benthic Invertebrates after 1 Year and Response of Estuarine Birds." *Estuarine, Coastal and Shelf Science* 57(1-2):201-208.

MACTEC Engineering and Consulting, Inc. (MACTEC). 2009. *Phase I Compensatory Mitigation Plan*. Prepared for Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC as Project No. 8093-07-6565, dated Feb 18, 2009, Raleigh, North Carolina. Accession No. ML093380280.

Maryland Department of the Environment (MDE). 2008. *Mitigation*. Accessed October 2, 2008 at http://www.mde.state.md.us/Programs/WaterPrograms/Wetlands_Waterways/regulations/mitigation.asp.

Maryland Department of Natural Resources (MDNR). 2004. *Lower Patuxent River In Calvert County Watershed Characterization December 2003*. Accessed February 6, 2008 at http://dnr.maryland.gov/watersheds/surf/proj/wras.html.

Maryland Department of Natural Resources (MDNR). 2007. *Rare, Threatened, and Endangered Animals of Maryland*. Annapolis, Maryland. Available at http://dnrweb.dnr.state.md.us/download/rteanimals.pdf.

Maryland Department of Natural Resources (MDNR). 2008. *Guidelines for Rare, Threatened and Endangered Plant Reintroductions in Maryland*. Accessed September 29, 2008 at http://www.dnr.state.md.us/wildlife/rteplantreintro.html.

Maryland Department of Natural Resources, Maryland Power Plant Research Program (MDNR PPRP). 2008. *Environmental Review of Proposed Unit 3 at Calvert Cliffs Nuclear Power Plant*. PSC Case No. 9127. Maryland Power Plant Research (PPRP).

Maryland Department of Planning (MDP). 2008. *2007 Maryland Statistical Handbook.* Accessed September 2, 2008 at http://www.mdp.state.md.us/msdc/. .

Maryland Historical Trust (MHT). 2009. Letter from J. Rodney Little (MHT) to William Seib (USACE), "Subject: MHT Review of Phase II National Register Evaluations and Assessment of Effects for Cultural Resources, Calvert Cliffs Nuclear Power Plant Expansion, Calvert County, Maryland." February 13, 2009. Accession No. ML090570416.

Maryland Public Service Commission (MPSC). 2009. *In the Matter of the Application of UniStar Nuclear Energy, LLC and UniStar Nuclear Operating Services, LLC for a Certificate of Public Convenience and Necessity to Construct a Nuclear Power Plant at Calvert Cliffs in Calvert County, Maryland*. Case Number 9127. Proposed Order of Hearing Examiner, April 28, 2009.

Maurer, D., R. Keck, J. Tinsman, W. Leathem, C. Wethe, C. Lord, and T. Church. 1986. "Vertical Migration and Mortality of Marine Benthos in Dredged Material: A Synthesis." *Internationale Revue der gesamten Hydrobiologie und Hydrographie* 71(1):49-63.

Migratory Bird Treaty Act (MBTA) of 1918. 16 U.S.C. 703 et seq.

National Council on Radiation Protection and Measurements (NCRP). 2009. *Ionizing Radiation Exposure of the Population of the United States.* NCRP Report No. 160, Bethesda, Maryland.

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

National Historic Preservation Act of 1966 (NHPA). 16 U.S.C. 470, et seq.

Natural Resources 5-1601-1612. 2009. "Forest Conservation." *Michie's Annotated Code of Maryland*.

Noise Control Act of 1972. 42 U.S.C. 4901-4918, et seq.

Popper, A.N., T.J. Carlson, A.D. Hawkins, B.L. Southall, and R.L. Gentry. 2006. *Interim Criteria for Injury of Fish Exposed to Pile Driving Operations: A White Paper*.

Ramakrishna, D.M. and T. Viraraghavan. 2005. "Environmental Impact of Chemical Deicers - a Review." *Water, Air, and Soil Pollution* 166(1-4):49-63.

Rivers and Harbors Appropriation Act of 1899 (Rivers and Harbors Act). 33 U.S.C. 403, as amended.

Saricks, C.L. and M.M. Tompkins. 1999. *State-Level Accident Rates for Surface Freight Transportation: A Reexamination*. ANL/ESD/TM-150, Argonne National Laboratory, Argonne, Illinois.

Secrest, T.J., D.C. Mussatti, and M.J. Scott. 2010. *Calvert Cliffs Unit 3 COL Discussions Regarding Socioeconomic and Environmental Justice—Interviews with the Public.* Accession No. ML100050174.

Southerland, M., L. Erb, G. Rogers, R. Morgan, K. Eshleman, M. Kline, K. Kline, P. Kazyak ,J. Kilian, J. Ladell, and J. Thompson. 2005. *Maryland Biological Stream Survey 2000-2004, Stressors Affecting Maryland Streams*. Volume XIV, Publication # DNR-12-0305-0101, Maryland DNR, Annapolis, Maryland.

Tetra Tech NUS. 2007. *Final Faunal Survey Report for Proposed UniStar Nuclear Project Area Calvert Cliffs Nuclear Power Plant Site Calvert County, Maryland*. Prepared for UniStar Nuclear Development, LLC by Tetra Tech NUS, Germantown, Maryland. Accession No. ML090690128.

Tipler, P.A. 1982. *Physics*. Worth Publishers, New York.

UniStar Nuclear Energy, LLC (UniStar). 2007. *Technical Report in Support of Application of UniStar Nuclear Operating Services, LLC for Certificate of Public Convenience and Necessity Before the Maryland Public Service Commission for Authorization to Construct Unit 3 at Calvert Cliffs Nuclear Power Plant and Associated Transmission Lines*. November 6, 2007. Accession Nos. ML100960624.

UniStar Nuclear Energy (UniStar). 2008a. Letter from G. Vanderheyden (UniStar) to U.S. Nuclear Regulatory Commission in response to NRC letter dated May 13, 2008, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Submittal of Response to Requests for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3 and Request for Withholding of Documents." June 12, 2008. Accession No. ML100040300.

UniStar Nuclear Development, LLC (UniStar). 2008b. Letter from G. Gibson (UniStar) to U.S. Nuclear Regulatory Commission in response to NRC letters dated May 13, 2008, June 12, 2008, and August 29, 2008, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Submittal of Response Requests for Additional Information for the Calvert Cliffs Nuclear Power

Plant, Unit 3 – Supplemental Aquatic RAIs." September 29, 2008. Accession No. ML082760508.

UniStar Nuclear Development, LLC (UniStar). 2008c. Letter from D. Lutchenkov (UniStar) to Maryland Department of the Environment, "Joint Federal/State Application to the United States Army Corps of Engineers and the Maryland Department of the Environment for the Alteration of any Floodplain, Waterway, Tidal or Nontidal Wetland in Maryland Calvert Cliffs Nuclear Power Plant - Unit 3 Calvert County, Maryland, USAEC Application Number NAB-2007-08123-M05." May 16, 2008. Accession No. ML081840343.

UniStar Nuclear Energy, LLC (UniStar). 2008d. UniStar Nuclear Operating Services, LLC - Rebuttal Testimony of Paul C. Myers. Case No. 9127, Public Service Commission, Maryland, Annapolis. Available at http://webapp.psc.state.md.us/Intranet/CaseNum/submit.cfm?DirPath=C:\Casenum\9100-9199\9127\Item_46\&CaseN=9127\Item_46. Accession No. ML100480729.

UniStar Nuclear Development, LLC (UniStar). 2009a. *Calvert Cliffs Nuclear Power Plant Unit 3, Combined License Application, Part 3, Environmental Report.* Revision 6, Baltimore, Maryland, September 30, 2009. Accession No. ML092880921.

UniStar Nuclear Energy (UniStar). 2009b. Letter from G. Gibson (UniStar) to U.S. Nuclear Regulatory Commission in response to NRC letter dated February 3, 2009, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Calvert Cliffs Nuclear Power Plant, Unit 3, Environmental RAIs No. 1001 through 1011." March 5, 2009. Accession No. ML090710146.

UniStar Nuclear Energy (UniStar). 2009c. Letter from G. Gibson (UniStar) to U.S. Nuclear Regulatory Commission, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Calvert Cliffs Nuclear Power Plant, Unit 3, Restrictions of Construction/Refurbishment of the Barge Slip/Unloading Facility and Associated Dredging." April 14, 2009. Accession No. ML091060748.

UniStar Nuclear Energy (UniStar). 2009d. Letter from G. Gibson (UniStar) to U.S. Nuclear Regulatory Commission, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Calvert Cliffs Nuclear Power Plant, Unit 3, Follow-up Response to Environmental Report RAI No. 124, Estimated Tax Benefit." November 19, 2009. Accession No. ML093220193.

UniStar Nuclear Energy (UniStar). 2009e. Letter from G. Gibson (UniStar) to U.S. Nuclear Regulatory Commission, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Calvert Cliffs Nuclear Power Plant, Unit 3, Responses to NRC Telecom Questions Regarding Combined License Application (COLA) Revision 6, Environmental Report." December 4, 2009. Accession No. ML093421232.

University of Michigan Museum of Zoology. 2008. *Gastrophryne carolinensis, eastern narrow-mouthed toad.* Accessed April 29, 2008 at http://animaldiversity.ummz.umich.edu/site/accounts/information/Gastrophryne_carolinensis.htm.

University of Michigan Transportation Research Institute (UMTRI). 2003. *Evaluation of the Motor Carrier Management Information System Crash File, Phase One*. UMTRI, Ann Arbor, Michigan.

U.S. Army Corps of Engineers (USACE). 1987. *Corps of Engineers Wetlands Delineation Manual*. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

U.S. Army Corps of Engineers (USACE). 2002. *Regulatory Guidance Letter, Subject: Guidance on Compensatory Mitigation Projects for Aquatic Resource Impacts Under the Corps Regulatory Program Pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899*. No. 02-2. Accessed at http://www.usace.army.mil.

U.S. Army Corps of Engineers (USACE). 2010. Letter from K.B. Anderson (USACE) to R.J. Nelson (Office of Federal Agency Programs, Advisory Council on Historic Preservation), Review of US Army Corps of Engineers and Maryland State Historic Preservation Officer regarding Calvert Cliffs 3 Nuclear Plant (CENAB-OP-RMS) effect on historic properties and Memorandum of Agreement. March 16, 2010. Accession No. ML100810272.

U.S. Army Corps of Engineers and U.S. Nuclear Regulatory Commission (USACE and NRC). 2008. *Memorandum of Understanding: Environmental Reviews Related to the Issuance of Authorizations to Construct and Operate Nuclear Power Plants*. September 12, 2008. Accession No. ML082540354.

U.S. Bureau of Labor Statistics (USBLS). 2008a. *TABLE 1. Incidence Rates of Nonfatal Occupational Injuries and Illnesses by Industry and Case Types, 2007*. Accessed December 30, 2009 at http://www.bls.gov/iif/oshwc/osh/os/ostb1917.pdf. Accession No. ML093210629.

U.S. Bureau of Labor Statistics (USBLS). 2008b. *TABLE 6. Incidence Rates of Nonfatal Occupational Injuries and Illnesses by Industry and Case Types, 2007 – Maryland*. Accessed December 30, 2009 at http://www.bls.gov/iif/oshwc/osh/pr076md.pdf. Accession No. ML093210629.

U.S. Department of Agriculture (USDA). 2008a. *Plants Profile,* Quercus prinus *L., chestnut oak*. Accessed February 15, 2008 at http://plants.usda.gov/java/profile?symbol=QUPR2. Accession No. ML093210633.

U.S. Department of Agriculture (USDA). 2008b. *Plants Profile,* Kalmia latifolia *L., mountain laurel*. Accessed February 19, 2008 at http://plants.usda.gov/java/nameSearch. Accession No. ML100490942.

U.S. Department of Agriculture (USDA). 2008c. *Plants Profile,* Thelypteris noveboracensis *(L.) Nieuwl., New York fern*. Accessed February 19, 2008 at http://plants.usda.gov/java/nameSearch. Accession No. ML100490967.

U.S. Department of Agriculture (USDA). 2008d. *Plants Profile,* Quercus shumardii *Buckley Shumard's oak*. Accessed February 14, 2008 at http://plants.usda.gov/java/profile?symbol=QUSH. Accession No. ML093210634.

U.S. Department of Agriculture (USDA). 2008e. *Plants Profile,* Liriodendron tulipifera *L. tuliptree*. Accessed February 15, 2008 at http://plants.usda.gov/java/profile?symbol=LITU. Accession No. ML093210632.

U.S. Department of Transportation (DOT). 2003. "From Home to Work, the Average Commute is 26.4 Minutes," *Omnistats*, Volume 3, Issue 4. October 2003. Accession No. ML100621425.

U.S. Department of Transportation (DOT). 2007. *National Transportation Statistics 2007.* Accessed at http://www.bts.gov/publications/national_transportation_statistics/.

U.S. Department of Transportation (DOT). 2008a. *Maryland, Toll of Motor Vehicle Crashes, 2006*. Accessed February 19, 2010 http://www-nrd.nhtsa.dot.gov/departments/nrd-30/ncsa/stsi/24_MD/2006/24_MD_2006.htm. Accession No. ML100500636.

U.S. Department of Transportation (DOT). 2008b. *Maryland - Calvert County, Toll of Motor Vehicle Crashes, 2006*. Accessed at http://www-nrd.nhtsa.dot.gov/departments/nrd-30/ncsa/stsi/24_MD/2006/Counties/Maryland_Calvert%20County_2006.htm.

U.S. Environmental Protection Agency (EPA). 2003. *Water on Tap: What You Need to Know.* Office of Water, EPA 816-K-03-007, Washington, D.C. Available at www.pueblo.gsa.gov/cic_text/health/watertap/ch4.htm.

U.S. Environmental Protection Agency (EPA). 2009. *Global Greenhouse Gas Data*. Accessed December 15, 2009 at http://www.epa.gov/climatechange/emissions/globalghg.html. Accession No. ML100221499.

U.S. Fish and Wildlife Service (FWS). 1993. *Puritan Tiger Beetle (Cicindela Puritana G. Horn Recovery Plan*. U.S. Fish and Wildlife Service Northeast Region, Hadley, Massachusetts.

U.S. Fish and Wildlife Service (FWS). 2007. *National Bald Eagle Management Guidelines*. Accession No. ML083260017.

U.S. Fish and Wildlife Service (FWS). 2009. Email from B. Zepp (FWS) to K. Anderson (US ACE) regarding Calvert Cliffs Migratory Bird Act briefly stating that there would be no time of year (TOY) construction restriction for migratory birds. January 29, 2009. Accession No. ML091671068.

U.S. Geological Survey (USGS). 2008. *ARMI National Atlas for Amphibian Distributions.* Accessed February 7, 2008 at http://www.pwrc.usgs.gov/armiatlas/species.cfm?recordID=173467. Accession No. ML093210639.

U.S. Minerals Management Service (MMS). 2009*. Cape Wind Energy Project Final Environmental Impact Statement.* OCS Publication No. 2008-040, U.S. Department of Interior, Minerals Management Service, Herndon, Virginia.

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, *Main Report,* NUREG-1437, Vols. 1 and 2, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report,* NUREG-1437, Addendum 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2002. *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, Supplement 1 Regarding the Decommissioning of Nuclear Power Reactors*. NUREG-0586, Supplement 1, Vol. 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2008. *Final Environmental Impact Statement for an Early Site Permit (ESP) at the Vogtle Electric Generating Plant Site.* NUREG-1982, Washington, D.C.

Viada, S.T., R.M. Hammer, R. Racca, D. Hannay, M.J. Thompson, B.J. Balcom, and N.W. Phillips. 2007. "Review of Potential Impacts to Sea Turtles from Underwater Explosive Removal of Offshore Structures." *Environmental Impact Assessment Review* 28:267–285.

5.0 Station Operation Impacts at the Proposed Site

This chapter examines environmental impacts associated with operation of the proposed new nuclear Unit 3 at the Calvert Cliffs site for an initial 40-year period as described by UniStar. As part of its combined license (COL) application, UniStar submitted an Environmental Report (ER) that discussed the environmental impacts of station operation (UniStar 2009a). In its evaluation of operational impacts, the U.S. Nuclear Regulatory Commission (NRC) staff relied on operation details supplied by UniStar in its ER and its responses to NRC Requests for Additional Information (RAIs). Also consulted were permitting correspondences between UniStar and the U.S. Army Corps of Engineers (USACE or Corps), a cooperating agency for preparation of this environmental impact statement (EIS), and the Maryland Department of the Environment (MDE) (UniStar 2009b).

This chapter is divided into 13 sections. Sections 5.1 through 5.11 respectively discuss the potential operational impacts related to land use, meteorology and air quality, water, terrestrial and aquatic ecosystems, socioeconomics, historic and cultural resources, environmental justice, nonradiological and radiological health effects, postulated accidents, and applicable measures and controls that would limit the adverse impacts of station operation during the 40-year operating period. In accordance with Title 10 of the Code of Federal Regulations (CFR) Part 51, impacts have been analyzed and a significance level of potential adverse impacts (i.e., SMALL, MODERATE, or LARGE) has been assigned to each impact category. In the area of socioeconomics related to taxes, the impacts may be considered beneficial and are stated as such. The staff's determination of significance levels is based on the assumption that the mitigation measures identified in the ER or activities planned by various state and county governments, such as infrastructure upgrades, as discussed throughout this chapter, are implemented. Failure to implement these upgrades might result in a change in significance level. Possible mitigation of adverse impacts is also presented, where appropriate. A summary of these impacts is presented in Section 5.12. The references cited in this chapter are listed in Section 5.13.

5.1 Land-Use Impacts

Sections 5.1.1 and 5.1.2 contain information regarding land-use impacts associated with operation of proposed Unit 3 at the Calvert Cliffs site. Section 5.1.1 discusses land-use impacts at the site and in the vicinity of the site. Section 5.1.2 discusses land-use impacts with respect to offsite transmission line corridors and other offsite areas.

5.1.1 The Site and Vicinity

Onsite land-use impacts from operation of proposed Unit 3 are expected to be minimal. Proposed Unit 3 would use one mechanical draft cooling tower with plume abatement to dissipate waste heat (UniStar 2009a). As discussed in Sections 5.3.1.1 and 5.7.1, operation of the cooling system would have minimal impacts on vegetation. In addition, a small area within the Chesapeake Bay would experience impacts from the operation of proposed Unit 3. Small portions of the Captain John Smith Chesapeake National Historic Trail and the Star-Spangled Banner National Historic Trail would overlap with the in-water exclusion area required for the operation of Unit 3. An in-water exclusion area already exists at the site for the operation of existing Units 1 and 2; therefore, the slight expansion of the already existing exclusion area would result in negligible impacts to these trails.

Based on the information provided by UniStar and the review team's own independent evaluation, the review team concludes that the land-use impacts of operation would be SMALL, and additional mitigation would not be warranted.

5.1.2 Transmission Line Corridors and Offsite Areas

Some offsite land-use changes can be expected as a result of operational activities. Possible changes include the conversion of some land in surrounding areas to housing developments (e.g., recreational vehicle parks, apartment buildings, single-family condominiums and homes, and manufactured home parks) and retail development to serve plant workers. Property tax revenue from the addition of a new nuclear unit could also lead to additional growth in Calvert County as a result of infrastructure improvements (e.g., new roads and utility services). Additional information on operational-related infrastructure impacts is presented in Section 5.4.

No new offsite transmission line corridors are planned for proposed Unit 3 (UniStar 2009a). Consequently, no new land-use impacts resulting from operation of transmission lines serving Unit 3 are expected. Therefore, the review team concludes that the offsite land-use transmission line corridor impacts of operating Unit 3 would be SMALL, and mitigation would not be warranted. Transmission line corridor management practices are discussed in Section 5.3.

5.2 Water-Related Impacts

This section discusses water-use and water-quality-related impacts in the surrounding environment from operation of the proposed Unit 3. The primary water-related impacts are associated with proposed Unit 3's cooling water system. Details of the operational modes and cooling water systems associated with operation of the plant can be found in Section 3.3.2.2 of this EIS.

Managing water resources requires understanding and balancing the tradeoffs between various, often conflicting, objectives. At the Unit 3 site, these objectives include navigation, recreation, visual aesthetics, a fishery, and a variety of beneficial consumptive uses of water. The responsibility for any work in, over, or under navigable waters of the United States is delegated to the Corps. The MDE is responsible for protecting and restoring the quality of Maryland's water, air, and land resources, and is the Coastal Zone Management Agency in Maryland, which addresses Federal actions that are reasonably likely to affect any land or water use of natural water resources associated with the State's coastal zone.

Water-use and water-quality impacts involved with operation of a nuclear plant are similar to the impacts associated with any large thermoelectric power generation facility. Accordingly, UniStar must obtain the same water-related permits and certifications as any other large industrial facility. These include:

- Clean Water Act Section 401 Certification. This certification would be issued by the MDE and would ensure that operation of the plant would not conflict with state water-quality management programs.
- Clean Water Act Section 402(p) National Pollutant Discharge Elimination System (NPDES) Discharge Permit. This permit would be issued by the MDE and would regulate limits of pollutants in liquid discharges to surface water.
- Clean Water Act Section 316(a). This section regulates the cooling water discharges to protect the health of the aquatic environment. The scope will be covered under the NPDES permit with the MDE.
- Clean Water Act Section 316(b). This section regulates cooling water intake structures to minimize environmental impacts associated with location, design, construction, and capacity of those structures. The scope will be covered under the NPDES permit with the MDE.

This section discusses the hydrological alterations and the resulting water-use and water-quality impacts from operation of Unit 3. The combined impacts of operating Unit 3 along with Calvert Cliffs Nuclear Power Plant (CCNPP) Units 1 and 2, as well as other activities in the surrounding environment, are discussed in Chapter 7 (Cumulative Impacts) of this EIS.

5.2.1 Hydrological Alterations

This section addresses impacts that will occur during plant operation. During plant operations, all water needs would be met using Chesapeake Bay water. Most of that water would be used directly for cooling. The remainder would be treated in a desalination plant and used for power plant operations, such as freshwater makeup for the essential service water system (ESWS) cooling towers and the ultimate heat sink (UHS), potable water, and sanitary water. Unit 3 would not require groundwater for operational purposes. However, UniStar has requested that the groundwater wells installed to obtain construction water be made available in the event the desalination plant becomes temporarily nonoperational.

In summary, the hydrological alterations applicable to operations are limited to the intake of Chesapeake Bay water and discharge to the Bay of blowdown water and associated waste streams.

5.2.2 Water Use Impacts

A description of water-use impacts to surface water and groundwater is presented in the next sections. The water-resource usage by Unit 3 operations is limited to the Chesapeake Bay. Groundwater usage would be minimal.

5.2.2.1 Surface Water Use Impacts

Under average conditions, Unit 3 would withdraw 41,095 gpm from the Chesapeake Bay for cooling and other plant activities. Given the variations of salinity of the water at the intake, variations in circulating water supply system (CWS) cooling tower evaporation rates under different meteorological conditions, and plant operations modes, that withdrawal rate can be increased to a maximum of 47,383 gpm. A portion of the water withdrawn would be lost to the atmosphere via evaporation and to the adjacent land surface via drift. The remainder, along with minor amounts of treated wastewater, would be returned to the Bay. The projected average and maximum blowdown rates for plant operations are 21,019 and 24,363 gpm, respectively.

Discussions between UniStar and the Maryland Power Plant Research Program (PPRP) resulted in the PPRP recommending that the Chesapeake Bay water appropriation be increased to average and maximum values of 43,750 gpm (63 MGD) and 50,000 gpm (72 MGD), respectively (MPSC 2009). The appropriation values were increased to provide a 5 percent contingency as UniStar finalizes its design. For this EIS, however, the actual values provided by UniStar (2008a) were considered unless otherwise noted.

The Chesapeake Bay is large, occupying 4480 mi^2 and holding 1.8×10^{13} gal of water. The maximum annual plant consumption rate represents just 0.06 percent of the Bay volume. The comparison to just the freshwater inflow to the Bay is a nearly identical percentage. Based on the small volume of water consumed relative to the Bay’s water volume and the Bay’s freshwater inflow, the review team concludes that the impact to surface water use of operating the proposed Unit 3 would be SMALL, and mitigation would not be warranted.

5.2.2.2 Groundwater Use Impacts

UniStar does not plan to use groundwater for operation of the proposed Unit 3. For situations when the water supply from the desalination plant is temporarily interrupted, UniStar plans to have enough stored water to continue operations for up to 12 hours. For situations when the water supply from the desalination plan would be interrupted for more than 12 hours, UniStar has requested permission from the MDE to use groundwater from the Aquia aquifer at the rate of 1,250,000 gpd for up to 15 days; the MDE is evaluating this request. The total quantity of groundwater represented by this request would be equivalent to about a half year of groundwater pumping at the rate already approved for an 8-year construction period. Because the total groundwater withdrawal proposed for this emergency use is much smaller than the total withdrawal approved for construction, the review team concludes that the impact to groundwater of operating the proposed Unit 3 would be SMALL, and mitigation would not be warranted.

5.2.3 Water Quality Impacts

This section discusses the impacts to the quality of water resources from the operation of proposed Unit 3.

5.2.3.1 Surface Water Quality Impacts

Surface water impacts include thermal, chemical, and radiological effluents discharged by the plant. The impacts of radiological liquid effluents are discussed in Section 5.9.

The Chesapeake Bay is listed as an impaired water body under Section 303(d) of the Clean Water Act because of low dissolved oxygen and the presence of nutrient pollution, such as nitrogen and phosphorus. Constellation Nuclear Energy Group, LLC (Constellation) has an NPDES permit for CCNNPP Units 1 and 2 that regulates their discharge of heated water and the concentration of several specific chemical constituents. During its license renewal evaluation of Units 1 and 2, the NRC staff concluded that the water quality impacts of these two units were SMALL (NRC 1996, 1999).[a]

State of Maryland regulations (COMAR 2007a, b) governing the thermal discharge from Unit 3 are the following:

> (a) The 24-hour average of the maximum radial dimension measured from the point of discharge to the boundary of the full capacity 2°C above ambient isotherm (measured during the critical periods) may not exceed 1/2 of the average ebb tidal excursion.

(a) NUREG-1437 was originally issued in 1996. Addendum 1 to NUREG-1437 was issued in 1999. Hereafter, all references to NUREG-1437 include NUREG-1437 and its Addendum 1.

(b) The 24-hour average full capacity 2°C above ambient thermal barrier (measured during the critical periods) may not exceed 50 percent of the accessible cross section of the receiving water body. Both cross sections shall be taken in the same plane.

(c) The 24-hour average area of the bottom touched by waters heated 2°C or more above ambient at full capacity (measured during the critical periods) may not exceed 5 percent of the bottom beneath the average ebb tidal excursion multiplied by the width of the receiving water body.

(d) The maximum temperature outside the mixing zone may not exceed 90°F (32°C) or the ambient temperature of the surface waters, whichever is greater.

(e) A thermal barrier that adversely affects aquatic life may not be established.

Using the CORMIX model (Doneker and Jirka 2007), UniStar calculated that the thermal discharge from Unit 3 would meet all State of Maryland requirements (UniStar 2008a). For example, the area of bottom touched by water 2°C above ambient was about 2.9×10^4 ft^2, which is 0.02% of the permissible area per COMAR 2007a. UniStar's analysis also showed that there is no interaction between the larger discharge plumes from CCNPP Units 1 and 2 and the plume from Unit 3. The review team conducted an independent confirmatory evaluation with the CORMIX model and the maximum discharge volume proposed by UniStar and produced similar results.

The sources of discharge water from Unit 3 include blowdown from the CWS tower, the ESWS cooling towers, the desalination plant, and site waste streams. Discharge from these sources would be routed to a common retention basin before being discharged to the Chesapeake Bay. The constituents that end up in this basin prior to discharge include biocides, chemicals (including chromium and zinc), organics, and dissolved solids. Water evaporates in the cooling tower, leaving the concentration of solutes dissolved in the cooling water at higher levels. The evaporation process merely concentrates the solutes already in the Chesapeake Bay waters and does not add any new solutes. However, additional chemicals, such as biocides, are added to control the chemistry of the cooling water. With the exception of the greater concentration of solutes from the Bay's water and small quantities of cooling tower treatment chemicals, these constituents are similar to discharges from CCNPP Units 1 and 2. The discharge from Unit 3 would be regulated by the NDPES permit that would be issued by MDE prior to initiation of operation.

Turbidity issues associated with disturbance of sediments at both water intake and discharge from Unit 3 could affect water quality. The Unit 3 inlet area will share the southeast end of the existing intake bay with CCNPP Units 1 and 2. Siltation has occurred at this location, requiring periodic dredging that has been conducted in accordance with the Corps and Maryland State requirements. NRC (1996) considered the impacts of the CCNPP Units 1 and 2 intake structure, including altered current patterns and salinity gradients, scouring, and water use conflicts and concluded that the impacts were small. The intake rate for Unit 3 is only 2 percent of the intake rate for CCNPP Units 1 and 2. Because the increase in overall intake is small and the intake velocity would be kept below 0.5 ft/s, sedimentation, current patterns, and salinity gradients caused by operation of all three units ought to be similar to those currently observed for CCNPP Units 1 and 2. Therefore, operation of the proposed Unit 3 intake structure would have no detectable impact on the water quality of the Chesapeake Bay.

The discharge from CCNPP Units 1 and 2 scoured the sediment in a small area around the discharge ports. The scouring removed the sand substrate that was initially present to reveal a hard-pan clay substrate. The rate of discharge from proposed Unit 3 would be about 1 percent of that for CCNPP Units 1 and 2, so that scouring should be much less. Therefore, there should be little impact to the water quality of the Chesapeake Bay from any scouring caused by discharge from Unit 3.

Discharges from the cooling tower and the chemical additives that would be used to ensure proper functioning of the cooling system are regulated by U.S. Environmental Protection Agency (EPA) under 40 CFR Part 423 to ensure protection of water resources. Other chemical effluents are regulated through the NPDES permit. The rapid dilution confirmed by the review team's independent review of the CORMIX analysis establishes that a small mixing zone would restore concentrations to ambient levels within a short distance of the discharge.

Given that the discharges would have relatively low projected contaminant levels, that they would be controlled through the permitting process, and that they would be similar to an already permitted discharge, and given the review team's independent confirmation that thermal and chemical plant discharges to the Chesapeake Bay would have minimal impact, the review team concludes the impacts of the proposed Unit 3 discharges on water quality would be SMALL, and additional mitigation would not be warranted.

5.2.3.2 Groundwater Quality Impacts

The proposed Unit 3 would not use groundwater for operation and would not discharge any liquids to groundwater during operations. Therefore, the review team concludes that the impacts to groundwater quality of proposed Unit 3 operation would be SMALL, and mitigation is not warranted.

5.2.4 Water Monitoring

There are no monitoring requirements imposed by the NRC for water-use or nonradiological water-quality. However, hydrological monitoring of the proposed new intake would be required by the State of Maryland. Hydrological, thermal, and chemical monitoring would likely be required by MDE as part of the NPDES permit. Monitoring would be required to ensure compliance with the State of Maryland's regulations regarding thermal discharges (see Section 5.3.2.1).

5.3 Ecological Impacts

This section describes the potential impacts to ecological resources from operation of the proposed Unit 3, transmission line operation, and transmission line corridor maintenance. The impacts are discussed for terrestrial and aquatic ecosystems.

5.3.1 Terrestrial and Wetland Impacts

Impacts on terrestrial communities and species related to the operation of proposed Unit 3 usually result from cooling system operations and transmission line operation and maintenance. Operation of the cooling system can result in deposition of dissolved solids; increased local fogging, precipitation, or icing; increased noise levels; a greater risk of collision mortality; and shoreline alteration of the source waterbody. Impacts from the operation and maintenance of the transmission system that may affect terrestrial species include collision mortality and electrocution, electromagnetic fields (EMF), and the maintenance of vegetation within transmission line corridors. Impacts of transmission on terrestrial resources are discussed in Section 5.3.1.2.

As described in Chapter 3, the proposed cooling system for proposed Unit 3 at the Calvert Cliffs site is a closed-cycle system using a single plume-abated mechanical draft cooling tower. The heat would be transferred to the atmosphere in the form of water vapor and drift. Typically, vapor plumes and drift from cooling towers may affect crops, ornamental vegetation, and native plants, and water losses from cooling tower operation could affect shoreline habitat. In addition, bird collisions and noise-related impacts are possible with mechanical draft cooling towers and other tall structures.

5.3.1.1 Terrestrial Resources – Site and Vicinity

Cooling System Impacts on Vegetation

Native plants, ornamental plants, and agricultural crops may be affected by cooling tower drift, fogging, and increased humidity. There is no agriculture on the Calvert Cliffs site, and land cover on site and in the vicinity includes forests, wetlands, and openings from previous disturbance.

Total dissolved solids (TDS), including salt, can stress vegetation after being deposited directly onto foliage or indirectly from the accumulation in the soils. Visible leaf damage has been observed when TDS is deposited in the range of 9 to 18 lb/ac per month on leaves during the growing season (NRC 1996). Flowering dogwood (*Cornus florida*), a forest shrub also present in mixed deciduous understories of the Calvert Cliffs site, was identified by Tetra Tech NUS (2007) as the most sensitive to acute injury from salt deposition in Calvert County. Acute toxicity was documented for flowering dogwood at TDS deposition rates exceeding 4.6 lb/ac per month (NRC 1996). Onsite TDS deposition could be as high as 1.96 lb/ac per month, and a maximum TDS deposition of 0.71 lb/ac per month would occur offsite and south of the site boundary (UniStar 2009a). All of these deposition levels are well below the level that would cause leaf damage to even the sensitive flowering dogwood (NRC 1996). Therefore, cooling tower operation impacts would be negligible on vegetation both on the Calvert Cliffs site and in the vicinity.

Fauna collisions with Power Plant Structures

The potential for avian mortality due to collision with proposed nuclear power plant structures does exist. Typically, the cooling tower and the meteorological tower are the structures likely to pose the greatest risk, with other tall structures like the containment building and vent stack posing less of a risk. With a cooling tower 164 ft tall and a scant plume, bird collision mortality would be unlikely at the Calvert Cliffs site. Even if collisions do occur, thriving bird populations can withstand these losses without threat to their continued existence (Brown 1993), and the NRC concluded that the threat of avian collision being a biologically significant source of mortality is very low (NRC 1996). Therefore, mortality from birds colliding with buildings, including the cooling tower, containment building, and vent stack, are expected to be undetectable at a population level.

Noise

Plant operations are not expected to emit noise at levels above those known to cause a startle response in wildlife (UniStar 2009a). Although noise levels would be greatest near the cooling tower, noise would be partially attenuated by surrounding forest cover. Also, noise from cooling tower operation is broadband noise, which is often indistinguishable from ambient noise. Wildlife species sensitive to noise may be displaced from suitable habitat immediately adjacent to Unit 3, but most local wildlife would likely adapt to operational noise levels. Operational noise-related impacts to wildlife are expected to be negligible.

5.3.1.2 Terrestrial Resources – Transmission Line Corridors

Two existing 500-kV transmission line corridors currently service CCNPP Units 1 and 2. To accommodate the proposed Unit 3, two new 500-kV circuits would be operated to connect proposed Unit 3 to the existing CCNPP Units 1 and 2 substation onsite in the existing 1-mi-long corridor. Construction impacts of this connection were discussed in Chapter 4, and impacts related to operation and maintenance of the new lines are discussed here.

The primary transmission maintenance activity that may affect terrestrial resources is vegetation control. The annual mowing of herbaceous and low woody vegetation and cutting of large shrubs and trees every fifth year would continue (UniStar 2009a). Increased erosion and sedimentation may occur along access roads and in areas where heavy machinery is used. To minimize this, access roadways are covered with gravel to prevent degradation, allowed to revegetate with grass, and are cut as necessary to maintain access. Herbicides are also used occasionally when needed and are only applied in accordance with the Baltimore Gas and Electric Company (BGE) Forestry Program (UniStar 2009a) that follows industry standards established by the Tree Care Industry Association. Also, the suppression of woody vegetation within the existing transmission line corridors may contribute to forest interior dwelling species (FIDS) nest parasitism, as it maintains forest edge habitat created during building of the transmission line corridors. The brown-headed cowbird (*Molothrus ater*), a bird species that thrives along forest edge, parasitizes songbird nests (Cornell 2008) and could affect FIDS, such as the scarlet tanager (*Piranga olivacea*). Therefore, maintenance of transmission corridors to support the operation of the proposed Unit 3 could adversely affect important species, such as FIDS, and their habitats. However, new maintenance specific to the operation of Unit 3 would be limited to the new 1-mi-long corridor, and this corridor is located adjacent to the project footprint, minimizing the edge effects of forest fragmentation to the extent possible. Effects would not be substantial.

Impacts of Avian Mortality from Power Transmission

Avian mortality may result from collision with tall, artificial human-built structures (FCC 2004). Two new circuits and associated towers would be installed for proposed Unit 3 within a new 1-mi-long corridor. Although electrocution of an immature bald eagle from the existing transmission system was documented on the Calvert Cliffs site and reported (Constellation 2004), this event is likely an isolated event, and the addition of the towers is not expected to noticeably affect eagle populations. The NRC (1996) concluded that bird collisions with transmission lines are of small significance at existing U.S. nuclear power plants, including transmission lines corridors with variable numbers of transmission lines. This level of mortality would not cause a measurable reduction in local bird populations. Consequently, the incremental number of bird collisions posed by the operation of the two new 1-mi-long transmission lines for the proposed Unit 3 would be negligible.

Impacts of Electromagnetic Fields on Flora and Fauna

<u>Flora</u>

The NRC determined EMFs produced by operating transmission lines for existing U.S. nuclear power plants up to 1100 kV were not linked to significant harmful effects on flora (NRC 1996). Minor damage to plant foliage and buds can occur near strong electric fields, caused by heating of the leaf tips and margins. Damage does not appear within lower levels of the plants and would not significantly affect growth (NRC 1996). Therefore, the increased EMF posed by the operation of the proposed transmission lines would have a minimal impact on flora.

<u>Fauna</u>

EMFs have been demonstrated to affect some fauna. Voltage buildup can affect overall health of honeybee hives (NRC 1996). Birds that nest within transmission line corridors experience chronic EMF exposure, but lines energized at levels less than 765 kV did not affect terrestrial biota (NRC 1996). The NRC concluded that the impacts of EMF exposure on terrestrial fauna were of small significance at operating U.S. nuclear power plants, including transmission systems with variable numbers of transmission lines (NRC 1996). Therefore, the incremental EMF impact on fauna posed by the operation of the proposed transmission lines at the Calvert Cliffs site would be minimal.

5.3.1.3 Important Terrestrial Species and Habitat

This section discusses the potential impacts of operation of the proposed Unit 3 on important species, including Federally and State-listed species, and important habitats.

Federally Listed Species

Two Federally listed or proposed threatened or endangered species exists on or near the Calvert Cliffs site: the Puritan tiger beetle (*Cicindela puritana*) and the northeastern beach tiger beetle (*Cicindela dorsalis dorsalis*). The Puritan tiger beetle inhabits steep, bare bluffs of the Chesapeake Bay and the narrow beaches below. This species is found on the southern portion of the Calvert Cliffs site. The northeastern beach tiger beetle inhabits the upper intertidal beaches of the Chesapeake Bay on the Flag Ponds Natural Area immediately north of the Calvert Cliffs site. Adults are occasionally found on the northern most 300 ft of beach that adjoins Flag Ponds Natural Area.

Chesapeake Bay is the cooling water source for the proposed Unit 3, and water withdrawal from the Bay has the potential to affect the two tiger beetle species. However, the impact on the shoreline of water withdrawal for cooling Unit 3 would not be measurable. As a result of withdrawal, beach habitat would not be altered, and tiger beetles as well as other fauna and flora residing along the Chesapeake Bay shoreline would be unaffected. Maintenance dredging also has the potential to affect the tiger beetles. A few adult Puritan tiger beetles have been observed on beaches adjacent to the barge dock (Knisley 2009). Activities that occur on the beach during the time of year these beetles are active could directly affect Puritan tiger beetles; also, activities that alter the beach when the beetles are not active could affect their habitat. However, it is likely that FWS and/or the Corps would require protective measures, such as time-of-year restrictions, if maintenance dredging is conducted in a manner that may affect the beetles. Consequently, the potential effects on Federally listed species from operation of the proposed Unit 3 and from maintenance dredging would be unlikely to adversely affect the Puritan tiger beetle and northeastern beach tiger beetle populations.

State-Listed Species

Species listed by the State of Maryland and known to occur on the Calvert Cliffs site include the bald eagle (*Haliaeetus leucocephalus*), eastern narrow-mouthed toad (*Gastrophryne carolinensis*), showy goldenrod (*Solidago speciosa*), spurred butterfly pea (*Centrosema virginianum*), and Shumard's oak (*Quercus shumardii*). Noise and human activity from the operation of the proposed Unit 3 may displace bald eagles in the immediate vicinity of Unit 3. However, known active bald eagle nests are located a sufficient distance away from the proposed cooling tower location, which minimizes effects from noise that would result in disturbance as defined by the FWS (FWS 2007). An immature bald eagle was electrocuted on a transmission line that services CCNPP Units 1 and 2 (Constellation 2004). It was determined that this incident was likely isolated, and no corrective action was recommended or taken (Constellation 2004).

The eastern narrow-mouthed toad is not known to occur within the footprint of the proposed Unit 3. However, it may occur in nearby wetlands, and both TDS deposition and herbicide use could affect water chemistry within those wetlands. TDS deposition is not known to affect wetlands in temperate climates (NRC 1996), and as discussed above, cooling tower operation would result in minimal amounts of TDS deposition. Best Management Practices (BMPs) for vegetation maintenance would be used to minimize herbicide use in sensitive areas such as wetlands. Therefore, effects from the operation of the proposed Unit 3 on eastern narrow-mouthed toads, if present in the vicinity, are not expected to be noticeable.

Operational impacts to State-listed plant species would most likely result from cooling tower operation and transmission line maintenance. TDS deposition could affect plants, but deposition from the proposed Unit 3 cooling tower is expected to be far below levels that would have any effect on plants. The showy goldenrod only occurs in open habitats, and vegetation management maintains the transmission line corridors as open habitat potentially suitable for showy goldenrod. The spurred butterfly pea is a habitat generalist and could occur in the open or under a forest canopy, and Shumard's oak could become established within transmission line corridors if maintenance ceased. However, regular vegetation management within transmission line corridors would likely preclude showy goldenrod, spurred butterfly pea and Shumard's oak from becoming established within transmission line corridors. Since none of these species are currently known to occur within the transmission line corridors, adverse impacts to State-listed plant species from the operation of the proposed Unit 3 would be minimal. For these reasons, adverse impacts to State-listed species may result from the operation of the proposed Unit 3, but the impacts would be minor.

Wetlands Impacts Related to Operations

As mentioned above, both TDS deposition and herbicide use could affect water chemistry within wetlands. TDS deposition is not known to affect wetlands in temperate climates (NRC 1996), and as discussed above, cooling tower operation would result in minimal amounts of TDS deposition. The new onsite transmission corridor would not traverse any wetlands or floodplains. As a result, operation of the proposed Unit 3 and maintenance of the transmission line corridors are not expected to have any adverse impact on wetlands.

5.3.1.4 Terrestrial Monitoring

There are no ongoing terrestrial monitoring activities related to transmission on the Calvert Cliffs site or identified for proposed Unit 3 operation.

5.3.1.5 Summary of Impacts to Terrestrial Resources

Maximum TDS deposition throughout the year, both on and off the Calvert Cliffs site, would be below the rate that would cause leaf damage to even the most sensitive species. Water droplets emitted from the proposed cooling tower would be minimal, so the potential for fogging, icing, or localized precipitation would be virtually eliminated. With a cooling tower only 164 ft tall, bird collision mortality would be unlikely. Plant operations would not be expected to emit noise at levels above ambient noise levels found along the Calvert Cliffs site boundary, and noise would likely be attenuated by surrounding forest cover, further limiting any impact. The amount of shoreline exposed from withdrawal from the Chesapeake Bay would not be measurable, and potential maintenance dredging of the barge slip would follow applicable permit conditions. Flora and fauna residing along the Chesapeake Bay shoreline, including two Federally listed tiger beetle species, would be minimally affected by operations.

To accommodate the proposed Unit 3, two new 500-kV circuits would be constructed to connect proposed Unit 3 to the existing CCNPP Units 1 and 2 switchyard. Impacts from operation and maintenance of the new transmission line corridor, such as vegetation removal, access road maintenance, and continued prevention of forest succession, would not be substantial. The new transmission corridor would not affect any wetlands or floodplains.

Operational impacts to State-listed species would likely result from transmission line corridor maintenance. Annual maintenance activities would likely preclude showy goldenrod, spurred butterfly pea, and Shumard's oak from becoming established within transmission line corridors. None of these species are currently known to occur within transmission corridors that would support the proposed Unit 3. Based on information provided by UniStar and the review team's independent review, the review team concludes that the impacts from the operation of proposed Unit 3 and associated transmission lines to Calvert Cliffs site terrestrial ecosystems would be SMALL, and additional mitigation would not be warranted.

5.3.2 Aquatic Impacts

This section discusses the potential impacts of the operation of the proposed Unit 3 and associated transmission lines on the freshwater resources in onsite streams and ponds and the estuarine resources in Chesapeake Bay.

5.3.2.1 Aquatic Resources – Site and the Vicinity

Stormwater Drainage

The principal impacts from the operation of proposed Unit 3 on the freshwater resources would be from the increased stormwater runoff from the 130 ac of impervious surfaces added to the site. During the period of operation, onsite streams, ponds, wetlands, and the Chesapeake Bay could be affected by stormwater drainage. UniStar prepared a conceptual stormwater management plan to control stormwater runoff that might occur during the construction and operation of proposed Unit 3 (Bechtel 2008). The plan considered applicable State of Maryland, Calvert County, and the U.S. Natural Resources Conservation Service regulations and design criteria. UniStar proposes to conduct a detailed stormwater management study to establish the specific design criteria necessary to maintain downstream flow rates, sediment loads, and water quality similar to those that now exist on the site. Because such design criteria would be protective of aquatic resources, the review team concludes that based on the use of a stormwater system described in the stormwater management plan, the impacts to onsite waterbodies and the Chesapeake Bay from operation of the proposed Unit 3 would be minor.

Salt deposition from the cooling tower plume would occur primarily to the southern part of the Calvert Cliffs site and would deposit a maximum of 1.96 lb/ac per month on the site (UniStar 2009a). Maximum deposition at the Unit 3 switchyard would be 1.2 lb/ac per month. Data on the sensitivity of aquatic organisms to salt deposition levels are not available. However, both maximum deposition values are much lower than that documented to affect sensitive terrestrial plants (see Section 5.3.1.1). Therefore, the effects of the predicted salt deposition on freshwater resources on the site would likely be minor.

Chesapeake Bay

In addition to the minor impacts from stormwater drainage as discussed above, the principal impacts from the operation of proposed Unit 3 on the Chesapeake Bay resources would be from operation of the proposed cooling system. This section discusses impacts on Bay resources from the proposed intakes and discharge as well as maintenance dredging.

Water Intake and Consumption

The primary concerns for aquatic resources related to water intake and consumption are the relative amount of water drawn from the cooling water source, the Chesapeake Bay, and the potential for organisms to be impinged on the intake screens, entrained into the cooling water system, or entrapped within the common intake forebay. Impingement occurs when organisms are trapped against the intake screens by the force of the water passing through the CWS. Fish and invertebrates that are impinged on the intake screens can be injured or killed. Some species survive impingement better than others. The intake system design for the proposed Unit 3 CWS includes a fish-return system located at the screens in the proposed forebay versus the expanded embayment. Larger animals, such as sea turtles, could be impinged on the trash racks at the intake pipeline openings in the wedge-shaped intake pool, or entrapped within the pool or within the common forebay. Entrainment occurs when organisms are drawn through the CWS into the plant's cooling system. Organisms that become entrained are normally relatively small benthic, planktonic, and nektonic (water column organisms) species, including early life stages of fish and shellfish, which often serve as prey for larger organisms (66 FR 65256). As entrained organisms pass through a plant's cooling system, they are subject to mechanical, pressure, thermal, and toxic stresses. For this analysis, the review team assumes 100 percent mortality as a result of entrainment. Entrapment would occur when entrained organisms remain within the common forebay and are not drawn into the traveling screens and associated fish-return system. Entrapment likely would result in the development of a mostly isolated, microcosmic estuarine ecosystem in the common forebay. Some entrapped animals could be impinged on trash racks or traveling screens at the CWS and UHS intakes.

An important factor affecting impingement and entrainment losses is the percentage of the flow of the source waterbody past the site that is withdrawn by the station. To minimize impact, the EPA determined that the total design intake flow over one tidal cycle of ebb and flow must be no greater than 1 percent of the water volume of the water column within the area centered about the opening of the intake with a diameter defined by the distance of one tidal excursion at the mean low water level. The intake design through-screen velocity greatly influences the rate of impingement of fish and shellfish at a facility. EPA determined that species and life stages evaluated in various studies could endure a velocity of 1.0 ft/sec and then applied a safety factor of two to derive the threshold of 0.5 ft/sec, which became established as a national standard for the maximum design through-screen velocity (66 FR 65256).

UniStar plans to use a closed-cycle, recirculating, wet cooling system with a cooling tower for the proposed Unit 3 (UniStar 2009a). The intake system for proposed Unit 3 would incorporate protection measures that may reduce entrainment and impingement. The estimated maximum intake volume of 47,383 gpm for the Unit 3 would not exceed the EPA 1-percent water column criterion (UniStar 2009a). The CWS proposed for Unit 3 would have a fish-return system generally similar to that employed at existing CCNPP Units 1 and 2. The UHS proposed for

Unit 3 would have traveling screens but would not have a fish-return system because it would operate only occasionally or in the case of a design basis accident (DBA) (UniStar 2009c). The proposed intake and fish-return system would include several features designed to reduce the chance for injury to organisms caught within the system (Section 3.3.2.1.1). Moreover, the through-screen flow velocity would be less than 0.5 ft/sec under the worst case scenario of minimum Chesapeake Bay level with highest makeup demand flow (UniStar 2009a). The projected intake flow for Unit 3 is about 96.8 cfs, which is considerably less than the combined flow of CCNPP Units 1 and 2 of 5332 cfs. Because the projected intake flow volume for Unit 3 is about 1.82 percent of that at CCNPP Units 1 and 2, and assuming that the relationship between flows is linear, the projected entrainment and impingement rates at Unit 3 are projected to be correspondingly small).

Despite the generally high productivity within Chesapeake Bay, the area off the Calvert Cliffs site, where the intake pipeline for Unit 3 begins, is not particularly productive although there is some recreational fishing in the area. As discussed in Section 2.4.2, there is no substantial submerged aquatic vegetation (SAV) habitat off the site, the benthic infaunal communities are degraded, and oysters are not abundant. The PPRP determined that the area off the Calvert Cliffs site is not a significant spawning area (McLean et al. 2002).

Entrainment

The review team used historical data collected at CCNPP Units 1 and 2 extrapolated to the proposed Unit 3 to evaluate the potential effects of entrainment within the cooling water system and the impingement on the intake traveling screens on estuarine biota. Phytoplankton data used to estimate entrainment at proposed Unit 3 were collected between 1978 through 1980 at CCNPP Units 1 and 2. Microzooplankton data were collected from 1974 through 1980, and ichthyoplankton data were collected in 1978 and 1979 (UniStar 2008a). More recently, ichthyoplankton entrainment sampling was conducted at the intake system of CCNPP Units 1 and 2 from March 2006 through September 2007 (EA Engineering 2008). Additional ichthyoplankton samples were collected just outside the existing baffle wall separating the intake area from the open waters of the Bay from April to December 2006, which allowed comparison of entrained organisms with natural populations in the Bay.

Several researchers used these historical data to evaluate the potential impacts of the CCNPP Units 1 and 2 intake on plankton communities near the site as part of a program to determine the overall effects of the plant on the Chesapeake Bay. Sellner and Kachur (1987) determined that entrainment within the cooling water system of CCNPP Units 1 and 2 significantly reduced phytoplankton density in the discharge stream and changed phytoplankton photosynthesis metabolism such that carbon fixation was reduced. Importantly, however, they determined that these changes had no discernable effect on the phytoplankton densities or metabolism in the Chesapeake Bay waters near the Calvert Cliffs site. Olson (1987) found that zooplankton densities were lower at the discharge point than they were at the intake point, which suggests that entrainment causes some zooplankton loss. Larval copepods were most affected. Olson also indicated that survival after entrainment was typically very high, about 65 to 100 percent for the species studied, and that no important changes in the zooplankton community could be detected. The predominant zooplankton included calanoid copepod larval stages (nauplii, copepodites) and adults. The predominant nauplii were of the copepod *Acartia tonsa*. The copepods *A. clausi* and *Eurytemora affinis* also were commonly found in the samples.

By extrapolating historical data, the review team estimated phytoplankton entrainment at proposed Unit 3 to range between 1.19×10^{16} and 4.25×10^{16} cells annually. The predominant groups included diatoms (Bacillariophyta), cryptomonads (Cryptophyta), dinoflagellates (Pyrrophyta), and blue-green algae (Cyanophyta). Similarly, the review team estimated the proposed Unit 3 annual entrainment for microzooplankton to range between 1.33×10^{21} and 2.50×10^{22} organisms.

EA Engineering (2008) estimated that the total ichthyoplankton entrainment from March 2006 to September 2007 at the maximum design flow for the intake systems of CCNPP Units 1 and 2, was at least 11.9 billion organisms, including fish fertilized eggs, larvae, juveniles, and adults. This value is a minimum estimate of the total potential entrainment because daytime samples were not collected in March 2006, October through December 2006, and January through March 2007. Most of the entrainment during the EA Engineering study occurred from May to September. The bay anchovy (*Anchoa mitchilli*), including all life stages, was the predominant taxon entrained, accounting for about 75 percent and 69 percent of the total organisms estimated as entrained during 2006 and 2007, respectively. About 5.7 million adult bay anchovies were estimated to be entrained at the maximum design flow rate. Sciaenid (croaker) eggs, Atlantic menhaden (*Brevoortia tyrannus*) eggs and larvae, and naked goby (*Gobiosoma bosc*) larvae and juveniles accounted for about 18.5, 3.3, and 1.5 percent of the entrained organisms, respectively. Hogchoker eggs (*Trinectes maculatus*), sciaenid eggs, and Atlantic menhaden eggs and larvae accounted for about 14.1, 6.0, and 4.9 percent of the organisms estimated entrained in 2007, respectively. Bay anchovy (all life stages), sciaenid eggs, Atlantic menhaden eggs and larvae, and naked goby larvae and juveniles were the predominant organisms collected just outside the intake system baffle wall, although the proportional contribution of each varied somewhat (EA Engineering 2008). Comparisons of the intake and baffle-wall samples showed that most taxa were entrained at rates relative to their occurrence in the Bay waters. However, juvenile bay anchovies, American eel juveniles, Atlantic menhaden eggs and larvae, and sciaenid eggs were more abundant at the intake than they were at the baffle wall.

The review team used the April through September data for each year to estimate the total potential entrainment by the proposed Unit 3 intake system because only those months had samples collected during the day and night. The April through September time period was the main period of entrainment captured by the study. Entrainment of most species and lifestages, except Atlantic croaker (*Micropogonias undulatus*) juveniles, was nonexistent or very reduced between October and March. The estimate also considered that the projected intake flow volume for the proposed Unit 3 would be about 1.82 percent of that at CCNPP Units 1 and 2 and assumed that the relationship between the two flows is linear. The review team's projection of ichthyoplankton entrainment by the intake system for the proposed Unit 3 for April through September ranged from about 83 million to about 132 million organisms. The projected annual total entrainment for the proposed Unit 3 would not be much greater than these estimates, with the possible exception of Atlantic croaker juveniles, because entrainment from April through September is much greater than it is during the rest of the year.

The review team did not compare these gross entrainment levels to total fish populations in the Bay because total fish population data are not directly comparable to them. Fish sampling techniques used to estimate population size do not capture all of the species that are entrained, and some entrained species are not caught by the surveys. It is more important to evaluate individual species that vary in entrainment susceptibility and population trends. Data on individual species, and the potential implications of entrainment on those species, are presented in the Important Species section. However, based on the percentage of water withdrawn, the planned low through-screen intake velocity, use of closed-cycle cooling, and the lack of significant spawning in the area, the review team finds that the impacts to Chesapeake Bay biota from entrainment at the proposed Unit 3 would be minor.

<u>Impingement</u>

The BGE sponsored impingement sampling at CCNPP Units 1 and 2 from 1975 through 1995 (Ringger 2000). Annual fish and blue crab (*Callinectes sapidus*) impingement during that time varied considerably (Table 5-1). Peak fish impingement occurred during the spring and summer. Blue crab impingement generally was greatest in spring, summer, or fall. Ringger (2000) identified two of the factors that contribute to increased impingement as low dissolved oxygen levels at night and weather-related sudden decreases in temperature (5.4 to 7.2°F in 1 to 2 days). There did not to appear to be annual trends, except that impingement generally appeared to be less after 1986 than previously. The most commonly impinged fish during the 21-year period were bay anchovy, hogchoker, spot (*Leiostomus xanthurus*), and Atlantic menhaden. As for fish, blue crab impingement generally was lower after the mid 1980s than before. Ringger (2000) attributed much of the variability in impingement to natural variation in environmental conditions. Ringger (2000) used the impingement data and data from survival studies to estimate the annual fish and blue crab mortality from impingement (Table 5-1). The apparent difference in impingement rates before and after the mid 1980s may be related to several operational and structural modifications to the intake and fish-return systems that were made from about 1984 to 1986, partly in response to severe impingement events that occurred in 1983 (Ringger 2000).

Table 5-1. Estimated Impingement and Mortality at CCNPP Units 1 and 2 (1975 to 1995) and Projected Values for Proposed Unit 3

Impingement		**Maximum Estimated Impingement**	**Minimum Estimated Impingement**	**Average Estimated Impingement**
Fish	Units 1 & 2	9,671,262	79,081	1,303,751
	Unit 3	175,684	1437	23,683
	Total	9,846,946	80,518	1,327,434
Blue Crabs	Units 1 & 2	1,883,619	81,927	627,711
	Unit 3	34,217	1488	11,403
	Total	1,917,836	83,415	639,114
Mortality		**Maximum Estimated Mortality**	**Minimum Estimated Mortality**	**Average Estimated Mortality**
Fish	Units 1 & 2	2,229,859	17,240	348,298
	Unit 3	40,507	313	6327
	Total	2,270,366	17,553	354,625
Blue Crabs	Units 1 & 2	10,172	442	3390
	Unit 3	185	8	62
	Total	10,357	450	3452

Source: CCNPP Units 1 and 2 data from Ringger 2000

The review team scaled the numbers of organisms impinged at CCNPP Units 1 and 2 to the proposed Unit 3 intake cooling water withdrawal flow. The average annual fish and blue crab impingement rates predicted for proposed Unit 3 are 23,683 fish and 11,403 crabs (Table 5-1). These resulted in estimated average annual impingement mortality rates at proposed Unit 3 of 6327 fish and 62 crabs (Table 5-1). The very low crab mortality estimate results from the high survival rate (99.46 percent) following impingement (Ringger 2000). The impingement mortality estimates for fish and blue crabs probably are somewhat conservative because the entire 21-year data set was used for the calculations regardless of apparently reduced impingement after modifications made in the mid 1980s to Units 1 and 2 (such modifications were implemented to reduce impingement) and because proposed Unit 3 intake approach velocities within the forebay would be less than 0.5 ft/sec, which would allow more fish and crabs to avoid impingement. Unit 3 would also incorporate a fish-return system in the common forebay that may help increase survival following impingement by returning fish and crabs beneath the surface of the Bay. The fish-return outfall pipe (Section 3.2.2) would extend about 40 ft into the Bay with end of the pipe emerging from the bay floor but remaining below mean lower low tide level (UniStar 2008b). This design was chosen to minimize any drop at the exit point to facilitate the returning of the fish to the Chesapeake Bay (UniStar 2008a).

The impingement of some large and/or abundant organisms occasionally may affect plant operations. Special Condition N of the NPDES permit for CCNPP Units 1 and 2 requires notification of any impingement on the water intake apparatus of aquatic organisms substantial enough to cause modification to plant operations within 24 hours (UniStar 2009a). CCNPP staff reported seven impingement incidents (from operation of Units 1 and 2) to the NRC in 2005 and 2006. In July and September 2006, there were five reported incidents of significant jellyfish impingement at the intakes of Units 1 and 2 that required one or more circulating water pumps to be secured temporarily (NRC 2006a, 2006b, 2006c, 2006e). The jellyfish species was not identified. The plant remained at 100 percent power during four of these occurrences. Significant fish kills involving cownose rays (*Rhinoptera bonasus*) were reported in the summer 2005 (80 to 100 rays) and 2006 (50 to 200 rays) (NRC 2005, 2006d). The rays were impinged on the trash racks of both units. Such impingement events could occur on the trash racks for proposed CWS intake pipes.

The proposed UHS intake system would not have an associated fish-return system. Any organisms that were caught on the traveling screens for the UHS pumps would be discarded and lost. However, because the UHS pumps would only operate periodically or in the case of a DBA (UniStar 2009c), the overall impingement losses at the UHS intake screens would likely be minor.

Water from the wedge-shaped pool would enter the common forebay that would supply water to the CWS and UHS intakes (Section 4.2). Organisms, such as cownose rays, impinged on the trash bars at the intake pipe openings would likely die because there is no rake or return system at that interface with the Bay. Such organisms would likely be larger than 3.5-in., which is the spacing between the trash bars. In addition, once in the wedge-shaped pool, organisms could grow and later be impinged at the trash bars or traveling screens in front of the CWS and UHS intakes.

The Unit 3 estimated impingement mortality values are extremely low compared to Bay populations. For example, the average annual fish mortality of 6327 is considerably less than the estimated population size of the bay anchovy alone (about 11.2 billion individuals between 1.2 and 10 in. long) (Table 5-2), one of the most commonly impinged species. The 2007 commercial blue crab catch in Maryland was about 22 million pounds (MDNR 2008). Assuming a conservative estimate of one pound per crab (the average weight is likely less than one pound), the 2007 catch would have been about 22 million individuals, much greater than the estimated Unit 3 annual impingement mortality of 62 crabs. Because of the planned low through-screen intake velocity, the use of closed-cycle cooling, the design of the fish-return system, and the historically low impingement mortality rates for the existing CCNPP Units 1 and 2, the review team concludes that impacts from impingement of fish and blue crabs for the proposed Unit 3 would be minor.

Entrapment

Organisms that enter the common CWS/UHS forebay could become entrapped there because there would be no mechanism to remove them from the common forebay other than the fish-return system associated with the CWS pumps (UniStar 2009c). The CWS and UHS intakes would have slow through-screen velocities, and it would be possible for some organisms to remain within the large common forebay without being drawn toward the intake structures. The review team did not have specific information about entrapment that would be necessary to confidently estimate the numbers of the individuals that would be entrapped. However, the species most likely to become entrapped would be those that were impinged by the traveling screens at CCNPP Units 1 and 2 and those whose early life stages were among the more commonly entrained organisms during the studies conducted at Units 1 and 2. Some species may thrive in the common forebay although others may not; regardless, all organisms entrapped in the forebay would be effectively removed from the Bay ecosystem. Because the review team concluded that the overall effects of entrainment and impingement were minor, the incremental effects of entrapment on aquatic resources in the Bay would likely also be minor.

Water Discharge

The effluent from proposed Unit 3 would be discharged directly into the Chesapeake Bay. Section 3.2.2 discusses the location and design of the discharge piping. The potential impacts to the Chesapeake Bay aquatic resources from the discharge of cooling water from the proposed Unit 3 include the impacts of heated effluents on aquatic resources, chemical impacts, and physical impacts.

Thermal Impacts

The review team used Abbe's (1987) evaluation of the potential effects of the thermal discharge from CCNPP Units 1 and 2 and the staff's CORMIX modeling (see Section 5.2.3.1) to estimate the potential impacts from the expected discharge for proposed Unit 3.

Abbe (1987) concluded that the thermal discharge from CCNPP Units 1 and 2 had no important adverse impacts on fish, eastern oysters, blue crabs, and soft-shell clams (*Mya arenaria*). In its latest review of issues concerning the operation of power plants in the State, the Maryland PPRP concluded that the effects of thermal discharges from power plants into Chesapeake Bay habitats were localized and not significant (MDNR PPRP 2008b). CORMIX modeling results indicate that the thermal discharge plume from proposed Unit 3 discharge would be small, and therefore, waste heat would dissipate quickly because of the small size of the thermal plume (see Section 5.2.3.1) and would not contribute to heat-shock stress to fish or crabs. The thermal plume's predicted small size suggests that it would have little, if any, effect on fish passage or the migration of other important aquatic organisms.

Cold shock occurs when aquatic organisms that have been acclimated to warm water, such as fish in a power plant's discharge canal, are exposed to a sudden temperature decrease, which sometimes occurs when power plants shut down suddenly in winter. Cold shock mortalities at U.S. nuclear power plants are "relatively rare" and typically involve few fish (NRC 1996). Abbe (1987) concluded that the potential for cold shock associated with the discharge plume from CCNPP Units 1 and 2 probably was not significant because the relatively small area of warmer water did not attract many fish during the winter. Cold shock is also unlikely to be a factor at the proposed Unit 3 site because the discharge is into a large bay where the volume of the discharge is very small in comparison to the volume of the Bay (UniStar 2008c).

Based on the foregoing, the review team concludes that the thermal impacts on the fish populations from proposed Unit 3 would be minor.

Chemical Impacts

The ER indicates that chemicals, such as anti-scaling compounds, corrosion inhibitors, and biocides, would be added to the cooling water system and the ESWS (UniStar 2009a). Biofouling normally would be controlled by injecting chlorine into the Chesapeake Bay influent water during the spring through fall (UniStar 2009a). The CWS would provide about 90 percent of the effluent discharged to the Chesapeake Bay, with the desalinization plant contributing another 9 percent (UniStar 2008a). UniStar provided estimated concentrations of various constituents in the waste stream based on design data. To illustrate the expected low concentrations of these constituents, UniStar compared expected concentrations of five metal contaminants (arsenic, chromium, copper, nickel, zinc) to aquatic life chronic salt water limits specified by the State of Maryland (COMAR 2008a). Predicted concentrations within the discharge from proposed Unit 3 would be substantially less than the State aquatic life limits (UniStar 2008a). UniStar would calculate more precise estimates of constituent concentrations in the effluent as part of the NPDES permitting process for Unit 3.

UniStar expects that the NPDES permit for Unit 3 would require bioassay testing as does the permit for Units 1 and 2 to assess the potential toxicity of the discharge and provide for corrective action if necessary. To date, the bioassay testing performed for CCNPP Units 1 and 2 has not indicated any toxicity to test organisms (UniStar 2009a). Based on the foregoing, the review team concludes that the chemical impacts on the aquatic resources from proposed Unit 3 would be minor.

Physical Impacts from Discharge

The primary physical and ecological impacts from the CCNPP Units 1 and 2 cooling water discharge are sediment scour near the high-velocity discharge. The bottom scour by the discharge from CCNPP Units 1 and 2 is about 42 ac (UniStar 2008a). The sand substrate present prior to the operation of CCNPP Units 1 and 2 was scoured by the discharge, leaving a hard clay substrate. The benthic community changed from one characterized by burrowing soft-bottom organisms to one dominated by fouling organisms (UniStar 2009a). The bottom scouring near the discharge from CCNPP Units 1 and 2 caused the habitat to change from sandy sediment to hard clay and also caused a change from a sand-inhabiting infaunal community to an epifaunal community comprised of oysters, mussels, barnacles, and sea anemones (Abbe 1987).

It is expected that the physical impacts associated with proposed Unit 3 cooling water discharge would be limited to sediment scour of a small area. The area of Bay bottom that may be scoured would be minimized by the placement of riprap for about 10 ft on either side of the diffuser (UniStar 2008b). The potential scour area was estimated by comparing the sediment type to expected discharge flow velocities. Sediments in the area are primarily sandy (Section 2.4.2), and UniStar calculated that a water velocity of about one ft/sec would be required to move sand particles of a size between 0.210 mm and 0.177 mm (0.008 and 0.007 in.) (UniStar 2008a). The distance beyond which water velocities are expected to drop below the one ft/sec threshold was estimated to be about 92 ft, which resulted in an estimated potential scour area of 13,256 ft^2, which is about 0.3 ac.

The infaunal community inhabiting the area near the discharge point, which was characterized during 2006 and 2007 (EA Engineering 2007), was moderately degraded to degraded (Section 2.4.2). The community had low organism abundance and few species. The predominant taxa were polychaete worms (*Streblospio benedicti*, *Glycinde solitaria*) and a small clam species (*Gemma gemma*). A historical study of benthic fish feeding at a location north of the Calvert Cliffs site (Kenwood Beach) found that nematode worms and polychaetes were among the predominant prey (UniStar 2008a).

A habitat change, similar to the scouring at the Unit 1 and 2 discharges, but much less extensive, is likely if the sediment becomes scoured near the discharge for Unit 3. The small predicted size of the potential scour area and relative impoverishment of the infaunal community that would be replaced would likely have a minor effect on the regional infaunal populations or their predators.

Based on this analysis of the potential for physical impacts to the aquatic ecosystem from the discharge of cooling water to the Chesapeake Bay and the review team's independent evaluation, the review team concludes that the physical impacts from discharges from the proposed Unit 3 would be minor.

<u>Maintenance Dredging</u>

During construction, an area adjacent to the existing barge dock that is about 1500-ft-long by 130-ft-wide (average width), covering 195,000 ft^2, would be dredged to a bottom elevation of −16 ft mean low water (UniStar 2008b). UniStar has requested permission from the Corps to conduct maintenance dredging of the barge dock area for 10 years (USACE 2008). Assuming that the dredging methods would be the same as those used during construction, the effects on the aquatic resources of Chesapeake Bay would be the same as those described in Section 4.3.2.1. These include disturbance of bottom habitats, which would limit any possible recolonization of the substrate, and increased water column turbidity.

5.3.2.2 Aquatic Resources – Transmission Line Corridor

The proposed transmission system includes a new 19-ac substation and two 1-mi-long connecting circuit lines with associated towers, all within the Calvert Cliffs site (UniStar 2009a). These facilities would connect to existing offsite Baltimore Gas and Electric transmission system via the existing onsite CCNPP Units 1 and 2 substation. The proposed new transmission lines would not cross any onsite waterbodies, but the transmission corridor approaches Johns Creek at one point (UniStar 2009a).

The operation and maintenance of transmission line corridors for the existing CCNPP Units 1 and 2 follow standard industry practices, and such procedures would be followed for the additional lines that service proposed Unit 3. Overgrown or diseased trees, and other vegetation, are pruned or removed according to relevant American National Standards Institute (ANSI) standards to reduce the likelihood that they may cause power outages or injury to the public and company employees (UniStar 2009a)

The transmission system and corridors are checked twice a year, with comprehensive inspections performed on a rotating five-year schedule. The inspections guide the maintenance performed on the corridors. Maintenance routinely involves cutting herbaceous and low, woody growth once a year, and cutting saplings, larger shrubs, and small trees every 5 years (UniStar 2009a). Herbicides and defoliants are used infrequently, if at all.

No direct impacts to the aquatic ecosystem in the Chesapeake Bay from transmission system operations are anticipated because the transmission facilities are not near the Bay (UniStar 2009a). Indirect impacts, such as the potential runoff of herbicides and defoliants, into tributary streams may occur, but the effects would be mitigated by stormwater retention facilities.

The review team concludes that transmission line corridor maintenance activities would not adversely affect aquatic resources or ecosystems and that additional mitigation beyond that described above would not be warranted.

5.3.2.3 Important Aquatic Species

The principal impacts from the operation of proposed Unit 3 on the important freshwater species listed in Section 2.4.2 would be from the increased stormwater runoff from the 130 ac of impervious surfaces added to the site. Runoff from these surfaces could carry sediment and contaminants into the freshwater resources onsite and into the Chesapeake Bay.

State and Federally-list Species

Important estuarine species would be affected primarily by the operation of the cooling water intake and discharge systems. Two State-listed estuarine species may occur on the site (Section 2.4.2). Sea purslane (*Sesuvium maritimum*) and the spotted killifish (*Fundulus luciae*) are listed as State endangered and State “Rare?”, respectively. Neither has been found on the site (Section 2.4.2) and neither is likely to be adversely affected by the operation of Unit 3. The shortnose sturgeon (*Acipenser brevirostrum*), loggerhead turtle (*Caretta caretta*), green turtle (*Chelonia mydas*), leatherback turtle (*Dermochelys coriacea*), and Kemp’s ridley turtle (*Lepidochelys kempii*) are the Federally listed species known to potentially occur near the Calvert Cliffs site. The Atlantic sturgeon (*Acipenser oxyrinchus*) is a Federal candidate species that may occur near the Calvert Cliffs site. The alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*) are Federally listed species of concern. In accordance with Section 7 of the ESA, the NRC and the Corps are jointly consulting with National Marine Fisheries Service (NMFS) regarding Federally listed estuarine species. The biological assessment is provided in Appendix F. There are no areas designated as critical habitat for threatened and endangered aquatic species near the Calvert Cliffs site.

The shortnose sturgeon and Atlantic sturgeon spawn in fresh waters, and the migration of young downstream does not occur until the late larval stage. Therefore, the eggs and young larvae of these two species are unlikely to be affected by entrainment in the cooling water intake of proposed Unit 3 (UniStar 2008c). Neither species was found in the entrainment samples collected at the intake system for Units 1 and 2 during 2006 and 2007 or in the samples collected outside the baffle wall in 2006 (EA Engineering 2008). Neither sturgeon species occurred in the impingement samples collected at CCNPP Units 1 and 2 from 1975 to 1995 (Ringger 2000). Only one shortnose sturgeon has been caught in trawls during the many years of sampling off the Calvert Cliffs site area, and none has been impinged (UniStar 2008c). For those reasons, the shortnose sturgeon and Atlantic sturgeon populations in the Chesapeake Bay are not expected to be adversely affected by operation of Unit 3.

Only two protected sea turtle species, the loggerhead and Kemp’s ridley, are likely to venture near the Calvert Cliffs site area (Section 2.4.2), although both are common in the lower Bay (Mansfield 2006). There are a few records of Kemp’s ridley and loggerhead turtles in waters off Calvert County (Section 2.4.2). A search of the event logs maintained by the NRC revealed the occurrence of fatal sea turtle impingement at the trash racks of the existing CCNPP facility (NRC 2001b). The impinged species was not identified. Leatherback and green turtles do not typically swim into the vicinity of the Calvert Cliffs site. Operation of the proposed Unit 3 is not expected to jeopardize the continued existence of loggerhead, Kemp’s ridley, green, or leatherback populations.

Two of the operational factors most likely to affect other important fish species are entrainment and impingement. The review team used the March 2006 through September 2007 entrainment data collected by EA Engineering to estimate the entrainment by the intake system for proposed Unit 3 that might have occurred during that 19-month time period (Table 5-2). Those entrainment data suggest that American eel, Atlantic croaker (*Micropogonias undulatus*), Atlantic menhaden, bay anchovy, spot (*Leiostomus xanthurus*), weakfish (*Cynoscion regalis*), white perch (*Morone americana*), alewife (*Alosa pseudoharengus*), and blueback herring (*A. aestivalis*) likely would be entrained by the proposed Unit 3 intake system. No life stages of American shad (*A. sapidissima*), cownose ray, striped bass (*Morone saxatilis*), species having essential fish habitat (EFH) designated within Chesapeake Bay (see Section 2.4.2), blue crab, or eastern oyster occurred in the entrainment samples collected in 2006 and 2007 (EA Engineering 2008).

Table 5-2. Estimated Entrainment at CCNPP Units 1 and 2 (under maximum design flow) for March 2006 through September 2007 and Projected Values for Proposed Unit 3

Important Species	Units 1&2	Proposed Unit 3	Units 1&2+3	Bay Population Estimate[c]
	Total	**Total**	**Total**	**# × 10^6**
American eel – juveniles	1,633,760	29,678	1,663,438	no data
Atlantic croaker – juveniles	18,853,347	342,482	19,195,829	59.5
Atlantic menhaden –juveniles	17,647,318	320,573	17,967,891	11.4
Atlantic menhaden – eggs/larvae	504,700,991	9,168,178	513,869,169	no data
Bay anchovy – Adults	5,685,244	103,276	5,788,520	no data
Bay anchovy – juveniles	976,021,709	17,729,984	993,751,693	no data
Bay anchovy – eggs/larvae	8,192,501,876	148,821,408	8,341,323,284	no data
Bay anchovy – Sum of adults + juveniles	981,706,953	17,833,260	999,540,213	11,164.0
River herring[a] – pysl[b]	2,554,646	46,407	2,601,053	131.4 [d]
Spot – juveniles	13,095,732	237,891	13,333,623	21.6
Weakfish – juveniles	365,103	6,632	371,735	35.5
Weakfish – pysl	2,847,261	51,722	2,898,983	no data
White Perch – eggs	11,461,571	208,206	11,669,777	111.2

Source for Units 1&2 data: EA Engineering 2008.
Source for fish population estimates: Jung and Houde 2003.
(a) could include alewife, American shad, and/or blueback herring
(b) pysl = post yolk sac larvae
(c) population estimates based on fish 1.2 in. < TL < 10 in. long
(d) population total includes blueback herring and alewife

Jung and Houde (2003) used 1995 to 2000 trawl data to estimate the abundances of pelagic fish in the Bay that provide some context for the entrainment values listed in Table 5-2. The trawl size restricted the catch to fish larger than 1.2 in. and smaller than 10 in. long, which limits the abundance comparisons to the entrainment values for juveniles and adults. All of the species listed in Table 5-2, except American eel and river herring, were among the seven most abundant species caught during the surveys. The bay anchovy was the most abundant fish with an estimated abundance of 11.15 billion fish. Abundance estimates for the other species ranged from about 22 million spot to 60 million Atlantic croaker. White perch, for which only eggs were entrained, abundance was estimated to be about 111 million fish. The predicted Unit 3 entrainment values for these species are substantially less than these Bay abundance values, and the overall effects on the species would likely be minor. The cumulative effects of entrainment by all three units are discussed in Chapter 7.

Many of the important species listed in Section 2.4.2 occurred in the impingement samples collected at CCNPP Units 1 and 2 from 1975 to 1995 (Ringger 2000). The fish species most frequently impinged during those 21 years were Atlantic croaker, Atlantic menhaden, bay anchovy, blueback herring, butterfish, spot, summer flounder, weakfish, white perch, and winter flounder (Table 5-3). Blue crabs were abundant in the impingement samples collected from the CCNPP Units 1 and 2 intake system from 1975 to 1995 (Ringger 2000). The total numbers impinged ranged from about 82,000 crabs to about 1.66 million crabs. More than 99 percent of impinged blue crabs survive. Eastern oysters, because they are attached to Bay substrate, are not impinged. No sea turtles were reported in the 1975 to 1995 impingement samples (Ringger 2000). The review team could not estimate impingement numbers for individual important species, other than blue crabs, because data for the species were not reported. However, the review team concludes that the overall effects of impingement to most important species would likely be minor because several species have high impingement survival rates (Table 5-3), several species have not been impinged by CCNPP Units 1 and 2, and most species with low impingement survival rates had lower impingement rates after improvements were made to the CCNPP Units 1 and 2 intake system. The intake design at the proposed Unit 3 is expected to comply with regulations requiring the use of best technology available and, therefore, impingement rates at the proposed Unit 3 are expected to be even lower than impingement rates at the modified Units 1 and 2 intakes.

The discharge plume projected for proposed Unit 3, because of its small size, is unlikely to adversely affect any important species. Similarly, maintenance dredging is not likely to have long-lasting effects on important species. Any of the important species that could become entrained or impinged by operation of the cooling water system could be entrapped in the wedge-shaped pool or common forebay. The potential for entrapment and the specific effects on each important species cannot be estimated with certainty.

Table 5-3. Occurrence of Important Fish Species in Impingement Samples Collected at CCNPP Units 1 and 2 from 1975 to 1995 (Ringger 2000)

Common Name	Scientific Name	Number of years	Years in Top 5 Impinged	Impingement Survival Rate (%)[(a)]
alewife	*Alosa pseudoharengus*	12	0	–
American shad	*Alosa sapidissima*	0	–	–
Atlantic croaker	*Micropogonias undulatus*	21	5	19
Atlantic menhaden	*Brevoortia tyrannus*	21	14	52
Atlantic sturgeon	*Acipenser oxyrinchus*	0	–	–
bay anchovy	*Anchoa mitchilli*	21	21	68
black sea bass	*Centropristis striata*	6	0	
blueback herring	*Alosa aestivalis*	20	5	47
bluefish	*Pomatomus saltatrix*	9	0	
butterfish	*Peprilus triacanthus*	15	0	–
clearnose skate	*Raja eglanteria*	0	–	–
cownose ray	*Rhinoptera bonasus* [(b)]	0	–	–
little skate	*Leucoraja erinacea*	0	–	–
red drum	*Sciaenops ocellatus*	1	0	
shortnose sturgeon	*Acipenser brevirostrum*	0	–	–
spot	*Leiostomus xanthurus*	21	16	84
spotfin killifish	*Fundulus luciae*	0	–	–
striped bass	*Morone saxatilis*	10	0	–
summer flounder	*Paralichthys dentatus*	18	1	90
weakfish	*Cynoscion regalis*	16	1	38
white perch	*Morone americana*	19	0	–
windowpane flounder	*Scophthalmus aquosus*	5	0	–
winter flounder	*Pseudopleuronectes americanus*	15	3	93
winter skate	*Leucoraja ocellata*	0	–	–

(a) Calculated only for species occurring in the top five most impinged.
(b) Large numbers of cownose rays were impinged in 2005 and 2006 (NRC 2005, 2006d).

Invasive or Nuisance Organisms

None of the estuarine non-native species of concern listed by the State of Maryland has been documented to occur near the Calvert Cliffs site (Section 2.4.2). Two taxa often considered nuisance aquatic organisms that occur near the site are the alga *Pfiesteria* (*Pfiesteria piscicida*) and sea nettles (*Chrysaora quinquecirrha*). Population booms of *Pfiesteria* are more likely to be associated with high nutrient content in the water rather than relatively small increases in temperature (Magnien 2001). The discharge from the proposed Unit 3 is not expected to create a plume with a high nutrient content. Sea nettles and other jellyfish are known to clog the intake screens of power plants, including the Calvert Cliffs and Chalk Point (Delano 2006). Sea nettles may increase in abundance with increasing water temperatures, but the response is not dictated by temperature alone (Purcell 2007). Low freshwater input, high salinity, and high insolation all contribute to potentially high sea nettle abundances. Large numbers of sea nettles in July and

September 2006 clogged the intake screens at CCNPP Units 1 and 2 (NRC 2006a, 2006b, 2006c, 2006e). The large numbers of sea nettles observed at Calvert Cliffs in 2006 probably resulted from favorable Bay-wide conditions rather than from localized increases in temperature at the thermal plume operated by CCNPP Units 1 and 2. Therefore, no large growth of invasive or nuisance organisms is anticipated from the discharge plume for the proposed Unit 3.

5.3.2.4 Aquatic Monitoring

UniStar does not plan to monitor the aquatic ecosystems during operations other than that required as a condition of a new NPDES permit (UniStar 2009a). The permit probably would require flow and temperature monitoring and monitoring of certain chemical constituents in the discharge. The NPDES permit is required for the entire duration of plant operation and must be renewed every five years with provisions for updating monitoring programs and parameters, as necessary.

5.3.2.5 Summary of Impacts to Aquatic Resources

The review team has reviewed the proposed operation activities for proposed Unit 3 and associated transmission lines and the potential impacts to aquatic biota in the onsite freshwater habitats and the Chesapeake Bay. The addition of proposed Unit 3 would increase potential entrainment, impingement, entrapment, and thermal loading to the Chesapeake Bay, but operation of the additional unit would not increase them such that they would noticeably alter the aquatic resources of the Bay. Other impacts from operational activities, such as cooling tower drift, maintenance dredging, and transmission corridor maintenance, would be minor if not negligible. Based on the review of operational activities described in the preceding sections and species' biological information, the review team concludes that the impacts to the freshwater and Chesapeake Bay aquatic biota resulting from the proposed Unit 3 and associated transmission line operation activities would be SMALL, and additional mitigation would not be warranted.

5.4 Socioeconomic Impacts

Operations activities of nuclear power plants can affect individual communities, the surrounding region, and minority and low-income populations. This evaluation assesses the impacts of operations-related activities of the proposed Unit 3 and of the Unit 3 operations workforce on the region. The text in this section relies on information gathered from State and county agencies, local officials, and on the ER (UniStar 2009a).

Regional social and economic impacts occur within the entire 50-mi radius, but primarily include Calvert and St. Mary's Counties in Maryland, which constitutes the primary impact area, as described in Section 2.5 and below in Section 5.4.2. Approximately 91 percent of the current

CCNPP Units 1 and 2 workforce lives in Calvert and St. Mary's Counties, and the review team expects the Unit 3 workforce residential distribution to be similar. Based on commuter patterns and the distribution of residential communities in the area, the review team found minimal impacts on other counties within the 50-mi radius in Maryland and the adjacent States.

5.4.1 Physical Impacts

Potential physical impacts include noise, odors, exhausts, thermal emissions, and visual intrusions. The review team believes these impacts will be mitigated through operations of the facility in accordance with all applicable Federal, State, and local environmental regulations and, therefore, will not significantly affect the region surrounding the Calvert Cliffs site. The following sections assess the potential operations-related physical impacts of proposed Unit 3 on specific segments of the population, the plant, and nearby communities.

5.4.1.1 Workers and the Local Public

There are no residential areas located within the site boundary. The distribution of population is approximately 30 people within 1 mi of the site, less than 2500 within 2 mi, and approximately 41,000 people within 10 mi of the site*.* The land surrounding the Calvert Cliffs site is zoned for a combination of light industrial, farm, forest, and residential uses, and is bounded by the Chesapeake Bay to the east and forested land to the north and south. No significant industrial or commercial facilities other than the Calvert Cliffs site exist or are planned in the vicinity. The recreational areas closest to the plant include the Flag Ponds Nature Park to the north and the Calvert Cliffs State Park to the south, both of which are adjacent to the plant site (Figure 2-4).

Once the new unit begins operation, it would not produce air pollutants in significant quantities. The primary sources of pollutants would be (1) the periodic testing and operation of Calvert Cliffs' standby diesel generators and auxiliary power systems, (2) vehicle dust and exhaust, and (3) odors from operations. Because the permit to operate the diesel generators would require the applicant to comply with all applicable air emissions regulations, the review team expects the impact of diesel generator operation on air quality would be minimal. Access road maintenance and speed-limit enforcement will reduce the amount of dust generated by deliveries and the commuting workforce. UniStar would use a staggered shift schedule for its operations workforce, which would also help mitigate the effects of vehicle exhaust (UniStar 2009a). UniStar plans to use BMPs to control the odors emitted by chemicals and other sources during operations and routine outages. Therefore, the review team believes the addition of one new reactor to the site will have only a minimal impact on air quality and will not require mitigation. Air quality impacts of plant operation are discussed in more detail in Section 5.7 of this document.

Unit 3 would produce noise from the operation of pumps, transformers, turbines, generators, and switch yard equipment. The noise levels would be controlled in accordance with State and

Federal regulations and outside the site boundary would be below a level of 65 dBA during the day and 55 dBA at night. Most equipment would be located inside structures, reducing the outdoor noise level. UniStar plans to use one CWS cooling tower with plume abatement to remove excess heat. Mechanical draft cooling towers emit broadband noise, but UniStar does not expect the noise level to be greater than 10 dBA above background levels (UniStar 2009a). Noise levels below 60 dBA to 65 dBA are not considered to be significant because these levels are not sufficient to cause hearing loss (NRC 1996). Ambient noise heard by recreational users at Flag Ponds State Park to the north and Calvert Cliffs State Park to the south under normal conditions includes some noise from the operation of CCNPP Units 1 and 2. As stated above, the maximum sound level generated by the operation of proposed Unit 3 at the site boundary would be below the 55 dBA to 65 dBA range, would not affect the usage of nearby recreational areas, and would not require mitigation. Therefore, the review team determined the noise-related effect on workers, residents, and recreational users of nearby areas would be minimal, and mitigation would not be warranted.

5.4.1.2 Buildings

Operations activities would not affect offsite buildings (UniStar 2009a). Onsite buildings have been constructed to safely withstand any possible impact, including shock and vibration, from operations activities associated with the generation of electricity at a nuclear power plant (10 CFR Part 50, Appendix A). Except for Calvert Cliffs site structures, no other industrial, commercial, or residential structures will be affected. Consequently, the review team determined the operations impacts to onsite and offsite buildings would be minimal.

5.4.1.3 Roads

Roads within the vicinity of the Calvert Cliffs site would experience an increase in traffic at the beginning and the end of each operations shift and the beginning and end of each outage support shift. Commuter traffic would be controlled by speed limits. The access roads to the Calvert Cliffs site would be paved. Maintaining good road conditions and enforcing appropriate speed limits would reduce the noise level and particulate matter generated by deliveries and the workforce commuting to and from the Calvert Cliffs site. Because the construction workforce would be about ten times larger than the operations workforce, any upgrades (e.g., signalization) implemented to mitigate site development activities (see Section 4.4.1.3) would be adequate to meet the increase in traffic due to operation activities. Therefore, the review team determined the road-related impacts from noise and dust to workers, residents, and other users of the roads within the vicinity of the site would be minimal.

5.4.1.4 Aesthetics

Approximately 30 people live within 1 mi of the site as well as other ground locations to the north, west, and south, and are screened by vegetation and site topography. As such, the proposed unit and the associated cooling tower would not be clearly visible (see Section 3.1). From the east on Chesapeake Bay most of Unit 3 structures would be not be visible because of its elevation and the critical zone setback from the shoreline. The intake and discharge structures would be visible from Chesapeake Bay, along the shoreline and near structures for CCNPP Units 1 and 2.

The visual impacts from the new cooling tower would be from the tower itself. The cooling tower plume abatement equipment is expected to reduce any vapor plume to insignificance. Given that the site has already been affected by the presence of two reactors and that the new structures are shorter than the tallest of the existing Units 1 and 2 structures, the review team concludes that the aesthetic impact of the new reactor and cooling tower would be minimal.

Once the new unit is operational, electricity would be transmitted via the existing 500-kV transmission lines, and no additional transmission corridors or other offsite land use would be required. Thus, no aesthetic impacts are expected from power transmission.

5.4.1.5 Summary of Physical Impacts

Based on the information provided by UniStar, review team interviews with local public officials, and NRC's own independent review, the review team concludes that the physical impacts of operation of the proposed new unit would be SMALL. Thus, additional mitigation measures beyond those identified by UniStar would not be warranted.

5.4.2 Demography

UniStar anticipates employing 363 operations workers at the new unit (UniStar 2009a). As shown in Table 2-11, the review team determined the number of available operations workers in the 50-mi region is small, relative to the large work force within that same area. Given that the operation of a nuclear facility requires a highly specialized workforce, which is generally not available within the region, UniStar would have to recruit such labor from beyond a reasonable commuting distance, which results in a relatively high proportion of in-migrating operations workers. Therefore, the review team considers a 50 percent in-migration scenario to be more reasonable and accurate than the estimates made by UniStar in its ER, and incorporates that assumption in the discussions below.

Using the U.S. Census Bureau average household size in the U.S. of 2.61, the expected increase in population in the 50-mi region from the 182 operations workers and their families would be approximately 474 people.

The review team assumed the residential distribution of new operations workers and their families would resemble the residential distribution of employees operating CCNPP Units 1 and 2. Therefore, approximately 91 percent would likely reside in Calvert County (320 people) and St. Mary's County (113 people) while the other 9 percent (41 people) would live in the remainder of the 50-mi radius. This compares to 2015 population projections of 99,000, 119,000, and 3.4 million for Calvert County, St. Mary's County, and the 50-mi radius, respectively.

Table 5-4. Potential Increase in Resident Population Resulting from Operating Proposed Unit 3

County	Percent of Current Calvert Cliffs Site Workforce	Unit 3 Related Increase in Population	Projected Population, 2015	Percentage Increase in Resident Population
Calvert	67.5	320	98,650	0.03
St. Mary's	23.8	113	119,450	0.001
Remainder of 50-mi Region	8.7	41	3,435,350	<0.00001
Total	100.0	474		

Given that the Unit 3-related population increase is less than half a percent for Calvert and St. Mary's Counties and the 50-mi region, the review team concludes that the demographic impacts of operation of the new unit at the Calvert Cliffs site would be SMALL, and mitigation would not be warranted.

5.4.3 Economic Impacts to the Community

The impacts of station operation on the local and regional economy are dependent on the region's current and projected economy and population. Although future impacts cannot be predicted with certainty, some insight can be obtained for the projected economy and population by consulting with county planners and population data. The economic impacts over a 40-year period of station operation are discussed quantitatively where possible. Because 91 percent of in-migrating workers are expected to live in Calvert and St. Mary's Counties, these two counties represent the economic impact area. The primary economic impacts from employing 363 new workers to operate the proposed Unit 3 would be related to taxes, housing, and increased demand for goods and services, with the largest impact associated with plant property tax revenues (discussed in 5.4.3.2).

5.4.3.1 Economy

The primary economic impacts of nuclear power plant operation result from jobs created, wages paid, regional purchases, and tax payments made in the course of operating the power plant. The impacts of plant operation on the local and regional economy depend on the region's economy and population at that time and will be influenced by how the affected communities have responded to the impacts of the construction phase. Although future impacts cannot be predicted with certainty, consideration of historical patterns, projected economic and demographic trends, and consultation with local planners can provide some insight into the qualitative nature of these impacts. The review team estimated the potential economic impacts on the surrounding region as a result of operating the proposed Unit 3 at the Calvert Cliffs site, assuming a 40-year operating license.

The review team assumes half of the 363 new direct jobs associated with operations of Unit 3 would in-migrate from outside the 50-mi radius. As discussed in 4.4.3.1, new indirect jobs are created through a process called the "multiplier effect," whereby a new (direct) job in a given area stimulates spending on goods and services, which results in the economic need for a fraction of a new (indirect) job, typically in retail and service related industries. The cumulative effect of a new direct job workforce being added to an economy induces the creation of a number of new indirect jobs. The ratio of new indirect jobs to the number of new direct jobs is called the "employment multiplier." The U.S. Department of Commerce Bureau of Economic Analysis (BEA), Economics and Statistics Division, provides regional multipliers for industry employment and earnings (UniStar 2009a). The BEA employment multiplier is applied to only in-migrating workers because the BEA model assumes the income effect from construction workers that already live in the area will have no additional impact on the economy. Through the multiplier effect, these 182 new jobs would induce the creation of 363 indirect jobs (multiplier of 2.0), which would likely be filled by unemployed individuals already living in the 50-mi region. Therefore, the review team estimated the increase in operations related total employment in the 50-mi region to be 545 jobs, of which 497 would be in the economic impact area, the remainder of which would be outside the two counties. Within the economic impact area, this translates into an increase in employment of 0.01 percent for Calvert County and 0.003 percent for St. Mary's County. Outside of the two-county economic impact area, the employment impacts become even more diluted in the larger economic base of the surrounding counties and Washington, D.C.

The operation of the new unit at the Calvert Cliffs site would also increase the workforce needed for scheduled outages by an additional 1000 workers for a 15-day period every 18 months. This outage workforce would be composed of contract employees to perform equipment maintenance, refueling, and special outage projects at the Calvert Cliffs site. Most of the outage workers would stay in local hotels, rent rooms in local homes, or bring travel trailers so they can stay as close as possible to the Calvert Cliffs site. Outside of the two-county economic impact area, the impacts become more diffuse because of each area's larger economic base with more available hotel rooms and temporary housing.

The overall impact on the economy of the region from operating the new unit at the Calvert Cliffs site would be minimal and beneficial. Imperceptible minimal, beneficial economic impacts may occur in other nearby counties within commuting distance of the plant.

5.4.3.2 Taxes

The tax structure of the region is discussed in Section 2.5. Several types of taxes would be generated during the operational life of proposed Unit 3 at the Calvert Cliffs site. Employees would pay sales, use, personal property, and income taxes; and vendors selling materials and services to the facility would pay a variety of State, Federal, and local taxes. The Calvert Cliffs site would be subject to property taxes paid to Calvert County.

Sales, Use, and Income Taxes

To the extent that new operations employees move into the area from outside the State to work at the plant, the states, counties, and communities within the region would experience an increase in sales and use taxes and income tax revenues. This increase in revenue would come from both the taxes paid by Unit 3 employees on their personal incomes, sales taxes on goods they purchase, and from owners of Unit 3 for property taxes on Unit 3. Maryland counties do not receive sales tax. Instead, the tax payments go to the State. Given the large dollar amount in sales tax revenue the State receives, the sales tax revenue for the 182 in-migrating workers would have a minimal and beneficial impact. The 182 in-migrating permanent operations employees will pay income taxes on their earnings to the counties. Given the large economic and tax base in the economic impact area and surrounding areas, the increased income tax revenue would not be noticeable at a regional level.

Property Taxes

Property taxes on the plant accrue only to Maryland and Calvert County. For Maryland, the tax revenues are less than 1 percent of total tax revenues. For Calvert County, the primary source of economic impact related to the operation of new unit would be property taxes assessed on the facility. Property taxes that would be paid by the owners for the new unit during operations depend on many factors such as future millage rates and the assessed value of the plant. UniStar made simplifying assumptions to develop an estimate of tax payments based on the estimated value of the reactor. Unit 3 qualifies for a 50 percent reduction in assessed property value. For the first year of operation, it is estimated that the owners of Unit 3 will pay approximately $57.1 million in property taxes. This would represent about a 25.81 percent increase over Calvert County 2009 revenues of $221.3 million. Property taxes related to Unit 3 will decline each year for the first 15 years of operations due to depreciation eventually reaching $42.8 million. After the first 15 years Unit 3 property taxes will increase to $82.1 million as the county taxes the full assessed value of the unit and then again will depreciate yearly reaching $32.2 million at the end of the 40 year license of the plant. Given that Unit 3 is expected to represent such a large percentage of Calvert County revenues during operations, the review team expects Unit 3 operations to have a significant and beneficial impact on Calvert County.

In addition to the property taxes paid on the value of the plant itself, all of the counties within the 50-mi region, particularly Calvert County, where the review team assumes the largest portion of operations workers will establish residence, could experience an increase in property tax revenues on new homes, if the influx of workers results in any new residential construction and/or increases in existing home prices. However, this overall impact would likely be minimal and beneficial, since the operations workforce and their families would only make up a small percentage of the existing population in the region.

5.4.3.3 Summary of Economic Impacts to the Community

Based on the information provided by UniStar, review team interviews with local public officials, and NRC's own independent review of data on the regional economy and taxes, the review team concludes that the tax-related impacts on the regional economy from operating proposed Unit 3 at the Calvert Cliffs site would be SMALL and beneficial for all counties except Calvert County, which would experience a LARGE beneficial increase in tax revenue.

5.4.4 Infrastructure and Community Services

Infrastructure and community services include transportation, recreation, housing, public services, and education. The operation of the new unit at the Calvert Cliffs site would impact the transportation network as additional workforce use the local roads to commute to and from work and possibly additional truck deliveries are made to support operation of the new unit. These same commuters could also potentially impact recreation in the area. As the workforce in-migrates and settles in the region, there may be impacts on housing, education, and public sector services.

5.4.4.1 Transportation

Similar to the building impacts discussed in Section 4.4.4, the greatest impact of operation on transportation and traffic would be greatest on Maryland (MD) State Route 2/4, the north-south highway that provides the main access to the Calvert Cliffs site. A Traffic Impact Analysis (TIA) was conducted by UniStar's contractor, KDL Enginerring, P.C., to evaluate the need to install a new access road and to upgrade intersections and turn lanes near the Calvert Cliffs site without and with the decision to build the proposed Unit 3 at the Calvert Cliffs site. The TIA recommended that three intersections retain upgrades implemented during development of Unit 3. The TIA recommendations for the other three intersections studied ranged from convert to the original configuration or downgrade to a flashing signal or stop sign to operate properly (KLD 2009).

A critical area not addressed by the TIA is access from the south over the Thomas Johnson Memorial Bridge that connects Calvert and St. Mary's Counties, where the four-lane MD State Route 2/4 narrows to two lanes across the bridge. As reported in Section 2.5.2.3, the Maryland State Highway Administration and the Federal Highway Administration expect to complete the planning process in 2010 and construction by 2020. The construction date for the bridge is after the Unit 3 project is projected to have been completed. This limits access to the counties that lie to the west (principally St. Mary's and Charles) and would have the effect of channeling the traffic flow to the north and south in Calvert County, which increases the need to implement the mitigation measures discussed in the TIA.

To reduce traffic congestion while building Unit 3, two intersections may be signalized to minimize bottlenecks. If the two intersections have not been signalized by commencement of operations, then again both should be reevaluated for signalization. However, given the relatively small number of employees on staggered shifts, the estimated workforce of 363 persons is expected to have a minimal impact on the transportation network in Calvert and St. Mary's Counties.

5.4.4.2 Recreation

A detailed description of local tourism and recreation is provided in Section 2.5. Major park facilities located within Calvert County include Calvert Cliffs State Park located south of the Calvert Cliffs site and the Flag Ponds Nature Park to the north. Recreational activities include bird watching, fishing, fossil hunting, hiking, picnicking, swimming and a playground (MDNR 2007). The review team expects impacts on area recreation resources to be minimal during operations because the operations would not affect recreational opportunities. The aesthetic impacts of the plant operations from the vantage point of local recreational areas would be minimal.

5.4.4.3 Housing

Section 2.5.2 states there were 1830 and 3814 vacant housing units (owner occupied and rental) in Calvert County and St. Mary's County in 2006. The estimated 182 housing units needed in Calvert and St. Mary's Counties to house the operations workforce represent 3 percent of the vacant housing. In addition, there are more than 30 apartment complexes in Calvert and St. Mary's Counties (excluding any housing supply that would have been constructed to meet the needs of the construction workforce) and several housing developments are planned or underway.

Based on the information provided by UniStar, interviews with local real estate agents and city and county planners, and NRC's own independent review, the review team expects the housing-related impacts of operation of proposed Unit 3 would be minimal.

Unit 3 would need as many as 1000 additional outage workers for a period of approximately 15 days during each outage to refuel and maintain the new reactor. The outages for the new unit would be staggered with the other two units. The temporary outage workers for the existing two Calvert Cliffs reactors typically stay in area apartments, hotels or recreational vehicles dispersed throughout the region. The analysis of housing availability for the construction workforce in Section 4.5.4 indicates that the supply of hotel/motel/bed and breakfast rooms may need to be expanded to accommodate the influx of temporary workers. Overall, this influx of temporary workers would be expected to have a minimal impact on the permanent housing stock or housing market in the region.

5.4.4.4 Public Services

Water Supply Facilities

The proposed Unit 3 would use water from Chesapeake Bay for operation and would not require water from county sources (UniStar 2009a).

The Calvert County Planning Department believes that the aquifers are adequate to meet the needs of the expected growth in population through 2030 (Calvert County 2008). The St. Mary's County Metropolitan Commission water supply facilities also operate at about 43 percent of average capacity (UniStar 2009a). The increase in the number of households in the two-counties would raise the average operating capacity to 46 percent in Calvert County and slightly more than 43 percent in St. Mary's, which would leave sufficient unused capacity to meet base growth and the increase in population created by operation of Unit 3. The average per capita water usage in the United States is 90 gpd for personal use, bathing, laundry, and other household uses (EPA 2003). Therefore, the new operations workforce and their families would require an additional 28,800 gpd in Calvert County and 10,170 gpd in St. Mary's County. This increase is well within the excess capacity of 2.4 MGD in the Calvert County water systems and 4.8 MGD in the St. Mary's County water systems. Given this increase is well within the excess capacity of the water supply facilities and there would be unused capacity to meet base growth, the review team expects impacts to water supply facilities to be minimal.

Wastewater Treatment Facilities

The Calvert Cliffs site has a wastewater treatment facility for the existing units. As part of the new unit's construction project, the facility would be expanded to also support the wastewater treatment needs of proposed Unit 3. Therefore, plant operations would not directly impact the local offsite wastewater treatment capacity.

The public wastewater treatment systems in Calvert County and St. Mary's County operated at an average capacity of 54 percent and 58 percent, respectively in 2005. Assuming 100 percent of the water consumed would be disposed of through these wastewater treatment facilities, Unit 3 plant operations would require an additional 28,800 gpd of wastewater treatment capacity in Calvert County and 10,170 gpd in St. Mary's County. Currently, Calvert County has approximately 700,000 gpd of excess wastewater treatment capacity while St. Mary's County has 2.9 million gpd of excess capacity. Residents not serviced by a public sewer district/system rely upon septic tanks for wastewater treatment. The review team concludes that the impacts of operations on wastewater treatment facilities would be minimal, and additional mitigation would not be warranted.

Police and Fire Services

Given that the review team expects the increase in population for either of the two counties to be less than 1 percent (see Section 5.4.2), and the increased demand for police and fire services is also projected to be less than 1 percent, the impact of new operations workers and their families on police and fire services would fall well within the expected population growth planned by their local governments. Therefore, the in-migration of operations workers would have a minimal impact, and mitigation would not be warranted.

Medical, Health and Human Services

Section 2.5.2.6 describes the level of medical and human services within Calvert and St. Mary's Counties and Section 4.4.4.4 describes the ability of these services to accommodate the construction workforce, which the review team determined is sufficient to absorb the operations-related influx of workers. New jobs created to operate and maintain Unit 3 would benefit the disadvantaged population served by the state health and human resource offices by adding some additional jobs to the region, which may go to people who are currently under-employed or unemployed, mitigating their involvement on some social services' client lists (food banks, housing assistance, etc.). While the influx of new workers and their families may also create additional pressure on some social services, the review team concludes that the impact of the new permanent operations workforce on local and State welfare and social services would be minimal.

5.4.4.5 Education

Section 5.4.2 discusses the review team's underlying assumptions about the distribution of workers' families within the 50-mi radius area around the site. These assumptions indicate the expected increase in population and associated student enrollment for Calvert and St. Mary's school districts would be less than 1 percent. This rate is well within the planned growth rate for each county government and would, therefore, have a minimal impact; mitigation would not be warranted.

5.4.4.6 Summary of Impacts to Infrastructure and Community Services

Based on information supplied by the applicant, review team interviews conducted with and information solicited from public officials in Calvert and St. Mary's Counties, and the review team evaluation of data concerning the current availability of services and current State and community planning efforts, the review team concludes that the operation impacts on the regional infrastructure and community services would be SMALL, and mitigation would not be warranted.

5.4.5 Summary of Socioeconomic Impacts

Based on information supplied by UniStar, review team interviews conducted with public officials in Calvert and St. Mary's Counties concerning the current availability of services, and additional taxes that would likely compensate the need for additional services, the review team concludes that the impacts on the local economy would be beneficial and SMALL with the exception of Calvert County, which will likely see LARGE beneficial impacts. The estimated workforce of 363 people (182 in-migrating) would have a SMALL impact on the regional infrastructure and community services including the local transportation network throughout the region and in Calvert and St. Mary's Counties. The site is relatively isolated, light industrial in nature, and well masked by vegetation in most directions so the impacts on aesthetics would be SMALL, as would the impacts on recreation. The impacts on public services and infrastructure would be SMALL.

5.5 Environmental Justice

Environmental justice refers to a Federal policy under which each Federal agency identifies and addresses disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority or low-income populations. On August 24, 2004, the Commission issued its policy statement on the treatment of environmental justice matters in licensing actions (69 FR 52040). Section 2.6 discusses the locations of minority and low-income populations around the Calvert Cliffs site and within the 50-mi radius.

The scope of the review as defined in NRC guidance (NRC 2001a, 2004; 69 FR 52040) should include an analysis of the impacts on minority and low-income populations, the location and significance of any environmental impacts during operations on populations that are particularly sensitive, and any additional information pertaining to mitigation. The descriptions to be provided by this review should state whether the impacts are likely to be disproportionately high and adverse. The review should also evaluate the significance of such impacts.

The review team evaluated whether the health or welfare of minority and low-income populations at those census blocks identified in Section 2.6 of this EIS could be disproportionately affected by the potential impacts of operating a new reactor at the site. To perform this assessment, the review team used the same process employed in Section 4.5.

5.5.1 Health Impacts

For all three health-related considerations described in Section 2.6.1, the review team determined through literature searches and consultations with NRC staff health experts that the expected operations-related level of environmental emissions is well below the protection levels established by NRC and EPA regulations and cannot impose a disproportionately high and adverse effect on minority or low-income populations. The results of the normal operation dose assessments presented in Section 5.9 indicate that the maximum individual dose for these pathways would be insignificant, well below the regulatory guidelines in Appendix I of 10 CFR Part 50 and the regulatory standards of 10 CFR Part 20. As discussed in Section 4.5.1 of this EIS in the context of construction and preconstruction activities, there is no evidence that radiological or nonradiological effects from operations affect any demographic subgroup differently from any other subgroup. Furthermore, as discussed in Section 2.6 of this EIS, the review team did not identify any evidence of unique characteristics or practices in the minority and low-income populations that may result in different health pathway impacts compared to the general population. Therefore, the review team concluded that there would be no disproportionate and adverse health impacts on minority and low-income members of the public from the release of radiological material from operations or from DBAs. The environmental justice impacts on health derived from operating the proposed Unit 3 would be SMALL.

5.5.2 Physical and Environmental Impacts

For the three environmental and physical considerations identified in Section 2.6.1, the review team determined that the physical impacts from operations activities at the proposed Unit 3 would attenuate rapidly with distance. However, the review team did not find any evidence of unique characteristics or practices among any populations of interest and expects there would be no disproportionately high and adverse impact on any minority or low-income community. The following four subsections discuss each of the four primary physical pathways in greater detail.

5.5.2.1 Soil

No new transmission line corridors are planned for Unit 3. As discussed in Section 5.9, the review team does not believe there would be any operations-related environmental effects to soils at the Calvert Cliffs site that would impact nearby residents. Therefore, the review team believes there can be no disproportionate impact on any minority or low-income population. No other environmental pathways related to soil were identified. In addition, as discussed in Section 2.6 of this EIS, the review team did not identify any evidence of unique characteristics or practices in the minority or low-income populations that may result in different soil-related impacts compared to the general population. Consequently, the review team determined the marginal impact to soils from the proposed new unit would not cause any disproportionate and adverse impacts on the minority of low-income communities.

5.5.2.2 Water

As discussed in Sections 5.2 and 5.3.2, the review team determined the proposed Unit 3 at the Calvert Cliffs site would operate with a small thermal plume in the Chesapeake Bay, and that solutes in the effluent discharged would be diluted by the volume in the Chesapeake Bay.

Consequently, the concentration of these chemicals in the Bay should quickly return to negligible levels and the impact to aquatic biota would be negligible.

Under normal plant operation, consumptive losses of the proposed Unit 3 would be undetectable. Unit 3 would not use groundwater and, therefore, would not affect any offsite wells (see Section 5.2.2). As discussed in Section 2.6 of this EIS, the review team did not identify any evidence of unique characteristics or practices in the minority or low-income populations that may result in different water-related impacts compared to the general population. Therefore, the review team believes there would be no water-related disproportionate and adverse impact on minority and low-income populations from operations of Unit 3.

5.5.2.3 Air

The total liquid and gaseous effluent doses from all three units (the two existing units plus the proposed new unit) would be well within the regulatory limits of the NRC and EPA, implying that impacts on any population are likely to be minimal from this source. As described in Section 5.7.2, the review team concludes that the potential impacts from all potential air medium sources would be SMALL. Furthermore, the review team believes because of the distance between the Calvert Cliffs site and minority or low-income populations, any airborne pollutants emanating from the new Unit 3 would rapidly disperse to near background levels. As discussed in Section 2.6 of this EIS, the review team did not identify any evidence of unique characteristics or practices in the minority or low-income populations that may result in different air-related impacts compared to the general population. Therefore, the review team determined there would be no disproportionate and adverse impacts on minority or low-income populations within the analytical area.

5.5.3 Socioeconomic Impacts

The review team determined that once the proposed new unit is operational at the Calvert Cliffs site, any adverse construction- and preconstruction-related socioeconomic impacts on any group within the 50-mi area would either stop or significantly diminish. Socioeconomic impacts were concluded to be SMALL in Section 5.4. While the addition of new operations employees might exert a small pressure on local infrastructures (schools, hospitals, etc.), as discussed in Section 2.6 of this EIS, the review team did not identify any evidence of unique characteristics or practices in the minority or low-income populations that may result in greater impacts than those experienced by the general population. The review team believes any adverse impact the in-migration might create would be overwhelmed by the positive contributions of that workforce to their new local communities through income and taxes. Furthermore, the review team's interviews of surrounding communities revealed a high level of preparedness with regard to any potential influx of temporary site development or permanent operations workers.

5.5.4 Subsistence and Special Conditions

NRC's environmental justice methodology includes an assessment of populations of particular interest or unusual circumstances, such as minority communities exceptionally dependent on subsistence resources or identifiable in compact locations, such as Native American settlements.

Fish advisories from the State of Maryland focus on heavy metals and other non-radiological pollutants and do not indicate the level of radioactive contamination in fish and shellfish that could be harmful if ingested. The potential radiological releases from Unit 3 would be a fraction of those from the existing for CCNPP Units 1 and 2, and the combined releases from all three units will be well below regulatory limits. In addition, while subsistence consumption of fish species from the Chesapeake Bay may be a health problem for minority and low-income populations due to the levels of mercury and/or polychlorinated biphenyls (PCBs), it is not attributable to the existing reactors and cannot be reasonably projected to be exacerbated by an additional reactor at the Calvert Cliffs site. Thus, based on the levels of anticipated releases, there is no indication that proposed Unit 3 would add significantly to the total radiological releases or ingestion from subsistence harvest of fish and/or shellfish, and therefore there can be no disproportionate and adverse impact to minorities or low-income populations form subsistence activities in the Chesapeake Bay.

No other unique characteristics or practices were identified for the low-income and minority populations that would indicate that they are dependent on subsistence resources that would be impacted by operation of the proposed Unit 3.

5.5.5 Summary of Environmental Justice Impacts

Based on information provided by UniStar and review team interviews conducted with public officials in Calvert and St. Mary's Counties concerning the potential for environmental pathways and unique characteristics or practices, the review team determined there would be no disproportionately high and adverse impact on any minority or low-income populations. Therefore, the review team determined the operations-related environmental justice impacts of the proposed Unit 3 at Calvert Cliffs would be SMALL.

5.6 Historic and Cultural Resource Impacts from Operation

The National Environmental Policy Act of 1969, as amended (NEPA), requires Federal agencies to take into account the potential effects of their undertakings on the cultural environment, which includes archaeological sites, historic buildings, and traditional places important to local populations. The National Historic Preservation Act of 1966 (NHPA), as amended, also requires Federal agencies to consider impacts to those resources if they are eligible for listing on the National Register of Historic Places (such resources are referred to as "Historic Properties" in

NHPA). As outlined in 36 CFR 800.8, "Coordination with the National Environmental Policy Act of 1969," the NRC coordinated compliance with Section 106 of the NHPA in meeting the requirements of NEPA. For specific historic and cultural information regarding the Calvert Cliffs site, see Section 2.7.

Building, operating, and decommissioning power units can affect either known or undiscovered cultural resources. Therefore, in accordance with the provisions of NHPA and NEPA, the review team is required to make a reasonable and good faith effort to identify historic properties in the Area of Potential Effect (APE) and, if present, determine if any significant impacts are likely to occur. Identification is to occur in consultation with the State Historic Preservation Officer (SHPO), American Indian Tribes, interested parties, and the public. If significant impacts are possible, efforts should be made to mitigate them. As part of the NEPA/NHPA integration, if no historic properties (i.e., places listed or eligible for listing on the National Register of Historic Places) are present or affected, the review team is required to notify the SHPO before proceeding. If it is determined that historic properties are present, the NRC staff is required to assess and resolve adverse effects of the undertaking.

For the purposes of NHPA 106 consultation (36 CFR Part 800), based on (1) the measures that UniStar would take to avoid adverse impacts to significant cultural resources during operational activities, (2) the review team's cultural resource analysis and consultation, and (3) UniStar's commitment to follow its procedures should ground-disturbing activities discover cultural or historic resources, the review team concludes a finding of no historic properties affected. Section 4.6 has a finding for historic properties affected by construction and preconstruction activities.

For the purposes of the review team's NEPA analysis, the review team does not expect any significant impacts on cultural and historic resources during operation of proposed Unit 3. Any new ground-disturbing activities that might occur during operation would follow UniStar procedures currently in development, which would require further evaluation to determine if additional cultural resources review is necessary (UniStar 2009a). In addition, training of site staff in the Section 106 process would ensure that informed decisions are made when considering the effects of projects on historic and archaeological resources. Lands not previously surveyed for cultural resources would require investigation by a professional archaeologist and/or an architectural historian prior to any ground disturbing activities in the future. Any changes to these procedures or project plans would be developed in consultation with the NRC, Corps, and the Maryland Historical Trust (MHT). With procedures in place, impacts to historic and cultural resources from operations would be SMALL. As discussed above the review team does not expect any significant impacts on cultural and historic resources during operation of proposed Unit 3, but if an unanticipated discovery is made during operation, a similar procedure to that of the unanticipated discovery plan that is contained in the Memorandum of Agreement (MOA) (USACE 2010) for construction would be sufficient for operation.

5.7 Meteorological and Air Quality Impacts

The primary impacts of operation of proposed Unit 3 on local meteorology and air quality would be from releases to the environment of heat and moisture from the primary cooling system (cooling tower), operation of auxiliary equipment, and emissions from workers' vehicles. The potential impacts of releases from operation of the cooling system are discussed in Section 5.7.1. Section 5.7.2 covers potential air quality impacts from nonradioactive effluent releases at the Calvert Cliffs site.

5.7.1 Cooling Tower Impacts

The CWS for proposed Unit 3 at the Calvert Cliffs site would use a mechanical draft cooling tower with plume abatement. In a cooling tower of this design, the primary heat transfer to the atmosphere is through evaporation of cooling water as in a normal wet cooling tower. Though technically not referred to as a hybrid wet-dry tower, this tower has a dry section above the wet section. The dry section warms the rising moist air, thereby evaporating water droplets that have condensed with the purpose of eliminating the visible cooling tower plume. Because proposed Unit 3 would use plume abatement for the CWS, there would be little or no visible plume during plant operation, and there would be no significant aesthetic impact or shadowing.

Some water leaves wet cooling towers as drift. Drift is composed of small droplets formed in the tower directly from the cooling water; they are not formed by condensation of evaporated water. Consequently, drift contains solids and chemicals found in the cooling water. Cooling towers include drift eliminators to minimize the amount of water lost through drift. Drift eliminators, in combination with the dry section of the cooling tower proposed for Unit 3, result in a very low drift rate of 0.0005 percent for the proposed Unit 3 CWS. The maximum salt deposition rate for drift from the CWS tower at the proposed unit switchyard is estimated by EPA's AERMOD computer code (EPA 2004) to be about 1.2 (lb/ac) per month. The literature review in the *Generic Environmental Impact Statement for License Renewal* (GEIS) (NUREG-1437) (NRC 1996) suggests that a deposition rate of about 8.9 (lb/ac) per month is the lower threshold for the onset of damage to vegetation. Impacts of drift on air quality are addressed in the next section. Ecological impacts of drift are discussed in the EIS sections on ecology.

Four smaller mechanical draft cooling towers are planned for the ESWS. In normal operation, only two of ESWS towers operate at a time and the ESWS heat load is about 3 percent of the CWS cooling tower heat load (UniStar 2009a). UniStar included the small additional amount of salt deposition contributed by the ESWS in the AERMOD calculation described above. On this basis, the review team concludes that the atmospheric impacts of the ESWS cooling towers would be minimal.

Diesel generators and boilers currently operate at Calvert Cliffs site for limited periods; generators and boilers that would be associated with the Calvert Cliffs site proposed Unit 3 would similarly operate for limited periods. Interaction between pollutants emitted from these sources and the cooling tower plumes would be a function of wind direction and would, therefore, be intermittent. The interaction would have a minimal impact on air quality.

5.7.2 Air Quality

UniStar includes a brief discussion of the impacts of proposed Unit 3 operation on air quality in the ER (UniStar 2009a). There is a much more extensive discussion of the impacts of construction on air quality in UniStar's submission to the Maryland DNR's PPRP in support of the application for a Certificate of Public Convenience and Necessity (CPCN) (UniStar 2007). In response to the CPCN application, the Maryland PPRP conducted an extensive review of the UniStar submittal (MDNR PPRP 2008b). The NRC staff review of the air quality impacts of Unit 3 draws from the UniStar submittal and the PPRP review of that submittal, as well as from the ER.

As indicated in Section 2.9, Calvert County, Maryland, is an attainment area for all criteria pollutants except ozone. Consequently, the material submitted by UniStar in support of the CPCN application (UniStar 2007) has been evaluated by Maryland PPRP in accordance with the requirements of both the nonattainment New Source Review (NA-NSR) program and the Prevention of Significant Deterioration (PSD) program (MDNR PPRP 2008b). Major sources of volatile organic compounds (VOCs) and nitrogen oxide (NO_x) are required by NA-NSR to limit emissions of pollutants through the implementation of Lowest Achievable Emission Rate. In addition pollutant "offsets" must be obtained for regulated pollutants emitted. In attainment areas, major pollutant sources are required by the PSD program to use best available control technology (BACT) and perform additional impact assessments.

Regulated emissions sources associated with the proposed Unit 3 include (MDNR PPRP 2008b):

- The CWS cooling tower with a maximum water circulation rate of 777,560 gpm
- Four ESWS cooling towers with a maximum water circulation rate of 19,075 gpm
- Four emergency diesel generators (EDG) rated at 10,130 kW(e)
- Two station blackout (SBO) generators rated at 5000 kW(e)
- Six diesel fuel storage tanks (design specifications not completed).

Based in part on input from UniStar, PPRP (MDNR PPRP 2008b) contains the estimates of the annual release rates of criteria pollutants for proposed Unit 3 operations presented in Table 5-5. These estimates are consistent with estimates made by UniStar.

Calvert Cliffs is classified by Maryland as an existing major stationary source for air permitting purposes. Consequently, the basis for determining PSD applicability is based on determining if there is a significant increase in emission of regulated pollutants. The increases in particulate releases shown in Table 5-5 exceed the threshold establishing significance. As a result, UniStar had to meet the following requirements for the cooling towers and diesel generators:

- demonstrate the use of BACT
- use dispersion modeling to assess the impacts of the emissions
- conduct additional impact assessments.

Table 5-5. Regulated Sources Emissions (Tons/yr)

Source	Total PM[(a)]	PM_{10}[(b)]	$PM_{2.5}$[(c)]	NO_x[(d)]	CO[(e)]	VOC[(f)]	SO_2[(g)]
Circulating Water Supply System (CWS) Cooling Tower	306.5	238.5	39.7				
Essential Service Water System Cooling Towers	3.1	3.1	1.6				
Four EDGs[(h)]	1.0	1.0	1.0	10.7	23.4	2.6	1.3
Two SBOs[(i)]	0.6	0.6	0.6	12.1	5.5	1.2	0.0
Total	311.1	243.0	42.8	22.8	28.9	3.8	1.3

(a) particulate matter
(b) particulate matter less than 10 microns in diameter
(c) particulate matter less than 2.5 microns in diameter
(d) oxides of nitrogen
(e) carbon monoxide
(f) volatile organic compounds
(g) sulfur dioxide
(h) 600 hr/year operation total, displacement > 30 liters, low-sulfur fuel
(i) 200 hr/year operation total, displacement between 10 and 30 liters, low-sulfur fuel

The UniStar submittal to Maryland DNR (UniStar 2007) addressed each of these requirements, and PPRP (MDNR PPRP 2008b) reviewed the UniStar analyses. PPRP concluded (1) that the UniStar cooling tower designs represent use of BACT, and (2) that limitations on the hours of operation and fuel represent BACT for the diesel generators. Dispersion modeling results presented by PPRP do not indicate that the impacts of emissions associated with proposed Unit 3 would exceed applicable standards. PPRP also concluded that there are no uncertainties "that would significantly alter the findings of the air quality modeling analysis." Finally, the PPRP review of the additional impact assessment performed by UniStar concluded:

- "emissions from the Calvert Cliffs project during operation will have minimal effects on soils, vegetation, wildlife, and local visibility."
- "predicted values due to the cooling tower are lower than threshold deposition rates needed to have an adverse impact on the nearby flora and fauna."
- "it can be reasonably concluded that the Calvert Cliffs facilities impacts on visibility in the surrounding Class I areas are likely to be minimal."

In addition to evaluating emissions of criteria pollutants, PPRP (MDNR PPRP 2008b) evaluated releases of toxic air pollutants (TAPs) as defined in Maryland regulations (COMAR 2008b) and releases of hazardous air pollutants (HAP) listed in Section 112 of the Clean Air Act (42 U.S.C. 7401 et seq.). The TAPs of concern are those associated with emissions of chemical additives used in the cooling tower water. Table 5-6 lists the projected emissions from the proposed Unit 3 CWS tower and the corresponding Code of Maryland emission rate limits (MDNR PPRP 2008b). In each case, the projected emission rate is an insignificant fraction of the limit. Emissions from the ESWS would be smaller still and, therefore, have not been evaluated further. Diesel generators are exempt from Maryland TAP regulations (MDNR PPRP 2008b).

Table 5-6. Circulating Water Supply System Cooling Tower Toxic Air Pollutant Emission Rates (lb/hr)

Source	NaOCl[(a)]	NaOH[(b)]	HEDP[(c)]	Petroleum Distillate
Circulating Water Supply System (CWS) Cooling Tower	0.00064	0.00016	0.00022	0.00008
COMAR Limit	0.21	0.04	0.21	0.04

(a) sodium hypochlorite
(b) sodium hydroxide
(c) hydroxyethylidine diphosphonic acid

Fuel oil for the diesel generators is the source of HAP emissions associated with proposed Unit 3. To be considered a major source of HAP, a facility must have the potential to emit 10 tons/yr of an individual HAP or 25 tons/yr or more total for all HAPs. None of the proposed Unit 3 diesel generators would be expected to emit as much as 0.03 ton/yr of any HAP, and the sum of all HAP releases is less expected to be less than 0.05 ton/yr (MDNR PPRP 2008b).

Finally, the operation of a nuclear power plant involves the emission of some greenhouse gases, primarily carbon dioxide (CO_2). The review team has estimated in Appendix L that the total carbon footprint for actual plant operations for 40 years is of the order of 330,000 metric tons of CO_2 equivalent, as compared to a total United States annual CO_2 emissions rate of 6,000,000,000 metric tons (EPA 2009). Periodic testing of diesel generators accounts for about 60 percent of the total. Workforce transportation accounts for most of the rest. Based on its assessment of the relatively small plant operations carbon footprint as compared to the United States annual CO_2 emissions, the review team concludes that the atmospheric impacts of greenhouse gases from plant operations would not be noticeable, and additional mitigation would not be warranted.

Based on its evaluation of the extensive review of the air quality impacts of operation of the proposed Unit 3 conducted for the Maryland DNR, the review team concludes that the environmental impacts from operation of proposed Unit 3 would be minimal, and additional mitigation would not be warranted. Based on its assessment of the carbon footprint of plant operations, the review team concludes that the atmospheric impacts of greenhouse gases from plant operations would not be noticeable, and additional mitigation would not be warranted.

5.7.3 Transmission Line Impacts

Impacts of existing transmission lines on air quality are addressed in NUREG-1437 (NRC 1996). Small amounts of ozone and even smaller amounts of NO_x are produced by transmission lines. The production of these gases was found to be insignificant for 745-kV transmission lines (the largest lines in operation) and for a prototype 1200-kV transmission line. In addition, it was determined that potential mitigation measures, such as burying transmission lines, would be very costly and would not be warranted.

UniStar (2009a) stated that no new offsite transmission facilities would be required to connect proposed Unit 3 to the transmission grid. Further, UniStar stated that approximately 1 mi of new 500-kV transmission line, all on site, would be required to connect the Unit 3 substation with the existing substation for Units 1 and 2. The size of this line would be well within the range of transmission lines provided in NUREG-1437, and the review team therefore concludes that air quality impacts from transmission lines would not be noticeable.

5.7.4 Summary of Impacts to Air Quality

The review team evaluated potential impacts on air quality associated with criteria pollutants and greenhouse gas emissions from operating Unit 3 at Calvert Cliffs. The review team also evaluated potential impacts of cooling system emissions and transmission lines. In each case, the review team determined that the impacts would be minimal. On this basis, the review team concludes that the impacts of operation of Unit 3 on air quality from emissions of criteria pollutants, CO_2 emissions, and cooling system emissions would be SMALL, and no further mitigation is warranted.

5.8 Nonradiological Health Impacts

This section addresses the nonradiological health impacts to the public and workers from operating proposed Unit 3 at the Calvert Cliffs site. Nonradiological public health impacts are considered from operation of the cooling system, from noise generated by operations, from EMF, and from transporting material and personnel to the site. Nonradiological health impacts from the same sources are also evaluated for workers at the site during the operation of proposed Unit 3. Section 2.10 provides background information on the affected environment and nonradiological health at and within the vicinity of the Calvert Cliffs site. Health impacts from radiological sources during operations are discussed in Section 5.9.

5.8.1 Etiological Agents

Operation of the proposed Unit 3 would result in a thermal discharge to Chesapeake Bay (UniStar 2009a). As described in NUREG-1555 (NRC 2000a), nuclear power plants that discharge into receiving waters that have high flow (>100,000 ft^3/sec) would not have a detrimental impact from the thermal discharges on the concentration levels of deleterious thermophilic microorganisms. The average flow rate of the tidal exchanges that occur in Chesapeake Bay at the CCNPP is estimated to be 800,000 ft^3/sec, which far exceeds this threshold.

The proposed offshore discharge structure, located approximately 1200 ft south of the proposed Unit 3 intake structure, is designed to extend approximately 550 ft into Chesapeake Bay and would include a multiport diffuser for enhanced mixing of the thermal effluent with the receiving waters (UniStar 2009a). Review team conducted an independent analysis of the thermal discharge (see Section 5.2.3.1), and results showed all State of Maryland requirements for thermal discharge would be met.

Limited recreational activity occurs in the immediate vicinity of the proposed discharge structure. Two state parks flank the Calvert Cliffs site; to the north is Flag Ponds Park and to the south is Calvert Cliffs State Park. In addition, the Captain John Smith Chesapeake National Historic Trail and the Star-Spangled Banner National Historic Trail include water trails in the Chesapeake Bay at the location of the Calvert Cliffs site. The thermal plume from Unit 3 would not extend to or influence the waters in the vicinity of the parks, but the portion of the thermal plume that extends beyond the Unit 3 exclusion zone would influence the waters of the National Historic Trails. Just offshore from Unit 3 and in the vicinity of the thermal plume is Natural Oyster Bar (NOB) 19-2, as designated by the Maryland DNR (MDNR PPRP 2008a). The heated water returned to the Bay would be discharged directly over the oyster bar, and the thermal plume may enhance native populations of *Vibrio* spp., human pathogens that commonly occur with oysters. Most cases of disease associated with *Vibrio* spp. occur following consumption of raw oysters (Wright et al. 1996; Louis et al. 2003). The occurrence of *Vibrio* spp. in Chesapeake Bay is more frequent in the summer months when water temperatures are higher. Although these bacteria are ubiquitous in the marine environment and their optimal temperature and salinity ranges are within those parameters in Chesapeake Bay, the small temperature differential associated with the thermal discharge would not likely have an effect on the concentration of *Vibrio* spp. in the vicinity of the CCNPP site (Louis et al. 2003, Wright et al. 1996, UniStar 2009a).

UniStar has procedures for workers to wear personal protective equipment (including respiratory protection) and have stated that Occupational Safety and Health Administration (OSHA) standards will be adhered to for onsite exposure to vapors, dusts and other air contaminants for workers (UniStar 2009a). These practices would likely minimize exposure to *Legionella pneumophila* in water vapors while personnel are working with the cooling towers. The protective equipment meets OSHA requirements, and meets OSHA recommendations for respiratory protection of work where a person may breathe water aerosol (UniStar 2009a).

Based on the relatively low incidence of diseases from thermophilic microorganisms in Maryland, the small temperature increase expected as a result of operating proposed Unit 3, the high tidal flows around the proposed discharge structure, the distance from shore of the discharge structure, and the relative absence of swimming or activities resulting in water immersion in the vicinity of the proposed discharge structures, the review team concludes that potential impacts from etiological agents on human health would be minor, and mitigation would not be warranted.

5.8.2 Noise

In NUREG-1437 (NRC 1996), the NRC staff discusses the environmental impacts of noise from operations at existing nuclear power plants. Common sources of noise from plant operation include cooling towers, transformers, turbines, and the operation of pumps along with intermittent contributions from loud speakers and auxiliary equipment, such as diesel generators. In addition, while there may be corona discharge noise associated with high-voltage transmission lines, the occurrences are infrequent and often weather related when the public is likely to be indoors. These common sources of noise are discussed in this section.

UniStar addresses noise from proposed Unit 3 operation in both its ER (UniStar 2009a) and its submission to the Maryland DNR for a CPCN (UniStar 2007). The noise sources at the Calvert Cliffs site are sufficiently distant from the plant boundaries that the noise generated by the plant is attenuated to near-ambient levels before reaching critical receptors outside the plant boundary. According to the ER, noise associated with the proposed Unit 3 cooling tower is estimated to increase noise levels to 50 to 55 dBA at three locations near the southern boundary of the site from existing levels that are less than 50 dBA (UniStar 2009a). Estimated noise levels at offsite locations are not expected to increase significantly due to cooling tower noise. Noise associated with traffic is addressed in the ER, but quantitative estimates of the noise level are not addressed. However, the ER does discuss measures such as staggered shift hours, as mitigation for increased traffic noise.

After reviewing the UniStar CPCN submission, the Maryland PPRP (MDNR PPRP 2008b) concluded that the cooling tower noise levels would comply with applicable noise limits. The PPRP then recommends that the State include a license condition that requires UniStar to conduct noise monitoring after the plant becomes operational to ensure that the noise impacts of the cooling tower are acceptable.

According to NUREG-1437 (NRC 1996), noise levels below 60 to 65 dBA are considered to be of small significance. More recently, the impacts of noise were considered in the *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities* (NUREG-0586, Supplement 1) (NRC 2002). The criterion for assessing the level of significance was not expressed in terms of sound levels, but was based on the effect of noise on human activities and on threatened and endangered species. The criterion in NUREG-0586, Supplement 1, is stated as follows:

> The noise impacts...are considered detectable if sound levels are sufficiently high to disrupt normal human activities on a regular basis. The noise impacts...are considered destabilizing if sound levels are sufficiently high that the affected area is essentially unsuitable for normal human activities, or if the behavior or breeding of a threatened and endangered species is affected.

Based on the relatively low levels of noise associated with the operation of proposed Unit 3 and the significant attenuation of that noise, the review team concludes that potential noise impacts associated with the operation of the new unit on the public would be minor and would not require mitigation.

5.8.3 Acute Effects of Electromagnetic Fields

Electric shock resulting from direct access to energized conductors or from induced charges in metallic structures is an example of an acute effect from EMF associated with transmission lines (NRC 1996). Such acute effects are controlled and minimized by conformance with National Electrical Safety Code (NESC) criteria and adherence to the standards for transmission systems.

The potential impacts from EMF of the existing transmission lines for CCNPP Units 1 and 2 were evaluated as part of the environmental review for renewal of the CCNPP Unit 1 and 2 operating license (NRC 1996). In that review, the review team concluded that the potential impact for electrical shock was small. In the ER, UniStar states that new transmission facilities would be required to connect proposed Unit 3 to the existing transmission system. UniStar also stated that all new transmission lines would be contained within the Calvert Cliffs site property lines. Finally, UniStar stated that the design and construction of the proposed Unit 3 substation and transmission circuits would comply with NESC provisions that limit the induced current due to electrostatic effects to 5 milliamperes (mA) (UniStar 2009a).

With UniStar's commitment to design and construct new transmission lines to ensure that the present NESC criteria are met, the review team concludes that the impact potential to the public from acute effects of EMF would be minor, and further mitigation would not be warranted.

5.8.4 Chronic Effects of Electromagnetic Fields

Operating power transmission lines in the United States produce EMF of nonionizing radiation at 60 Hz, which is considered to be an extremely low frequency (ELF) EMF. Research on the potential for chronic effects of EMF from energized transmission lines was reviewed and addressed by the NRC in NUREG-1437 (NRC 1996). At that time, research results were not conclusive. The National Institute of Environmental Health Sciences (NIEHS) directs related research through the U.S. Department of Energy. An NIEHS report (NIEHS 1999) contains the following conclusion:

> The NIEHS concludes that ELF-EMF exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard. In our opinion, this finding is insufficient to warrant aggressive regulatory concern. However, because virtually everyone in the United States uses electricity and therefore is routinely exposed to ELF-EMF, passive regulatory action is warranted such as a continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. The NIEHS does not believe that other cancers or non-cancer health outcomes provide sufficient evidence of a risk to currently warrant concern.

The review team reviewed available scientific literature on chronic effects to human health from ELF-EMF published since the NIEHS report and found that several other organizations reached the same conclusions (AGNIR 2006; WHO 2007a). Additional work under the auspices of the World Health Organization (WHO) updated the assessments of a number of scientific groups reflecting the potential for transmission line EMF to cause adverse health impacts in humans. The monograph summarized the potential for ELF-EMF to cause disease such as cancers in children and adults, depression, suicide, reproductive dysfunction, developmental disorders, immunological modifications, and neurological disease. The results of the review by WHO (2007b) found that the extent of scientific evidence linking these diseases to EMF exposure is not conclusive.

The review team reviewed available scientific literature on chronic effects of EMF on human health and found that the scientific evidence regarding the chronic effects of ELF-EMF on human health does not conclusively link ELF-EMF to adverse health impacts.

5.8.5 Occupational Health

As discussed in Section 2.10, human health risks for personnel engaged in activities such as maintenance, testing, and plant modifications for proposed Unit 3 are expected to be dominated by occupational accidents (e.g., falls, electric shock, burns) or occupational illnesses from noise exposure, exposure to toxic or oxygen-replacing gases, and other hazards. Historically, actual injury and fatality rates at nuclear reactor facilities have been lower than the average U.S. industrial rates. Occupational injury and fatality risks are reduced by strict adherence to NRC and OSHA safety standards (29 CFR Part 1910), practices, and procedures. Appropriate State and local statutes must also be considered when assessing the occupational hazards and health risks for new nuclear unit operation. The review team expects that UniStar will fully adhere to NRC, OSHA, and State safety standards, practices, and procedures during operations of the new unit.

Additional occupational health impacts may result from exposure to hazards, such as noise, toxic or oxygen-replacing gases, thermophilic microorganisms in the condenser bays, and caustic agents. UniStar (2009a) reports that it maintains a health and safety program to protect workers from industrial safety risks at the operating units and would implement the program for the proposed new units.

Based on mitigation measures identified by UniStar in its ER, adherence to NRC and OSHA safety standards, practices, and procedures, and the review team's independent evaluation, the review team concludes that occupational health impacts to proposed Unit 3 onsite personnel would be minimal and no further mitigation would be warranted.

5.8.6 Transporting Operations Personnel to the Proposed Site

This EIS assesses the impact of transporting workers to and from the Calvert Cliffs site from the perspective of three areas of impact: The socioeconomic impacts, the air quality impacts of fugitive dust and particulate matter emitted by vehicle traffic, and the potential health impacts due to additional traffic-related accidents. Human health impacts are addressed in this section while the socioeconomic impacts are addressed in Section 5.4.1 and air quality impacts are addressed in Section 5.7.2.

The general approach used to calculate non-radiological impacts of fuel and waste shipments is the same as that used to calculate the impacts of transporting operations and outage personnel to and from the Calvert Cliffs site. However, preliminary estimates are the only data available to estimate these impacts. The assumptions made to provide reasonable estimates of the parameters needed to calculate non-radiological impacts are discussed below.

- The number of workers needed for operations was given in UniStar's ER as 363 workers per unit. An additional 1000 temporary workers are estimated to be needed for refueling outages every 18 months (UniStar 2009a).
- The average commute distance for operations and outage workers was assumed by the NRC staff to be 20 mi one way. This is based on U.S. Department of Transportation (DOT) data that estimates the typical commute distance is 16 mi (DOT 2003).
- To develop representative commuter traffic impacts, data from the U.S. DOT (2008a) provide a Maryland-specific fatality rate for all traffic from 2001 through 2006. The average fatality rate for the 2001 to 2006 period in Maryland was used as the basis for estimating Maryland-specific injury and accident rates. Adjustment factors were developed using national-level traffic accident statistics in the U.S. DOT publication *National Transportation Statistics 2007* (DOT 2007). The adjustment factors are the ratio of the national injury rate to the national fatality rate and the ratio of the national accident rate to the national fatality

rate. These adjustment factors were multiplied by the Maryland-specific fatality rate to approximate the injury and accident rates for commuters in the State of Maryland.

The estimated impacts of transporting operations and outage workers to and from the proposed Unit 3 site are shown in Table 5-7. The total annual traffic fatalities during operations, including both operations and outage personnel, represents less than 0.2 percent increase above the 21 traffic fatalities that occurred in Calvert County, Maryland, in 2006 (DOT 2008b). This represents a small increase relative to the current traffic fatality risk in the area surrounding the Calvert Cliffs site.

Based on the information provided by UniStar, the review team's independent evaluation, and considering that this increase would be small relative to the current traffic fatalities in Calvert County, the review team concludes that the nonradiological impacts of transporting personnel to the Calvert Cliffs site would be minimal, and mitigation would not be warranted.

Table 5-7. Estimated Impacts of Transporting Workers to and from the Proposed Unit 3 Site

	Accidents per Yr Per Unit	Injuries per Yr Per Unit	Fatalities per Yr Per Unit
Permanent Workers	3.4×10^{0}	1.6×10^{0}	2.3×10^{-2}
Outage Workers	5.6×10^{-1}	2.6×10^{-1}	3.9×10^{-3}

5.8.7 Summary of Nonradiological Health Impacts

The review team evaluated health impacts to the public and the workers from the cooling systems, noise generated by unit operations, acute and chronic impacts of EMFs, and transporting operations and outage workers to and from the proposed Unit 3 site. Health risks to workers are expected to be dominated by occupational injuries at rates below the average U.S. industrial rates. Health impacts to the public and workers from etiological agents, noise generated by plant operations, and acute impacts of EMF would be minimal. The review team reviewed available scientific literature on chronic effects of EMF on human health and found that the scientific evidence regarding the chronic effects of ELF-EMF on human health does not conclusively link ELF-EMF to adverse health impacts. Based on the information provided by UniStar and the review team's independent evaluation, the review team concludes that the potential impacts to nonradiological health resulting from the operation of proposed Unit 3 would be SMALL, and mitigation would not be warranted.

5.9 Radiological Impacts of Normal Operations

This section addresses the radiological impacts of normal operations of the proposed Unit 3, including a discussion of the estimated radiation dose to a member of the public and to the biota inhabiting the area around the Calvert Cliffs site. Estimated doses to workers at the proposed unit are also discussed. Radiological impacts were determined using the AREVA NP Inc. (AREVA) U.S. EPR reactor design with expected direct radiation and liquid and gaseous radiological effluent rates in the evaluation (see discussion in Section 3.4).

5.9.1 Exposure Pathways

The public and biota would be exposed to increased ambient background radiation from a nuclear unit via the liquid effluent, gaseous effluent, and direct radiation pathways. UniStar estimated the potential exposures to the public and biota by evaluating exposure pathways typical of those surrounding a nuclear unit at the Calvert Cliffs site. UniStar considered pathways that could cause the highest calculated radiological dose based on the use of the environment by the residents located around the site (UniStar 2009a). For example, factors such as the location of homes in the area, consumption of meat, fish and shellfish from the area, and consumption of vegetables grown in area gardens were considered.

For the liquid effluent release pathway, the ER considered the following exposure pathways in evaluating the dose to the maximally exposed individual (MEI): ingestion of aquatic food (i.e., fish and invertebrates), ingestion of desalinated drinking water, and direct radiation exposure from shoreline activities (Figure 5-1). The analysis for population dose considered the following exposure pathways: ingestion of aquatic food and direct radiation exposure from shoreline, swimming, and boating activities. Drinking water was not evaluated in the population exposure because the Chesapeake Bay is not used as an offsite source of drinking water. Liquid effluents were assumed to be released into Chesapeake Bay at the offshore discharge line.

For the gaseous effluent release pathway, UniStar (2009a) considered the following exposure pathways in evaluating the dose to the individual: immersion in the radioactive plume, direct radiation exposure from deposited radioactivity, inhalation, ingestion of garden fruit and vegetables, and ingestion of beef. UniStar (2009a) did not calculate a MEI dose from milk ingestion because the most recent land-use census indicated that no milk cows existed within 5 mi of the site.

For population doses from the gaseous effluents, UniStar (2009a) used the same exposure pathways as used for the individual dose assessment, with the addition of the cow milk ingestion pathway (Figure 5-1). All agricultural products grown within 50 mi of the proposed Unit 3 were assumed to be consumed by the population within 50 mi of the proposed Unit 3.

UniStar (2009a) states that direct radiation from the reactor buildings and the Independent Spent Fuel Storage Installation (ISFSI) would be the primary sources of direct radiation exposure to the public from the proposed Unit 3. However, UniStar asserts that contained sources of radiation at the proposed Unit 3 would be shielded and would not contribute to the external dose of the MEI or the population.

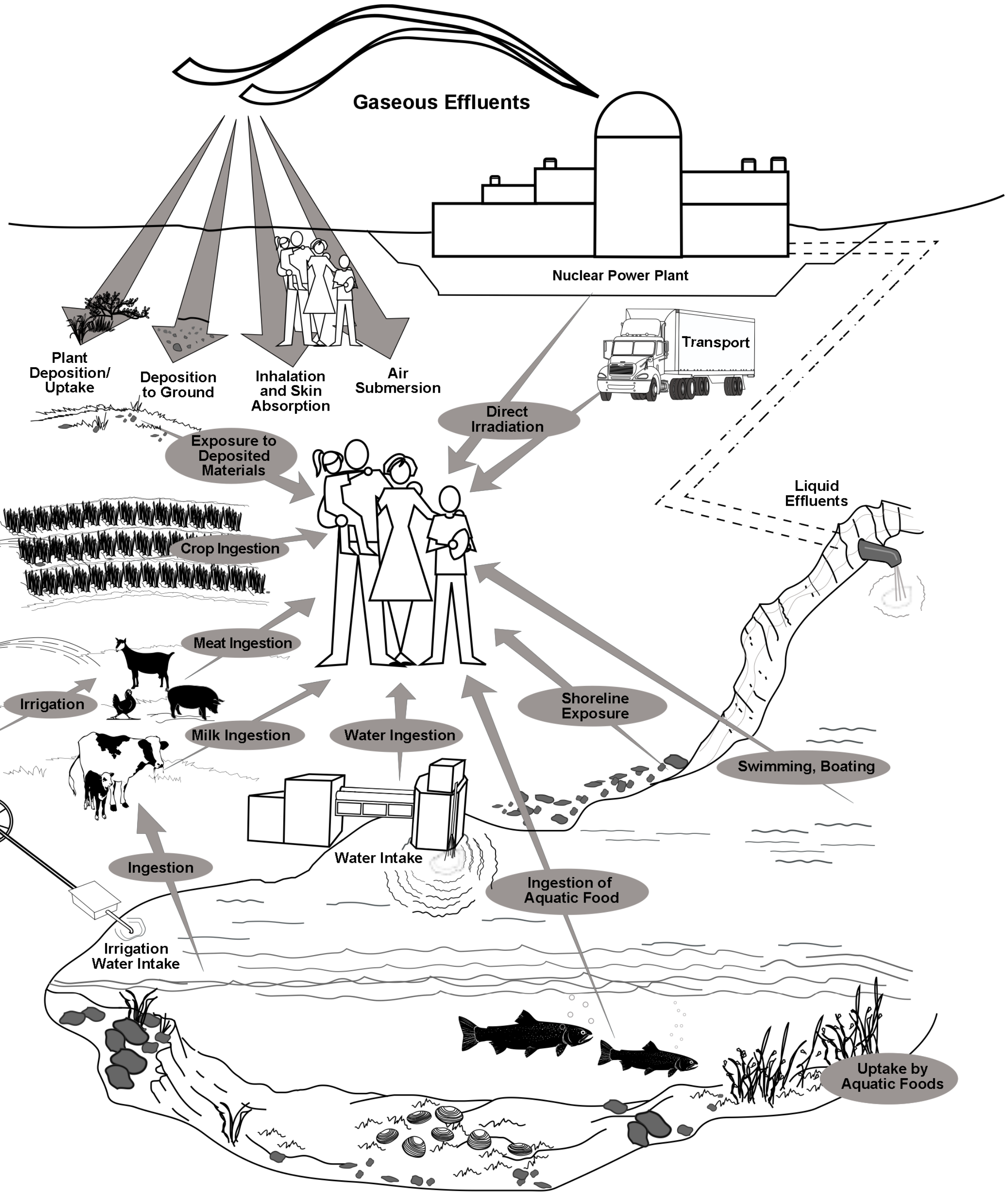

Figure 5-1. Exposure Pathways to Man (adapted from Soldat et al. 1974)

Exposure pathways (UniStar 2009a, Table 5.4-16) considered in evaluating dose to the biota are shown in Figure 5-2 and include:

- ingestion of aquatic foods
- external exposure from water immersion or surface effect
- inhalation of airborne radionuclides
- external exposure to immersion in gaseous effluent plumes
- surface exposure from deposition of iodine and particulates from gaseous effluents (NRC 1977).

The staff reviewed the exposure pathways for the public and non-human biota identified by UniStar (2009a) and found them to be appropriate based on a documentation review, a tour of environs, and interviews with UniStar staff and contractors during the site visit in March 2008.

5.9.2 Radiation Doses to Members of the Public

UniStar calculated the dose to the MEI individual and the population living within a 50-mi radius of the site from both the liquid and gaseous effluent release pathways (UniStar 2009a). As discussed in the previous sections, direct radiation exposure to the MEI individual from sources of radiation at the proposed Unit 3 would be negligible.

5.9.2.1 Liquid Effluent Pathway

Liquid pathway doses to the MEI were calculated by UniStar using the LADTAP II computer program (Strenge et al. 1986). The following activities were considered in the dose calculations: (1) consumption of desalinated drinking water contaminated by liquid effluents, (2) consumption of fish, shellfish or other aquatic organisms from water sources contaminated by liquid effluents, and (3) direct radiation from swimming boating and shoreline usage on waterbodies contaminated by liquid effluents. UniStar (2009a) states that because of the brackish nature of the Chesapeake Bay water, it is not used for irrigation or to water livestock.

The liquid effluent releases used in the estimates of dose are found in Table 3.5-7 of the ER (UniStar 2009a). Other parameters used as inputs to the LADTAP II program include effluent discharge rate, dilution factor for discharge, transit time to receptor, and liquid pathway consumption and usage factors (i.e., shoreline usage, fish consumption, and drinking water consumption) and are found in Tables 5.4-1 and 5.4-2 of the ER (UniStar 2009a).

UniStar calculated liquid pathway doses to the MEI and population as shown in Table 5-8. The MEI was an adult with the majority of the dose from ingestion of fish and other organisms from Chesapeake Bay. The maximally exposed organ was the adult lower intestine (GI-LLI) and as with the total body dose, the majority of the dose was received from consumption of Chesapeake Bay fish and other organisms.

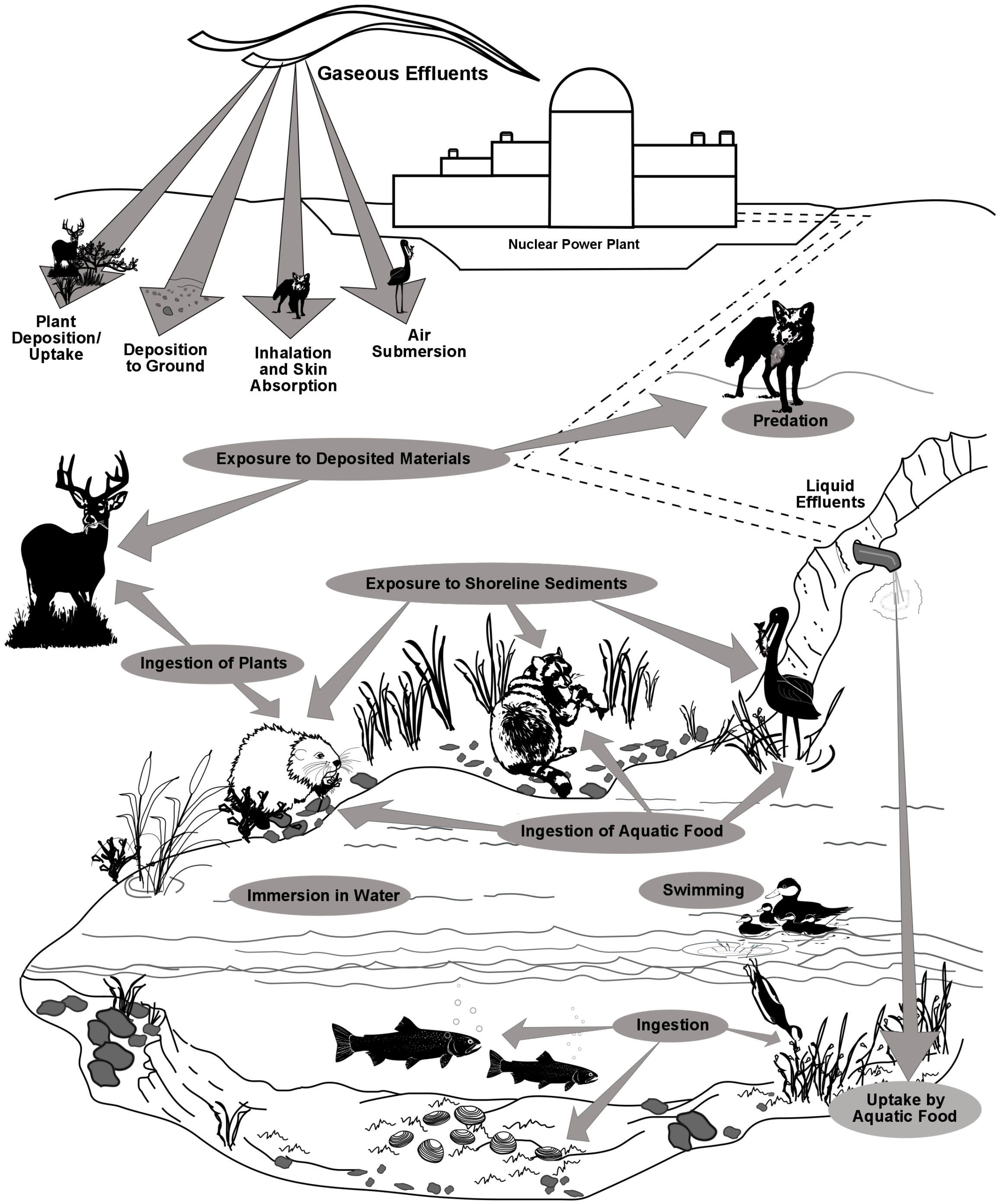

Figure 5-2. Exposure Pathways to Biota Other Than Man (adapted from Soldat et al. 1974)

Table 5-8. Annual Doses to the Maximally Exposed Individual for Liquid Effluent Releases from Calvert Cliffs Proposed Unit 3

Pathway	Age Group	Total Body (mrem/yr)	Maximum Organ (GI-LLI) (mrem/yr)	Thyroid (mrem/yr)
Drinking Water	Adult	0.0056	0.0056	NR
	Teen	0.004	0.004	NR
	Child	0.0076	NR	0.0085
	Infant	0.0074	NR	0.0089
Fish and Other Organisms	Adult	0.0074	0.083	0.071
	Teen	0.0058	0.066	0.065
	Child	0.0049	0.0294	0.069
Direct Radiation	All	0.00097	0.00097	0.00097

Source: UniStar 2009a. Tables 5.4-7 and 5.4-8. No infant doses were calculated for ingestion of fish and other organisms pathway because the doses that infants receive would be bounded by the dose calculated for the child.
NR – Not reported by UniStar.

The staff recognizes the LADTAP II computer program as an appropriate method for calculating dose to the MEI for liquid effluent releases. The staff also performed an independent evaluation of liquid pathway doses using input parameters from the ER and found similar results. All input parameters used in UniStar's calculations were judged by the staff to be appropriate. Results of the staff's independent evaluation are found in Appendix G.

5.9.2.2 Gaseous Effluent Pathway

Gaseous pathway doses to the MEI were calculated by UniStar using the GASPAR II computer program (Strenge et al. 1987) at the nearest residence, garden, and meat animal and the exclusion area boundary. The GASPAR II computer program was also used to calculate annual population doses. The following activities were considered in the dose calculations: (1) direct radiation from immersion in the gaseous effluent cloud and from particulates deposited on the ground, (2) inhalation of gases and particulates, (3) ingestion of meat from animals eating contaminated grass, and (4) ingestion of garden vegetables contaminated by gases and particulates. Although UniStar (2009a) states that no milk cows or milk goats are located within 5 mi of the proposed site, UniStar did include the milk pathway in the calculation of population dose based on milk production within a 50-mi radius of proposed Unit 3. The gaseous effluent releases used in the estimate of dose to the MEI and population are found in Table 3.5-8 of the ER (UniStar 2009a). Other parameters used as inputs to the GASPAR II program, including population data, atmospheric dispersion factors, ground deposition factors, receptor locations, and consumption factors, are found in Tables 5.4-3, 5.4-4, 5.4-5 and 5.4-6 of the ER (UniStar 2009a). Gaseous pathway doses to the MEI calculated by UniStar are found in Table 5-9.

Table 5-9. Doses to the MEI from Gaseous Effluent Pathway for Unit 3

Location	Age Group	Total Body Dose (mrem/yr)	Max Organ (Bone) (mrem/yr)	Skin Dose (mrem/yr)
Plume (0.88 mi SE)	All	2.14×10^{-1}	2.14×10^{-1}	$2.05 \times 10^{+0}$
Ground (0.88 mi SE)	All	1.49×10^{-3}	1.49×10^{-3}	1.74×10^{-3}
Inhalation (0.88 mi SE)	Adult	4.13×10^{-3}	7.36×10^{-5}	4.30×10^{-3}
	Teen	4.36×10^{-3}	8.98×10^{-5}	4.34×10^{-3}
	Child	3.85×10^{-3}	1.10×10^{-4}	3.83×10^{-3}
	Infant	2.22×10^{-3}	5.76×10^{-5}	2.20×10^{-3}
Vegetable (1.3 mi SSE)	Adult	2.34×10^{-2}	1.07×10^{-1}	2.29×10^{-2}
	Teen	3.71×10^{-2}	1.76×10^{-1}	3.62×10^{-2}
	Child	8.63×10^{-2}	4.22×10^{-1}	8.53×10^{-2}
Meat (0.88 mi SSE)	Adult	1.74×10^{-2}	8.18×10^{-2}	1.72×10^{-2}
	Teen	1.44×10^{-2}	6.91×10^{-2}	1.44×10^{-2}
	Child	2.67×10^{-2}	1.30×10^{-1}	2.67×10^{-2}

Source: UniStar 2009a, Table 5.4-11. No infant doses were calculated for the vegetable or meat pathway because the doses that infants receive from this diet would be bounded by the dose calculated for the child.

The staff recognizes the GASPAR II computer program as an appropriate tool for calculating dose to the MEI and population from gaseous effluent releases. The staff reviewed the input parameters and values used by UniStar (2009a) for appropriateness, including references made to the U.S. EPR Design Control Document submitted by AREVA (AREVA 2007a). The staff concluded that the assumed input parameters and values used by UniStar were appropriate. The staff performed an independent evaluation of gaseous pathway doses and obtained similar results for the MEI (See Appendix G for details).

5.9.3 Impacts to Members of the Public

This section describes the staff's evaluation of the estimated impacts from radiological releases and direct radiation from proposed Unit 3. The evaluation addresses dose from operations to the MEI located at the proposed Unit 3 site boundary and the population dose (collective dose to the population within 50 mi) around the proposed Unit 3 site.

5.9.3.1 Maximally Exposed Individual

UniStar (2009a) states that total body and organ dose estimates to the MEI from liquid and gaseous effluents for the proposed Unit 3 would be within the design objectives of 10 CFR Part 50, Appendix I. Doses to total body and maximum organ at the Chesapeake Bay from liquid effluents were well within the respective 3-mrem/yr and10-mrem/yr Appendix I design objectives. Doses at the exclusion area boundary from gaseous effluents were well within the

Appendix I design objectives of 10 mrad/yr air dose from gamma radiation, 20 mrad/yr air dose from beta radiation, 5 mrem/yr to the total body, and 15 mrem/yr to the skin. In addition, dose to the thyroid was within the 15 mrem/yr Appendix I design objective. A comparison of dose estimates for the proposed new unit to the Appendix I design objectives is found in Table 5-10. The staff completed an independent evaluation of compliance with Appendix I design objectives and found similar results as shown in Appendix G.

Table 5-10. Comparisons of MEI Annual Dose Estimates from Liquid and Gaseous Effluents to 10 CFR Part 50, Appendix I Design Objectives

Radionuclide Releases/Dose	UniStar Assessment	Appendix I Design Objectives
Gaseous effluents(noble gases only)		
Beta air dose (mrad/yr)	2.79	20
Gamma air dose (mrad/yr)	0.341	10
Total body dose (mrem/yr)	0.215	5
Skin dose (mrem/yr)	2.05	15
Gaseous effluents (radioiodines and particulates)		
Organ dose (mrem/yr)	0.554	15
Liquid effluents		
Total body dose (mrem/yr)	0.014	3
Maximum organ dose (mrem/yr)	0.0902	10

Source: UniStar 2009a

UniStar (2009a) compared the combined dose estimates from direct radiation and gaseous and liquid effluents from the existing Units 1 and 2 and the proposed Unit 3 against the 40 CFR Part 190 standards (Table 5-11). UniStar states that the total body and organ dose estimates to the MEI from liquid and gaseous effluents for CCNPP Units 1 and 2 would be less than the estimates from Unit 3 which is well within the design objectives of 10 CFR Part 50, Appendix I. Section 4.9.1 of this EIS states that the direct radiation doses from the existing Calvert Cliffs Units 1 and 2 at the site boundary do not vary significantly from background radiation levels. As stated in Section 5.9.1, exposure at the site boundary from direct radiation sources at the proposed new Unit 3 would not contribute significantly to the MEI dose. Table 5-11 shows UniStar's assessment that the total doses to the MEI from liquid and gaseous effluent as well as direct radiation at the Calvert Cliffs site are well below the 40 CFR Part 190 standards. The staff completed an independent evaluation of the site total dose (cumulative dose) for comparison with 40 CFR Part 190 standards and found similar results, as shown in Appendix G.

Table 5-11. Comparison of Doses to 40 CFR Part 190[(a)]

	Units 1 & 2	Unit 3				
	Combined liquid and gaseous (mrem/yr)	**Liquid (mrem/yr)**	**Gaseous (mrem/yr)**	**Combined (mrem/yr)**	**Site Total (mrem/yr)**	**40 CFR Part 190 Dose Standards (mrem/yr)**
Whole body dose	0.018	0.014	0.33	0.35	0.364	25
Thyroid	0.018	0.079	0.52	0.60	0.616	75
Other organ	0.35	0.09 (adult GI-LLI)	0.76 (child bone)	0.86	1.21	25

Source: UniStar (2009a Table 5.4-15)

A power uprate of 1.38 percent was granted to CCNPP Units 1 and 2 in July, 2009. This uprate will be implemented by the time Unit 3 operation begins. The uprate may increase the maximum annual dose to a member of the public from CCNPP Units 1 and 2 by as much as 1.38 percent; even with this addition, the site total dose the annual dose would still be well below 40 CFR Part 190 standards.

5.9.3.2 Population Dose

UniStar estimates the collective total body dose within a 50-mi radius of the proposed Unit 3 site to be 5.52 person-rem/yr (UniStar 2009a). The estimated collective dose to the same population from natural background radiation is estimated to be 192,000 person-rem/yr. The dose from natural background radiation was calculated by multiplying the 50-mi population estimate for 2060 of approximately 6,162,511 people by the annual background dose rate of 311 mrem/yr (NCRP 2009).

Collective dose was estimated for the gaseous and liquid effluent pathways using the GASPAR II and LAPTAP II computer codes, respectively. The staff performed an independent evaluation of population doses and obtained similar results (see Appendix G).

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

Both National Council on Radiation Protection and Measurements (NCRP) and ICRP suggest that when the collective effective dose is smaller than the reciprocal of the relevant risk detriment (i.e., less than 1/0.00057, which is less than 1754 person-rem), the risk assessment should note that the most likely number of excess health effects is zero (NCRP 1995; ICRP 2007). The estimated collective whole body dose to the population living within 50 mi of the proposed Unit 3 site is 5.52 person-rem/yr (UniStar 2009a), which is less than the 1754 person-rem value that ICRP and NCRP suggest would most likely result in zero excess health effects (NCRP 1995, ICRP 2007).

In addition, at the request of the U.S. Congress, the National Cancer Institute (NCI) conducted a study and published, “Cancer in Populations Living Near Nuclear Facilities,” in 1990 (NCI 1990). This report included an evaluation of health statistics around all nuclear power plants as well as several other nuclear fuel cycle facilities in operation in the United States in 1981 and found “no evidence that an excess occurrence of cancer has resulted from living near nuclear facilities” (NCI 1990).

5.9.3.3 Summary of Radiological Impacts to Members of the Public

The staff evaluated the health impacts from routine gaseous and liquid radiological effluent releases from the proposed Unit 3 at the Calvert Cliffs site. Based on the information provided by UniStar and NRC’s own independent evaluation, the staff concludes there would be no observable health impacts to the public from normal operation of the new unit, the health impacts would be SMALL, and additional mitigation would not be warranted.

5.9.4 Occupational Doses to Workers

At Calvert Cliffs, the annual occupational dose for 2006 was 204 person-rem for existing CCNPP Units 1 and 2 (NRC 2007a). The estimated occupational doses for advanced reactor designs, including the AREVA U.S. EPR at the proposed Unit 3 site, were 50 person-rem, less than the annual occupational doses for current light-water reactors (LWRs) (AREVA 2007a). This collective dose was based on an 18-month fuel cycle and would be bounding for a 24-month fuel cycle.

The licensee of a new plant would need to maintain individual doses to workers within 0.05 Sv (5 rem) annually as specified in 10 CFR 20.1201 and incorporate provisions to maintain doses as low as reasonably achievable (ALARA).

The staff concludes that the health impacts from occupational radiation exposure would be SMALL based on individual worker doses being maintained within 10 CFR 20.1201 limits and collective occupational doses being typical of doses found in current operating LWR reactors. Additional mitigation would not be warranted because the operating plant would be required to maintain doses ALARA.

5.9.5 Doses to Biota Other than Humans

UniStar estimated doses to biota species in the CCNPP site environs, in many cases using surrogate species. Surrogate species, as used in the ER, are well-defined and provide an acceptable method for evaluating doses to the biota. Surrogate species analyses were performed for aquatic species such as fish, invertebrates, and algae, and for terrestrial species such as muskrats, raccoons, herons and ducks. For aquatic species on the CCNPP site, various mussel and mollusk species and crayfish are represented by invertebrates as a surrogate species; darter, shiner, catfish, sunfish, perch, eels, largemouth bass, and striped bass are represented by fish as a surrogate species; and aquatic plants are represented by an algae as a surrogate species. For terrestrial species, white-tailed deer, raccoon, gray squirrel, Eastern cottontail rabbit, coyotes, gray fox, and pocket gopher are represented by raccoon and muskrat as surrogate species; wood duck is represented by duck as a surrogate species; and bald eagle and scarlet tanager are represented by the heron as a surrogate species. Exposure pathways considered in evaluating dose to the biota were discussed in Section 5.9.1 and shown in Figure 5-1. The NRC staff reviewed UniStar's calculations (UniStar 2009a) and performed an independent evaluation (Appendix G) of the fish invertebrates, algae, muskrat, raccoon, duck, and heron, but they used more conservative gaseous effluent exposure assumptions and found higher results than those reported by UniStar but still below national and international guidelines (Appendix G).

5.9.5.1 Liquid Effluent Pathway

UniStar (2009a) used the LADTAP II computer code to calculate doses to the biota from the liquid effluent pathway. In estimating the concentration of radioactive effluents in Chesapeake Bay, UniStar (2009a) used a transit dilution model. Liquid pathway doses were higher for biota compared to man because of considerations for bioaccumulation of radionuclides, ingestion of aquatic plants, ingestion of invertebrates, and increased time spent in water and shoreline compared to man. The liquid effluent releases used in estimating biota dose are found in Table 3.5-7 of the ER (UniStar 2009a). Table 5-12 presents UniStar's estimates of the doses to biota from the liquid and gaseous pathways from the Calvert Cliffs proposed new unit 3.

Table 5-12. Biota Doses for Proposed Unit 3

Biota	UniStar Biota Dose Estimates		
	Liquid Pathway (mrad/yr)	Gaseous Pathway (mrad/yr)	Total Body Biota Dose All Pathways (mrad/yr)
Fish	3.26×10^{-1}	0	3.3×10^{-1}
Invertebrate	$2.62 \times 10^{+0}$	0	$2.6 \times 10^{+0}$
Algae	$5.13 \times 10^{+0}$	0	$5.1 \times 10^{+0}$
Muskrat	$1.28 \times 10^{+0}$	2.24×10^{-1}	$1.5 \times 10^{+0}$
Raccoon	4.71×10^{-2}	2.24×10^{-1}	2.7×10^{-1}
Heron	1.74×10^{-1}	2.24×10^{-1}	3.9×10^{-1}
Duck	$1.3 \times 10^{+0}$	2.24×10^{-1}	$1.5 \times 10^{+0}$

Source: UniStar (2009a)

5.9.5.2 Gaseous Effluent Pathway

Gaseous effluents would contribute to the total body dose of the terrestrial surrogate species (i.e., muskrat, raccoon, heron, and duck). The exposure pathways include inhalation of airborne radionuclides, external exposure because of immersion in gaseous effluent plumes, and surface exposure from deposition of iodine and particulates from gaseous effluents. The dose calculated to the MEI from gaseous effluent releases in Table 5-9 would also be applicable to terrestrial surrogate species with a doubling of the ground deposition factor because terrestrial species are closer to the ground than humans. The gaseous effluent releases used in estimating dose are found in Table 3.5-8 of the ER (UniStar 2009a). The ER used doses at the exclusion area boundary 0.88 mi SE of the proposed Unit 3 site in estimating terrestrial species doses. Total body dose estimates to the surrogate species from the gaseous pathway are shown in Table 5-10. As discussed in Appendix G, the staff examined the potential for higher doses closer to the plant, and found that the reported dose is still significantly below the biota guidelines.

5.9.5.3 Impact of Estimated Non-Human Biota Doses

Radiological doses to non-human biota are expressed in units of absorbed dose (rad) because dose equivalent (rem) only applies to human radiological doses. The ICRP (ICRP 1977, 1991, 2007) states that if humans are adequately protected, other living things are also likely to be sufficiently protected. The International Atomic Energy Agency (IAEA 1992) and the NCRP (1991) reported that a chronic dose rate of no greater than 10 mGy/d (1000 mrad/d) to the MEI in a population of aquatic organisms would ensure protection of the population. IAEA (1992) also concluded that chronic dose rates of 1 mGy/d (100 mrad/d) or less do not appear to cause observable changes in terrestrial animal populations.

Table 5-13 compares estimated total body dose rates to surrogate biota species that would be produced by releases from Unit 3 to the IAEA/NCRP biota dose guidelines (IAEA 1992; NCRP 1991). The staff dose estimates from the gaseous pathway are higher because the staff used a bounding calculation that assumed an organism could be inside the site boundary at 0.25 mi for an entire year. Daily dose rates for no surrogate species exceeded the IAEA guidelines. The biota dose estimates for the proposed units are also conservative because they do not consider decay of liquid effluents during transit. Actual doses to the biota are likely to be much less.

Table 5-13. Comparison of Biota Doses from the Proposed Unit 3 to Relevant Guidelines for Biota Protection[(a)]

Biota	Total Body Dose – UniStar (mrad/d)[(b)]	IAEA/NCRP Guidelines for Protection of Biota Populations (mrad/d)[(b)]
Fish	8.9×10^{-4}	1000
Invertebrate	0.0072	1000
Algae	0.014	1000
Muskrat	0.0042	100
Raccoon	7.4×10^{-3}	100
Heron	0.0011	100
Duck	0.0041	100

(a) Total dose from liquid and gaseous effluents in Table 5-10.
(b) For comparison purposes, UniStar's reported dose in mrad/yr was converted to mrad/d by dividing by 365 d/yr. Published guidelines reported mGy/d (1 mGy equals 100 mrad).

The maximum total dose from both liquid and gaseous pathways from the bounding calculation is about 5.1 mrad/yr, or about 0.014 mrad/d. Thus, doses to biota calculated by both UniStar and the staff are far below the 100-mrad/d (0.1- rads/d) IAEA guidelines (IAEA 1992) for terrestrial biota and the 1-rad/d IAEA guideline (IAEA 1992) for aquatic biota.

Based on the information provided by UniStar and the NRC's independent evaluation, the staff concludes that the radiological impact on biota from the routine operation of the proposed Unit 3 would be SMALL, and additional mitigation would not be warranted.

5.9.6 Radiological Monitoring

A radiological environmental monitoring program (REMP) has been in place for the Calvert Cliffs site since operations began in 1974, with preoperational sample collection activities beginning in 1970 (UniStar 2009a). The REMP includes monitoring of the airborne exposure pathway, direct exposure pathway, water exposure pathway, aquatic exposure pathway from the Chesapeake Bay, and the ingestion exposure pathway in a 5-mi radius of the station, with indicator locations near the plant perimeter and control locations at distances greater than 10 mi. Milk is not currently sampled because there is no known production within 5 mi of the site. An annual survey is conducted for the area surrounding the site to verify the accuracy of assumptions used in the analyses, including the occurrence of milk production. The pre-operational REMP sampled various media in the environment to determine a baseline from which to observe the magnitude and fluctuation of radioactivity in the environment once the units began operation. The pre-operational program included collection and analysis of samples of air particulates, precipitation, crops, soil, well water, surface water, fish, and silt as well as measurement of ambient gamma radiation. After operation of CCNPP Unit 1 began in 1974, the monitoring program continued to assess the radiological impacts on workers, the public, and the environment. Radiological releases are summarized in the two annual reports: the *Annual Radiological Environmental Operating Report* (Constellation 2007a) and *Annual Radioactive Effluent Release Report* (Constellation 2007b). The limits for all radiological releases are specified in the *Offsite Dose Calculation Manual For Calvert Cliffs Nuclear Power Plant* (Constellation 2005). No additional monitoring program has yet been established for the new unit. To the greatest extent practical, the REMP for the proposed Unit 3 would use the procedures and sampling locations used by the existing Calvert Cliffs site. The staff reviewed the documentation for the existing REMP, the *Offsite Dose Calculation Manual*, and recent monitoring reports from the Calvert Cliffs site, and determined that the current operational monitoring program is adequate to establish the radiological baseline for comparison with the expected impacts on the environment related to the construction and operation of the proposed new units at the Calvert Cliffs site.

5.10 Nonradioactive Waste Impacts

This section describes the potential impacts to the environment that could result from the generation, handling, and disposal of nonradioactive waste and mixed waste during the operation of the proposed Unit 3. Section 3.4.4 of this EIS describes the nonradioactive waste systems. Types of nonradioactive waste that could be generated, handled, and disposed of during operational activities include solid wastes, liquid effluents, and air emissions. Solid wastes include municipal waste, dredge spoils, sewage treatment sludge, and industrial wastes. Liquid waste includes NPDES-permitted discharges such as effluents containing chemicals or biocides, wastewater effluents, site stormwater runoff, and other liquid wastes such as used oils, paints, and solvents that require offsite disposal. Air emissions would primarily be generated by vehicles, diesel generators, and combustion generators. In addition, small quantities of hazardous waste, and mixed waste, which is waste that has both hazardous and radioactive characteristics, may be generated during plant operations. The assessment of potential impacts resulting from these types of wastes is presented in the following sections.

5.10.1 Impacts to Land

Operation of the proposed Unit 3 would generate solid and liquid wastes similar to those already generated by current operations at CCNPP Units 1 and 2. Solid wastes such as office waste would be collected and disposed or recycled at offsite facilities (UniStar 2009a). Process wastes such as oil, solvents, and hydraulic fluids would be reused or recycled if possible or transported offsite by approved and licensed contractors. Solid waste that cannot be reused or recycled would be transported to an offsite landfill. The total volume of solid and liquid waste would increase during operation of proposed Unit 3; however, management practices would be the same or similar to CCNPP Units 1 and 2 (UniStar 2009a). Currently, CCNPP Units 1 and 2 operations do not release solid waste effluents. Therefore, based on this experience UniStar expects to have nearly zero solid waste effluent during operation of proposed Unit 3 (UniStar 2009a).

Debris from trash racks and screens on the water intake structure would be routinely collected and disposed of at an offsite landfill according to the NPDES permit regulation. Spoils from maintenance dredging of the intake bay will comply with the Department of the Army, Clean Water Act Section 404 permit. UniStar indicated the spoils would be disposed onsite within the Lake Davies spoils disposal area (UniStar 2009a). These practices would follow or be very similar to current disposal management practices for CCNPP Units 1 and 2 (UniStar 2009a).

A wastewater treatment plant would be built and used to treat sanitary wastes during operation of proposed Unit 3. The wastewater treatment plant would not treat wastes from the existing CCNPP Units 1 and 2. UniStar would use a private contractor to manage sanitary waste handling. Waste sludge from the sanitary system would be removed and transported to a waste processing plant.

Based on the effective practices for reusing, recycling, and minimizing waste already in place for CCNPP Units 1 and 2 and UniStar's plans to manage solid and liquid wastes in a similar manner in accordance with all applicable Federal, State, and local requirements and standards, the review team expects that impacts to land from nonradioactive waste generated during the operation of proposed Unit 3 would be minimal, and no further mitigation would be warranted.

5.10.2 Impacts to Water

Water withdrawn from the Chesapeake Bay for cooling and other operational purposes for proposed Unit 3 would be discharged back to the Chesapeake Bay. These discharges would contain both chemicals and biocides. UniStar states that water entering the cooling system from the Chesapeake Bay would be treated in a manner similar to water treatment for Units 1 and 2 (UniStar 2009a). Discharges of liquid effluents to the Chesapeake Bay would be controlled by MDE via the NPDES permit. Other potential releases of nonradioactive liquid effluents to the Chesapeake Bay that would also require NPDES permits are: discharges from the Potable and Sanitary Water Distribution Systems via the seal well, and stormwater discharge. In all cases, the NPDES permit would limit the volume and constituent concentrations. Section 5.2.3 of this EIS discusses impacts to surface and groundwater quality from operation of proposed Unit 3.

Based on the regulated practices for managing liquid discharges, the review team expects that impacts to water from nonradioactive effluents during the operation of proposed Unit 3 would be minimal, and no further mitigation would be warranted.

5.10.3 Impacts to Air

Operation of the proposed Unit 3 would result in gaseous emissions from operation of diesel generators. In addition, vehicular traffic associated with personnel necessary to operate Unit 3 would increase vehicle emissions in the area. Impacts to air quality are discussed in Section 5.7 of this EIS. Increases in air emissions from the operation of Unit 3 would require an amended or new MDE permit to comply with the Federal, State, and local air quality control laws and regulations.

Based on the regulated practices for managing air emissions from stationary sources, the review team expects that impacts to air from nonradioactive emissions during operation of proposed Unit 3 would be minimal, and no further mitigation would be warranted.

5.10.4 Mixed Waste Impacts

Mixed waste contains both low-level radioactive waste and hazardous waste. The generation, storage, treatment, or disposal of mixed waste is regulated by the Atomic Energy Act, the Solid Waste Disposal Act of 1965, as amended by the Resource, Conservation, and Recovery Act (RCRA) in 1976, and the Hazardous and Solid Waste Amendments (which amended RCRA in 1984). No mixed waste has been generated and disposed at CCNPP Units 1 and 2 since 2004. Currently, mixed waste for CCNPP Units 1 and 2 is managed in accordance with a Memorandum of Understanding (MOU) with the MDE. The MOU is patterned after the EPA 1991 Mixed Waste Enforcement Policy (UniStar 2009a). UniStar expects the quantities of mixed waste generated from the proposed Unit 3 to be minimal and plans to manage, handle, and dispose of the waste in a similar method to that currently employed at CCNPP Units 1 and 2.

Based on the effective practices for minimizing waste already in place for CCNPP Units 1 and 2 and the plans to manage mixed wastes in a similar manner in accordance with all applicable Federal, State, and local requirements and standards, the review team expects that impacts from the generation of mixed waste at proposed Unit 3 would be minimal, and no further mitigation would be warranted.

5.10.5 Summary of Nonradiological Impacts

Solid, liquid, gaseous, and mixed wastes generated during operation of proposed Unit 3 would be handled according to county, State and Federal regulations. County and State permits and regulations for handling and disposal of solid waste, and Department of the Army permits for disposal of dredged spoils, would be obtained and implemented. Discharges to the Chesapeake Bay of liquid effluents used for operations, including wastewater and stormwater, would be controlled by MDE via an NPDES permit. Air emissions from Unit 3 operations would be compliant with local, State, and Federal air quality standards and regulations. Mixed waste generation, storage, and disposal during operation of proposed Unit 3 would comply with applicable requirements and standards.

Based on the information provided by UniStar, the effective practices for recycling, minimizing, managing, and disposing of wastes already in use at the Calvert Cliffs site, the review team's expectation that regulatory approvals would be obtained to regulate the additional waste that would be generated from proposed Unit 3, and the review team's independent evaluation, the review team concludes that the potential impacts from nonradioactive waste resulting from the operation of the proposed Unit 3 at the Calvert Cliffs site would be SMALL, and no further mitigation would be warranted.

Cumulative impacts to water and air from nonradioactive emissions and effluents are discussed in Section 7.2 and 7.6, respectively. For the purposes of Chapter 9, the review team expects that there would be no substantive differences between the impacts of nonradioactive waste for proposed Unit 3 and the alternative sites and no substantive cumulative impacts that warrant further discussion beyond those discussed for alternative sites in Section 9.3.

5.11 Environmental Impacts of Postulated Accidents

The staff considered the radiological consequences on the environment of potential accidents at the proposed Unit 3. UniStar based its COL application on the proposed installation of the AREVA U.S. EPR standard design, which is being evaluated for design certification by the NRC staff. The term "accident," as used in this section, refers to any off-normal event not addressed in Section 5.9 that results in release of radioactive materials into the environment. The focus of this review is on events that could lead to releases substantially in excess of permissible limits for normal operations. Normal release limits are specified in 10 CFR Part 20, Appendix B, Table 2.

Numerous features combine to reduce the risk associated with accidents at nuclear power plants. Safety features in the design, construction, and operation of the plants, which compose the first line of defense, are intended to prevent the release of radioactive materials from the plant. The design objectives and the measures for keeping levels of radioactive materials in effluents to unrestricted areas ALARA are specified in 10 CFR Part 50, Appendix I. Additional measures are designed to mitigate the consequences of failures in the first line of defense. These measures include the NRC's reactor site criteria in 10 CFR Part 100, which require the site to have certain characteristics that reduce the risk to the public and the potential impacts of an accident, and emergency preparedness plans and protective action measures for the site and environs, as set forth in 10 CFR 50.47, 10 CFR Part 50, Appendix E, and NUREG-0654/FEMA-REP-1 (NRC 1980). All of these safety features, measures, and plans make up the defense-in-depth philosophy to protect the health and safety of the public and the environment.

This section discusses (1) the types of radioactive materials that may be released; (2) the potential paths to their release to the environment; (3) the relationship between radiation dose and health effects; and (4) the environmental impacts of reactor accidents, both DBA and severe accidents. The environmental impacts of accidents during transportation of spent fuel are discussed in Chapter 6.

The potential for dispersion of radioactive materials in the environment depends on the mechanical forces that physically transport the materials and on the physical and chemical forms of the material. Radioactive material exists in a variety of physical and chemical forms. The majority of the material in the fuel is in the form of nonvolatile solids. However, there is a significant amount of material that is in the form of volatile solids or gases. The gaseous radioactive materials include the chemically inert noble gases (e.g., krypton and xenon), which have a high potential for release. Radioactive forms of iodine, which are created in substantial quantities in the fuel by fission, are volatile. Other radioactive materials formed during the operation of a nuclear power plant have lower volatilities and, therefore, have lower tendencies to escape from the fuel than the noble gases and isotopes of iodine.

Radiation exposure to individuals is determined by their proximity to radioactive material, the duration of their exposure, and the extent to which they are shielded from the radiation. Pathways that lead to radiation exposure include (1) external radiation from radioactive material in the air, on the ground, and in the water; (2) inhalation of radioactive material; and (3) ingestion of food or water containing material initially deposited on the ground and in water.

Radiation protection experts assume that any amount of radiation may pose some risk of causing cancer or a severe hereditary effect and that the risk is higher for higher radiation exposures. Therefore, a linear, no-threshold dose response relationship is used to describe the relationship between radiation dose and detriments such as cancer induction. A report by the National Research Council (2006), the BEIR VII report, uses the linear, no-threshold dose response model as a basis for estimating the risks from low doses. This approach is accepted by the NRC as a conservative method for estimating health risks from radiation exposure, recognizing that the model may overestimate those risks. Based on this method, the staff estimated the risk to the public from radiation exposure using the nominal probability coefficient for total detriment. This coefficient has the value of 570 fatal cancers, nonfatal cancers, and severe hereditary effects per 1,000,000 person-rem (10,000 person-Sv), equal to 0.00057 effects per person-rem. The coefficient is taken from Publication 103 of the International Commission on Radiological Protection (ICRP 2007). Physiological effects are clinically detectable if individuals receive radiation exposure resulting in a dose greater than about

25 rem over a short period of time (hours). Untreated doses of about 250 to 500 rem received over a relatively short period (hours to a few days) can be expected to cause some fatalities.

5.11.1 Design Basis Accidents

UniStar evaluated the potential consequences of postulated accidents to demonstrate that a U.S. EPR could be constructed and operated at the Calvert Cliffs site without undue risk to the health and safety of the public (UniStar 2009a). These evaluations used a set of DBAs that are representative for the design being considered for the Calvert Cliffs site and site-specific meteorological data. The set of accidents covers events that range from relatively high probability of occurrence with relatively low consequences to relatively low probability with high consequences.

The bases for analyses of postulated accidents for this design are well established because the reactor is a pressurized water type reactor that is being reviewed in the NRC's advanced reactor design certification process. Potential consequences of DBAs are evaluated following procedures outlined in regulatory guides and standard review plans. The potential consequences of accidental releases depend on the specific radionuclides released, the amount of each radionuclide released, and the meteorological conditions. The source terms for the U.S. EPR reactor and methods for evaluating potential accidents are based on guidance in Regulatory Guide 1.183 (NRC 2000b).

For environmental reviews, consequences are evaluated assuming realistic meteorological conditions. Meteorological conditions are represented in these consequence analyses by an atmospheric dispersion factor, which is also referred to as χ/Q and has units of s/m^3. Acceptable methods of calculating χ/Q for DBAs from meteorological data are set forth in Regulatory Guide 1.145 (NRC 1983). Smaller χ/Q values are associated with greater atmospheric dilution.

Table 5-14 lists χ/Q values pertinent to the environmental review of DBAs for the Calvert Cliffs site (UniStar 2009a). The first column lists the time periods and boundaries for which χ/Q and dose estimates are needed. For the exclusion area boundary, the postulated DBA dose and its atmospheric dispersion factor are calculated for a short-term (i.e., 2 hours) and for the low population zone they are calculated for the course of the accident (i.e., 30 days) composed of five time periods. The second column lists the χ/Q values presented in UniStar's ER (UniStar 2009a) response using the site meteorological information discussed in ER Sections 2.7.4.4 and the exclusion area boundary and low population zone distances. No credit was taken for building wake. UniStar calculated the χ/Q values listed in Table 5-14 using 7 years of onsite meteorological data (2000 to 2006) for the Calvert Cliffs site, assuming that the release point was located at ground level.

Table 5-14. Atmospheric Dispersion Factors for Calvert Cliffs Site DBA Calculations

Time Period and Boundary	χ/Q (s/m^3)
Worst 2-hr period, Exclusion Area Boundary	8.08×10^{-5}
Worst 2-hr period, Low Population Zone	1.53×10^{-5}
0 to 8 hr, Low Population Zone	1.18×10^{-5}
8 to 24 hr, Low Population Zone	9.39×10^{-6}
1 to 4 d, Low Population Zone	6.61×10^{-6}
4 to 30 d, Low Population Zone	3.99×10^{-6}

The NRC staff reviewed the meteorological data used by UniStar and the UniStar atmospheric dispersion factors. Based on these reviews, the staff concludes that the atmospheric dispersion factors for the Calvert Cliffs site provided are reasonable for use in evaluating potential environmental consequences of postulated DBAs for the U.S. EPR reactor design at the Calvert Cliffs site.

Table 5-15 lists the set of DBAs considered by UniStar and presents the UniStar estimates of the environmental consequences of each accident in terms of total effective dose equivalent (TEDE). In these analyses, TEDE is the sum of the committed effective dose equivalent from inhalation and the effective dose equivalent from external exposure. Dose conversion factors from Federal Guidance Report 11 (Eckerman et al. 1988) were used to calculate the committed effective dose equivalent. Similarly, dose conversion factors from Federal Guidance Report 12 (Eckerman and Ryman 1993) were used to calculate the effective dose equivalent.

The staff reviewed UniStar selection of DBAs by comparing the accidents listed in the COL application with the DBAs considered in the U.S. EPR Design Control Document (AREVA 2007a), which is being reviewed in the design certification process. The DBAs in the ER are the same as those considered in the design certification; therefore, the staff concludes that the set of DBAs is appropriate. In addition, the staff reviewed the calculation of the site-specific consequences of the DBAs and found the results of the calculations to be reasonable for use in its evaluation of environmental consequences of DBAs.

There are no environmental criteria related to the potential consequences of DBAs. Consequently, the review criteria used in the NRC staff's safety review of DBA doses are included in Table 5-15 to illustrate the magnitude of the calculated environmental consequences (TEDE doses). In all cases, the calculated TEDE values are considerably smaller than the

TEDE doses used as safety review criteria. Therefore, the NRC staff concludes that, with respect to DBAs, the Calvert Cliffs Unit 3 site is environmentally suitable for operation of a U.S. EPR reactor.

Table 5-15. DBA Doses for a U.S. EPR Reactor

Accident	Standard Review Plan Section[b]	TEDE in rem[a]		
		EAB[c]	LPZ[d]	Review Criterion
Main Steam Line Break	15.1.5			
Pre-existing iodine spike		1.96×10^{-2}	5.38×10^{-3}	$2.5 \times 10^{+1}$(e)
Accident-initiated iodine spike		2.17×10^{-2}	1.81×10^{-2}	$2.5 \times 10^{+0}$(f)
Steam Generator Rupture	15.6.3			
Pre-existing iodine spike		8.93×10^{-2}	2.88×10^{-2}	$2.5 \times 10^{+1}$(e)
Accident-initiated iodine spike		5.90×10^{-2}	6.96×10^{-2}	$2.5 \times 10^{+0}$(f)
Loss-of-Coolant Accident	15.6.5	1.01×10^{0}	1.14×10^{0}	$2.5 \times 10^{+1}$(e)
Rod Ejection	15.4.8	4.57×10^{-1}	3.05×10^{-1}	$6.25 \times 10^{+0}$(f)
Reactor Coolant Pump Rotor Seizure (locked rotor)	15.3.3	1.82×10^{-1}	7.56×10^{-2}	$2.5 \times 10^{+0}$(f)
Failure of Small Lines Carrying Primary Coolant Outside Containment	15.6.2	1.45×10^{-1}	2.75×10^{-2}	$2.5 \times 10^{+0}$(f)
Fuel Handling	15.7.4	4.54×10^{-1}	9.04×10^{-2}	$6.25 \times 10^{+0}$(f)

(a) To convert rem to Sv, divide by 100.
(b) NUREG-0800 (NRC 2007b).
(c) EAB=Exclusion area boundary.
(d) LPZ=Low population zone.
(e) 10 CFR 52.79 and 10 CFR 100.21 criteria.
(f) Standard Review Plan criterion.

5.11.1.1 Summary of DBA Impacts

The NRC staff reviewed the UniStar DBA analysis in the ER, which is based on analyses performed for design certification of the U.S. EPR design with adjustment for Calvert Cliffs site-specific characteristics. The results of the UniStar analyses and NRC staff review indicate that the environmental consequences associated with DBAs, if a U.S. EPR reactor were to be located at the Calvert Cliffs site, would be within NRC siting criteria. On this basis, the staff concludes that the environmental consequences of DBAs at the Calvert Cliffs site would be SMALL for a U.S. EPR reactor.

5.11.2 Severe Accidents

In its ER (UniStar 2009a), UniStar considers the potential consequences of severe accidents for a U.S. EPR at the Calvert Cliffs site. Three pathways are considered: (1) the atmospheric pathway, in which radioactive material is released to the air; (2) the surface-water pathway, in which airborne radioactive material falls out on open bodies of water; and (3) the groundwater pathway, in which groundwater is contaminated by a basemat melt-through with subsequent contamination of surface water by the groundwater.

The UniStar evaluation of the potential environmental consequences for the atmospheric and surface water ingestion pathways incorporates the results of the MELCOR Accident Consequence Code System (MACCS2) computer code (Chanin et al. 1990; Chanin and Young 1998; Jow et al. 1990) run using U.S. EPR reactor source term information and site-specific meteorological, population, and land-use data. UniStar provided the NRC staff with copies of the input and output files for the MACCS2 code runs (UniStar 2008a). The NRC staff reviewed the files, made confirmatory calculations, and determined that UniStar's results were reasonable. Environmental consequences of some potential surface-water pathways (e.g., swimming and fishing) are not evaluated by MACCS2. UniStar relied on generic analyses in NUREG 1437 (NRC 1996) for these pathways. Similarly, the MACCS2 code does not address the potential environmental consequences of the groundwater pathway. UniStar relied on generic analyses in NUREG-1437 and earlier analyses to evaluate the potential consequences of releases to groundwater.

The MACCS computer code was developed to evaluate the potential offsite consequences of severe accidents for the sites covered by NUREG-1150 (NRC 1990). The MACCS2 code evaluates the consequences of atmospheric releases of material following a severe accident. The pathways modeled include exposure to the passing plume, exposure to material deposited on the ground and skin, inhalation of material in the passing plume and resuspended from the ground, and ingestion of contaminated food and surface water.

Three types of severe accident consequences were assessed in the MACCS2 analysis: (1) human health, (2) economic costs, and (3) land area affected by contamination. Human health effects are expressed in terms of the number of cancers that might be expected if a severe accident were to occur. These effects are directly related to the cumulative radiation dose received by the general population. MACCS2 estimates both early cancer fatalities and latent fatalities. Early fatalities are related to high doses or dose rates and can be expected to occur within a year of exposure (Jow et al. 1990).

Latent fatalities are related to exposure of a large number of people to low doses and dose rates and can be expected to occur after a latent period of several (2 to 15) years. Population health-risk estimates are based on the population distribution within a 50-mi radius of the site. Economic costs of a severe accident include the costs associated with short-term relocation of people; decontamination of property and equipment; interdiction of food supplies, land, and equipment use; and condemnation of property. The affected land area is a measure of the areal extent of the residual contamination following a severe accident. Farm land decontamination is an estimate of the area that has an average whole body dose rate for the 4-year period following the release that would be greater than 0.5 rem/yr if not reduced by decontamination and that would have a dose rate following decontamination of less than 0.5 rem/yr. Decontaminated land is not necessarily suitable for farming.

Risk is the product of the frequency and the consequences of an accident. For example, the probability of a severe accident without loss of containment for a U.S. EPR reactor at the Calvert Cliffs site is estimated to be 3.4×10^{-7} per reactor year (Ryr) (UniStar 2008a). The cumulative population dose associated with a severe accident without loss of containment at the Calvert Cliffs site is calculated to be 47,200 person-rem (UniStar 2008a). The population dose risk for this release class is the product of 3.4×10^{-7} Ryr^{-1} and 47,200 person-rem, which equals 1.6×10^{-2} person-rem Ryr^{-1} (UniStar 2009a). The following sections discuss the estimated risks associated with each pathway. The risks presented in the following tables are risks per year of reactor operation.

5.11.2.1 Air Pathway

The MACCS2 code directly estimates consequences associated with releases to the air pathway. The results of the MACCS2 runs (UniStar 2008a) are presented in Table 5-16. The core damage frequencies (CDFs) given in these tables are for internally initiated accident sequences, internal fires, and internal floods, while the plant is at power. Internally initiated accident sequences include sequences that are initiated by human error, equipment failures, loss of offsite power, etc. The CDFs used by UniStar are those from the Final Safety Analysis Report (FSAR) submitted as part of the application for certification of the U.S. EPR reactor design (AREVA 2007b).

Core damage frequencies for other at power events (external events), including tornadoes and hurricanes, are discussed in the U.S. EPR FSAR (AREVA 2007b) and the FSAR for proposed Unit 3 (UniStar 2009d). Sections 19.1.5 of the FSAR discuss external initiating events. Section 19.1.5.1 discusses a seismic margins analysis in which probabilistic risk assessment (PRA) methods are used to identify potential vulnerabilities in the design so corrective measures can be taken to reduce risk. Similarly, Section 19.1.5.4 addresses risks associated with high winds, tornado missiles, external flooding, and external fires. Risks associated with these events are considered to be insignificant by AREVA NP. The total CDF for events occurring while the reactor is at low power or shutdown is estimated to be about an order of magnitude less than the total at-power CDF (AREVA 2007b).

Table 5-16 shows that the probability-weighted consequences (i.e., risks) of severe accidents for a U.S. EPR located on the Calvert Cliffs site are small for all risk categories considered. For perspective, Table 5-17 and Table 5-18 compare the health risks from severe accidents for a U.S. EPR at the Calvert Cliffs site with the risks for current-generation reactors at various sites.

Table 5-16. Environmental Risks from an U.S. EPR Reactor Severe Accident at the Calvert Cliffs Site

Release Category Description[b] (Accident Class)		Core Damage Frequency (Ryr^{-1})[a]	Environmental Risk[a]					
			Population Dose (person-rem Ryr^{-1})[c]	Fatalities (Ryr^{-1}) Early[d]	Fatalities (Ryr^{-1}) Latent[e]	Cost[f] ($ Ryr^{-1})	Farm Land Decontamination[g] (ha Ryr^{-1})	Population Dose from Water Ingestion (person rem Ryr^{-1})[c]
RC101	No containment failure	3.4×10^{-7}	1.6×10^{-2}	0	8.3×10^{-6}	$5	3.1×10^{-5}	6.8×10^{-5}
RC201	Containment isolation failure before breach, melt remains in vessel	5.0×10^{-10}	2.1×10^{-3}	$<1.0 \times 10^{-11}$	1.1×10^{-6}	$4	1.6×10^{-5}	1.1×10^{-4}
RC206	Containment failure due to failure to isolate 2" or smaller lines	1.6×10^{-8}	$5.2 \times 10^{+0}$	1.3×10^{-8}	3.0×10^{-5}	$55	3.4×10^{-4}	1.0×10^{-3}
RC303	Containment fails before breach due to containment failure, without MCCI[g], flooded, sprays	2.3×10^{-9}	1.1×10^{-2}	$<1.0 \times 10^{-11}$	5.3×10^{-6}	$11	6.7×10^{-5}	1.4×10^{-3}
RC304	Containment fails before breach due to containment failure, without MCCI, flooded, no sprays	1.8×10^{-8}	1.1×10^{-1}	1.7×10^{-10}	5.5×10^{-5}	$115	6.5×10^{-4}	1.4×10^{-3}
RC404	Containment fails after breach and before quench due to rupture, without MCCI, flooded, no sprays	1.4×10^{-8}	5.0×10^{-2}	0	2.4×10^{-5}	$57	3.6×10^{-4}	6.8×10^{-4}
RC504	Containment fails after quench due to rupture, without MCCI, flooded, no sprays	1.2×10^{-7}	5.7×10^{-2}	0	2.6×10^{-5}	$8	3.6×10^{-5}	2.4×10^{-4}
RC701	Steam Generator Tube Rupture with fission product scrubbing	1.0×10^{-8}	2.4×10^{-2}	0	1.4×10^{-5}	$19	1.4×10^{-4}	2.3×10^{-4}
RC702	Steam Generator Tube Rupture without fission product scrubbing	5.4×10^{-9}	8.5×10^{-2}	2.7×10^{-8}	7.8×10^{-5}	$89	3.8×10^{-4}	2.4×10^{-3}
Total		5.3×10^{-7}	4.1×10^{-1}	4.1×10^{-8}	2.5×10^{-4}	$369	2.1×10^{-3}	6.4×10^{-3}

(a) All values in the table are based on data supplied by UniStar (2008a).
(b) Release categories contributing less than 1 percent of the risk in all categories are not shown. Totals include all release categories. In all cases, the risks shown exceed 98 percent of the total risk.
(c) To convert person-rem to person-SV, divide by 100.
(d) Early fatalities are fatalities related to high doses or dose rates that generally can be expected to occur within a yr of the exposure (Jow et al. 1990).
(e) Latent fatalities are fatalities related to low doses or dose rates that can be expected to occur after a latent period of several (2 to 15) yr.
(f) Cost risk includes costs associated with short-term relocation of people, decontamination, interdiction, and condemnation. It does not include costs associated with health effects (Jow et al. 1990).
(g) Land risk is area where the average whole body dose rate for the 4-year period following the accident exceeds 0.5 rem/yr but can be reduced to less than 0.5 rem/yr by decontamination.
(h) MCCI – molten corium-to-concrete interaction

Table 5-17. Comparison of Environmental Risks for an U.S. EPR Reactor at the Calvert Cliffs Site with Risks for Current-Generation Reactors at Five Sites Evaluated in NUREG-1150 (NRC 1990)

	Core Damage Frequency (Ryr^{-1})	50-mi Population Dose Risk (person-rem Ryr-1)[a]	Fatalities Ryr^{-1}		Average Individual Fatality Risk Ryr^{-1}	
			Early	Latent	Early	Latent Cancer
Grand Gulf[b]	4.0×10^{-6}	$5 \times 10^{+1}$	8×10^{-9}	9×10^{-4}	3×10^{-11}	3×10^{-10}
Peach Bottom[b]	4.5×10^{-6}	$7 \times 10^{+2}$	2×10^{-8}	5×10^{-3}	5×10^{-11}	4×10^{-10}
Sequoyah[b]	5.7×10^{-5}	$1 \times 10^{+3}$	3×10^{-5}	1×10^{-2}	1×10^{-8}	1×10^{-8}
Surry[b]	4.0×10^{-5}	$5 \times 10^{+2}$	2×10^{-6}	5×10^{-3}	2×10^{-8}	2×10^{-9}
Zion[b]	3.4×10^{-4}	$5 \times 10^{+3}$	4×10^{-5}	2×10^{-2}	9×10^{-9}	1×10^{-8}
U.S. EPR[c] at the Calvert Cliffs site	5.3×10^{-7}	4.1×10^{-1}	4×10^{-8}	2×10^{-4}	1×10^{-11}	3×10^{-10}

(a) To convert person-rem to person-Sv, divide by 100.
(b) Risks were calculated using the MACCS code and are presented in NUREG-1150 (NRC 1990).
(c) Calculated with MACCS2 code using Calvert Cliffs site-specific input for internal and external at power initiating events (UniStar 2008a).

Table 5-18. Comparison of Environmental Risks from Severe Accidents for an U.S. EPR Reactor at the Calvert Cliffs Site with Risks for Current Plants from Operating License Renewal Reviews, including CCNPP Units 1 and 2

	Core Damage Frequency (yr^{-1})	**50-mi Population Dose Risk (person-rem Ryr^{-1})[(a)]**
Current Reactor Maximum[(b)]	2.4×10^{-4}	$6.9 \times 10^{+1}$
Calvert Cliffs Unit 1 or 2[(c)(d)]	2.4×10^{-4}	$6.9 \times 10^{+1}$
Current Reactor Mean[(b)]	2.7×10^{-5}	$1.6 \times 10^{+1}$
Current Reactor Median[(b)]	1.6×10^{-5}	$1.3 \times 10^{+1}$
Current Reactor Minimum[(b)]	1.9×10^{-6}	3.4×10^{-1}
U.S. EPR[(d)(e)] at Calvert Cliffs	5.3×10^{-7}	4.1×10^{-1}

(a) To convert person-Sv to person-rem, multiply by 100.
(b) Based on MACCS and MACCS2 calculations for 76 current plants at 44 sites.
(c) NUREG-1437, Supplement 1 (NRC 1996).
(d) Population dose risk includes risk associated with internal and externally initiated events with the reactor at power.
(e) Calculated with MACCS2 code using Calvert Cliffs site-specific input (UniStar 2008a).

In Table 5-17, the health risks estimated for a U.S. EPR at the Calvert Cliffs site are compared to health-risk estimates for the five reactors considered in NUREG-1150 (NRC 1990). Although risks associated with both internally and externally initiated events were considered for the Peach Bottom and Surry reactors in NUREG-1150, only risks associated with internally initiated events are presented in Table 5-17. The health risks shown for a U.S. EPR at the Calvert Cliffs site include risks for the most significant external events. Even with the addition of the externally initiated events for a U.S. EPR reactor, the health risks are significantly lower than the risks associated with current-generation reactors presented in NUREG-1150.

The last two columns of Table 5-17 provide average individual fatality risk estimates. To put these estimates into context for the environmental analysis, the staff compares these estimates to the safety goals. The Commission has set safety goals for average individual early fatality and latent cancer fatality risks from reactor accidents in the Safety Goal Policy Statement (51 FR 30028). These goals are presented here solely to provide a point of reference for the environmental analysis and do not serve the purpose of a safety analysis. The Policy Statement expressed the Commission's policy regarding the acceptance level of radiological risk from nuclear power plant operation as follows:

- Individual members of the public should be provided a level of protection from the consequences of nuclear power plant operation such that individuals bear no significant additional risk to life and health.
- Societal risks to life and health from nuclear power plant operation should be comparable to or less than the risks of generating electricity by viable competing technologies and should not be a significant addition to other societal risks.

The following quantitative health objectives are used in determining achievement of the safety goals:

- The risk to an average individual in the vicinity of a nuclear power plant of prompt fatalities that might result from reactor accidents should not exceed one-tenth of 1 percent (0.1 percent) of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population are generally exposed.
- The risk to the population in the area near a nuclear power plant of cancer fatalities that might result from nuclear power plant operation should not exceed one-tenth of 1 percent (0.1 percent) of the sum of cancer fatality risks resulting from all other causes.

These quantitative health objectives are translated into two numerical objectives as follows:

- The individual risk of a prompt fatality from all "other accidents to which members of the U.S. population are generally exposed," is about 4.0×10^{-4} per year, including a 1.6×10^{-4} per year risk associated with transportation accidents (NSC 2009). One-tenth of 1 percent of these figures implies that the individual risk of prompt fatality from a reactor accident should be less than 4 x 10^{-7} per Ryr.

- "The sum of cancer fatality risks resulting from all other causes" for an individual is taken to be the cancer fatality rate in the United States which is about 1 in 500 or 2 x 10^{-3} per year (Reed 2007). One-tenth of 1 percent of this implies that the risk of cancer to the population in the area near a nuclear power plant because of its operation should be limited to 2 x 10^{-6} per Ryr.

MACCS2 calculates average individual early and latent cancer fatality risks. The average individual early fatality risk is calculated using the population distribution within 1 mi of the plant boundary. The average individual latent cancer fatality risk is calculated using the population distribution within 10 mi of the plant. For the plants considered in NUREG-1150, these risks were well below the Commission's safety goals. Risks calculated for the U.S. EPR reactor design at the Calvert Cliffs site are comparable to or lower than the risks associated with the current-generation reactors considered in NUREG-1150 and are well below the Commission's safety goals.

The staff compared the CDF and population dose risk estimate for a U.S. EPR at the Calvert Cliffs site with statistics summarizing the results of contemporary severe accident analyses performed for 76 reactors at 44 sites. The results of these analyses are included in the final site-specific Supplements 1 through 37 to NUREG-1437 (NRC 1996) and in the ERs included with license renewal applications for those plants for which supplements have not been published. All of the analyses were completed after publication of NUREG-1150 (NRC 1990); the analyses for 72 of the reactors used MACCS2, which was released in 1997. Table 5-18 shows that the CDF estimated for the U.S. EPR is significantly lower than those of current-generation reactors. Similarly, the population doses estimated for an U.S. EPR at the Calvert Cliffs site are well below the mean and median values for current-generation reactors that have undergone or are undergoing license renewal.

Finally, the population dose risk from a severe accident for a new U.S. EPR at the Calvert Cliffs site (4.1 × 10^{-1} person-rem/Ryr) may be compared to the dose risk for normal operation of a U.S. EPR at the Calvert Cliffs site of 5.5 × 10^{+0} person-rem/yr (see Section 5.9.3.2).

5.11.2.2 Surface Water Pathways

Surface-water pathways are an extension of the air pathway. These pathways cover the effects of radioactive material deposited on open bodies of water. The surface water pathways of interest include external radiation from submersion in water and activities near the water, ingestion of water, and ingestion of fish and other aquatic creatures. Of these pathways, the MACCS2 code evaluates only the ingestion of contaminated water. The risks associated with this surface water pathway calculated for the Calvert Cliffs site are included in the last column of Table 5-18.

Doses from other surface water pathways are not modeled in MACCS or MACCS2. However, NUREG-1437 (NRC 1996) contains an estimate of the risk associated with uninterdicted consumption of aquatic foods for the current units at the Calvert Cliffs site. This risk is 5500-person rem/Ryr. Assuming that the ratio of the uninterdicted aquatic food pathway dose to the air pathway dose would be the same for the U.S. EPR as the ratio of doses shown in the NUREG-1437 Supplement 1 for CCNPP Units 1 and 2 (NRC 1996), the uninterdicted aquatic food risk for a U.S. EPR at the Calvert Cliffs site would be about 7.5×10^{-1} person-rem/Ryr. This dose risk assumes that the aquatic food harvest for the region has remained constant over the year. This is not the case. The regional aquatic food harvest has decreased since 1976 (NMFS 2007), the year of the data used to estimate the aquatic food path dose risk in NUREG-1437. Further, should a severe accident occur at a U.S. EPR reactor located at the Calvert Cliffs site, it is likely that Federal, State, and local officials would restrict access to the Chesapeake Bay near the site. These actions would further reduce aquatic food ingestion pathway risk. At sites such as the Calvert Cliffs site, interdiction could reduce the risk by a factor of 2 to 10 (NRC 1996). Thus, the dose risk for the aquatic food path is not likely to be significantly greater the air pathway dose risk and may be substantially less than the air pathway dose risk.

Analysis of water-related exposure pathways are discussed in the GEIS (NUREG-1437), based on a study at the Fermi reactor (NRC 1981), which suggests that population exposures from swimming are significantly lower than exposures from the aquatic ingestion pathway.

5.11.2.3 Groundwater Pathway

The groundwater pathway involves a reactor core melt, reactor vessel failure, and penetration of the floor (basemat) below the reactor vessel. Ultimately, core debris reaches the groundwater where soluble radionuclides are transported with the groundwater. In the GEIS (NUREG-1437), the staff assumes a 1×10^{-4} Ryr^{-1} probability of occurrence of a severe accident with a basemat melt-through leading to potential groundwater contamination and concluded that groundwater contribution to risk is generally a small fraction of the risk attributable to the atmospheric pathway.

The staff has re-evaluated its assumption of a 1×10^{-4} Ryr^{-1} probability of a basemat melt-through. The staff believes that the 1×10^{-4} probability is too large for new power plants. Elements have been included in the U.S. EPR reactor design to minimize the potential for reactor core debris to reach groundwater. These elements include a spreading room beneath the reactor vessel, external reactor vessel cooling, and external-vessel core debris cooling.

Furthermore, the probability of core melt with basemat melt-through should be no larger than the total CDF estimate for the reactor.

Table 5-16 gives a total CDF estimate of 5.3×10^{-7} for the U.S. EPR reactor. NUREG-1150 indicates that the conditional probability of a basemat melt-through ranges from 0.05 to 0.25 for current-generation reactors. On this basis, the staff believes that a basemat melt-through probability of 5×10^{-8} Ryr^{-1} is reasonable and still conservative. According to the AREVA probabilistic risk assessment for the U.S. EPR reactor (AREVA 2007b), the CDF for basemat melt-through with a large release is about 4×10^{-10} Ryr^{-1}.

The groundwater pathway is more tortuous than the atmospheric release pathway; affords more time for implementing protective and remedial actions; and, therefore, results in a lower risk to the public. As a result, the NRC staff concludes that the risks associated with releases to groundwater are sufficiently small that they would not have a significant effect on overall risk of a severe accident for a U.S. EPR reactor at the Calvert Cliffs site.

Summary of Severe Accident Impacts

The NRC staff reviewed the severe accident analysis in the ER and conducted its independent evaluation. The results of the UniStar analysis and the NRC staff evaluation indicate that the environmental risks associated with severe accidents if a U.S. EPR reactor were to be located at Calvert Cliffs site would be small compared to risks associated with operation of the current-generation reactors at the Calvert Cliffs site and other sites. These risks are well within the NRC safety criteria. On these bases, the NRC staff concludes that the probability-weighted consequences of severe accidents at the Calvert Cliffs site would be SMALL for a U.S. EPR reactor.

5.11.3 Severe Accident Mitigation Alternatives

UniStar references a U.S. EPR reactor design that incorporates many features intended to reduce severe accident CDFs and risks associated with severe accidents. The expected effectiveness of the U.S. EPR reactor design features in reducing risk is evident in Table 5-17 and Table 5-18, which compare CDFs and severe accident risks for the design with CDFs and risks for current-generation reactors including CCNPP Units 1 and 2. Core damage frequencies and risks have generally been reduced by a factor of 100 or more when compared to the existing units.

The purpose of the evaluation of severe accident mitigation alternatives (SAMAs) is to determine whether there are severe accident mitigation design alternatives (SAMDAs) or procedural modifications or training activities that can be justified to further reduce the risks of severe accidents (NRC 2000a). Consistent with direction from the Commission to consider the

SAMDAs at the time of certification, the AREVA U.S. EPR vendor (AREVA 2007b, c) has considered 167 design alternatives for a U.S. EPR at a generic site.

The U.S. EPR design already has numerous plant features intended to reduce CDF and risk; as a result, the benefits and risk reduction potential of any additional plant improvements are significantly reduced from those of existing reactors. This reduction is true for both internally and externally initiated events. The NRC staff does not expect that either improvements in modeling or data would change its conclusions.

In its ER (UniStar 2009a), UniStar assesses 167 SAMDAs that were considered in the U.S. EPR DCD (AREVA 2007a) using the Calvert Cliffs site-specific information. UniStar determined that the maximum averted cost risk for a single U.S. EPR at the Calvert Cliffs site is so low that none of the SAMDAs is cost beneficial. A more realistic assessment would show that the potential reductions in cost risk are substantially less than the maximum averted cost risk because no SAMDA can reduce the remaining risk to zero. The NRC staff has updated the UniStar analysis based on Revision 1 of the AREVA SAMDA analysis (AREVA 2009).

SAMDAs are a subset of the SAMA review. The other attributes of the SAMA review, procedural modifications and training activities, have not been addressed by UniStar or AREVA for design certification (AREVA 2007c). However, UniStar (2009a) has stated that risk insights would be considered in development of procedures and training.

Appendix I contains a detailed review of the AREVA and UniStar SAMA analyses and presents the NRC staff conclusions related to the UniStar Calvert Cliffs site-specific analysis. After reviewing the UniStar analysis, the NRC staff concludes that there are no U.S. EPR SAMDAs that would be cost beneficial at the Calvert Cliffs site.

As discussed in Appendix I, because the maximum attainable benefit is so low, a SAMA based on procedures or training for an U.S. EPR at the Calvert Cliffs site would have to reduce the CDF or risk to near zero to become cost beneficial. Based on its evaluation, the staff concludes that it is unlikely that any of the SAMAs based on procedures or training would reduce the CDF or risk that much. Therefore, the staff further concludes it is unlikely that these SAMAs would be cost effective. In addition, based on statements by UniStar in the ER (UniStar 2009a), the staff expects that UniStar will consider risk insights in the development of procedures and training. However, this expectation is not crucial to the staff's conclusions because the staff already concluded procedural and training SAMAs would be unlikely to be cost effective. Therefore, the NRC staff concludes that SAMAs have been appropriately considered.

5.11.4 Summary of Postulated Accident Impacts

The NRC staff evaluated the environmental impacts from DBAs and severe accidents for a U.S. EPR reactor at the Calvert Cliffs site. Based on the information provided by AREVA, UniStar, and NRC's own independent review, the NRC staff concludes that the potential environmental impacts (risks) from a postulated accident from the operation of the proposed Unit 3 would be SMALL, and no further mitigation would be warranted.

5.12 Measures and Controls to Limit Adverse Impacts During Operation

In its evaluation of environmental impacts during operation of the proposed Unit 3, the staff relied on UniStar's compliance with the following measures and controls that would limit adverse environmental impacts:

- compliance with applicable Federal, State, and local laws, ordinances, and regulations intended to prevent or minimize adverse environmental impacts (e.g., solid waste management, erosion and sediment control, air emissions, noise control, stormwater management, spill response and cleanup, hazardous material management)
- compliance with applicable requirements of permits or licenses required for operation of the new unit (e.g., Corps' Section 404 Permit, NPDES)
- compliance with existing CCNPP Unit 1 and 2 processes and/or procedures applicable to proposed Unit 3 environmental compliance activities for the Calvert Cliffs site (e.g., solid waste management, hazardous waste management, and spill prevention and response)
- incorporation of environmental requirements into construction contracts
- implementation of BMPs.

The review team considered these measures and controls in its evaluation of the impacts of plant operation. Table 5-19, which is the staff's adaptation from sections of UniStar's Table 5.10-1 of the ER (UniStar 2009a), lists a summary of measures and controls to limit adverse impacts during operation proposed by UniStar.

Table 5-19. Summary of Measures and Controls Proposed by UniStar to Limit Adverse Impacts During Operation (adapted from UniStar 2009a)

Resource Category	Specific Measures and Controls
Land Use	
The Site and Vicinity	• Proposed Unit 3 footprint would be wholly contained on an existing nuclear power plant site; onsite land is not used for farmland nor is it considered prime or unique. • Solids deposition (assumed as salt) rates below NUREG-1555 (NRC 2000a) significance level, with drift eliminator in place.

Table 5-19. (contd)

Resource Category	Specific Measures and Controls
Transmission Line Corridors	• Use existing transmission corridor maintenance policies and practices to protect terrestrial and aquatic ecosystems. • Develop onsite transmission maintenance policies and practices (BMPs) and use UniStar's site Resource Management Plan to protect site resources such as wetlands and streams in vicinity.
Water	
Water-Use	• Comply with MDE Water Appropriations and Use Permit. • Implement Spill Prevention, Control, and Countermeasures (SPCC) Plan. • Develop new stormwater impoundments and/or modify existing impoundments as part of plant. • Install desalination plant.
Water-Quality	• Comply with Unit 3 NPDES permit. • Implement Storm Water Pollution Prevention Plan (SWPPP), which includes sediment and erosion control. • Comply with the Corps' 404 Permit requirements. • Implement SPCC Plan.
Cooling System Intake	• Small incremental water withdrawal compared to CCNPP Units 1 and 2, which was considered by the NRC to have a small impact in NUREG-1437 S1 (NRC 1996). • Low intake velocity design. • Perform periodic dredging, as needed.
Discharge System Effluents	• Use closed-cycle system, incorporating a subsurface, multi-port diffuser.
Heat Dissipation to the Atmosphere	• Solids deposition (assumed as salt) rates below NUREG-1555 significance level, with a drift eliminator in place. • Operation of drift eliminators.
Terrestrial	• Operation of drift eliminators would limit deposition of TDS below NUREG-1555 significance level. • Low profile tower design and minimal cooling tower lighting, as practicable and allowed by regulation. • Existing offsite transmission lines and corridors would be used for the new unit; mitigation of potential impacts to offsite terrestrial ecosystems would be unchanged. • Use site Resource Management Plan and BMPs to protect resources. Transplant rare plant species to open field areas. • Implement onsite routine transmission system

Table 5-19. (contd)

Resource Category	Specific Measures and Controls
	maintenance policy and procedures, including vegetation control, erosion control, and important species protection.
Aquatic	• Use BAT (Best Available Technology) intake design. Design of cooling water system includes a fish-return system to reduce entrainment/impingement issues. • Use closed-cycle cooling, minimizing effluent temperatures and flow rates. • Existing offsite transmission lines and corridors would be used for the new unit; mitigation of potential impacts to offsite aquatic ecosystems would be unchanged. • Use site Resource Management Plan and BMPs to protect resources (e.g., wetlands and streams). • Implement onsite routine transmission system maintenance policy and procedures, including vegetation control, erosion control, and important species protection.
Socioeconomic	
Physical Impacts	• Traffic noise limited to normal weekday, business hours when possible. • Install new site perimeter and access roads; develop traffic management plan. • Compliance with applicable EPA and MDE air quality regulations and permits. • Siting limits visibility from local residences and road traffic due to heavily wooded area and from shoreline because of offset from cliff. Plume abatement equipment to minimize plume.
Social and Economic Impacts	• There are no mitigating measures identified by the applicant with regard to adverse socioeconomic impacts. Increases in demand for road capacity, housing, public services, and schools in Calvert and St. Mary's Counties likely would be larger during building activities and, if necessary, would be mitigated then.
Environmental Justice	• None necessary because there are no disproportionate adverse impacts expected on minority or low income populations in the 50-mi region.
Historic Properties and Cultural Resources	• Perform Phase III Cultural Resource Survey. • Follow Data Recovery Plan. • Implement Mitigation Plan. • Implement MOA that stipulates agreed-upon mitigation measures.

Table 5-19. (contd)

Resource Category	Specific Measures and Controls
Nonradiological Health	• Makeup of freshwater for the Essential Service Water System and mechanical draft cooling towers would be treated with a biocide. • Comply with Federal and State air quality requirements or permits. • Procedures and personal protective equipment (including respiratory protection) to minimize exposure onsite to vapors, dusts, and other air contaminants for workers. • Implement site-wide Safety and Medical Program, including safety policies, safe work practices, as well as general and topic-specific training. • Install new site perimeter and access roads; develop traffic management plan. Existing offsite transmission lines and corridors would be used for the new unit; mitigation of potential impacts from noise, electric shock, and electric field gradients would be unchanged. • Onsite exposure expected to be similar or less than existing transmission system due to smaller onsite footprint and distance to public areas.
Radiological Impacts of Normal Operation	
Radiation Doses to Members of the Public	• Calculated radiation doses to members of the public within NRC and EPA standards (10 CFR Part 20, Appendix I of 10 CFR Part 50, and 40 CFR Part 190). Radiological effluent and environmental monitoring programs will be implemented.
Occupational Radiation Doses	• Estimated occupational doses would be within NRC standards (10 CFR Part 20). Program would be implemented to maintain occupational doses ALARA (10 CFR Part 20).
Impacts to Biota Other than Humans	• Calculated doses for biota would be well within NCRP and IAEA guidelines. Radiological environmental monitoring program would be implemented.
Waste from Operations	
Nonradioactive Waste	• Reuse, recycle, and reclaim solid waste and liquids as appropriate; otherwise use approved transporters and offsite disposal facilities. • Comply with applicable State and Federal hazardous waste and air quality regulations. • Comply with NPDES permit, including implementing a Storm Water Pollution Prevention Plan.

Table 5-19. (contd)

Resource Category	Specific Measures and Controls
Mixed Waste	• Proposed Unit 3 mixed waste quantities expected to be comparable to the mixed wastes for CCNPP Units 1 and 2, which are minimal. • Implement storage, shipment, and emergency response procedures.
Uranium Fuel Cycle	• Possible use of centrifuge uranium enrichment process in lieu of gaseous diffusion process, which significantly reduces energy use and resultant environmental effects.
Postulated Accidents	
Design Basis Accidents	• Calculated dose consequences of design basis accidents for the U.S. EPR at the Calvert Cliffs site were found to be within regulatory limits.
Severe Accidents	• Calculated probability-weighted consequences of severe accidents for the U.S. EPR at the Calvert Cliffs site were found to be lower than the Commission's safety goals and the probability-weighted consequences for current operating reactors. • Severe accident mitigation design alternatives analysis identified no cost-beneficial alternatives for the U.S. EPR design using Calvert Cliffs site-specific meteorology and population distribution.

Source: adapted from UniStar 2009a

5.13 Summary of Operational Impacts

The review team's evaluation of the environmental impacts of operations is summarized in Table 5-20. Impact level categories are denoted in the table as SMALL, MODERATE, or LARGE as a measure of their expected adverse impacts, if any. With the socioeconomic issues for which the impacts are likely to be beneficially MODERATE or LARGE, this is noted in the Comments column. The Impact Level column designates beneficial impacts as SMALL.

Table 5-20. Characterization of Operational Impacts at the Proposed Unit 3 Site

Category	Comments	Impact Level
Land-Use Impacts		
The Site and Vicinity	Operation of one new onsite unit. Possible new housing and retail space in the vicinity.	SMALL
Transmission Line Corridors and Offsite Areas	No new offsite corridors needed.	SMALL

Table 5-20. (contd)

Category	Comments	Impact Level
Water-Related Impacts		
Water Use	The Chesapeake Bay provides a vast water source. Using desalination system will eliminate need for using groundwater.	SMALL
Water Quality	Closed-cycle cooling provides a relative small amount of discharge to the Chesapeake Bay, and the rapid dilution and large assimilative capacity of the Bay will make the thermal discharge and other effluents undetectable away from the discharge outlet.	SMALL
Ecological Impacts		
Terrestrial Ecosystems and Wetlands	Flora and fauna would be minimally affected. New transmission corridor would not affect any wetlands or floodplains.	SMALL
Aquatic Ecosystems		
Freshwater	Impacts to freshwater systems from increased runoff would be ameliorated by implementation of a stormwater management program.	SMALL
Chesapeake Bay	Estuarine aquatic resources would not be adversely affected because of the small volume of water required for the proposed Unit 3 cooling system.	SMALL
Socioeconomic Impacts		
Physical Impacts	Impact from Unit 3 operations on the public would be minimal. Impact on workers would be mitigated with training and protective equipment. Operation would not affect any offsite buildings. Outage workers would put temporary pressure on local access roads, but traffic control and management measures would protect any local roads during outages. Operations activities would result in SMALL aesthetic impacts from the steam plume from the cooling towers. Since Calvert Cliffs has two existing operating units, the change to the aesthetics of the plant would be SMALL to offsite receptors.	SMALL
Demography	The population of the socioeconomic impact area and the 50-mi region will continue to grow independent of Unit 3.	SMALL

Table 5-20. (contd)

Category	Comments	Impact Level
Economic Impacts to the Community	Employment would be higher in the region with Unit 3. Much of this activity could occur in Calvert and St. Mary's County. Increase in property tax base would be LARGE for Calvert County and SMALL elsewhere within the 50-mi region.	SMALL to LARGE (BENEFICIAL)
Infrastructure and Community Services	Roads in Calvert County have the capacity to handle expected traffic levels in the vicinity of the site. Small impacts on use of recreation facilities; no adverse impact on tourism. Calvert County, which would likely receive the highest percentage of in-migrating workers relative to the available housing stock, would experience a SMALL increase in housing demand. No noticeable changes elsewhere. The population of Calvert County is expected to grow about 2.5 percent over the next few years, which would not greatly affect any services. There should be spare capacity in most services as a result of having gone through the site development period. The distribution of school capacity and growth in both capacity and school-age population by district from other sources, impacts on Calvert County school districts would be SMALL. There should be no noticeable impact elsewhere.	SMALL
Environmental Justice	No environmental pathways or unique characteristics or practices of the minority and low-income population were found that would lead to adverse and disproportionate impacts.	SMALL
Historic and Cultural Resources	No impacts to cultural resources are anticipated during operations. However, there is a low potential that unidentified cultural resources could be encountered during operations. Procedures for addressing impacts to unanticipated cultural resources would be provided in an unanticipated discoveries plan to be prepared in coordination with the MD SHPO.	SMALL
Meteorological and Air Quality Impacts	Emissions would be regulated by MDE.	SMALL
Nonradiological Health Impacts	Nonradiological impacts of transporting construction materials, personnel, fuel, and waste to and from the Unit 3 site and alternative sites shown to be a small fraction of the traffic accidents, injuries, and fatalities in their respective counties.	SMALL

Table 5-20. (contd)

Category	Comments	Impact Level
Radiological Health Impacts		
Members of the Public	Doses to members of the public would be below NRC and EPA standards and there would be no observable health impacts (10 CFR Part 20, Appendix I to 10 CFR Part 50, 40 CFR Part 190).	SMALL
Plant Workers	Occupational doses to plant workers would be below NRC standards and program to maintain doses ALARA would be implemented.	SMALL
Biota other than Humans	Doses to biota other than humans would be well below NCRP and IAEA guidelines.	SMALL
Nonradioactive Waste	Solid, liquid, gaseous, and mixed wastes generated during operation of proposed Unit 3 would be handled according to county, State and Federal regulations.	SMALL
Postulated Accidents		
Design Basis Accidents	Impacts of design basis accidents would be well below regulatory criteria.	SMALL
Severe Accidents	Probability-weighted consequences of severe accidents would be lower than the Commission's safety goals and probability-weighted consequences for currently operating reactors.	SMALL

5.14 References

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

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

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

10 CFR Part 52. Code of Federal Regulations, Title 10, *Energy*, Part 50, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

10 CFR Part 100. Code of Federal Regulations, Title 10, *Energy*, Part 100, "Reactor Site Criteria."

29 CFR Part 1910. Code of Federal Regulations, Title 29, *Labor*, Part 1910, "Occupational Safety and Health Standards."

36 CFR Part 800. Code of Federal Regulations, Title 36, *Parks, Forests, and Public Property*, Part 800, "Protection of Historic Properties."

40 CFR Part 190. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations."

40 CFR Part 423. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 423, "Steam Electric Power Generating Point Source Category."

51 FR 30028. August 21, 1986. "Safety Goals for the Operation of Nuclear Power Plants; Policy Statement; Correction and Republication." *Federal Register*. U.S. Nuclear Regulatory Commission.

66 FR 65256. December 18, 2001. "National Pollutant Discharge Elimination System: Regulations Addressing Cooling Water Intake Structures for New Facilities." *Federal Register.* U.S. Environmental Protection Agency.

69 FR 52040. August 24, 2004. "Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions." *Federal Register*. U.S. Nuclear Regulatory Commission.

Abbe, G.R. 1987. "Thermal and Other Discharge-Related Effects on the Bay Ecosystem." Chapter 9 in *Ecological Studies in the Middle Reach of Chesapeake Bay, Calvert Cliffs*. K.L. Heck Jr., ed., Springer-Verlag, New York.

Advisory Group on Non-ionising Radiation (AGNIR). 2006. *Power Frequency Electromagnetic Fields, Melatonin and the Risk of Breast Cancer*. RCE-1, Health Protection Agency, Oxford, UK. Accessed on November 1, 2009 at http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1204286180274.

AREVA NP Inc. (AREVA). 2007a. *AREVA Design Control Document, Rev 0 – Tier 2 Chapter 12 Radiation Protection – Section 12.3 Radiation Protection Design Features.* Accession No. ML073531699.

AREVA NP Inc. (AREVA). 2007b. *U.S. EPR Final Safety Analysis Report*. Revision 0, December 2007. Accession No. ML073531265.

AREVA NP Inc. (AREVA). 2007c. *AREVA NP Environmental Report, Standard Design Certification*. ANP-10290, Revision 0. Accession No. ML073530589.

AREVA NP Inc. (AREVA). 2009. *AREVA NP Environmental Report, Standard Design Certification*. ANP-10290, Revision 1. Accession No. ML092650775.

Bechtel Power Corporation (Bechtel). 2008. "Calvert Cliffs Unit 3 Storm Water Management Plan Document No: 25237-209-30G-KO3G-00001 Revision A," provided in UniStar Letter UN#08-037 to NRC, September 29, 2008. Accession No. ML090220702.

Brown, W.M. 1993. "Avian Collisions with Utility Structures: Biological Perspectives." In *Proceedings: Avian Interactions with Utility Structures, International Workshop*, pp. 12-1 – 3. Electric Power Research Institute (EPRI), Palo Alto, California.

Calvert County. 2008. *Calvert County Comprehensive Water & Sewerage Plan 2008*. Accessed on October 26, 2009 at http://www.co.cal.md.us/business/planning/documents/2008watersewerplan/.

Chanin, D.I. and M.L. Young. 1998. *Code Manual for MACCS2: Volume 1, User's Guide*. SAND97-0594, Sandia National Laboratories, Albuquerque, New Mexico.

Chanin, D.I., J.L. Sprung, L.T. Ritchie, and H.N. Jow. 1990. *MELCOR Accident Consequence Code System (MACCS), User's Guide*. NUREG/CR-4691, Vol. 1, Sandia National Laboratories, Albuquerque, New Mexico.

Clean Air Act. 42 U.S.C. 7401 et seq.

Clean Water Act. 33 U.S.C. 1251, et seq. (also referred to as the Federal Water Pollution Control Act [FWPCA]).

COMAR 26.08.03.03. 2007a. "Water Quality Impact Assessment for Thermal Discharges." *Code of Maryland Regulations*.

COMAR 26.08.02.03-3. 2007b. "Water Quality Criteria Specific to Designated Uses." *Code of Maryland Regulations*.

COMAR 26.08.02.03-2. 2008a. "Numerical Criteria for Toxic Substances in Surface Waters." *Code of Maryland Regulations*.

COMAR 26.11.16.06. 2008b. "Class I Toxic Air Pollutants." *Code of Maryland Regulations*.

Constellation Energy Group (Constellation). 2004. Letter from Kevin J. Nietmann (Constellation Energy Group, Plant General Manager) to U.S. Nuclear Regulatory Commission dated July 28, 2004, "Calvert Cliffs Nuclear Power Plant, Unit Nos. 1 & 2; Docket Nos. 50-317 & 50-318, Special Report: Mortality of a Species Protected by the Act of 1973." Accession No. ML042150154.

Constellation Generation Group, LLC (Constellation). 2005. Letter from Mark Tonacci (Constellation) to the NRC dated July 14, 2005, “Calvert Cliffs Nuclear Power Plant Unit Nos. 1 and 2; Docket Nos. 50-317 & 50-318; 2004 Radioactive Effluent Release Report and Dose Assessment.” Accession No. ML052020232.

Constellation Energy Group, LLC (Constellation). 2007a. *Annual Radiological Environmental Operating Report for the Calvert Cliffs Nuclear Power Plant Units 1 and 2 and the Independent Spent Fuel Storage Installation, January 1 - December 31, 2006*. Accession No. ML071590393.

Constellation Generation Group, LLC (Constellation). 2007b. *Calvert Cliffs Nuclear Power Plant Effluent and Waste Disposal 2006 Annual Report*. Accession No. ML072050478.

Cornell Lab of Ornithology (Cornell). 2008. *All About Birds, Brown-headed Cowbird*. Accessed October 7, 2008 at http://www.birds.cornell.edu/AllAboutBirds/BirdGuide/Brown-headed_Cowbird_dtl.html.

Delano, F. 2006. *A Nettle-some Problem on Potomac*. Accessed January 6, 2008 at http://a4nr.org/library/failures/07.15.2006-fredricksburg.

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

EA Engineering Science and Technology (EA Engineering). 2007. *Aquatic Field Studies for UniStar Calvert Cliffs Expansion Project May 2007*. Prepared for UniStar Nuclear Development, LLC by EA Engineering Science and Technology, Sparks, Maryland. Accession No. ML090690170.

EA Engineering, Science, and Technology (EA Engineering). 2008. *Entrainment Characterization Data Report for Calvert Cliffs Nuclear Power Plant*. Prepared for Constellation Energy and provided as Enclosure – UN#08-060, Attachment 2 to UniStar’s RAI response letter to NRC dated October 31, 2008. Accession No. ML083110678.

Eckerman, K.F., A.B. Wobarst, and A.C.B. Richardson. 1988. *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion.* Federal Guidance Report No. 11, EPA-520/1-88-020, U.S. Environmental Protection Agency, Washington D.C.

Eckerman, K.F and J.C. Ryman. 1993. *External Exposure to Radionuclides in Air, Water, and Soil*. Federal Guidance Report No. 12, EPA-402-R-93-81, U.S. Environmental Protection Agency, Washington D.C.

Federal Communications Commission (FCC). 2004. *Notice of Inquiry Comment Review, Avian/Communication Tower Collisions*. Prepared for the FCC by Avatar Environmental, LLC, West Chester Pennsylvania, EDM International, Inc., Fort Collins, Colorado, and Pandion Systems, Inc., Gainesville, Florida.

International Atomic Energy Agency (IAEA). 1992. *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards*. Technical Report Series No. 332, Vienna, Austria.

International Commission on Radiological Protection (ICRP). 1977. *Recommendations of the International Commission on Radiological Protection: Adopted January 17, 1977*. Pergamon Press, New York.

International Commission on Radiological Protection (ICRP). 1991. *1990 Recommendations of the International Commission on Radiological Protection*. ICRP Publication 60, Pergamon Press, New York.

International Commission on Radiological Protection (ICRP). 2007. "2007 Recommendations of the International Commission on Radiological Protection." ICRP Publication 103, *Annals of the ICRP* 37(2-4):1-332.

Jow, H.N., J.L. Sprung, J.A. Rollstin, L.T. Ritchie, and D.I. Chanin. 1990. *MELCOR Accident Consequence Code System (MACCS), Model Description*. NUREG/CR-4691, Vol. 2, U.S. Nuclear Regulatory Commission, Washington, D.C.

Jung, S. and E.D. Houde. 2003. "Spatial and temporal variabilities of pelagic fish community structure and distribution in Chesapeake Bay, USA." *Estuarine, Coastal and Shelf Science* 58:335–351.

KLD Engineering, P.C. (KLD). 2009. *Traffic Impact Study at the Calvert Cliffs Nuclear Power Plant, Draft Final Report, Rev. 2.* TR-427, Hauppauge, New York. Accession No. ML093570407.

Knisley, C.B. 2009. Email from C. Barry Knisley (Randolph-Macon College, Professor) to Corey A. Duberstein (Pacific Northwest National Laboratory, Ecology Scientist), "Subject: RE: Calvert Cliffs Tiger Beetles." January 13, 2009. Accession Nos. ML090920737 and ML100050568.

Louis, V.R., E. Russek-Cohen, N. Choopun, I.N.G. Rivera, B. Gangle, S.C. Jiang, A. Rubin, J.A. Patz, A. Huq, and R.R. Colwell. 2003. "Predictability of *Vibrio cholerae* in Chesapeake Bay." *Applied and Environmental Microbiology* 69(5):2773-2785.

Magnien, R.E. 2001. "The Dynamics of Science, Perception, and Policy during the Outbreak of *Pfiesteria* in the Chesapeake Bay." *BioScience* 51(10):843-852.

Mansfield, K.L. 2006. *Sources of Mortality, Movements and Behavior of Sea Turtles in Virginia-A Dissertation Presented To: The Faculty of the School of Marine Science, the College of William and Mary*. PhD Dissertation, College of William and Mary, Williamsburg, Virginia.

Maryland Department of Natural Resources (MDNR). 2007. *Calvert Cliffs State Park*. Accessed November 19, 2008 at http://www.dnr.state.md.us/publiclands/southern/calvertcliffs.html.

Maryland Department of Natural Resources (MDNR). 2008. *DNR Announces Estimated 2007 Blue Crab Harvest Numbers*. Accessed February 4, 2008 at http://www.dnr.state.md.us/dnrnews/pressrelease2008/020408.html.

Maryland Department of Natural Resources, Maryland Power Plant Research Program (MDNR PPRP). 2008a. *Environmental Review of Proposed Unit 3 at Calvert Cliffs Nuclear Power Plant*. PSC Case No. 9127. Maryland Power Plant Research.

Maryland Department of Natural Resources, Maryland Power Plant Research Program (MDNR PPRP). 2008b. *Maryland Power Plants and the Environment. A Review of the Impacts of Power Plants and Transmission Lines on Maryland's Natural Resources. Maryland Cumulative Environmental Impact Report – 14th Edition.* MDNR Publication No. 12-1142008-271, PPRP-CEIR-14.

Maryland Public Service Commission (MPSC). 2009. In the Matter of the Application of UniStar Nuclear Energy, LLC and UniStar Nuclear Operating Services, LLC for a Certificate of Public Convenience and Necessity to Construct a Nuclear Power Plant at Calvert Cliffs in Calvert County, Maryland. Case Number 9127. Proposed Order of Hearing Examiner, April 28, 2009.

McLean, R., W.A. Rickhus, S.P. Schreiner, and D. Fluke. 2002. *Maryland Power Plant Cooling Water intake Regulations and Their Application in Evaluation of Adverse Environmental Impact*. PPRP-127, Maryland Department of Natural Resources, Annapolis, Maryland.

National Cancer Institute (NCI). 1990. *Cancer in Populations Living Near Facilities*. National Institutes of Health, Washington, D.C.

National Council on Radiation Protection and Measurements (NCRP). 1991. *Effects of Ionizing Radiation on Aquatic Organisms*. NCRP Report No. 109, Bethesda, Maryland.

National Council on Radiation Protection and Measurements (NCRP). 1995. *Principles and Application of Collective Dose in Radiation Protection.* NCRP Report No. 121, NCRP Publications, Bethesda, Maryland.

National Council on Radiation Protection and Measurements (NCRP). 2009. *Ionizing Radiation Exposure of the Population of the United States*. NCRP Report No. 160, Bethesda, Maryland.

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

National Historic Preservation Act of 1966 (NHPA). 16 U.S.C. 470, et seq.

National Institute of Environmental Health Science (NIEHS). 1999. NIESH Report on Health Exposure to Power Line Frequency and Electric and Magnetic Fields. Publication No. 99-4493, Research Triangle Park, North Carolina. Accession No. ML093240277.

National Marine Fisheries Service (NMFS). 2007. *Fisheries of the United States, 2006*. National Marine Fisheries Service, Office of Science and Technology, Silver Spring, Maryland.

National Research Council. 2006. *Health Risks for Exposure to Low Levels of Ionizing Radiation: BEIR VII - Phase 2*. National Academies Press, Washington, D.C.

National Safety Council (NSC). 2009. "Odds of Dying From…." In *Injury Facts*. Itasca, Illinois.

Olson, M.M. 1987. "Entrainment Studies, Zooplankton Entrainment." Chapter 7 in *Ecological Studies in the Middle Reach of Chesapeake Bay, Calvert Cliffs*. K.L. Heck Jr., ed., Springer-Verlag, New York.

Purcell, J.E., S. Uye, and W.T. Lo. 2007. "Anthropogenic Causes of Jellyfish Blooms and Their Direct Consequences for Humans: A Review." *Marine Ecology Progress Series* 350:153–174.

Reed, E. 2007. *Preventing and Controlling Cancer the Nation's Second Leading Cause of Death*. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, Atlanta, Georgia. Available at www.toiholliday.com/files/cancer.pdf.

Resource Conservation and Recovery Act (RCRA). 42 U.S.C. 6901 et seq.

Ringger, T.G. 2000. "Investigations of Impingement of Aquatic Organisms at the Calvert Cliffs Nuclear Power Plant, 1975-1995." *Environmental Science and Policy* 3:S261-S273.

Sellner, K.G. and M.E. Kachur. 1987. "Entrainment Studies, Phytoplankton Entrainment." Chapter 7 in *Ecological Studies in the Middle Reach of Chesapeake Bay, Calvert Cliffs*. K.L. Heck Jr., ed., Springer-Verlag, New York.

Soldat, J.K., N.M. Robinson, and D.A. Baker. 1974. *Models and Computer Codes for Evaluating Environmental Radiation Doses*. BNWL-1754, Battelle Pacific Northwest Laboratory, Richland, Washington.

Strenge, D.L., R.A. Peloquin, and G. Whelan. 1986. *LADTAP II: Technical Reference and User Guide*. NUREG/CR-4013, Pacific Northwest Laboratory, Richland, Washington.

Strenge, D.L., T.J. Bander, and J.K. Soldat. 1987. *Gaspar II: Technical Reference and User Guide*. NUREG/CR-4653, Pacific Northwest Laboratory, Richland, Washington.

Solid Waste Disposal Act. 42 U.S.C. 6901 et seq.

Tetra Tech NUS, Inc. 2007. *Final Flora Survey Report for Proposed UniStar Nuclear Project Area, Calvert Cliffs Nuclear Power Plant Site, Calvert County, Maryland*. Prepared for UniStar, Baltimore, Maryland. Accession No. ML090690128.

UniStar Nuclear Development, LLC (UniStar). 2007. *Technical Report in Support of Application of UniStar Nuclear Energy, LLC and UniStar Nuclear Operating Services, LLC for Certificate of Public Convenience and Necessity Before the Maryland Public Service Commission for Authorization to Construct Unit 3 at Calvert Cliffs Nuclear Power Plant and Associated Transmission Lines*. Baltimore, Maryland. Accession No. ML090680053.

UniStar Nuclear Energy (UniStar). 2008a. Letter from G. Vanderheyden (UniStar) to U.S. Nuclear Regulatory Commission in response to NRC letter dated May 13, 2008, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Submittal of Response to Requests for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3 and Request for Withholding of Documents." June 12, 2008. Accession No. ML100040300.

UniStar Nuclear Energy (UniStar). 2008b. Letter from G. Gibson (UniStar) to U.S. Nuclear Regulatory Commission in response to NRC letters dated May 13, 2008, June 12, 2008, and August 29, 2008, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Submittal of Response Requests for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3 – Supplemental Aquatic RAIs." September 29, 2008. Accession No. ML090420560.

UniStar Nuclear Energy (UniStar). 2008c. Letter from G. Gibson (UniStar) to U.S. Nuclear Regulatory Commission in response to NRC letter dated October 14, 2008, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Calvert Cliffs Nuclear Power Plant, Unit 3, Submittal of Response to Requests for Additional Information, Environmental Impact Statement (EIS) Issues." October 31, 2008. Accession Nos. ML083110676.

UniStar Nuclear Development, LLC (UniStar). 2009a. *Calvert Cliffs Nuclear Power Plant Unit 3 Combined License Application, Part 3, Environmental Report*. Revision 6. Baltimore, Maryland, September 30, 2009. Accession No. ML092880921.

UniStar Nuclear Development, LLC (UniStar). 2009b. Letter from G. Gibson (UniStar) to U.S. Nuclear Regulatory Commission in response to NRC letter dated February 3, 2009, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Calvert Cliffs Nuclear Power Plant, Unit 3, Environmental RAIs No. 1001 through 1011." March 5, 2009. Accession No. ML090710146.

UniStar Nuclear Energy (UniStar). 2009c. Letter from G. Gibson (UniStar) to U.S. Nuclear Regulatory Commission in response to NRC letter dated February 3, 2009, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016 Calvert Cliffs Nuclear Power Plant, Unit 3 Follow-up Responses to Environmental Report RAI NO.1 003-2, Aquatic Ecology and RAI NO.1 008-4, Ecological Impacts (Fish Return System)." July 24, 2009. Accession No. ML092150728.

UniStar Nuclear Energy (UniStar). 2009d. *Calvert Cliffs Nuclear Power Plant Unit 3 Combined License Application, Part 2, Final Safety Analysis Report*. Revision 6, September 30, 2009, Baltimore, Maryland. Accession No. ML092880897.

U.S. Army Corps of Engineers (USACE). 2008. *Public Notice. Application Number CENAB-OP-RMS (NAB-2007-08l23-M05 (Calvert Cliffs 3 Nuclear Project, LLC/Unistar Nuclear Operating Services, LLC)*. PN-08-60. September 3, 2008. Accession No. ML082550288.

U.S. Army Corps of Engineers (USACE). 2010. Letter from K.B. Anderson (USACE) to R.J. Nelson (Office of Federal Agency Programs, Advisory Council on Historic Preservation), Review of US Army Corps of Engineers and Maryland State Historic Preservation Officer regarding Calvert Cliffs 3 Nuclear Plant (CENAB-OP-RMS) effect on historic properties and Memorandum of Agreement. March 16, 2010. Accession No. ML100810272.

U.S. Department of Transportation (DOT). 2003. "From Home to Work, the Average Commute is 26.4 Minutes," *Omnistats*, Volume 3, Issue 4. October 2003. Accession No. ML100621425.

U.S. Department of Transportation (DOT). 2007. *National Transportation Statistics 2007.* Bureau of Transportation Statistics, Washington, D.C. Available at http://www.bts.gov/publications/national_transportation_statistics/2007/index.html.

U.S. Department of Transportation (DOT). 2008a. *Maryland, Toll of Motor Vehicle Crashes, 2006*. Available at http://www-nrd.nhtsa.dot.gov/departments/nrd-30/ncsa/stsi/24_MD/2006/24_MD_2006.htm.

U.S. Department of Transportation (DOT). 2008b. *Maryland – Calvert County, Toll of Motor Vehicle Crashes, 2006*. Accessed August 1, 2008 at http://www-nrd.nhtsa.dot.gov/departments/nrd-30...006/Counties/Maryland_Calvert%20County_2006.HTM. Accession No. ML100500636.

U.S. Environmental Protection Agency (EPA). 2003. *Water on Tap: What You Need to Know.* Office of Water, EPA 816-K-03-007, Washington, D.C. Available at www.pueblo.gsa.gov/cic_text/health/watertap/ch4.htm. Accession No. ML100820227.

U.S. Environmental Protection Agency (EPA). 2004. *AERMOD: Description of Model Formulation*. EPA-454/R-03-004, Research Triangle Park, North Carolina.

U.S. Environmental Protection Agency (EPA). 2009. *Global Greenhouse Gas Data*. Accessed December 15, 2009 at http://www.epa.gov/climatechange/emissions/globalghg.html. Accession No. ML100221499.

U.S. Fish and Wildlife Service (FWS). 2007. *National Bald Eagle Management Guidelines.* Annapolis, Massachusetts. Available at http://www.fws.gov/midwest/Eagle/guidelines/guidelines.html.

U.S. Nuclear Regulatory Commission (NRC). 1977. *Regulatory Guide 1.109 – Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I*, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1980. *Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants*. NUREG-0654, Rev. 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1981. *Final Environmental Impact Statement Related to the Operation of Enrico Fermi Atomic Power Plant.* NUREG-0769, Addendum No. 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1983. *Regulatory Guide 1.145 - Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants*. Revision 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1990. *Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants*. NUREG-1150 Vol. 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, *Main Report,* NUREG-1437, Vols. 1 and 2, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report,* NUREG-1437, Addendum 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2000a. *Environmental Standard Review Plan—Standard Review Plans for Environmental Reviews for Nuclear Power Plants*. NUREG-1555, Vol. 1, Washington, D.C. Includes 2007 revisions.

U.S. Nuclear Regulatory Commission (NRC). 2000b. *Regulatory Guide 1.183 - Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Plants.* Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2001a. *Procedural Guidance for Preparing Environmental Assessments and Considering Environmental Issues*. Appendix D in NRR Office Instruction LIC-203, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2001b. *Event Notification Report for June 5, 2001.* Calvert Cliffs Nuclear Power Plant Impingement Incidents Event Number: 38049. Available at http://www.nrc.gov/reading-rm/doc-collections/event-status/event/2001/20010605en.html.

U.S. Nuclear Regulatory Commission (NRC). 2002. *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, Supplement 1 Regarding the Decommissioning of Nuclear Power Reactors*. NUREG-0586, Supplement 1, Vol. 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2004. *Procedural Guidance for Preparing Environmental Assessments and Considering Environmental Issues.* LIC-203, Revision 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2005. *Event Notification Report for July 18, 2005.* Calvert Cliffs Nuclear Power Plant Impingement Incidents Event Number: 41845. Available at http://www.nrc.gov/reading-rm/doc-collections/event-status/event/2005/20050718en.html.

U.S. Nuclear Regulatory Commission (NRC). 2006a. *Event Notification Report for July 12, 2006.* Calvert Cliffs Nuclear Power Plant Impingement Incidents Event Numbers: 42699 and 42700. Available at http://www.nrc.gov/reading-rm/doc-collections/event-status/event/2006/20060712en.html.

U.S. Nuclear Regulatory Commission (NRC). 2006b. *Event Notification Report for July 13, 2006.* Calvert Cliffs Nuclear Power Plant Impingement Incidents Event Number: 42702.

Available at http://www.nrc.gov/reading-rm/doc-collections/event-status/event/2006/20060713en.html.

U.S. Nuclear Regulatory Commission (NRC). 2006c. *Event Notification Report for July 14, 2006.* Calvert Cliffs Nuclear Power Plant Impingement Incidents Event Number: 42704. Available at http://www.nrc.gov/reading-rm/doc-collections/event-status/event/2006/20060714en.html.

U.S. Nuclear Regulatory Commission (NRC). 2006d. *Event Notification Report for August 16, 2006.* Calvert Cliffs Nuclear Power Plant Impingement Incidents Event Number: 42776. Available at http://www.nrc.gov/reading-rm/doc-collections/event-status/event/2006/20060816en.html.

U.S. Nuclear Regulatory Commission (NRC). 2006e. *Event Notification Report for September 6, 2006.* Calvert Cliffs Nuclear Power Plant Impingement Incidents Event Number: 42827. Available at http://www.nrc.gov/reading-rm/doc-collections/event-status/event/2006/20060906en.html.

U.S. Nuclear Regulatory Commission (NRC). 2007a. *Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities 2006*. NUREG-0713, Vol. 28, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2007b. *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants.* NUREG-0800, Washington, D.C.

Wright, A.C., R.T. Hill, J.A. Johnson, M.C. Roghman, R.R. Colwell, and J.G. Morris Jr. 1996. "Distribution of *Vibrio vulnificus* in the Chesapeake Bay." *Applied and Environmental Microbiology* 62(2):717-724.

World Health Organization (WHO). 2007a. *Electromagnetic Fields and Public Health*. *Exposure to Extremely Low Frequency Fields*. Fact sheet No. 322. Available at http://www.who.int/mediacentre/factsheets/fs322/en.

World Health Organization (WHO). 2007b. *Extremely Low Frequency Fields.* Environmental Health Criteria Monograph No. 238, Geneva, Switzerland.

6.0 Fuel Cycle, Transportation, and Decommissioning

This chapter addresses the environmental impacts from (1) the uranium fuel cycle and solid waste management, (2) the transportation of radioactive material, and (3) the decommissioning of a new nuclear unit, proposed Unit 3, at the Calvert Cliffs Nuclear Power Plant (CCNPP) site.

In its evaluation of uranium fuel cycle impacts from the Unit 3 at the Calvert Cliffs site, UniStar used the AREVA NP Inc. (AREVA) U.S. EPR advanced light-water reactor (LWR) design, assuming a capacity factor of 95 percent as reported by AREVA (UniStar 2009a) for the U.S. EPR reactor design.

This chapter presents the U.S. Nuclear Regulatory Commission's (NRC) assessment of the environmental impacts from fuel cycle, transportation, and decommissioning activities in relation to the U.S. EPR design that UniStar is proposing for Calvert Cliffs Unit 3.

6.1 Fuel Cycle Impacts and Solid Waste Management

This section discusses the environmental impacts from the uranium fuel cycle and solid waste management for the U.S. EPR reactor design. The environmental impacts of this design are evaluated against specific criteria for LWR designs at Title 10 of the Code of Federal Regulations (CFR) Part 51.

The regulations in 10 CFR 51.51(a) states that

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

The U.S. EPR proposed for Unit 3 at the Calvert Cliffs site would use uranium dioxide fuel. Therefore, Table S–3 (10 CFR 51.51(b)) can be used to assess environmental impacts of the uranium fuel cycle. Table S–3 values are normalized for a reference 1000-MW(e) LWR at an 80-percent capacity factor. The 10 CFR 51.51(a) Table S–3 values are reproduced in

Table 6-1. The power rating for the proposed Unit 3 is 4590 MW(t) (UniStar 2009a). With a capacity factor of 95 percent, this corresponds to 1625 MW(e).

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

Environmental Considerations	Total	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1000 MW(e) LWR
Natural Resource Use		
Land (acres):		
Temporarily committed[b]	100	
Undisturbed area	79	
Disturbed area	22	Equivalent to a 100-MW(e) coal-fired power plant.
Permanently committed	13	
Overburden moved (millions of MT)	2.8	Equivalent to a 95-MW(e) coal-fired power plant.
Water (millions of gallons):		
Discharged to air	160	= 2 percent of model 1000-MW(e) LWR with cooling tower.
Discharged to water bodies	11,090	
Discharged to ground	127	
Total	11,377	<4 percent of model 1000 MW(e) with once-through cooling.
Fossil fuel:		
Electrical energy (thousands of MW-hour)	323	<5 percent of model 1000 MW(e) LWR output.
Equivalent coal (thousands of MT)	118	Equivalent to the consumption of a 45-MW(e) coal-fired power plant.
Natural gas (millions of standard cubic feet)	135	<0.4 percent of model 1000 MW(e) energy output.
Effluents--Chemical (MT)		
Gases (including entrainment):[c]		
SO_x^{-1}	4400	
NO_x^{-1}[d]	1190	Equivalent to emissions from 45 MW(e) coal-fired plant for a year.
Hydrocarbons	14	
CO	29.6	
Particulates	1154	
Other gases:		
F	0.67	Principally from uranium hexafluoride (UF_6) production, enrichment, and reprocessing. The concentration is within the range of state standards–below level that has effects on human health.
HCl	0.014	

Table 6-1. (contd)

Environmental Considerations	Total	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1000 MW(e) LWR
Liquids:		
SO_4^-	9.9	From enrichment, fuel fabrication, and reprocessing steps. Components that constitute a potential for adverse environmental effect are present in dilute concentrations and receive additional dilution by receiving bodies of water to levels below permissible standards. The constituents that require dilution and the flow of dilution water are: NH_3—600 cfs, NO_3—20 cfs, Fluoride—70 cfs.
NO_3^-	25.8	
Fluoride	12.9	
Ca^{++}	5.4	
Cl^-	8.5	
Na^+	12.1	
NH_3	10	
Fe	0.4	
Tailings solutions (thousands of MT)	240	From mills only–no significant effluents to environment.
Solids	91,000	Principally from mills–no significant effluents to environment.
Effluents–Radiological (curies)		
Gases (including entrainment):		
Rn-222		Presently under reconsideration by the Commission
Ra-226	0.02	
Th-230	0.02	
Uranium	0.034	
Tritium (thousands)	18.1	
C-14	24	
Kr-85 (thousands)	400	
Ru-106	0.14	Principally from fuel reprocessing plants.
I-129	1.3	
I-131	0.83	
Tc-99		Presently under consideration by the Commission.
Fission products and transuranics	0.203	
Liquids:		
Uranium and daughters	2.1	Principally from milling–included tailings liquor and returned to ground–no effluents; therefore, no effect on environment.
Ra-226	0.0034	From UF_6 production.
Th-230	0.0015	
Th-234	0.01	From fuel fabrication plants–concentration 10 percent of 10 CFR Part 20 for total processing 26 annual fuel requirements for model LWR.
Fission and activation products	5.9×10^{-6}	
Solids (buried onsite):		

Table 6-1. (contd)

Environmental Considerations	Total	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1000 MW(e) LWR
Other than high level (shallow)	11,300	9100 Ci comes from low-level reactor wastes and 1500 Ci comes from reactor decontamination and decommissioning—buried at land burial facilities. 600 Ci comes from mills—included in tailings returned to ground. Approximately 60 Ci comes from conversion and spent fuel storage. No significant effluent to the environment.
TRU and HLW (deep)	1.1×10^7	Buried at Federal Repository.
Effluents—thermal (billions of British thermal units)	4063	<5 percent of model1000-MW(e) LWR.
Transportation (person-rem):		
Exposure of workers and general public	2.5	
Occupational exposure (person-rem)	22.6	From reprocessing and waste management.

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

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

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

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

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

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

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

The Nuclear Non-Proliferation Act (22 U.S.C. 3201, et seq.) was enacted in 1978. This law significantly impacted the disposition of spent nuclear fuel by deferring indefinitely the commercial reprocessing and recycling of spent fuel produced in the U.S. commercial nuclear power program. While the ban on reprocessing spent fuel was lifted during the Reagan administration, economic circumstances changed, reserves of uranium ore increased, and the stagnation of the nuclear power industry in the United States provided little incentive for industry to resume reprocessing. During the 109th Congress, the Energy Policy Act of 2005 (Public Law 109-58) was enacted. It authorized the U.S. Department of Energy (DOE) to conduct an advanced fuel recycling technology research and development program to evaluate proliferation-resistant fuel recycling and transmutation technologies that minimize environmental or public health and safety impacts. Consequently, while Federal policy does not prohibit reprocessing, additional DOE efforts would be required before commercial reprocessing and recycling of spent fuel produced in the U.S. commercial nuclear power plants could commence.

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

The following assessment of the environmental impacts of the fuel cycle as related to the operation of the proposed project is based on the values given in Table S–3 (Table 6-1) and the staff's analysis of the radiological impact from radon-222 and technetium-99. In NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS)

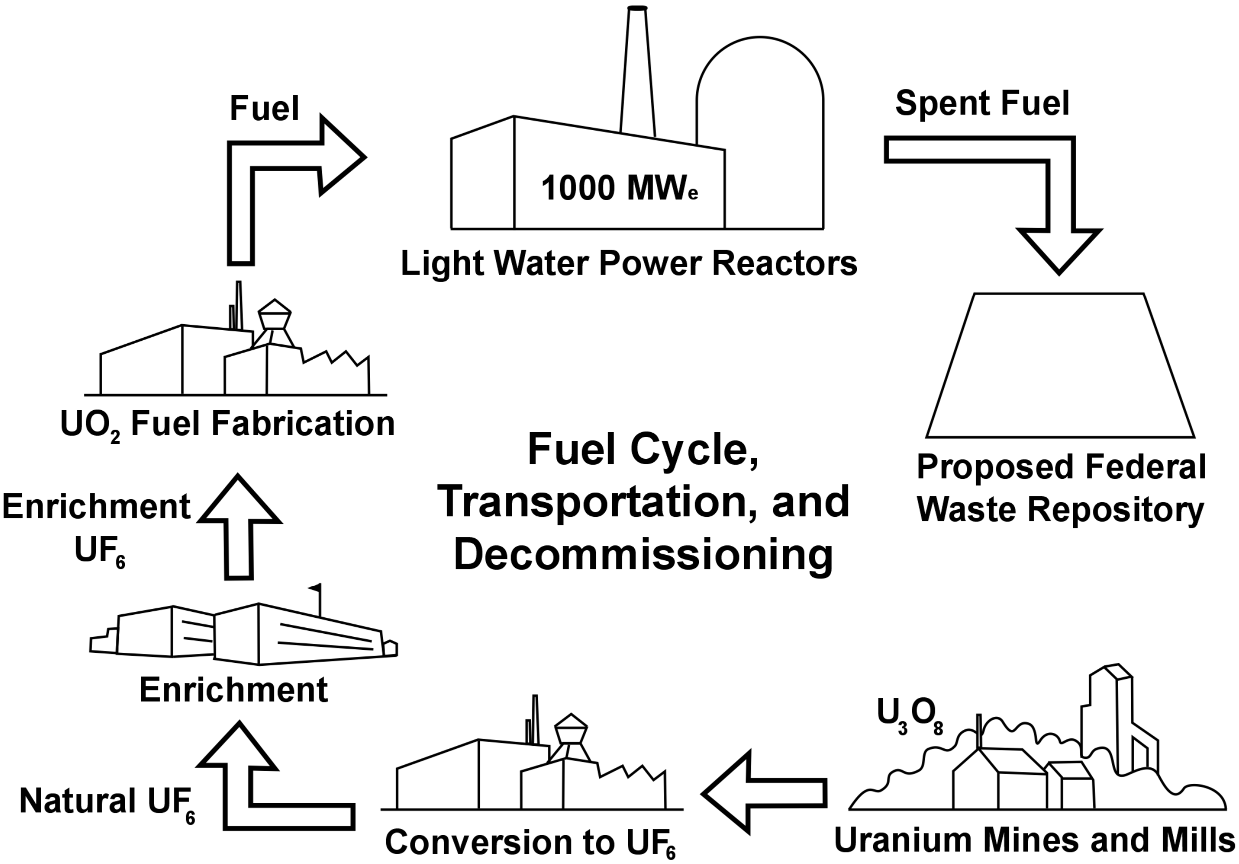

Figure 6-1. The Uranium Fuel Cycle: No-Recycle Option (derived from NRC 1996)

(NRC 1996, 1999),[a] the staff provides a detailed analysis of the environmental impacts from the uranium fuel cycle. Although NUREG-1437 is specific to the impacts related to license renewal for operating reactors, the information is relevant to this review because the advanced LWR design considered here uses the same type of fuel. The staff's analyses in Section 6.2.3 of NUREG-1437 are summarized and set forth here.

The fuel cycle impacts in Table S–3 are based on a reference 1000-MW(e) LWR operating at an annual capacity factor of 80 percent for a net electric output of 800 MW(e). In the following review and evaluation of the environmental impacts of the fuel cycle, the staff considered the capacity factor of 95 percent with a total net electric output of 1625 MW(e) for the proposed new unit at the Calvert Cliffs site (UniStar 2009a); this is about 2 times (i.e., 1625 MW(e) divided by 800 MW(e) yields 2.03) the impact values in Table S–3 (see Table 6-1). Throughout this

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(a) NUREG-1437 was originally issued in 1996. Addendum 1 to NUREG-1437 was issued in 1999. Hereafter, all references to NUREG-1437 include NUREG-1437 and its Addendum 1.

chapter, this will be referred to as the 1000-MW(e) LWR-scaled model, reflecting 1625 MW(e) for the site and, for simplicity, the Table S–3 results are scaled by a factor of 2 rather than 2.03.

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

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

The values in Table S–3 were calculated from industry averages for the performance of each type of facility or operation within the fuel cycle. Recognizing that this approach meant that there would be a range of reasonable values for each estimate, the staff followed the policy of choosing the assumptions or factors to be applied so that the calculated values would not be underestimated. This approach was intended to confirm that the actual environmental impacts would be less than the quantities shown in Table S–3 for all LWR nuclear power plants within the widest range of operating conditions. Many subtle fuel cycle parameters and interactions were recognized by the staff as being less precise than the estimates and were not considered or were considered but had no effect on the Table S–3 calculations. For example, to determine the quantity of fuel required for a year's operation of a nuclear power plant in Table S–3, the staff defined the model reactor as a 1000-MW(e) LWR reactor operating at 80-percent capacity with a 12-month fuel reloading cycle and an average fuel burnup of 33,000 MWd/MTU. This is a "reactor reference year" or "reference reactor year" depending on the source (either Table S–3 or the NUREG-1437), but it has the same meaning. If approved, the combined license (COL) for the proposed Unit 3 would allow 40 years of operation. In NUREG-1437, the sum of the initial fuel loading plus all of the reloads for the lifetime of the reactor was divided by a 60-year lifetime (40-year initial license term and 20-year license renewal term) to obtain an average annual fuel requirement. This was the approach followed by the NRC staff in NUREG-1437 for both boiling water reactors and pressurized water reactors; the higher annual requirement, 35 metric tonnes of uranium made into fuel for a boiling water reactor, was chosen in NUREG-1437 as the basis for the reference reactor year (NRC 1996). The average annual fuel requirement presented in NUREG-1437 would only be increased by 2 percent if a 40-year lifetime were evaluated. However, a number of fuel management improvements have been adopted by owner/operators of nuclear power plants to achieve higher performance and to reduce fuel and separative work (enrichment) requirements. Since the time when Table S–3 was promulgated, these improvements have reduced the annual fuel requirement, which means the Table S–3 assumptions remain bounding as applied to the proposed Unit 3.

Another change supporting the bounding nature of the S–3 assumptions with respect to Unit 3 impacts is the elimination of the U.S. restrictions on the importation of foreign uranium. Until recently, the economic conditions of the uranium market favored utilization of foreign uranium at the expense of the domestic uranium industry. From the mid-1980s to 2004, the price of U_3O_8 remained below $20 per pound. These market conditions forced the closing of most U.S. uranium mines and mills, substantially reducing the environmental impacts in the United States from these activities. However, the spot price of uranium increased dramatically from $24 per pound in April 2005 to $135 per pound in July 2007 and remained near $60 per pound throughout most of 2008 (Seccombe 2008), but as of March 2010 is about $42 per pound (Ux Consulting Company 2010). As a result, there is a renewed interest in uranium mining and milling in the United States and the NRC anticipates receiving multiple license applications for uranium mining and milling in the next several years. The majority of these applications are expected to be for *in situ* leach solution mining that does not produce tailings. Factoring in changes to the fuel cycle suggests that the environmental impacts of mining and tail millings could drop to levels below those given in Table S–3; however, Table S–3 estimates have not been reduced for these analyses.

In sum, these reasons highlight why Table S–3 is likely to overestimate impacts from the proposed Unit 3 and therefore remains a bounding approach for this analysis.

Section 6.2 of NUREG-1437 discusses the sensitivity to recent changes in the fuel cycle on the environmental impacts in greater detail.

6.1.1 Land Use

The total annual land requirement for the fuel cycle supporting the 1000-MW(e) LWR-scaled model is about 226 ac. Approximately 26 ac are permanently committed land, and 200 ac are temporarily committed. A “temporary” land commitment is a commitment for the life of the specific fuel cycle plant (e.g., a mill, enrichment plant, or succeeding plants). Following completion of decommissioning, such land can be released for unrestricted use. “Permanent” commitments represent land that may not be released for use after plant shutdown and decommissioning because decommissioning activities do not result in removal of sufficient radioactive material to meet the limits in 10 CFR Part 20, Subpart E, for release of that area for unrestricted use. Of the 200 ac of temporarily committed land, 158 ac are undisturbed and 44 ac are disturbed. In comparison, a coal-fired power plant using the same MW(e) output as the LWR-scaled model and strip-mined coal requires the disturbance of about 370 ac per year for fuel alone. The staff concludes that the impacts on land use to support the 1000-MW(e) LWR-scaled model would be SMALL.

6.1.2 Water Use

The principal water use for the fuel cycle supporting a 1000-MW(e) LWR-scaled model is that required to remove waste heat from the power stations supplying electrical energy to the enrichment step of this cycle. Scaling from Table S–3, of the total annual water use of 2.3×10^{10} gal, about 2.25×10^{10} gal are required for the removal of waste heat, assuming that a new unit uses once-through cooling. Also, scaling from Table S–3 other water uses involve the discharge to air (e.g., evaporation losses in process cooling) of about 3.2×10^{8} gal/yr and water discharged to the ground (e.g., mine drainage) of about 2.6×10^{8} m^3/yr (UniStar 2009a).

On a thermal effluent basis, annual discharges from the nuclear fuel cycle are about 4 percent of the 1000-MW(e) LWR-scaled model using once-through cooling. The consumptive water use is about 2 percent of the 1000-MW(e) LWR-scaled model using cooling towers. The maximum consumptive water use (assuming that all plants supplying electrical energy to the nuclear fuel cycle use cooling towers) would be about 6 percent of the 1000-MW(e) LWR-scaled model using cooling towers. Under this condition, thermal effluents would be negligible. The staff concludes that the impacts on water use for these combinations of thermal loadings and water consumption would be SMALL.

6.1.3 Fossil Fuel Impacts

Electric energy and process heat are required during various phases of the fuel cycle process. Electric energy is usually produced by the combustion of fossil fuel at conventional power plants. Electric energy associated with the fuel cycle represents about 5 percent of the annual electric power production of the reference 1000-MW(e) LWR. Process heat is primarily generated by the combustion of natural gas. This gas consumption, if used to generate electricity, would be less than 0.4 percent of the electrical output from the model plant.

The largest source of carbon dioxide (CO_2) emissions associated with nuclear power is from the fuel cycle, not the operation of the plant, as indicated in the previous paragraph and in Table S–3. The CO_2 emissions from the fuel cycle are about 5 percent of the CO_2 emissions from an equivalent fossil fuel-fired plant.

The largest use of electricity in the fuel cycle comes from the enrichment process. It appears that GC technology is likely to eventually replace GD technology for uranium enrichment in the United States. The same amount of enrichment from a GC facility uses less electricity and therefore results in lower amounts of air emissions such as CO_2 than a GD facility. Therefore, the NRC staff concludes that the values for electricity use and air emissions in Table S–3 continue to be appropriately bounding values.

In Appendix L, the staff estimates that the carbon footprint of the fuel cycle to support a reference 1000 MW(e) LWR for a 40-year plant life is on the order of 1.8×10^7 metric tons of CO_2 including a very small contribution from other greenhouse gases. Scaling this footprint to the 1625 MW(e) power level of the U.S. EPR reactor, the staff estimates the carbon footprint for 40 years of fuel cycle emissions to be 3.5×10^7 metric tons of CO_2.

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

6.1.4 Chemical Effluents

The quantities of gaseous and particulate chemical effluents produced in fuel cycle processes are given in Table S–3 (Table 6-1) for the reference 1000-MW(e) LWR and, according to WASH-1248 (AEC 1974), result from the generation of electricity for fuel cycle operations. The principal effluents are sulfur oxides, nitrogen oxides, and particulates. Table S–3 states that the fuel cycle for the reference 1000-MW(e) LWR requires 323,000 MWh of electricity. The fuel cycle for the 1000-MW(e) LWR scaled model would therefore require 646,000 MWh of electricity, or 0.016 percent of the 4.1 billion MWh of electricity generated in the United States in 2008 (DOE/EIA 2009). Therefore, the gaseous and particulate chemical emissions would add about 0.016 percent to the national gaseous and particulate chemical effluents for electricity generation.

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

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

Based on the discussions above, the NRC staff concludes that the impacts of these gaseous, particulate, and liquid chemical effluents would be SMALL.

6.1.5 Radiological Effluents

Radioactive effluents estimated to be released to the environment from waste management activities and certain other phases of the fuel cycle process are set forth in Table S–3 (Table 6-1). Using these effluents in NUREG-1437 (NRC 1996), the staff calculated the 100-year environmental dose commitment to the U.S. population from the fuel cycle of 1 year of operation of the model 1000-MW(e) LWR. The total overall whole body gaseous dose commitment and whole body liquid dose commitment from the fuel cycle (excluding reactor releases and dose commitments because of exposure to radon-222 and technetium-99) were calculated to be approximately 400 person-rem and 200 person-rem, respectively. Scaling these dose commitments by a factor of about 2 for the 1000-MW(e) LWR-scaled model results in whole body dose commitment estimates of 800 person-rem for gaseous releases and 400 person-rem for liquid releases. Therefore, for both pathways, the estimated 100-year environmental dose commitment to the U.S. population would be approximately 1200 person-rem for the 1000-MW(e) LWR-scaled model.

Currently, the radiological impacts associated with radon-222 and technetium-99 releases are not addressed in Table S–3. Principal radon releases occur during mining and milling operations and as emissions from mill tailings, whereas principal technetium-99 releases occur from gaseous diffusion enrichment facilities. UniStar provided an assessment of radon-222 and technetium-99 in its environmental report (ER) (UniStar 2009a). UniStar's evaluation relied on the information discussed in NUREG-1437 (NRC 1996).

In Section 6.2 of NUREG-1437 (NRC 1996), the staff estimated the radon-222 releases from mining and milling operations and from mill tailings for each year of operations of the reference 1000-MW(e) LWR. The estimated releases of radon-222 for the reference reactor year for the 1000-MW(e) LWR-scaled model, or for the total electric power rating for the proposed Unit 3 for a year, are approximately 10,400 curies (Ci). Of this total, about 78 percent would be from mining, 15 percent from milling operations, and 7 percent from inactive tails before stabilization. For radon releases from stabilized tailings, the staff assumed that the LWR-scaled model would result in an emission of 2 Ci per site year, (i.e., about 2 times the NUREG-1437 (NRC 1996) estimate for the reference reactor year). The major risks from radon-222 are from exposure to the bone and the lung, although there is a small risk from exposure to the whole body. The organ-specific dose-weighting factors from 10 CFR Part 20 were applied to the bone and lung doses to estimate the 100-year dose commitment from radon-222 to the whole body. The estimated 100-year environmental dose commitment from mining, milling, and tailings before stabilization for each site year (assuming the 1000-MW(e) LWR-scaled model) would be approximately 2100 person-rem to the whole body. From stabilized tailings piles, the estimated 100-year environmental dose commitment would be approximately 39 person-rem to the whole body. Additional insights regarding Federal policy/resource perspectives concerning institutional controls comparisons with routine radon-222 exposure and risk and long-term releases from stabilized tailing piles are discussed in NUREG-1437 (NRC 1996).

Also as discussed in NUREG-1437, the staff considered the potential doses associated with the releases of technetium-99. The estimated releases of technetium-99 for the reference reactor year for the 1000-MW(e) LWR-scaled model are 14 mCi from chemical processing of recycled uranium hexafluoride before it enters the isotope enrichment cascade and 10 mCi into the groundwater from a repository. The major risks from technetium-99 are from exposure of the gastrointestinal tract and kidney, although there is a small risk from exposure to the whole body. Applying the organ-specific dose-weighting factors from 10 CFR Part 20 to the gastrointestinal tract and kidney doses, the total-body 100-year dose commitment from technetium-99 to the whole body was estimated to be 203 person-rem for the 1000-MW(e) LWR-scaled model.

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

The nominal probability coefficient was multiplied by the sum of the estimated whole body population doses from gaseous effluents, liquid effluents, radon-222, and technetium-99 discussed above (approximately 3500 person-rem/yr) to calculate that the U.S. population would incur a total of approximately 2.0 fatal cancers, nonfatal cancers, and severe hereditary effects annually.

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

In addition, at the request of the U.S. Congress, the National Cancer Institute (NCI) conducted a study and published *Cancer in Populations Living Near Nuclear Facilities* in 1990 (Jablon et al. 1990). This report included an evaluation of health statistics around all nuclear power plants, as well as several other nuclear fuel cycle facilities, in operation in the United States in 1981 and found "no evidence that an excess occurrence of cancer has resulted from living near nuclear facilities." The contribution to the annual average dose received by an individual from fuel-cycle-related radiation and other sources as reported in a report published by the National Council on Radiation Protection and Measurements (NCRP) (NCRP 2009) is listed in Table 6-2. The nuclear fuel cycle contribution to an individual's annual average radiation dose is extremely small (less than 0.1 mrem/yr) compared to the annual average background radiation dose (about 311 mrem/yr).

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

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

Source: (NCRP 2009)

(a) NCRP Report 160 table expressed doses in mSv/yr (1 mSv/yr equals 100 mrem/yr).

(b) Occupational dose is regulated separately from public dose and is provided here for informational purposes.

(c) Calculated using 153 person-Sv/yr from Table 6-1 of NCRP 160 and a 2006 U.S. population of 300 million.

Based on the analyses presented above, the staff concludes that the environmental impacts of radioactive effluents from the fuel cycle are SMALL.

6.1.6 Radiological Wastes

The quantities of buried radioactive waste material (low-level, high-level, and transuranic wastes) are specified in Table S–3 (Table 6-1). For LLW disposal at land burial facilities, the Commission notes in Table S–3 that there would be no significant radioactive releases to the environment.

UniStar indicated in its letter dated December 9, 2009 (UniStar 2009b), that the ER will be revised to indicate that the Barnwell LLW disposal facility in Barnwell, South Carolina, no longer accepts Class B and C wastes from sources in states outside of the Atlantic Compact. By the time Calvert Cliffs Unit 3 would begin operation, UniStar expects to enter into an agreement with an NRC-licensed facility that would accept LLW from Calvert Cliffs. If that expectation is not met, UniStar could implement measures to reduce or eliminate the generation of Class B and C wastes, extending the capacity of the onsite Solid Waste Storage System to store such wastes to over 10 years. UniStar could also construct additional storage facilities onsite and has indicated that such facilities would be designed and operated to meet the guidance standards in Appendix 11.4-A of the Standard Review Plan (NUREG-0800) (NRC 1987). Finally, UniStar indicated that it could enter into an agreement with a third-party contractor to process, store, own, and ultimately dispose of LLW from Calvert Cliffs (UniStar 2009b). Because UniStar will have to choose one or a combination of these three options, the staff considered the environmental impacts of each of these three options.

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

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

In most circumstances, the NRC's regulations (10 CFR 50.59) allow licensees operating nuclear power plants to construct and operate additional onsite LLW storage facilities without seeking approval from the NRC. Licensees are required to evaluate the safety and environmental impacts before constructing the facility and make those evaluations available to NRC inspectors. A number of nuclear power plant licensees have constructed and operate such facilities in the United States. Typically, these additional facilities are constructed near the power block inside the security fence on land that has already been disturbed during initial plant construction. Therefore, the impacts on environmental resources (e.g., land use and aquatic and terrestrial biota) would be very small. All of the NRC (10 CFR Part 20) and EPA (40 CFR Part 190) dose limitations would apply both for public and occupational radiation exposure. The radiological environmental monitoring programs around nuclear power plants that operate such facilities show that the increase in radiation dose at the site boundary is not significant; the radiation doses continue to be below 25 mrem/yr, the dose limit of 40 CFR Part 190. The NRC staff concludes that doses to members of the public within the NRC and EPA regulations are a small impact. Therefore, the impacts from radiation would be SMALL.

In addition, NUREG-1437 assessed the impacts of LLW storage onsite at currently operating nuclear power plants and concluded that the radiation doses to offsite individuals from interim LLW storage are insignificant (NRC 1996). The types and amounts of LLW generated by the proposed reactor at Calvert Cliffs Unit 3 would be very similar to those generated by currently operating nuclear power plants and the construction and operation of these interim LLW storage facilities would be very similar to the construction and operation of the currently operating facilities.

The Commission notes that high-level and transuranic wastes are to be buried at a repository, such as the geologic high-level waste (HLW) repository at Yucca Mountain, Nevada, and that no release to the environment is expected to be associated with such disposal because it has been assumed that all of the gaseous and volatile radionuclides contained in the spent fuel are released to the atmosphere before the disposal of the waste. In NUREG-0116 (NRC 1976), which provides background and context for the Table S–3 values established by the Commission, the staff indicates that these high-level and transuranic wastes will be buried and will not be released to the environment.

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

Furthermore, in the Commission's Waste Confidence Decision, 10 CFR 51.23, the Commission has made the generic determination that "if necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impacts for at least 30 years beyond the licensed life for operation … of that reactor at its spent fuel storage basin or at either onsite or offsite independent spent fuel storage installations." That regulation also states that "the Commission believes there is reasonable assurance that at least one mined geologic repository will be available within the first quarter of the twenty-first century, and sufficient repository capacity will be available within 30 years beyond the licensed life for operation of any reactor to dispose of the commercial high-level waste and spent fuel originating in such a reactor and generated up to that time." The regulation provides that, accordingly, no discussion of any environmental impact of spent fuel storage for the period following the term of the reactor combined license is required in any environmental impact statement (EIS) prepared in connection with the issuance of that combined license.

In October 2008, the Commission proposed a rulemaking to update and revise the Waste Confidence Decision (73 FR 59551). Public comments were received on the rulemaking, and the public comment period for the rule was extended through February 2009 (73 FR 72370). At this time, however, the Commission has not approved the publication of a final rule. If a revised rule concerning the waste confidence determination is ultimately issued by the Commission, the staff will be required to follow that determination. Absent further developments with respect to the Waste Confidence rulemaking, Table S–3 and the existing Waste Confidence Decision indicate that any environmental impacts associated with the high-level waste that would be generated by Unit 3 would be SMALL.

In the context of operating license renewal, Sections 6.2 and 6.4 of NUREG-1437 (NRC 1996) provide additional description of the generation, storage, and ultimate disposal of LLW, mixed waste, and spent fuel from power reactors, concluding that environmental impacts from these activities are SMALL. For the reasons stated above, the staff concludes that the environmental impacts of radioactive waste storage and disposal associated with Unit 3 would be SMALL.

6.1.7 Occupational Dose

The annual occupational dose attributable to all phases of the fuel cycle for the 1000-MW(e) LWR-scaled model is about 1220 person-rem. This is based on a 600 person-rem occupational dose estimate attributable to all phases of the fuel cycle for the model 1000 MW(e) LWR (NRC 1996). The NRC staff concludes that the environmental impact from this occupational dose is considered SMALL because the dose to any individual worker would be maintained within the limits of 10 CFR Part 20, which is 5 rem/yr.

6.1.8 Transportation

The transportation dose to workers and the public related to the uranium fuel cycle totals about 2.5 person-rem annually for the reference 1000-MW(e) LWR per Table S–3 (Table 6-1). This corresponds to a dose of 5.1 person-rem for the 1000-MW(e) LWR-scaled model. For purposes of comparison, the estimated collective dose from natural background radiation to the population of the United States is 9,000,000 person-rem/yr (UniStar 2009a). On the basis of this comparison, the staff concludes that environmental impacts of transportation would be SMALL.

6.1.9 Conclusions

The NRC staff evaluated the environmental impacts of the uranium fuel cycle, as given in Table S–3 (Table 6-1), considered the effects of radon-222 and technetium-99, and appropriately scaled the impacts for the 1000-MW(e) LWR-scaled model. The NRC staff also evaluated the environmental impacts of greenhouse gas emissions from the uranium fuel cycle and appropriately scaled the impacts for the 1000-MW(e) LWR-scaled model. Based on the evaluation above, the staff concludes that the impacts would be SMALL.

6.2 Transportation Impacts

This section addresses both the radiological and nonradiological environmental impacts from normal operating and accident conditions resulting from (1) shipment of unirradiated fuel to the Calvert Cliffs site and alternative sites, (2) shipment of irradiated (spent) fuel to a monitored retrievable storage facility or a permanent repository, and (3) shipment of low-level radioactive waste and mixed waste to offsite disposal facilities. Alternative sites evaluated in this EIS are the existing Calvert Cliffs site (proposed site), Bainbridge, Eastalco, and the former Thiokol site (see Section 9.3).

The NRC performed a generic analysis of the environmental effects of transportation of fuel and waste to and from LWRs in the Environmental Survey of the Transportation of Radioactive Materials to and from Nuclear Power Plants, WASH-1238 (AEC 1972) and in a supplement to WASH-1238, NUREG-75/038 (NRC 1975) and found the impact to be minimal. These documents provided the basis for Table S–4 in 10 CFR 51.52 that summarizes the environmental impacts of transportation of fuel and waste to and from one LWR of 3000 to 5000 MW(t) (1000 to 1500 MW(e)). Impacts are provided for normal conditions of transport and accidents in transport for a reference 1100-MW(e) LWR.[a] Dose to transportation workers during normal transportation operations was estimated to result in a collective dose of 4 person-rem per reference reactor year. The combined dose to the public along the route and dose to onlookers were estimated to result in a collective dose of 3 person-rem per reference reactor year.

Environmental risks (radiological) during accident conditions were determined to be small. Nonradiological impacts from postulated accidents were estimated as one fatal injury in

(a) The transportation impacts associated with the Calvert Cliffs site were normalized for a reference 1100-MW(e) LWR at an 80-percent capacity factor for comparisons to Table S–4. Note that the basis for Table S–4 is an 1100 MW(e) LWR at an 80 percent capacity factor (AEC 1972, NRC 1975). The basis for Table S–3 in 10 CFR 51.51(b) that was discussed in Section 6.1 of this EIS is an 1000 MW(e) LWR with an 80 percent capacity factor (NRC 1976). However, because fuel cycle and transportation impacts are evaluated separately, this difference does not affect the results and conclusions in this EIS.

100 reactor years and one nonfatal injury in 10 reference reactor years. Subsequent reviews of transportation impacts in NUREG-0170 (NRC 1977b) and Sprung et al. (2000) concluded that impacts were bounded by Table S–4 in 10 CFR 51.52.

In accordance with 10 CFR 51.52(a), a full description and detailed analysis of transportation impacts is not required when licensing an LWR (i.e., impacts are assumed bounded by Table S–4) if the reactor meets the following criteria:

- The reactor has a core thermal power level not exceeding 3800 MW(t).
- Fuel is in the form of sintered uranium oxide pellets having a uranium-235 enrichment not exceeding 4 percent by weight; and pellets are encapsulated in zircaloy-clad fuel rods.
- Average level of irradiation of the fuel from the reactor does not exceed 33,000 MWd/MTU, and no irradiated fuel assembly is shipped until at least 90 days after it is discharged from the reactor.
- With the exception of irradiated fuel, all radioactive waste shipped from the reactor is packaged and in solid form.
- Unirradiated fuel is shipped to the reactor by truck; irradiated (spent) fuel is shipped from the reactor by truck, rail, or barge; and radioactive waste other than irradiated fuel is shipped from the reactor by truck or rail.

The environmental impacts of the transportation of fuel and radioactive wastes to and from nuclear power facilities were resolved generically in 10 CFR 51.52, provided that the specific conditions in the rule (see above) are met; if not, then a full description and detailed analysis is required for initial licensing.

In its application, UniStar requested a COL for an additional reactor at its Calvert Cliffs site in Calvert County, Maryland. The proposed new reactor would be an U.S EPR advanced LWR. The U.S. EPR reactor has a thermal power rating of 4590 MW(t), with a design net electrical output of 1562 MW(e). The thermal power rating exceeds the 3800 MW(t) condition given in 10 CFR 51.52(a). The U.S. EPR reactors are expected to operate with a 95 percent capacity factor, so the net electrical output (annualized) is about 1484 MW(e) (UniStar 2009a). Fuel for the plants would be enriched up to about 4.62 weight percent uranium-235, which exceeds the 10 CFR 51.52(a) condition. In addition, the expected irradiation level of about 52,000 MWd/MTU (UniStar 2009a) exceeds the 10 CFR 51.52(a) condition. Therefore, a full description and detailed analysis of transportation impacts is required.

In its ER (UniStar 2009a), UniStar provided a full description and detailed analyses of the impacts of transporting fuel to and from the Calvert Cliffs site. In these analyses, radiological transportation impacts were calculated using the RADTRAN 5.6 computer code (Weiner et al. 2008). RADTRAN 5.6 was used in this EIS and is the most commonly used transportation impact analysis software used in the nuclear industry.

6.2.1 Transportation of Unirradiated Fuel

The NRC staff performed an independent analysis of the environmental impacts of transporting unirradiated (i.e., fresh) fuel to the Calvert Cliffs site and alternative sites. Radiological impacts of normal operating conditions and transportation accidents, as well as nonradiological impacts, are discussed in this section. Radiological impacts to populations and maximally exposed individuals (MEIs) are presented. Because the specific fuel fabrication plant for Calvert Cliffs Unit 3 unirradiated fuel is not known at this time, the staff's analysis assumes a "representative" route between the fuel fabrication facility and Calvert Cliffs site and alternative sites. This means that the route characteristics (distance and population distribution) are the same, and there are no differences between the impacts calculated for transporting unirradiated fuel to the Calvert Cliffs site and the three alternative sites. However, site-specific differences would be small because the radiation doses from unirradiated fuel transport and the differences in shipping distances between potential fuel fabrication plants and the Calvert Cliffs site and alternative sites are small.

6.2.1.1 Normal Conditions

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

Truck Shipments

Table 6-3 provides an estimate of the number of truck shipments of unirradiated fuel for the U.S. EPR design compared to those of the reference 1100-MW(e) reactor specified in WASH-1238 (AEC 1972) operating at 80-percent capacity (880 MW(e)). After normalization to electric generation capacity, the number of truck shipments of unirradiated fuel to the proposed Calvert Cliffs site is fewer than the number of truck shipments of unirradiated fuel estimated for the reference LWR in WASH-1238.

Shipping Mode and Weight Limits

In 10 CFR 51.52(a)(5), a condition is identified that states all unirradiated fuel is shipped to the reactor by truck. UniStar specifies that unirradiated fuel would be shipped to the reactor site by truck (UniStar 2009a). Table S–4 at 10 CFR 51.52 includes a condition that the truck shipments not exceed 73,000 lbs as governed by Federal or State gross vehicle weight restrictions.

UniStar states in its ER that the unirradiated fuel shipments to the proposed Calvert Cliffs site would comply with applicable weight restrictions (UniStar 2009a).

Table 6-3. Numbers of Truck Shipments of Unirradiated Fuel for the Reference LWR and the U.S. EPR

Reactor Type	Number of Shipments per Reactor: Total[(a)]	Unit Electric Generation, MW(e)[(b)]	Capacity Factor[(b)]	Normalized, Shipments per 1100 MW(e)[(c)]
Reference LWR (WASH-1238)	252	1100	0.8	252
CCNPP U.S. EPR	298	1562	0.95	177

(a) Total shipments of unirradiated fuel over a 40-year plant lifetime (i.e., initial core load plus 39 years of average annual reload quantities).
(b) Unit capacities and capacity factors were taken from WASH-1238 (ACE 1972) for the reference LWR and the ER (UniStar 2009a) for the U.S. EPR reactor.
(c) Normalized to net electric output for WASH-1238 reference LWR (i.e., 1100-MW(e) plant at 80 percent or net electrical output of 880 MW(e)).

Radiological Doses to Transport Workers and the Public

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

One of the key assumptions in WASH-1238 (AEC 1972) for the reference LWR unirradiated fuel shipments is that the radiation dose rate at 1 m (3.3 ft) from the transport vehicle is about 0.1 mrem/hr. This assumption was also used in the NRC staff's analysis of the U.S. EPR reactor unirradiated fuel shipments. This assumption is reasonable because the U.S. EPR reactor fuel materials would be low-dose-rate uranium radionuclides and would be packaged similarly to that described in WASH-1238 (i.e., inside a metal container that provides little radiation shielding). The numbers of shipments per year were obtained by dividing the normalized shipments in Table 6-3 by 40 years of reactor operation. Other key input parameters (listed in metric units) used in the radiation dose analysis for unirradiated fuel are shown in Table 6-4.

Table 6-4. RADTRAN 5.6 Input Parameters for Unirradiated Fuel Shipments

Parameter	RADTRAN 5.6 Input Value	Source
Shipping distance, km	3200	AEC (1972)[(a)]
Travel Fraction – Rural	0.90	NRC (1977b)
Travel Fraction – Suburban	0.05	NRC (1977b)
Travel Fraction – Urban	0.05	NRC (1977b)
Population Density – Rural, persons/km^2	10	DOE (2002a)
Population Density – Suburban, persons/km^2	349	DOE (2002a)
Population Density – Urban, persons/km^2	2260	DOE (2002a)
Vehicle speed – km/hr	88.5	Conservative in transit speed of 88.5 km/hr (55 mph) assumed; predominantly interstate highways used.
Traffic count – Rural, vehicles/hr	530	DOE (2002a)
Traffic count – Suburban, vehicles/hr	760	DOE (2002a)
Traffic count – Urban, vehicles/hr	2400	DOE (2002a)
Dose rate at 1 m from vehicle, mrem/hr	0.1	AEC (1972)
Packaging length, m	9.1	Approximate length of two U.S. EPR fuel assemblies placed on end (AREVA 2009)
Number of truck crew	2	AEC (1972), NRC (1977b), and DOE (2002a)
Stop time, hr/trip	4	Based on one 30-minute stop per 4 hr driving time (Johnson and Michelhaugh 2003)
Population density at stops, persons/km^2	See Table 6-8 for truck stop parameters	

(a) AEC (1972) provides a range of shipping distances between 40 km (25 mi) and 4800 km (3000 mi) for unirradiated fuel shipments. A 3200-km (2000-mi) "representative" shipping distance was assumed in the staff's analysis.

UniStar's ER (UniStar 2009a) assumed unirradiated fuel would be transported to the Calvert Cliffs site from the fuel fabrication plant near Richland, Washington, versus the "representative" truck shipment route assumed by the NRC staff for this analysis. A confirmatory analysis was conducted by the staff to independently verify the results of the ER calculations. The staff evaluated the ER analysis, including adjusting the results of UniStar's analysis to address differences in shipping distances and population densities, and determined they were consistent with the results presented in this EIS. Therefore, the NRC staff concludes that UniStar prepared a reasonable and comprehensive analysis of the impacts of transporting unirradiated fuel to the

Calvert Cliffs site. The generic route information was used in this analysis for consistency with the assumptions used in WASH-1238 (AEC 1972).

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

- Worker dose: 1.71×10^{-3} person-rem/shipment
- General public dose (onlookers/persons at stops and sharing the highway): 3.62×10^{-3} person-rem/shipment)
- General public dose (along route/persons living near a highway or truck stop): 5.12×10^{-5} person-rem/shipment.

These values were combined with the average annual shipments of unirradiated fuel for the U.S. EPR reactor to calculate annual doses to the public and workers. Table 6-5 presents the annual radiological impacts to workers, public onlookers (persons at stops and sharing the road), and members of the public along the route (i.e., residents within 0.5 mi of the highway) for transporting unirradiated fuel to the Calvert Cliffs site. The cumulative annual dose estimates in Table 6-5 were normalized to 1100 MW(e) (880 MW(e) net electrical output). The NRC staff performed an independent review and determined that all dose estimates are bounded by the Table S–4 conditions of 4 person-rem/yr to transportation workers, 3 person-rem/yr to onlookers, and 3 person-rem/yr to members of the public along the route.

Table 6-5. Radiological Impacts Under Normal Conditions of Transporting Unirradiated Fuel to the Calvert Cliffs Site and Alternative Sites

Plant Type	Normalized Average Annual Shipments	Cumulative Annual Dose; person-rem/yr per 1100 MW(e)[(a)] (880 MW(e) net)		
		Workers	Public–Onlookers	Public–Along Route
Reference LWR (WASH-1238)	6.3	0.011	0.023	0.00032
CCNPP and Alternative Sites U.S. EPR	4.4	0.0076	0.016	0.00023
10 CFR 51.52, Table S–4 Condition	<1 per day	4	3	3

(a) Multiply person-rem/yr times 0.01 to obtain doses in person-Sv/yr.

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

Both NCRP and ICRP suggest that when the collective effective dose is smaller than the reciprocal of the relevant risk detriment (i.e., less than 1/0.00057, which is less than 1754 person-rem), the risk assessment should note that the most likely number of excess health effects is zero (NCRP 1995; ICRP 2007). The largest annual collective dose estimate for transporting unirradiated fuel to the Calvert Cliffs site and alternative sites was 1.6×10^{-2} person-rem, which is less than the 1754 person-rem value that ICRP and NCRP suggest would most likely result in zero excess health effects. To place these impacts in perspective, the average United States resident receives about 311 mrem/yr effective dose equivalent from natural background radiation (i.e., exposures from cosmic radiation, naturally occurring radioactive materials such as radon, and global fallout from testing of nuclear explosive devices (NCRP 2009). Using this average effective dose, the collective population dose from natural background radiation to the population along this representative route would be about 2.2×10^5 person-rem. Therefore, the radiation doses from transporting unirradiated fuel to the Calvert Cliffs site and alternative sites are small compared to the collective population dose to the same population from exposure to natural sources of radiation.

Maximally Exposed Individuals Under Normal Transport Conditions

A scenario-based analysis was conducted by the NRC staff to develop estimates of incident-free radiation doses to maximally exposed individuals (MEIs) for fuel and waste shipments to and from the Calvert Cliffs site and alternative sites. The following discussion applies to unirradiated fuel shipments and spent fuel and radioactive waste shipments to and from any of the alternative sites. The analysis is based on data in the Yucca Mountain Final EIS (DOE 2002b) and incorporates data about exposure times, dose rates, and the number of times an individual may be exposed to an offsite shipment. Adjustments were made where necessary to reflect the normalized fuel and waste shipments addressed in this EIS. In all cases, the NRC staff assumed that the dose rate emitted from the shipping containers is 10 mrem/hr at 6.6 ft from the side of the transport vehicle. This assumption is conservative in that the assumed dose rate is the maximum dose rate allowed by U.S. Department of Transportation (DOT) regulations (49 CFR 173.441). Most unirradiated fuel and radioactive waste shipments would have much lower dose rates than the regulations allow (AEC 1972; DOE 2002a). An MEI is a person who may receive the highest radiation dose from a shipment to and/or from the Calvert Cliffs site and alternative sites. The analysis is described below. Population dose impacts for spent fuel transportation are presented in Section 6.2.2.

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

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

Inspectors. Radioactive shipments are inspected by Federal or State vehicle inspectors, for example, at State ports of entry. The Yucca Mountain Final EIS (DOE 2002a) assumed that inspectors would be exposed for 1 hour at a distance of 3.3 ft from the shipping containers. The dose rate at 3.3 ft is about 14 mrem/hr; therefore, the dose per shipment is about 14 mrem. This is independent of the location of the reactor site. Based on this conservative value and the assumption that the same person inspects all shipments of fuel and waste to and from the Calvert Cliffs site and alternative sites, the annual doses to vehicle inspectors were calculated by the staff to be about 0.8 rem/yr, based on a combined total of 60 shipments of unirradiated fuel, spent fuel, and radioactive waste per year. This value is less than one-half of the 2 rem/yr DOE administrative control level (DOE 2005) on individual doses and one-fifth of the 5 rem/yr NRC occupational dose limit.

Resident. The analysis assumed that a resident lives adjacent to a highway where a shipment would pass and would be exposed to all shipments along a particular route. Exposures to residents on a per-shipment basis were obtained from the NRC staff's RADTRAN 5.6 output files. These dose estimates are based on an individual located 100 ft from the shipments that are traveling 15 mph. The potential radiation dose to the maximally exposed resident is about 0.036 mrem/yr for shipments of fuel and waste to and from the site.

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

Person at a truck service station. This scenario estimates doses to an employee at a service station where all truck shipments to and from the Calvert Cliffs site and alternative sites are assumed to stop. The NRC staff's analysis assumed that the person is exposed for 49 minutes at a distance of 52 ft from the loaded shipping container (DOE 2002b). The exposure time and distance were based on observations discussed in Griego, Smith, and Neuhauser (1996). This results in a dose of about 0.34 mrem/shipment and an annual dose of about 20 mrem/yr for the Calvert Cliffs site and alternative sites, assuming that a single individual services all unirradiated fuel, spent fuel, and radioactive waste shipments to and from the Calvert Cliffs site and alternative sites.

6.2.1.2 Radiological Impacts of Transportation Accidents

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

6.2.1.3 Nonradiological Impacts of Transportation Accidents

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

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

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

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

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

The nonradiological accident impacts for transporting unirradiated fuel to (and empty shipping containers from) the Calvert Cliffs site and alternative sites are shown in Table 6-6. The nonradiological impacts associated with the WASH-1238 reference LWR are also shown for comparison purposes. Note that there are only small differences between the impacts calculated for an U.S. EPR at the Calvert Cliffs site and alternative sites and the reference LWR in WASH-1238 due entirely to the smaller number of shipments.

Table 6-6. Nonradiological Impacts of Transporting Unirradiated Fuel to the Calvert Cliffs Site and Alternative Sites, Normalized to Reference LWR

Plant Type	Annual Shipments Normalized to Reference LWR	One-Way Shipping Distance, km	Round-trip Distance, km per Year	Annual Impacts		
				Accidents per Year	Injuries per Year	Fatalities per Year
Reference LWR (WASH-1238)	6.3	3200	4.0×10^{4}	1.9×10^{-2}	9.3×10^{-4}	5.8×10^{-4}
CCNPP and Alternative Sites U.S. EPR	4.4	3200	2.8×10^{4}	1.3×10^{-2}	6.6×10^{-3}	4.1×10^{-4}

6.2.2 Transportation of Spent Fuel

The staff performed an independent analysis of the environmental impacts of transporting spent fuel from the proposed Calvert Cliffs site and alternative sites to a spent fuel disposal repository. For the purposes of these analyses, the staff considered the geologic HLW repository at the Yucca Mountain site in Nevada as a surrogate destination. Currently, NRC has not made a decision on the DOE application for the geologic HLW repository at Yucca Mountain. However, the NRC staff considers that an estimate of the impacts of the transportation of spent fuel to a possible repository in Nevada to be a reasonable bounding estimate of the transportation impacts to a storage or disposal facility because of the distances involved and the representativeness of the distribution of members of the public in urban, suburban, and rural areas (i.e., population distributions) along the shipping routes. Radiological impacts of normal operating conditions and transportation accidents, as well as nonradiological impacts, are discussed in this section.

This analysis is based on shipment of spent fuel by legal-weight trucks in shipping casks with characteristics similar to casks currently available (i.e., massive, heavily shielded, cylindrical metal pressure vessels). Due to the large size and weight of spent fuel shipping casks, each shipment is assumed to consist of a single shipping cask loaded on a modified trailer. These assumptions are consistent with those made in the evaluation of the environmental impacts of transportation of spent fuel in Addendum 1 to NUREG-1437 (NRC 1996). Because the alternative transportation methods involve rail transportation or heavy-haul trucks, which would reduce the overall number of spent fuel shipments (NRC 1996), thereby reducing impacts, these assumptions are conservative. Also, use of current shipping cask designs results in conservative impact estimates because the current shipping cask designs are based on transporting short-cooled spent fuel (approximately 120 days out of reactor). Future shipping casks would be designed to transport longer-cooled fuel (greater than five years out of reactor) and would require much less shielding to meet external dose limitations. Therefore, future shipping casks are expected to have higher cargo capacities, thereby reducing the numbers of shipments and associated impacts.

Radiological impacts of transportation of spent fuel were calculated by the NRC staff using the RADTRAN 5.6 computer code (Weiner et al. 2008). Routing and population data used in RADTRAN 5.6 for truck shipments were obtained from the TRAGIS routing code (Johnson and Michelhaugh 2003). The population data in the TRAGIS code are based on the 2000 census. Nonradiological impacts were calculated using published traffic accident, injury, and fatality data (Saricks and Tompkins 1999) in addition to route information from TRAGIS (Johnson and Michelhaugh 2003). Traffic accident rates used the RADTRAN 5.6 and nonradiological impact calculations were adjusted to account for under-reporting, as discussed in Section 4.8.3.

6.2.2.1 Normal Conditions

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

Shipping casks have not been designed for the spent fuel from advanced reactor designs such as the U.S. EPR. Information in *Early Site Permit Environmental Report Sections and Supporting Documentation* (INEEL 2003) indicated that advanced LWR fuel designs would not be significantly different from existing LWR designs; therefore, current shipping cask designs were used for the analysis of U.S. EPR reactor spent fuel shipments. The NRC staff assumed the capacity of a truck shipment of U.S. EPR reactor spent fuel was 0.5 MTU/shipment, the same capacity used in WASH-1238 (AEC 1972). In its ER, UniStar assumed a shipping cask capacity of 1.8 MTU/shipment, representative of future shipping cask designs.

Input to RADTRAN 5.6 includes the total shipping distance between the origin and destination sites and the population distributions along the routes. This information was obtained by the NRC staff by running the TRAGIS computer code (Johnson and Michelhaugh 2003) for highway routes from the Calvert Cliffs site and alternative sites to the geologic HLW repository at Yucca Mountain. The resulting route characteristics information is shown in Table 6-7. Note that for truck shipments, all the spent fuel is assumed to be shipped to the geologic HLW repository at the Yucca Mountain site over designated highway-route controlled quantity routes. In addition, TRAGIS data was loaded into RADTRAN 5.6 on a state-by-state basis. This increases precision and allows the results to be presented for each state along the route between the Calvert Cliffs site and alternative sites and the geologic HLW repository at Yucca Mountain, if desired.

Table 6-7. Transportation Route Information for Shipments from the Calvert Cliffs Site and Alternative Sites to the Geologic HLW Repository at Yucca Mountain Spent Fuel Disposal Facility

Advance Reactor Site	One-way Shipping Distance, km				Population Density, persons/km^2			Stop time per trip, hr
	Total	Rural	Suburban	Urban	Rural	Suburban	Urban	
CCNPP Site	4569	3502	962	106	10	317	2273	5
Bainbridge	4638	3515	1013	110	10	316	2260	5
Eastalco	4497	3477	933	86	10	305	2213	5
Thiokol	4560	3517	935	108	10	318	2277	5

Note: This table presents aggregated route characteristics provided by TRAGIS (Johnson and Michelhaugh 2003), including estimated distances from the alternative sites to the nearest TRAGIS highway node. Input to the RADTRAN 5.6 computer code was disaggregated to a state-by-state level.

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

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

1 **Table 6-8**. RADTRAN 5.6 Normal (Incident-free) Exposure Parameters

Parameter	RADTRAN 5.6 Input Value	Source
Vehicle speed, km/hr	88.5	Based on average speed in rural areas given in DOE (2002a). Conservative in-transit speed of 88.5 km/hr (55 mph) assumed; predominantly interstate highways used.
Traffic count – Rural, vehicles/hr Traffic count – Suburban, vehicles/hr Traffic count – Urban, vehicles/hr	State-specific	State-specific rural, suburban, and urban traffic counts are taken from Weiner et al. (2008), Appendix B
Vehicle occupancy, persons/vehicle	1.5	DOE (2002a)
Dose rate at 1 m from vehicle, mrem/hr	14	DOE (2002a, b) – approximate dose rate at 1 m that is equivalent to maximum dose rate allowed by Federal regulations (i.e., 10 mrem/hr at 2 m from the side of a transport vehicle).
Packaging dimensions, m	Length – 5.2 Diameter – 1.0	DOE (2002b)
Number of truck crew	2	AEC (1972), NRC (1977b), and DOE (2002a, b)
Stop time, hr/trip	Route-specific	See Table 6-7
Population Density at Stops, persons/km^2	30,000	Sprung et al. (2000). Equivalent to nine persons within 10 m of vehicle. See Figure 6-2.
Min/Max Radii of Annular Area Around Vehicle at Stops, m	1 to 10	Sprung et al. (2000)
Dimensionless Shielding Factor Applied to Annular Area Surrounding Vehicle at Stops	1 (no shielding)	Sprung et al. (2000)
Population Density Surrounding Truck Stops, persons/km^2	340	Sprung et al. (2000)
Min/Max Radius of Annular Area Surrounding Truck Stop, m	10 to 800	Sprung et al. (2000)
Dimensionless Shielding Factor Applied to Annular Area Surrounding Truck Stop	0.2	Sprung et al. (2000)

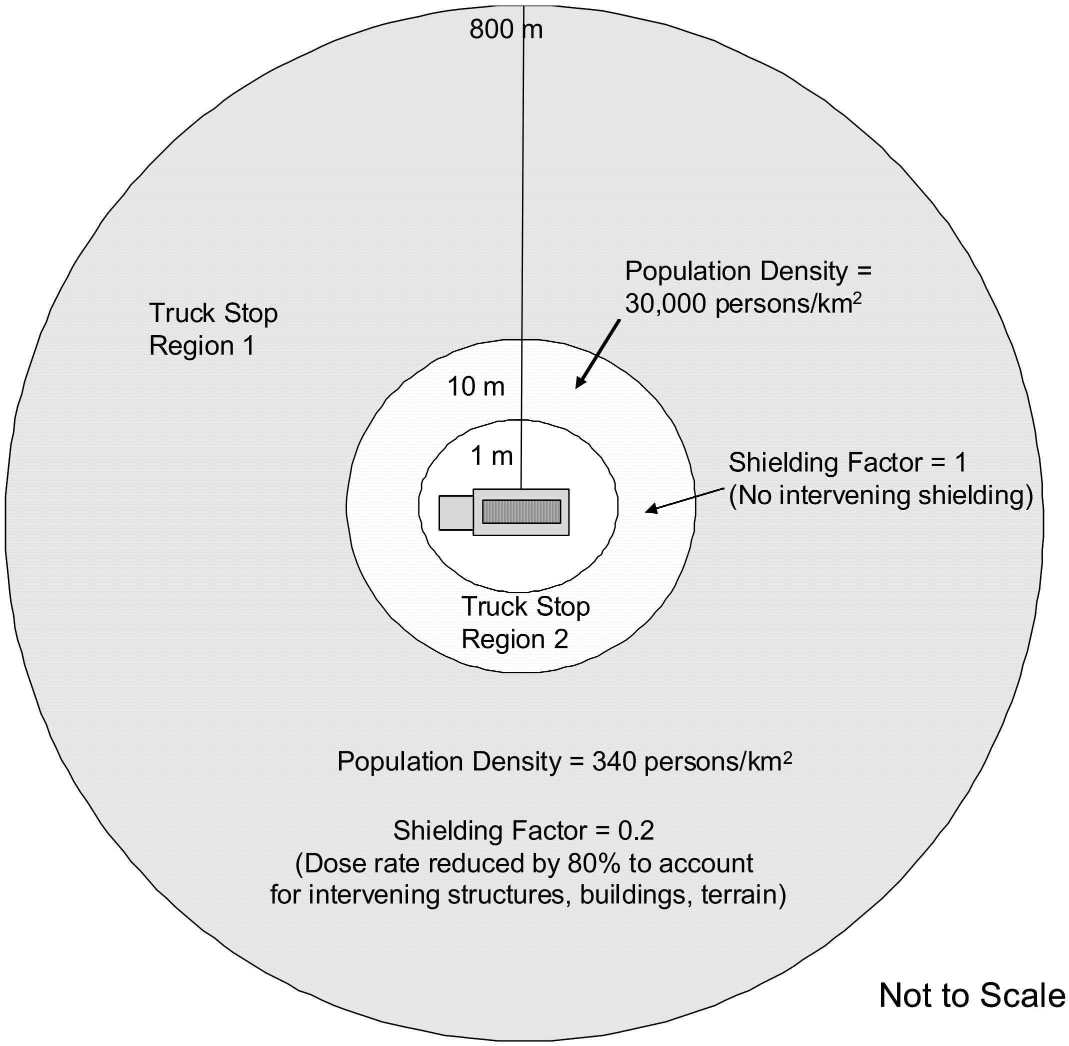

Figure 6-2. Illustration of Truck Stop Model

The results of these normal (incident-free) exposure calculations are shown in Table 6-9 for the proposed Calvert Cliffs site and alternative sites. Population dose estimates are given for workers (i.e., truck crew members), onlookers (doses to persons at stops and persons on highways exposed to the spent fuel shipment), and along the route (persons living near the highway). Shipping schedules for spent fuel generated by the proposed new unit have not been determined. The NRC staff concludes that it is reasonable to calculate annual doses assuming that the annual number of spent fuel shipments is equivalent to the annual refueling requirements. Population doses were normalized to the reference LWR in WASH-1238 (880 net MW(e)). This corresponds to an 1100-MW(e) LWR operating at 80-percent capacity.

Table 6-9. Normal (Incident-Free) Radiation Doses to Transport Workers and the Public from Shipping Spent Fuel from the Calvert Cliffs Site and Alternative Sites to the Geologic HLW Repository at Yucca Mountain

	Worker (Crew)	Along Route	Onlookers
Reference LWR (WASH-1238), person-rem/yr[a]	12	0.71	25
CCNPP COL Normalized Impacts, person-rem/yr	9.4	0.53	19
Bainbridge, person-rem/yr	9.5	0.55	19
Eastalco, person-rem/yr	9.2	0.50	18
Thiokol, person-rem/yr	9.4	0.52	19
Table S–4 Condition, person-rem/yr	4	3	3

(a) To convert person-Sv to person-rem, multiply by 100.

There are only small differences in transportation impacts among the Calvert Cliffs site and the three alternative sites evaluated. The differences are due to the route characteristics (distance; population density) for shipments from the Calvert Cliffs and alternative sites to the geologic HLW repository at Yucca Mountain.

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

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

The calculated population doses to the crew and onlookers for the reference LWR and the Calvert Cliffs and alternative site shipments exceed Table S–4 values. A key reason for the higher population doses relative to Table S–4 is the longer shipping distances assumed for this analysis (i.e., to a repository in Nevada) than the distances used in WASH-1238. WASH-1238 assumed that each spent fuel shipment would travel a distance of 1000 mi one way. The shipping distances used in this assessment were more than 2800 mi one way. If the shorter distance was used to calculate the impacts of the Calvert Cliffs spent fuel shipments, the doses in Table 6-9 could be reduced by half or more. Other important differences are the model related to vehicle stops described above and the additional precision that results from incorporating state-specific route characteristics and vehicle densities (vehicles per hour).

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

- Use of the regulatory maximum dose rate (10 mrem/hr at 2 m) in the RADTRAN 5.6 calculations. The shipping casks assumed in the EIS prepared by DOE in support of the application for the geologic HLW repository at Yucca Mountain (DOE 2002b) were designed to transport spent fuel that has cooled a minimum of 5 years (see 10 CFR 962, Subpart B).

Most spent fuel would have cooled for much longer than 5 years before being shipped to a possible geologic repository.For this reason, shipments from the Calvert Cliffs site and alternative sites are also expected to be cooled for longer than 5 years. Consequently, the estimated population doses in Table 6-9 could be further reduced if more realistic dose rate projections and shipping cask capacities are used.

- Use of 30 minutes as the average time at a truck stop in the calculations. Many stops made for actual spent fuel shipments are of short duration (i.e., 10 minutes) for brief visual inspections of the cargo (e.g., checking the cask tie-downs). These stops typically occur in minimally populated areas, such as an overpass or freeway ramp in an unpopulated area. Furthermore, empirical data provided in Griego et al. (1996) indicate that a 30-minute duration is toward the high end of the stop time distribution. Average stop times observed by Griego et al. (1996) are on the order of 18 minutes.

A sensitivity study was performed to demonstrate the effects of using more realistic dose rates and stop times on the incident-free population dose calculations. For this sensitivity study, the dose rate was reduced to 5 mrem/hr, the approximate 50 percent confidence interval of the dose rate distribution estimated by Sprung et al. (2000) for future spent fuel shipments. The stop time was reduced to 18 minutes per stop. All other RADTRAN 5.6 input values were unchanged. The result is that the annual crew doses were reduced to about 3.3 person-rem/yr or about 36 percent of the annual dose shown in Table 6-9. The annual onlooker doses were reduced to 5 person-rem/yr (27 percent), and the annual doses to persons along the route were reduced to 0.19 person-rem/yr (37 percent). The NRC staff concluded that using more realistic parameters for shipment capacities, stop times, and dose rates would reduce the annual doses in Table 6-9 to below the Table S–4 values.

UniStar described in the ER the results of a RADTRAN 5.6 analysis of the impacts of incident-free transport of spent fuel to the geologic HLW repository at Yucca Mountain. Although the overall approaches are the same (e.g., use of TRAGIS and RADTRAN 5.6), there are also some differences in the modeling details. For example, the NRC staff's analysis used state-by-state route characteristics and a shipment capacity of 0.5 MTU, whereas UniStar selected to use aggregated route information and a shipment capacity of 1.8 MTU. After adjusting UniStar's results for these key differences, the results are similar to those calculated by the NRC staff in this EIS.

Using the linear, no-threshold dose response relationship discussed in Section 6.2.1.1, the annual public dose impacts for transporting spent fuel from the Calvert Cliffs site and alternative sites to the geologic HLW repository Yucca Mountain are about 29 person-rem/yr, which is less than the 1754 person-rem value that ICRP and NCRP suggest would most likely result in zero excess health effects. This dose is very small compared to the estimated 2.9×10^5 person-rem that the population along the spent fuel shipping route would incur annually from exposure to natural sources of radiation. Note that the estimated doses to persons along the Calvert-Cliffs-to-Yucca-Mountain route from natural background radiation is different than the natural background dose calculated by the NRC staff for unirradiated fuel shipments in Section 6.2.1.1 of this EIS because the route characteristics are different. A generic route was used in Section 6.2.1.1 for unirradiated fuel shipments and actual highway routes were used in this section for spent fuel shipments.

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

6.2.2.2 Radiological Impacts of Accidents

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

Radionuclide inventories are important parameters in the calculation of accident risks. The radionuclide inventories used in this analysis were taken from UniStar’s ER (UniStar 2009a). Spent fuel inventories used in the NRC staff analysis are presented in Table 6-10. The list of radionuclides set forth in the table includes all of the radionuclides that were included in the analysis conducted by Sprung et al. (2000). The staff’s analysis also included the estimated inventory of crud, or radioactive material deposited on the external surfaces of LWR spent fuel rods. Because crud is deposited from corrosion products generated elsewhere in the reactor cooling system and the complete reactor design and operating parameters are uncertain, the quantities and characteristics of crud deposited on U.S. EPR reactor spent fuel are not available at this time. The Calvert Cliffs site U.S. EPR spent fuel transportation accident impacts were calculated in this EIS and in the UniStar’s ER (UniStar 2008 and 2009a) assuming the cobalt-60 inventory in the form of crud is 76 Ci/MTU based on information in Sprung et al. (2000).

Robust shipping casks are used to transport spent fuel because of the radiation shielding and accident resistance required by 10 CFR Part 71. Spent fuel shipping casks must be certified Type B packaging systems, meaning they must be designed to withstand a series of severe postulated hypothetical accident conditions with essentially no loss of containment or shielding capability. These casks are also designed with fissile material controls to verify the spent fuel remains subcritical under normal and accident conditions. According to Sprung et al. (2000), the probability of encountering accident conditions during transport that would lead to shipping cask failure is less than 0.01 percent (i.e., more than 99.99 percent of all accidents would result in no release of radioactive material from the shipping cask). The NRC staff assumed that shipping casks approved for transportation of spent fuel from an U.S. EPR reactor would provide equivalent mechanical and thermal protection of the spent fuel cargo.

Table 6-10. Radionuclide Inventories Used in Transportation Accident Risk Calculations for the U.S. EPR[(a)(b)]

Radionuclide	Ci/MTU	Bq/MTU	Physical-Chemical Group
Am-241	1.25×10^{3}	4.6×10^{13}	Particulate
Am-242m	2.38×10^{1}	8.8×10^{11}	Particulate
Am-243	3.22×10^{1}	1.2×10^{12}	Particulate
Ce-144	1.52×10^{4}	5.6×10^{14}	Particulate
Cm-242	4.35×10^{1}	1.6×10^{12}	Particulate
Cm-243	3.19×10^{1}	1.2×10^{12}	Particulate
Cm-244	4.84×10^{3}	1.8×10^{14}	Particulate
Cm-245	6.19×10^{-1}	2.3×10^{10}	Particulate
Co-60	7.59×10^{1}	2.8×10^{12}	Crud
Cs-134	5.84×10^{4}	2.2×10^{15}	Cesium
Cs-137	1.42×10^{5}	5.3×10^{15}	Cesium
Eu-154	1.16×10^{4}	4.3×10^{14}	Particulate
Eu-155	5.73×10^{3}	2.1×10^{14}	Particulate
I-129	4.65×10^{-2}	1.7×10^{9}	Gas
Kr-85	1.05×10^{4}	3.9×10^{14}	Gas
Pm-147	3.54×10^{4}	1.3×10^{15}	Particulate
Pu-238	6.95×10^{3}	2.6×10^{14}	Particulate
Pu-239	4.24×10^{2}	1.6×10^{13}	Particulate
Pu-240	7.24×10^{2}	2.7×10^{13}	Particulate
Pu-241	1.17×10^{5}	4.3×10^{15}	Particulate
Pu-242	2.28×10^{0}	8.4×10^{10}	Particulate
Ru-106	2.05×10^{4}	7.6×10^{14}	Ruthenium
Sb-125	5.35×10^{3}	2.0×10^{14}	Particulate
Sr-90	1.03×10^{5}	3.8×10^{15}	Particulate
Y-90	1.03×10^{5}	3.8×10^{15}	Particulate

(a) Divide Becquerel per Metric Ton Uranium (Bq/MTU) by 3.7×10^{10} to obtain curies per MTU (Ci/MTU).
(b) The source of the spent fuel inventories is UniStar (2009a).

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

The RADTRAN 5.6 accident risk calculations were performed using the radionuclide inventories given in Table 6-10. The resulting risk estimates were then multiplied by assumed annual spent fuel shipments to derive estimates of the annual accident risks associated with spent fuel shipments from the Calvert Cliffs site and alternative sites to the geologic HLW repository at Yucca Mountain in Nevada. As was done for normal transport exposures, the NRC staff assumed that the numbers of shipments of spent fuel per year are equivalent to the annual discharge quantities.

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

The staff used RADTRAN 5.6 to calculate the population dose from the released radioactive material from four of five possible exposure pathways.[(a)] These pathways are:

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

Table 6-11 presents the environmental consequences of transportation accidents when shipping spent fuel from the Calvert Cliffs site and alternative sites to the geologic HLW Yucca Mountain repository. The shipping distances and population distribution information for the routes were the same as those used for the normal "incident-free" conditions (see Section 6.2.2.1). The results are normalized to the WASH-1238 reference reactor (880-MW(e) net electrical generation, 1100-MW(e) reactor operating at 80-percent capacity) to provide a common basis for comparison to the impacts listed in Table S–4. Note that the impacts for all site alternatives are less than the reference LWR impacts. Also, although there are slight differences in impacts among the alternative sites, none of the alternative sites would be clearly favored.

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

Table 6-11. Annual Spent Fuel Transportation Accident Impacts for an U.S. EPR Reactor at the Calvert Cliffs Site and Alternative Sites, Normalized to Reference 1100-MW(e) LWR Net Electrical Generation

	Normalized Population Impacts, Person-rem/yr[(a)]
Reference LWR (WASH-1238)	1.1×10^{-4}
CCNPP Site Normalized Impacts	8.4×10^{-5}
Bainbridge	1.0×10^{-4}
Eastalco	6.0×10^{-5}
Thiokol	8.5×10^{-5}

(a) Multiply person-Sv/yr times 100 to obtain person-rem/yr.

Using the linear, no-threshold dose response relationship discussed in Section 6.2.1.1, the annual risk to the public from accidents during transportation of spent fuel from the Calvert Cliffs site and alternative sites to the geologic HLW Yucca Mountain repository is lower than the value of 1754 person-rem value that ICRP (2007) and NCRP (1995) suggest would most likely result in zero excess health effects. This risk is quite small compared to the estimated 2.8×10^5 person-rem that the same population along the route from Calvert Cliffs to the geologic HLW repository at Yucca Mountain would incur annually from exposure to natural sources of radiation. Note that the estimated population dose to persons along the Calvert-Cliffs-to-Yucca-Mountain route is different than the population dose calculated by the NRC staff for unirradiated fuel shipments in Section 6.2.1.1 of this EIS because the route characteristics are different.

The NRC staff performed a confirmatory evaluation of UniStar's spent fuel transportation accident risk analysis. It was noted that UniStar used a different, though valid, methodology for the ER calculations. The primary difference was that UniStar assumed aggregated route parameters, whereas in this EIS, the NRC staff used state-by-state shipping distances and population densities. The staff concluded that UniStar's analysis was reasonable and comprehensive and meets the intent of 10 CFR 51.52(b).

6.2.2.3 Nonradiological Impact of Spent Fuel Shipments

The general approach used to calculate nonradiological impacts of spent fuel shipments is the same as that used for unirradiated fuel shipments. The main difference is that the spent fuel shipping route characteristics are better-defined so the state-level accident statistics in Saricks and Tompkins (1999) may be used. State-by-state shipping distances were obtained from the TRAGIS output file and combined with the annual number of shipments and accident, injury, and fatality rates by state from Saricks and Tompkins (1999) to calculate nonradiological impacts. In addition, the accident, injury, and fatality rates from Saricks and Tompkins (1999) were adjusted to account for under-reporting (see Section 6.2.1.3). The results are shown in Table 6-12.

Table 6-12. Nonradiological Impacts of Transporting Spent Fuel from the Calvert Cliffs Site and Alternative Sites to the Geologic HLW Repository at Yucca Mountain, Normalized to Reference LWR

Site	One-way Shipping Distance, km	Nonradiological Impacts, per year		
		Accidents/yr	Injuries/yr	Fatalities/yr
Calvert Cliffs (preferred site)	4568	0.16	0.099	0.0076
Bainbridge	4638	0.16	0.10	0.0072
Eastalco	4496	0.15	0.093	0.0070
Thiokol	4559	0.15	0.097	0.0072

Note: The number of shipments of spent fuel assumed in the calculations is 46 shipments/yr after normalizing to the reference LWR.

6.2.3 Transportation of Radioactive Waste

This section discusses the environmental effects of transporting radioactive waste other than spent fuel from the Calvert Cliffs site and alternative sites. The environmental conditions listed in 10 CFR 51.52 that apply to shipments of radioactive waste are as follows:

- Radioactive waste (except spent fuel) would be packaged and in solid form.
- Radioactive waste (except spent fuel) would be shipped from the reactor by truck or rail.
- The weight limitation of 73,000 lb per truck and 100 tons per cask per railcar would be met.
- Traffic density would be less than the one truck shipment per day or three railcars per month condition.

Radioactive waste other than spent fuel from the U.S. EPR reactor is expected to be capable of being shipped in compliance with Federal or State weight restrictions. Table 6-13 presents estimates of annual waste volumes and annual waste shipment numbers for an U.S. EPR reactor normalized to the reference 1100-MW(e) LWR defined in WASH-1238 (AEC 1972). The expected annual radioactive waste volumes for the U.S. EPR reactor are estimated at 7340 ft^3/yr, and the annual number of waste shipments was estimated at 15 shipments per year (UniStar 2009a). The expected annual waste volume exceeds that for the 1100-MW(e) reference reactor that was the basis for Table S–4. However, the number of radioactive waste shipments for the U.S. EPR is smaller than the reference LWR because UniStar assumed higher-capacity shipments than were assumed in WASH-1238. The staff reviewed the shipment capacities assumed by UniStar (2009a) and concluded that these are reasonable assumptions based on current LWR operating experience. Therefore, even though the estimated annual waste volumes for the U.S. EPR may exceed those for the reference LWR, the number of shipments of radioactive waste other than spent fuel to disposal facilities is expected to be smaller than the reference LWR in WASH-1238.

Table 6-13. Summary of Radioactive Waste Shipments from the Calvert Cliffs Site and Alternative Sites

Reactor Type	Waste Generation Information	Annual Waste Volume, m^3/yr per Unit	Electrical Output, MW(e) per Unit	Normalized Rate, m^3/1100 MW(e) Unit (880 MW(e) Net)[(a)]	Shipments/ 1100 MW(e) (880 MW(e) Net) Electrical Output[(b)]
Reference LWR (WASH-1238)	3800 ft^3/yr per unit	108	1100	108	46[(b)]
CCNPP U.S. EPR	7340 ft^3/yr per unit[(c)]	208	1562[(c)]	123	9[(d)]

Conversions: 1 m^3 = 35.31 ft^3. Drum volume = 210 liters (0.21 m^3).
(a) Capacity factors used to normalize the waste generation rates to an equivalent electrical generation output are 80 percent for the reference LWR (AEC 1972) and 95 percent for the U.S. EPR (UniStar 2009a). Waste generation for the U.S. EPR is normalized to 880 MW(e) net electrical output (1100-MW(e) unit with an 80-percent capacity factor).
(b) The number of shipments per 1100 MW(e) was calculated assuming the WASH-1238 average waste shipment capacity of 2.34 m^3 (82.6 ft^3) per shipment.
(c) These values were taken from the ER (UniStar 2009a).
(d) This value was obtained by normalizing the UniStar (2009a) estimate (15 shipments/yr) to the reference LWR electrical generation output. If the WASH-1238 shipment capacity is used (2.34 m^3 per shipment) in lieu of the UniStar (2009a) annual shipment estimate, the normalized shipments from the U.S. EPR would be about 53 shipments per year.

The sum of the daily shipments of unirradiated fuel, spent fuel, and radioactive waste for an U.S. EPR located at the Calvert Cliffs site or alternative sites is less than the one-truck-shipment-per-day condition given in 10 CFR 51.52, Table S–4.

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

Nonradiological impacts of radioactive waste shipments were calculated using the same general approach as unirradiated and spent fuel shipments. For this EIS, the shipping distance was assumed to be 500 mi) one way (AEC 1972). Because the actual destination is uncertain, national median accident, injury, and fatality rates were used in the calculations (Saricks and Tompkins 1999). These rates were adjusted to account for under-reporting, as described in Section 6.2.1.3. The results are presented in Table 6-14. As shown, the calculated non-radiological impacts for transportation of radioactive waste other than spent fuel from the Calvert Cliffs site and alternative sites to waste disposal facilities are less than the impacts calculated for the reference LWR in WASH-1238.

Table 6-14. Nonradiological Impacts of Radioactive Waste Shipments from the Calvert Cliffs Site

	Normalized Shipments per Year	One-Way Distance, km	Accidents per Year	Injuries per Year	Fatalities per Year
Reference LWR (WASH-1238)	46	800	3.4×10^{-2}	1.7×10^{-2}	1.1×10^{-3}
CCNPP U.S. EPR	9	800	6.7×10^{-3}	3.3×10^{-3}	2.1×10^{-4}

Note: The shipments and impacts have been normalized to the reference LWR; the expected waste volumes and shipments from the U.S. EPR (UniStar 2009a) were used.

6.2.4 Conclusions

The NRC staff conducted an independent confirmatory analysis of potential impacts under normal operating and accident conditions of transporting fuel and wastes to and from an U.S. EPR reactor to be located at the Calvert Cliffs site and three alternative sites. To make comparisons to Table S–4, the environmental impacts were adjusted (that is, normalized) to the environmental impacts associated with the reference LWR in WASH-1238 (AEC 1972) by multiplying the U.S. EPR impact estimates by the ratio of the total electric output for the reference reactor to the electric output of the proposed reactor.

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

The NRC staff notes that on March 3, 2010, (DOE 2010) DOE submitted a motion to the Atomic Safety and Licensing Board to withdraw with prejudice its application for a permanent geologic repository at Yucca Mountain, Nevada. Regardless of the outcome of this motion, the NRC staff concludes that transportation impacts are roughly proportional to the distance from the reactor site to the repository site, in this case Maryland to Nevada. The distance from the Calvert Cliffs site or any of the alternate sites to any new planned repository in the contiguous United States would be no more than double the distance from the Calvert Cliffs site to Yucca Mountain. Doubling the environmental impact estimates from the transportation of spent reactor fuel, as presented in this Section, would provide a reasonable bounding estimate of the impacts for NEPA purposes. The NRC staff concludes that the environmental impacts of these doubled estimates would still be SMALL.

6.3 Decommissioning Impacts

At the end of the operating life of a power reactor, NRC regulations require that the facility undergo decommissioning. Decommissioning is the safe removal of a facility from service and the reduction of residual radioactivity to a level that permits termination of the NRC license. The regulations governing decommissioning of power reactors are found in 10 CFR 50.75.

An applicant for a COL is required to certify that sufficient funds will be available to provide for radiological decommissioning at the end of power operations. As part of its COL application for the proposed Unit 3 on the Calvert Cliffs site, UniStar included a Decommissioning Funding Assurance Report (UniStar 2009a). UniStar will establish an external sinking funds account to accumulate funds for decommissioning.

Environmental impacts from the activities associated with the decommissioning of any reactor before or at the end of an initial or renewed license are evaluated in the *Generic Environmental Impact Statement for Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors*, NUREG-0586, Supplement 1 (NRC 2002) (referred to as the GEIS-DECOM). Environmental impacts of the DECON, SAFSTOR, and ENTOMB decommissioning methods are evaluated in the GEIS-DECOM. A COL applicant is not required to identify a decommissioning method at the time of the COL application. The staff's evaluation of the environmental impacts of decommissioning presented in the GEIS-DECOM, identifies a range of impacts for each environmental issue for a range of different reactor designs. The NRC staff concludes that the construction methods that would be used for the U.S. EPR are not sufficiently different from the construction methods used for the current plants to significantly affect the impact evaluated in the GEIS-DECOM. Therefore, the NRC staff concludes that the impacts discussed in the GEIS-DECOM remain bounding for reactors deployed after 2002, including the U.S. EPR.

The GEIS-DECOM does not specifically address the carbon footprint of decommissioning activities. However, it does list the decommissioning activities and states that the decommissioning workforce would be expected to be smaller than the operational workforce and that the decontamination and demolition activities could take up to 10 years to complete. Finally, it discusses SAFSTOR, in which decontamination and dismantlement are delayed for a number of years. Given this information, the NRC staff estimated the CO_2 footprint of decommissioning to be of the order of 3.5×10^4 metric tons without SAFSTOR. This footprint is about equally split between decommissioning workforce transportation and equipment usage. The details of the estimate are presented in Appendix L. A 40-year SAFSTOR period would increase the footprint of decommissioning by about 40 percent. These CO_2 footprints are roughly three orders of magnitude lower than the CO_2 footprint presented in Section 6.1.3 for the uranium fuel cycle.

Therefore, the NRC staff relies upon the bases established in the GEIS-DECOM and concludes the following with respect to the decommissioning of proposed Unit 3:

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

On the basis of the GEIS-DECOM, and the evaluation of air quality impacts from greenhouse gas emissions above, the NRC staff concludes that, as long as the regulatory requirements on decommissioning activities to limit the impacts of decommissioning are met, the decommissioning activities would result in a SMALL impact.

6.4 References

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

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

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

10 CFR Part 71. Code of Federal Regulations, Title 10, *Energy*, Part 71, “Packaging and Transportation of Radioactive Material.”

10 CFR 962. Code of Federal Regulations, Title 10, *Energy*, Part 962, "Byproduct Material."

40 CFR Part 190. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations."

49 CFR Part 173. Code of Federal Regulations, Title 49, *Transportation,* Part 173, "Shippers – General Requirements for Shipments and Packagings."

61 FR 65120. December 10, 1996. "Resolution of Dual Regulation of Airborne Effluents of Radioactive Materials; Clean Air Act." *Federal Register.* U.S. Nuclear Regulatory Commission.

73 FR 59551. October 9, 2008. "Waste Confidence Decision Update" *Federal Register*. U.S. Nuclear Regulatory Commission.

73 FR 72370. November 28, 2008. "Consideration of Environmental Impacts of Temporary Storage of Spent Fuel after Cessation of Reactor Operation and Waste Confidence Decision Update: Extension of Comment Period." *Federal Register.* U.S. Nuclear Regulatory Commission.

AREVA NP, Inc. (AREVA). 2009. *AREVA NP Environmental Report, Standard Design Certification.* ANP-10290, Rev. 1. Accession No. ML092650775.

Baltimore Gas & Electric Co. v. Natural Resources Defense Council, Inc. 1983. *United States Reports*, Vol. 460, p. 1034.

Energy Policy Act of 2005. Public Law 109–58.

Griego, N.R., J.D. Smith, and K.S. Neuhauser. 1996. *Investigation of RADTRAN Stop Model Input Parameters for Truck Stops*. Sandia National Laboratories, Albuquerque, New Mexico.

Idaho National Engineering and Environmental Laboratory (INEEL). 2003. *Early Site Permit Environmental Report Sections and Supporting Documentation*. Engineering Design File Number 3747, Idaho Falls, Idaho.

International Commission on Radiological Protection (ICRP). 2007. "2007 Recommendations of the International Commission on Radiological Protection." ICRP Publication 103, *Annals of the ICRP* 37(2-4):1-332.

Jablon S., Z. Hrubec, J. D. Boice, Jr., and B. J. Stone. 1990. *Cancer in Populations Living Near Nuclear Facilities*. NIH Pub. No. 90-874, National Institutes of Health, Washington, D.C.

Johnson, P.E. and R.D. Michelhaugh. 2003. *Transportation Routing Analysis Geographic Information System (TRAGIS) User's Manual*. ORNL/TM-2000/86. Oak Ridge, Tennessee.

National Council on Radiation Protection and Measurements (NCRP). 1995. *Principles and Application of Collective Dose in Radiation Protection.* NCRP Report No. 121, NCRP Publications, Bethesda, Maryland.

National Council on Radiation Protection and Measurements (NCRP). 2009. *Ionizing Radiation Exposure of the Population of the United States*. NCRP Report No. 160, NCRP Publications, Bethesda, Maryland.

National Research Council. 2006. *Health Risks for Exposure to Low Levels of Ionizing Radiation: BEIR VII - Phase 2*. National Research Council of the National Academies, National Academies Press, Washington, D.C.

Nuclear Nonproliferation Act of 1978. 22 U.S.C. 3201, et seq.

Saricks, C.L. and M.M. Tompkins. 1999. *State-Level Accident Rates for Surface Freight Transportation: A Reexamination.* ANL/ESD/TM-150, Argonne National Laboratory, Argonne, Illinois.

Seccombe, A. 2008. "Uranium Prices Softer in Short Term." *Miningmx,* May 15, 2008. Accessed November 23, 2008 at http://www.miningmx.com/energy/148893.htm.

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

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

UniStar Nuclear Energy (UniStar). 2008. Letter from George Vanderheyden (UniStar) in response to NRC request for additional information dated May 13, 2008, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Submittal of Response to Requests for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3 and Request for Withholding of Documents." June 12, 2008. Accession No. ML100040300.

UniStar Nuclear Development, LLC (UniStar). 2009a. *Calvert Cliffs Nuclear Power Plant Unit 3 Combined License Application, Part 3, Environmental Report*. Revision 6. UniStar, Baltimore, Maryland. Accession No. ML092880921.

UniStar Nuclear Energy (UniStar). 2009b. Letter from G. Gibson to NRC, "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Calvert Cliffs Nuclear Power Plant, Unit 3, Response to RNC Telecom Question Regarding CCNPP Unit 3 Low Level Radioactive Waste Disposal Plans." UN#09-510. December 9, 2009. Accession No. ML093480069.

U.S. Atomic Energy Commission (AEC). 1972. *Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants*. WASH-1238, Washington, D.C.

U.S. Atomic Energy Commission (AEC). 1974. *Environmental Survey of the Uranium Fuel Cycle*. WASH-1248, Washington, D.C.

U.S. Department of Energy (DOE). 2002a. *A Resource Handbook on DOE Transportation Risk Assessment*. DOE/EM/NTP/HB-01, Washington, D.C.

U.S. Department of Energy (DOE). 2002b. *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*. DOE/EIS-0250, Washington, D.C.

U.S. Department of Energy (DOE). 2005. *DOE Standard Radiation Control.* DOE-STD-1098-99, Washington, D.C.

U.S. Department of Energy (DOE). 2010. March 03, 2010. U.S. Department of Energy's 2 Motion to Withdraw. Docket No. 63-001. Accession No. ML100621397.

U.S. Department of Energy, Energy Information Administration (DOE/EIA). 2009. *Electric Power Monthly.* DOE/EIA-0226 (2009/08). Washington, D.C. Accessed on August 24, 2009 at http://www.eia.doe.gov/cneaf/electricity/epm/epm_sum.html. Accession No. ML100490684.

U.S. Department of Transportation (DOT). 2003. *What Aircrews Should Know About Their Occupational Exposure to Ionizing Radiation*. DOT/FAA/AM-3/16, Federal Aviation Administration, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1975. *Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants, Supplement 1*. NUREG-75/038, WASH-1238, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1976. *Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle*. NUREG-0116 (Supplement 1 to WASH-1248), Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1977a. *Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle*. NUREG-0216 (Supplement 2 to WASH-1248), Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1977b. *Final Environmental Statement on Transportation of Radioactive Material by Air and Other Modes*. NUREG-0170, Vol.1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1987. *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, LWR edition*. NUREG-0800, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report*, NUREG-1437, Vols. 1 and 2, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report,* NUREG-1437, Addendum 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2002. *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors*. NUREG-0586, Supplement 1, Vols. 1 and 2, Washington, D.C.

Ux Consulting Company. 2010. *UxC Nuclear Fuel Price Indicators.* Accessed March 1, 2010 at http://www.uxc.com/review/uxc_Prices.aspx.

Weiner, R.F., D.M. Osborn, G.S. Mills, D. Hinojosa, T.L. Heames, and D.J. Orcutt. 2008. *RadCat 2.3 User Guide*. SAND2006-6315, Sandia National Laboratories, Albuquerque, New Mexico.

7.0 Cumulative Impacts

The National Environmental Policy Act (NEPA) requires Federal agencies to consider the cumulative impacts of proposals under its review. Cumulative impacts may result when the environmental effects associated with the proposed action are overlaid or added to temporary or permanent impacts associated with past, present, and reasonably foreseeable future projects. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time. In its proposal for a new nuclear unit at the Calvert Cliffs site, UniStar Nuclear Development, LLC, on behalf of Calvert Cliffs 3 Nuclear Project, LLC, and UniStar Nuclear Operating Services, LLC (collectively known as UniStar) submitted a combined license (COL) application including the Environmental Report (ER) to the U.S. Nuclear Regulatory Commission (NRC). When evaluating the potential of building and operating a new unit, the NRC and the U.S. Army Corps of Engineers (USACE or Corps) review team considered potential cumulative impacts to resources that could be affected by the construction, preconstruction, and operation of one AREVA NP, Inc. (AREVA) U.S. EPR at the Calvert Cliffs site. Cumulative impacts result when the effects of an action are added to or interact with other past, present, and reasonably foreseeable future effects on the same resources. For purposes of this analysis, past actions are those prior to the receipt of the COL application. Present actions are those related to resources from the time of the COL application until the start of NRC-authorized construction of the proposed new unit. Future actions are those that are reasonably foreseeable through building and operating the proposed Unit 3, including decommissioning. The geographical area over which the past, present, and future actions could contribute to cumulative impacts is dependent on the type of resource considered and is described below for each resource area. The review team considered, among other actions, the cumulative effects of proposed Unit 3 with current operations at Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 1 and Unit 2.

The approach for this environmental impact statement (EIS) is outlined in the following discussion. To guide its assessment of environmental impacts of a proposed action or alternative actions, the NRC has established a standard of significance for impacts based on guidance developed by the Council on Environmental Quality (CEQ) (40 CFR 1508.27). The three significance levels established by the NRC – SMALL, MODERATE, or LARGE – are defined as follows:

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

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

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

The impacts of the proposed action, as described in Chapters 4 and 5, are combined in this chapter with other past, present, and reasonably foreseeable future actions in the general area surrounding the Calvert Cliffs site that would affect the same resources affected by the proposed Unit 3, regardless of what agency (Federal or non-Federal) or person undertakes such actions. These combined impacts are defined by CEQ as "cumulative" in Title 40 of the Code of Federal Regulations (CFR) 1508.7 and include individually minor but collectively potentially significant actions taking place over a period of time. It is possible an impact that may be SMALL by itself could result in a MODERATE or LARGE impact when considered in combination with the impacts of other actions on the affected resource. Likewise, if a resource is regionally declining or imperiled, even a SMALL individual impact could be important if it contributes to or accelerates the overall resource decline.

The description of the affected environment in Chapter 2 serves as the baseline for the cumulative impacts analysis, including the effects of past actions. The incremental impacts related to the construction activities requiring NRC authorization (10 CFR 50.10(a)) are described and characterized in Chapter 4, and those related to operations are described and characterized in Chapter 5. These impacts are summarized for each resource area in the sections that follow. The level of detail is commensurate with the significance of the impact for each resource area.

The specific resources and components that could be affected by the incremental effects of the proposed action and other actions in the same geographical area were assessed. This assessment includes the impacts of construction and operations for the proposed new unit as described in Chapters 4 and 5; impacts of preconstruction activities as described in Chapter 4; impacts of fuel cycle, transportation, and decommissioning as described in Chapter 6; and impacts from past, present, and reasonably foreseeable Federal, non-Federal, and private actions that could affect the same resources affected by the proposed actions.

The review team visited the Calvert Cliffs site on March 17 through 19, 2008. The team then used the information provided in the ER, UniStar's responses to the request for addition information (RAIs) issued by the NRC and Corps staff, information from other Federal and State agencies, and information gathered during visits to the Calvert Cliffs site to evaluate the cumulative impacts on resources affected by building and operating a new nuclear power plant at the site. To inform the cumulative analysis, the review team researched U.S. Environmental Protection Agency (EPA) databases for recent EISs within the region, used an EPA database of permits for water discharges (NEPAssist) in the geographic area, and used the www.recovery.gov website to identify projects in the area funded by the American Recovery and Reinvestment Act of 2009 (Public Law 111-5). Other actions and projects that were identified during this review and considered in the review team's independent analysis of the potential cumulative effects are described in Table 7-1.

Table 7-1. Past, Present, and Reasonably Foreseeable Projects and Other Actions Considered in the Cumulative Analysis

Project Name	Summary of Project	Location	Status
Energy Projects			
Operation and decommissioning of CCNPP Units 1 and 2	CCNPP consists of two existing nuclear generating units, Units 1 and 2, with combined net electric generating capacity of 1700-1780 MW(e).	Approximately 0.5 mi northwest from proposed Unit 3.	Operational. In 2000, the NRC extended the license of Unit 1 to July 31, 2034 and the license of Unit 2 to August 31, 2036.[a]
Uprate at CCNPP Units 1 and 2	Uprate the maximum power level at which the nuclear power plant may operate by 1.38%.	Approximately 0.5 mi northwest from proposed Unit 3.	The uprate was approved in December 2009 for Unit 2 and a decision is expected by the end of summer 2010 for Unit 1.[b]
Dominion Cove Point Liquefied Natural Gas (LNG) Facility	LNG is unloaded at an off-shore dock, then stored and transported onshore through a pipeline.	Approximately 4 mi south from proposed Unit 3.	Operational. An expansion project, completed in 2009, increased storage and capacity by approximately 80%.[c]
Dominion Cove Point Pier Reinforcement Project	Upgrades and modifications to existing off-shore pier to allow docking of larger-sized LNG vessels.	Approximately 4 mi south from proposed Unit 3.	Planned.[d][e] Original schedule called for project to be completed in spring 2011.
Operation of Chalk Point Generating Station	Chalk Point consists of 11 fossil fuel-based power-generating units with a listed capacity of 2413 MW.	Approximately 15 mi northwest from proposed Unit 3.	Operational.[f]
Operation of H.A. Wagner Power Plant	H.A. Wagner consists of 4 fossil fuel-based power-generating units with a listed capacity of 1020 MW.	Approximately 50 mi north from proposed Unit 3.	Operational.[g]

Table 7-1. (contd)

Project Name	Summary of Project	Location	Status
Mid-Atlantic Power Pathway (MAPP) Transmission Line Project	Proposed new 500-kV and 640-kV transmission lines.	500-kV line from Possum Point Substation in Virginia to the Calvert Cliffs Substation, with subsequent 640-kV line constructed under Chesapeake Bay via the Vienna Substation in MD and terminating at the Indian River Substation in Delaware.	Proposed. The proposed line from Possum Point Substation to Calvert Cliffs Substation is estimated to be completed by 2012 and the proposed line from Calvert Cliffs Substation to Indian River Substation is estimated to be completed by 2014.[i] Under consideration by the MD Public Service Commission as Case 9179.
Transportation Projects			
MD 2/4, Solomons Island Road, Maryland SHA	Upgrade of sections of MD 2, 4, 231 and 235, Solomons Island Road, Calvert County, MD.	Approximately 5 to 10 mi southwest from proposed Unit 3.	Parts of this project are currently under construction while others are still in the planning stages.[h]
Parks and National Trails			
Star-Spangled Banner National Historic Trail	The trail traces four major events from the Chesapeake Campaign of the War of 1812. The trail, which includes forested and open water areas, provides opportunities for recreation, interpretation, and learning.	A portion of the trail is adjacent to the Calvert Cliffs site.	In development. A management plan and environmental assessment (MP/EA) for the Star-Spangled Banner National Trail will be published in 2010.[n]
Captain John Smith Chesapeake National Historic Trail	The trail provides opportunities for recreation, interpretation, and learning.	A portion of the trail is adjacent to the Calvert Cliffs site.	A comprehensive management plan will be published in 2010.[o]
Calvert Cliffs State Park	Primarily forested area used for recreation and conservation purposes. Approximately 1079 ac are designated as a	Adjacent to the Calvert Cliffs site.	Established park and therefore development is unlikely in the designated area.

Table 7-1. (contd)

Project Name	Summary of Project	Location	Status
	wildlands area, and hunting of upland game, turkey, and deer is allowed within approximately 550 ac. [(m)]		
Flags Ponds Nature Park	Primarily forested area used for recreation and conservation purposes.	Adjacent to the Calvert Cliffs site.	Established park and therefore development is unlikely in the designated area.
Other Actions/Projects			
Patuxent River Naval Air Station Complex	Large facility for the U.S. Navy's research, development testing, training and evaluation of aircraft and related components and operations.	Approximately 9 mi south from proposed Unit 3.	Operational.[(l)]
Chemical Manufacturing (including organic chemical, inorganic chemical, and other miscellaneous chemical product and preparation manufacturing)	Various facilities throughout the region of Calvert Cliffs Unit 3.	Throughout region.	Facilities are in operation, but more could be developed as demand increases.
Petroleum Bulk Stations and Terminals	Various facilities throughout the region of Calvert Cliffs Unit 3.	Throughout region.	Facilities are in operation, but more could be developed as demand increases.
Poultry Farms and Food Processing Facilities	Various poultry farms and processing facilities; fresh and frozen seafood processing facilities; dry, condensed, and evaporated dairy product manufacturing; spice and extract manufacturing; bottled and canned soft drink facilities; fruit and vegetable canning; frozen fruit, juice, and vegetable manufacturing; and other animal food manufacturing.	Throughout region.	These facilities are already in operation.

Table 7-1. (contd)

Project Name	Summary of Project	Location	Status
Commercial and Recreational Fishing	Commercial and recreational fishing of the eastern oyster (*Crassostrea virginica*), blue crab (*Callinectes sapidus*), striped bass (*Morone saxatilis*), weakfish (*Cynoscion regalis*), summer flounder (*Paralichthys dentatus*), Atlantic croaker (*Micropogonias undulates*), and several species of forage fish.[j]	Throughout Chesapeake Bay and its tributaries.	Current.
Various hospitals and industrial facilities that use radioactive materials	Medical or other isotopes.	Within 50 mi.	Operational.
Waterfront Development	A variety of residential and commercial waterfront property development, including potential pier facilities, dredging and shoreline erosion control structures, and controlled commercial and residential development both outside and within the limits of the town center designated areas of the various County master plans.	Throughout region.	Construction would occur in the future, as described in State and local land-use planning documents.[k]
Future Urbanization	Construction of housing units and associated commercial buildings; roads, bridges, and rail; and water and/or wastewater treatment and distribution facilities and associated pipelines as described in local land-use planning documents.	Throughout region.	Construction would occur in the future, as described in State and local land-use planning documents.[k]

(a) Source: NRC 2000
(b) Source: NRC 2009
(c) Source: Dominion 2009
(d) Source: FERC 2009a

Table 7-1. (contd)

Project Name	Summary of Project	Location	Status

(e) Source: FERC 2009b
(f) Source: Mirant 2009
(g) Source: Constellation Energy 2009
(h) Source: MD SHA 2009
(i) Source: PHI 2009c, Entrix 2009
(j) Source: CBP 2007, McBride 2006
(k) Source: SMCBCC 2003, CCCP 2004, CCBCC 2006
(l) Source: DOD 2010
(m) Source: MDNR 2010
(n) Source: NPS 2010a
(o) Source: NPS 2010b

7.1 Land Use

The description of the affected environment in Section 2.2 serves as a baseline for the cumulative impacts assessment in this resource area. As described in Section 4.1, the impacts of NRC-authorized construction on land use would be SMALL, and no further mitigation would be warranted. As described in Section 5.1, the review team concludes that the effects of operations on land-use impacts would be SMALL, and no further mitigation would be warranted.

The combined impacts from construction and preconstruction are described in Section 4.1 and determined to be SMALL. In addition to the impacts from construction, preconstruction, and operations, the cumulative analysis also considers other past, present, and reasonably foreseeable projects that could affect land use. For this cumulative analysis, the geographic area of interest is the area within 15 mi of the Calvert Cliffs site. This geographic area of interest includes the primary communities, such as Prince Frederick, that would be affected by proposed Unit 3.

Historically, the Calvert Cliffs site and vicinity were a combination of wetlands and forests. Residential development in Calvert County began in the early 1900s and was accelerated when the building of Units 1 and 2 commenced about 1970. Much of the Calvert Cliffs site was cleared to build Units 1 and 2. Some of the cleared land not used by the completed site buildings and associated infrastructure was farmed until the mid-2000s. Over the past few decades, the general trend in the 15-mi geographic area of interest has been an increase in residential areas, roads, utilities, businesses, and other facilities (see Table 7-1) and a decrease in wetlands, forests, and agricultural lands. Of note are the Dominion Cove Point liquefied natural gas (LNG) import facility (a little over 100 ac of industrial land use) in Calvert County and the Patuxent River Naval Air Station Complex (approximately 6500 ac) in St. Mary's County (Dominion 2009, DOD 2010).

Cumulative Impacts

The Calvert Cliffs site abuts land and water portions of the Star-Spangled Banner National Historic Trail and the Captain John Smith Chesapeake National Historic Trail (NPS 2010a, 2010b). The U.S. National Park Service (NPS) is still developing portions of the Star-Spangled Banner National Historic Trail and the Captain John Smith Chesapeake National Historic Trail. These NPS projects would contribute small additions to recreational and conservation land uses in the vicinity of the Calvert Cliffs site.

As described in Sections 4.1 and 4.3, there would be a conversion of open and forested land to an industrial/utility land-use type at the site from building proposed Unit 3 and the proposed project would result in some offsite land conversions to residential areas, roads, and businesses to accommodate growth, new workers, and services related to the proposed nuclear facility. Other reasonably foreseeable projects in the geographic area of interest, such as waterfront development, would also contribute to decreases in open, forested, and wetland areas and increases in residential areas, roads, and business; however, these projects would be consistent with Calvert County's land-use plans and control. Cumulative land-use impacts within the 15-mi geographic area of interest would be consistent with existing land-use plans and zoning and would be minimal.

No new offsite transmission corridors are planned for proposed Unit 3 (UniStar 2009a). Consequently, no new land-use impacts resulting from operation of transmission lines serving Unit 3 are expected. The Mid-Atlantic Power Pathway (MAPP) transmission line project would result in a second 500 kV circuit in the existing Chalk Point-to-Calvert Cliffs transmission line corridor from Possum Point, Virginia, to the Pepco Burches Hill and Chalk Point substations and continuing to a substation at the Calvert Cliffs site. Within the geographic area of interest, the new transmission line would be constructed in an existing corridor in Calvert County (PHI 2009a). Although the MAPP project work within Calvert County would occur within existing rights-of-way (ROWs), the project area is not currently being maintained as a transmission line corridor. Therefore, habitat conversion would occur because the maintained portion of the ROW would be expanded to accommodate new lines. Most notably, the MAPP project would include a permanent wetland conversion, from forested to emerging scrub-shrub (Entrix 2009).

Global climate change (GCC) could increase precipitation, sea level, and storm surges in the geographic area of interest (GCRP 2009), thus changing land use through inundation of low-lying areas that are not buffered by the high cliffs. However, the cliffs could experience increased rates of erosion as a result of frequent storm surges, flooding events, and sea-level rise (GCRP 2009). Forest growth may increase as a result of more carbon dioxide in the atmosphere (GCRP 2009). Existing parks, reserves, and managed areas would help preserve wetlands and forested areas to the extent that they are not affected by the same factors. In addition, GCC could reduce crop yields and livestock productivity (GCRP 2009), which might change portions of agricultural land uses in the geographic area of interest. Direct changes resulting from GCC could cause a shift in land use in the geographic area of interest.

Building and operating Unit 3 and other past, present, and reasonably foreseeable projects discussed above would result in minimal land use changes. Therefore, the review team concludes that the cumulative land use impacts, including impacts associated with transmission line development would be SMALL.

7.2 Water Use and Quality

This section analyzes the potential cumulative impacts of the proposed new unit in addition to other past, present, and reasonably foreseeable projects on water use and water quality.

7.2.1 Surface Water Use Impacts

The description of the affected environment in Section 2.3 serves as the baseline for the cumulative impact assessment in this resource area. As described in Section 4.2, the NRC staff concludes that impacts of NRC-authorized construction on surface water use would be SMALL, and no further mitigation would be warranted. As described in Section 5.2, the review team concludes that the impacts of operations on surface water use would also be SMALL, and no further mitigation would be warranted.

The combined surface water use impacts from construction and preconstruction were described in Section 4.2.2 and determined to be SMALL. In addition to the impacts from construction, pre-construction, and operations, the cumulative analysis also considers past, present, and reasonably foreseeable future actions that could affect surface water quality. For this analysis, the geographic area of interest is strongly influenced by the site's nearness to the Atlantic Ocean. To examine cumulative surface water-use impacts, this analysis extends 20 mi from of the intake and discharge structures, which would be expected to encompass the area affected by proposed Unit 3 on this portion of the Chesapeake Bay resource.

As described in Section 5.2.2.1, the review team determined that the consumptive use of surface water from the operation of Unit 3 (none is planned for construction and preconstruction activities) would remain insignificant relative to the volume of water in the Chesapeake Bay (maximum annual plant consumption rate is 0.06 percent of the Bay volume) and the impacts would be minor within the 20-mi geographic area of interest. The predominant surface water user within a 20-mi radius of the Calvert Cliffs site is CCNPP Units 1 and 2, and its withdrawals have an insignificant effect on surface water availability. Unit 3 would use less water than CCNPP units 1 and 2, and the total withdrawals from Units 1, 2, and 3 would have an insignificant effect on surface water availability. In addition, the Chalk Point Generating Station, currently the largest power plant in Maryland, is a fossil fuel facility located about 15 mi northwest of the Calvert Cliffs site that draws its cooling water from the Patuxent River, a water source to the Chesapeake Bay. Again, given the volume of water in the Chesapeake Bay, this withdrawal has an insignificant volumetric impact on the Chesapeake Bay.

The review team is also aware of the potential climate changes that could affect the water resources available for cooling and the impacts of reactor operations on the water resources for other users. A recent compilation of the state of the knowledge in this area (GCRP 2009) has been considered in the preparation of this EIS. Projected changes in the climate for the region during the life of Unit 3 include an increase in average temperature of 3 to 4ºF and a slight increase in precipitation in the winter, spring, summer, and fall (GCRP 2009). Changes in climate during the life of proposed Unit 3 could result in a slight increase in the amount of runoff (GCRP 2009). In other words, the source of fresh water into the Chesapeake Bay is predicted to increase slightly. While the changes that are attributed to climate change in these studies are not insignificant, the review team did not identify anything that suggests the cumulative impacts would noticeably alter this resource.

The review team determined the consumptive use of surface water from the operation of CCNPP Units 1 and 2, the Unit 3, and other consumptive uses (existing or likely future uses) could not alter the volume of water in the Chesapeake Bay. Based on its evaluation, the review team concludes that the cumulative impacts to surface water use would be SMALL, and no mitigation would be warranted.

7.2.2 Groundwater Use Impacts

The description of the affected environment in Section 2.3 serves as the baseline for the cumulative impact assessment in this resource area. As described in Section 4.2, the NRC staff concludes that impacts of NRC-authorized construction on groundwater use would be SMALL, and no further mitigation would be warranted. As described in Section 5.2, the review team concludes that the impacts of operations on groundwater use would also be SMALL, and no further mitigation would be warranted.

The combined groundwater use impacts from construction and preconstruction were described in Section 4.2.2 and determined to be SMALL. In addition to the impacts from construction, preconstruction, and operation, the cumulative analysis also considers past, present, and reasonably foreseeable future actions that could impact groundwater use. For this analysis, the geographic area of interest is considered to be the local Surficial aquifer and the regional Piney Point-Nanjemoy aquifer and the Aquia aquifer because these are the three aquifers that could potentially be impacted by proposed Unit 3.

The Surficial aquifer is not a reliable regional aquifer because of its low yield and spatial discontinuity. CCNPP Units 1 and 2 do not use this aquifer nor would Unit 3. Regionally, the Piney-Point-Nanjemoy aquifer is primarily tapped for domestic water supply. A well monitored 2.5 mi southeast of the Calvert Cliffs site showed a 0.6 ft/yr decline in the potentiometric surface since 1979. Seven CCNPP Units 1 and 2 wells draw from the Piney Point-Nanjemoy aquifer; however, Unit 3 would not use water from this aquifer. The Aquia aquifer is a major source of water in southern Maryland and would be the primary source of water used during the building of Unit 3. In a study that encompassed the area of Calvert County, Soeder et al. (2007) reported groundwater withdrawals increasing 55 percent from the early 1980s through 2005, with the result that potentiometric surfaces have declined. In the Aquia aquifer beneath the Calvert Cliffs site, the drop was 60 ft. The maximum regional drop in the Aquia aquifer potentiometric surface was 100 ft. This drop occurred beneath the Patuxent River Naval Air Station, which is the largest groundwater user in the vicinity of the Calvert Cliffs site. Withdrawals from the Aquia aquifer by Patuxent River Naval Air Station and two nearby municipalities totaled 3 MGD in 2005. Regional use of groundwater is expected to continue, with the result that the potentiometric surface of the Aquia would continue to drop. The Maryland Department of the Environment (MDE) regulates withdrawals that exceed 10,000 gpd to prevent the regional potentiometric surface from declining more than 80 percent below the aquifer's available drawdown. This constraint ensures that the potentiometric surface does not drop below the top of the aquifer.

In Calvert County, the CCNPP Units 1 and 2 permitted withdrawal rate of 450,000 gpd from the Aquia aquifer represents 8 percent of the total permitted withdrawals. Unit 3 would require an average withdrawal of 100,000 gpd of water from new wells in the Aquia aquifer for construction and preconstruction activities. No groundwater would be withdrawn for Unit 3 operations. The desalination plant would have capacity in excess of the operating needs of Unit 3. This excess capacity of the desalination plant would eliminate the need to withdraw groundwater from the Aquia aquifer for operation of Units 1 and 2 and thereby free up the existing capacity used by Units 1 and 2 for future groundwater users. Although the Unit 3 desalination plant would be beneficial to the groundwater resource, it would not offset the many other existing and future demands on the regional groundwater resources.

Given that the proposed Unit 3 would not use groundwater for operations, the quantity of groundwater used for construction and preconstruction of Unit 3 would be small relative to other withdrawals within Calvert County, and the temporary use of groundwater for construction would not affect the overall productivity of the Aquia aquifer, the review team determines that the groundwater-use impacts resulting from the construction of Unit 3 would be minor. Moreover, given the declining trend in groundwater availability due to regional use (i.e., declining potentiometric surfaces), the review team concludes that the cumulative groundwater use impacts would be MODERATE. Once the proposed desalination plant comes on line and CCNPP groundwater use is terminated, the addition of Unit 3 would be beneficial for this resource, and no further mitigation beyond that described in Chapter 4 would be warranted. Therefore, the incremental impacts from NRC authorized activities would be SMALL.

7.2.3 Surface Water Quality Impacts

The description of the affected environment in Section 2.3 serves as the baseline for the cumulative impact assessment in this resource area. As described in Section 4.2, the NRC staff concludes that impacts of NRC-authorized construction on surface water quality would be SMALL, and no further mitigation would be warranted. As described in Section 5.2, the review team concludes that the impacts of operations on surface water quality would also be SMALL, and no further mitigation would be warranted.

The combined impacts from construction and preconstruction were described in Section 4.2.3 and determined to be SMALL. In addition to the impacts from construction, preconstruction, and operations, the cumulative analysis also considers past, present, and reasonably foreseeable future actions that could impact surface-water quality. To examine cumulative surface water-quality impacts, this analysis extends 20 mi from the intake and discharge structures, which would be expected to encompass the area affected by proposed Unit 3 on this portion of the Chesapeake Bay resource.

Point and non-point sources have affected the water quality of the Susquehanna River and Chesapeake Bay. These include pesticides and herbicides sources associated with agriculture (see Section 2.4.2), and more recent sources of pharmaceuticals, hormones, detergents, disinfectants, and fire retardants. The productivity of the Chesapeake Bay has been significantly and adversely affected by these sources, as well as an increase in nutrients. Restoration of the Chesapeake Bay is the focus of considerable Federal, State, and local efforts currently and into the future.

Key actions, in addition to CCNPP Unit 3, influencing the water quality in the Chesapeake Bay within this 20-mi area include the operation of CCNPP Units 1 and 2, the building, operation, and expansion of the Cove Point LNG facility, and the Chalk Point Generating Station, located about 15 mi northwest of the Calvert Cliffs site on the Patuxent River. The chemicals released into the Chesapeake Bay via the CCNPP Units 1 and 2 cooling water discharge would include biocides and some other metal and organic compounds (see Section 5.3.2.1), but the discharge would not include agricultural pesticides, herbicides, or the more recent slurry of compounds that affect the Bay. The areal extent of the influence of other facilities on water quality is very small, and the influence of these facilities would be insignificant at the 20-mi radius.

Although nutrient loads have impaired the Chesapeake Bay's ability to support biota (addressed in Section 7.3.2), they have not impaired the water quality in a manner that limits the ability of the Bay to support other functions, including serving as a supply of cooling water. Based on its evaluation, the review team concludes that the cumulative surface water quality impacts would be SMALL, and no further mitigation beyond that described in Chapters 4 and 5 would be warranted.

7.2.4 Groundwater Quality Impacts

The description of the affected environment in Section 2.3 serves as the baseline for the cumulative impact assessment in this resource area. As described in Section 4.2, the NRC staff concludes that impacts of NRC-authorized construction on groundwater quality would be SMALL, and no further mitigation would be warranted. As described in Section 5.2, the review team concludes that the impacts of operations on groundwater quality would also be SMALL, and no further mitigation would be warranted.

The combined impacts to groundwater quality from construction and preconstruction were described in Section 4.2.3 and determined to be SMALL. In addition to the impacts from construction, preconstruction, and operations, the cumulative analysis also considers other reasonably foreseeable projects that could impact groundwater resources. For this analysis, the geographic area of interest is considered to be the local Surficial aquifer and the regional Piney Point-Nanjemoy and Aquia aquifers because these are the three aquifers that could be impacted by the building of proposed Unit 3. As mentioned in Section 7.2.2, groundwater would not be used for operation of Unit 3.

The Surficial aquifer is not used at the Calvert Cliffs site or immediately surrounding the site because of its low yield and spatial discontinuity. Any impacts to the quality of this aquifer at the site from activities associated with construction and preconstruction of the proposed Unit 3 would not affect this resource regionally; conversely, any impacts to this aquifer outside the boundary of the Calvert Cliffs site would not affect the resource at the site.

There are no known water quality issues in the regional Piney-Point-Nanjemoy aquifer. Seven CCNPP Units 1 and 2 wells currently draw from the Piney Point-Nanjemoy aquifer; none discharge water to the aquifer. Unit 3 would not use water from this aquifer. There are no known contaminant plumes in the Piney-Point-Nanjemoy aquifer in the vicinity of the Calvert Cliffs site that might be affected by groundwater withdrawals at the site.

There are no known water quality issues in the regional Aquia aquifer. Five CCNPP Units 1 and 2 wells currently draw from the Aquia aquifer; none discharge water to the aquifer. Two proposed Unit 3 wells would withdraw water from this aquifer for construction and preconstruction activities; neither would discharge liquid to the aquifer. There are no known contaminant plumes in the Aquia aquifer in the vicinity of the Calvert Cliffs site that might be affected by groundwater withdrawals at the site.

Saltwater intrusion into groundwater aquifers is a potential water quality issue along the Maryland coastline. As discussed in Section 2.3.3.2, there is no evidence that saltwater intrusion is occurring in the aquifers beneath Calvert County. However, the continued decline in the potentiometric surface of the aquifers could create conditions for saltwater intrusion sometime in the future. Because the MDE regulates groundwater withdrawal rates in each aquifer, the incidence of saltwater intrusion would be managed and mitigated.

Given that potential impacts from building and operating Unit 3 would be minimal, there is no evidence of a decrease in groundwater quality as a result of the regional use of groundwater, there are no known contaminant plumes, and there would be no discharges to groundwater by Unit 3, the review team concludes that the cumulative groundwater quality impacts would be SMALL, and no mitigation beyond that described in Chapters 4 and 5 would be warranted.

7.3 Ecology

This section addresses the cumulative impacts on terrestrial, wetlands and aquatic ecological resources as a result of activities associated with the proposed new unit at the Calvert Cliffs site and past, present, and reasonably foreseeable future activities within the geographic area of interest of each resource.

7.3.1 Terrestrial Ecology and Wetlands

The description of the affected environment in Section 2.4.1 serves as a baseline for the cumulative impacts assessment in this resource area. As described in Section 4.3.1, the NRC staff concludes the impacts of NRC-authorized construction on terrestrial ecology and wetlands would be SMALL, and no further mitigation would be warranted. As described in Section 5.3.1, the review team concludes that the impacts of operations on terrestrial ecology and wetlands would be SMALL, and no further mitigation would be warranted.

The combined impacts from construction and preconstruction were described in Section 4.3.1 and determined to be MODERATE for terrestrial resources. In addition to the impacts from construction, preconstruction, and operations, the cumulative analysis also considers other past, present and reasonably foreseeable projects that could affect terrestrial resources and wetlands. For this analysis, the geographic area of interest is considered to be the Calvert County. Calvert County is expected to encompass the resource area expected to be affected by proposed Unit 3 because of the nature of the potential impacts to terrestrial resources and the characteristics of the resources, including important species such as home range size, distribution, abundance, and habitat preferences. Calvert County is peninsular, thus limiting effects of terrestrial impacts, and the county's northern border is so far away from the Calvert Cliffs site that impacts on terrestrial resources from the proposed project would not be detectable beyond the county line to the north. GCC effects near the Calvert Cliffs site would result in regional increases in the frequency of severe weather, in annual precipitation, and in average temperature (GCRP 2009).

7.3.1.1 Wildlife Habitat

Calvert County was predominantly forest with some agriculture and little urban development prior to the building of Units 1 and 2. Development was limited by isolation of Calvert County by the Chesapeake Bay and the Patuxent River until the mid to late 1900s. Since the building of roads and bridges improved travel access in the 1960s, Calvert County has experienced remarkable urbanization and development (Calvert County 2009). Development within the county was particularly intense from 1995 to 2002 with respect to other counties in Maryland. During this period, 2661 ac of forest were cleared in Calvert County (332 ac/year average), which was more than 9 percent of the forest cleared in the State of Maryland (MDNR 2004a). Cutting of forest not only reduces the amount of forest habitat, it increases the degree of fragmentation in the landscape. Forest fragmentation reduces interior forest, a critical resource for forest interior dwelling species (FIDS) such as the scarlet tanager (*Piranga olivacea*). Fragmentation also may allow the establishment and spread of invasive species. Prior to the building of CCNPP Units 1 and 2, some forest had already been cleared on the site for agricultural use and for the establishment of Camp Conoy (BGE 1970). About 100 additional ac of forest on the Calvert Cliffs site were harvested causing fragmentation in the early 1970s during construction of CCNPP Units 1 and 2 and during construction of local utility corridors (BGE 1970, AEC 1973). Additional small amounts of forests were cleared in the area during construction of the Dominion Cove Point LNG facility and its associated pipelines.

Some of the onsite cleared areas, including Camp Conoy, have been maintained with landscaping and not allowed to revert back to forest cover, prolonging the effects of habitat fragmentation. Lack of maintenance in other areas has resulted in succession to old field or mixed deciduous regeneration forest. In addition to past actions and the proposed building and operation of proposed Unit 3, other projects, such as the recently expanded Dominion Cove Point LNG facility, have also decreased forested habitat and increased habitat fragmentation. Existing pipeline corridors were widened, permanently reducing forest cover by 423 ac and further reducing interior forest (FERC 2006). Vegetation maintenance activities within pipeline corridors prolong habitat fragmentation by limiting the establishment of woody vegetation. Also, proposed projects such as the MAPP transmission project would increase transmission capability from Chalk Point, Maryland to the Calvert Cliffs substation. Although the MAPP project work within Calvert County would occur within existing ROWs, the project area is not currently being maintained as a transmission line corridor. Therefore, habitat conversion would occur because the maintained portion of the ROW would be expanded to accommodate new lines. Most notably, the MAPP project would include a moderate amount of permanent wetland conversion, from forested to emerging scrub-shrub (Entrix 2009).

Upgrades to roads, including MD 2/4 and MD 4 may also contribute to forest loss. The magnitude of forest loss from this project is unknown, but if upgrades take place within or along existing roadways, increased fragmentation would be somewhat limited. Continued urbanization and development is the greatest threat to county forest cover (CCCP 2004). Forest would be lost and fragmented from future development, but the Calvert County Commission has adopted a strategy to plan such development around town centers and has actions within its plan to map and track forest loss, maintain large forest tracks including interior forest, preserve and restore riparian forest, and replace lost forest and connectivity (CCCP

2004). Also, Calvert County has adopted mandatory subdivision cluster regulations to reduce impacts of residential development on wildlife habitat (CCCP 2004).

Nearby parks would provide habitat for the present and reasonably foreseeable future. For example, there are two parks totaling 3357 ac adjoining the Calvert Cliffs site; Flag Ponds Nature Park is to the north and Calvert Cliffs State Park is to the south. In addition, there are three more parks totaling 1188 ac within 8 mi of the site. Most of these parks are forested, and the primary land uses of these parcels include recreation and conservation. The presence of the parks may limit the degree of forest loss and fragmentation in the immediate vicinity of the Calvert Cliffs site. These parks could also serve as a source for repopulation of forest flora and fauna.

Changes in climate could alter and fragment key terrestrial habitats in the geographic area of interest for the Calvert Cliffs site (GCRP 2009). For example, increased precipitation and sea-level rise could inundate low-lying areas that are not buffered by the high cliffs. Forest growth may increase as a result of more carbon dioxide in the atmosphere (GCRP 2009).

Habitat within the Chesapeake Bay Critical Area (CBCA) would also be affected from building and operating of the proposed Unit 3 (Table 4-1). More than 23 ac of various habitat types within the CBCA, including forest and herbaceous marsh, would be disturbed. Impervious surfaces within the Intensely Developed Area (IDA) would increase by 2.8 ac. Impervious surfaces would also be removed at the Eagle's Den site. Mitigation actions for the building of proposed Unit 3, as discussed in Chapter 4, would also be conducted in the CBCA, including the planting of 19.6 ac of mixed deciduous forested wetland with expectations that it would provide forest interior dwelling species (FIDS) habitat in 20 to 30 years. Cove Point LNG expansion activities occurred at three locations within the CBCA (FERC 2006). To minimize impacts, Dominion used horizontal directional drilling from outside the CBCA to access area under the CBCA (FERC 2006).

7.3.1.2 Wetlands

Similar to forest loss, Calvert County wetlands were lost to agriculture and development. County-level impacts to wetlands are unknown, but it is estimated one-half of all wetlands have been lost statewide (CCCP 2004). Wetland losses from the building of Units 1 and 2 undoubtedly occurred, as a deep ravine became a dredge spoil deposition area, but were not quantified (AEC 1973). During the Cove Point LNG expansion, no wetlands were affected at the terminal, but more than 32 wetland ac were temporarily affected and 9 ac permanently affected within the pipeline corridor (71 FR 26491). Temporary impacts to wetlands within the maintained transmission line corridors included habitat conversion from forest to emergent or scrub/shrub wetlands, which could increase windthrow in adjacent forested wetlands (71 FR 26491). Mitigation actions were implemented to offset wetland loss. Additionally, about 1.4 ac of wetlands near the Calvert Cliffs site were affected by road construction when upgrades were built on MD 2/4 (Table 7-1). Approximately 11.7 ac of non-tidal wetlands within the Calvert Cliffs site, including herbaceous marsh and both well and poorly-drained bottomland deciduous forest, would be filled and graded for the proposed Unit 3. These amounts represent approximately 20 percent of all non-tidal wetlands within the Calvert Cliffs site (described in Wetlands discussion in Section 4.3.1.3).

Wetlands would continue to be threatened by development, GCC, and other activities in Maryland and within Calvert County. Frequency of storm surge, coastal flooding, and erosion resulting from GCC could contribute to wetland losses (GCRP 2009). For example, as mentioned above, the MAPP project would include a moderate amount of permanent wetland conversion, from forested to emerging scrub-shrub. To address this, the State of Maryland has set a goal of “no net loss” of wetlands, and Calvert County planners have pledged to restrict impacts on wetlands, restore or create them where possible, develop penalties for unauthorized destruction, and study the effectiveness of wetland buffers in management of wetlands (CCCP 2004).

7.3.1.3 Important Species

The impacts of GCC on plants and wildlife in the geographic area of interest are not precisely known. Changes in climate could result in substantial northward shifts in species ranges, diversity, and abundance (GCRP 2009).

Populations of two Federally threatened species reside along the Chesapeake Bay shore in Calvert County, the Puritan tiger beetle (*Cicendela puritana*) and the northeastern beach tiger beetle (*C. dorsalis dorsalis*). The major threat to the Puritan tiger beetle is alteration of the bluffs and beaches along the Chesapeake Bay (FWS 1993). Most of the sites known to contain Puritan tiger beetle habitat in Calvert County have been subdivided and developed, and bluff habitat has been lost to beach stabilization from commercial development near Randle Cliffs and on the Calvert Cliffs site (FWS 1993). The proposed Unit 3 could also affect the Puritan tiger beetle. However, Puritan tiger beetle habitat would not be noticeably affected as most work activities are proposed in unsuitable habitat, and time-of-year agreements between UniStar and the U.S. Fish and Wildlife Service (FWS) would limit work in areas that may be suitable habitat. The establishment of Flag Ponds Nature Park, the Calvert Cliffs site, and Calvert Cliffs State Park has limited residential development along substantial portions of the Chesapeake Bay shore in Calvert County, benefitting the Puritan tiger beetle. Continued existence of these facilities could preserve suitable habitat as development continues in other areas. GCC is expected to increase storm intensity, increasing erosion rates (GCRP 2009). The bare bluffs that are used by this species are maintained through erosion, so the effects of increased erosion on this species are unclear. No other projects, facilities, or activities listed in Table 7-1 are expected to result in cumulative impacts on this species.

The major threat to the northeastern beach tiger beetle species is beach alteration and recreational use. Oil spills and natural phenomena, such as winter beach erosion and flood tides, may also affect this species (FWS 1994). Historically, more than 90 percent of the Maryland population of this species was in Calvert County. Although there is no known established population of northeastern tiger beetles on the Calvert Cliffs site, oil spills resulting from dredging and increased barge traffic related to proposed Unit 3 activities could be carried to beaches where larvae are present. The creation and existence of Flag Ponds Nature Park and Calvert Cliffs State Park allows beach access to be managed, but public ownership of these parcels may ultimately result in increased recreational use of beaches where northeastern tiger beetle reside, which could increase impacts to the species. Increased winter storm intensity from GCC and subsequent increased beach erosion (GCRP 2009) may have adverse effects on this species. No other projects, facilities, or activities listed in Table 7-1 are expected to result in cumulative impacts to northeastern tiger beetles.

The bald eagle (*Haliaeetus leucocephalus*), formerly a Federally listed species, is still listed by the State of Maryland. Regional bald eagle populations have increased because of reductions of pesticides in the environment (72 FR 37346). Three active nests are known on the Calvert Cliffs site. A tree containing an eagle nest within an active territory was removed in preparation for the proposed Unit 3 in 2009 following the issuance of an incidental take permit by the Maryland DNR and a Federal fish and wildlife permit by the FWS (UniStar 2009b). A study was undertaken to evaluate potential alternate nest locations on the site. Ten candidate nest trees were identified and the immediate surroundings were improved with prescribed tree trimming. It is not yet known if any of these alternate nest locations would be used by bald eagles. Other activities listed in Table 7-1, such as the MAPP transmission line project, waterfront development, and future urbanization, could also affect the bald eagle. However, the Chesapeake Bay bald eagle population has experienced significant growth over the last 30 years. Many nests are located on publicly owned and protected lands, and many more nests and habitats are afforded protection within the CBCA. The regional bald eagle population has continued to grow during periods of accelerated development and is expected to do so despite continued habitat loss (72 FR 37346).

The scarlet tanager (*Piranga olivacea*) thrives in contiguous and riparian forest and represents other FIDS in this review. All projects that reduce or fragment forest cover, including building Units 1 and 2 and land clearing previous to the establishment of the Calvert Cliffs site, affect the scarlet tanager (see forest discussion under Wildlife Habitat section above). If land clearing takes place during the spring/summer time period, scarlet tanager and other FIDS nests would be destroyed. Approximately 21 ac of FIDS habitat would be lost from the proposed Unit 3, and UniStar has proposed mitigation (Section 4.3.1.3). Projects that cut corridors through unfragmented forest, such as MAPP transmission line installation, the Cove Point LNG pipeline, and new road construction, can be especially effective at eliminating FIDS from previously suitable habitat. To address interior and riparian forest loss within Calvert County, the Calvert

County government plans to map forest resources and track its loss, replace lost forest, preserve and restore riparian forest, maintain forest interior and corridors between large forest tracts, and include forest interior to guide the Planning Commission (CCCP 2004).

Local populations of white-tailed deer (*Odocoileus virginianus*), identified as important on the Calvert Cliffs site, may be temporarily affected by regional development activities. This species is a habitat generalist and common in most habitats. All activities in the county that would cause habitat alteration have the potential to affect the white-tailed deer. During land clearing for Unit 3, habitat would be lost. Also, some deer may be displaced by work activity, resulting in increased road and hunting mortality. Increased development and urbanization would also decrease habitat available. However, this species is highly adaptable and can thrive in highly fragmented landscapes. Deer would also benefit from lands protected from development, including conservation areas on the site, the Flag Ponds Nature Park and Calvert Cliffs State Park. Any impacts are not expected to destabilize populations. Also, the State of Maryland manages the white-tailed deer as a game species, so destabilization resulting from overpopulation could be managed through harvest.

Seven plant species were identified as important on the Calvert Cliffs site (Table 2-1). Four of these species, the chestnut oak (*Quercus prinus*), mountain laurel (*Kalmia latifolia*), New York fern (*Thelypteris noveboracensis*), and the tulip poplar (*Liriodendron tulipifera*) are common throughout the site, county, and region. Although building of Unit 3 and most actions listed in Table 7-1 would affect individuals of these species, cumulative effects would not be expected to destabilize county-level populations.

The showy goldenrod (*Solidago speciosa*), a Maryland State-threatened plant that grows in open areas, could benefit from activities that fragment the forested landscape. It is not known if this plant was affected by the building of CCNPP Units 1 and 2. However, activities related to proposed Unit 3 would affect patches of this plant found near Camp Conoy, and mitigation has been proposed. Projects such as the Cove Point LNG facility expansion may have also affected this species if it occurred within the existing pipeline corridor. However, widening of the pipeline may result in a net increase in suitable, open habitat for showy goldenrod. The MAPP transmission line may also create habitat for this species by expanding and maintaining open habitats that would normally reforest through succession. Subsequent vegetation management would preclude establishment in the newly maintained portion of the ROW. Continued urbanization and development could also result in additional old field habitat that would allow this species to spread. Other projects and activities listed in Table 7-1 are not expected to affect the showy goldenrod.

In Maryland, Shumard's oak (*Q. shumardii*) is found within various hardwood forest types. Activities that reduce forest cover, such as the building of CCNPP Unit 1 and 2, Cove Point expansion, roadway widening, and urban development could affect the occurrence of this species. No individuals are known to occur within the proposed Unit 3 footprint. It is a Maryland

State-threatened species and is known to occur in upland sites. It is not known to what extent cumulative impacts would affect this species, but the predominance of forest in the Calvert County landscape and the plan to manage future development to maintain forest cover would indicate this species would continue to occur within the county.

Spurred butterfly pea (*Centrosema virginianum*) is rare in Maryland but has a wide tolerance of habitat conditions (Section 2.4.1.3). Although this plant was reported on the Calvert Cliffs site outside the proposed Unit 3 footprint, its distribution throughout Calvert County is unknown. All projects that alter existing ground cover and reduce habitat available to plants would affect this species. The spurred butterfly pea is not listed as threatened or endangered in Maryland, and it is unknown whether cumulative impacts would affect this status.

During review of the Calvert Cliffs ER, the projects and activities listed in Table 7-1, the list of Federally and State-listed species that occur in Calvert County and their life history information, no other past, present, or future development actions within the region were identified that would contribute to cumulative impacts to important terrestrial wildlife habitats or species.

7.3.1.4 Summary of Terrestrial Ecology and Wetland Impacts

Loss of forest cover, wetlands, and other wildlife habitat from continued development is unavoidable, and would continue to occur within Calvert County and across the State of Maryland. Habitat loss occurred before the Calvert Cliffs site existed, and has accelerated since the building of CCNPP Units 1 and 2. Forest loss and fragmentation is disproportionately high in Calvert County. Forest loss from the proposed Unit 3 equates to approximately 2/3 of the average annual forest lost in Calvert County during a time period of intense urbanization within the county. In addition to impacts from the proposed Unit 3, forest, wetlands, and other habitat have been or would be converted during expansion and upgrades from the energy industry (Dominion Cove LNG facility and the MAPP transmission line project), upgrades to area roads and highways, and continued development and urbanization. The State of Maryland, Calvert County, and the CBCA Commission recognize forest conversion and wetland loss as conservation threats, and have instituted policy to manage and mitigate the effects of development on these resources.

Important species have also been affected by past actions and would likely be affected by future actions. Calvert County contains two Federally listed tiger beetle species that are threatened by development within the coastal zone of the Chesapeake Bay. The Puritan tiger beetle has lost habitat to residential and commercial development including that which occurred on the Calvert Cliff site. Bluff and beach stabilization also threatens this species. The northeastern tiger beetle is also threatened by beach stabilization as well as recreational use and chemical pollution of beaches. Incremental impact from the proposed Unit 3 is not expected to reduce the likelihood that these beetle species would continue to occupy suitable habitat within Calvert County. Bald eagles nest on the site and elsewhere in the county. Although eagle habitat has been affected by 30 years of development and a nest within an active eagle territory was removed in preparation of the proposed Unit 3, bald eagle populations continue to increase and are expected to continue to do so in the region. The high rate of forest fragmentation in the county has reduced and degraded scarlet tanager and FIDS habitat. Further development, including the building of the proposed Unit 3, would contribute to a continued decreasing trend in FIDS habitat quantity and quality.

Populations of common and abundant important species, including the white-tailed deer, chestnut oak, mountain laurel, New York fern, and the tulip poplar, are not expected to be noticeably affected by cumulative impacts throughout the county. The showy goldenrod would be affected by the proposed Unit 3, but may benefit by other projects that convert forest cover into old field habitat. Distribution and abundance of Shumard's oak and the spurred butterfly pea are not known well enough to estimate cumulative impacts at the county level.

Cumulative loss of Calvert County wildlife and wildlife habitat resulting from past, present, and future land management actions is unavoidable. Unavoidable loss would also result from construction, preconstruction, and operation of the proposed Unit 3. Terrestrial resources would be affected to varying degrees for reasons described above. Cumulative impacts from past actions on terrestrial resources and wetlands have noticeably changed ecosystems within Calvert County. Forest clearing, habitat fragmentation, and wetland loss are detectable and noticeably alter ecological functions and values. Proposed actions, including clearing and grading of site forests and the filling of wetlands and streams during preconstruction, exacerbate this loss.

Based on this evaluation, the review team concludes that cumulative impacts from past, present, and reasonably foreseeable future actions to Calvert County terrestrial resources, including forests and wetlands, would be MODERATE. The review team concludes that the incremental contribution from building and operating the proposed Unit 3 to cumulative impacts on county flora and fauna, including Federally and State-listed species, would be MODERATE. Further, the NRC staff concludes that the incremental contribution of the NRC-authorized activities related to the proposed Unit 3 would be less substantial and, therefore, SMALL.

7.3.2 Aquatic Ecology

The description of the affected environment in Section 2.4.2 serves as a baseline for the cumulative impacts assessment in this resource area. As described in Section 4.3.2, the NRC staff concludes that impacts of NRC-authorized construction on freshwater and estuarine resources would be SMALL. As described in Section 5.3.2, the review team concludes that the impacts of operations on freshwater and estuarine resources would be SMALL, and no further mitigation would be warranted.

The combined impacts from construction and preconstruction were described in Section 4.3.2 and determined to be MODERATE for freshwater and estuarine resources. In addition to the impacts from construction, preconstruction, and operation, the cumulative analysis also considers other past, present, and reasonably foreseeable projects that could affect freshwater and estuarine resources.

For this analysis, the geographic area of interest is the Calvert Cliffs site, the St. Leonard Creek subwatershed, the Lower Western Shore watershed, and the mesohaline (salinity ranges from about 5 to 19 parts per thousand) western portion of the Chesapeake Bay. The St. Leonard Creek subwatershed is the largest component of the Lower Patuxent River watershed and includes all creeks that drain into St. Leonard Creek. The major creeks on the Calvert Cliffs site flow into St. Leonard Creek. The Lower Western Shore watershed extends along the western shore of Chesapeake Bay from the Magothy River south to Drum Point. The extent of the mesohaline zone in the Chesapeake Bay varies seasonally, but at its maximum, includes the western Bay shore from about the mouth of the Rappahannock River to Baltimore, which includes the Patuxent River as far upriver as the Chalk Point area (MDNR PPRP 2008, CBP 2009). These geographic areas of interest for cumulative impacts include the aquatic resources that are most likely to be affected by cumulative natural and anthropogenic events and activities.

Factors contributing to the potential cumulative impacts affecting the freshwater and estuarine resources within the geographic area of interest include building and operating of the proposed Unit 3, operation of the existing CCNPP Units 1 and 2, increased urban development, recreational activities, eutrophication and runoff, commercial and recreational fisheries, the expansion and operation of other power plants and the Cove Point LNG facility, and short- or long-term changes in sea level, precipitation, or temperature. The review team considered these potential sources of impacts in its evaluation of the cumulative aquatic ecology impacts.

7.3.2.1 Freshwater Habitats and Fauna

The primary effect of the development of proposed Unit 3 on the St. Leonard Creek subwatershed would be the removal of several small headwater tributaries of Johns Creek, which is the primary tributary flowing from the east into St. Leonard Creek. The removal of the headwater tributaries, which are ecologically important, would be accompanied by an increase in the amount of impervious or nearly impervious surface acreage in the subwatershed. The acreage of impervious surfaces that would be added directly by the proposed Unit 3 would increase the impervious surface percentage in the St. Leonard Creek subwatershed to at least 1.5 percent, which approaches the threshold (2 percent) at which stream degradation begins to become noticeable (MDNR 2004b). Additional impervious surface area would be added to the watershed should the increased workforce require that new residences or additional hotels/motels be built. Building the new unit would directly affect some of the aquatic resources within the Lower Western Shore watershed. The loss of a small, artificial pond (Camp Conoy

Pond), impacts to small streams, and an increase in impervious surface cover would be the primary impacts within this watershed.

Anthropogenic (derived from human activities) stressors, such as habitat loss and nonpoint pollution related to agriculture and increased urbanization along the shores of streams in the watersheds, not directly associated with the Calvert Cliffs site activities already exist in the area and contribute to cumulative impacts to the St. Leonard Creek subwatershed and Lower Western Shore watershed. Future development within Calvert County is likely to increase impervious surface acreage in addition to that added by the proposed Unit 3, which may affect both watersheds near the Calvert Cliffs site. The expansion of the LNG facility at Cove Point occurred within the Lower Western Shore watershed, but was not expected to adversely affect Grays Creek and the few small ponds near that site (FERC 2006). As part of the MAPP transmission line project, Potomac Electric Power Company (Pepco) plans to build a second 500-kV transmission line from Possum Point, Virginia to Calvert Cliffs, Maryland (Entrix 2009). The line would intersect the region of interest upon crossing the Patuxent River at Chalk Point. Pepco would install four lattice steel transmission structures within the Patuxent River to convey transmission lines across the river. The single-line structures would be similar to existing structures and would be placed parallel to them. Pepco proposes that each tower would be supported by six to eight piles driven into the river bottom. Pepco does not expect the project to have significant effects on aquatic resources in the Patuxent River (Entrix 2009). The transmission line path from Chalk Point to Calvert Cliffs would share the corridor for the existing 500-kV transmission lines between the locations. The path leading to Calvert Cliffs would cross five named streams, including Perrin Branch and Woodland Branch (and an unnamed tributary of Woodland Branch), both of which flow into St. Leonard Creek (Entrix 2009). Impacts to streams would be from the placement of mats to facilitate truck crossings, disturbance of streambeds, and possible spills of fuel, engine coolants, and herbicides. The impacts are expected to be temporary. The Chalk Point-to-Calvert Cliffs portion of the MAPP transmission line project would not affect aquatic resources that also would be affected by the building and operation of Unit 3. However, the two primary northern tributaries of St. Leonard Creek would be at least temporarily affected, which coupled with the impacts to Johns Creek could have synergistic effects on St. Leonard Creek.

The presence of natural environmental stressors (e.g., short- or long-term changes in precipitation or temperature) would contribute to the cumulative environmental impacts to the St. Leonard Creek subwatershed and Lower Western Shore watershed. Under certain conditions, the Calvert Cliffs site operations, other anthropogenic stressors, and climatic events could combine to adversely affect the aquatic populations of both watersheds. Changes in precipitation would affect streamflow, which then would affect runoff of nutrients and sediment, and could affect resident biota populations (GCRP 2009). However, because precipitation depends on several factors, changes in precipitation are difficult to predict, and model results often disagree. Most models predict, although with considerable variability, that precipitation in winter and spring in the latter part of the 21st century could increase an average of 3 percent over current levels (Najjar et al. 2009). Some of the model variability includes the possibility that precipitation could decrease.

American eel (*Anguilla rostrata*) is a commercially important species that occurs in Johns Creek and other waters on the Calvert Cliffs site. Habitat for this species could be adversely affected by proposed Unit 3. The State of Maryland has specified that UniStar should implement stream restoration activities that meet the habitat and physiological needs of the eel, other migratory and resident fish, and benthic invertebrates (MPSC 2009).

7.3.2.2 Estuarine Habitats and Fauna

Most activities related to building and operating the intake and discharge systems, installing and operating the fish return system, and the refurbishing and maintaining the barge dock area to support the proposed Unit 3 would have moderate, but very localized, impacts on the Chesapeake Bay aquatic ecosystem that most likely would be temporary, but cannot generally be reduced (see Section 4.3.2). About 5 ac of estuarine habitat conversion resulting from the armoring or dredging of certain underwater areas for Unit 3 would be permanent (Section 4.3.2).

The expansion of the LNG facility at Cove Point was not expected to include any construction activity that would affect the Chesapeake Bay bottom habitats (FERC 2006). Dominion proposes to reinforce the pier at the LNG facility to allow for the docking larger tankers (USCG and USACE 2009). This project would primarily involve dredging of an area of Bay bottom near the present pier, the installation of mooring and breasting dolphins, and the disposal of the dredged material. One option for the dredged material disposal would be to use the material as fill to restore the shoreline at Cove Point marsh to its 1978 location. This would convert about 17 ac of Bay bottom from soft bottom habitat to tidal marsh. The second part of the MAPP project would involve building an underwater crossing of the Chesapeake Bay that would extend from Calvert Cliffs to the Maryland eastern shore. The route could include broadband fiber optic cables (PHI 2009b). Details of this part of the project are not yet available but the installation of underwater cables would most likely involve horizontal directional drilling from the shore into the Bay and some type of trenching to install the cable within the Bay. Until more details about the project are released, specific impacts cannot be evaluated. The current schedule suggests that the crossing under the Bay should be completed in 2014 (PHI 2009c).

Entrainment and impingement of aquatic organisms represent important effects that contribute to the cumulative impacts on declining populations in the Bay. One contributor to potential entrainment and impingement losses in the area is the once-through cooling water system at CCNPP units 1 and 2. However, historical studies concluded that the entrainment and impingement of organisms by the intake system of CCNPP Units 1 and 2 have not significantly affected the aquatic resources in Chesapeake Bay (Sellner and Kachur 1987; Olson 1987; Ringger 2000; McLean et al. 2002). The expected intake system flow for proposed Unit 3 is less than 2 percent of the flow for CCNPP Units 1 and 2. Assuming that the relationship between flows is linear, the projected incremental entrainment and impingement by Unit 3 alone would be minor. Other potential sources of entrainment within the region of interest that would affect some of the same species that would be entrained by the proposed Unit 3 include the withdrawal of water from the Bay for ballast by ships that unload at the LNG facility at Cove Point and cooling water withdrawals at power plants, especially the non-nuclear plant at Chalk Point on the Patuxent River, which is a large plant that uses once-through cooling. Entrainment losses because of reballasting by ships at the LNG facility would likely be relatively unimportant because of the comparatively small volumes withdrawn. McLean et al. (2002) described historical entrainment effects at several power plants, including the Chalk Point and H. A. Wagner plants, within the geographic area of interest. Although species-specific entrainment numbers for both plants were not identified, McLean et al. (2002) described the entrainment at Chalk Point and H. A. Wagner as potentially having significant adverse effects on the bay anchovy (*Anchoa mitchilli*), which is an important prey species and was the predominant taxon entrained at CCNPP Units 1 and 2 in 2006 and 2007 (EA Engineering 2008). Entrainment by the Chalk Point plant could capture as much as 51 percent of the bay anchovy population in the Patuxent River estuary (McLean et al. 2002). The entrainment effects at the H. A. Wagner plant on Baltimore Harbor were considered potentially large (McLean et al. 2002) with as much as 49 percent of the local bay anchovy population lost because of entrainment. EA Engineering (2008) estimated bay anchovy entrainment by CCNPP Units 1 and 2 from March 2006 through September 2007 to total about 9.17 billion fish, including all life stages (see Table 5-2). The review team used the 2006 to 2007 data from CCNPP Units 1 and 2 to estimate that proposed Unit 3 would have entrained an additional 167 million bay anchovies (all life stages) had it been operating during that period, which would have yielded a total of 9.34 billion entrained by all three units. There is concern that entrainment may be adversely affecting bay anchovy populations in the Bay (McBride 2006), and the incremental bay anchovy entrainment by proposed Unit 3, albeit estimated to be relatively small, would add to the total bay anchovy entrainment losses from the Chalk Point, Wagner, and existing CCNPP Units 1 and 2.

The projected April through September ichthyoplankton entrainment by the intake system for the proposed Unit 3 would range from about 83 million to about 132 million organisms. The projected combined April through September ichthyoplankton entrainment for all three units during those months would range from about 4.6 billion to 7.4 billion organisms. Total entrainment values for the other power plants in the geographic area of interest were not available. The State also evaluated the combined effects of impingement by all power plants on key Bay species and concluded that impingement would not significantly affect Bay resources (McLean et al. 2002).

The review team also considered the potential cumulative impacts related to thermal discharges. The assessments performed by the review team and described in Section 5.3.2 explicitly considered the combined impacts of concurrent operation of the existing CCNPP

Units 1 and 2 and the proposed Unit 3. CORMIX modeling using average conditions of the cooling water discharge plume from proposed Unit 3 predicted that the 3.6°F above ambient isotherm would extend about 149 ft beyond the discharge multi-port diffusers on the maximum ebb and flood tides. This plume would be much smaller than, and south of, that from CCNPP Units 1 and 2. The review team CORMIX modeling predicted that the two plumes probably would not intersect. However, at flood tide, measurements taken in 1978 showed that a 1.8 to 3.6°F above ambient remnant of the Units 1 and 2 thermal plume from the previous tidal cycle extended from the existing intake embayment toward the barge dock and the area proposed for the Unit 3 discharge (Schreiner et al. 1999). Any intersection between the thermal remnant and the Unit 3 plume would be short-lived, occurring only during flood tide. The two thermal plumes should not add to the cumulative thermal impacts on key Bay resources because of their small sizes relative to the size of the Bay and the distances to other thermal discharges.

The review team considered the potential cumulative impacts from chemical releases into the Bay. The primary contaminants historically entering the Bay have been pesticides and herbicides associated with agriculture (see Section 2.4.2). More recent contaminants emerging as potential issues include pharmaceuticals, hormones, detergents, disinfectants, and fire retardants. The chemicals released into Chesapeake Bay via the cooling water discharge would include biocides and some other metal and organic compounds (see Section 5.3.2), but the discharge would not include agricultural pesticides, herbicides, or the more recent slurry of compounds that affect the Bay. Chemicals discharges would be similar to those used at CCNPP Units 1 and 2. The additional releases by proposed Unit 3 are not expected to add significantly to the chemical discharges in the geographic area of interest.

Anthropogenic stressors related to the substantial growth of human populations in the Bay's watershed have caused degraded water quality, habitat loss, and adversely affected flora and fauna populations (Phillips 2007). Agriculture and increased urbanization along the shores of the Chesapeake Bay have caused eutrophication from increased nutrient discharges into the Bay, habitat loss, and nonpoint pollution (Kemp et al. 2005; Phillips 2007). Other activities associated with increased human populations, such as recreational boating, may contribute to the overall condition of the Bay, but that contribution is comparatively minor. The building and operation of the proposed Unit 3 would not be expected to produce impacts similar to those caused by eutrophication, habitat loss, and pollution. Heavy fishing pressure, in conjunction with habitat loss and pollution, has caused serious reductions in the populations of many species inhabiting the Bay. Notable among these are the eastern oyster (*Crassostrea virginica*), blue crab (*Callinectes sapidus*), striped bass (*Morone saxatilis*), and several species of forage fish (CBP 2007). Other species, including weakfish (*Cynoscion regalis*), summer flounder (*Paralichthys dentatus*), and Atlantic croaker (*Micropogonias undulatus*), have been affected primarily by overfishing (McBride 2006). Steps to reduce fishing pressure, such as catch limits and moratoria, have contributed to population increases of some of these species (McBride 2006). Entrainment, impingement, and entrapment by power plants' cooling water systems, including proposed Unit 3, which essentially function as non-specific environmental fish and invertebrate samplers that remove some organisms from the Bay, would contribute to reduced fish populations, particularly those of forage taxa such as the bay anchovy. Although the incremental effect of the operation of proposed Unit 3 would be relatively minor, the combined effects of continued fishing pressure and entrainment and impingement by several facilities, as mentioned above, would hinder the recovery of fish and invertebrate populations in the Bay.

The presence of natural environmental stressors (e.g., short- or long-term changes in precipitation or temperature) would contribute to the cumulative environmental impacts to the Chesapeake Bay. The Calvert Cliffs site operations, other anthropogenic stressors, and climatic events could combine to adversely affect the aquatic populations of the Chesapeake Bay. A significant issue facing the Chesapeake Bay is global climate change. The buildup of greenhouse gas emissions that occurred in the 20th century has assured that some climate change will occur within the 21st century, even without increasing the current rates of emissions (Teng et al. 2006). The projected climate changes are predicted to affect the Chesapeake Bay primarily through increasing sea level, air and water temperatures, and changes in precipitation (Jasinski and Claggett 2009; GCRP 2009). Increased water acidity, which is a looming issue in some ocean habitats (Doney et al. 2009), is considered a less important factor for the Chesapeake Bay at present (Jasinski and Claggett 2009). Wu et al. (2009) projected that the sea level at Solomons Island, about 7.5 mi south of the Calvert Cliffs site, is expected to rise by about 22 to 24 in. by the end of the 21st century. However, the estimate did not consider that the melting of the West Antarctic Ice Sheet could cause regional differences in sea level rise, which implies that the projection may have underestimated the rise in sea level in the Chesapeake Bay area by as much as one-third (Mitrovica et al. 2009). Najjar et al. (2009) projected that air temperatures in the Chesapeake Bay region could rise by about 5 to 12°F by the year 2100. Because surface-water temperature is roughly related to air temperature, a similar increase in water temperature could be expected (Wood et al. 2002). Changes in rainfall are difficult to predict, and model results often disagree. Most models predict, with considerable variability, that precipitation in winter and spring in the latter part of the 21st century could change an average of 3 percent over current levels (Najjar et al. 2009). One of the effects of increased precipitation is a reduction in salinity, particularly in the winter and spring (Jasinski and Claggett 2009). Therefore, such changes related to climate change could alter aquatic habitats and result in substantial northward shifts in species ranges, diversity, and abundance in the geographic area of interest for the Calvert Cliffs site (GCRP 2009).

The interaction of the operation of the proposed Unit 3 and the predicted rise in Chesapeake Bay water level is difficult to assess, but it is not likely that the plant's operations would add significantly to the potential impacts of sea-level rise (e.g., increased shoreline erosion). Similarly, the small sizes of the discharge plumes from Units 1 and 2 and proposed Unit 3 compared to the volume of water in the Chesapeake Bay suggests that the thermal discharges from all three units would not add importantly to the thermal regime in the Bay. Salinity in the

Bay is predominantly related to discharge from the Susquehanna River (Gibson and Najjar 2000), and the comparatively small discharges from all three units would not contribute to significant salinity changes in the Bay.

Among the important estuarine species considered in Section 2.4.2, there are five Federally threatened or endangered species: shortnose sturgeon (*Acipenser brevirostrum*), loggerhead turtle (*Caretta caretta*), green turtle (*Chelonia mydas*), Kemp's ridley turtle (*Lepidochelys kempii*), and leatherback turtle (*Dermochelys coriacea*). These species have a relatively low likelihood of interaction with the proposed Unit 3, which would not add to the stresses (e.g., vessel strikes, entrapment in pound nets) encountered by these species in the region.

7.3.2.3 Summary of Aquatic Ecology Impacts

As discussed above, site development for Unit 3 would remove some habitat for many freshwater species, including that of the 11 important species or taxa described in Section 2.4.2. Although the combined impacts from construction and preconstruction on freshwater resources on the Calvert Cliffs site would be MODERATE, the geographic area of interest for this cumulative analysis is slightly broader including more of the St. Leonard Creek subwatershed. Beyond the site, there are other major headwater systems feeding into St. Leonard Creek; therefore, the direct impacts of the project would be detectable but would not be as likely to noticeably alter habitat for resident biota and the water quality, of St. Leonard Creek on the larger subwatershed scale. For this reason and because habitats for freshwater species on the site are not unique, and the species are broadly distributed, and the review team concludes that building and operating the proposed Unit 3 and maintaining associated transmission lines would not be expected to contribute significantly to the cumulative stresses on the freshwater fauna and habitats of the geographic area of interest. The review team concludes that the cumulative impacts from past, present, and reasonably foreseeable actions, including building and operating proposed Unit 3 and maintaining associated transmission lines, on freshwater aquatic resources in the geographic area of interest would be SMALL.

The cumulative impacts of natural and anthropogenic stressors on the Chesapeake Bay ecosystem, as described briefly above, are well documented to have substantially degraded the system. Building and operating the proposed Unit 3 on the Calvert Cliffs site would have localized effects on the Bay. In particular, there would be permanent habitat conversion by the addition of armoring to the Chesapeake Bay bottom to protect various parts of the cooling water system. None of these localized impacts would add significantly to the primary factors that affect the Bay. The main impacts from the operation of Unit 3 would be from entrainment, which non-specifically removes some early life stages of key forage species from the Bay, and impingement and entrapment, which adversely affect some later life stages of important Bay species. One of the most heavily entrained species by the plants in the region, the bay anchovy, is an important forage fish, and the effects of reduced anchovy populations could affect other important species through food web interactions. However, the small water withdrawal proposed for Unit 3 indicates that entrainment and impingement would be considerably less than that occurring from Calvert Cliffs Units 1 and 2 and at other plants in the geographical area of interest. Overall, the Bay is large and the incremental contribution of building and operating proposed Unit 3 on aquatic resources in the geographic area of interest and would not adversely change conditions within the Bay. Therefore, the review team concludes that the cumulative impacts of past, present, and reasonable foreseeable future activities, including building and operating proposed Unit 3, on the aquatic resources of the Chesapeake Bay would be MODERATE. However, the NRC staff concludes that the incremental contribution of the NRC-authorized activities related to the proposed Unit 3 would be less substantial and, therefore, SMALL.

7.4 Socioeconomics and Environmental Justice

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

7.4.1 Socioeconomics

The description of the affected environment in Section 2.5 serves as the baseline for the cumulative impact assessment in this resource area. As described in Section 4.4, the NRC staff concludes that any negative impacts of the NRC-authorized construction on socioeconomics would be SMALL, and no further mitigation would be warranted with two exceptions. NRC-authorized construction would result in LARGE and beneficial tax revenue impacts to Calvert County and SMALL beneficial economic and tax revenue impacts elsewhere in the region. NRC-authorized construction would result in MODERATE and adverse transportation impacts on MD Route 2/4 near the site. As described in Section 5.4, the review team concludes that the impacts of operations on socioeconomics, would be SMALL, and no further mitigation would be warranted.

The combined impacts from construction and preconstruction were described in Section 4.4 and determined to be SMALL and adverse with two exceptions. The review team determined that traffic impacts in the vicinity of the site would be MODERATE and adverse and property tax revenues to Calvert County would be LARGE and beneficial. In addition to the impacts from construction, preconstruction, and operations, the cumulative analysis also considers other past, present, and reasonably foreseeable projects that could impact socioeconomics. For this analysis, the geographic area of interest is considered to be Calvert and St. Mary’s Counties because these counties are the principle areas where socioeconomics impacts would occur. However, the geographic area of interest was modified as appropriate for specific impact analyses; for example, taxation jurisdictions were used when appropriate.

Both Calvert and St. Mary's Counties have experienced steady population growth for the last three and half decades (1970-2005) (UniStar 2009a). The foundation of the counties' economy was in tobacco farming and later fishing, but during the Second World War (WWII), Calvert County really started to evolve and progress to its current state. The Navy and Marines established a training site in Calvert County during WWII, which brought an influx of personnel and dollars to the county. Calvert County has since continued to grow with the construction of new roads, the Thomas Johnson Bridge and with suburbanization from Washington, D.C. (Calvert County 2009). The Patuxent River Naval Air Station built in the 1940s has had long lasting effects on the economy in St. Mary's County and it continues to build defense industry jobs.

The impact analyses in Chapters 4 and 5 are cumulative by nature. Economic impacts associated with ongoing activities listed in Table 7-1 have been considered as part of the socioeconomic baseline presented in Section 2.5, or in the analyses for Sections 4.4 and 5.4. For example, the economic impacts of existing enterprises such as mining, other electrical utilities, etc., are part of the base used for establishing the Regional Input-Output Multiplier System (RIMS) II multipliers. Regional planning efforts and associated demographic projections formed the basis for the review team's assessment of reasonably foreseeable future impacts. State and county plans along with modeled demographic projections like those used in Sections 2.5, 4.4 and 5.4 include forecasts of future development and population increases. Thus, cumulative impacts associated with construction, preconstruction, and operation of proposed Unit 3 are evaluated in Chapters 4 and 5.

Regarding reasonably foreseeable future projects that may not be a part of general growth in the region, the MAPP transmission line project is expected to be under construction during the building of Unit 3. However, unless the number of workers for this project is large and highly specialized, cumulative impacts to public services, education and housing would be minimal. Seventy percent of the new transmission lines are expected to follow existing right-of-ways and therefore, cumulative aesthetic impacts are expected to be minimal. Since transmission line construction is not at a centralized location but rather scattered over miles, cumulative transportation impacts would be minimal. However, if transmission line construction near the Calvert Cliffs site coincides with building Unit 3 then traffic impacts would be noticeable.

Based on the above considerations, UniStar's COL ER, and the review team's independent evaluation, the review team concludes that under some circumstances, building proposed Unit 3 could make a temporary detectable adverse contribution to the cumulative effects associated with some socioeconomic issues. Those impacts would include: physical impacts (workers and the local public, buildings, transportation, and visual aesthetics), demography, local infrastructures and community services (transportation; recreation; housing; water and wastewater facilities; police, fire, and medical services; social services; and schools). The cumulative effects on regional economies and tax revenues would be beneficial and SMALL with the exception of Calvert County, which would see a LARGE and beneficial cumulative effect on taxes and a MODERATE and adverse cumulative effect on transportation on MD State Route 2/4 near the Calvert Cliffs Site. The incremental impact from NRC authorized activities would be LARGE and beneficial on taxes in Calvert County and MODERATE and adverse on transportation on MD State Route 2/4. The review team concludes that building Unit 3 in addition to other past, present and reasonably foreseeable projects would have SMALL and adverse cumulative impacts on all other socioeconomic impact categories.

7.4.2 Environmental Justice

The description of the affected environment in Section 2.6 serves as a baseline for the cumulative impacts assessment in this resource area. As described in Section 4.5, the NRC staff concludes that the NRC-authorized construction would impose no disproportionate and adverse impacts on minority or low-income populations and, therefore, the environmental justice impacts would be SMALL. As described in Section 5.5, the review team concludes that the impacts of operations on environmental justice would be SMALL, and no further mitigation would be warranted.

The combined impacts from construction and preconstruction were described in Section 4.5 and determined to be SMALL. In addition to the impacts from construction, preconstruction, and operations, the cumulative analysis also considers other past, present, and reasonably foreseeable projects that could cause environmental justice impacts on minority and low-income populations. For this cumulative analysis, the geographic area of interest is considered to be the 50-mi region described in Section 2.5.1.

From an environmental justice perspective, there is a potential for minority and low-income populations to be disproportionately affected by environmental impacts. The review team found low-income, Black, and aggregated minority populations that exceed the percentage criteria established in Section 2.6.1 for environmental justice analyses in greater detail. However, most of these populations were on the outer edge of the 50-mi region radius. The nearest minority and low-income populations were in St. Mary's County. The review team found no unique characteristics or practices in the analyses in Sections 2.6, 4.5, and 5.5 through which minority or low-income populations would be disproportionately and adversely affected

The impact analyses in Chapters 4 and 5 are cumulative by nature. Environmental justice impacts associated with activities listed in Table 7-1 already have been considered as part of the environmental justice baseline presented in Sections 2.6 and 7.4.1. Based on the above considerations, information provided by UniStar, and the review team's independent evaluation, the review team concludes that building and operating Unit 3 would not contribute additional environmental justice cumulative impacts beyond impacts described in Chapters 4 and 5. Those impacts areas would include: physical impacts (workers and the local public, noise, air quality, buildings, transportation, and visual aesthetics), and local infrastructures and community services (transportation; recreation; housing; water and wastewater facilities; police, fire, and medical services; social services; and schools).

The review team concludes there would be no disproportionate and adverse cumulative impacts to minority and low income populations from the above areas, and the environmental justice impacts would be SMALL, and no further mitigation beyond that described in Chapters 4 and 5 would be warranted.

7.5 Historic and Cultural Resources

The description of the affected environment in Section 2.7 serves as a baseline for this cumulative impacts assessment in this resource area. As described in Section 4.6, the staff concluded that the impacts to cultural resources from NRC authorized construction would be SMALL. As described in Section 5.6, the review team concluded that the impacts to cultural resources from operations are SMALL. Mitigative actions may be warranted only in the event of an unanticipated discovery during any ground-disturbing activities associated with construction or maintenance of the operations facility; these actions would be determined by UniStar in consultation with the Maryland State Historic Preservation Officer (SHPO). UniStar has agreed to follow procedures if historic or cultural resources are discovered. UniStar also committed to develop an “Unanticipated Discoveries Plan” for cultural resources during construction. This plan was developed in consultation with the Maryland SHPO and was incorporated into a Memorandum of Agreement (MOA) for the treatment of National Register eligible historic properties adversely impacted by the proposed project that was signed on March 16, 2010 (USACE 2010). The NRC staff does not believe that it is likely that unanticipated discoveries will be made during operation of the plant, however, the NRC staff expects that UniStar will follow an Unanticipated Discoveries Plan during operation similar to the plan used during construction, and will appropriately notify the Maryland SHPO of any discoveries during operation.

The combined impacts from construction and preconstruction were described in Section 4.6 and determined to be LARGE. In addition to the impacts from construction, preconstruction, and operations, the cumulative analysis also considers past, present, and reasonably foreseeable projects that could impact historic and cultural resources. For this cumulative analysis, the geographic area of interest is considered to be the Areas of Potential Effect (APEs) defined in Section 2.7. The APEs were developed in consultation with the Maryland SHPO.

The Section 106 process and coordination with the SHPO provides information on cultural resources and potential impacts to cultural resources with respect to other past, present and reasonably foreseeable future actions in Maryland. Historical activities affecting historic and cultural resources were discussed in Sections 2.7, 4.6, and 5.6 of this EIS.

Projects identified in Table 7-1 that may impact historic and cultural resources include operation of CCNPP Units 1 and 2, uprate at CCNPP Units 1 and 2, MD Route 2/4, the MAPP transmission line project, waterfront development, and future urbanization. Building and operating one additional unit at the Calvert Cliffs site, in addition to the other projects that could impact historic and cultural resources identified above, would likely add to cumulative cultural resource impacts in the APEs. Only Federal undertakings would require a Section 106 review. Cultural resources are non-renewable; therefore, the impacts to historic and cultural resources within the APEs are cumulative. Section 4.6 described how the proposed NRC and Corps actions would destroy three properties that are eligible for listing on the *National Register of Historic Places* within the associated APEs, which would result in an aggregated LARGE impact. Therefore, the cumulative impacts to historic and cultural resources from building and operating Unit 3 and other past, present, and reasonably foreseeable projects are bounded by the potential impacts from building the proposed project. The review team concludes that the cumulative historical and cultural resources impacts would be LARGE. The incremental impact from NRC-authorized activities would be SMALL, and no mitigative actions would be warranted beyond those discussed in Sections 4.6 and 5.6.

7.6 Air Quality

The description of the affected environment in Chapter 2.9 serves as the baseline for the cumulative impact assessment in this resource area. As described in Section 4.7, the NRC staff concludes that the impacts of NRC-authorized construction on air quality would be SMALL, but some mitigation may be warranted, depending on the outcome of a conformity applicability analysis being performed by NRC pursuant to the Clean Air Act Section 176 (42 U.S.C section 7506) and 40 CFR Part 93, Subpart B. As described in Section 5.7, the review team concludes that the impacts on air quality from operations would be SMALL, and no further mitigation would be warranted.

7.6.1 Criteria Pollutants

The combined impacts from construction and preconstruction were described in Section 4.7 and determined to be SMALL. In addition to impacts from construction, preconstruction, and operations, the cumulative analysis also considers past, present, and reasonably foreseeable future actions that impact the same environmental resources. For this analysis, the geographic area of interest is considered to be the Southern Maryland Intrastate Air Quality Control Region (AQCR) as defined in 40 CFR 81.156. Air quality attainment status for Calvert County as set forth in 40 CFR 81.321 reflects the effects of past and present emissions from all pollutant sources in the region. Calvert County is in attainment of all criteria pollutants, except for the 8-hour ozone standard.

Impact to air quality impact from site development would be local and temporary. The distance from building activities to the site boundary would be sufficient to generally avoid significant cumulative air quality impacts. The notable exception to this conclusion is in the area of impacts of the transportation of construction workers to and from the site. UniStar has proposed several mitigation measures to limit these impacts.

Calvert Cliffs is located in a non-attainment area for ozone. Operation of the proposed Unit 3 Cooling Water Supply System would be a large source of airborne particulate material, and Calvert Cliffs Units 1 and 2 are classified as an existing major stationary source for air-permitting purposes. In part because of these three factors, UniStar was required to conduct extensive modeling efforts and impact assessments beyond those normally done for nuclear power plants. These modeling efforts and impact assessments, which are described in some detail in the Maryland Department of Natural Resources' (MDNR) Power Plant Research Program report (MDNR PPRP 2008), consider other emission sources, including air and major point sources. The conclusions of the PPRP set forth in Section 5.7 were that, with mitigation measures recommended by the PPRP, the cumulative air quality impacts of operation for the proposed Unit 3 would be minimal. On the basis of review of the PPRP analysis, the review team concludes that the cumulative air quality impacts of operation of the proposed Unit 3 would be minimal, and no further mitigation would be warranted.

Most of the effects on air quality from other projects in Table 7-1 would be to maintain the status quo. Any new industrial projects would either have de minimis impacts or would be subject to regulation by the Maryland DNR. Given these institutional controls, it is unlikely that the air quality in the region would degrade significantly (i.e., degrade to the extent that the region is in nonattainment of the national standard).

7.6.2 Greenhouse Gas Emissions

As discussed in the state of the science report issued by the U. S. Global Change Research Program (GCRP), it is the "… production and use of energy that is the primary cause of global warming, and in turn, climate change will eventually affect our production and use of energy. The vast majority of U.S. greenhouse gas emissions, about 87 percent, come from energy production and use…" Approximately one third of the greenhouse gas emissions are the result of generating electricity and heat (GCRP 2009). This assessment is focused on greenhouse gas emissions. Other elements of climate change are discussed in the EIS sections on land use, hydrology, ecology, and nonradiological health.

Greenhouse gas emissions associated with building, operating, and decommissioning a nuclear power plant are addressed in Sections 4.7, 5.7.2, 6.1.3, and 6.3. The review team has concluded that the atmospheric impacts of the emissions associated of each aspect of building, operating and decommissioning a single plant are minimal. The review team also concludes that the impacts of the combined emissions for the full plant life cycle are minimal.

It is difficult to evaluate cumulative impacts of a single or combination of greenhouse gas sources because:

- The impact is global rather than local or regional
- The impact is not particularly sensitive to location of the release point
- The magnitude of individual greenhouse gas sources related to human activity, no matter how large compared to other sources, are small when compared to the total mass of greenhouse gases in the atmosphere.
- The total number and variety of greenhouse gas sources is extremely large and they are located everywhere.

These points are illustrated by the following comparison of annual carbon dioxide emission rates (Table 7-2).

Table 7-2. Comparison of Annual Carbon Dioxide Emission Rates

Source	Metric Tons per Year
Global Emissions	28,000,000,000[(a)]
United States	6,000,000,000[(a)]
1000 MW Nuclear Power Plant (including fuel cycle, 90 percent capacity factor)	400,000[(b)]
1000 MW Nuclear Power Plant (operations only, 90 percent capacity factor)	5,000[(b)]
Average U. S. Passenger Vehicle	5[(c)]

(a) EPA 2009
(b) Appendix I of this EIS
(c) FHWA 2006

Evaluation of cumulative impacts of greenhouse gas emissions requires the use of a global climate model. The GCRP report referenced above provides a synthesis of the results of numerous climate modeling studies. The review team concludes that the cumulative impacts of greenhouse emissions around the world as presented in the report are the appropriate basis for its evaluation of cumulative impacts. Based on the impacts set forth in the GCRP report, the review team concludes that the national and worldwide cumulative impacts of greenhouse gas emissions are noticeable but not destabilizing. The review team further concludes that the cumulative impacts would be noticeable but not destabilizing, with or without the greenhouse gas emission of the proposed project.

Consequently, the review team has determined a meaningful approach to address the cumulative impacts of greenhouse gases emissions, including carbon dioxide, is to recognize that such emissions contribute to climate change and that the carbon footprint is a relevant factor in evaluating energy alternatives. Section 9.2.5 contains a comparison of carbon footprints of the viable energy alternatives.

7.6.3 Summary of Air Quality Impacts

Cumulative impacts to air quality resources are estimated based on the information provided by UniStar and the review team's independent evaluation. Other past, present, and reasonably foreseeable activities exist in the geographic areas of interest (local for criteria pollutants and global for greenhouse gas emissions) that could affect air quality resources. The cumulative impacts on criteria pollutants from emissions of effluents from the Calvert Cliffs site and other projects would be minimal. The national and worldwide cumulative impacts of greenhouse gas emissions are noticeable but not destabilizing. The review team concludes that the cumulative impacts would be noticeable but not destabilizing, with or without the greenhouse gas emissions from the Calvert Cliffs site. The review team concludes that cumulative impacts from other past, present, and reasonably foreseeable future actions on air quality resources in the geographic areas of interest would be SMALL to MODERATE. The incremental contribution of impacts on air quality resources from building and operating proposed Unit 3 would be SMALL. The incremental contribution of impacts on air quality resources from the NRC-authorized activities would also be SMALL.

7.7 Nonradiological Health

The description of the affected environment in Section 2.10 serves as a baseline for the cumulative analysis for nonradiological health. As described in Section 4.8, the impacts from NRC-authorized construction on nonradiological health would be SMALL, and no further mitigation would be warranted. As described in Section 5.8, the review team concludes that the impacts of operations on nonradiological health would also be SMALL, and no further mitigation would be warranted.

As described in Section 4.8, the combined nonradiological health impacts from construction and preconstruction would be SMALL, and no further mitigation would be warranted other than what is described in UniStar's ER. In addition to impacts from construction, preconstruction, and operations, the cumulative analysis also considers other past, present, and reasonably foreseeable future actions that could contribute to cumulative impacts to nonradiological health (see Table 7-1). Based on the localized nature of nonradiological health impacts, the geographic area of interest for this cumulative impacts analysis includes projects within the 5-mi radius of the Calvert Cliffs site. This area is expected to encompass areas where public and worker health could be influenced by the proposed project, in combination with any past, present, or reasonably foreseeable future actions. Other than the continued operation of CCNPP Units 1 and 2, the operation of the Cove Point LNG Facility, and the Cove Point Pier Reinforcement Project, there are no major current projects in the geographic area of interest that would contribute to the cumulative impacts for nonradiological health. Future projects that would be expected to occur within the geographic area of interest include improvements to MD Route 2/4, transmission-line development, and urbanization.

There are no existing or future projects that could contribute to cumulative occupational injuries for workers at proposed Unit 3. Existing and potential development of new transmission lines would increase nonradiological health impacts from exposure to acute electric magnetic fields (EMFs); however, as stated in Section 5.8.3, adherence to Federal criteria and State utility codes would create minimal cumulative nonradiological health impacts. With regard to chronic effects of EMFs, the scientific evidence on human health does not conclusively link extremely low frequency EMFs to adverse health impacts. Noise and vehicle emissions associated with current urbanization, current operations of CCNPP Units 1 and 2, the Cove Point LNG Facility, the Cove Point Pier Reinforcement Project, and improvements to MD 2/4 could contribute to public nonradiological health impacts. However, as discussed in Sections 4.8 and 5.8, the proposed Unit 3 contribution to these impacts would be temporary and minimal, and existing facilities would likely comply with local, State, and Federal regulations governing noise and emissions. Section 7.9.2 discusses cumulative nonradiological health impacts related to additional traffic on the regional and local highway networks leading to and from the Calvert Cliffs site, and these impacts would be minimal.

The health impacts of operating the existing CCNPP Units 1 and 2 and proposed new Unit 3 at the Calvert Cliffs site were evaluated relative to the Chesapeake Bay and the potential propagation of thermophilic or other etiological microorganisms. As discussed in Section 5.8, the operation of the Unit 3 would not have a detrimental impact from the thermal discharges on concentration levels of deleterious thermophilic microorganisms. Limited recreational activity occurs in the immediate vicinity of the proposed discharge structure for Unit 3 to have any bearing on potential nonradiological health impacts.

The review team is also aware of the potential climate changes that could affect human health; a recent compilation of the state of the knowledge in this area (GCRP 2009) has been considered in the preparation of this EIS. Projected changes in the climate for the region during the life of proposed Unit 3 include an increase in average temperature, and less winter precipitation falling as snow and more as rain. This may result in an increase in water temperature and frequency of downpours, which may alter the presence of microorganisms and parasites. While the changes that are attributed to climate change in these studies are not insignificant, the review team did not identify anything that would alter its conclusion regarding the presence of etiological agents or change in the incidence of water-borne diseases.

Cumulative impacts to nonradiological health are based on information provided by UniStar and the review team's independent evaluation of impacts resulting from the proposed Unit 3, along with a review of potential impacts from other past, present, and reasonably foreseeable projects and urbanization located in the geographic areas of interest. The review team concludes that cumulative impacts on public and worker nonradiological health would be SMALL, and that mitigation beyond what is discussed in Sections 4.8 and 5.8 would not be warranted. The review team does acknowledge that there is no conclusive link between chronic EMF exposure and human health impacts.

7.8 Radiological Health Impacts of Normal Operation

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

The combined impacts from construction and preconstruction were described in Section 4.9 and determined to be SMALL. In addition to impacts from construction, preconstruction, and operations, this cumulative analysis also considers past, present, and reasonably foreseeable future actions that could contribute to cumulative radiological impacts. For this analysis, the geographic area of interest is considered to be the area within a 50-mi radius of the proposed Unit 3. Historically, the NRC has used the 50-mi radius as a standard bounding geographical area to evaluate population doses from routine releases from nuclear power plants. Within the 50-mi radius, there are the existing Calvert Cliffs Units 1 and 2, as well as hospitals using and industrial facilities that could use radioactive materials. Currently, there are no other nuclear facilities planned within 50 mi of the proposed Unit 3.

As stated in Section 2.11, UniStar has conducted a radiological environmental monitoring program around the CCNPP Units 1 and 2 since 1974. The Radiological Environmental Monitoring Program (REMP) measures radiation and radioactive materials from all sources, including existing Units 1 and 2, area hospitals, and industrial facilities. Based on the results of the REMP, the levels of radiation and radioactive material in the environment around CCNPP Units 1 and 2 generally show little or no increase above natural background. In 2004 and 2005, concentrations of tritium, up to twice the minimum detectable level, were found in a few onsite groundwater well samples. No groundwater sample concentrations above the minimum detectable level have been reported in subsequent years.

As described in Section 4.9, the estimate of dose to construction workers during the building of the proposed Unit 3 are well within NRC annual exposure limits (i.e., 100 mrem) designed to protect the public health. This estimate includes exposure from Units 1 and 2, including the power uprate of 1.38 percent. As described in Section 5.9, the public and occupational doses predicted from the proposed operation of the new unit at the Calvert Cliffs site are well below regulatory limits and standards. In addition, the site-boundary dose to the maximally exposed individual (MEI) from the existing Units 1 and 2 (including a power uprate of 1.38 percent) and the proposed Unit 3 at the Calvert Cliffs site would be well within the regulatory standard of 40 CFR Part 190.

Based on results of the REMP, any potential increased impact from the 1.38 percent power uprate, and the estimates of doses to biota given in Chapter 5.9, the NRC staff concludes that the cumulative radiological impact on biota would not be significant. The results of the REMP indicate that effluents and direct radiation from area hospitals and industrial facilities that use radioactive materials do not contribute measurably to the cumulative dose.

Currently, there are no other nuclear facilities planned within 50 mi of the Calvert Cliffs site. The NRC, the U.S. Department of Energy (DOE), and the State of Maryland would regulate or control any reasonably foreseeable future actions in the region that could contribute to cumulative radiological impacts. Therefore, the NRC staff concludes that the cumulative radiological impacts of operation of the proposed Unit 3 and existing Units 1 and 2 would be SMALL, and no further mitigation would be warranted.

7.9 Postulated Accidents

As described in Section 5.11.4, the NRC staff concludes that the potential environmental impacts (risk) from a postulated accident from the operation of proposed Calvert Cliffs Unit 3 would be SMALL. Section 5.11 considers both design basis accidents and severe accidents.

The COL application references a steam electric system of the U.S. EPR design. As described in Section 5.11.1, the NRC staff concludes that the environmental consequences of design basis accidents (DBAs) at the Calvert Cliffs site would be SMALL for an U.S. EPR reactor. DBAs are addressed specifically to demonstrate that a reactor design is robust enough to meet NRC safety criteria. The consequences of DBAs are bounded by the consequences of severe accidents.

As described in Section 5.11.2, the NRC staff concludes that the severe-accident probability-weighted consequences (i.e., risks) of an U.S. EPR reactor at the Calvert Cliffs site are SMALL compared to risks to which the population is generally exposed, and no further mitigation would be warranted. The cumulative analysis considers risk from potential severe accidents at all other existing and proposed nuclear power plants that have the potential to increase risks at any location within 50 mi of the proposed Unit 3. Existing reactors within the geographic area of interest include the Calvert Cliffs (Units 1 and 2), North Anna (Units 1 and 2), Salem (Units 1 and 2), Hope Creek (Unit 1), Surry (Units 1 and 2), and Peach Bottom (Unit 3). Also, within the geographic area of interest, new reactors have been proposed at the North Anna Site. In addition, interest has been expressed in an early site permit for new reactors in southern New Jersey.

Tables 5-16 and 5-17 in Section 5.11.2 provide comparisons of estimated risk for the proposed Unit 3 U.S. EPR reactor and current-generation reactors. The estimated population dose risk for the Unit 3 U.S. EPR reactor is well below the median value for current-generation reactors. In addition, estimates of average individual early fatality and latent cancer fatality risks are well below the Commission's safety goals (51 FR 30028). For existing plants within the geographic area of interest, namely Calvert Cliffs (Units 1 and 2), North Anna (Units 1 and 2), Salem (Units 1 and 2), Hope Creek (Unit 1), Surry (Units 1 and 2), and Peach Bottom (Unit 3) nuclear generating stations, the Commission has determined that the probability-weighted consequences of severe accidents are small (10 CFR 51, Appendix B, Table B-1). Finally, review of the North Anna Power Station Unit 3 EIS (NRC 2010) shows that risks for the proposed unit at the North Anna site would also be well below risks for current-generation reactors and meet the Commission's safety goals. It is expected that risks for any new reactors at the southern New Jersey site would be well below risks for current-generation reactors and meet the Commission's safety goals. The severe accident risk due to any particular nuclear power plant gets smaller as the distance from that plant increases. However, the combined risk at any location within 50 mi of the VCSNS site would be bounded by the sum of risks for all these operating and proposed nuclear power plants. Even though there would be potentially several plants included in the combination, this combined risk would still be low. On this basis, the NRC staff concludes that the cumulative risks of severe accidents at any location within 50 mi of the Calvert Cliffs site likely would be SMALL, and no further mitigation would be warranted.

7.10 Fuel Cycle, Transportation, and Decommissioning

The cumulative impacts related to the fuel cycle, transportation of radioactive materials (fuel and waste), and facility decommissioning for the proposed site are described below.

7.10.1 Fuel Cycle

As described in Section 6.1, the NRC staff concludes that the impacts of the fuel cycle due to operation of proposed Unit 3 would be SMALL. Fuel-cycle impacts would occur not only at the site of proposed Unit 3 but would also be scattered through other locations in the United States or, in the case of foreign-purchased uranium, in other countries as described in Section 6.1.

In addition to fuel-cycle impacts from proposed Unit 3, this cumulative analysis also considers fuel-cycle impacts from existing Units 1 and 2. There are no other nuclear power plants within 50 mi of the Calvert Cliffs site. The fuel-cycle impact of Units 1 and 2 would be similar to that of proposed Unit 3. Per 10 CFR 51.51(a), the NRC staff concludes the impacts would be acceptable for the 1000-MW(e) reference reactor. The impacts of producing and disposing of nuclear fuel include mining the uranium ore, milling of the ore, conversion of the uranium oxide to uranium hexafluoride, enrichment of the uranium hexafluoride, fuel fabrication (where the uranium hexafluoride is converted into uranium oxide fuel pellets), and disposition of the spent fuel in a proposed Federal waste repository. As discussed in Section 6.1, advances in reactors since the development of Table S–3 will have the effect of reducing environmental impacts relative to the operating reference reactor. For example, a number of fuel management improvements have been adopted by nuclear power plants to achieve higher performance and to reduce fuel and separative work (enrichment) requirements. In Section 6.1 of this EIS, the NRC staff multiplied the values in Table S-3 by a factor of two, to scale the impacts up from the 1000-MW(e) LWR model to address the fuel cycle impacts of proposed Unit 3. Adding the fuel cycle impacts from Units 1 and 2 would increase the scaling to no more than a factor of four. Therefore, the staff considers the cumulative fuel-cycle impacts of operating the Calvert Cliffs site to be SMALL.

7.10.2 Transportation

The description of the affected environment in Section 2.5.2 serves as a baseline for the cumulative impacts assessment in this resource area. As described in Sections 4.8.3 and 5.8.6, the review team concludes that impacts of transporting personnel and nonradiological materials to and from the Calvert Cliffs site would be SMALL. In addition to impacts from construction, preconstruction, and operations, the cumulative analysis also considers other past, present, and reasonably foreseeable future actions that could contribute to cumulative transportation impacts. For this analysis, the geographic area of interest is the 50-mi region surrounding the Calvert Cliffs site.

Non-radiological transportation impacts are directly related to the additional traffic on the regional and local highway networks leading to and from the Calvert Cliffs site. Additional traffic would result from shipments of construction materials and movements of construction personnel to and from the site. Mitigation measures designed to improve traffic flow have been proposed by UniStar (2009a). However, the additional traffic increases the risk of traffic accidents, injuries, and fatalities. A review of the projects listed in Table 7-1 indicate that other projects in the region could potentially increase non-radiological impacts if traffic to and from the Calvert Cliffs site interact with traffic traveling to and from operating facilities in the region. Cumulative nonradiological impacts could result from major construction projects, such as the Dominion Cove Point Pier Reinforcement Project, the MAPP transmission line project, and the MD 2/4 Solomons Island Road project. However, it is unlikely that the construction schedules for all of these projects would overlap resulting in a significant cumulative impact.

Transportation of construction materials and personnel to and from these new facilities would tend to increase the cumulative impacts in the regions surrounding the Calvert Cliffs site and alternative sites. Table 7-1 also lists a number of highway improvement projects. These projects would tend to enhance traffic flow, and thus reduce the risks of traffic accidents, injuries, and fatalities in the regions surrounding the Calvert Cliffs site and alternative sites.

Finally, a number of recreation projects such as park improvements in the area are generally of much smaller scope and have much lower resource and personnel requirements than constructing a new nuclear power plant, LNG facility, or highway, and are therefore less likely to result in a measurable cumulative impact. In this EIS, it was shown that the impacts of transporting construction material and personnel to and from the CCNPP site and alternative sites is a small fraction of the existing non-radiological accidents injuries, and fatalities in the counties in which the alternative sites are located. Based on this conclusion and magnitude of building a nuclear power plant relative to the other industrial construction activities listed above, the review team considers the cumulative non-radiological transportation impacts of constructing and operating proposed Unit 3 would be minimal, and no further mitigation would be warranted.

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

Historically, the radiological impacts to the public and environment associated with transportation of radioactive materials in the 50-mi region surrounding the Calvert Cliffs site are dominated by shipments of fuel and waste to and from the existing CCNPP Units 1 and 2. Additional cumulative impacts to the Calvert Cliffs site would result from the additional fuel and waste shipments from the operation of the new unit and from the power uprate at CCNPP Units 1 and 2. Radiological impacts of transporting radioactive materials would occur along the routes leading to and from the Calvert Cliffs site and would also be scattered throughout the United States. Radiological transportation impacts have been shown to be a small fraction of the impacts from natural background radiation. The impacts of transporting this fuel and radioactive waste to and from the Calvert Cliffs site would be consistent with the environmental impacts associated with transportation of fuel and radioactive wastes from current-generation reactors presented in Table S–4 of 10 CFR 51.52. Based on 10 CFR 51.52, the NRC staff concludes the impacts to be acceptable for the 1000-MW(e) reference reactor. Advances in reactors since the development of Table S–4 of 10 CFR 51.52 will have the effect of reducing environmental impacts relative to the operating reference reactor. For example, fuel management improvements have been adopted by nuclear power plants to achieve higher performance and to reduce fuel requirements. This leads to fewer unirradiated and spent fuel shipments than estimated for the 1000-MW(e) reference reactor in 10 CFR 51.52. In addition, advances in shipping cask designs to increase their capacities will result in fewer shipments of spent fuel to offsite storage or disposal facilities.

Therefore, the NRC staff concludes the cumulative non-radiological and radiological transportation impacts of operating the proposed new reactor at the Calvert Cliffs site would be SMALL.

7.10.3 Decommissioning

As discussed in Section 6.3 of this EIS, NRC staff concludes that the environmental impacts of decommissioning proposed Unit 3 are expected to be SMALL because the licensee would have to comply with decommissioning regulatory requirements.

In this cumulative analysis, the geographic area of interest is within a 50-mi radius of the Calvert Cliffs site. In addition to Unit 3, the only other nuclear power plants within this area are the existing CCNPP Units 1 and 2. The impacts of decommissioning nuclear power plants are bounded by the assessment in Supplement 1 to NUREG-0586, *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*. In that document, the NRC found the impacts on radiation dose to workers and the public, waste management, water quality, air quality, ecological resources, and socioeconomics to be small (NRC 2002). In addition, in Section 6.3 the review team concluded that the impact of greenhouse gas emissions on air quality during decommissioning would be small. Therefore, the cumulative impacts from decommissioning would be SMALL.

7.11 Conclusions

The review team considered the potential cumulative impacts resulting from construction, preconstruction, and operation of one additional nuclear unit at the Calvert Cliffs site together with past, present, and reasonably foreseeable future actions. The specific resources that could be affected by the effects of the proposed action and other past, present, and reasonably foreseeable actions, in the same geographical area, were assessed. This assessment included the impacts of construction and operations for the proposed new unit as described in Chapters 4 and 5; impacts of preconstruction activities as described in Chapter 4; impacts of fuel cycle, transportation, and decommissioning impacts described in Chapter 6; and impacts of past, present and reasonably foreseeable Federal, non-Federal, and private actions that could affect the same resources affected by the proposed action, as described in Table 7-1.

Table 7-3 summarizes the cumulative impacts by resource area. The cumulative impacts for the majority of resource areas would be SMALL, although there could be MODERATE or LARGE impacts for some resources, as discussed below.

Table 7-3. Cumulative Impacts on Environmental Resources, Including the Impacts of Proposed Unit 3

Resource Category	Impact level
Land-Use	SMALL
Water-Related	
Surface-Water Use	SMALL
Groundwater Use	MODERATE
Surface-Water Quality	SMALL
Groundwater Quality	SMALL
Ecology	
Terrestrial Ecosystems and Wetlands	MODERATE
Aquatic Ecosystems	MODERATE
Socioeconomic	
Physical Impacts	SMALL
Demography	SMALL
Taxes and Economy	SMALL to LARGE Beneficial
Housing and Transportation	SMALL to MODERATE
Public Services and Education	SMALL
Aesthetics and Recreation	SMALL
Environmental Justice	SMALL
Historic and Cultural Resources	LARGE
Air Quality	SMALL to MODERATE
Nonradiological Health	SMALL
Radiological Health	SMALL
Postulated Accidents	SMALL
Fuel Cycle, Transportation, and Decommissioning	SMALL

The review team concludes that the cumulative groundwater use impacts would be MODERATE, primarily from the declining trend in groundwater availability due to regional use (i.e., declining potentiometric surfaces). The incremental impacts from NRC-authorized activities would be SMALL, and once the proposed desalination plant comes on line and CCNPP groundwater use is terminated, the addition of Unit 3 would be beneficial for this resource.

Cumulative terrestrial ecology impacts would be MODERATE, primarily from the proposed project and from the past, current, and reasonably foreseeable projects that would result in forest clearing, habitat fragmentation, and wetland loss. These actions have noticeably altered ecological functions and values and have affected county flora and fauna, including Federally and State-listed species, but have not destabilized terrestrial resources or populations. The incremental contribution from NRC-authorized activities would be less substantial and, therefore, SMALL.

The cumulative aquatic impacts would be SMALL to MODERATE, primarily because of the natural and anthropogenic stressors on the Chesapeake Bay ecosystem that have degraded the system. Overall, the Bay is large in size and the incremental contribution of NRC-authorized activities associated with proposed Unit 3 on aquatic resources would be SMALL and would not adversely change conditions noticeably within the geographic area of interest in the Bay.

For socioeconomics, most categories would have SMALL impacts. However, there would be a LARGE and beneficial cumulative impact associated with tax revenues in Calvert County. The incremental impact from NRC authorized activities would be LARGE and beneficial. The review team also identified a MODERATE and temporary impact on transportation due to increased traffic on MD State Route 2/4 near the Calvert Cliffs site. The incremental impact from NRC authorized activities would be MODERATE near the Calvert Cliffs site. Cumulative impacts to other socioeconomic impact categories would be SMALL.

The cumulative impacts to cultural resources would be LARGE because three properties that are eligible for listing on the *National Register of Historic Places* would be impacted during building activities. The incremental contribution from NRC-authorized activities would be SMALL.

For air quality, the cumulative impacts would be SMALL to MODERATE primarily due to national and world-wide impacts of greenhouse gases emissions. The incremental impacts from NRC-authorized activities would be SMALL because such impacts would be minimal.

7.12 References

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

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

40 CFR 81. Code of Federal Regulations, Title 40, *Protection of Environment,* Part 31, “Designation of Areas for Air Quality Planning Purposes.”

40 CFR Part 93. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 93, "Determining Conformity of General Federal Actions to State or Federal Implementation Plans."

40 CFR Part 190. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations."

40 CFR Part 1508. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 1508, "Terminology and Index."

51 FR 30028. August 21, 1986. "Safety Goals for the Operations of Nuclear Power Plants; Policy Statement; Republication." *Federal Register.* U.S. Nuclear Regulatory Agency.

71 FR 26491. May 5, 2006. "U.S. Army Corps of Engineers, Baltimore District; Dominion Cove Point LNG, LP; Dominion Transmission, Inc.; Notice of Availability of the Final Environmental Impact Statement for the Cove Point Expansion Project." *Federal Register. U.S.* Department of Energy.

72 FR 37346. July 9, 2007. "Endangered and Threatened Wildlife and Plants; Removing the Bald Eagle in the Lower 48 States from the List of Endangered and Threatened Wildlife." *Federal Register*. U.S. Department of the Interior.

American Recovery and Reinvestment Act of 2009. Public Law 111-5.

Baltimore Gas and Electric Company (BGE). 1970. *Environmental Report: Calvert Cliffs Nuclear Power Plant.* Baltimore, Maryland.

Calvert County. 2009. *Welcome to Calvert County*. Accessed on January 5, 2010 at http://www.co.cal.md.us/visitors/profile/history.

Calvert County Board of County Commissioners (CCBCC). 2006. *Calvert County Land Preservation, Parks and Recreation Plan*. Accessed June 19, 2008 at http://www.co.cal.md.us/assets/Planning_Zoning/PDF_Files/AdoptedOpenSpacePlan.pdf.

Calvert County Comprehensive Plan (CCCP). 2004. *2004 Comprehensive Plan; Calvert County, Maryland.* Available at http://www.co.cal.md.us/government/departments/planning/comprehensiveplan/.

Chesapeake Bay Program (CBP). 2007. *Chesapeake Bay 2006 Health & Restoration Assessment Part One: Ecosystem Health*. Accessed May 29, 2007 at http://www.chesapeakebay.net.

Chesapeake Bay Program (CBP). 2009. *Chesapeake Bay Program: Water Quality – Maps.* Accessed September 1, 2009 at http://www.chesapeakebay.net/maps.aspx?menuitem=15165.

Clean Air Act. 42 U.S.C. 7401 et seq.

Constellation Energy. 2009. *Power Generation – H.A. Wagner Power Plant.* Accessed at http://www.constellation.com/portal/site/constellation/menuitem.75e42773621571908d84ff10025166a0.

Dominion. 2009. *Dominion Cove Point LNG.* Accessed December 16, 2009 at http://www.dom.com/business/gas-transmission/cove-point/index.jsp.

Doney, S.C., V.J. Fabry, R.A. Feely, and J.A. Kleypas. 2009. "Ocean Acidification: The Other CO2 Problem." *Annual Review of Marine Science* 1:169–192.

EA Engineering, Science, and Technology (EA Engineering). 2008. *Entrainment Characterization Data Report for Calvert Cliffs Nuclear Power Plant*. Prepared for Constellation Energy. Accession No. ML083110678.

Entrix. 2009. *Environmental Review Document Chalk Point to Calvert Cliffs*. Prepared for Potomac Electric Power Company (Pepco) Washington, DC by Entrix, Inc., New Castle, Delaware.

Federal Energy Regulatory Commission (FERC). 2006. *Cove Point Expansion Project Final EIS*. Docket Nos. CP05-130-000, CP05-132-000. Accessed December 12, 2008 at http://www.ferc.gov/industries/lng/enviro/eis/2006/04-28-06-eis-cove.asp. Accession No. ML093220672.

Federal Energy Regulatory Commission (FERC). 2009a. *Application for Pipeline Certificate of Dominion Cove Point LNG, LP in CP09-60*. Docket numbers CP09-60-000, CP09-60-001.

Federal Energy Regulatory Commission (FERC). 2009b. *Request for Rehearing of Washington Gas Light Company under CP09-60, et al.* Docket numbers CP09-60-002.

Federal Highway Administration (FHWA). 2006. *Highway Statistics 2005* (Table VM-1). Office of Highway Policy Information. Washington, D.C.

Gibson, J.R. and R.G. Najjar 2000. "The Response of Chesapeake Bay Salinity to Climate-induced Changes in Streamflow." *Limnology and Oceanography* 45:1764–1772.

Jasinski, P and P. Claggett. 2009. *Responding to Climate Change in the Chesapeake Bay Watershed*: A draft report fulfilling Section 202(d) of Executive Order 13508.

Kemp, W.M., W.R. Boynton, J.E. Adolf, D.F. Boesch, W.C. Boicourt, G. Brush, J.C. Cornwell, T.R. Fisher, P.M. Glibert, J.D. Hagy, L.W. Harding, E.D. Houde, D.G. Kimmel, W.D. Miller, R.I.E. Newell, M.R. Roman, E.M. Smith, and J.C. Stevenson. 2005. "Eutrophication of

Chesapeake Bay: Historical Trends and Ecological Interactions." *Marine Ecology Progress Series* 303:1-29.

Maryland Department of Natural Resources (MDNR). 2004a. *The Maryland Forest Conservation Act: A Ten-Year Review*. Accessed November 16, 2008 at http://www.dnr.state.md.us/forests/download/FCA_10_year_review.pdf.

Maryland Department of Natural Resources (MDNR). 2004b. *Lower Patuxent River In Calvert County Watershed Characterization December 2003*. Accessed February 6, 2008 at http://dnr.maryland.gov/watersheds/surf/proj/wras.html. Accession No. ML093210684.

Maryland Department of Natural Resources (MDNR). 2010. Calvert Cliffs State Park. Accessed January 29, 2010 at http://www.dnr/state/md/us/publiclands/southern/calvertcliffs.html.

Maryland Department of Natural Resources, Maryland Public Power Research Program (MDNR PPRP). 2008. *Maryland Power Plants and the Environment. A Review of the Impacts of Power Plants and Transmission Lines on Maryland's Natural Resources. Maryland Cumulative Environmental Impact Report — 14th Edition.* MDNR Publication No. 12-1142008-271, PPRP-CEIR-14.

Maryland Public Service Commission (MPSC). 2009. *In the Matter of the Application of UniStar Nuclear Energy, LLC and UniStar Nuclear Operating Services, LLC for a Certificate of Public Convenience and Necessity to Construct a Nuclear Power Plant at Calvert Cliffs in Calvert County, Maryland*. Case Number 9127. Proposed Order of Hearing Examiner, April 28, 2009.

Maryland State Highway Administration (MD SHA). 2009. *Calvert County – Pre-Construction - Construction.* Accessed February 19, 2010 at http://www.sha.state.md.us/WebProjectLifeCycle/countyProjects.asp?county=4.

McBride, M. 2006. *Managed Fisheries of the Chesapeake Bay*. In Chesapeake Bay Fisheries Ecosystem Advisory Panel (National Oceanic and Atmospheric Administration Chesapeake Bay Office), pages 13-79. *Fisheries ecosystem planning for Chesapeake Bay*. American Fisheries Society, Trends in Fisheries Management 3, Bethesda, Maryland.

McLean, R., W.A. Rickhus, S.P. Schreiner, and D. Fluke. 2002. *Maryland Power Plant Cooling Water intake Regulations and Their Application in Evaluation of Adverse Environmental Impact*. PPRP-127, Maryland Department of Natural Resources, Annapolis, Maryland.

Mirant. 2009. *Chalk Point Generating Plant.* Accessed December 16, 2009 at http://www.mirant.com/our_business/where_we_work/chalkpoint.htm.

Mitrovica, J.X., N. Gomez, and P.U. Clark. 2009. "The Sea-Level Fingerprint of West AntarcticCollapse." *Science* 323:753.

Najjar, R., L. Patterson, and S. Graham. 2009. "Climate simulations of major estuarine watersheds in the Mid-Atlantic region of the US." *Climatic Change* 95:139-168.

National Park Service (NPS). 2010a. *Star-Spangled Banner National Historic Trail*. Accessed on January 29, 2010, at http://www.nps.gov/stsp/index.htm. Accession No. ML100750370.

National Park Service (NPS). 2010b. *Captain John Smith Chesapeake National Historic Trail*. Accessed on January 29, 2010 at http://www.nps.gov/cajo/index.htm. Accession No. ML100750366.

Olson, M.M. 1987. "Entrainment Studies, Zooplankton Entrainment." Chapter 7 in *Ecological Studies in the Middle Reach of Chesapeake Bay, Calvert Cliffs*. K. L. Heck Jr., ed. Springer-Verlag, New York.

Pepco Holdings, Inc. (PHI). 2009a. "Mid-Atlantic Power Pathway Locating Map." Accessed December 2, 2009 at http://www.powerpathway.com/mapping.html.

Pepco Holdings, Inc. (PHI). 2009b. *Pepco Holdings, Inc. & Maryland Broadband Cooperative Plan Single Chesapeake Bay Utility Crossin*g. News Release March 24, 2009.

Pepco Holdings, Inc. (PHI). 2009c. *Project Schedule*. Accessed November 4, 2009 at http://www.powerpathway.com/schedule.html.

Phillips, S.W. 2007. "Chapter 1: Introduction and Overview of Findings." In *Synthesis of U.S. Geological Survey Science for the Chesapeake Bay Ecosystem and Implications for Environmental Management*. S.W. Phillips, ed. U.S. Geological Survey Circular 1316, USGS, Reston, Virginia.

Ringger, T.G. 2000. "Investigations of Impingement of Aquatic Organisms at the Calvert Cliffs Nuclear Power Plant, 1975-1995." *Environmental Science & Policy* 3 (2000) S261-S273.

Schreiner, S.P., T.A. Krebs, D.E. Strebel, A. Brindley, and C.G. McCall. 1999. *Validation of the CORMIX Model Using Thermal Plume Data from Four Maryland Power Plants*. Report prepared for the Maryland Department of Natural Resources, Power Plant Research Program. PPRP-114. Report prepared by Versar, Inc., Columbia, Maryland.

Sellner, K.G. and M.E. Kachur. 1987. "Entrainment Studies, Phytoplankton Entrainment." Chapter 7 in *Ecological Studies in the Middle Reach of Chesapeake Bay, Calvert Cliffs*. K. L. Heck Jr., ed. Springer-Verlag, New York.

Soeder, D.J., J.P. Raffensperger, and M.R. Nardi. 2007. *Effects of Withdrawals on Ground-water Levels in Southern Maryland and the Adjacent Eastern Shore, 1980–2005*. U.S. Geological Survey Scientific Investigations Report 2007–5249. Available at http://pubs.usgs.gov/sir/2007/5249/.

St. Mary's County Board of County Commissioners (SMCBCC). 2003. *Quality of Life in St Mary's County – A Strategy for the 21st Century*. Accessed November 19, 2008 at http://www.co.saint-marys.md.us/planzone/docs/CompPlanamendedMarch03.pdf.

Teng, H. L.E. Buja, and G.A. Meehl. 2006. "Twenty-first-century Climate Change Commitment from a Multi-model Ensemble." *Geophysical Research Letters* 33: L07706, doi:10.1029/2005GL024766.

UniStar Nuclear Development, LLC (UniStar). 2009a. *Calvert Cliffs Nuclear Power Plant Unit 3 Combined License Application, Part 3, Environmental Report*. Revision 6, Baltimore, Maryland. Accession No. ML092880921.

UniStar Nuclear Development, LLC (UniStar). 2009b. *Application for Wildlife Permit/License Renewal Calvert Cliffs Nuclear Power Plant, December 2009*. Enclosure to Letter from G. Gibson (UniStar) to Maryland DNR, dated December 8, 2009. "Subject: Renewal/Extension of Maryland Department of Natural Resources Wildlife and Heritage Service Endangered Species Permit Number 45135." Accession No. ML093520693.

U.S. Army Corps of Engineers (USACE). 2010. Letter from K.B. Anderson (USACE) to R.J. Nelson (Office of Federal Agency Programs, Advisory Council on Historic Preservation), Review of US Army Corps of Engineers and Maryland State Historic Preservation Officer regarding Calvert Cliffs 3 Nuclear Plant (CENAB-OP-RMS) effect on historic properties and Memorandum of Agreement. March 16, 2010. Accession No. ML100810272.

U.S. Atomic Energy Commission (AEC). 1973. *Environmental Statement Related to Operation of Calvert Cliffs Nuclear Power Plant Units 1 and 2, Baltimore Gas and Electric Company, Dockets Nos. 50-317 and 50-318,* (April 1973). Washington, D.C.

U.S. Coast Guard and U.S. Army Corps of Engineers (USCG and USACE). 2009. *Cove Point Pier Reinforcement Project Environmental Assessment*. Federal Energy Regulatory Commission, Dominion Cove Point LNG, LP Docket No. CP09-60-000.

U.S. Department of Defense (DOD). 2010. *CNIC--Naval Air Station Patuxent River*. Accessed January 29, 2010 at https://www.cnic.navy.mil/Patuxent/AboutCNIC/index.htm.

U.S. Environmental Protection Agency (EPA). 2009. *Greenhouse Gas Emissions and Sinks: 1990-2005* (Table 3-7). Washington, D.C.

U.S. Fish and Wildlife Service (FWS). 1993. *Puritan Tiger Beetle (Cicindela puritana G. Horn), Recovery Plan*. U.S. Fish and Wildlife Service Northeast Region, Hadley, Massachusetts.

U.S. Fish and Wildlife Service (FWS). 1994. *Northeastern Beach Tiger Beetle (Cincindela dorsalis dorsalis Say), Recovery Plan*. U.S. Fish and Wildlife Service, Hadley, Massachusetts. Accession No. ML071970332.

U.S. Global Change Research Program (GCRP). 2009. *Global Climate Change Impacts in the United States.* T.R. Karl, J.M. Melillo, and T.C. Peterson, eds. Cambridge University Press, New York. Available at http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf.

U.S. Nuclear Regulatory Commission (NRC). 2000. *Calvert Cliffs Nuclear Power Plant, Units 1 and 2 – Renewal of Operating License.* Available at http://www.nrc.gov/reading-rm/doc-collections/commission/secys/2000/secy2000-0010/2000-0010scy.html.

U.S. Nuclear Regulatory Commission (NRC). 2002. *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors*. NUREG-0586, Supplement 1, Vols. 1 and 2, NRC, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2009. *Calvert Cliffs, Unit Nos. 1 and 2, Amendment Regarding Measurement Uncertainty Recapture Power Uprate.* Accession No. ML091820366.

U.S. Nuclear Regulatory Commission (NRC). 2010. *Supplemental Environmental Impact Statement for the Combined License (COL) for North Anna Power Station Unit 3 – Final Report.* NUREG-1917. Washington D.C.

Wood, R.J., D.F. Boesch, and V.S. Kennedy. 2002. "Future Consequences of Climate Change for the Chesapeake Bay Ecosystem and its Fisheries." *American Fisheries Society Symposium* 32:171-184.

Wu, S-Y., R. Najjar, and J. Siewert. 2009. "Potential Impacts of Sea-level Rise on the Mid- and Upper-Atlantic Region of the United States." *Climatic Change* 95:121–138.

8.0 Need for Power

The purpose and need for the proposed NRC action, as stated in Section 1.3.1 of this environmental impact statement (EIS), is to provide for additional large baseload electrical generating capacity within the State of Maryland. As stated in Section 3.2.1 of this EIS, proposed Unit 3 at the Calvert Cliffs site would provide a net output of 1562 MW(e). UniStar (the applicant) projects that Unit 3 would begin commercial operation in December 2015 (UniStar 2009).

The Maryland Public Service Commission (MPSC) analyzed the need for power from a new baseload generating unit in a 2007 report (MPSC 2007) and in its 2009 Order granting a Certificate of Public Convenience and Necessity (CPCN) to UniStar for proposed Unit 3 (MPSC 2009a). The NRC staff relied on the MPSC's determinations to reach its conclusion that there is a need for power from proposed Unit 3 at the Calvert Cliffs site by December 2015. The MPSC determined in its 2007 report and in its CPCN decision that there is a need for at least that amount of baseload power in Maryland. Because the demand for baseload power is at least as much as the supply from the proposed new unit, the NRC staff concluded there is a need for the power. The staff concluded in Section 9.2.3 of this EIS that renewable energy alternatives, such as wind and solar, would not be a reasonable alternative to a new nuclear generating unit operated as a baseload power plant.

Chapter 8 of the U.S. Nuclear Regulatory Commission's (NRC's) NUREG-1555, *Environmental Standard Review Plan* (ESRP) (NRC 2000), guided the staff's review and analysis of the need for power from the proposed nuclear power plant. The staff was also guided by the Commission's 2003 denial of a petition that NRC amend its regulations to remove requirements that applicants analyze the need for power from a proposed new nuclear power plant (68 FR 55905). In its reasons for denial of that petition, the Commission stated that:

1. NRC does not supplant the States, which have traditionally been responsible for assessing the need for power generating facilities, their economic feasibility and for regulating rates and services. As the petitioner noted, the NRC has acknowledged the primacy of State regulatory decisions regarding future energy options (68 FR 55905).

2. The need for power must be addressed in connection with new power plant construction so that the NRC may weigh the likely benefits (e.g., electrical power) against the environmental impacts of constructing and operating a nuclear power reactor. The Commission emphasizes, however, that such an assessment should not involve burdensome attempts to precisely identify future conditions. Rather, it should be sufficient to reasonably characterize the costs and benefits associated with proposed licensing actions (68 FR 55905).

In June 2009, the MPSC granted UniStar a CPCN for Unit 3 at the Calvert Cliffs site (MPSC 2009a). In affirming the Hearing Examiner's Order, the MPSC concluded that Unit 3 would have a beneficial effect on the stability and reliability of the electrical system in Maryland (MPSC 2009b).

The following sections discuss the need for new baseload generating capacity in Maryland. Section 8.1 describes the power system in Maryland and the surrounding region. Section 8.2 discusses power demand. Section 8.3 discusses power supply. Section 8.4 provides the staff's assessment of the need for new baseload generating capacity in Maryland. Section 8.5 contains the staff's conclusions. Section 8.6 includes the references cited in this chapter.

8.1 Description of Power System

Thirteen electric utilities serve Maryland customers. Four of the largest are investor-owned utilities (Baltimore Gas & Electric Co., Delmarva Power & Light Co., Allegheny Power Co., and Potomac Electric Power Co.), four are electric cooperatives (two of which serve only small areas), and five are municipal utilities (MPSC 2009c).

Maryland is in a regional electric grid operated by PJM Interconnection, LLC (PJM). PJM is the largest power grid in North America and also operates the world's largest competitive wholesale electricity market (MPSC 2009c). PJM coordinates the movement of wholesale electricity in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and the District of Columbia (PJM 2009). PJM operates but does not own the transmission systems in its territory (MPSC 2009c). Regional transmission organizations were created as a result of Order No. 2000 issued by the Federal Energy Regulatory Commission (FERC). In the Order, FERC encouraged the voluntary formation of such organizations to administer the transmission grid on a regional basis throughout North America (FERC 2009).

Maryland is also part of the geographic territory of the Reliability First Corporation (RFC). RFC is one of the eight approved regional entities in North America under the North American Electric Reliability Corporation (NERC). NERC's mission is to verify the reliability of the bulk power system in North America. NERC develops and enforces reliability standards, monitors the bulk power system, assesses and reports on future transmission and generation adequacy, and offers education and certification programs to industry personnel (NERC 2009). RFC's primary responsibilities include developing reliability standards and monitoring compliance to those reliability standards for all owners, operators, and users of the bulk electric system and providing seasonal and long-term assessments of bulk electric system reliability within the RFC geographic area (RFC 2008). RFC members serve the electrical requirements of more than 72 million people in a 238,000-sq-mi area covering all of the states of Delaware, Indiana, Maryland, Ohio, Pennsylvania, New Jersey, West Virginia, and the District of Columbia, as well as portions of Illinois, Kentucky, Michigan, Tennessee, Virginia, and Wisconsin (NERC 2009). RFC does not have officially designated subregions; however, the RFC geographic territory overlaps with the geographic coverage of two regional transmission organizations—PJM and the Midwest Independent Transmission System Operator, Inc. (MISO) (NERC 2009). Approximately one-third of the RFC load is within the MISO territory, and nearly the entire remaining load is within PJM (NERC 2009).

8.2 Power Demand

In 2007, Maryland's electricity users consumed approximately 65.9 million MWh of electricity (MDNR PPRP 2010). In 2005, 42 percent of electricity was consumed by Maryland residential users, 31 percent by industry, and 26 percent by commercial users (DOE 2008). As of December 2007, Maryland's total peak load requirement was approximately 17,500 MW (16,100 MW demand plus a reserve margin of 1400 MW, for a total requirement of 17,500 MW). Between 1997 and 2007, the annual growth rate in electricity consumption in Maryland was 1.51 percent compared to the U.S. growth rate of 1.81 percent (MDNR PPRP 2010). Peak electricity demand and usage are expected to grow over the next 10 years in Maryland and the surrounding region due primarily to expected increases in population and economic activity (MPSC 2009c).

RFC expects to be summer peaking in its region through 2018 (NERC 2009). RFC projects a 1.4 percent/yr summer peak load growth through 2018 (NERC 2009; RFC 2009). RFC's forecast takes account of demand forecasts made by PJM, MISO, and the Ohio Valley Electric Corporation (NERC 2009; RFC 2009). RFC estimates that aggregate net internal demand in its region for the summer peak will increase from 169,900 MW in 2009 to approximately 193,100 MW in 2018 (NERC 2009; RFC 2009). Net internal demand represents the system demand that is planned for by the reliability authority and is equal to internal demand less direct control load management and interruptible demand (DOE/EIA 2007).

PJM projects the summer peak load growth rate between 2010 and 2020 in the areas served by Maryland investor-owned utilities as follows: Baltimore Gas & Electric 1.8 percent, Delmarva Power & Light 1.4 percent, Allegheny Power Co. 1.4 percent, and Potomac Electric Power Co. 1.2 percent (PJM 2010).

8.3 Power Supply

The generation and supply of electricity are not regulated in Maryland, and prices are set by the competitive wholesale and retail electricity markets. The distribution of electricity continues to be a regulated monopoly function of the local utility, and hence continues to be subject to price regulation by the MPSC (MDNR PPRP 2009).

As stated in Section 8.2, Maryland's electricity users consumed approximately 65.9 million MWh of electricity in 2007 (MDNR PPRP 2010). In contrast, generation plants in Maryland produced approximately 50.0 million MWh of electricity in 2007 (MPSC 2009c). Also as stated in Section 8.2, Maryland's total peak load requirement was approximately 17,500 MW in 2007. As of December 2007, Maryland's net summer generating capacity was 12,675 MW (MPSC 2009c). Therefore, nearly 4800 MW of capacity in the transmission system served to meet Maryland's peak load requirements in 2007 (MPSC 2009c).

As of 2009, 38 power plants in Maryland with generation capacities greater than 2 MW were connected to the grid (MDNR PPRP 2010). Only 700 MW of new generation capacity has been added in Maryland since 2000 (MPSC 2008).

As of January 2009, the generation capacity profile in Maryland was approximately as follows: coal (39 percent), dual-fueled (petroleum and natural gas) (26 percent), nuclear (14 percent), natural gas and other gases (9 percent), petroleum (7 percent), hydroelectric (4 percent), and other renewable sources (1 percent) (MPSC 2009c). Coal and nuclear power plants typically operate continuously in a baseload manner. Consequently, in 2007, coal-fired power plants were the source of 59.4 percent of the electricity generated in Maryland and nuclear plants 28.7 percent (MPSC 2009c). Although Maryland produces a small amount of coal in the western portion of the State, most of its coal-fired power plants burn coal shipped from West Virginia and Pennsylvania. Maryland's only nuclear plant, the dual-unit Calvert Cliffs facility, supplies all of Maryland's nuclear power. The Conowingo hydroelectric plant on the Susquehanna River provides almost all of Maryland's hydroelectricity. More than one-third of Maryland households use electricity as their main source of energy for home heating (DOE/EIA 2009).

In the RFC territory, the fuel mix of generating units as of 2009 was approximately 15 percent nuclear, 3 percent hydroelectric and pumped storage hydroelectric, 47 percent coal, 6 percent oil, 28 percent natural gas, and 1 percent other (RFC 2009).

Maryland's generation fleet is aging, as 67.1 percent of the State's total generating capacity is more than 30 years old and another 10.7 percent is over 20 years old (MPSC 2009c). In the RFC region, the amount of capacity that is more than 40 years old is projected to grow from approximately 23 percent in 2009 to about 44 percent in 2018 (RFC 2009). As capacity ages, the likelihood that it will be retired increases.

Using data from PJM and MISO, RFC estimates that the amount of capacity in its region for the summer of 2009 is 215,600 MW (NERC 2009; RFC 2009). For the period through 2018, RFC expects a total capacity increase in its region, net of plant retirements, of approximately 12,500 MW (NERC 2009; RFC 2009). The 12,500 MW represents both planned capacity and a portion of conceptual capacity. RFC uses an 18.4 percent "confidence" factor to estimate the portion of the conceptual capacity to include in the expected reserve margins (NERC 2009). Proposed Calvert Cliffs Unit 3 is identified by RFC (2009) as a conceptual resource.

8.4 Assessment of Need for Power

In conjunction with its assessment of the need for power from UniStar's proposed Unit 3 at the Calvert Cliffs site, the staff reviewed the 2009 Order by the MPSC to issue UniStar a CPCN for Unit 3 and several reports prepared by State and regional entities. Key findings from the MPSC's Order and the reports are summarized below.

8.4.1 Grant of a Certificate of Public Convenience and Necessity for Unit 3

For any person to build a new power plant in Maryland, a CPCN must be obtained from the MPSC. As part of this licensing process, applicants must address a full range of environmental, engineering, socioeconomic, planning, and cost issues (MDNR PPRP 2007). The MPSC is required by statute, Maryland Annotated Code Section 7-207(e)(2)(i) of the Maryland Public Utilities Companies Article, to issue a CPCN only after taking due consideration of the effect of a proposed generating station on the stability and reliability of the electrical system (Annotated Code of Maryland).

In the CPCN proceeding, Mr. Craig Taborsky, an Electric Generation and Transmission Engineer with MPSC's Engineering Division, testified that proposed Unit 3 would have a positive effect on the reliability and stability of the electric system in Maryland if it complies with all PJM requirements as the additional power supplied by the plant would be a beneficial source for Maryland and the grid in general. Mr. Taborsky noted that the plant would provide power with an alternate source, nuclear power, which would lessen Maryland's dependence on fossil fuels such as coal, oil, and natural gas. He also stated that the plant would be beneficial in reducing the State's dependence on imported electricity, as Maryland imported approximately 30 percent of its electric power in 2006. Mr. Taborsky further noted that Maryland may face a shortage of electricity in coming years, perhaps by the year 2011 or 2012, and wholesale prices continue to increase due to congestion, especially in central Maryland. Therefore, he testified that the new nuclear unit at Calvert Cliffs would be a welcome source of baseload power designed to run continuously, which is expected to reduce peak period congestion on transmission lines within Maryland and reduce the need for imported power (MPSC 2009b).

In its 2009 Order granting a CPCN to UniStar for Unit 3 (MPSC 2009a), the MPSC affirmed the following findings made by the Hearing Examiner relating to the need for Unit 3 (MPSC 2009b):

- Unit 3 would constitute a new large source of power that would be of benefit to the citizens and State of Maryland.

- The beneficial effect of Unit 3 on the stability and reliability of the electric system is supported by the evidence on the MPSC's record.
- The additional power provided by Unit 3 would lessen Maryland's dependence on fossil fuels and would reduce the State's dependence on imported electricity.
- Unit 3 would be a welcome source of baseload power designed to run continuously, which would help peak period congestion on transmission lines within Maryland to the benefit of the public.
- Unit 3 would have a positive effect on the reliability and stability of the electric system and would be a beneficial power source for Maryland and the electric grid in general.

In the CPCN proceeding, opponents of the proposed project argued, in part, that (1) the CPCN should not be granted and that alternative forms of generation and additional conservation be used instead, and (2) that if a CPCN is granted it should be conditioned on UniStar making additional investment in energy conservation, solar power, and wind power. In reaching its decision, the MPSC rejected these arguments.

8.4.2 Maryland Public Service Commission Electric Supply Adequacy Report

In 2007, the MPSC issued its *Electric Supply Adequacy Report of 2007* (MPSC 2007). Among other things, the MPSC report takes account of PJM's generation profile and potential generation additions; new generating resources planned for construction in Maryland; trends in Maryland electric power generation by fuel source; trends in Maryland electricity consumption by class of consumer; forecasts of future electricity sales made by PJM and electric utilities serving Maryland; transmission congestion in Maryland and surrounding states; demand side management, demand response, and distributed generation; and electric reliability assessments prepared by NERC.

In Chapter V, "Conclusions and Recommendations," the MPSC makes the following points (MPSC 2007):

- The outlook for the adequacy of Maryland's electricity supply can perhaps be best described as fragile.
- Maryland is the fifth largest electricity importing state in the United States. Maryland cannot meet its own electricity needs from internal resources and has not done so for more than 15 years
- If Maryland was a stand-alone system, it would need to install at least another 4000 MW to meet both peak load and have a satisfactory generating capacity reserve.
- Other states in or bordering the Mid-Atlantic and Southern regions of PJM are in a situation similar to Maryland. Consequently, these states will not be a near-term supply of electricity

for Maryland. Instead, they have been competing and will continue to compete with Maryland for access to electricity sources in the PJM western region.

- Maryland's dependence on out-of-state generation will likely increase over the next 5 to 10 years due to both growth in electricity demand and the possible derating or retirement of existing generating units. Much of the generation capacity in Maryland is relatively old, with several fossil units more than 40 years old.
- Maryland utilities and PJM are forecasting electricity demand in Maryland to grow between 1 and 2 percent/yr.
- As of the date of the MPSC report, the only significant new baseload generation plants in the PJM generation project queues were two nuclear units at the Calvert Cliffs site (UniStar's COL application is for one new nuclear unit at the Calvert Cliffs site).
- 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.
- The MPSC recognizes that a balanced approach is required to provide for adequate electricity supplies, including 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.

8.4.3 Reliability First Corporation Reserve Margin Projections

RFC predicts adequate reserves in its territory through 2018 (RFC 2009). The reserve margin for 2009 is 26.9 percent based on net internal demand and net capacity resources. The predicted reserve margin decreases to 18.2 percent in 2018, provided a total capacity increase in its region, net of plant retirements, of approximately 12,500 MW occurs (see Section 8.3) (RFC 2009). NERC's target reserve margin level for predominately thermal systems is 15 percent (NERC 2009).

8.4.4 Maryland Energy Administration

The principal conclusion in the *Maryland Strategic Electricity Plan* prepared by the Maryland Energy Administration (MEA 2008) is:

> Maryland is facing significant energy challenges and is not equipped to properly address them. The state is facing record high electricity prices and the possibility of rolling blackouts as soon as 2011. Maryland needs a long-term vision and plan to provide its citizens with affordable, reliable, clean energy.

The Plan also states that "to keep the lights on, Maryland needs to invest in new generation."

8.5 NRC Staff Conclusions

NRC guidance provides that additional independent review by the NRC is not needed when need for power analyses prepared by an affected State, NERC reliability council, and/or regional transmission organization are sufficiently (1) systematic, (2) comprehensive, (3) subject to confirmation, and (4) responsive to forecasting uncertainty (NRC 2000). Taken in aggregate, the NRC staff determined that the studies and reports summarized in Section 8.4 and the decision by the MPSC to grant a CPCN to UniStar for Unit 3 satisfy the four preceding tests.

- *Systematic*: RFC has a systematic and iterative process for load forecasting and reliability assessment that is updated annually and based on input from PJM and MISO. RFC, PJM, and MISO use industry best practices and methodological approaches to determine future system reliability and the need for new generating capacity.
- *Comprehensive*: The staff finds, in aggregate, that the studies and reports discussed in Section 8.4 and the MPSC's decision to grant UniStar a CPCN for Unit 3 are comprehensive. MPSC (2007) takes account of PJM's generation profile and potential generation additions; new generating resources planned for construction in Maryland; trends in Maryland electric power generation by fuel source; trends in Maryland electricity consumption by class of consumer; forecasts of future electricity sales made by PJM and electric utilities serving Maryland; transmission congestion in Maryland and surrounding States; demand side management, demand response, and distributed generation; and electric reliability assessments prepared by NERC (MPSC 2007). RFC, PJM, and MISO use industry best practices and methodological approaches to determine system reliability and the need for new generating capacity.
- *Subject to Confirmation*: The staff finds, in aggregate, the studies and reports discussed in Section 8.4 and the MPSC's decision to grant UniStar a CPCN for Unit 3 are subject to confirmation. PJM's and MISO's reliability forecasts are independently prepared. These forecasts are then independently reviewed, confirmed, and consolidated by RFC. The MPSC independently reviewed PJM and NERC information in preparing its electric supply adequacy report for Maryland (MPSC 2007).
- *Responsive to Forecasting Uncertainty*: In preparing their load forecasts and reliability assessments, PJM and RFC take account of demand forecasting uncertainty and generator outage schedules. They also take account of the facts that not all proposed new generating units will be built and some existing generating units may be taken offline for various reasons.

Based on its review of the documents discussed in Section 8.4 and the MPSC's decision to grant UniStar a CPCN for Unit 3, the NRC staff determined that, in aggregate, the documents and the MPSC decision are sufficiently (1) systematic, (2) comprehensive, (3) subject to confirmation, and (4) responsive to forecasting uncertainty to serve the needs of the NRC in complying with Section 102 of the National Environmental Policy Act. In keeping with the Chapter 8 ESRPs (NRC 2000) and the Commission's statements at 68 FR 55905, the staff gave particular credence to the (1) MPSC's decision to grant UniStar a CPCN for Unit 3 (MPSC 2009a), (2) MPSC's *Electric Supply Adequacy Report of 2007* (MPSC 2007), and (3) reliability assessment prepared by RFC (NERC 2009; RFC 2009).

The NRC staff concludes (1) there is a shortage of power in the Maryland region that could be at least partially addressed by construction of proposed Unit 3 at the Calvert Cliffs site; (2) construction of Unit 3 would reduce the likelihood of an electricity supply reliability crisis in Maryland; and (3) construction of Unit 3 would contribute to the new generation needed in the RFC region by 2018 to meet reserve targets. Based on its analysis, the staff concludes there is a justified need for new baseload generating capacity in Maryland in excess of the planned output of proposed Unit 3.

8.6 References

68 FR 55905. September 29, 2003. "Nuclear Energy Institute; Denial of Petition for Rulemaking." *Federal Register*. U.S. Nuclear Regulatory Commission.

Annotated Code of Maryland. Public Utility Companies. Title 7. Gas, Electric, and Water Companies.

Federal Energy Regulatory Commission (FERC). 2009. *Regional Transmission Organizations (RTO)/Independent System Operators (ISO).* Accessed October 30, 2009 at http://www.ferc.gov/industries/electric/indus-act/rto.asp. Accession No. ML093280296.

Maryland Department of Natural Resources, Maryland Public Power Research Program (MDNR PPRP). 2007. "Power Plant Licensing in Maryland." Accessed December 23, 2009 at http://esm.versar.com/pprp/licensing/licensing.html.

Maryland Department of Natural Resources, Maryland Public Power Research Program (MDNR PPRP). 2009. *Electricity in Maryland - Fact Book 2008*. Accessed December 22, 2009 at http://esm.versar.com/pprp/factbook/factbook.htm.

Maryland Department of Natural Resources, Power Plant Research Program (MDNR PPRP). 2010. *Maryland Power Plants and the Environment: A Review of the Impacts of Power Plants and Transmission Lines on Maryland's Natural Resources (CEIR–15)*. Available at http://esm.versar.com/pprp/ceir15/toc.htm.

Maryland Energy Administration (MEA). 2008. *Maryland Strategic Electricity Plan*. Accessed October 7, 2009 at http://www.energy.state.md.us/about/reports/index.asp.

Maryland Public Service Commission (MPSC). 2007. *Electric Supply Adequacy Report of 2007*. Accessed October 7, 2009 at http://webapp.psc.state.md.us/Intranet/psc/Reports_new.cfm.

Maryland Public Service Commission (MPSC). 2008. *Final Report of the Public Service Commission of Maryland to the Maryland General Assembly: Options for Re-Regulation and New Generation*. Accessed December 17, 2008 at http://webapp.psc.state.md.us/Intranet/psc/Reports_new.cfm.

Maryland Public Service Commission (MPSC). 2009a. *In the Matter of the Application of UniStar Nuclear Energy, LLC and UniStar Nuclear Operating Services, LLC for a Certificate of Public Convenience and Necessity to Construct a Nuclear Power Plant at Calvert Cliffs in Calvert County, Maryland*. Case Number 9127. Order Number 82741, June 26, 2009.

Maryland Public Service Commission (MPSC). 2009b. In the Matter of the Application of UniStar Nuclear Energy, LLC and UniStar Nuclear Operating Services, LLC for a Certificate of Public Convenience and Necessity to Construct a Nuclear Power Plant at Calvert Cliffs in Calvert County, Maryland. Case Number 9127. Proposed Order of Hearing Examiner, April 28, 2009.

Maryland Public Service Commission (MPSC). 2009c. *Ten-Year Plan (2008-2017) of Electric Companies in Maryland*. Accessed October 8, 2009 at http://webapp.psc.state.md.us/Intranet/psc/Reports_new.cfm.

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

North American Electric Reliability Corporation (NERC). 2009. *2009 Long-Term Reliability Assessment 2009-2018*. Accessed October 30, 2009 at http://www.nerc.com/page.php?cid=4 61.

PJM Interconnection (PJM). 2009. *Who We Are.* Accessed October 30, 2009 at http://www.pjm.com/about-pjm/who-we-are.aspx.

PJM Interconnection (PJM). 2010. PJM Load Forecast Report January 2010. Accessed January 21, 2010 at: http://www.pjm.com/documents/reports.aspx.

ReliabilityFirst Corporation (RFC). 2008. *About ReliabilityFirst*. Accessed October 8, 2009 at http://www.rfirst.org/MiscForms/AboutUs.aspx.

ReliabilityFirst Corporation (RFC). 2009. *Long Term Resource Assessment 2009-2018.* Accessed October 8, 2009 at http://www.rfirst.org/MiscForms/AboutUs.aspx.

UniStar Nuclear Development, LLC (UniStar). 2009. *Calvert Cliffs Nuclear Power Plant Unit 3 Combined License Application, Part 3, Environmental Report*. Revision 6. Accession No. ML092880921.

U.S. Department of Energy (DOE). 2008. "Electric Power and Renewable Energy in Maryland." Accessed December 28, 2009 at http://apps1.eere.energy.gov/states/electricity.cfm/state=MD. Accession No. ML093280377.

U.S. Department of Energy, Energy Information Administration (DOE/EIA). 2007. "Net Internal Demand, Capacity Resources, and Capacity Margins by North American Electric Reliability Council Region." Accessed October 30, 2009 at http://www.eia.doe.gov/cneaf/electricity/epa/epat3p2.html. Accession No. ML093280285.

U.S. Department of Energy, Energy Information Administration (DOE/EIA). 2009. *Maryland Quick Facts*. Accessed October 30, 2009 at http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=MD. Accession No. ML093280288.

U.S. Nuclear Regulatory Commission (NRC). 2000. *Environmental Standard Review Plan—Review Plans for Environmental Reviews for Nuclear Power Plants.* NUREG-1555, Washington, D.C. Includes 2007 updates.

9.0 Environmental Impacts of Alternatives

This chapter describes alternatives to the proposed NRC's action for a combined license (COL) and the U.S. Army Corps of Engineers' (USACE or Corps) action for a Department of Army (DA) Individual Permit application and discusses the environmental impacts of those alternatives. Section 9.1 discusses the no-action alternative. Section 9.2 addresses alternative energy sources. Section 9.3 reviews UniStar's (the applicant's) region of interest (ROI) as discussed in its Environmental Report (ER) (UniStar 2009a), its site selection process, and summarizes and compares the environmental impacts for the proposed and alternative sites. UniStar selected the State of Maryland as its ROI (UniStar 2009a). Section 9.4 examines plant design alternatives, and Section 9.5 lists the references cited in this chapter.

The need to compare the proposed action with alternatives arises from the requirement in Section 102(2)(c)(iii) of the National Environmental Policy Act of 1969, as amended (NEPA) (42 U.S.C. 4321) that environmental impact statements (EIS) include an analysis of alternatives to the proposed action. The U.S. Nuclear Regulatory Commission (NRC) implements this comparison through its regulations in Title 10 of the Code of Federal Regulations (CFR) Part 51 and its Environmental Standard Review Plan (ESRP) (NRC 2000a). The environmental impacts of the alternatives are evaluated using the NRC's three-level standard of significance – SMALL, MODERATE, or LARGE – developed using Council on Environmental Quality (CEQ) guidelines (40 CFR 1508.27) and set forth in the footnotes to Table B-1 of Title 10 CFR Part 51, Subpart A, Appendix B. The issues evaluated in this chapter are the same as those addressed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999)[a] with the additional issue of environmental justice. The NRC issues a site-specific supplemental EIS, adding to determinations already made in the NUREG-1437, for each proposed action of license renewal for a nuclear plant. Although NUREG-1437 was developed for license renewal, it provides useful information for this review and is referenced throughout this chapter.

As part of the evaluation of the permit application submitted to the Corps that is subject to Section 404 of the Clean Water Act, the Corps must define the overall project purpose in addition to the basic project purpose. The overall project purpose establishes the scope of the alternatives analysis and is used for evaluating practicable alternatives under the Environmental Protection Agency's (EPA's) Clean Water Act 404(b)(1) Guidelines (40 CFR Part 230). In accordance with the Guidelines and USACE Headquarters guidance (HQUSACE 1989), the overall project purpose must be specific enough to define the applicant's needs, but not so narrow and restrictive as to preclude a proper evaluation of alternatives. The Corps is

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(a) NUREG-1437 was originally issued in 1996. Addendum 1 to NUREG-1437 was issued in 1999 (NRC 1999). Hereafter, all references to NUREG-1437 include NUREG-1437 and its Addendum 1.

responsible for controlling every aspect of the Guidelines analysis. In this regard, defining the overall project purpose is the sole responsibility of the Corps. While generally focusing on the applicant's statement, the Corps will, in all cases, exercise independent judgment in defining the purpose and need for the project from both the applicant's alternatives and the public's perspective (33 CFR Part 325 Appendix B (9)(c)(4); see also 53 FR 3120, February 3, 1988).

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

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

The NRC's determination as to whether an alternative site is environmentally preferable to the proposed site for Calvert Cliffs Unit 3 is independent of the Corps' determination of a LEDPA pursuant to the Clean Water Act Section 404(b)(1) Guidelines at 40 CFR Part 230. The Corps will conclude its analysis of both offsite and onsite alternatives in its Record of Decision.

9.1 No-Action Alternative

For purposes of an application for a COL, the no-action alternative refers to a scenario in which the NRC would deny the COL requested by UniStar. Likewise, the Corps could also take no action as a result of the applicant electing to modify the proposal to eliminate work under the jurisdiction of the Corps or by the denial of the permit. Upon such a denial by the NRC, the construction and operation of a new nuclear unit at the Calvert Cliffs site in accordance with 10 CFR Part 52 would not occur and the predicted environmental impacts associated with the project would not occur. Preconstruction impacts associated with activities not within the definition of construction in 10 CFR 50.10(a) and 51.4 may occur. The no-action alternative would result in the proposed facility not being built. If no other power plant were built or electrical power supply strategy implemented to take its place, the benefits of the additional electrical capacity and electricity generation to be provided by the project would not occur. If no additional measures (e.g., conservation, importing power, restarting retired power plants, and/or extending the life of existing power plants) were enacted to realize the amount of electrical capacity that would otherwise be required for power in the ROI, then the need for baseload power, discussed in Chapter 8 of this EIS, would not be met. Therefore, the purpose and need of this proposed project would not be satisfied if the no-action alternative was chosen, and the need for power was not met by other means.

If other generating sources were built either at another site or using a different energy source, the environmental impacts associated with these other sources would eventually occur. As discussed in Chapter 8, there is a demonstrated need for power. It is reasonable to assume that the Maryland Public Service Commission (MPSC) would confirm that the need for power would be met. This needed power may be provided and supported through a number of alternatives that are discussed in Section 9.2 and 9.3. Therefore, this section does not include a discussion of other energy alternatives (discussed in Section 9.2) and alternative sites (discussed in Section 9.3) that could meet the need for power.

9.2 Energy Alternatives

The purpose and need for the proposed project identified in Section 1.3.1 of this EIS is to generate baseload power for use by the applicant and for possible future sale on the wholesale market. This section examines the potential environmental impacts associated with alternatives to construction of a new baseload nuclear generating facility. Section 9.2.1 discusses energy alternatives not requiring new generating capacity. Section 9.2.2 discusses energy alternatives requiring new generating capacity. Other alternatives are discussed in Section 9.2.3. A combination of alternatives is discussed in Section 9.2.4. Section 9.2.5 compares the environmental impacts from new nuclear, coal-fired, and natural gas-fired generating units at the Calvert Cliffs site. For analysis of energy alternatives, UniStar assumed a target installed capacity of 1600 MW(e) electrical output (UniStar 2009a). The review team also used this level of output in analyzing energy alternatives.

9.2.1 Alternatives Not Requiring New Generating Capacity

Four alternatives to the proposed action that do not require UniStar to construct new generating capacity are to:

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

As discussed in Chapter 8, Maryland already is a large importer of electricity and faces constraints to further electricity imports. The MPSC concluded that a balanced approach is required to provide adequate electricity supplies for Maryland, including adding new generation, upgrading the transmission system, preserving existing generating resources, and encouraging cost-effective conservation and demand response actions on the part of energy consumers (MPSC 2007).

If power to replace the capacity of the proposed new nuclear unit was to be purchased from sources within the United States or from a foreign country, the generating technology likely would be one that could provide baseload power (e.g., coal, natural gas, or nuclear, as discussed later in this section), as previously described by the NRC in its *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (NUREG-1437) (NRC 1996). NUREG-1437's description of the environmental impacts of other technologies is representative of the impacts associated with the construction and operation of a new generating unit at the Calvert Cliffs site. Under the purchased power alternative, the environmental impacts of power production would still occur but would be located elsewhere within the region, nation, or in another country. The environmental impacts of coal-fired and natural gas-fired plants are discussed in Section 9.2.2.

If the purchased power alternative were to be implemented, the most significant environmental unknown would be whether new transmission line corridors would be required. The construction of new transmission lines could have environmental consequences, particularly if new transmission line corridors were needed. The review team concludes that the local environmental impacts from purchased power would be SMALL when existing transmission line corridors are used and could range from SMALL to LARGE if acquisition of new corridors is required. The environmental impacts of power generation would depend on the generation technology and location of the generation site and, therefore, are unknown. However, as discussed in Section 9.2.5, the review team concluded that from an environmental perspective, none of the viable energy alternatives would be clearly preferable to construction of a new baseload nuclear power generation plant located within UniStar's ROI.

Retired generating plants, predominately coal-fired and natural gas-fired plants that potentially could be reactivated, would ordinarily require extensive refurbishment prior to reactivation. Such vintage plants would typically require costly refurbishment to meet current environmental requirements. The environmental impacts of any reactivation scenario would be bounded by the impacts associated with coal-fired and natural gas-fired alternatives (see Section 9.2.2), which the staff concludes are not environmentally preferable to the proposed actions (see Section 9.2.5). Given both these refurbishment costs and the environmental impacts of operating such facilities, the review team concludes that reactivating retired generating plants would not be a reasonable alternative to the proposed action.

Nuclear power facilities are initially licensed by the NRC for a period of 40 years. The operating license can be renewed for up to 20 years, and NRC regulations provide for the possibility of additional license renewal. The owner of proposed Unit 3 would be UniStar (2009a). Constellation Energy Nuclear Group, LLC (Constellation) owns the two existing nuclear units at the Calvert Cliffs site, a nuclear generation unit at the R.E. Ginna site in New York State, and two nuclear generating units at the Nine Mile Point (NMP) site in New York State. Constellation has received renewed operating licenses for all of its nuclear units from the NRC. The environmental impacts of continued operation of a nuclear power plant are significantly less than construction of a new plant. However, continued operation of the existing nuclear plants has already been accounted for in energy planning.

Older existing fossil-fueled plants, predominately coal-fired and natural gas-fired plants, are likely to need refurbishing to extend plant life for an extended period (the proposed action assumes a minimum operating period of 40 years), and meeting current environmental requirements would also be costly. UniStar identified four older power plants scheduled for retirement in New Jersey, but none in Maryland (UniStar 2009a). The MPSC stated that no generating facilities in Maryland were scheduled for retirement as of early 2009 (MPSC 2009b). The Reliability First Corporation (RFC) expects retirement of approximately 1700 MW of existing generation capacity in its region through 2018 (RFC 2009). RFC is one of the eight approved regional entities in North America under the North American Electric Reliability Corporation. Maryland is included in the RFC region. Given both the costs of refurbishment and the environmental impacts of operating such facilities (see Section 9.2.2 and 9.2.5), the review team concludes that extending the life of existing generating plants would not be a reasonable alternative to the proposed action.

Improved energy efficiency can cost less than construction of new generation and provide a hedge against market, fuel, and environmental risks. Baltimore Gas and Electric Company (BGE), the regulated electric distribution affiliate of Constellation Generation Group, has residential, commercial, and industrial programs designed to reduce both peak demands and daily energy consumption. Program components include the following elements (UniStar 2009a):

- Peak clipping program – Including 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 – Using time-of-use rates and cool storage rebate programs to encourage shifting loads from peak to off-peak periods.
- Conservation programs – Promoting 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.

UniStar estimates the BGE program results in an annual peak demand generation reduction of about 700 MW(e) and believes that generation savings can continue to be increased under the programs. Based on existing programs, the load growth projection anticipates a savings of approximately 1000 MW(e) in 2016 (UniStar 2009a).

In 2007, the MPSC approved the following BGE "fast track" Energy Star conservation and energy efficiency programs: compact fluorescent light bulbs, window air conditioner replacement, and rebates for certain large appliances (MPSC 2008a).

In 2008, BGE started implementation of its voluntary demand response initiative for residential customers. Under the program, BGE will cycle off customers' air conditioning units during specified periods. Overall, BGE estimates a benefit of 600 MW of demand reduction from implementing the demand response initiative (MPSC 2008a).

The Maryland General Assembly enacted the EmPower Maryland Energy Efficiency Act in April 2008. Under the Act, each Maryland utility is required to develop and implement cost-effective programs and services that encourage and promote the efficient use and conservation of energy by consumers and utilities alike. The Act also establishes long-term target reduction goals for electric consumption and demand based on a per capita basis and a 2007 energy consumption baseline (MPSC 2009b).

The MPSC issued an Order on December 31, 2008, approving for implementation a series of energy efficiency and demand response programs proposed by BGE (MPSC 2008c). The proposed programs include new proposals, as well as its already-approved demand response programs. The programs are designed to achieve an estimated reduction in peak demand of approximately 1190 MW for 2011. The programs cover six residential, two small commercial, and three large commercial programs.

As discussed in Chapter 8, the MPSC took account of demand side management, demand response, and distributed generation in preparing its *Electric Supply Adequacy Report of 2007* (MPSC 2007). In the report, the MPSC determined there was a need for power in Maryland, even taking into account conservation and demand side management programs. The role of conservation was also addressed in MPSC's Order granting a Certificate of Public Convenience and Necessity to UniStar for proposed Unit 3 (MPSC 2009a).

Based on the preceding discussion, the review team concludes that the options of purchasing electric power from other suppliers, reactivating retired power plants, extending the operating life of existing power plants, and conservation and demand-side programs are not reasonable alternatives to providing new baseload power generation capacity.

9.2.2 Alternatives Requiring New Generating Capacity

Consistent with the NRC's evaluation of alternatives to operating license renewal for nuclear power plants, a reasonable set of energy alternatives to the construction and operation of one or more new nuclear units at the Calvert Cliffs site should be limited to analysis of discrete power generation sources, a combination of sources, and those power generation technologies that are technically reasonable and commercially viable (NRC 1996). The current mix of baseload power generation options in Maryland is one indicator of the feasible choices for power generation technology within the State. As of January 2009, the generation capacity profile in Maryland was approximately as follows: coal (39 percent), dual-fueled (petroleum and natural gas) (26 percent), nuclear (14 percent), natural gas and other gases (9 percent), petroleum (7 percent), hydroelectric (4 percent), and other renewable sources (1 percent) (MPSC 2009b). Coal and nuclear power plants typically operate in a baseload manner. Consequently, in 2007 coal-fired power plants were the source of 59.4 percent of the electricity generated in Maryland and nuclear plants 28.7 percent (MPSC 2009b).

This section discusses the environmental impacts of energy alternatives to the proposed action that would require UniStar to construct new generating capacity. The three primary energy sources for generating electric power in the United States are coal, natural gas, and nuclear energy (DOE/EIA 2007). Coal-fired plants are the primary source of baseload generation in the United States (DOE/EIA 2007). Natural gas combined-cycle generation plants are often used as intermediate generation sources (DOE/EIA 2007), but are also used as baseload generation sources.

Each year, the Energy Information Administration (EIA), a component of the U.S. Department of Energy (DOE), issues an annual energy outlook. In its updated *Annual Energy Outlook 2009* (DOE/EIA 2009), EIA's reference case projects that total electric generating capacity additions between 2007 and 2030 will use the following fuel types in the approximate percentages: natural gas plants (55 percents), renewables (27 percent), coal-fired plants (14 percent), and nuclear plants (5 percent) (DOE/EIA 2009). The EIA projection includes baseload, intermittent, and peaking units and is based on the assumption that providers of new generating capacity would seek to minimize cost while meeting applicable environmental requirements.

The discussion in Section 9.2.2 is limited to the individual alternatives that appear to the review team to be viable baseload generation sources: coal-fired and natural gas combined cycle-fired generation. The impacts discussed in Section 9.2.2 are estimates based on present technology. Section 9.2.3 addresses alternative generation technologies that have demonstrated commercial acceptance but may be limited in application, total capacity, or technical feasibility when based on the need to supply reliable, baseload capacity.

The review team assumed that (1) new generation capacity would be located at the Calvert Cliffs site for the coal- and natural gas-fired alternatives; (2) a combination dry and wet (hybrid) cooling tower, as proposed by UniStar for Unit 3, would be used for plant cooling; and (3) no new offsite transmission corridors would be needed, which is consistent with UniStar's COL application for Unit 3.

9.2.2.1 Coal-Fired Generation

For the coal-fired generation alternative, the review team assumed construction of supercritical pulverized coal-fired units at the Calvert Cliffs site. Supercritical pulverized coal-fired plants are similar to conventional pulverized coal-fired plants except they operate at slightly higher temperatures and higher pressures, which allows for greater thermal efficiency. Supercritical coal-fired plants are commercially proven and represent an increasing proportion of new coal-fired power plants.

The review team also considered an integrated gasification combined cycle (IGCC) coal-fired plant. IGCC is an emerging technology for generating electricity with coal that combines modern coal gasification technology with both gas turbine and steam turbine power generation. The technology is cleaner than conventional pulverized coal plants because major pollutants can be removed from the gas stream before combustion. The IGCC alternative also generates less solid waste than the pulverized coal-fired alternative. The largest solid waste stream produced by IGCC installations is slag, a black, glassy, sand-like material that is potentially a marketable byproduct. 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. In spite of the preceding advantages, the review team concludes that, at present, a new IGCC plant is not a reasonable alternative to a 1600-MW(e) nuclear power generation facility for the following reasons: (1) IGCC plants are more expensive than comparable pulverized coal plants (NETL 2007), (2) existing IGCC plants have considerably smaller capacity than that of the proposed 1600-MW(e) nuclear plant, (3) system reliability of existing IGCC plants has been lower than pulverized coal plants, (4) the existing IGCC plants have had an extended (though ultimately successful) operational testing period (NPCC 2005), and (5) a lack of overall plant performance warranties for IGCC plants has hindered commercial financing (NPCC 2005). For these reasons, IGCC plants are not considered further in this EIS.

A 1600-MW(e) coal-fired plant sited at Calvert Cliffs would consume approximately 4.5 million tons of coal per year (NETL 2007). It is assumed that coal and lime (calcium oxide or calcium hydroxide) or limestone (calcium carbonate) for a coal-fired plant would likely be delivered to the Calvert Cliffs site by barge. There is no direct rail access in Calvert and St. Mary's Counties within an 8-mi vicinity of the Calvert Cliffs site (UniStar 2008b). UniStar assumed that the plant would burn bituminous coal (UniStar 2009a). Lime or limestone, used in the scrubbing process for control of sulfur dioxide (SO_2) emissions, is injected as a slurry into the hot effluent combustion gases to remove entrained SO_2. The lime-based scrubbing solution reacts with SO_2 to form calcium sulfite, which precipitates and is removed from the process as sludge.

Approximately 450,000 tons/yr of limestone would be needed for flue gas desulfurization (NETL 2007).

Air Quality

The impacts on air quality from coal-fired generation would vary considerably from those of nuclear generation because of emissions of sulfur oxides (SO_x), nitrogen oxides (NO_x), carbon monoxide (CO), particulate matter (PM), and hazardous air pollutants (such as mercury). Particulate matter would consist of total suspended particulates (TSP) and PM_{10} (particulates with a diameter of 10 micrometers or less). In its COL application, UniStar assumed a coal-fired plant design that would minimize air emissions through a combination of boiler technology and post-combustion pollutant removal. The review team estimates that the coal-fired alternative emissions would be approximately as follows (UniStar 2009a):

- SO_x – 8800 tons/yr
- NO_x – 1240 tons/yr
- TSP – 320 tons/yr
- PM_{10} – 73 tons/yr
- CO – 1240 tons/yr.

The preceding estimates are scaled from emissions estimated for an alternative coal-fired power plant in Table 8-2 of the final supplemental EIS for the Beaver Valley Power Station (NRC 2009k). The estimates reflect EPA emission factors. The Beaver Valley EIS was selected because of (1) its geographic proximity (Pennsylvania), (2) it represented a recent staff evaluation, and (3) the coal plant evaluated in the EIS is of comparable size (1842 MW(e)) to proposed Unit 3. The alternative coal plant would emit small amounts of mercury and other hazardous air pollutants, and some naturally occurring radioactive materials. UniStar estimates that the plant would also emit approximately 12.4 million tons/yr of carbon dioxide (CO_2) (UniStar 2009a).

The acid rain requirements of the Clean Air Act capped the nation's SO_2 emissions from power plants. UniStar would need to obtain sufficient pollution credits either from a set-aside pool or purchases on the open market to cover annual emissions from the plant.

A new coal-fired generation plant at the Calvert Cliffs site would likely need a prevention of significant deterioration (PSD) permit and an operating permit from the Maryland Department of the Environment (MDE). The plant would need to comply with the new source performance standards for such plants in 40 CFR Part 60, Subpart Da. The standards establish emission limits for PM and opacity (40 CFR 60.42Da), SO_2 (40 CFR 60.43Da), NO_x (40 CFR 60.44Da), and mercury (40 CFR 60.45Da).

The EPA has various regulatory requirements for visibility protection in 40 CFR Part 51, Subpart P, including a specific requirement for review of any new major stationary source in an area designated as in attainment or unclassified for criteria pollutants under the Clean Air Act (40 CFR 51.307(a)). Criteria pollutants under the Clean Air Act are lead, ozone, particulates, CO, NO_2, and SO_2. Ambient air-quality standards for criteria pollutants are in 40 CFR Part 50. As discussed in Section 2.9.2, with the exception of the 8-hour National Ambient Air Quality Standard for ozone, the Calvert Cliffs site is in an area designated as in attainment or unclassified for all criteria pollutants (40 CFR 81.344).

Section 169A of the Clean Air Act (42 U.S.C. 7491) establishes a national goal of preventing future and remedying existing impairment of visibility in mandatory Class I Federal areas when impairment occurs because of air pollution resulting from human activities. In addition, EPA regulations provide that for each mandatory Class I Federal area located within a State, the State must establish goals that provide for reasonable progress toward achieving natural visibility conditions. The reasonable progress goals must provide for an improvement in visibility for those days on which visibility is most impaired over the period of the implementation plan and confirm no degradation in visibility for the least visibility-impaired days over the same period (40 CFR 51.308(d)(1)). If a new coal-fired power generation station were located close to a mandatory Class I area, additional air pollution control requirements could be imposed. There are no mandatory Class I Federal areas within 50 mi of the Calvert Cliffs site. The fugitive dust emissions from construction activities would be mitigated using best management practices (BMPs). Such emissions would be temporary.

The generic environmental impact statement (GEIS) for license renewal mentions global warming from unregulated carbon dioxide emissions and acid rain from SO_x and NO_x emissions as a potential impact (NRC 1996). Adverse human health effects, such as cancer and emphysema, have been associated with byproducts of coal; combustion. Overall, the review team concludes that air quality impacts from new coal-fired power generation at the Calvert Cliffs site would be MODERATE. The impacts would be clearly noticeable but would not destabilize air quality.

Waste Management

As the NRC has described in NUREG-1437 (NRC 1996) and verified during its preparation of operating license renewal supplemental EIS analyses since the publication of that document, coal combustion generates waste in the form of ash, and equipment for controlling air pollution generates additional ash, spent selective catalytic reduction (SCR) catalyst, and scrubber sludge. UniStar estimates that landfill disposal of the ash and scrubber sludge generated by a 1600-MW(e) coal-fired plant over a 40-year plant life would require approximately 600 ac (UniStar 2009a). Approximately 89,000 tons/yr of scrubber sludge and 356,000 tons/yr of ash would be generated by the plant (NETL 2007).

In May 2000, EPA issued a "Notice of Regulatory Determination on Wastes from the Combustion of Fossil Fuels" (65 FR 32214). The EPA concluded that some form of national regulation is warranted to address coal combustion waste products because of health concerns. Accordingly, EPA announced its intention to issue regulations for disposal of coal-combustion waste under Subtitle D of the Resource Conservation and Recovery Act of 1976, as amended (RCRA). As of November 2009, EPA is continuing to study the appropriate form of regulation for coal combustion waste products.

Waste impacts on groundwater and surface water could extend beyond the operating life of the plant if leachate and runoff from the waste storage area occurs. Disposal of the waste could noticeably affect land use (because of the acreage needed for waste) and groundwater quality, but, with appropriate management and monitoring, it would not destabilize any resources. After closure of the waste site and revegetation, the land could be available for other uses. Construction-related debris would be generated during plant construction activities, and would be disposed of in approved landfills.

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

Human Health

Coal-fired power generation introduces worker risks from coal and limestone mining, worker and public risk from coal and lime/limestone transportation, worker and public risk from disposal of coal-combustion waste, and public risk from inhalation of stack emissions. In addition, the discharges of uranium and thorium from coal-fired plants can potentially produce radiological doses in excess of those arising from nuclear power plant operations (Gabbard 1993).

Regulatory agencies, including the EPA and State agencies, base air emission standards and requirements on human health impacts. These agencies also impose site-specific emission limits as needed to protect human health. Given the regulatory oversight exercised by the EPA and State agencies, the review team concludes that the human health impacts from radiological doses and inhaled toxins and particulates generated from coal-fired generation would be SMALL.

Other Impacts

Approximately 300 ac would need to be converted to industrial use for the powerblock, infrastructure and support facilities, coal and limestone storage, and handling sludge (UniStar 2009a). Land-use changes would also occur offsite in an undetermined coal-mining area to supply coal for the plant and for landfill disposal of ash and scrubber sludge. In NUREG-1437, the NRC staff estimated that approximately 22,000 ac would be needed for coal mining and waste disposal to supply a 1000-MW(e) coal-fired power plant over its operating life (NRC 1996), which would scale up to over 35,000 ac for a 1600-MW(e) facility. Based on the amount of land affected for both the site and mining, the review team concludes that land-use impacts would be MODERATE.

The amounts of water used, and the impacts on water use and quality from constructing and operating a coal-fired plant at the Calvert Cliffs site would be comparable to those associated with a new nuclear plant. All discharges would be regulated by the MDE through a National Pollutant Discharge Elimination System (NPDES) permit. Indirectly, water quality could be affected by acids and mercury from air emissions. However, these emissions are regulated to minimize impacts. In NUREG-1437, the NRC staff determined that some erosion and sedimentation would likely occur during construction of new facilities (NRC 1996). These impacts would be similar to those for a new nuclear plant. Overall, the review team concludes that the water-use and water-quality impacts would be SMALL.

The coal-fired generation alternative would introduce ecological impacts from construction and new incremental impacts from operations. The impacts would be similar to those of the proposed action at the Calvert Cliffs site. The noticeable impacts would include loss of wetland area and function, elimination of onsite streams and ponds, forest fragmentation, habitat loss for important species, and disruption and conversion of benthic habitats in the Bay. Some of the impact at the Calvert Cliffs site would occur in areas that were previously disturbed during the construction of Calvert Cliffs Nuclear Power Plant (CCNPP) Units 1 and 2, thereby limiting potential ecological effects. Disposal of waste products ash could affect aquatic and terrestrial resources. Impacts on threatened and endangered species would likely be similar to the impacts from a new nuclear facility located at the Calvert Cliffs site. Although the expected impact footprint for a coal-fired plant would be somewhat smaller than that for a nuclear facility (assuming waste disposal at another location), the review team concludes that the ecological impacts would be MODERATE.

Socioeconomic impacts would result from the workers needed to construct and operate the plant, demands on housing and public services during construction, and the loss of jobs after construction. Construction and operation of a coal plant is smaller in scale than a nuclear plant of comparable size due to the shorter construction timeline and smaller construction and operations workforce needed. Overall, because the scale of activity for coal-fired power generation would be smaller than that for Calvert Cliffs Unit 3, but still significant in Calvert County, the review team concludes that these impacts would be similar to those for a new nuclear plant: SMALL to MODERATE. UniStar would pay significant property taxes for the plant to Calvert County. Considering the population and economic condition of the County, the review team concludes that the taxes would have a LARGE beneficial impact to Calvert County with SMALL beneficial impacts elsewhere in the region.

The coal-fired powerblock units and cooling tower may be visible from Chesapeake Bay. The hybrid cooling tower would not produce any visible plume (UniStar 2009a). The exhaust stacks would be as much as 600 ft high and would be visible from Chesapeake Bay. The stacks and associated emissions would likely be visible in daylight hours for distances greater than 10 mi. The powerblock units and associated stacks would also be visible at night because of outside lighting. The Federal Aviation Administration (FAA) generally requires that all structures exceeding an overall height of 200 ft above ground level have markings and/or lighting so as not to impair aviation safety (FAA 2007). The visual impacts of a new coal-fired plant could be mitigated by landscaping and color selection for buildings that is consistent with the environment. Visual impacts at night could be mitigated by reduced use of lighting, enhanced use of downfacing lighting (provided the lighting meets FAA requirements), and appropriate use of shielding. Overall, the review team concludes that the aesthetic impacts associated with new coal-fired power generation at the Calvert Cliffs site would be MODERATE.

Coal-fired power generation would introduce mechanical sources of noise that would be audible offsite. Sources contributing to the noise produced by plant operation are classified as continuous or intermittent. Continuous sources include the mechanical equipment associated with normal plant operations. Intermittent sources include the equipment related to coal handling, solid-waste disposal, transportation related to coal and limestone delivery, use of outside loudspeakers, and the commuting of plant employees. Noise impacts associated with barge delivery of coal and lime/limestone would be minimal. The review team concludes that the impacts of noise on residents in the vicinity of the facility would be SMALL. Noise and light from the plant would be detectable offsite.

Historic and cultural resource impacts for a new coal-fired plant located at the Calvert Cliffs site would be similar to the impacts for a new nuclear plant, as discussed in Sections 4.6 and 5.6 of this EIS. A cultural resources inventory would likely be needed for any onsite property that has not been previously surveyed. Other lands, if any, acquired to support the plant would also likely need an inventory of field cultural resources, identification and recording of existing historic and archaeological resources, and possible mitigation of the adverse effect from ground-disturbing actions. The studies would likely be needed for all areas of potential disturbance at the plant site; any offsite affected areas, such as mining and waste-disposal sites; and along associated corridors where new construction would occur, such as roads. Because adverse effects are likely to affect three National Register of Historic Places (NRHP)-eligible resources, the review team concludes the historic and cultural resource impacts would be LARGE.

As discussed in Section 2.6 of this EIS, there are minority and low-income persons in the population near the Calvert Cliffs site. However, environmental impacts on minority and low-income populations associated with a new coal-fired plant located at the Calvert Cliffs site would be similar to those for a new nuclear plant, which the review team has concluded are SMALL.

The review team's characterizations of the construction and operation impacts of coal-fired power generation at the Calvert Cliffs site are summarized in Table 9-1.

9.2.2.2 Natural Gas-Fired Generation

For the natural gas alternative, the review team assumed construction and operation of a natural gas-fired plant located at the Calvert Cliffs site. The review team assumed that the plant would use combined-cycle combustion turbines.

Air Quality

Natural gas is a relatively clean-burning fuel. When compared to a coal-fired plant, a natural gas-fired plant would release similar types of emissions, but in lower quantities.

A new natural gas-fired power generation plant would likely need a PSD permit and an operating permit from the MDE. A new natural gas-fired combined-cycle plant would also be subject to the new source performance standards in 40 CFR Part 60, Subparts Da and GG. These regulations establish emission limits for particulates, opacity, SO_2, and NO_X.

The EPA has various regulatory requirements for visibility protection in 40 CFR Part 51, Subpart P, including a specific requirement for review of any new major stationary source in areas designated as in attainment or unclassified under the Clean Air Act. As discussed in Section 2.9.2, with the exception of the 8-hour National Ambient Air Quality Standard for ozone, the Calvert Cliffs site is in an area designated as in attainment or unclassified for criteria pollutants (40 CFR 81.32).

Section 169A of the Clean Air Act (42 U.S.C. 7491) establishes a national goal of preventing future impairment of visibility and remedying existing impairment in mandatory Class I Federal areas when impairment is from air pollution caused by human activities. In addition, EPA regulations provide that for each mandatory Class I Federal area located within a State, the State must establish goals that provide for reasonable progress toward achieving natural visibility conditions. The reasonable progress goals must provide for an improvement in visibility for the most impaired days over the period of the implementation plan and verify no degradation in visibility for the least-impaired days over the same period (40 CFR 51.308(d)(1)). If a new natural gas-fired power plant were located close to a mandatory Class I area, additional air pollution control requirements could be imposed. There are no mandatory Class I Federal areas within 50 mi of the Calvert Cliffs site.

Table 9-1. Summary of Environmental Impacts of Coal-Fired Power Generation

Impact Category	Impact	Comment
Land use	MODERATE	Uses approximately 900 ac for the powerblock, infrastructure and support facilities, coal and limestone storage and handling, and landfill disposal of ash and scrubber sludge. Mining activities would have additional impacts offsite.
Air quality	MODERATE	Estimated emissions: SO_x – 8800 tons/yr NO_x – 1240 tons/yr PM– 320 tons/yr of TSP 73 tons/yr of PM_{10} CO – 1240 tons/yr CO_2–12.4 million tons/yr Small amounts of hazardous air pollutants.
Water use and quality	SMALL	Impacts would be comparable to the impacts for a new nuclear power plant located at the Calvert Cliffs site.
Ecology	MODERATE	The impacts on and around the site would be similar to those of the proposed action. The noticeable impacts would include loss of wetland area and function, elimination of onsite streams and ponds, forest fragmentation and habitat loss for important species, and disruption and conversion of benthic habitats in the Bay. Impacts on threatened and endangered species would be similar to the impacts from a new nuclear facility at the Calvert Cliffs site.
Waste management	MODERATE	Approximately 89,000 tons/yr of scrubber sludge and 356,000 tons/yr of ash would be generated.
Socioeconomics (except Taxes and Economy)	SMALL to MODERATE Adverse	Impacts related to building the facilities would be noticeable. Depending on where the workforce lives, the building-related impacts would be noticeable or minor. Impacts of coal transportation during operation would be noticeable. The plant would have aesthetic impacts. Some offsite noise impacts would occur.
Socioeconomics (Taxes and Economy)	SMALL to LARGE Beneficial	Local property tax base would benefit mainly during operations.
Human health	SMALL	Regulatory controls and oversight are assumed to be protective of human health.
Historic and cultural resources	LARGE	Adverse effects are likely to three NRHP-eligible resources.
Environmental justice	SMALL	There are minority and low-income persons in the local population; however, impacts to such persons would likely be minimal.

The review team estimates that a natural gas-fired plant equipped with pollution control technology to meet emission limits would have approximately the following emissions (UniStar 2009a):

- SO_x – 112 tons/yr
- NO_x – 370 tons/yr
- PM_{10} – 65 tons/yr
- CO – 77 tons/yr.

The preceding estimates are scaled from emissions estimated for an alternative natural gas fired power plant in Table 8-3 of the final supplemental EIS for the Beaver Valley Power Station (NRC 2009k). The estimates reflect EPA emission factors. The Beaver Valley EIS was selected because of (1) its geographic proximity (Pennsylvania), (2) it represented a recent staff evaluation, and (3) the natural gas plant evaluated in the EIS is of comparable size (2000 MW(e)) to proposed Unit 3. The alternative natural gas plant would emit small amounts of hazardous air pollutants. UniStar estimates that the plant would also emit approximately 5.6 million tons/yr of CO_2 (UniStar 2009a).

The combustion turbine portion of the combined-cycle plant would be subject to EPA's National Emission Standards for Hazardous Air Pollutants for Stationary Combustion Turbines (40 CFR Part 63, Subpart YYYY) if the site is a major source of hazardous air pollutants. Major sources have the potential to emit 10 tons/yr or more of any single hazardous air pollutant or 25 tons/yr or more of any combination of hazardous air pollutants (40 CFR 63.6085(b)). The fugitive dust emissions from construction activities would be mitigated using BMPs; such emissions would be temporary.

The impacts of emissions from a natural gas-fired power generation plant would be clearly noticeable, but would not be sufficient to destabilize air resources. Overall, the review team concludes that air quality impacts resulting from construction and operation of new natural gas-fired power generation at the Calvert Cliffs site would be SMALL to MODERATE.

Waste Management

In NUREG-1437, the NRC staff concluded that waste generation from natural gas-fired technology would be minimal (NRC 1996). The only significant waste generated at a natural gas-fired power plant would be spent SCR catalyst, which is used to control NO_x emissions. The spent catalyst would be regenerated or disposed of offsite. Other than spent SCR catalyst, waste generation at an operating natural gas-fired plant would be largely limited to typical operations and maintenance waste. Construction-related debris would be generated during construction activities. Overall, the review team concludes that waste impacts from natural gas-fired power generation would be SMALL.

Human Health

Natural gas-fired power generation introduces public risk from inhalation of gaseous emissions. The risk may be attributable to NO_x emissions that contribute to ozone formation, which, in turn, contribute to health risk. Regulatory agencies, including the EPA and State agencies, base air emission standards and requirements on human health impacts. These agencies also impose site-specific emission limits as needed to protect human health. Given the regulatory oversight exercised by the EPA and State agencies, the review team concludes that the human health impacts from natural gas-fired power generation would be SMALL.

Other Impacts

A natural gas-fired generating plant would require approximately 60 ac for the power-block and support facilities (UniStar 2009a). Construction of a natural gas pipeline from the Calvert Cliffs site to the closest natural gas distribution line would require approximately 10 ac (UniStar 2009a). The Cove Point Liquid Natural Gas pipeline runs parallel to Maryland State Route 2/4 and would be the closest natural gas pipeline to the Calvert Cliffs site. Thus, the total land commitment locally would be approximately 70 ac. A small amount of additional land would also be required for natural gas wells and collection stations. Overall, the review team concludes that the land-use impacts from new natural gas-fired power generation at the Calvert Cliffs site would be SMALL.

The amount of water used and the impacts on water use and quality from constructing and operating a natural gas-fired plant at the Calvert Cliffs site would be somewhat less than the impacts associated with constructing and operating a new nuclear facility. The impacts on water quality from sedimentation during construction of a natural gas-fired plant were characterized in NUREG-1437 as SMALL (NRC 1996). The NRC also noted in this document that the impacts on water quality from operations would be similar to, or less than, the impacts from other generating technologies (NRC 1996). Overall, the review team concludes that impacts on water use and quality would be SMALL.

A natural gas-fired plant at the Calvert Cliffs site would have less extensive ecological impacts than a new nuclear facility. Most of the impacts could be limited to areas that were previously disturbed during the construction of Units 1 and 2. Although constructing a new underground gas pipeline to the site would result in conversion and fragmentation of about 10 ac of terrestrial habitat, no important ecological attributes would be noticeably altered. Impacts on threatened and endangered species would likely be similar to the impacts from a new nuclear facility located at the Calvert Cliffs site. Overall, the review team concludes that ecological impacts would be SMALL.

Socioeconomic impacts would result from the workers needed to construct and operate the plant, demands on housing and public services during construction, and the loss of jobs after construction. Overall, the review team concludes that these impacts would be SMALL because of the mitigating influence of the site's proximity to the surrounding population area and the relatively small number of workers needed to construct and operate the plant in comparison to nuclear and coal-fired generation alternatives. UniStar would pay property taxes for the plant to Calvert County. Considering the population and economic condition of the County, the review team concludes that the taxes would have a MODERATE beneficial impact on Calvert County with SMALL beneficial impacts elsewhere in the region.

The turbine buildings, four exhaust stacks (approximately 200 ft tall) and associated emissions, cooling towers, condensation plumes from the cooling towers, and the gas pipeline compressors would be visible during daylight hours from offsite. Noise and light from the plant would be detectable offsite. An ameliorating factor is that the Calvert Cliffs site is currently an industrial site located in a rural, forested area. Overall, the review team concludes that the aesthetic impacts associated with new natural gas-fired power generation at the Calvert Cliffs site would be similar to those for a nuclear plant and, therefore, SMALL.

Historic and cultural resource impacts for a new natural gas-fired plant located at the Calvert Cliffs site would be similar to the impacts for a new nuclear plant as discussed in Sections 4.6 and 5.6 of this EIS. A cultural resources inventory would likely be needed for any onsite property that has not been previously surveyed. Other lands, if any, acquired to support the plant would also likely need an inventory of field cultural resources, identification, and recording of existing historic and archaeological resources, and possible mitigation of the adverse effect from ground-disturbing actions. The studies would likely be needed for all areas of potential disturbance at the plant site; any offsite affected areas, such as mining and waste disposal sites; and along associated corridors where new construction would occur, such as roads. Because adverse effects are likely to three NRHP-eligible resources, the review team concludes that the historic and cultural resource impacts would be LARGE.

As described in Section 2.6, there are minority and low-income persons in the population around the Calvert Cliffs site. The impacts of a natural gas-fired plant at the Calvert Cliffs site on minority or low-income populations would be similar to the impacts for a nuclear plant and, therefore, SMALL.

The construction and operational impacts of natural gas-fired power generation at the Calvert Cliffs site are summarized in Table 9-2.

1 **Table 9-2**. Summary of Environmental Impacts of Natural Gas-Fired Power Generation

Impact Category	Impact	Comment
Land use	SMALL	Approximately 70 ac would be needed for the power-block and support systems and connection to a natural gas pipeline.
Air quality	SMALL to MODERATE	Estimated emissions: SO_x – 112 tons/yr NO_x – 370 tons/yr PM_{10} – 65 tons/yr CO – 77 tons/yr CO_2 – 5.6 million tons/yr Small amounts of hazardous air pollutants.
Water use and quality	SMALL	Impacts would be somewhat less than the impacts for a new nuclear power plant located at the Calvert Cliffs site.
Ecology	SMALL	Most of the impacts would be limited to areas that were previously disturbed during the construction of Units 1 and 2. Although constructing a new underground gas pipeline to the site would result in permanent loss of some terrestrial and aquatic function and conversion and fragmentation of about 10 ac of terrestrial habitat, no important ecological attributes would be noticeably altered. Impacts on threatened and endangered species would be less than or similar to the impacts from a new nuclear facility at the Calvert Cliffs site.
Waste management	SMALL	The only significant waste would be from spent SCR catalyst used for control of NO_x emissions.
Socioeconomics (except Taxes and Economy)	SMALL	Construction and operations workforces would be relatively small. Impacts during operation would be minor because of the small workforce involved. The plant would have aesthetic impacts.
Socioeconomics (Taxes and Economy)	SMALL to MODERATE Beneficial	Additions to the property tax base, while smaller than for a nuclear or coal-fired plant, would still be noticeable.
Human health	SMALL	Regulatory controls and oversight are assumed to be protective of human health.
Historic and cultural resources	LARGE	Adverse effects are likely to three NRHP-eligible resources.
Environmental justice	SMALL	There are minority and low-income persons in the local population; however, impacts to such persons would likely be minimal.

9.2.3 Other Alternatives

This section discusses other energy alternatives, the review team's conclusions about the feasibility of each alternative, and the review team's bases for those conclusions. A new nuclear unit at the Calvert Cliffs site would be a baseload generation plant. Any feasible alternative to the new unit would need to generate baseload power. In performing its initial evaluation in the ER, UniStar used the findings documented in NUREG-1437 (NRC 1996; UniStar 2009a). The review team also reviewed the information submitted by UniStar, conducted an independent review, and determined the other energy alternatives are not reasonable alternatives to a new nuclear unit that would provide baseload power.

The review team has not assigned significance levels to the environmental impacts associated with the alternatives discussed in this section because, in general, the generation alternatives would have to be installed at a location other than the Calvert Cliffs site. Any attempt to assign significance levels would require the review team's speculation about the unknown site.

9.2.3.1 Oil-Fired Generation

In its updated *Annual Energy Outlook 2009,* EIA's reference case projects that oil-fired power plants will not account for any new electric power generation capacity in the United States through the year 2030 (DOE/EIA 2009). Oil-fired generation is more expensive than nuclear, natural gas-fired, or coal-fired generation options. In addition, future increases in oil prices are expected to make oil-fired generation increasingly more expensive. The high cost of oil has resulted in a decline in its use for electricity generation. In Section 8.3.11 of NUREG-1437, the NRC staff estimated that construction of a 1000-MW(e) oil-fired plant would require about 120 ac of land (NRC 1996). Operation of an oil-fired power plant would have environmental impacts that would be similar to those of a comparably sized coal-fired plant (NRC 1996).

For the preceding economic and environmental reasons, the review team concludes that an oil-fired power plant would not be a reasonable alternative to construction of a 1600-MW(e) nuclear power generation facility that would be operated as a baseload plant within UniStar's ROI.

9.2.3.2 Wind Power

The Maryland Department of Natural Resources (MDNR) Power Plant Research Program has estimated Maryland's wind energy potential as between 627 and 1078 MW (MDNR PPRP 2008). The MPSC considered the potential for wind power in Maryland in a 2008 report (MPSC 2008b) and concluded the economic benefits from renewables remain uncertain and challenging. Onshore wind yields net economic benefits, albeit on a small scale. Offshore wind, as modeled in the report, does not yield economic benefits.

Newer wind turbines typically operate at approximately a 36 percent capacity factor (DOE 2008a). In comparison, the average capacity factor for a nuclear generation plant in 2008 in the United States was approximately 91.5 percent (NEI 2009). Wind turbines generally can serve as an intermittent baseload power supply (NPCC 2005). Wind power, in conjunction with energy storage mechanisms such as pumped hydroelectric or compressed air energy storage (CAES), or another readily dispatchable power source, such as hydropower, might serve as a means of providing baseload power.

EIA is not projecting any growth in pumped storage capacity through 2030 (DOE/EIA 2009). In addition, the review team concludes in Section 9.2.3.4 that the potential for new hydroelectric development in Maryland is limited. Therefore, the review team concludes that the use of pumped storage in combination with wind turbines to generate 1600 MW(e) is unlikely in Maryland.

A CAES plant consists of motor-driven air compressors that use low-cost, off-peak electricity to compress air into an underground storage medium. During high electricity demand periods, the stored energy is recovered by releasing the compressed air through a combustion turbine to generate electricity (NPCC 2009). Only two CAES plants are currently in operation. A 290 MW plant near Bremen, Germany began operating in 1978. A 110-MW plant located in McIntosh, Alabama has been operating since 1991. Both facilities use mined salt caverns (Succar and Williams 2008). A CAES plant requires suitable geology such as an underground cavern for energy storage. A 268-MW CAES plant coupled to a wind farm, the Iowa Stored Energy Park, has been proposed for construction near Des Moines, Iowa. The facility would use a porous rock storage reservoir for the compressed air (Succar and Williams 2008). To date, nothing approaching the scale of a 1600 MW(e) facility has been contemplated. Therefore, the review team concludes that the use of CAES in combination with wind turbines to generate 1600 MW(e) in Maryland is unlikely.

Southern Company and the Georgia Institute of Technology (GIT) studied the viability of offshore wind turbines in the southeast (Southern and GIT 2007). Among the conclusions of the study authors were the following: (1) the available wind data indicates that a wind farm located offshore of Georgia would likely have an adequate wind speed to support a project, although offshore project costs run approximately 50 to 100 percent higher than land-based systems; (2) based on today’s prices for wind turbines, the 20-year levelized cost of electricity produced from an offshore wind farm would be above the current production costs from existing power generation facilities; (3) the current commercially available offshore wind turbines are not built to withstand major hurricanes above a Category 3 or a 1-minute sustained wind speed of 124 mph; and (4) the U.S. Department of Interior Minerals Management Service (MMS) has jurisdiction, as authorized in the Energy Policy Act of 2005, over alternative energy-related projects on the outer continental shelf, including wind power developments. MMS issued final regulations in April 2009 (74 FR 19638) to establish a program to grant leases, easements, and rights-of-way for renewable energy project activities on the outer continental shelf. The review team believes that the preceding conclusions would generally apply to a wind farm located offshore of Maryland based on similarities in the physical and regulatory environments.

For the preceding reasons, the review team concludes that a wind energy facility would not currently be a reasonable alternative to construction of a 1600-MW(e) nuclear power generation facility that would be operated as a baseload plant within UniStar's ROI.

9.2.3.3 Solar Power

Solar technologies use energy and light from the sun to provide heating and cooling, light, hot water, and electricity for consumers. Solar energy can be converted to electricity using solar thermal technologies or photovoltaics. Solar thermal technologies employ concentrating devices to create temperatures suitable for power production. Concentrating thermal technologies are currently less costly than photovoltaics for bulk power production. They can also be provided with energy storage or auxiliary boilers to allow operation during periods when the sun is not shining (NPCC 2006). The largest operational solar thermal plant is the 310-MW Solar Energy Generating System located in the Mojave Desert in Southern California (NextEra Energy 2009).

Solar radiation has a low energy density relative to other common energy sources. Consequently, a large total acreage is needed to gather an appreciable amount of energy. Typical solar-to-electric power plants require 5 to 10 ac for every MW of generating capacity (TSECO 2008). Thus, approximately 8000–16,000 ac would be needed for a hypothetical 1600-MW(e) solar power plant. For a large solar plant to be practical, a means to store large quantities of energy (those discussed in Section 9.2.3.2) for distribution when the plant is producing less that 1600 MW(e) would be needed. However, the use of these storage mechanisms on this scale in Maryland is unlikely, as discussed in Section 9.2.3.2.

Looking at the specific technologies, for flat-plate photovoltaic collectors, DOE states that Maryland has a good, useful solar resource throughout most of the State. For concentrating collectors, Maryland has a marginal solar resource. Although certain technologies may work in specific applications, most concentrating collectors are not effective with Maryland's solar resource (DOE 2008b).

The MPSC considered the potential for solar power in Maryland in a 2008 report (MPSC 2008b) and concluded the economic benefits from renewables remain uncertain and challenging. For solar energy, the MPSC concluded that the overall economics of solar remain negative, but could improve if technology progresses much faster than contemplated in the report and various financial incentives continue over the long term.

For the preceding reasons, the review team concludes that solar energy facilities would not currently be a reasonable alternative to construction of a 1600-MW(e) nuclear power generation facility that would be operated as a baseload plant within UniStar's ROI.

9.2.3.4 Hydropower

Maryland has a relatively low hydropower resource as a percentage of the State's electricity generation (DOE 2008b). The Conowingo Hydroelectric Plant on the Susquehanna River, one of Maryland's largest generation facilities, provides almost all of the State's hydroelectricity (DOE/EIA 2008). A 1997 study by the Idaho National Engineering and Environmental Laboratory (INEEL) identified an approximate additional 29 MW of undeveloped hydro resource in Maryland (Conner and Francfort 1997).

EIA's reference case in its updated *Annual Energy Outlook 2009* projects that U.S. electricity production from hydropower plants will remain essentially stable through the year 2030 (DOE/EIA 2009).

In NUREG-1437, the NRC staff estimated that land requirements for hydroelectric power are approximately 1 million ac per 1000 MW(e) (NRC 1996). Because of the relatively low amount of undeveloped hydropower resource in Maryland and the large land-use and related environmental and ecological resource impacts associated with siting hydroelectric facilities large enough to produce 1600 MW(e), the review team concludes that hydropower is not a feasible alternative to construction of a new 1600 MW(e) nuclear power generation facility operated as a baseload plant within UniStar's ROI.

9.2.3.5 Geothermal Energy

Hydrothermal resources – reservoirs of steam or hot water – are available primarily in the western states, Alaska, and Hawaii. However, Earth's energy can be tapped almost anywhere with geothermal heat pumps and direct-use applications. Sources of other geothermal resources (e.g., hot dry rock or magma) require further technology development (DOE 2006).

Geothermal energy has an average capacity factor of 90 percent and can be used for baseload power where available. However, geothermal technology is not widely used as baseload power generation because of the limited geographical availability of the resource and immature status of the technology (NRC 1996). Geothermal systems have a relatively small footprint and minimal emissions (MIT 2006). A recent study led by the Massachusetts Institute of Technology (MIT) concluded that a $300 to $400 million investment over 15 years would be needed to make early-generation enhanced geothermal system power plant installations competitive in the evolving U.S. electricity supply markets (MIT 2006). Maryland has vast low-temperature resources suitable for geothermal heat pumps. However, Maryland does not have sufficient resources to use other geothermal technologies (DOE 2008b).

For the preceding reasons, the review team concludes that one or more geothermal energy facilities would not currently be a reasonable alternative to construction of a 1600-MW(e) nuclear power generation facility operated as a baseload plant within UniStar's ROI.

9.2.3.6 Wood Waste

In NUREG-1437, the NRC staff determined that a wood-burning facility can provide baseload power and operate with an average annual capacity factor of around 70 to 80 percent and with 20 to 25 percent efficiency (NRC 1996). The fuels required are variable and site-specific. A significant impediment to the use of wood waste to generate electricity is the high cost of fuel delivery and high construction cost per megawatt of generating capacity. The larger wood-waste power plants are only 40 to 50 MW(e) in size. Estimates in NUREG-1437 suggest that the overall level of construction impacts per megawatt of installed capacity would be approximately the same as that for a coal-fired plant, although facilities using wood waste for fuel would be built at smaller scales (NRC 1996). Similar to coal-fired plants, wood-waste plants require large areas for fuel storage and processing and involve the same type of combustion equipment.

Because of uncertainties associated with obtaining sufficient wood and wood waste to fuel a baseload power plant, the ecological impacts of large-scale timber cutting (for example, soil erosion and loss of wildlife habitat), and high inefficiency, the review team concludes that wood waste-based generation would not be a reasonable alternative to a 1600-MW(e) nuclear power generation facility operated as a baseload plant within UniStar's ROI.

9.2.3.7 Municipal Solid Waste

Municipal solid-waste combustors incinerate the waste and use the resultant heat to produce steam, hot water, or electricity. The combustion process reduces the volume of waste and the need for new solid waste landfills (EPA 2009a). Municipal waste combustors use three basic types of technologies: mass burn, modular, and refuse-derived fuel (DOE/EIA 2001). Mass burning technologies are most commonly used in the United States. This group of technologies processes raw municipal solid waste "as is," with little or no sizing, shredding, or separation before combustion. In NUREG-1437, the NRC staff determined that the initial capital cost for municipal solid-waste plants is greater than for comparable steam-turbine technology at wood-waste facilities because of the need for specialized waste-separation and waste-handling equipment for municipal solid waste (NRC 1996).

Municipal solid-waste combustors generate an ash residue that is buried in landfills. The ash residue is composed of bottom ash and fly ash. Bottom ash refers to that portion of the unburned waste that falls to the bottom of the grate or furnace. Fly ash represents the small particles that rise from the furnace during the combustion process. Fly ash is generally removed from flue gases using fabric filters and/or scrubbers (DOE/EIA 2001).

Currently, approximately 87 waste-to-energy plants are operating in the United States (EPA 2009a). These plants collectively generate approximately 2500 MW(e), or an average of approximately 29 MW(e) per plant (EPA 2009a). Given the small size of existing plants, the review team concludes that generating electricity from municipal solid waste would not be a reasonable alternative to a 1600-MW(e) nuclear power generation facility operated as a baseload plant within UniStar's ROI.

9.2.3.8 Other Biomass-Derived Fuels

In addition to wood and municipal solid-waste fuel, several other biomass-derived fuels are available for fueling electric generators, including burning crops, converting crops to a liquid fuel (such as ethanol), and gasifying crops (including wood waste). EIA estimates that wind and biomass will be the largest source of renewable electricity generation among the nonhydropower renewable fuels through the year 2030 (DOE/EIA 2009). However, in NUREG-1437, the NRC staff determined that none of these technologies has progressed to the point of being competitive on a large scale or of being reliable enough to replace a large baseload generating plant (NRC 1996).

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

The review team concludes that given the relatively small size of biomass generation facilities, biomass-derived fuels do not offer a reasonable alternative to a 1600-MW(e) nuclear power generation facility operated as a baseload plant within UniStar's ROI.

9.2.3.9 Fuel Cells

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

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

During the past three decades, significant efforts have been made to develop more practical and affordable fuel cell designs for stationary power applications, but progress has been slow. The cost of fuel cell power systems must be reduced before they can be competitive with conventional technologies (DOE 2008d).

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

For the preceding reasons, the review team concludes that a fuel cell energy facility would not currently be a reasonable alternative to construction of a 1600-MW(e) nuclear power generation facility operated as a baseload plant within UniStar's ROI.

9.2.4 Combination of Alternatives

Individual alternatives to the construction of a new nuclear unit at the Calvert Cliffs site might not be sufficient on their own to generate UniStar's target value of 1600 MW(e) because of the small size of the resource or lack of cost-effective opportunities. Nevertheless, it is conceivable that a combination of alternatives might be cost effective. There are many possible combinations of alternatives. It would not be reasonable to examine every possible combination of energy alternatives in an EIS. Doing so would be counter to CEQ's direction that an EIS should be analytic rather than encyclopedic, shall be kept concise, and shall be no longer than absolutely necessary to comply with NEPA and CEQ's regulations (40 CFR Part 1502.2(a), (b)). Given that UniStar's objective is for a new baseload generation facility, a fossil energy source, most likely coal or natural gas, would need to be a significant contributor to any reasonable alternative energy combination.

Section 9.2.2.2 assumes the construction of natural gas combined-cycle generating units at the Calvert Cliffs site using the cooling technology proposed by UniStar for Unit 3. For a combined alternatives option, the review team assessed the environmental impacts of an assumed combination of 1200 MW(e) of natural gas combined-cycle generating units at the Calvert Cliffs site and the following contributions from within UniStar's ROI: 25 MW(e) of hydropower; 75 MW(e) from solar power; 100 MW(e) from biomass sources, including municipal solid waste; 100 MW(e) from conservation and demand-side management programs; and 100 MW(e) from wind power. The conservation and demand side programs are assumed to be implemented by BGE. The wind power would need to be coupled with a storage mechanism such as CAES to provide baseload power. Based on the information presented in the preceding sections of this chapter, the review team believes that these contributions are reasonable and representative. A summary of the review team's characterization of the environmental impacts associated with the construction and operation of the preceding combination of energy alternatives is shown in Table 9-3.

Table 9-3. Summary of Environmental Impacts of a Combination of Power Sources

Impact Category	Impact	Comment
Land use	MODERATE	A natural gas-fired plant would have land-use impacts for the powerblock, cooling towers and support systems, and connection to a natural gas pipeline. Wind, solar, hydroelectric, and biomass facilities and associated transmission lines would have land-use impacts in addition to the land-use impacts of the natural gas-fired plant. Both offshore wind development and hydropower plants would potentially impede navigation.
Air quality	SMALL to MODERATE	Emissions from the natural gas-fired plant would be approximately: SO_x – 84 tons/yr NO_x – 277 tons/yr PM_{10} – 49 tons/yr CO – 58 tons/yr CO_2 – 4.2 million tons/yr. Small amounts of hazardous air pollutants would be emitted. Municipal solid waste and biomass facilities would also have emissions.
Water use and quality	SMALL	Impacts would be somewhat less than the impacts for a new nuclear power plant located at the Calvert Cliffs site.
Ecology	MODERATE	Wind energy facilities could result in some avian mortality and also affect aquatic resources if placed in Chesapeake Bay or offshore. Hydropower facilities would permanently convert substantial amounts of terrestrial and aquatic habitat (by inundation or completely changed flow regime) and species.
Waste management	SMALL to MODERATE	The only significant waste would be from spent SCR catalyst used for control of NO_x emissions and ash from biomass and municipal solid waste sources.
Socioeconomics (except Taxes and Economy)	SMALL to MODERATE Adverse	Construction and operations workforces would be relatively small. Construction-related impacts would be noticeable. Impacts during operation would be minor because of the small workforce involved. The plants would have aesthetic impacts.
Socioeconomics (Taxes and Economy)	SMALL to MODERATE Beneficial	Addition to property tax base, while smaller than for a nuclear or coal-fired plant, might still be quite noticeable.
Human health	SMALL	Regulatory controls and oversight would be protective of human health.
Historic and cultural resources	LARGE	Adverse effects are likely to three NRHP-eligible resources.
Environmental justice	SMALL	Some impacts on housing availability and prices during construction may occur, as might beneficial impacts from property tax revenues.

9.2.5 Summary Comparison of Energy Alternatives

Table 9-4 contains a summary of the review team's environmental impact characterizations for constructing and operating new nuclear, coal-fired, and natural gas-fired combined-cycle generating units at the Calvert Cliffs site. The combination of alternatives shown in Table 9-4 assumes siting of natural gas combined-cycle generating units at the Calvert Cliffs site and siting of other generating units within UniStar's ROI.

Table 9-4. Summary of Environmental Impacts of Construction and Operation of New Nuclear, Coal-Fired, and Natural Gas-Fired Generating Units and a Combination of Alternatives

Impact Category	Nuclear	Coal	Natural Gas	Combination of Alternatives
Land use	SMALL	MODERATE	SMALL	MODERATE
Air quality	SMALL	MODERATE	SMALL to MODERATE	SMALL to MODERATE
Water use and quality	SMALL	SMALL	SMALL	SMALL
Ecology	MODERATE	MODERATE	SMALL	MODERATE
Waste management	SMALL	MODERATE	SMALL	SMALL to MODERATE
Socioeconomics (except Taxes and Economy)	SMALL to MODERATE Adverse	SMALL to MODERATE Adverse	SMALL Adverse	SMALL to MODERATE Adverse
Socioeconomics (Taxes and Economy)	SMALL to LARGE Beneficial	SMALL to LARGE Beneficial	SMALL to MODERATE Beneficial	SMALL to MODERATE Beneficial
Human health	SMALL	SMALL	SMALL	SMALL
Historic and cultural resources	LARGE	LARGE	LARGE	LARGE
Environmental justice	SMALL	SMALL	SMALL	SMALL

The review team reviewed the available information on the environmental impacts of power generation alternatives compared to the construction of a new nuclear unit at the Calvert Cliffs site. Looking at the alternatives to a nuclear power plant, use of a natural gas plant has the least impacts. Comparing nuclear and natural gas, the gas plant would have less impacts to ecology while having greater impacts on air quality. And, while some socioeconomic impacts are reduced because of the smaller workforce, at the same time, the County and the local economy would accrue fewer benefits from the project. On balance, the review team concludes that the environmental impacts of these two options would be similar. Based on this review, the review team concludes, from an environmental perspective, none of the viable energy alternatives are clearly preferable to construction of a new baseload nuclear power generating plant located within UniStar's ROI.

Because of current concerns related to greenhouse gas emissions, the review team believes that it is appropriate to specifically discuss the differences among the alternative energy sources regarding carbon dioxide emissions. Carbon dioxide emissions for the proposed action and energy generation alternatives are discussed in Sections 5.7.2, 9.2.2.1, 9.2.2.2, and 9.2.4. Table 9-5 summarizes the CO_2 emission estimates for a 40-year period for the alternatives considered by the review team to be viable for baseload power generation. These estimates are limited to the emissions from power generation and do not include CO_2 emissions for workforce transportation, construction fuel-cycle, or decommissioning. Among the viable energy generation alternatives, the CO_2 emissions for nuclear power are a small fraction of the emissions of the other viable energy generation alternatives. Adding the transportation emissions for the nuclear plant workforce and fuel cycle emissions, would increase the emissions for plant operation over a 40-year period to about 35,000,000 metric tons. This number is still significantly lower than the emissions for any of the other alternatives.

Table 9-5. Comparison of Carbon Dioxide Emissions for Energy Alternatives

Generation Type	Years	CO_2 Emission (metric tons)
Nuclear Power[(a)]	40	191,000
Coal-Fired Generation[(b)]	40	451,000,000
Natural Gas-Fired Generation[(c)]	40	204,000,000
Combination of Alternatives[(d)]	40	153,000,000

(a) From Appendix L
(b) From Section 9.2.2.1
(c) From Section 9.2.2.2
(d) From Section 9.2.4 (assuming only natural gas generation has significant CO_2 emissions)

Carbon dioxide emissions associated with generation alternatives, such as wind power, solar power and hydropower would be associated with workforce transportation, construction, and decommissioning of the facilities. Because these generation alternatives do not involve combustion, the review team considers the emissions to be minor and concludes the emissions would have a minimal cumulative impact. Other energy generation alternatives involving combustion of oil, wood waste, municipal solid waste, or biomass-derived fuels would have CO_2 emissions from combustion, as well as from workforce transportation, plant construction, and plant decommissioning. It is likely that the CO_2 emissions from the combustion process for these alternatives would dominate the other CO_2 emissions associated with the generation alternative. It is also likely that the CO_2 emissions from these alternatives would be the same order of magnitude as the emissions for the fossil-fuel alternatives considered in Sections 9.2.2.1, 9.2.2.2, and 9.2.4. However, because these alternatives were determined by the review team not to meet the need for baseload power generation, the review team has not evaluated the CO_2 emissions quantitatively.

As discussed in Chapter 8, the review team has concluded that the need for the additional baseload power generation has been demonstrated. Also, as discussed earlier in this chapter, the review team concludes the viable alternatives to the proposed action all would involve the use of fossil fuels (coal or natural gas). The review team concludes the proposed action results in the lowest level of emissions of greenhouse gases among the viable alternatives.

9.3 Alternative Sites

NRC EISs prepared in conjunction with a COL application are to analyze alternatives to the proposed action (10 CFR 51.71(d)). The review team uses NRC guidance (NRC 2000a) to evaluate the alternative sites and determine if any obviously superior alternative exists to the site proposed. This section discusses UniStar's process for selecting its proposed and alternative sites, and the review team's evaluation of the process. UniStar's site selection process was based on guidance in the following documents (UniStar 2009a): NRC's ESRP (NRC 2000a), Regulatory Guide 4.2 (NRC 1976), Regulatory Guide 4.7 (NRC 1998), 10 CFR Part 100, and the Electric Power Research Institute's (EPRI) Siting Guide (EPRI 2002).

This section describes UniStar's site selection process, the review team's evaluation process, descriptions of the alternative sites selected by UniStar, and discussions of the environmental impacts of locating a new nuclear generating unit at each alternative site. For the purposes of this alternative sites evaluation, impacts evaluated include NRC-authorized construction, operation, and other cumulative impacts including preconstruction activities. Sections 9.3.3 through 9.3.5 provide a site-specific description of the environmental impacts at each alternative site based on issues such as land use, air quality, water resources, terrestrial and aquatic ecology, socioeconomics and environmental justice, historic and cultural resources, and transmission corridors. Section 9.3.6 contains tables of the review team's characterization of the impacts at the alternative sites and comparison with the proposed site to determine if there are any alternative sites that are environmentally preferable to the proposed site.

9.3.1 Alternative Site Selection Process

NRC's site selection process guidance calls for identification of a region of interest (ROI), the geographic area considered by an applicant in searching for candidate areas and potential sites for possible siting of a new nuclear power plant (NRC 2000a). Within that ROI, screening criteria are applied to sequentially evaluate candidate areas, potential sites, and candidate sites. This systematic process leads to the selection of a proposed site and alternative sites unless the applicant proposes a site based on the special case identified in ESRP 9.3 for proposing to locate a new nuclear facility on the site of an existing nuclear power plant previously found acceptable on the basis of a NEPA review. UniStar used the ESRP 9.3 special case to select the Calvert Cliffs site as its proposed site for a third unit.

The review team raised a number of concerns related to UniStar's site selection process and associated results submitted by UniStar in the COL application (through Revision 5 of the application) (UniStar 2009d). The most significant questions were documented in requests for additional information from the NRC dated May 13, 2008 (NRC 2008a), February 3, 2009 (NRC 2009a), and September 18, 2009 (NRC 2009b). As a result of these information requests, UniStar developed a major revision to its site selection process and documented it in Revision 6 to the ER (UniStar 2009a and in a separate Siting Report (UniStar 2009e). The process UniStar used to select its alternative sites is documented in ER Revision 6 (UniStar 2009a) and described in the following sections.

9.3.1.1 Selection of Region of Interest

UniStar selected the State of Maryland for its ROI (UniStar 2009a). The State of Maryland's shortfall in net generating capacity was documented by the MPSC (MPSC 2007) and verified in its granting of a Certificate of Public Convenience and Necessity (MPSC 2009a) to UniStar for the proposed Calvert Cliffs Unit 3 (see the discussion in Chapter 8 of the EIS).

As described in ESRP 9.3 (NRC 2000a), an ROI is typically selected based on geographic boundaries (e.g., the state in which the proposed site is located) or the relevant service area for the proposed plant. By selecting the State of Maryland, UniStar's designated ROI is consistent with expectations for an ROI. The review team concludes that the ROI used in UniStar's COL application is reasonable for consideration and analysis of potential sites. The review team also finds that UniStar's basis for defining its ROI did not arbitrarily exclude desirable candidate locations.

9.3.1.2 UniStar's Site Selection Process

In its COL application, UniStar proposed the Calvert Cliffs Nuclear Power Plant site for a new U.S. EPR nuclear unit. The decision to select the Calvert Cliffs site was based on a special case exception from the systematic site-selection process (NRC 2000a). This exception allows the applicant to select an existing nuclear facility as the proposed site for a new unit or units.

UniStar embarked on a systematic review of candidate areas, potential sites, and candidate sites within the State of Maryland to identify alternative sites for comparison with the Calvert Cliffs proposed site. UniStar's selection process to identify candidate areas and potential, candidate, and alternative sites is described in the following sections.

Selection of Candidate Areas

In describing the basis for its systematic selection of candidate areas, UniStar refers to the use of ESRP guidance (NRC 2000a) and the EPRI siting guide (EPRI 2002). UniStar applied the following screening criteria for candidate areas within Maryland: population density, distance to transmission lines, access to a suitable cooling water source, and if the site was available (UniStar 2009a). More specifically, areas were removed from further consideration if they exceeded the following characteristics:

- exhibited a population density of more than 300 persons per square mile
- were located more than 30 mi from 345-kV or higher transmission lines
- were located more than 15 mi from an adequate source of cooling water
- contained land that was dedicated to other uses, such as national and state parks and tribal lands.

UniStar developed a map representing each exclusionary criterion, and these were combined into a summary map of designated candidate areas (Figure 9-1) that were not eliminated by these criteria. These candidate areas are shown as darkened areas near the Chesapeake Bay and the Potomac, Susquehanna, and Patuxent Rivers.

Selection of Potential and Candidate Sites

In its selection process of potential sites within its candidate areas, UniStar made use of two databases: the Maryland Department of the Environment's *Brownfield, Voluntary Cleanup Programs and State Remediation Site* database and the U.S. DOE Energy Information Administration's (EIA) *State Energy Profile* database. The two databases provided a pool of 1036 possible sites in the ROI, including brownfield sites, remediation sites, and power facilities. These sites were plotted on the State map. Of those 1036 possible sites, 206 sites were located within the candidate areas and retained for further consideration.

UniStar applied a "de-select" criterion to narrow the list of 206 sites by removing all sites that did not meet a minimum of 420 ac needed to site a U.S. EPR unit, its ancillary structures, construction laydown areas, and parking. This reduced the total to eight potential sites, which were evaluated for viability and potential licensability. These were identified as:

- Bainbridge Naval Training Center
- BWI Airport (located near the airport)
- Beiler Property
- Conowingo
- Eastalco
- Thiokol Site (formerly owned by Thiokol)
- Morgantown
- Sparrows Point.

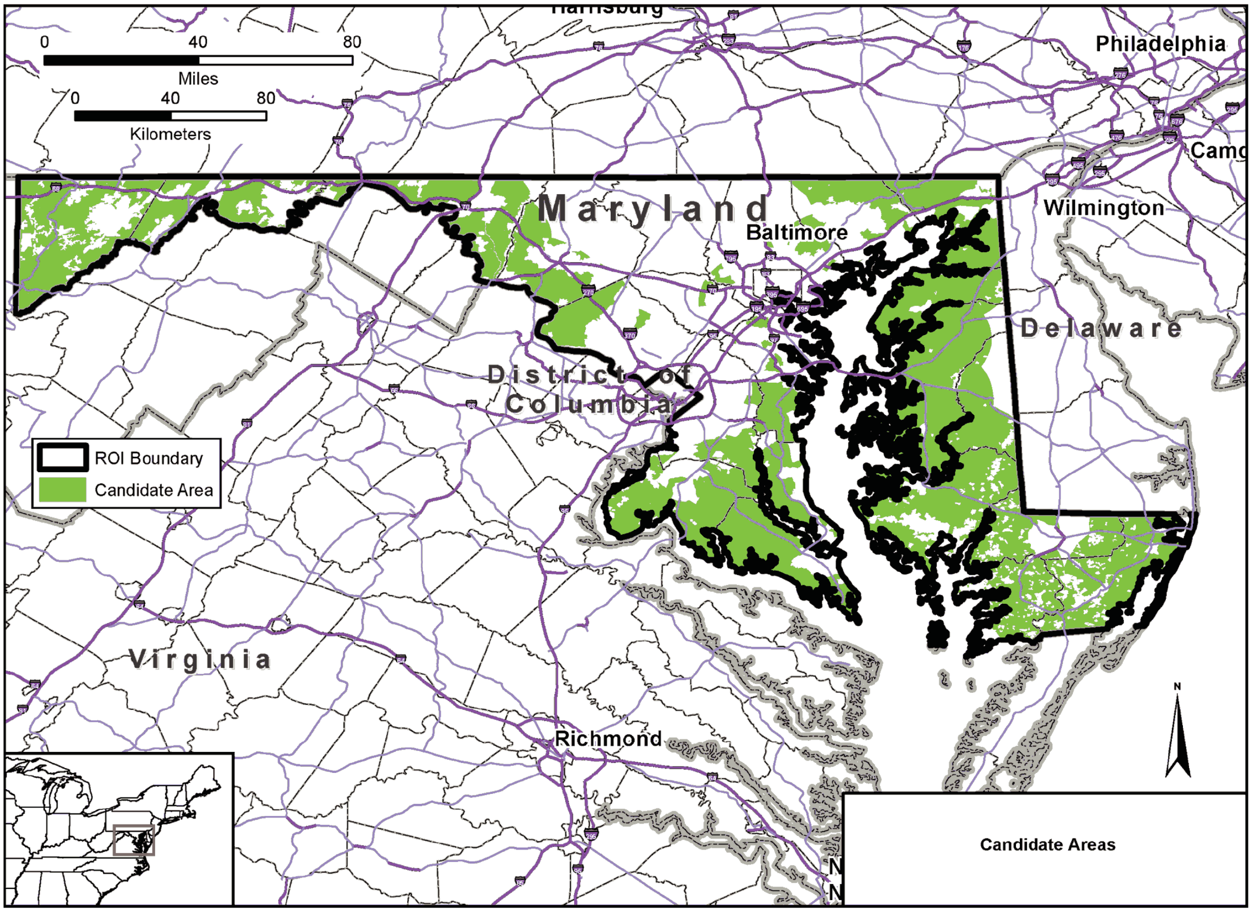

Figure 9-1. Locations of UniStar's Candidate Areas in Maryland (UniStar 2009a)

UniStar looked more closely at the eight potential sites and, for various reasons, eliminated four of them. One site was eliminated because of its proximity to a major airport (BWI airport), and a second site that met the previous density criteria was too near Baltimore for serious consideration (Sparrows Point). A third site contained an operating baseload fossil fuel facility, which is needed to meet current Maryland energy production and would be displaced by a new nuclear unit (Morgantown). A fourth site, although passing the candidate area screening for a water source, upon further reconnaissance-level evaluation, was unlikely to meet the volume requirement for water and depth for an intake structure (Beiler). After removing these four potential sites from further consideration, the remaining four potential sites were selected as what UniStar considered candidate sites:

- Bainbridge Naval Training Center
- Conowingo

- Eastalco
- Thiokol.

ESRP 9.3 considers candidate sites to include only the proposed and alternative sites. UniStar uses the term to include sites being considered for screening down to alternative sites, a difference that is not critical to the evaluation. UniStar then scored the candidate sites to select the alternative sites.

A generic greenfield site was also characterized in a separate evaluation by UniStar (2009a). A greenfield site implies that the site has not been used previously for industrial purposes, but may have been disturbed for activities such as agriculture. No specific geographic location was identified by UniStar for the greenfield site location. However, UniStar assumed this hypothetical site would be located near the Chesapeake Bay or the lower reaches of the main rivers within the ROI to have an adequate water supply. UniStar also assumed it would not be "detrimentally challenged with grid interconnection issues." Citing particularly (1) the likely need for land for switchyard and transmission lines in addition to the need to acquire, rezone, and disturb land for a plant site; (2) the likely need to integrate a plant into the socioeconomic and aesthetic environment; and (3) the likely need to improve roadways to a relatively remote, nonurban setting and associated transportation impacts, UniStar concluded that a greenfield site would offer no environmental advantages over the Calvert Cliffs site and would increase the severity of impacts (UniStar 2009a).

Selection of Alternative Sites

The next step of UniStar's process was to select alternative sites from its list of four candidate sites using 16 major criteria categories and 42 sub-criteria and ranking each candidate site against these criteria. Commercial criteria, such as cost-related criteria, were not included in this evaluation. UniStar organized a nine-member Delphi panel consisting of personnel from UniStar, AREVA NP Inc. (AREVA), and CH2M Hill to evaluate the four sites against the criteria. The panel represented a wide range of interests and expertise and had access to subject matter experts from CH2M HILL and AREVA for additional input (UniStar 2009e). In its analysis, the panel used publicly available data, information available through UniStar and Constellation Energy sources, and Google Earth images to evaluate the four sites (UniStar 2009e). Site investigations supplemented the evaluation as needed. For consistency in the analysis, the panel assumed that building and operation practices described for the proposed Calvert Cliffs Unit 3 in Chapters 4 and 5 would generally apply at each site.

Weighting factors were applied to each criteria with water resources weighted the highest followed by population density, wetlands, resources related to transmission corridors, and terrestrial and aquatic resources (weighted toward threatened and endangered species, floodplains, and water resource temperature at the discharge). These weighting factors were followed by geology/seismology, human health, socioeconomics, transportation access, historic resources, environmental justice, postulated accidents, air quality, and fuel cycle impacts. Although the review team would have preferred more emphasis on terrestrial and aquatic species (in addition to threatened and endangered species) and habitats, such factors were unlikely to have discriminated across the four sites. The review team found that the criteria and weighting factors were not unreasonable.

The Delphi panel developed a rating system (1 = least suitable; 5 = most suitable) for each criterion and scored the four sites using this system. The nine scores for each major criterion were averaged, and the composite ratings computed to rank the four sites from highest to lowest (UniStar 2009e). The results for the four sites were closely clustered with no obviously better or worse candidates. The site receiving the highest ranking was Eastalco, followed by Thiokol, Bainbridge, and Conowingo. The review team considered the ranking system to be a relatively qualitative screening despite the numerical scores, but found that it was not unreasonable.

UniStar selected the three sites with the highest scores as its alternative sites. These are:

- Bainbridge, the former Naval Training Center
- Eastalco, on property across from an inactive aluminum smelter
- Thiokol, a former manufacturing site of certain munitions components, since remediated.

Their locations along with the Calvert Cliffs proposed site are shown in Figure 9-2.

UniStar and its site selection contractor described these sites at a reconnaissance level in UniStar's ER (UniStar 2009a). Reconnaissance information is data that is readily available from agencies and other public sources. It can also include information obtained through visits to the site area. A formal environmental assessment has not been conducted at any of the alternative sites. UniStar compared the sites with the proposed Calvert Cliffs site for siting a new nuclear unit and determined that no alternatives were environmentally preferable to the Calvert Cliffs site.

9.3.2 NRC/Corps Alternative Site Evaluation

The review team reviewed the siting methodology used by UniStar to select its ROI, candidate areas, potential sites, candidate sites, and alternative sites. Based on UniStar's description of its process and the review team's evaluation of the criteria used (as addressed in the commentary in the previous section), the review team determined the process used to identify alternative sites was a logical approach consistent with NRC guidance (NRC 2000a) and, therefore, was adequate.

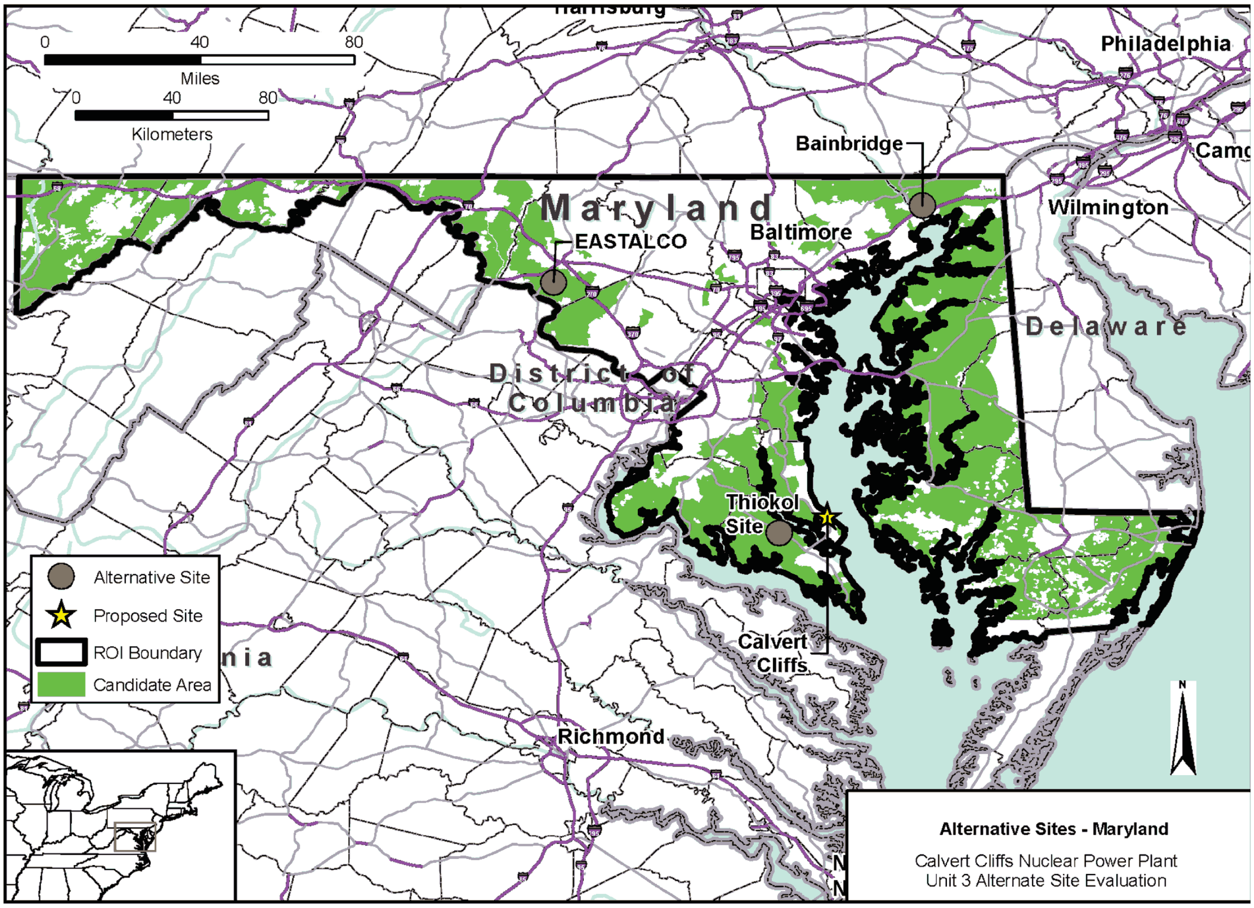

Figure 9-2. Locations of Alternative Sites and Proposed Site (UniStar 2009a)

In accordance with ESRP 9.3 (NRC 2000a), the review team performed an independent comparison of the proposed and alternative sites. The review team visited each of the alternative sites between October 2008 and August 2009. Following the guidance in ESRP 9.3, the review team collected and analyzed reconnaissance-level information for each of the alternative sites. The team then used the information provided in the ER, request for additional information (RAI) responses, information from other Federal and State agencies, and information gathered at the visits to each alternative site to evaluate the cumulative impacts of building and operating a new nuclear power plant at those sites. Therefore, the analysis includes the impacts of NRC-authorized construction and operation, as well as impacts from other actions affecting the same resources. Cumulative impacts occur when the effects of an action are added to or interact with other effects in a particular place and within a particular time. As a result, the cumulative impact assessment entails a more extensive and broader review of possible effects of the action beyond the site boundary.

The cumulative analysis for the impacts at the alternative sites was performed in the same manner as discussed in Chapter 7 for the proposed site except, as specified in ESRP 9.3 (NRC 2000a). The analysis was conducted at the reconnaissance level for the alternative sites. To inform the cumulative analysis, the review team researched EPA databases for recent EISs within the State, used an EPA database for permits for water discharges in the geographic area to identify water-use projects, and used www.recovery.gov to identify projects in the geographic area funded by the American Recovery and Reinvestment Act of 2009 (Public Law 111-5). The review team developed tables of the major projects near each alternative site that were considered relevant in the cumulative analysis. The review team used the information to perform an independent evaluation of the direct and cumulative impacts of the proposed action at the alternative sites to determine if one or more of the alternative sites were environmentally preferable to the proposed site.

Included are past, present, and reasonably foreseeable Federal, non-Federal, and private actions that could have meaningful cumulative impacts with the proposed action. For purposes of this analysis, the past is defined as the time period prior to receipt of the COL application. The present is defined as the time period from the receipt of the COL application until the start of building proposed Unit 3. The future is defined as the start of building Unit 3 through operation and eventual decommissioning.

Using Chapter 7 as a guide, the specific resources and components that could be affected by the incremental effects of the proposed action and other actions in the same geographical area were identified. The affected environment that serves as the baseline for the cumulative impacts analysis is described for each alternative site and includes a qualitative discussion of the general effects of past actions. For each resource area, the geographical area over which past, present, and reasonably foreseeable future actions could reasonably contribute to cumulative impacts is defined and described in later sections. The analysis for each resource area at each alternative site concludes with a cumulative impact finding (SMALL, MODERATE, or LARGE). For those cases in which the impact level to a resource was greater than SMALL, the review team also discussed whether building and operating a nuclear unit would be a “significant” contributor to the cumulative impact. In the context of this evaluation, “significant” is defined as a contribution that is important in reaching that impact level determination.

The cumulative impacts are summarized for each resource area in the sections that follow. The level of detail is commensurate with the significance of the impact for each resource area. The findings for each resource area at each alternative site then are compared in a table at the end of Section 9.3 to the cumulative impacts at the proposed site (brought forward from Chapter 7). The results of this comparison are used to determine if any of the alternative sites are environmentally preferable to the proposed site.

The impacts described in Chapter 6 (e.g., nuclear fuel cycle, decommissioning) would not vary significantly from one site to another. This is true because all of the alternative sites and the proposed site are in low-population areas and the review team assumes the same reactor design (therefore, the same fuel cycle technology, transportation methods, and decommissioning methods) for all of the sites. As such, these impacts would not differentiate between the sites and would not be useful in the determination of whether an alternative site is environmentally preferable to the proposed site. For this reason, these impacts are not discussed in the evaluation of the alternative sites.

9.3.3 Bainbridge Naval Training Center

This section covers the review team's evaluation of the potential environmental impacts of siting a new nuclear unit at the Bainbridge Naval Training Center (Bainbridge) site in northeast Maryland near the Susquehanna River just above its discharge into Chesapeake Bay. The Bainbridge site is located within the upland section of the Piedmont Plateau physiographic province in Cecil County, Maryland (MDNR 2001). This province is described as rolling hills and stream valleys covered with hardwood forests (FWS 2001).

Part of the Bainbridge site was home to the Tome School for Boys beginning in the early 1900s, and many of the school buildings are still standing. The Bainbridge Naval Training Center was constructed in 1942 for training Navy recruits during World War II (EPA 2000). The training center was deactivated in 1976. Although some office buildings and personnel quarters remain, most of the training center structures have been demolished and removed, and biota succession has reclaimed areas formerly maintained as open space.

The following sections describe a cumulative impact assessment conducted for each major resource area. The specific resources and components that could be affected by the incremental effects of the proposed action if it were sited at the Bainbridge site and other actions in the same geographical area were assessed. This assessment includes the impacts from building activities and operations. Also included are past, present, and reasonably foreseeable Federal, non-Federal, and private actions that could have meaningful cumulative impacts with the proposed action. Other actions and projects considered in this cumulative analysis are described in Table 9-6.

Table 9-6. Past, Present, and Reasonably Foreseeable Projects and Other Actions Considered in the Bainbridge Site Cumulative Analysis

Project Name or Other Action	Summary of Project	Location	Status
Energy Projects			
Conowingo Hydroelectric Station	Conowingo Hydroelectric Station is a hydroelectric facility (548 MW(e)).	Approximately 10 mi northwest of Bainbridge site	Operational. License expires in 2014. On March 12, 2009, Pre-Application Document was filed with FERC to renew the license.[a]
Rock Springs Generation Facility	Rock Springs Generation Facility is a gas-fired peaking facility (670 MW(e)).	Approximately 7 mi northeast of Bainbridge site	Operational.[b]
Operation of Peach Bottom Atomic Power Station Units 2 and 3	Peach Bottom consists of two existing power stations, Unit 2 and 3 (1140 MW(e) each).	Approximately 15 mi northwest of Bainbridge site	Operational. Licenses expire in 2033 and 2034.[c]
Operation of Hope Creek Generating Station, Unit 1	Hope Creek consists of one existing nuclear generating unit (1061 MW(e)).	Approximately 33 mi east of Bainbridge site	Operational. License expires April 11, 2026.[d]
Operation of Salem Nuclear Generating Station, Units 1 and 2	Salem consists of two existing nuclear generating units, Unit 1 (1174 MW(e)) and Unit 2 (1130 MW(e)).	Approximately 33 mi east of Bainbridge site	Operational. Unit 1 license expires August 13, 2016.[e] Unit 2 license expires April 18, 2020.[f]
PSEG proposed additional unit(s) at the existing Salem-Hope Creek Site	One or two new units may be proposed adjacent to the existing Salem and Hope Creek units.	Approximately 33 mi east of Bainbridge site	NRC is expecting an Early Site Permit (ESP) application in 2010.[g]
Operation of Three Mile Island Nuclear Station, Unit 1	Three Mile Island consists of one existing nuclear generating unit (786 MW(e)).	Approximately 50 mi northwest of Bainbridge site	Operational. License expires April 19, 2034.[h]
Operation of Limerick Generating Station, Units 1 and 2	Limerick consists of two existing nuclear generating units, Unit 1 (1134 MW(e)) and Unit 2 (1134 MW(e)).	Approximately 50 mi northeast of Bainbridge site	Operational. Unit 1 license expires October 26, 2024.[i] Unit 2 license expires June 22, 2029.[j]
PPL Holtwood Electric Plant	PPL Holtwood consists of one hydroelectric facility (108 MW(e)).	Approximately 20 mi northwest of Bainbridge site	Operational. FERC license expires in 2014. Application for expansion in process.[k]

Table 9-6. (contd)

Project Name or Other Action	Summary of Project	Location	Status
Other Actions/Projects			
Great Lakes Dredge and Dock Company LLC	Perform maintenance dredging at various locations along the Inland Waterway Chesapeake and Delaware Canal and Upper Chesapeake Bay areas.	Chesapeake Bay, Chesapeake City, MD; approximately 8 to 20 mi southeast of site	Planned. Over $8M contract awarded by USACE on Sept. 28, 2009.[l]
Aberdeen Proving Ground (APG) Base Realignment and Closure (BRAC)	Under the base realignment and closure action. DoD changing, and in some cases expanding, the site's mission such as investing over $1.1 billion in construction at Aberdeen Proving Ground for the new Army Team Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) center.	Approximately 15 mi south of Bainbridge site	Ongoing site development projects.[m]
Dominion/Antero Keystone Pipeline	250-mi natural-gas pipeline running from Green County to Chester County, PA.	A portion would pass approximately 10 mi northwest of the Bainbridge site	Proposed.[n]
Wastewater Treatment Plants	Six wastewater treatment plants.	Six WWTPs in 10-mi radius of Bainbridge site	Operational.
Various hospitals and industrial facilities that use radioactive materials	Medical and other isotopes.	Within 50 mi	Operational.
Susquehanna State Park	Primarily forested and open water areas used for recreation, fishing, hunting, conservation, and historic learning purposes.	Approximately 1 mi west of Bainbridge site	Development is unlikely.
Future Urbanization	Construction of housing units and associated commercial buildings; roads, bridges, and rail; construction of water- and/or wastewater-treatment and distribution facilities and associated pipelines, as described in local land use planning documents.	Throughout region	Construction would occur in the future, as described in State and local land use planning documents

Table 9-6. (contd)

Project Name or Other Action	Summary of Project	Location	Status

(a) Source: Exelon 2009.
(b) Source: ConEdison Development 2009.
(c) Source: NRC 2003.
(d) Source: NRC 2009d.
(e) Source: NRC 2009e, 2009f.
(f) Source: NRC 2009g.
(g) Source: NRC 2009h.
(h) Source: NRC 2009i.
(i) Source: NRC 2009j.
(j) Source: NRC 2009k.
(k) Source: FERC 2008.
(l) Source: Recovery Accountability and Transparency Board 2009.
(m) Source: BRACD 2005.
(n) Source: Dominion 2009.

9.3.3.1 Land Use

The following impact analysis includes impacts to land use from building activities and operations at the Bainbridge site and within the geographic area of interest, which is the 15-mi region surrounding the Bainbridge site. The analysis also considers past, present, and reasonably foreseeable future actions that impact land use, including other Federal and non-Federal projects and those projects listed in Table 9-6 within the geographic area of interest.

The Bainbridge site is an approximately 1185-ac tract of land located in Port Deposit, Cecil County, Maryland. The site is approximately 3 mi west of Interstate 95 (I-95) and is bounded by State Highway 276 to the north and northwest, to the east by residential properties beyond which is State Highway 275, and by State Highway 222 to the south. The site is situated atop the Piedmont Plateau and overlooks the Susquehanna River and the Port Deposit town center (MDE 2008). The southwestern edge of the site is parallel to and less than 0.1 mi from the Susquehanna River (UniStar 2009a). Figure 9-3 shows the property boundary in relation to the lower reach of the Susquehanna River. A 420-ac site footprint is contained within the property boundary. Figure 9-4 shows an overhead view of the property.

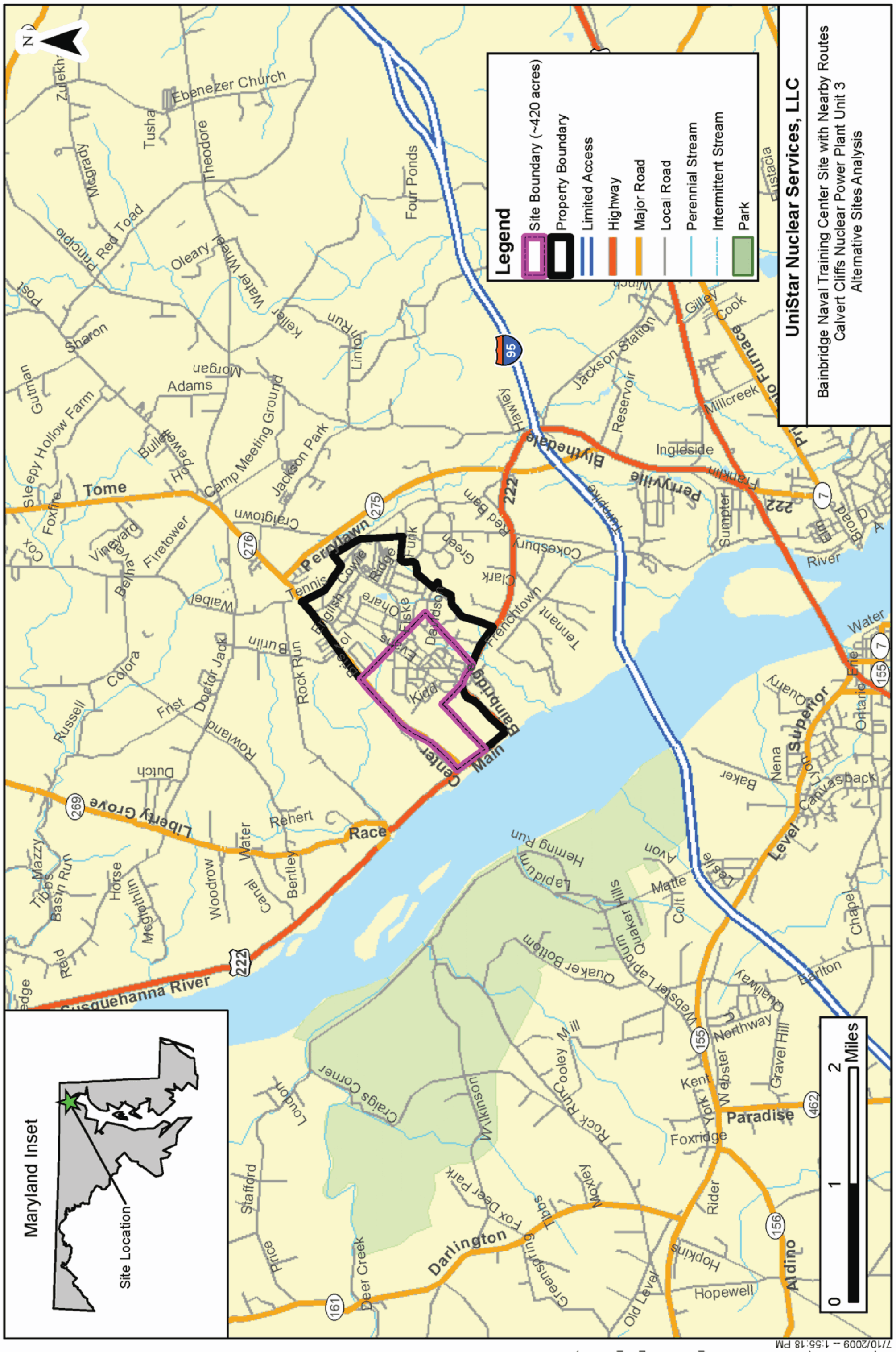

Figure 9-3. Site Location of the Bainbridge Naval Training Center (UniStar 2009a)

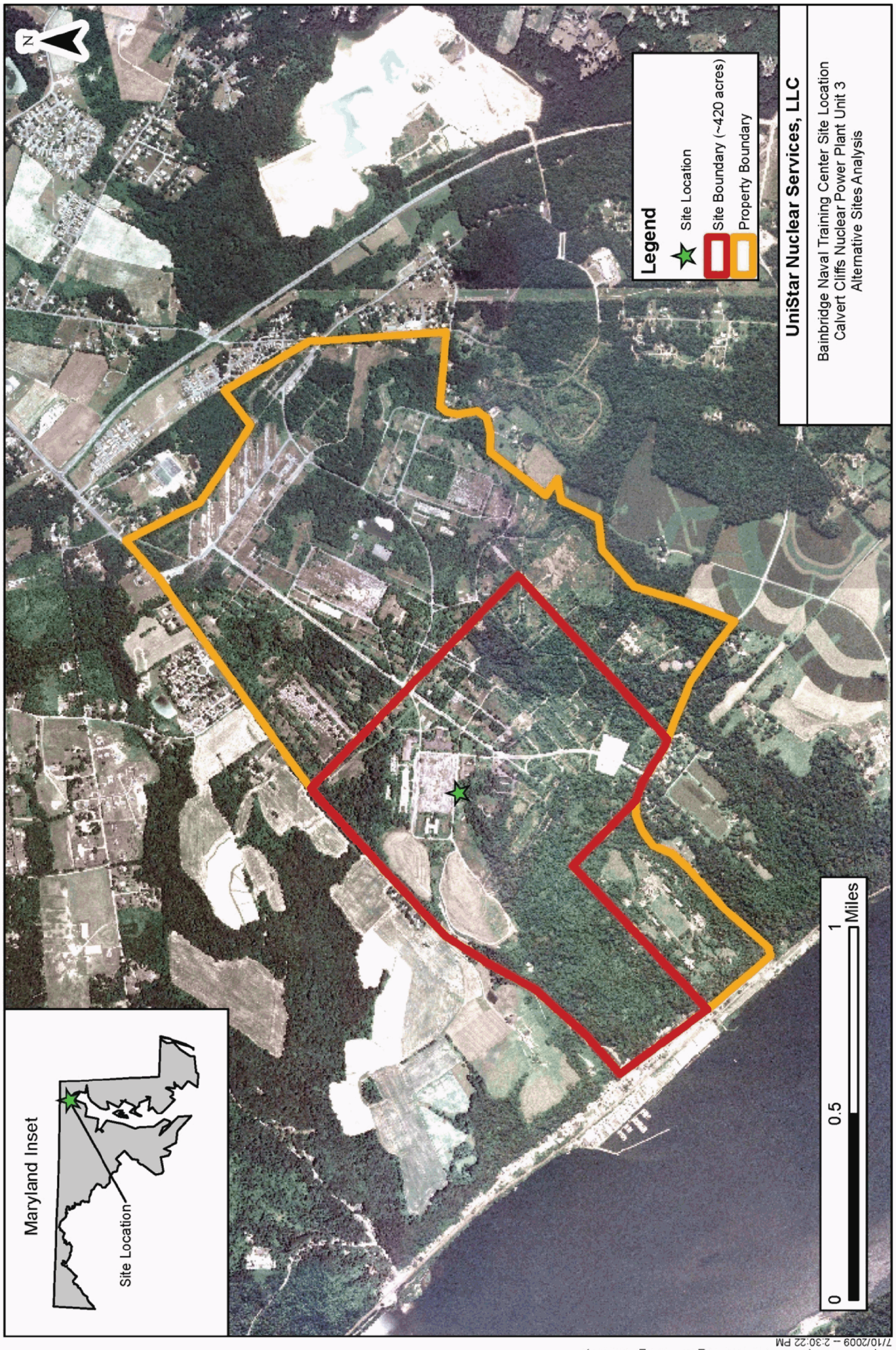

Figure 9-4. Bainbridge Naval Training Center Site and Surrounding Area (UniStar 2009a)

A portion of the site was used as a private school in the early 1900s. The U.S. Navy operated a training center on the site from 1942 to 1976. From 1978 to 1990, the U.S. Department of Labor sponsored a Job Corps Center at the site. The Navy conducted a variety of cleanup operations at the site from 1988 to 1999. The property was transferred from the Navy to the Bainbridge Development Corporation in 2000. Approximately 60 structures remain on the site in varying stages of decay (MDE 2008). The site is currently used as a truck driving school and for archery deer hunting during the regulated hunting season as a Maryland Cooperative Wildlife Management Area (CWMA).

The site is zoned Bainbridge Special Use. Industrial uses are permitted (Town of Port Deposit 2008). There are use restrictions covering the landfill cap for the landfill used by the Navy and use of groundwater where some contamination may remain (UniStar 2009a).

The majority of the elevation change on the site occurs near or along the bluff adjacent to the Susquehanna River. Within the interior of the site, the land is relatively level and could accommodate a new nuclear generating unit.

The nearest dedicated land (Federal, State, or Tribal) is Susquehanna State Park located approximately 3 mi northwest of Havre de Grace off Route 155 in Harford County.

If a new nuclear generating unit were constructed on the Bainbridge site, the 420-ac tract would be disturbed and much of the mixed deciduous forest on the tract would be lost. In addition, some offsite land would be affected to build a pipeline to bring water for cooling to the site from the Susquehanna River. A pipeline from the river would need to cross railroad tracks and a local road (UniStar 2009a).

In addition, one or more new transmission corridors would be needed to connect the Bainbridge site to the grid. Four existing 500-kV transmission lines would be available for possible interconnection. One line is 5 mi north of the site, and the other three are between 10 and 20 mi from the site. There are five existing 230-kV transmission lines within 5 mi of the site, and there are six 230-kV transmission lines between 10 and 20 mi from the site (UniStar 2009a).

Because of the short distances to the transmission interconnections, the review team concludes that the land-use impacts of building and operating transmission lines for a new nuclear plant at the Bainbridge site would be minor.

Cumulative Impacts

For this cumulative land use analysis, the geographic area of interest is the 15-mi region surrounding the Bainbridge site. This geographic area of interest includes the primary communities (Aberdeen, Havre de Grace, North East, and Perryville) that would be affected by the proposed project if it were located at the Bainbridge site.

The projects identified in Table 9-6 with the greatest likelihood of affecting land use in the geographic area of interest would be the Aberdeen Proving Ground Base Realignment and Closure (BRAC) and the Dominion/Antero pipeline. The Aberdeen Proving Ground BRAC would involve realignments through a combination of new construction, renovation, and reuse to accommodate incoming missions (U.S. Army 2007a). Activities would be conducted on the existing Aberdeen Proving Ground site located about 15 mi southeast of the Bainbridge site. Some indirect offsite land-use impacts may occur as a result of economic activity on the Aberdeen site. The Dominion/Antero pipeline route would pass approximately 10 mi northwest of the Bainbridge site. It would affect a relatively narrow band of land within the geographic area of interest. The Aberdeen BRAC and Dominion pipeline projects, along with other projects identified in Table 9-6, have contributed or would contribute to some decreases in open lands, wetlands, and forested areas and generally result in increased urbanization and industrialization. However, existing parks, reserves, and managed areas would help preserve open lands, wetlands, and forested areas. Because the projects within the geographic area of interest identified in Table 9-6 would be consistent with applicable land-use plans and control policies, the review team considers the cumulative land-use impacts from the projects to be manageable.

Because of the short distances to the transmission interconnections, the review team concludes that the cumulative transmission line land-use impacts of building and operating a new nuclear generating unit and associated transmission lines at the Bainbridge site would be minimal.

Similar to the area of interest for the Calvert Cliffs site, global climate change (GCC) could increase precipitation, sea level, and storm surges in the area of interest (GCRP 2009), thus changing land use through inundation of low-lying areas that are not buffered by the bluffs along the Susquehanna River. However, the cliffs could experience increased rates of erosion as a result of frequent storm surges, flooding events, and sea-level rise (GCRP 2009). Forest growth may increase as a result of more carbon dioxide in the atmosphere (GCRP 2009). Existing parks, reserves, and managed areas would help preserve wetlands and forested areas to the extent that they are not affected by the same factors. In addition, GCC could reduce crop yields and livestock productivity (GCRP 2009), which might change portions of agricultural land uses in the area of interest. Direct changes resulting from GCC could cause a shift in land use in the geographic area of interest.

Based on the information provided by UniStar and the review team's independent evaluation, the review team concludes that the cumulative land-use impacts of building and operating a new nuclear generating unit, including associated transmission lines, at the Bainbridge site would be SMALL. Building and operating a new nuclear unit at the Bainbridge site would be a significant contributor to this impact.

9.3.3.2 Water Use and Quality

Water for the Bainbridge site would be obtained primarily from the Susquehanna River. According to UniStar (2009a), the plant would require the withdrawal of about 50 MGD for cooling and other uses. Of that total, about 27 MGD (42 cfs) would be consumed, and the remainder would be discharged back to the Susquehanna River. UniStar (2008b) states that the plant would use closed-cycle cooling with a cooling tower. The plant would have separate intake and discharge structures in the Susquehanna River. Discharge water would include cooling tower blowdown, treated process wastewater, treated sanitary wastewater, and some radioactive water. The discharge would be at a slightly elevated temperature relative to the temperature of the Susquehanna River.

During a site visit on August 19, 2009, review team observed that the proposed location for the reactor would be the upper portion of the Bainbridge site, which is somewhat flat to undulating terrain. Moving westward toward the Susquehanna River, the terrain drops off more steeply until it reaches cliffs that abut the town of Port Deposit, which is on the river shoreline. There are several landfills on the Bainbridge site; landfill caps, deed restrictions, and groundwater use restrictions apply. There are some minor surface water drainages on site, but no flow was observed. An approximately 3-ac pond was observed somewhat in the center of the site.

The Bainbridge site would require normal alterations, including grading, construction of roads, piers, jetties, and water intake and discharge structures in the Susquehanna River. Development of the intake and discharge pipes would affect the pipe corridor from the site to the river and would affect the river bed in the vicinity of the intake and discharge structures. Although the site is close to the river, UniStar (2009a) identified the potential need to build an onsite impoundment to provide an ultimate heat sink. UniStar estimates that the area and depth of such an impoundment would be approximately 4.7 ac and 25 ft, respectively (UniStar 2009a).

The average flow of the Susquehanna River at Conowingo Dam between October 1967 and August 2009 was 26,570 MGD (41,110 cfs) (USGS 2009). The Bainbridge site is about 9 mi downstream of Conowingo Dam. In the vicinity of the site, the river is considered to be a tidal fresh water estuary. Water withdrawal for the plant would represent less than 0.2 percent of average flow conditions at Conowingo Dam; consumptive use would be less than 0.1 percent of the average flow. Although there appears to be sufficient water during average flow conditions, low-flow conditions could have the potential to impact plant operations. Such conditions are characterized using at a metric known as the 7Q10, which is the lowest 7-day average flow with a 10-year recurrence interval. UniStar (2009e) reported a 7Q10 value for the Conowingo Dam of 2452 MGD (3793 cfs). Total water withdrawal would represent only 2 percent of the 7Q10 value. Consumptive use would be less, approximately 1 percent of the 7Q10 value. Withdrawals of water from the Susquehanna River require approval by the MDE Water Management Administration and the Susquehanna River Basin Commission. Given that the

Susquehanna River near the Bainbridge site is tidally influenced, the water consumed by the plant would likely be quite small with respect to the existing resource.

The Bainbridge site has a shallow unconfined aquifer that overlies crystalline rock aquifers. The shallow aquifer is contaminated in some locations and deed restrictions limit its use. There are no known public or private wells that would be affected by the onsite contaminants. The crystalline rock aquifers could be used for potable water; median production rates in the region are 30 gpm. UniStar (2009a) states that groundwater would not be used for operations, but may be needed temporarily for building activities. UniStar has not determined the combination of sources and related quantities of water (i.e., ground and surface water) needed for development of this site.

Building activities, including surface alterations and dewatering, have the potential to affect the local hydrology, but because the site has already been heavily developed, any additional impacts from building a nuclear power plant would be temporary and localized. The groundwater resource in the deeper aquifers may be temporarily affected by withdrawals for building purposes but would not be affected during operations because this resource would not be used for that purpose.

Water quality alterations to both the surface water and groundwater would be regulated by NPDES discharge and stormwater permits. BMPs would prevent or mitigate spills from altering surface or groundwater resource quality. The nutrient load from the plant's sanitary effluent system would be a minor contribution to the Susquehanna River's cumulative nutrient load.

Based on the information provided by UniStar and the review team's independent evaluation, the review team concludes that although the local hydrology would be impacted, the impacts on regional surface and groundwater resources from building and operating a new nuclear generating unit at the Bainbridge site would be minor.

Cumulative Impacts

For the cumulative analysis of impacts on surface water, the geographic area of interest for the Bainbridge site is the drainage basin of the Susquehanna River upstream and downstream of the site because this is the area that would be impacted by the proposed project. Key actions that have current and reasonably foreseeable potential impacts to water supply and water quality in the geographic area of interest include the operation of the Peach Bottom Atomic Power Station Units 2 and 3 and other municipal and industrial activities in the Susquehanna River basin. For the cumulative analysis of impacts on groundwater, the geographic area of interest is the extent within Cecil County of the groundwater aquifers beneath the site.

Water Use. The surface-water-use impacts of building and operating a nuclear power plant at this site would be dominated by the demands that would occur under normal operation. As noted above, the impacts would be small relative to existing measures of water availability in the Susquehanna River; those measures reflect cumulative consumptive uses of current users upstream of the site.

The review team determined the consumptive use of water by the operation of a nuclear reactor at the Bainbridge site and all other consumptive uses (existing or likely future uses) could not plausibly alter the volume of water in the Susquehanna River in the vicinity of the Bainbridge site.

The review team is also aware of the potential climate changes that could affect the water resources available for cooling and the impacts of reactor operations on water resources for other users. The impact of climate change on the water available at the Bainbridge site would be small because of the availability of water from the tidally influenced portion of the Susquehanna River.

Increases in consumptive use of water in the Susquehanna River drainage is anticipated in the future. The impacts of the other operational projects listed in Table 9-6 are considered in the analysis included above or would have little or no impact on surface water use.

Based on its evaluation, the review team concludes that the cumulative impacts to surface water would be SMALL.

The regional crystalline rock aquifer is not as productive as the coastal plain aquifers, which explains why there are no significant groundwater users near the Bainbridge site. The nearest town, Port Deposit, derives its water supply from the Susquehanna River. Therefore, it is unlikely that the crystalline rock aquifer would be a significant source of water for the site and the review team concludes that the cumulative impacts to the regional groundwater resource would be SMALL.

Water Quality. An MDE-issued NPDES permit would be required to operate a nuclear plant at this site and would ensure that the discharges complied with the Clean Water Act. Point and non-point pollution sources have impacted the water quality of the Susquehanna River upstream and downstream of the site. For example, elevated levels of nutrients, turbidity, and temperature have been observed upstream at the Conowingo Dam in 2007 and 2008. The impacts of other projects listed in Table 9-6 are either considered in the analysis included above or would have little or no impact on surface water quality. Therefore, based on the existing conditions in the river, the review team concludes the cumulative impact on surface water quality would be MODERATE. Building and operating a new nuclear unit at the Bainbridge site would not be a significant contributor to this impact.

With the implementation of BMPs, the impacts on groundwater quality from building and operating a new nuclear unit at the Bainbridge site would be minimal. Regionally, the shallow and deep aquifers do not appear to be major groundwater resources. The impacts of other projects listed in Table 9-6 are either considered in the analysis included above or would have little or no impact on groundwater quality. Therefore, the review team concludes the cumulative impact on groundwater quality would be SMALL.

9.3.3.3 Terrestrial and Wetland Resources

The Bainbridge site is heavily vegetated and contains mixed deciduous forest stands in various stages of succession, scrub-shrub, and a small area dominated by grasses. Stands of mixed deciduous forest likely represent species known to occur in the region. More mature forest stands are present where forest was retained during the operation of the training facility. Young, regenerating forest and scrub-shrub occupy areas around former facilities and other areas formerly maintained as open space. A capped landfill covered with grass lies within the western site boundary.

Review of the National Wetlands Inventory data indicated there are a few small wetlands on the site (FWS 2008a). These wetlands total 4.6 ac (UniStar 2009f). Although the site does not contain or border a waterbody suitable for supplying water to the cooling system, the site is 0.1-mi away from the Susquehanna River. However, access to the Susquehanna River would require construction of a pipeline, part of which would occur outside the existing site boundary.

Within Cecil County there are three Federally listed animal species and one Federally listed plant (Table 9-7). None of these species have been observed or are known to occur on the site, and critical habitat has not been designated for any of these species. Each of these four species has specific habitat requirements that would likely preclude any of them from occurring on the Bainbridge site. The Puritan tiger beetle (*Cicindela puritana*) lives only on bare bluffs with narrow beaches below, neither of which are on the Bainbridge site (FWS 1993). The bog turtle (*Glyptemys muhlenbergii*) prefers small (<2 ac), open canopy sedge or grass-dominated meadows among forests, which also is not present on the site (FWS 2001). The Delmarva fox squirrel (*Sciurus niger cinereus*) occurs in mature deciduous and mixed deciduous forests with a closed canopy and an open understory, and it generally occurs in forest stands associated with farmlands (FWS 2008b). Although both deciduous and mixed deciduous forest habitats are present on the Bainbridge site, these habitats are not mature and are not characterized by closed canopies with open understories. Since the specific habitat the Delmarva fox squirrel prefers is not present, it is highly unlikely this species is present on the Bainbridge site. Swamp pink (*Helonias bullata*) is an obligate wetland plant that occurs along streams and seeps in freshwater swamps and other similar wetland habitats and is strongly associated with coniferous trees (FWS 1991). Although limited wetland habitat exists on the Bainbridge site, freshwater swamps are not present; this likely precludes the swamp pink from being found on the site.

The bald eagle (*Haliaeetus leucocephalus*) is protected by the Bald and Golden Eagle Protection Act and is also listed as threatened by the State of Maryland. There is no open water suitable for eagle foraging on the site. However, the section of the Susquehanna River where the Bainbridge site is located is a known bald eagle wintering area in Maryland (MDNR 2009b). Forest cover present on the bluff overlooking the Susquehanna River may be used by eagles for roosting or perching.

Table 9-7. Federally and State-Listed Terrestrial Species that Occur in Cecil County and May Occur on the Bainbridge Site or in the Immediate Vicinity

Scientific Name	Common Name	Federal Status	State Status
Cicindela puritana	Puritan Tiger Beetle	Threatened	Endangered
Glyptemys muhlenbergii	Bog Turtle	Threatened	Threatened
Sciurus niger cinereus	Delmarva Fox Squirrel	Endangered	Endangered
Helonias bullata	Swamp Pink	Threatened	Endangered
Agalinis obtusifolia	Blunt-leaved Gerardia		Endangered
Agalinis setacea	Thread-leaved Gerardia		Endangered
Agrimonia striata	Woodland Agrimony		Endangered
Antennaria solitaria	Single-headed Pussytoes		Threatened
Arnica acaulis	Leopard's-bane		Endangered
Asplenium piddatifidum	Lobed Spleenwort		Endangered
Bromus latiglumis	Broad-glumed Brome		Endangered
Cardamine longii	Long's Bittercress		Endangered
Carex buxbaumii	Buxbaum's Sedge		Threatened
Carex hitchcockiana	Hitchcock's Sedge		Endangered
Carex hystericina	Porcupine Sedge		Endangered
Carex vestita	Velvety Sedge		Threatened
Castilleja coccinea	Indian Paintbrush		Endangered
Chenopodium standleyanum	Standley's Goosefoot		Endangered
Cicuta bulbifera	Bulb-bearing Water Hemlock		Endangered
Clematis occidentalis	Purple Clematis		Endangered
Corrallorhiza wisteriana	Wister's Coralroot		Endangered
Coreopsis tripteris	Tall Tickseed		Endangered
Deschampsia cespitosa	Tufted Hairgrass		Endangered
Desmodium pauciflorum	Few-flowered Tick-trefoil		Endangered
Desmodium rigidum	Rigid Tick-trefoil		Endangered
Dirca palustris	Leatherwood		Threatened
Elatine minima	Small Waterwort		Endangered

Table 9-7. (contd)

Scientific Name	Common Name	Federal Status	State Status
Eleocharis compressa	Flattened Spikerush		Endangered
Eleocharis halaphila	Salt-marsh Spikerush		Endangered
Epilobium ciliatum	Northern Willowherb		Endangered
Epilobium strictum	Downy Willowherb		Endangered
Equisetum fluviatile	Water Horsetail		Endangered
Equisetum sylvaticum	Wood Horsetail		Endangered
Eriocaulon aquaticum	Seven-angled Pipewort		Endangered
Eriocaulon parkeri	Parker's Pipewort		Threatened
Erythroniumalbidum	White Trout Lily		Threatened
Euphorbia purpurea	Darlington's Spurge		Endangered
Eurybia radula	Rough-leaved Aster		Endangered
Galium boreale	Northern Bedstraw		Endangered
Gentiana andrewsii	Fringe-tip Closed Gentian		Threatened
Gentiana villosa	Striped Gentian		Endangered
Gentianopsis crinita	Fringed Gentian		Endangered
Haseola suaveolens	Sweet-scented Indian-plantain		Endangered
Helianthemum bicknellii	Hoary Frostweed		Endangered
Hydrastis canadensis	Goldenseal		Threatened
Iris prismatica	Slender Blue Flag		Endangered
Lathyrus palustris	Vetchling		Endangered
Limnobium spongia	American Frog's-bit		Endangered
Limosella australis	Mudwort		Endangered
Linum intercursum	Sandplain Flax		Threatened
Lithospermum latifolium	American Gromwell		Endangered
Lygodium palmatum	Climbing Fern		Threatened
Lysimachia hibrida	Lowland Loosestrife		Threatened
Matelea carolinensis	Anglepod		Endangered
Melanthium latifolium	Broad-leaved Bunchflower		Endangered
Minuartia michauxii	Rock Sandwort		Threatened
Pedicularis lanceolata	Swamp Lousewort		Endangered
Platanthera peramoena	Purple Fringeless Orchid		Threatened
Pluchea camphorata	Marsh Fleabane		Endangered
Polygala senega	Seneca Snakeroot		Threatened
Potamogeton zosteriformis	Flatstem Pondweed		Endangered

Table 9-7. (contd)

Scientific Name	Common Name	Federal Status	State Status
Purnus alleghaniensis	Alleghany Plum		Threatened
Pycnanthemum torrei	Torrey's Mountain-mint		Endangered
Pycnanthemum verticillatum	Whorled Mountain-mint		Endangered
Rhynchospora golbularis	Grass-like Beakrush		Endangered
Ruellia strepens	Rustling Wild-petunia		Endangered
Rumex altissimus	Tall Dock		Endangered
Salix exigua	Sandbar Willow		Endangered
Sanguisorba canadensis	Canada Burnet		Threatened
Scutellaria leonardii	Leonard's Skullcap		Threatened
Scutellaria nervosa	Veined Skullcap		Endangered
Sida hermaphrodita	Virginia Mallow		Endangered
Smilax pseudochina	Halberd-leaved Greenbrier		Threatened
Solidago speciosa	Showy Goldenrod		Threatened
Sphenopholis pensylvanica	Swamp-oats		Threatened
Spiranthes lucida	Wide-leaved Lady's Tresses		Endangered
Sporobolus clandestinus	Rough Rushgrass		Threatened
Sporobolus heterolepis	Northern Dropseed		Endangered
Stachys aspera	Rough Hedge-nettle		Endangered
Stellaria alsine	Trailing Stitchwort		Endangered
Stenanthium gramineum	Featherbells		Threatened
Symphyotrichum depauperatum	Serpentine Aster		Endangered
Talinum teretifolium	Fameflower		Threatened
Thaspium trifoliatum	Purple Meadow-parsnip		Endangered
Triosteum angustifolium	Narrow-leaved Horse-gentian		Endangered
Triphora trianthophora	Nodding Pogonia		Endangered
Valeriana pauciflora	Valerian		Endangered

Source: MDNR 2007c

Ecologically important species that likely occur on the Bainbridge site include tulip poplar (*Liriodendron tulipifera*), chestnut oak (*Quercus prinus*), and mountain laurel (*Kalmia latifolia*). These three species are considered ecologically important because they are widespread, abundant, and contribute resources to many upland habitats.

Recreationally important species found on the Bainbridge site include white-tailed deer (*Odocoileus virginianus*), wild turkey (*Meleagris gallapavo*), ring-necked pheasant (*Phasianus* *colchicus*), and the northern bobwhite quail (*Colinus virginianus*). The white-tailed deer and wild turkey can thrive in a habitat mosaic. The ring-necked pheasant and bobwhite quail prefer open habitats and would not likely be present in the local landscape without disturbance brought about by various land use practices, including agriculture.

Building and Operational Impacts

UniStar identified a representative 420-ac area within the Bainbridge site for the purposes of evaluating potential impacts of building a U.S. EPR nuclear power plant (see Figure 9-4). If a plant were built within this footprint, mixed deciduous forest in various stages of succession, scrub-shrub, and recently disturbed grass-dominated habitats would be permanently lost. No onsite wetlands would be affected (UniStar 2009a). The water supply pipeline and intake structure would disturb approximately 1.32 ac of wetlands offsite. Also, approximately 5.2 ac of wetlands would be affected by transmission line development.

The Bainbridge site is a Maryland CWMA that is open to deer hunting from September through January. A new reactor built on the Bainbridge site would necessitate closure of the CWMA on the site.

The Bainbridge site, although heavily vegetated, is mostly at an early to intermediate (seral) stage (in succession). The site does not provide suitable habitat for the Federally listed Puritan tiger beetle, bog turtle, and swamp pink, so effects to these species would be limited. The forests are not mature enough at this time to provide habitat for the Delmarva fox squirrel. However, these forests may become suitable if no disturbances occurr on this site, and therefore this species could lose potential future habitat if a nuclear plant is developed at this site. Installation of a cooling system pipeline to the Susquehanna River and transmission systems would affect terrestrial resources, including wetlands and streams. Wintering bald eagles could be displaced during building of these facilities. However, this displacement would be limited both spatially and temporally, and alternate roost and perch sites are likely along the lower Susquehanna River. Any disturbance of eagles is not expected to result in a decrease in eagle productivity. An extensive number of Maryland State-listed plants are found in Cecil County. Their distribution and abundance is unknown within the site and vicinity, and it is unknown to what extent any of these species would be affected. Some are wetland specific, and as wetland impacts could be avoided at this site, these species would be expected to be affected less than upland species and habitat generalists. Because the site has experienced considerable disturbance in the past, State-listed species that occur in disturbed habitats such as the showy goldenrod (*Solidago speciosa*), could be noticeably affected. Populations of the three ecologically important species (tulip poplar, chestnut oak, mountain laurel), by their nature of being important due to abundance and distribution, would not be noticeably affected on the site and within the county. Recreationally important white-tailed deer, wild turkey, ring-necked pheasant, and bobwhite quail could lose some habitat from conversion to facilities, but could also benefit from the temporary effects of disturbance to more mature habitats. However, these effects are not expected to be noticeable or destabilize even local populations of these animals.

Operational activities within the transmission corridors might include visual inspection and appropriate maintence of transmission line corridors. Maintenance activities might include clearing vegetation and tree trimming or removal. For maintenance purposes, wooded sections of the corridors would be cleared to the full width through mechanical clearing, hand cutting, or herbicide application.

Terrestrial ecological impacts that may result from operation of a new nuclear unit at the Bainbridge alternative site include those associated with the cooling system and maintenance of transmission line corridors. For impacts related to cooling system operations, the review team assumed that the one cooling tower proposed for Unit 3 at the Calvert Cliffs site would be used at each of the alternative sites. In NUREG-1437 (NRC 1996), the NRC staff evaluated terrestrial ecological impacts resulting from operation of existing nuclear power plants and transmission line operation and maintenance. The types of terrestrial ecological impacts resulting from operation of a new nuclear unit would be similar to those of existing nuclear power plants. Conclusions in the NUREG-1437 (NRC 1996) were used to assess terrestrial impacts resulting from the operation of the cooling tower and impacts from transmission line corridor maintenance and operation where more specific information was not available. Likewise, the effects of cooling tower drift, avian collisions, noise, and transmission lines would be similar to those described in Section 5.3.1.1 in which the operational impacts were determined to be undetectable at the population level.

Cooling Towers

The operation of a cooling tower results in the loss of water through evaporation and drift. Drift is described as small, unevaporated water droplets that are exhausted out the top of the tower. These droplets may carry minerals and chemicals that may impact crops, ornamental vegetation, and native plants. Adverse impacts from cooling tower drift cannot be evaluated in detail without knowing the specific location of the cooling tower. However, general guidelines for predicting effects of drift deposition on plants suggest that many species have thresholds for visible leaf damage in the range of 9 to 18 lb/ac/mo of salt deposition on leaves during the growing season (NRC 1996). The Susquehanna River would supply tidal freshwater to the Bainbridge site; therefore, the salt content in cooling water would be less at the Bainbridge site than at the proposed Calvert Cliffs site. Because the maximum salt deposition for the proposed Unit 3 is far below the level that could cause leaf damage in many common species, the impacts would be negligible both on the Calvert Cliffs site and in the vicinity. One could expect even less impact at the Bainbridge site because the salt content in the cooling water source would be lower. In general, the impacts of drift on crops, ornamental vegetation, and native plants were evaluated for existing nuclear power plants and were found to be of minor significance (NRC 1996).

Similarly, predicting mortality from bird collisions with cooling towers depends on factors such as the height, location, lighting, and the number of cooling towers. In this case, a single, large mechanical draft cooling tower with plume abatement would be used. The impacts of bird collisions for existing power plants were evaluated and found to be of minor significance for all operating nuclear plants, including those with various numbers and types of cooling towers (NRC 1996). On this basis, the review team concludes, for the purpose of comparing the alternative sites, that the impacts of cooling tower drift and bird collisions with the cooling tower resulting from operation of a new nuclear unit at Bainbridge would be minor.

Typical noise levels that can be expected at a distance of 1300 ft from the cooling tower are 65 dBA (UniStar 2009a). Noise from plant operation would also be quickly attenuated by surrounding forest cover, further limiting any impact. Local wildlife would likely adapt to noise levels, while cooling tower noise may also serve to limit the potential for avian collision. Consequently, the review team concludes the impacts of cooling tower noise on wildlife would be minimal at Bainbridge.

Transmission Lines

The impacts associated with transmission line operation consist of bird collisions with transmission lines and electromagnetic field (EMF) effects on flora and fauna. The impacts associated with building transmission lines and corridor maintenance activities are alteration and/or conversion of habitat due to tree cutting and herbicide application and similar related impacts such as use of temporary matting where corridors cross floodplains, wetlands, and other important habitats.

Direct mortality resulting from birds colliding with tall structures has been observed (Avatar 2004). Factors that appear to influence the rate of avian impacts with structures are diverse and related to bird behavior, structure attributes, and weather. Migratory flight by flocking birds during darkness has contributed to the largest mortality events. Tower height, location, configuration, and lighting also appear to play roles in avian mortality. Weather, such as low cloud ceilings, advancing fronts, and fog also contribute to this phenomenon. Waterfowl may be particularly vulnerable due to low, fast flight and flocking behavior (Brown 1993). However, in NUREG-1437, the NRC staff concluded that the threat of avian collision as a biologically significant source of mortality is very low as only a small fraction of total bird mortality could be attributed to collision with nuclear power plant structures, including transmission corridors with multiple transmission lines (NRC 1996). Although collision may contribute to local losses, thriving bird populations can withstand these losses without threat to their existence (Brown 1993). Although additional transmission lines would be required for a new nuclear unit at Bainbridge, increases in bird collisions would be minor and these would not likely be expected to cause a measurable reduction in local bird populations. Consequently, the incremental mortality posed by the addition of new transmission lines for a new nuclear unit would be negligible at Bainbridge.

EMFs are unlike other agents that have an adverse impact (e.g., toxic chemicals and ionizing radiation) in that dramatic acute effects cannot be demonstrated and long-term effects, if they exist, are subtle (NRC 1996). A careful review of biological and physical studies of EMFs did not reveal consistent evidence linking harmful effects with field exposures (NRC 1996). The impacts of EMFs on terrestrial flora and fauna are of small significance at operating nuclear power plants, including transmission systems with variable numbers of power lines and lines energized at levels less than 765 kV (NRC 1996). Since 1997, more than a dozen studies have been published that looked at cancer in animals that were exposed to EMFs for all or most of their lives (Moulder 2003). These studies have found no evidence that EMFs cause any specific types of cancer in rats or mice (Moulder 2003). Therefore, the incremental EMF impact posed by operation of existing transmission lines and the addition of new lines for a new nuclear unit would be negligible at the Bainbridge alternative site.

Existing roads providing access to the existing transmission line corridors at Bainbridge would likely be sufficient for use in any expanded corridors; however, new roads would be required during the development of new transmission line corridors. Transmission line corridor management activities (cutting and herbicide application) and related impacts to floodplains and wetlands in transmission line corridors are of minor significance at operating nuclear power plants, including those with transmission line corridors of variable widths (NRC 1996). Consequently, the incremental effects of transmission line corridor maintenance and associated impacts to floodplains and wetlands for a new nuclear unit would be negligible at Bainbridge.

For reasons discussed above, detectable impacts to important terrestrial species and habitat would be minimal, if any, at the Bainbridge site. Therefore, impacts to terrestrial resources, including wetlands, from building and operation of a nuclear power plant at the Bainbridge site would be minimal.

Cumulative Impacts

The geographic area of interest for the assessment of the potential cumulative impacts of building and operating a new reactor at the Bainbridge site and other past, present, and reasonably foreseeable actions on terrestrial resources and wetlands is defined as Cecil County, Maryland, because of the extent of terrestrial impacts is mostly localized and the site is several miles from neighboring counties. One exception is Harford County, which is close to the Bainbridge site but on the other side of the Susquehanna River, which is a natural barrier isolating most terrestrial impacts. The nearest managed area is the Susquehanna State Park, which is on the western shore of the Susquehanna River about 1 mi northwest of the Bainbridge site. The park is primarily a recreational area but also contains several historical sites. The primary impacts to the Susquehanna State Park would likely be exposure of wildlife to noise from building a new nuclear plant. No major development activities are proposed that would significantly contribute to the loss or degradation of terrestrial resources or wetlands within the reasonably foreseeable future in Cecil County. Construction of the Rock Springs Generation

Facility in the early 1990s did not significantly affect county terrestrial resources or wetlands. Since much of the impact resulting from building a power plant at Bainbridge would occur in recently disturbed habitats that are not occupied and likely would not be occupied by Federally listed species in the near future, the incremental impacts would not be noticeable and would not be expected to destabilize flora and fauna populations in the geographic area of interest.

Continued urbanization and GCC have the potential to alter and reduce the amount of terrestrial habitat and wetlands available to flora and fauna. GCC effects near the Bainbridge site could result in regional increases in the frequency of severe weather, in annual precipitation, and in average temperature (GCRP 2009). Such factors would affect the terrestrial resources in the geographic area of interest through reduced open lands and wetlands as a result of inundation of low-lying areas that are not buffered by the bluffs along the Susquehanna River. Forest growth may increase as a result of more carbon dioxide in the atmosphere (GCRP 2009). The impacts of GCC on plants and wildlife in the geographic area of interest are not precisely known. Changes in climate could alter and fragment key terrestrial habitats and result in substantial northward shifts in species' ranges, diversity, and abundance in the geographic area of interest for the Bainbridge site (GCRP 2009).

Based on the information provided by UniStar and the review team's independent evaluation, the review team concludes that the cumulative impacts to terrestrial and wetland resources of building and operating a new nuclear unit at the Bainbridge alternative site, including impacts attributable to permanent conversion of habitat for the facility footprint as well as operation of the cooling tower, transmission lines, and transmission line corridors would be SMALL.

9.3.3.4 Aquatic Resources

The Susquehanna River, which is about 0.1 mi from the site, would provide the cooling water for a new nuclear plant at Bainbridge (UniStar 2009a). The lower Susquehanna River is classified as tidal freshwater from the river mouth to the Conowingo Dam with little salt wedge intrusion from the Chesapeake Bay (MDE 2008). This part of the river and its tributaries located in Harford and Cecil Counties comprise the Lower Susquehanna River watershed. A new reactor on the Bainbridge site would require a new cooling water intake and discharge system.

The Susquehanna River is the largest and most important aquatic resource near the Bainbridge site. The river is well known as a pathway for several species of migratory anadromous and catadromous fish, including striped bass (*Morone saxatilis*), white perch (*M. americana*), yellow perch (*Perca flavescens*), alewife (*Alosa pseudoharengus*), blueback herring (*A. aestivalis*), hickory shad (*A. mediocris*), American shad (*A. sapidissima*), and American eel (*Anguilla americana*) (NMFS 2009). The area near Port Deposit is valued because it is good spawning habitat for species with eggs that are deposited on the bottom and historically has had dense beds of submerged aquatic vegetation (SAV) that may reach 100 ft toward the river channel (NMFS 2009). According to the most recent surveys, the SAV beds along the shore from

Port Deposit downstream to an area beyond the probable location of the Bainbridge intake on the river are very dense with 70-100 percent cover (VIMS 2010).

Other aquatic communities within the site include at least two small, temporary streams and a small reservoir that was built as a drinking water source for previous tenants on the property. The onsite resources have not been characterized, but the few small stream courses amount to 8654 linear ft (UniStar 2009f). However, during a site visit on August 19, 2009, it was observed that flow in the streams was minimal or non-existent. The reservoir has not been studied but probably is inhabited by species typical for such small freshwater impoundments.

The potential for impacts from building and operating of the proposed new reactor at Bainbridge to aquatic biota would be primarily to organisms inhabiting the streams and pond on the site and the Susquehanna River.

Commercially or Recreationally Important Species

The stretch of the Susquehanna River between the Conowingo Dam and Havre de Grace is a popular recreational fishing area. The primary species sought are shad, herring, and striped bass (locally called rockfish). However, the Port Deposit area of the Susquehanna River is upstream of designated essential fish habitat (EFH) for Federally managed species under the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801 et seq).

American Shad (*Alosa sapidissima*). The American shad, which is discussed in detail in Section 2.4.2, is an important part of the history of the Susquehanna River. The shad is an anadromous fish that enters the Susquehanna River to spawn. Shad fishing around Port Deposit, which is considered a “hot spot” for shad, begins in late spring (HPD 2009). Shad also contribute ecologically by linking estuarine, freshwater, and terrestrial ecosystems.

River Herring (*Alosa pseudoharengus* and *A. aestivalis*). The alewife and blueback herring are closely related and are both referred to river herring. Both are discussed in detail in Section 2.4.2. Although river herring population levels have declined substantially during the last 30 years, there is still some recreational fishing for the species. River herring occur nearshore in the Port Deposit area where they comprise a recreational dip-net fishery (HPD 2009). Both species were recorded during entrainment and impingement studies conducted at Calvert Cliffs Units 1 and 2 (discussed in Section 5.3.2) and would be expected to be susceptible to both impacts by a cooling water system for a new reactor built at the Bainbridge site.

Striped Bass (*Morone saxatilis*). Striped bass, which is discussed in detail in Section 2.4.2, is a popular commercial and recreational species throughout the Chesapeake Bay region. Both fisheries are tightly regulated as the result of substantial population declines that occurred in the latter 1900s. Catch-and-release recreational fishing begins in mid-spring in the Port Deposit area (HPD 2009). The Port Deposit Chamber of Commerce co-sponsors a rockfish tournament in the early summer (PDCC 2009b). Striped bass spawn at the Susquehanna flats near Port Deposit (HPD 2009).

Non-Native and Nuisance Species

The zebra mussel (*Dreissena polymorpha*), the Asian clam (*Corbicula fluminea*), and the rusty crayfish (*Orconectes rusticus*) are three introduced nuisance species that have been recorded in sections of the Susquehanna River, although not specifically near Port Deposit. The zebra mussel has been found at the Conowingo Dam (Vanesky 2009). The zebra mussel colonizes hard substrates and is capable of clogging intake water pipes. The Asian clam inhabits soft sediments and has been recorded from the Susquehanna River below the Conowingo Dam and at the river mouth near Havre de Grace (Foster et al. 2009). Large aggregations of Asian clams can foul power plant water systems. The rusty crayfish is native to the Ohio River basin but has been found in the stretch of the Susquehanna River at the mouth of Conowingo Creek, about 4 mi upriver from Port Deposit (MDNR 2007l). Maryland banned the possession of any crayfish species in the Susquehanna River basin in 2008 (MDNR 2009e).

Federally and State-Listed Species

One Federally listed endangered aquatic species, the shortnose sturgeon (*Acipenser brevirostrum*) is reported for Cecil County (MDNR 2007c), but no critical habitat has been designated for that species. River herring are considered species of concern by the National Marine Fisheries Service (NMFS) (NMFS 2007). State-listed aquatic vertebrates reported from Cecil County are the northern map turtle (*Graptemys geographica*), the hellbender (a salamander, *Cryptobranchus alleganiensis*), and the logperch (*Percina caprodes*) (MDNR 2007c). State-listed freshwater mussel species reported from Cecil County are the eastern lampmussel (*Lampsilis radiata*), the tidewater mucket (*Leptodea ochracea*), and the creeper (*Strophitus undulatus*) (MDNR 2007c).

<u>Shortnose Sturgeon (*Acipenser brevirostrum*)</u>. The shortnose sturgeon is discussed in detail in Section 2.4.2 and in the Biological Assessment (BA) prepared for this project (Appendix F). Shortnose sturgeons that might occur in the Susquehanna River near the Bainbridge site would most likely be part of the small population that remains in the Chesapeake Bay. NMFS considers the reach of the Susquehanna River downriver from the Conowingo dam as important shortnose sturgeon feeding habitat (NMFS 2009). Although recent shortnose sturgeon spawning has not been documented in the Chesapeake Bay or its tributaries (FWS 2009), the area near Port Deposit may be suitable for spawning.

<u>Northern Map Turtle (*Graptemys geographica*)</u>. The northern map turtle ranges predominantly from the central Midwest along the Mississippi and Ohio Rivers to southern Ontario, with scattered, disjunct populations in Pennsylvania, New Jersey, New York, and Maryland

(Richards and Seigel 2009). In Maryland, the northern map turtle population, which is listed as State endangered, is restricted to the Susquehanna River. Map turtles are sexually dimorphic with females reaching carapace lengths of about 10 in., which is almost twice as long as males (Roche 2002). The map turtle lives in rivers and lakes, where there is relatively low water flow, muddy substrates, and places to bask (Roche 2002). Map turtles only leave the water for basking or egg laying (Roche 2002). Adult turtles tend to inhabit the deeper parts of rivers away from shore, whereas turtles smaller than 2.5 in. stay in shallow waters near shore. Female map turtles eat mainly large snails and clams, whereas males eat small mollusks, crayfish, and insects. Nesting in the lower Susquehanna River occurred in June and July (Richards and Seigel 2009). Map turtles typically do not migrate long distances.

Richards and Seigel (2009) found that turtles occurred throughout the small part of the Susquehanna River in Maryland, but the most tracked were within an area next to several islands off the Susquehanna State Park, about 1.2 mi northwest of Port Deposit. These islands served as nesting habitat. The study tracked one individual from the islands in the eastern shore of the river to an area about 1 mi past the marina at Port Deposit, which indicates the area near the proposed intake at the Bainbridge site provides suitable habitat for a larger portion of the Maryland population of the northern map turtle. Six nesting sites were observed at unspecified locations along the eastern shore of the river near Port Deposit. Richards and Seigel (2009) reported that juvenile and hatchling map turtles frequently use the marina at Port Deposit.

<u>Hellbender (*Cryptobranchus alleganiensis*)</u>. The eastern hellbender is a fully aquatic salamander listed as endangered by the State. The hellbender can reach a length of about 29 in., and may live as long as 30 years (Mayasich et al. 2003). Although the historical range of the hellbender includes the Susquehanna River, it apparently no longer resides in portions of the river within Maryland (Mayasich et al. 2003, MDNR 2006).

<u>Logperch (*Percina caprodes*)</u>. Maryland lists the logperch as State-threatened species (MDNR 2007c). Logperches can reach a length of about 5 in. and live on muddy to rocky bottoms in large rivers, or in tributaries that flow into large rivers, generally occurring in water deeper than about 4 ft (Steiner 2000). Spawning occurs in shallow water during late spring to early summer. A study of streams in the lower Susquehanna River basin recorded logperches from only two sites, both small tributaries of the Susquehanna River at least 10 mi upriver from Port Deposit (Millard et al. 1999). Neely and George (2006) made anecdotal reference to the occurrence of the species in Conowingo Creek, which joins the Susquehanna River about 4 mi upriver from Port Deposit. Near (2008) presented evidence that the species inhabiting the lower Susquehanna River basin should be called the Chesapeake logperch (*P. bimaculata*), which has been considered a subspecies of logperch (*P. caprodes*). The removal of the Chesapeake logperch from synonymy with the logperch has important meaning for conservation of the species because the distribution of the Chesapeake logperch is much more restricted, and its

populations are much smaller than those of the logperch. Near (2008) argued that the Chesapeake logperch should be considered for protection under the Endangered Species Act (ESA). The possible occurrence of the Chesapeake logperch within the mainstem Susquehanna River near the Bainbridge site is not known but cannot be discounted.

Eastern Lampmussel (*Lampsilis radiata*). The eastern lampmussel, which occurs in coastal freshwaters from South Carolina to Nova Scotia, is a moderately large freshwater mussel that can reach a length of about 4 in. (PANHP 2009a). It typically occurs in streams and rivers with sand or gravel bottoms. Maryland ranks the eastern lampmussel as State Uncertain (MDNR 2007c). Within Cecil County, the mussel is generally shown as occurring in piedmont streams, coastal plain streams, and piedmont rivers that are tributaries of the Susquehanna River (MDNR 2005). The eastern lampmussel's possible occurrence in the Susquehanna River near the Bainbridge site is not known.

Tidewater Mucket (*Leptodea ochracea*). The tidewater mucket occurs in coastal freshwaters from Georgia to Nova Scotia (ME DIFW 2003). This mussel can reach a length of about 3 in., and inhabits several types of substrates in low-flow stretches of rivers, lakes, and ponds. Maryland ranks the eastern lampmussel as Highly State Rare/State Rare (MDNR 2007c). Within Cecil County, the mussel is generally shown as occurring in coastal plain streams and piedmont rivers that are tributaries of the Susquehanna River (MDNR 2005). Its possible occurrence in the Susquehanna River near the Bainbridge site is not known.

Creeper (*Strophitus undulatus*). The creeper is a freshwater mussel that occurs in the shallow waters of rivers and streams in the eastern half of the United States and Canada (Nedeau 2007). The species usually occurs on gravel and sand river bottoms where currents are low to moderate and many fish species are present (Nedeau 2007). Maryland ranks the species as State Imperiled (MDNR 2007c), although elsewhere populations may be stable (Grabarkiewicz and Davis 2008).

Building and Operation Impacts

Building a new reactor on the Bainbridge site would directly affect the two small streams. About 1557 linear ft of stream channels would be affected by building a new plant on the site (UniStar 2009a). Assuming that the plant design would be similar to that proposed for Calvert Cliffs Unit 3, a new plant would permanently add about 130 ac of impervious surface to the Bainbridge site, which would increase runoff during storms potentially increasing erosion and adding pollutants to aquatic resources. The potential impacts of the proposed activities on the upland aquatic resources primarily would be loss of stream habitat, but building and operating it would not adversely affect the overall upland aquatic resources in the region.

New cooling water intake and discharge structures would be required at the Bainbridge site. The intake and discharge structures are assumed to be designed like those at the proposed site, having no screens or return system at the intake pipe openings, which lead to a common forebay (see Chapter 3.) Although the Bainbridge site is about 0.1 mi from the Susquehanna River, a pipeline for the cooling water system would be considerably longer because of the 142-ft-high bluffs that border the western part of the site. An exact pipeline route has not been determined, but the pipeline would most likely cross one or more small streams en route to the river. UniStar (2009f) estimated that the area of the river below ordinary high water that would be affected by the installation of the intake pipelines would be 0.23 ac. Building a new intake could convert the river bottom to habitat that cannot support SAV. Historically, the river bottom in the Port Deposit area is hard bottom that supports SAV (NMFS 2009), affecting reproductive habitat for anadromous species. Adverse effects on the reproductive potential of anadromous species would have indirect effects on Federally managed species (under MSA) that prey on such anadromous species (NMFS 2009). Installation of the intake and discharge structures on hard-bottom substrates could involve the use of cofferdams and dewatering, which would introduce pile-driving noise, discussed in Section 4.3.2.1, as a potential impact. Some silt runoff could occur as the intake is built and could affect local fish and benthic populations. However, the impacts on aquatic organisms would be temporary and largely be mitigated through the use of BMPs with the exception of the permanent habitat conversion from very dense SAV beds to riprap supporting and stabilizing the pipes. Such habitat conversion would remove some highly valuable nursery habitat for migratory species that spawn in the immediate vicinity.

The eastern shore of the Susquehanna River south of Port Deposit, where the intake and discharge system might be placed, is frequented by the State-endangered northern map turtle, including hatchlings and juveniles, during the summer months. Building activities during those months could adversely affect the Maryland population. Based on distributional records and life-history information, available to date, the review team concludes that building a new unit at the Bainbridge site could affect the State-listed northern map turtles that may be near the intake/discharge system location. The use of the nearshore habitat by smaller map turtles would make potential impingement and entrapment within the common forebay during the operation of a plant at the site a primary concern.

The most likely effects on aquatic populations from operation of a new nuclear unit at the Bainbridge site would be the impingement, entrainment, and entrapment of organisms from the Susquehanna River. Assuming that a new reactor at the Bainbridge site would use a closed-cycle cooling system that meets the EPA's Phase I regulations for new facilities (66 FR 65256), has a maximum through-screen velocity of 0.5 ft/s (0.15 m/s) at the cooling water intake structure on the Susquehanna River, and meets the appropriate EPA intake flow-to-source water volume criterion, adverse impacts at the population level of many Susquehanna River aquatic species from impingement, entrainment, and entrapment would not be anticipated. However, some migratory species, such as river herring and American shad, which have valuable reproductive and nursery habitat near the likely intake area for the Bainbridge site and have been entrained or impinged at some nuclear power plants, could be directly affected by losses at the intake structure in the tidal freshwater portion of the Susquehanna River. Given the location of the proposed intake in the same area used by anadromous species for spawning and nursery grounds, entrainment and entrapment could remove enough organisms to noticeably alter important attributes of the populations despite compliance with EPA's Phase I regulations. The potential entrainment and entrapment of anadromous fish eggs and larvae is of particular concern because of direct effects on the species, which already have declining populations, and indirect effects on their Federally managed predators (NMFS 2009).

In addition, hatchling and juvenile northern map turtles are smaller than the spacing between the trash bars proposed for Calvert Cliffs Unit 3 and would be susceptible to impingement and entrapment in the common forebay, which would not provide suitable habitat for the northern map turtle. To avoid adverse effects to the map turtle, the intake structure would likely have to be redesigned or sited elsewhere. As for the proposed Unit 3 at the Calvert Cliffs site (see Chapter 4), the review team recognizes that potential mitigation measures could be implemented at the intake pipeline openings at the Bainbridge site to reduce entrainment, impingement, and entrapment effects on aquatic species in the Susquehanna River. Most notably, creation of a recessed intake and installation of small-mesh traveling screens or wedgewire screens and a fish/turtle-return system at the intake pipeline openings in the river would significantly reduce adverse effects on aquatic organisms.

Although a discharge plume has not been modeled for the Bainbridge site, the Susquehanna River is a large and deep waterbody at that location, and the review team assumes the plume would be similar in areal extent and depth to that modeled for the Calvert Cliffs site. Therefore, the plume would likely be relatively small compared to the river size in the area, and there would not likely be a thermal barrier to fish passage. In addition, the potential for adverse impacts from cold shock or heat shock because of exposure to the thermal plume would be minor. Chemical concentrations in the effluents from the Bainbridge site, which eventually could include a molluskicide to control zebra mussels, would be required to follow permitted guidelines.

New transmission lines would be needed to connect a new reactor on the Bainbridge site to existing lines that are about 5 to 20 mi from the site (UniStar 2009a). A specific route for the new right-of-way has not been specified, but approximately 3517 linear ft of streams would be affected by development of new transmission line corridors (UniStar 2009a). The severity of impacts would depend on the characteristics of the aquatic resources within the corridor, but the use of BMPs during building and operation would lessen the potential impacts.

Overall, the impacts of building and operation of a new reactor on the Bainbridge site to most aquatic resources, including those in the Susquehanna River, would be substantial because of noticeable alterations to important reproductive habitat and reproductive success for migratory fish. In addition, the potential impact to the State-Endangered northern map turtle, primarily from the potential for impingement and entrapment of hatchlings and juveniles during plant operations, would be noticeable and potentially destabilizing to the disjunct Maryland population.

Cumulative Impacts

The geographic area of interest for the assessment of the potential cumulative aquatic ecology impacts of building and operating a new reactor at the Bainbridge site and other past, present and reasonably foreseeable projects on aquatic resources is defined as the stretch of the Susquehanna River from the Conowingo Dam to the Chesapeake Bay, the tributaries that flow into the river below the dam, and the tidal freshwater part of the Bay where salinity ranges from 0 to 0.5 parts per thousand. The bayward extent of tidal freshwater varies seasonally, extending to near the mouth of the Sassafras River (CBP 2009). Within this defined area, a new reactor on the Bainbridge site would add to the effects resulting from the operation of the Conowingo Hydroelectric Plant, which is about 10 mi upriver. The Conowingo Dam affects aquatic resources in the Susquehanna River primarily by introducing variation in river water levels and flow, changing water quality, and directly affecting aquatic biota, especially fish (Patty et al. 1999). The major impact to fish has been the interruption of the migration of anadromous fish, although that has been somewhat ameliorated by the installation of fish lifts and ladders, which has increased the number of fish passing the dam (NRC 2003). Low dissolved oxygen levels are the main water quality impact from the dam, which have been corrected by the implementation of turbine venting that mixes air with water passing through a turbine (Patty et al. 1999). Low water flow over the dam adversely affects benthic communities downstream and the operators of the dam are required to release water to maintain minimum flow rates, which can vary seasonally (SRBC 2006). The Mid-Atlantic Express Pipeline Project would build an 88-mi-long liquefied natural gas (LNG) pipeline from Baltimore to Eagle, Pennsylvania. The pipeline would use horizontal directional drilling to cross the Susquehanna River upriver of the Conowingo Dam (AES no date) and would not interact with a new reactor on the Bainbridge site. Port Deposit has a small-boat marina located just upriver from the potential location of the intake and discharge system. Activities associated with operating boats in the marina and nearby waters could affect species that might be affected by the intake and discharge system. One such activity is the hydroplane race series on the Susquehanna River held on Labor Day weekend. The race course is located just offshore along the river south of Port Deposit (PDCC 2009a) and would be near potential locations for intake/discharge structures. Urbanization in the Susquehanna River drainage could adversely affect water quality and, therefore, aquatic habitat, through increases in both point and nonpoint source pollution.

In addition to direct anthropogenic activities, GCC would impose additional stressors on aquatic communities. The presence of natural environmental stressors (e.g., short- or long-term changes in precipitation or temperature) would contribute to the cumulative environmental impacts to the Susquehanna River. GCC could lead to increased precipitation, increased sea levels, varying freshwater inflow, increased pollution from nonpoint source runoff, increased temperatures, increased storm surges, and greater intensity of coastal storms in the geographic area of interest (GCRP 2009). Such changes could alter salinity, change freshwater inflow, and reduce dissolved oxygen, which directly affect aquatic habitat. Rising sea water due to GCC could affect water levels in the Susquehanna River and subsequently change the water quality associated with the mixing of freshwater and estuarine waters of the Chesapeake Bay (GCRP 2009). These stressors would result in shifts in species' ranges, habitats, and migratory behaviors and also alter ecosystem processes (GCRP 2009).

Summary

Based on the information provided by UniStar and by NMFS, and the review team's independent evaluation, the review team concludes that the cumulative impacts of building and operating a new reactor on the Bainbridge site combined with other past, present, and reasonably foreseeable future activities on most aquatic resources, including migratory fish in the geographic area of interest, would be MODERATE to LARGE. The most notable of the impacts involves potential losses of hatchling and juvenile northern map turtles, a State-endangered species that occurs near the proposed intake structure. Building and operating a new nuclear unit at the Bainbridge site would be a significant contributor to these impacts.

9.3.3.5 Socioeconomics

For the analysis of socioeconomic impacts at the Bainbridge site, the geographic area of interest is the 50-mi region centered on the Bainbridge site with special consideration of Cecil County, as that is where the review team expects socioeconomic impacts to be the greatest. In evaluating the socioeconomic impacts of site development and operation at the Bainbridge site in Port Deposit, Maryland, within Cecil County, the review team undertook a review of the site using data sources discussed in Section 9.3.2. Impacts from both building and station operation are discussed.

Physical Impacts

Many of the physical impacts of building and operation would be similar regardless of the site. Building activities can cause temporary and localized physical impacts such as noise, odor, vehicle exhaust, vibration, shock from blasting (if used), and dust emissions. The use of public roadways, railways, and waterways would be necessary to transport building materials and equipment. Offsite areas that would support building activities (for example, borrow pits, quarries, and disposal sites) would be expected to be already permitted and operational. Impacts on those facilities from building a new unit would be minimal.

Potential impacts from station operation include noise, odors, exhausts, emissions, and visual intrusions (aesthetics). A new unit would produce noise from the operation of pumps, cooling towers, transformers, turbines, generators, and switchyard equipment. Traffic at the site also would be a source of noise. Any noise coming from the site would be controlled in accordance with standard noise protection and abatement procedures. By inference, this practice also would be expected to apply to all alternative sites. Commuter traffic would be controlled by speed limits. Good road conditions and appropriate speed limits would minimize the noise level generated by the workforce commuting to the Bainbridge site.

Any new unit at an alternative site would have standby diesel generators and auxiliary power systems. Permits obtained for these generators would confirm that air emissions comply with applicable regulations. In addition, the generators would be operated on a limited, short-term basis. During normal plant operation, a new unit would not use a significant quantity of chemicals that could generate odors that exceed odor threshold values. Good access roads and appropriate speed limits would minimize the dust generated by the commuting workforce.

In summary, building activities would be temporary and would occur mainly within the boundaries of the Bainbridge alternative site. Offsite impacts would represent minimal changes to offsite services supporting the building activities. During facility operations, noise levels would be managed by State and local ordinances. Air quality permits would be required for the diesel generators, and chemical use would be limited, which should limit odors. Based on the information provided by UniStar and the review team's independent evaluation, the review team concludes that the physical impacts of building and operating a nuclear unit at the Bainbridge site would be minimal.

Demography

The Bainbridge site is located in the town of Port Deposit (2008 population 701), in Cecil County in northeastern Maryland. The U.S. Census Bureau (USCB) indicates that Cecil County had a 2008 population of 99,926 which was a 14 percent increase from 2000 (USCB 2009a). By 2030, the population is expected to increase by an additional 60,000 people (Sage Policy Group, Inc. 2007). Baltimore is approximately 42 mi southwest and Wilmington, Delaware is 37 mi northeast. The population in the 50 mile region is 5.2 million people (UniStar 2009a).

At the peak of the site development period, UniStar expects an onsite workforce of 3950 construction workers (UniStar 2009a). Based on the analysis of impacts presented in Section 4.4.2, the maximum number of construction workers migrating into the region (within 50 mi of the site) from outside of the region would be between 790-1383 workers (20 to 35 percent of the total workforce) at the peak of the building period. Using an average household size of 2.61, the total in-migrating population would be between 2062 and 3608 people. The majority of impacts would be expected to occur in Cecil County because it contains the site. The impacts are more dispersed farther away from the site due to the large populations of the other counties within commuting distance of the Bainbridge site such as neighboring Harford County. Considering that the maximum estimation of in-migrating population would be less than four percent of the total population for Cecil County, the demographic impacts of building a new nuclear plant at the Bainbridge site are expected to be minimal.

If the facility were built at the Bainbridge site and operations commenced, the operational workforce would number at least 363 workers, half (182 workers) of whom may migrate into the region. At the Bainbridge site, a larger number of security and administrative workers would need to be hired, but because this is not specialized labor, they would likely already reside in the 50-mi region. Given the small number of in-migrating workers and the large population in the 50-mi region, the review team concludes that the demographic impact during operation would be minimal.

Economy and Taxes

According to the U.S. Census Bureau 2005-2007 American Community Survey, the labor force in Cecil County was 53,339 persons and, of these, 49,709 were employed. The four industries in Cecil County that accounted for more than 50 percent of employment were educational services, health care, and social assistance (18 percent); manufacturing (12 percent); retail trade (12 percent); and construction (11 percent) (USCB 2009c). The 2005–2007 estimated unemployment rate for Cecil County was 6.7 percent, compared to 5.6 percent for the State of Maryland (USCB 2009b).

Economic impacts would be spread across the 50-mi region but would likely be the greatest in Cecil County. Impacts are generally considered minimal if plant-related employment is less than 5 percent of the study area's total employment (NRC 1996). During the development of the new unit, up to 3950 construction workers would be required to build the plant (at the peak period). While some of these workers may need to in-migrate to the region, many would be drawn from the approximate 140,000–150,000 construction workers in the workforce of more than 2.5 million in the greater Maryland and Washington, D.C. Metropolitan Statistical Area (MSA) (USBLS 2007a, b). The peak construction workforce would represent less than 5 percent of the current workforce in the region. Therefore, the review team concludes that the impacts of building a nuclear plant on the economy of the region minimal and beneficial, but temporary.

The wages and salaries of the building and operating workforce would have a multiplier effect that could result in increases in business activity, particularly in the retail and service sectors. This would have a positive impact on the business community and could provide opportunities for new businesses to get started and increase job opportunities for local residents. During operations, approximately 182 new operations jobs would be added to the local economy. Based on the analysis in Section 5.4.3.1 for the proposed Calvert Cliffs site, the review team concludes that the impact of these new jobs would constitute a small percentage of the total number of jobs in Cecil County and would have a minimal and beneficial economic impact.

As with the new proposed unit at the Calvert Cliffs site, there would be some positive sales, use, income, and property tax revenue benefits that would be generated as a result of the building and operating a new nuclear unit at the Bainbridge site (Sections 4.4.2.2 and 5.4.3.2). Tax revenues would accrue to the State primarily from income and sales taxes and to local governments from taxes on property and income taxes (see Section 2.5.2.2). The primary tax impacts would occur once the new unit becomes valued as property and property tax revenues are collected by Cecil County according to the millage rate and the negotiated value of the plant. In fiscal year 2007, Cecil County tax revenues totaled $148.5 million. The tax revenues from a unit in Cecil County are unknown, but likely to be similar to the revenues estimated for the Calvert Cliffs site. Estimated tax revenue for Unit 3 at the Calvert Cliffs site would be up to $71 million during building and approximately $57 million once operations commenced. The review team concludes that the impact on tax revenues from building and operating a nuclear unit would be greatest in Cecil County, with a substantial and beneficial impact. The revenue impacts from building and operating a nuclear unit at the Bainbridge site for the remainder of the 50-mi region would be minimal and beneficial.

Transportation and Housing

Road access to the Bainbridge site is provided by MD State Highway 276, which runs north of the site and U.S. Highway 222 to the south. Interstate 95 is 3 mi from the site, as are other state and local roads (see Figure 9-3). The site has barge access on the Susquehanna River, and a rail line runs along the western border (UniStar 2009a). The review team expects traffic impacts from building activities, including both construction workers and deliveries, would be minimal for the region, but could be noticeable but not destabilizing on the local roads near the site during shift change when the construction workforce is at its peak. During operations, impacts would be minimal, except during outages when an additional 800 to 1000 workers would be employed onsite and impacts would be noticeable but not destabilizing.

Based on the analysis in Sections 4.4.2 and 5.4.2, up to 1383 construction workers and 363 operations workers and their families would in-migrate to the 50-mi region during the building of a unit at the Bainbridge site and the subsequent operation. According to the 2005-2007 American Community Survey data, there are 3703 vacant housing units in Cecil County, which is adequate to accommodate the expected influx of construction workers. Workers could also find housing in other parts of the 50-mi region, which has approximately 243,587 vacant housing units (UniStar 2009a). The review team expects that the in-migrating building and operations workforce would have a minimal impact on housing demand in Cecil County and the larger 50-mi region.

Public Services and Education

The influx of construction workers and plant operations staff in-migrating into the region could impact local municipal water and water treatment plants and other public services (police, fire and medical) in the region. These impacts would likely be in proportion with the demographic impacts, unless these resources have excess capacity or are particularly strained during building, which would decrease or increase the impact, respectively. There are approximately three hospitals, six police stations, and 17 fire stations located in Cecil County (UniStar 2009a). Cecil County has four public water systems and five wastewater treatment facilities. The average daily wastewater flow is 5.4 MGD with 3.1 MGD of additional capacity. Excess capacity exists within the current systems to support the expected increase of 186,000 gpd to 325,000 gpd increase in water supply needs and wastewater treatment. Therefore, the review team concludes that the impacts from building of a nuclear unit at the Bainbridge site would be minimal. The much smaller operations workforce is expected to also have a minimal impact on public services. However, according to county plans, the 2030 wastewater flows are expected to be approximately 10.5 MGD. Several system upgrades and expansions are planned to meet this 2-MGD deficit in capacity in 2030. Therefore, the review team concludes that the impacts of operating a nuclear unit on public services in Cecil County and the larger 50-mi region would be minimal.

Cecil County has one school district, which includes 29 schools and a 2006–2007 student body population of 16,421 students. The average student/teacher ratio was 14.4 (NCES 2009). As stated in Section 4.4.4.5, approximately 361 to 632 students are expected to in-migrate into the 50-mi region during building activities. Though they could in-migrate anywhere within the 50-mi region, if they were to all go into Cecil County schools, it would only raise their student population less than 4 percent. Given the number of schools in Cecil County and the large student body populations, it is likely that new students from building and operating a nuclear unit at the Bainbridge site would be absorbed easily, and education impacts would be minimal for Cecil County and the larger 50-mi region.

Recreation and Aesthetics

In Cecil County there are 40 town parks that provide opportunities for hiking, biking, camping, horseback riding, hunting and fishing (CCT 2009). The Bainbridge site is currently used as a CWMA for hunters from September 15 through January 31 (MDNR 2009c). The Port Deposit Chamber of Commerce co-sponsors a hydroplane race series on the Susquehanna River during Labor Day weekend. The race course is located just offshore along the river south of Port Deposit (PDCC 2009a) and would be near potential locations for intake/discharge structures. Recreational users in the vicinity of the site may be impacted by traffic near the plant during shift change. Otherwise, impacts on recreation in the region would be minimal.

UniStar's plume abatement technology and the wooded area at the site would provide some viewshed protection. An undetermined number of miles of transmission lines would need to be built. Impacts on aesthetics of a nuclear unit on the Bainbridge site would be minimal.

Cumulative Impacts

For the analysis of socioeconomic impacts at the Bainbridge site, the geographic area of interest is the 50-mi region centered on the Bainbridge site with special consideration for Cecil

County as that is where the review team expects socioeconomic impacts would be the greatest. Historically, Cecil County has been known as a generally rural area, but in recent years has become more suburban as it lies on the edge of both the Philadelphia and Baltimore metropolitan areas. Cecil County's population was 50,000 (150 mi^2) in 1990 but by 2005 the population was near 100,000 (270 mi^2) (Sage Policy Group 2007).

In addition to socioeconomic impacts from building and operating a nuclear unit at the Bainbridge site, the cumulative analysis also considers other past, present, and reasonably foreseeable future actions that could contribute to cumulative socioeconomic impacts. The projects identified in Table 9-6 have or would contribute to the demographics, economic climate, and community infrastructure of the region and generally result in increased urbanization and industrialization. However, many impacts such as those on housing or public services are able to adjust over time, particularly with increased tax revenues. Furthermore, State and county plans along with modeled demographic projections include forecasts of future development and population increases. Because the projects within the geographic area of interest identified in Table 9-6 would be consistent with applicable land-use plans and control policies, the review team considers the cumulative socioeconomic impacts from the projects to be manageable. Physical impacts include impacts on workers and the general public, existing buildings, transportation, aesthetics, noise levels, and air quality. Social and economic impacts span issues of demographics, economy, taxes, infrastructure, and community services. In summary, on the basis of information provided by UniStar and the review team's independent evaluation, the review team concludes that the cumulative impacts of building and operation of a nuclear unit at the Bainbridge site on socioeconomics would be SMALL in terms of physical impacts, demography, housing, public service, educational, aesthetics and recreational impacts. MODERATE impacts are expected for transportation during building and operation. The impacts on the Cecil County economy and tax base with regard to building and operating a nuclear unit would be beneficial and LARGE. Building and operating a new nuclear unit at the Bainbridge site would be a significant contributor to these impacts.

9.3.3.6 Environmental Justice

The 2000 Census block groups were used for ascertaining minority and low-income populations in the region. There were a total of 3714 census blocks groups within the 50-mi region (which included portions of Delaware, Maryland, New Jersey, and Pennsylvania). Approximately 789 of these census block groups were classified as aggregate minority populations with 752 of them African American, mostly in the Baltimore area. Cecil County did not have any block groups classified as minority populations. There are 333 census block groups classified as low income in the 50-mi region, none of which are in Cecil County. Figure 9-5 shows the geographic locations of the minority populations of significance within the 50-mi radius of the Bainbridge site, and Figure 9-6 shows the geographic locations of the low-income populations of significance within the 50-mi radius of the Bainbridge site.

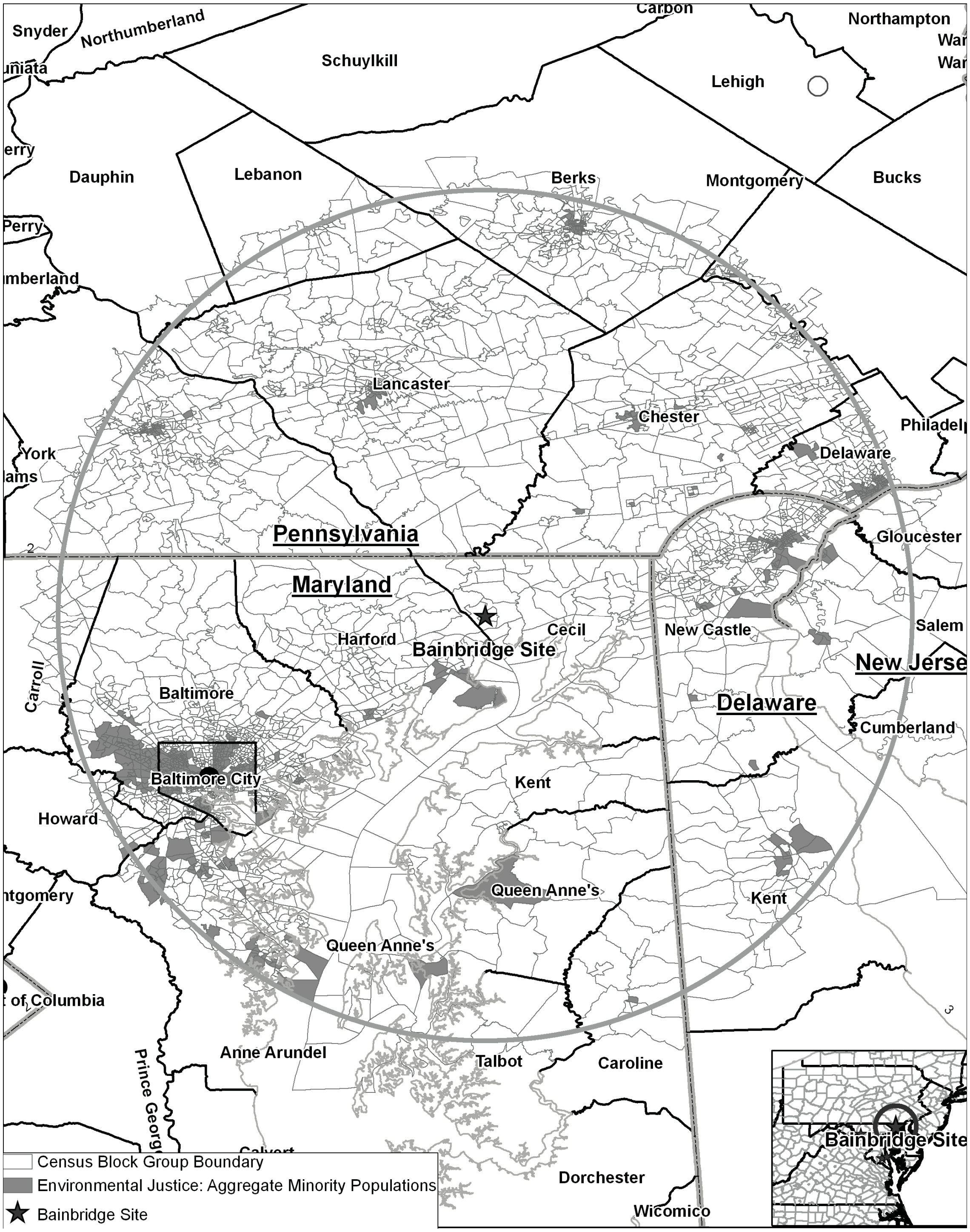

Figure 9-5. Distribution of Aggregate Minority Populations of Significance in 2000 for the Bainbridge Site

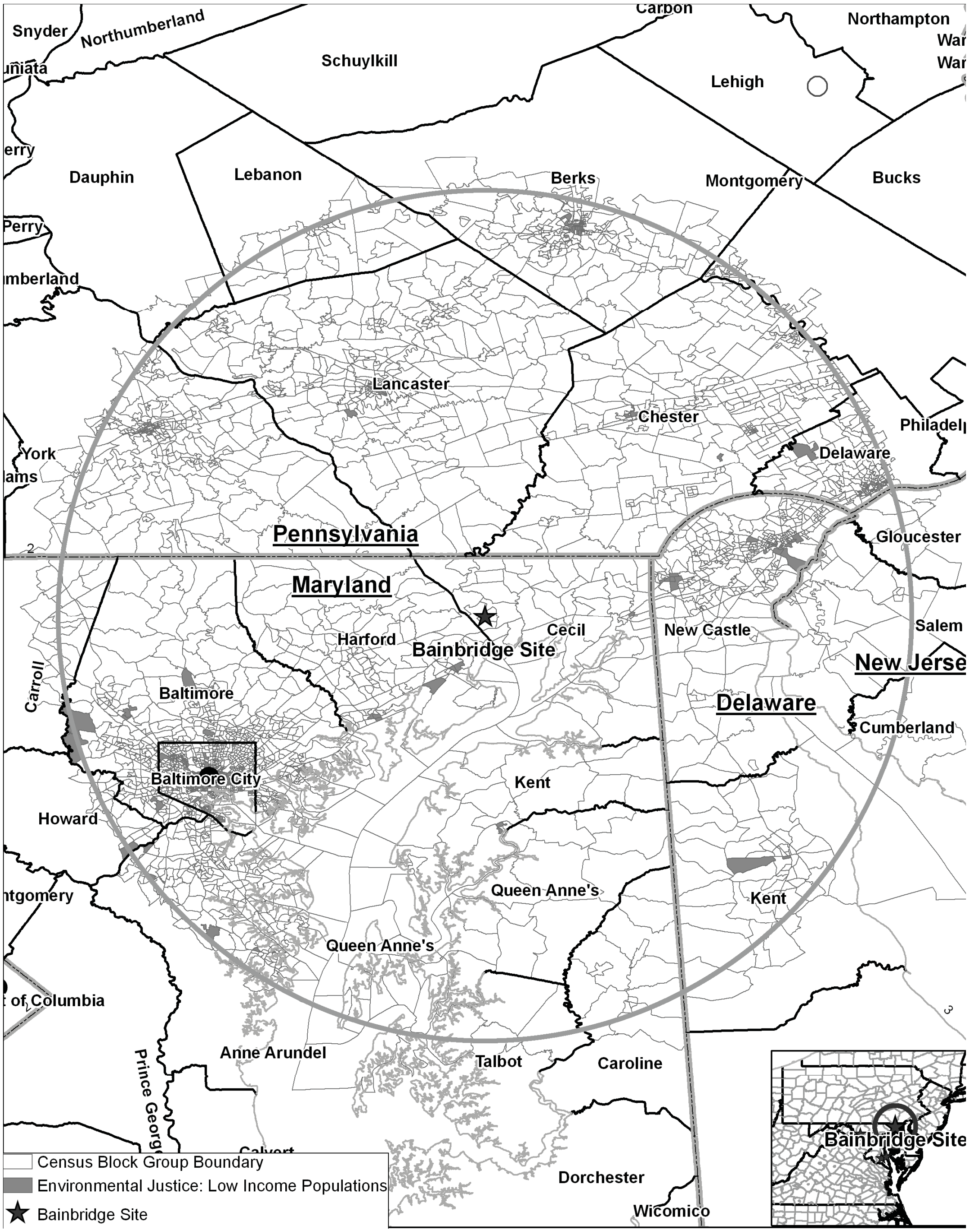

Figure 9-6. Distribution of Low-Income Populations of Significance in 2000 for the Bainbridge Site

Building and operations activities (e.g., noise, fugitive dust, air emissions, traffic) would not impose a disproportionate and adverse affect on minority populations because of their distance from the Bainbridge site. See Sections 4.5 and 5.5 for more information about environmental justice criteria and impacts.

The projects identified in Table 9-6 likely did not or would not contribute to environmental justice impacts of the region, with the possible exception of housing rental rates, which could be an area of concern for low-income populations. If projects bring so many new workers into an area that the cost of renting increases, there may be a disproportionate and adverse impact on low-income populations. However, such impacts would be temporary, with rental prices returning to their original levels once the project was completed. Therefore, based on information provided by UniStar and the review team's independent evaluation, the review team concludes that there would not be any long-term disproportionate and adverse environmental justice cumulative impacts from building and operating a new generating unit at the Bainbridge site in addition to other past, present, and reasonably foreseeable projects on minority or low-income populations, and the cumulative environmental justice impacts at the Bainbridge site would be SMALL.

9.3.3.7 Historic and Cultural Resources

The Bainbridge Naval Training Center served the United States during war and peace time from 1942 until 1976 and was then deactivated in 1976. Much of the Center has been demolished, but several buildings remain today that were built in the early 1940s. The Tome School for Boys is located on the Bainbridge site property. It was built around the turn of the 20th century. The remains of the school on the Bainbridge site were added to the National Registry of Historic Places as a historic district in 1984 (NRHP 2006). The School continues to operate in the town of North East, Maryland and is one of the oldest schools in the State of Maryland (USNTCB 2009). However, no archaeological and/or architectural surveys have been conducted to determine the significance of the resources.

The area surrounding the Bainbridge site is rich in history. UniStar conducted a literature review at the Maryland Historical Trust (MHT) and found 12 properties listed on the National Register of Historic Places within 5 mi of the site, with two of the properties located within 1 mi of the site (UniStar 2009a). The project has the potential to affect some of these resources.

Consultation with the MHT would be necessary regarding the need for systematic archaeological and architectural surveys to identify historic and archaeological resources prior to any ground disturbing activities to address impacts to historic, cultural, and archaeological resources at this particular site. UniStar would be expected to put protective measures in place to protect discoveries in the event that historic or archaeological materials are found during building or operating of a new plant. In the event that an unanticipated discovery is made, site personnel should notify the MHT and consult with them in conducting an assessment of the discovery to determine if additional work is needed.

Cumulative Impacts

The following cumulative impact analysis includes building and operating a nuclear generating unit at the Bainbridge site. The analysis also considers other past, present, and reasonably foreseeable future actions that could impact cultural resources, including other Federal and non-Federal projects and those projects listed in Table 9-6 within the geographical area of interest. For the analysis of cultural impacts at the Bainbridge site, the geographic area of interest is the area of potential effect (APE) that would be defined for this considered undertaking. This includes the physical APE, defined as the area that would be directly affected by the site development and operation activities at the site and transmission lines, and the visual APE. The visual APE is defined as an additional 1-mi radius around the physical APE consistent with the discussion in Section 2.7 and about the maximum distance from which the structures can be seen.

Reconnaissance activities in a cultural resource review have particular meaning. Typically, for example, it includes preliminary field investigations to confirm the presence or absence of cultural resources. In developing this EIS, the review team relied upon reconnaissance-level information to perform its evaluations of alternative sites. Reconnaissance-level information is data readily available from agencies and other public sources. It can also include information obtained through visits to the site area. To identify the historic and cultural resources at the Bainbridge site, the following information was used:

- UniStar ER (UniStar 2009a).
- NRC-Alternative Site Visit August 2009 (NRC 2010a).

Cultural resources are non-renewable. Therefore, the impact of destruction of cultural resources is cumulative.

No projects were identified in Table 9-6 that would contribute to cumulative impacts to historic and cultural resources within the geographic area of interest.

Based on reconnaissance level information, specifically the significant built environment and history associated with the Bainbridge site, the review team concludes that the cumulative impacts on historic properties of constructing and operating a new generating unit at the Bainbridge site would be MODERATE to LARGE. Building and operating a new nuclear unit at the Bainbridge site would be a significant contributor to these impacts. Archaeological and/or architectural surveys would be necessary to determine the significance of the resources.

9.3.3.8 Air Quality

The emissions related to building and operation of a nuclear power plant at the Bainbridge site in Cecil County would be similar to those at the Calvert Cliffs site as described in Chapters 4 and 5. Cecil County is in the East Shore Intrastate Air Quality Control Region (40 CFR 81.154).

However, Harford County, which is across the Susquehanna River from the Bainbridge site, is in the Metropolitan Baltimore Intrastate Air Quality Control Region (40 CFR 81.28). The air quality attainment status for Cecil and Harford Counties as set forth in 40 CFR 81.321 reflects the effects of past and present emissions from all pollutant sources in the region. Cecil County is in non-attainment of the 8-hour ozone standard, and Harford County is in non-attainment of both the 8-hour ozone standard and the PM 2.5 (particulate matter with a diameter of less than 2.5 microns) standard.

Reflecting on the projects listed in Table 9-6, most of the effects on air quality would be to maintain the status quo. Any new industrial projects would either have *de minimis* effects or would be subject to regulation by the Maryland DNR. Given these institutional controls, it is unlikely that the air quality in the region would degrade significantly (i.e., degrade to the extent that the region is in nonattainment of national standards).

The cooling tower for the power plant would be a significant source of small particles. As a result, although the air quality impacts of building and operation of a nuclear power plant at the Bainbridge site would probably be minimal, it is possible that the cumulative impacts of the cooling tower particulate emissions could be MODERATE. Building and operating a new nuclear unit at the Bainbridge site would be a significant contributor to these impacts.

Greenhouse gas emissions related to nuclear power are discussed in Chapters 4, 5, and 6 for building and operating a nuclear power plant and for the fuel cycle, respectively. As described in Chapter 7, the impacts of greenhouse gas emissions are not sensitive to location of the source. Consequently, the discussions in the previous chapters and in Section 9.2.5 are applicable to a nuclear power plant located at the Bainbridge site. The impacts of greenhouse gas emissions considered in isolation would be minimal, but the cumulative impact of greenhouse gas emissions would be MODERATE. Building and operating a new nuclear unit at the Bainbridge site would not be a significant contributor to these impacts.

9.3.3.9 Nonradiological Health Impacts

The following impact analysis includes nonradiological health impacts from building activities and operations to the public and workers from a nuclear unit at the Bainbridge alternative site. The analysis also considers other past, present, and reasonably foreseeable future actions that impact nonradiological health, including other Federal and non-Federal projects and those projects listed in Table 9-6 within the geographic area of interest. The building-related activities that have the potential to impact the health of members of the public and workers include exposure to dust and vehicle exhaust, occupational injuries, noise, and the transport of construction materials and personnel to and from the site. The operation-related activities that have the potential to impact the health of members of the public and workers includes exposure to etiological agents, noise, EMFs, and impacts from the transport of workers to and from the site. For the analysis of nonradiological health impacts at the Bainbridge alternative site, the geographic area of interest is considered to include projects within a 5-mi radius from the site's center based on the localized nature of the impacts. For impacts associated with transmission lines, the geographic area of interest is the transmission line corridor.

Building Impacts

Nonradiological health impacts to construction workers and members of the public from building a new nuclear unit at the Bainbridge site would be similar to those evaluated in Section 4.8 for the Calvert Cliffs site. The impacts include noise, vehicle exhaust, dust, occupational injuries, and transportation accidents, injuries, and fatalities. Applicable Federal and State regulations on air quality and noise would be complied with during the site preparation and building phase. The incidence of construction worker accidents would not be expected to be different from the incidence of accidents estimated for the Calvert Cliffs site. The Bainbridge site is located in a rural area and building impacts would likely be minimal on the surrounding populations. Access routes to the site for construction workers would include I-95, which is approximately 3 mi south of the site. Local 2-lane roads provide access from I-95 to the site and from the north and east. The ER (UniStar 2009a) states that the local 2-lane roads may become congested as a result of the additional building-related traffic. Mitigation may be necessary to ease congestion, thereby improving traffic flow and reducing nonradiological health impacts (i.e., traffic accidents, injuries, and fatalities) during the building period.

No past or current actions in the geographic areas of interest were identified that would impact the public or workers. Proposed future actions would include transmission line development and/or upgrading, and future urbanization, which would both occur throughout the designated geographical areas of interest. These actions would likely result in nonradiological health impacts similar to those discussed above for the building of a nuclear unit at the Bainbridge site.

Operational Impacts

Nonradiological health impacts from operation of a new nuclear unit on occupational health and members of the public at the Bainbridge site would be similar to those evaluated in Section 5.8 for the Calvert Cliffs site. Occupational health impacts to workers (e.g., falls, electric shock or exposure to other hazards) at the Bainbridge site would likely be the same as those evaluated for workers at the new unit at the Calvert Cliffs site. Based on the configuration of the proposed new unit at the Bainbridge site (closed-cycle, wet cooling system with mechanical draft cooling towers), etiological agents would not likely increase the incidence of water-borne diseases in the vicinity of the site. Noise and EMF exposure would be monitored and controlled in accordance with applicable Occupational Safety and Health Administration regulations (OSHA). Effects of EMF on human health would be controlled and minimized by conformance with National Electrical Safety Code (NESC) criteria. Nonradiological impacts of traffic associated with the operations workforce would be less than the impacts during building. Mitigation measures taken during building to improve traffic flow would also minimize impacts during operation of a new unit.

Past and present actions in the geographic area of interest associated with existing transmission lines are the only nonradiological health impacts from operations to the public and workers. Proposed future actions that would impact nonradiological health in a similar way to operation activities at the Bainbridge site would include transmission line systems and future urbanization, which would both occur within the geographical areas of interest.

The review team is also aware of the potential climate changes that could affect human health. A recent compilation of the state of the knowledge in this area (GCRP 2009) has been considered in the preparation of this EIS. Projected changes in the climate for the region include an increase in average temperature and an increase in precipitation, which may alter the presence of microorganisms and parasites. In view of the water source characteristics, the review team did not identify anything that would alter its conclusion regarding the presence of etiological agents or change in the incidence of water-borne diseases.

Summary

Based on the information provided by UniStar and the review team's independent evaluation, the review team expects that the impacts to nonradiological health from building and operation of a new unit at the Bainbridge site would be similar to the impacts evaluated for the Calvert Cliffs site. While there are past, present, and future activities in the geographic area of interest that could affect nonradiological health in ways similar to the building and operation of a new unit at the Bainbridge site, those impacts would be localized and managed through adherence to existing regulatory requirements. The review team concludes, therefore, that the cumulative impacts of building and operation of a nuclear unit at Bainbridge on nonradiological health would be SMALL.

9.3.3.10 Radiological Impacts of Normal Operations

The following impact analysis includes radiological impacts to the public and workers from building activities and operations for one nuclear unit at the Bainbridge alternative site. The analysis also considers other past, present, and reasonably foreseeable future actions that impact radiological health, including other Federal and non-Federal projects and those projects listed in Table 9-6 within the geographic area of interest. As described in Section 9.3.3, the Bainbridge site is a deactivated naval training site; there are currently no nuclear facilities on the site. The geographic area of interest is the area within a 50-mi radius of the Bainbridge site. Existing facilities potentially affecting radiological health within this area are Peach Bottom Units 2 and 3, Three Mile Island Unit 1, Limerick Units 1 and 2, Salem Units 1 and 2, and Hope Creek Unit 1. In addition, the NRC anticipates an application for an early site permit for new nuclear power plants at the Salem/Hope Creek site in the near future. Finally, there are likely to be hospitals and industrial facilities within 50 mi of the Bainbridge site that use radioactive materials.

The radiological impacts of building and operating the proposed U.S. EPR unit at the Bainbridge site include doses from direct radiation, and liquid and gaseous radioactive effluents. These pathways would result in low doses to people and biota offsite that would be well below regulatory limits. These impacts are expected to be similar to those estimated for the Calvert Cliffs Unit 3 site.

The radiological impacts of the other operating nuclear power plants listed above also include doses from direct radiation and liquid and gaseous radioactive effluents. These pathways result in low doses to people and biota offsite that are well below regulatory limits as demonstrated by the ongoing radiological environmental monitoring programs (REMP) conducted around these plants. The proposed plants at the Salem/Hope Creek site would also result in radiological impacts from direct radiation and liquid and gaseous radioactive effluents. The NRC staff expects that these pathways would result in low doses to people and biota offsite that would be well below regulatory limits. The NRC staff concludes that the dose from direct radiation and effluents from hospitals and industrial facilities that use radioactive materials would be an insignificant contribution to the cumulative impact around the Bainbridge site. This conclusion is based on data from REMPs conducted around currently operating nuclear power plants.

Based on the information provided by UniStar and the NRC staff's independent analysis, the NRC staff concludes that the cumulative radiological impacts from building and operating the proposed U.S. EPR unit and other existing and planned projects and actions in the geographic area of interest around the Bainbridge site would be SMALL.

9.3.3.11 Postulated Accidents

The following impact analysis includes radiological impacts from postulated accidents from operations for one nuclear unit at the Bainbridge alternative site. The analysis also considers other past, present, and reasonably foreseeable future actions that impact radiological health from postulated accidents, including other Federal and non-Federal projects and those projects listed in Table 9-6 within the geographic area of interest. As described in Section 9.3.3, Bainbridge is a deactivated naval training site. There are currently no nuclear facilities on the site. The geographic area of interest considers all existing and proposed nuclear power plants that have the potential to increase the probability-weighted consequences (i.e., risks) from a severe accident at any location within 50 mi of the Bainbridge site. Existing facilities potentially affecting radiological accident risk within this geographic area of interest are existing Calvert Cliffs Units 1 and 2, Peach Bottom Units 2 and 3, Three Mile Island Unit 1, Limerick Units 1 and 2, Salem Units 1 and 2, and Hope Creek Unit 1. No other reactors have been proposed within the geographic area of interest, but the NRC anticipates an application for an early site permit for new nuclear power plants at the Salem/Hope Creek site in the near future.

As described in Section 5.10.1, the NRC staff concludes that the environmental consequences of design basis accidents (DBAs) at the Calvert Cliffs site would be minimal for U.S. EPR. DBAs are addressed specifically to demonstrate that a reactor design is robust enough to meet NRC safety criteria. The U.S. EPR design is independent of site conditions and the meteorology of the Bainbridge and Calvert Cliffs sites are similar. Therefore, the NRC staff concludes that the environmental consequences of DBAs at the Bainbridge site would be minimal. Because the meteorology, population distribution, and land use for the Bainbridge alternative site are expected to be similar to the proposed Calvert Cliffs site, risks from a severe accident for a U.S. EPR reactor located at the Bainbridge alternative site are expected to be similar to those analyzed for the proposed Calvert Cliffs site. These risks for the proposed Calvert Cliffs site are presented in Table 5-16 and Table 5-17 and are well below the median value for current-generation reactors. In addition, estimates of average individual early fatality and latent cancer fatality risks are well below the Commission's safety goals (51 FR 30028). For existing nuclear power plants within the geographic area of interest, which are Calvert Cliffs Units 1 and 2, Salem Units 1 and 2, Hope Creek Unit 1, Peach Bottom Units 2 and 3, Three Mile Island Unit 1, and Limerick Units 1 and 2, the Commission has determined that the probability-weighted consequences of severe accidents are small (10 CFR 51, Appendix B, Table B-1). Because of the NRC's safety review criteria, it is expected that risks for any new reactors at the Salem/Hope Creek site would be well below risks for current-generation reactors and meet the Commission's safety goals. On this basis, the NRC staff concludes that the cumulative risks of severe accidents at any location within 50 mi of the Bainbridge alternative site would be SMALL.

9.3.4 Eastalco Site

This section covers the review team's evaluation of the potential environmental impacts of siting a new nuclear unit at the Eastalco Aluminum Smelter (Eastalco) site in central Maryland. The Eastalco site is located within the Lowland Section of the Piedmont Plateau physiographic province in Frederick County, Maryland (Figure 9-7) (MDNR 2001). This province is described as rolling hills and stream valleys covered with hardwood forests (FWS 2001).

The Eastalco site is approximately 2200 ac and contains an inactive aluminum production facility that was shut down in 2005. The facility is being maintained for possible future production. The site is industrial with agricultural fields (Figure 9-8).

The following sections describe the cumulative impact assessment conducted for each resource area. The specific resources and components that could be affected by the incremental effects of the proposed action if it were sited at the Eastalco site and other actions in the same geographical area were assessed. This assessment includes the impacts of construction and operations and impacts of preconstruction activities. Also included are past, present, and reasonably foreseeable Federal, non-Federal, and private actions that could have meaningful cumulative impacts with the proposed action. Other actions and projects considered in this cumulative analysis are described in Table 9-8.

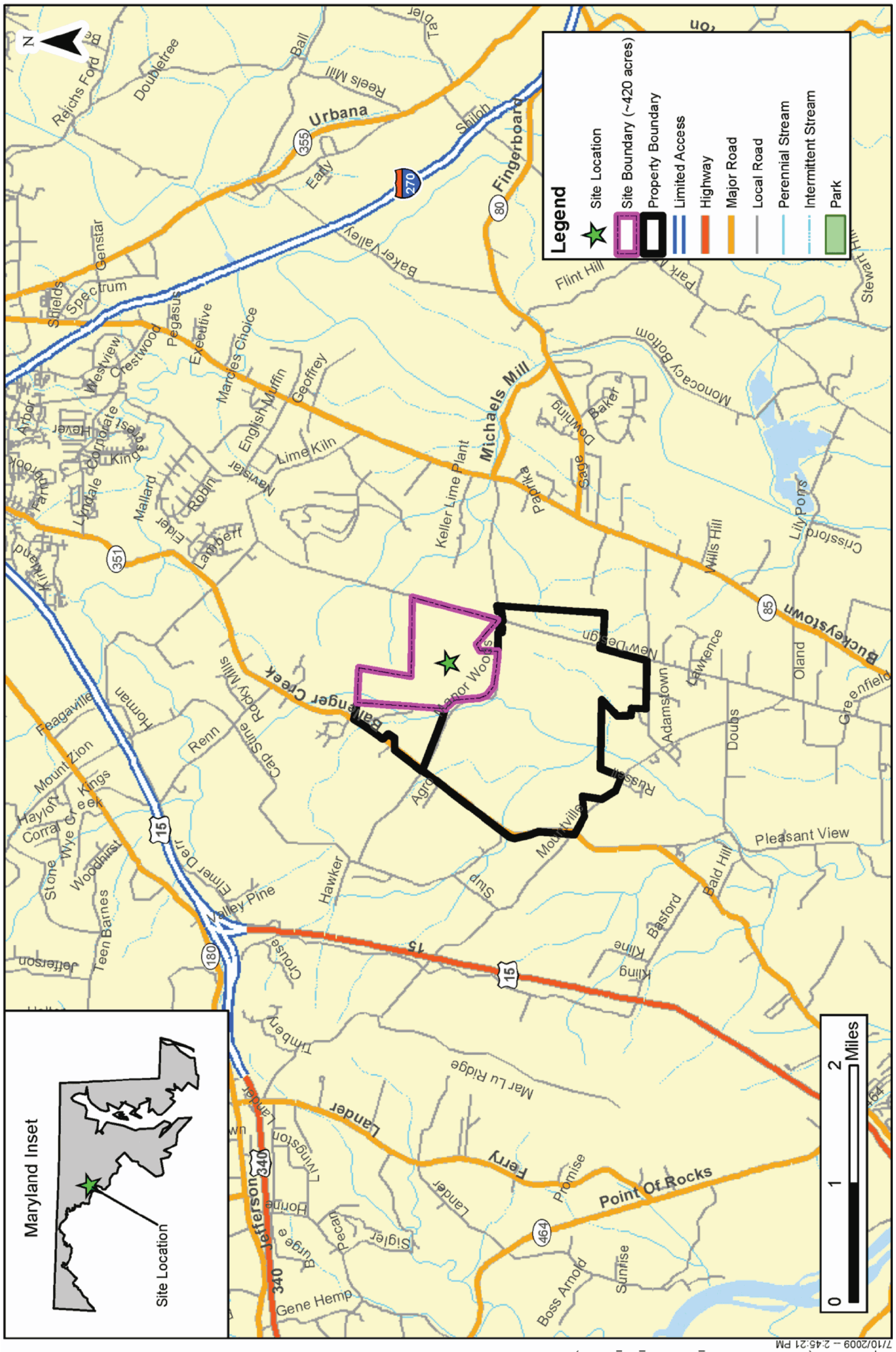

Figure 9-7. Eastalco Site Location (UniStar 2009a)

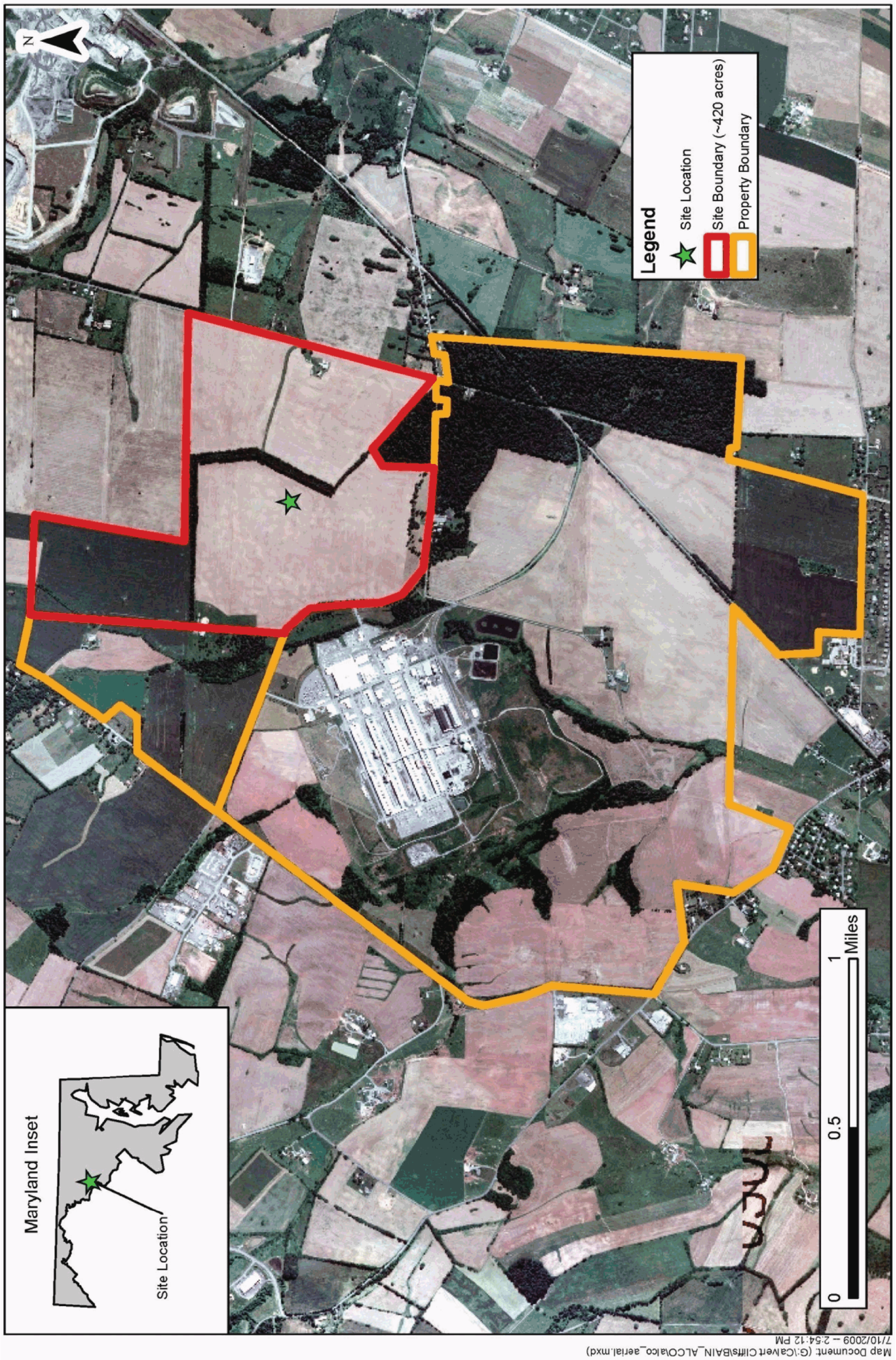

Figure 9-8. Eastalco Site and Surrounding Area (UniStar 2009a)

1 **Table 9-8**. Past, Present, and Reasonably Foreseeable Projects and Other Actions
2 Considered in the Eastalco Site Cumulative Analysis

Project Name or Other Action	Summary of Project	Location	Status
Energy Projects			
Dickerson Generating Plant	Dickerson Generating Plant is a fossil-fuel power plant (849 MW).	Approximately 7 mi south of Eastalco site	Operational. Currently upgrading air pollution control equipment; project expected to be completed by end of 2009.[(a)]
Montgomery County Resource Facility	Montgomery County Resource Facility burns solid waste to generate up to 55 MW.	Approximately 7 mi south of Eastalco site	Operational.[(b)]
R. Paul Smith Generating Station	R. Paul Smith Generating Station consists of two coal-fired units (116 MW total capacity).	Approximately 26 mi northwest of Eastalco site	Operational.[(c)]
Potomac-Appalachian Transmission Highline (PATH) Project	PATH Project is a 765-kV transmission line proposed as a joint venture of American Electric Power and Allegheny Energy.	Southwestern West Virginia to central Maryland (~275 mi), runs through Frederick County, MD, approximately 2 mi south of Eastalco site	Proposed. Expected to be operational by 2014.[(d)]
National Institute of Standards and Technology (NIST) Reactor	NIST Reactor is a heavy water research reactor and has a maximum power level of 20 MW(t).	Approximately 22 mi southeast of Eastalco site	Operational. Currently licensed for operations through 2029.[(e)]
Fort Detrick	BRAC expansion recommendations and construction of National Interagency Biodefense Campus facilities.	Approximately 10 mi northeast of Eastalco site	Ongoing. Schedule calls for construction completion in 2012.[(f)]
Fort Ritchie	Potential business and residential development.	Approximately 27 mi north of Eastalco site	Ongoing development. Based on BRAC recommendations, the military installation was essentially closed in 1998. In 2006, 500 ac were transferred to the PenMar Development Corp.[(g)]

Table 9-8. (contd)

Project Name or Other Action	Summary of Project	Location	Status
Transportation Projects			
Upgrades to US 15, MD 85, I-70, I-270	Changes to improve access and traffic flow in the area.	Frederick, MD; depending on location, could be within 2 mi of site	Planned. Changes to US 15 to improve access to Fort Detrick are City and County top transportation priority.[h]
Upgrades to I-270, US 15 corridor	This is a multi-modal corridor study to consider highway and transit improvements in the I-270/US 15 corridor in Montgomery and Frederick counties from Shady Grove Metro Station to north of Biggs Ford Road (27.90 mi).	Montgomery and Frederick Counties, MD	Planned. Project is in the planning stage – developing a preferred alternative based on public comments.[i]
Other Actions/Projects			
Brunswick Wastewater Treatment Plant	Plant expansion and addition of enhanced nitrogen removal technology.	Approximately 6 mi west of Eastalco site	Completed in 2008.[j]
Various hospitals and industrial facilities that use radioactive materials	Medical and other isotopes.	Within 50 mi	Operational.

(a) Source: Mirant 2009a.
(b) Source: Montgomery County 2009.
(c) Source: Allegheny Energy, Inc. 2009.
(d) Source: Path 2009b.
(e) Source: NRC 2009c.
(f) Source: Fort Detrick 2009.
(g) Source: EPA 2009b.
(h) Source: MD SHA 2009a.
(i) Source: MD SHA 2009b.
(j) Source: City of Brunswick 2009.

9.3.4.1 Land Use

The following impact analysis includes impacts to land-use from building and operations at the Eastalco site and geographic area of interest, which is the 15-mi region surrounding the Eastalco site. The analysis also considers past, present, and reasonably foreseeable future actions that affect land-use, including other Federal and non-Federal projects (Table 9-8) within the geographic area of interest. The Eastalco site is an approximately 2200 ac tract of land located in an unincorporated area of Frederick County, Maryland, approximately 10 mi southwest of the City of Frederick (UniStar 2009a). The site was used for aluminum production from 1970–2005. The structures associated with aluminum production are still on the site. The current owner of the site is Alcoa, Inc.

Of the 2200 ac, approximately 1320 ac are currently zoned industrial (Gazzette.Net 2009). Land in proximity to the site is used for agricultural, light industrial, and residential purposes. Corn and soybeans are the predominant crops in the region. The site is relatively level with an elevation change of approximately 33 ft.

If a new nuclear generating unit is developed on the site, some agricultural and forested land would be lost. In addition, offsite land would be impacted to build an approximately 5.8 mi pipeline to bring water for cooling to the site from the Potomac River. The pipeline would need to cross railroad tracks, local roads, and the Chesapeake and Ohio Canal towpath. The Chesapeake and Ohio Canal is a National Historical Park (see Section 9.3.4.8). Until the mid-1990s, water was withdrawn from the Potomac River and piped to the site for use by the aluminum plant.

The Eastalco site includes a railroad spur, natural gas service, and an electrical substation. When operating, the aluminum plant was the largest industrial user of electricity in Maryland.

The nearest dedicated land (Federal, State, or Tribal) is the State-owned Monocacy Natural Resources Management Area located approximately 3.5 mi from the Eastalco site (UniStar 2009a). The Monocacy National Battlefield, administered by the U.S. National Park Service, is located approximately 4 mi from the site.

There is a large transmission corridor leading to the Eastalco site. It is likely this corridor would be adequate to construct the necessary transmission lines associated with a new nuclear generating unit located at Eastalco (UniStar 2009a). In addition, there are seven existing 500-kV transmission lines within 5 mi of the site and a 345-kV transmission line about 12.7 mi northwest of the site. There are also nine 230-kV transmission lines available for interconnection. One line is about 0.5 mi from the site, another line is 1.8 mi, two lines are 2.2 mi, and another five lines are more than 4 mi from the site (UniStar 2009a). Because transmission lines are often co-located and are relatively narrow, the review team expects that the impact of connecting a new plant at the Eastalco site to current transmission lines would be consistent with the land-use plans and zoning regulations of the affected counties.

Cumulative Impacts

For this cumulative land-use analysis, the geographic area of interest is the 15-mi region surrounding the Eastalco site. This area of interest includes the primary communities (Adamstown, Buckeystown, and Frederick) that would be affected by the proposed project if it were located at the Eastalco site.

The project identified in Table 9-8 with the greatest likelihood of affecting land use in the geographic area of interest would be the Fort Detrick BRAC. The Fort Detrick BRAC would involve the construction and operation of new U.S. Army Medical Research Institute of Infectious Diseases facilities and the decommissioning and partial demolition of existing facilities (U.S. Army 2007b). Activities would take place on Fort Detrick. Some indirect offsite land-use impacts may occur as a result of economic activity on the Fort Detrick site.

In addition, the transmission corridor for the Potomac-Appalachian Transmission Highline (PATH) project (see Table 9-8) would pass approximately 2 mi south of the Eastalco site (PATH 2009a). The PATH project would contribute to the cumulative land-use impacts from the additional amount of noticeably altered land use through the conversion to utility corridor use. If additional transmission lines are built from other energy projects, they would also contribute to a cumulative land-use impact from the additional amount of land converted to utility corridor use for transmission lines.

The projects identified in Table 9-8 within the geographic area of interest, have or would contribute to decreases in open lands, wetlands, and forested areas and generally result in increased urbanization and industrialization consistent with applicable land-use plans and control policies. In addition, GCC could increase precipitation, flooding, and wetland losses in the area of interest (GCRP 2009), thus changing land use through inundation of low-lying areas and river shoreline. Forest growth may increase as a result of more carbon dioxide in the atmosphere (GCRP 2009). Existing parks, reserves, and managed areas would help preserve open lands, wetlands, and forested areas to the extent that they are not affected by the same factors. In addition, GCC could reduce crop yields and livestock productivity (GCRP 2009), which might change agricultural land uses, which are predominant in the area of interest. Direct changes resulting from GCC could cause a shift in land use in the geographic area of interest.

Based on the information from UniStar and the review team’s independent evaluation, the review team concludes that the cumulative land-use impacts of building and operating a new nuclear generating unit and associated transmission lines at the Eastalco site would be SMALL to MODERATE. This conclusion reflects that the direct transmission line land-use impacts associated with siting the proposed project at the Eastalco site would be SMALL, but that cumulative impacts would be greater than SMALL because of the close proximity of the PATH transmission corridor. Therefore, building and operating a new nuclear unit at the Eastalco site would not be a significant contributor to these impacts.

9.3.4.2 Water Use and Quality

Water for the Eastalco site would be obtained primarily from the Potomac River. The Eastalco site is about 5.5 mi northeast of the Potomac River, where it passes Point of Rocks, Maryland. According to UniStar (2009a), the proposed plant would require the withdrawal of about 50 MGD for cooling and other uses. Of that total, about 27 MGD would be consumed, and the remainder would be discharged back to the Potomac River. UniStar (2008b) states the plant would use closed-cycle cooling with a cooling tower. The plant would have separate intake and discharge structures in the Potomac River. Discharge water would include cooling tower blowdown, treated process wastewater, treated sanitary wastewater, and some radioactive water. The discharge would be at an elevated temperature relative to the temperature of the Potomac River.

There are no major surface waterbodies on the Eastalco site. There are two minor drainages along the edges of the alternative site footprint. One drainage is unnamed, and the other feeds Tuscarora Creek.

The Eastalco site would require normal alterations, including grading, building of roads, piers, jetties, and water intake and discharge structures in the Potomac River. Building of the intake and discharge pipes would affect the pipeline corridor from the site to the river, and it would affect the river bed in the vicinity of the intake and discharge structures. UniStar (2009a) identified the potential need to build an onsite impoundment to provide an ultimate heat sink (UHS). UniStar estimates the area and depth of such an impoundment would be approximately 4.7 ac and 25 ft, respectively (UniStar 2009a).

The average flow of the Potomac River at Point of Rocks, Maryland, between 1895 and 2009 is 6149 MGD (USGS 2009). Water withdrawal for the alternative plant site would represent less than 1.0 percent of average flow conditions at Point of Rocks. Although there appears to be sufficient water during average flow conditions, low-flow conditions could have the potential to impact plant operations. UniStar (2009a) reported a 7Q10 value for the Potomac River of approximately 372 MGD for the gauge at Point of Rocks, Maryland. Total water withdrawal would represent almost 14 percent of the 7Q10 value. Consumptive use would be about half that value.

Withdrawals of water from the Potomac River require approval by the MDE Water Management Administration and compliance with the Low Flow Allocation Agreement (LFAA) signed by the Interstate Commission on the Potomac River Basin. The LFAA allows for water withdrawal restrictions during droughts to maintain sufficient flow to sustain aquatic resources. Maryland requires large consumptive water users, such as the proposed plant if it were to be located at the Eastalco site, to maintain storage for low-flow augmentation to meet the requirements of the LFAA. The amount of storage required is based on the amount of consumptive use and would be determined at the time of application. UniStar (2008b) believes that this may be a significant consideration for development of the Eastalco site. Because the amount of water consumed relative to the existing resource in the Potomac River is limited and because low-flow conditions would be monitored, controlled, and offset by flow augmentation (UniStar 2009a), the review team concludes the hydrological alterations of impacts to the Potomac River from plant operations would be minor.

UniStar (2009a) states that groundwater would not be used for operations, but may be needed temporarily for building activities. UniStar has not yet determined the quantities of water needed for development of this site. The geohydrology of the area is characterized as a regolith-fractured bedrock aquifer system. The regolith consists of soil, alluvium, and saprolite; thickness varies from 0 to more than 150 ft. Underlying the regolith is the Piedmont bedrock, which can be either crystalline or carbonate.

Building activities, including surface alterations and dewatering, have the potential to affect the local hydrology, but because the site has already been heavily developed, any impacts from building a nuclear power plant would be temporary and localized. Groundwater from deeper aquifers would be much less affected because this resource would not be used during operations. The review team determined that, although the local hydrology would be impacted, the impacts of building and operation of a new nuclear unit at the Eastalco site on the regional groundwater resources would be minor.

Activities with the potential to alter either surface water or groundwater quality would be regulated by NPDES discharge and stormwater permits. BMPs would prevent or mitigate spills from altering the quality of the surface water or groundwater resources. The nutrient load from the plant's sanitary effluent system would be a minor contribution to the Potomac River's cumulative nutrient load.

Based on the information provided by UniStar and the review team's independent evaluation, the review team concludes that although the local hydrology would be altered, the cumulative impacts on regional surface and groundwater resources of constructing and operating a new nuclear generating unit at the Eastalco site would be minor.

Cumulative Impacts

For the cumulative analysis of impacts on surface water, the geographic area of interest for the Eastalco site is the drainage basin of the Potomac River upstream and downstream of the site because this is the resource that would be impacted if the proposed project were located at the Eastalco site. Key actions that have past, present, and future potential impacts to water supply and water quality in the Potomac River basin include the operation the Dickerson Generating Station located 7 mi downstream, the R. Paul Smith Power Station located 26 mi upstream, and other municipal and industrial activities in the Potomac River basin. For the cumulative analysis of impacts on groundwater, the geographic area of interest is the extent within Frederick County of the groundwater aquifers beneath the site.

<u>Water Use</u>. The surface water-use impacts of building and operating a nuclear power plant at this site are dominated by the higher demands that would occur under normal operation. The projected consumptive water use of a nuclear unit onsite is expected to be about 42 cfs or less than one percent of the average river discharge of 6149 cfs near the site. During extremely low-

flow conditions, the water use is expected to be less than 8 percent of the river flow. These average river flow and extreme low flow values reflect cumulative consumptive uses of current users upstream of the site.

The review team is also aware of the potential climate changes that could affect the water resources available for cooling and the impacts of reactor operations on water resources for other users. The impact of climate change would be similar for all the alternative sites.

Increases in consumptive use of water in the Potomac River drainage is anticipated in the future. The impacts of the other operational projects listed in Table 9-8 are considered in the analysis included above or would have little or no impact on surface water use.

As indicated, groundwater would be used as a potable water source during building and operation. Due to the high yields for the aquifers in this region and demonstrated by past use at the Eastalco site, no significant impact is anticipated to other nearby users of groundwater.

The review team concludes that the cumulative impacts to surface water from building and operation of the proposed plant at the Eastalco site would be SMALL in normal years and MODERATE in drought years. Building and operating a new nuclear unit at the Eastalco site would be a significant contributor to these impacts. The review team also concludes that the cumulative impacts to groundwater use from building and operation of the proposed project would be SMALL.

Water Quality. Point and non-point pollution sources have impacted the water quality of the Potomac River upstream and downstream of the site. Water quality information presented for the impacts of building and operating a new unit at the Eastalco site would also apply to evaluation of cumulative impacts. As mentioned, an MDE-issued NPDES permit would be required to operate the nuclear project at this site. Effluent discharge through an NPDES-permitted outfall would confirm the discharges complied with the Clean Water Act. Such permits for other point source discharges into the Potomac River and its tributaries and EPA's Total Maximum Daily Load program for non-point sources are designed to protect water quality. The impacts of other projects listed in Table 9-8 are either considered in the included analysis or would have little or no impact on surface water quality. The review team also concludes that with the implementation of BMPs, the impacts on groundwater quality from building and operating a new nuclear unit at the Eastalco site would likely be minimal and, therefore, concludes the cumulative impact on surface and ground water quality would be SMALL.

9.3.4.3 Terrestrial and Wetland Resources

The Eastalco site is a deactiviated aluminum production site in Frederick County, Maryland, with existing structures that occupy about 400 ac. The ecological potential of this site had been drastically reduced during clearing for the construction of the aluminum production facility

(MDNR PPRP 2006). Primary cover types include agricultural fields, maintained grasslands, and forested woodlots. Most agricultural fields consist of row crops, including corn, soybeans, and winter wheat. Grasses consist of meadow fescue (*Festuca pratensis*) and switchgrass (*Panicum virgatum*) (MDNR PPRP 2006). Woodlots are deciduous and dominated by oaks (*Quercas* spp.), maples (*Acer* spp.), and tulip poplar. Man-made drainage ditches are present and are vegetated with grasses, weedy species, and a few black locust (*Robinia pseudoacacia*), cottonwood (*Populus deltoides*), and ash (*Fraxinus* sp.) trees. This site is surrounded primarily by agricultural lands. Eastalco contains 10 discrete wetlands totaling approximately 4.5 ac (UniStar 2009a).

No Federally listed threatened or endangered species are known to occur on the Eastalco site or in Frederick County. The bald eagle, protected by the Bald and Golden Eagle Protection Act, is listed as threatened by the State of Maryland (Table 9-9). Bald eagles may occur along the Potomac River and in the vicinity of the Eastalco site. The Potomac River is a primary bald eagle nesting area in Maryland (MDNR 2009b). In 2004, there were 43 active bald eagle nests along the Potomac River. However, it appears the eagles prefer to nest elsewhere as only three nests are known in Frederick County and only one was active (MDNR 2008). There is no open water at Eastalco suitable for eagle foraging on the site, and forest cover used for nesting, roosting, and perching is limited in distribution. Therefore, it is unlikely that bald eagles would occur on the Eastalco site.

In addition to the bald eagle, the Maryland DNR Natural Heritage Program's list of rare, threatened, and endangered species for Frederick County, Maryland contains 7 terrestrial wildlife and 49 terrestrial plant species (Table 9-9). However, no Federally listed species are known to occur in Frederick County (MDNR 2007d). The upland sandpiper (*Bartramia longicauda*) is a shorebird that occupies grasslands exclusively and is commonly found nesting in airports in the northeastern United States (Houston and Bowen 2001). The Eastalco site contains grass habitats and croplands, but it is unknown if these habitat are suitable and used by the upland sandpiper. The green-patterned tiger beetle (*Cicindela patruela*) commonly occurs in open areas of dry, sandy soils within forests, such as abandoned roads, trails, sand pits, and bare slopes (USGS 2006; NatureServe 2009). UniStar stated this species may occur along the Potomac River where cooling water system structures would be located. The blackburnian warbler (*Dendroica fusca*) is a neotropical migrant that nests within the forest interior of mixed forests (Morse 2004). Forest stands on the Eastalco site have been highly fragmented, and it is unlikely this species would nest on the site. The loggerhead shrike (*Lanius ludovicianus*) is an irregular resident of Maryland that prefers disturbed or open habitats (Reuven 1996), such as those located along streams and fence lines on the site. The Allegheny woodrat (*Neotoma magister*) occurs in rocky habitats (Chamblin et al. 2004), which are not present on the site. Bewick's wren (*Thryomanes bewickii altus*) is a species that has benefitted from the fragmentation of forested landscapes. It thrives in a landscape mosaic of early-successional habitats, such as forest edges, and has been associated with brushy areas around

1 **Table 9-9**. State-Listed Terrestrial Species that Occur in Frederick County and May Occur on
2 the Eastalco Site or in the Immediate Vicinity

Scientific Name	Common Name	State Status
Bartramia longicauda	Upland Sandpiper	Endangered
Cicindela patruela	Green-patterned Tiger Beetle	Endangered
Dendroica fusca	Blackburnian Warbler	Threatened
Haliaeetus leucocephalus	Bald Eagle	Threatened
Lanius ludovicianus	Loggerhead Shrike	Endangered
Neotoma magister	Allegheny Woodrat	Endangered
Thryomanes bewickii altus	Bewick's Wren	Endangered
Adlumia fungosa	Climbing Fumitory	Threatened
Agalinis auriculata	Auricled Gerardia	Endangered
Agastache scrophulariifolia	Purple Giant Hyssop	Threatened
Asplenium pinnatifidum	Lobed Spleenwort	Endangered
Botrychium oneidense	Blunt-lobe Grape-fern	Endangered
Calopogon tuberosus	Grass-pink	Endangered
Carex aestivalis	Summer Sedge	Endangered
Carex davisii	Davis' Sedge	Endangered
Carex shortiana	Short's Sedge	Endangered
Castilleja coccinea	Indian Paintbrush	Endangered
Chelone obliqua	Red Turtlehead	Threatened
Coeloglossum viride	Long-bracted Orchid	Endangered
Coptis trifolia	Goldthread	Endangered
Corallorhiza wisteriana	Wister's Coralroot	Endangered
Cornus rugosa	Round-leaved Dogwood	Endangered
Dirca palustris	Leatherwood	Threatened
Dryopteris campyloptera	Mountain Wood-fern	Endangered
Equisetum sylvaticum	Wood Horsetail	Endangered
Erythronium albidum	White Trout Lily	Threatened
Euphorbia purpurea	Darlington's Spurge	Endangered
Eurybia radula	Rough-leaved Aster	Endangered
Filipendula rubra	Queen-of-the-prairie	Endangered
Gentiana andrewsii	Fringe-tip Closed Gentian	Threatened
Glyceria acutiflora	Sharp-scaled Mannagrass	Endangered
Hasteola suaveolens	Sweet-scented Indian-plantain	Endangered

Table 9-9. (contd)

Scientific Name	Common Name	State Status
Helianthus microcephalus	Small-headed Sunflower	Endangered
Hydrastis canadensis	Goldenseal	Threatened
Krigia dendelion	Potato Dandelion	Endangered
Lythrum alatum	Winged Loosestrife	Endangered
Melanthium latifolium	Broad-leaved Bunchflower	Endangered
Minuartia glabra	Mountain Sandwort	Endangered
Nymphoides cordata	Floating-heart	Endangered
Oryzonpsis recemosa	Black-fruited Mountainrice	Threatened
Platanthera ciliaris	Yellow Fringed Orchid	Threatened
Platanthera grandiflora	Large Purple Fringed Orchid	Threatened
Platanthera permoena	Purple Fringeless Orchid	Threatened
Pycnanthemum torrei	Torrey's Mountain-mint	Endangered
Quercus shumardii	Shumard's Oak	Threatened
Rumex altissimus	Tall Dock	Endangered
Sagittaria rigida	Sessile-fruited Arrowhead	Endangered
Scutellaria leonardii	Leonard's Skullcap	Threatened
Scutellaria nervosa	Veined Skullcap	Endangered
Scutellaria saxatilis	Rock Skullcap	Endangered
Sida hermaphrodita	Virginia Mallow	Endangered
Smilacina stellata	Star-flowered False Solomon's-seal	Endangered
Spiranthes ochroleuca	Yellow Nodding Lady's Tresses	Endangered
Stenanthium gramineum	Featherbells	Threatened
Triosteum angustifolium	Yellowfruit Horse-gentian	Endangered
Zanthoxylum americanum	Northern Prickly-ash	Endangered

Source: MDNR 2007b

homes and backyards (James and Green 2009). The existence of the *altus* subspecies of Bewick's wren that occupies the Appalachian region has been called into question (James and Green 2009). It is believed the Bewick's wren may have been outcompeted and replaced by the house wren (*Troglodytes aedon*), a common backyard bird.

Of the 49 State-listed plant species found in Frederick County, 16 are wetland plants, 25 are found in uplands, and the remaining 8 may occur in both habitats. The distribution and abundance of these plant species on the Eastalco site is unknown. Because much of the site has been previously converted to agriculture, it is doubtful many of these plants would occur on the site. UniStar stated that only three of the State-listed plant species – yellowfruit horse-gentian (*Triosteum angustifolium*), potato dandelion (*Krigia dandelion*), and tall dock (*Rumex altissimus*) – could occur in highly disturbed habitats (UniStar 2009a). If any of these species did occur on the site, they would likely be limited to areas of existing natural vegetation, including forests, stream and wetland corridors, and grassy areas.

Tulip poplar, mountain laurel, chestnut oak, and New York fern, which were identified as ecologically important species for the Calvert Cliffs site, either do not occur on the Eastalco site or do not occur in sufficient numbers to contribute noticeably to the ecological integrity of the site. Therefore, these species are not considered important at the Eastalco site. The white-tailed deer, wild turkey, northern bobwhite, and ring-necked pheasant, all recreationally important species, would likely occur at this site. White-tailed deer are common in agricultural settings and were observed on the site during the site audit. Wild turkey would also be expected based on habitat types present and the known distribution in Maryland (UniStar 2009a). The Eastalco site appears to be well suited as habitat for the northern bobwhite and ring-necked pheasant. Both thrive in disturbed habitats and do particularly well in landscape mosaics that include agriculture.

Building and Operational Impacts

UniStar identified a representative 420-ac area within the Eastalco site for the purposes of this analysis. If a plant were built within this footprint, no wetlands would be affected. The water supply pipeline would disturb approximately 105 additional ac (UniStar 2009a).

The Eastalco site is highly disturbed and dominated by row crop production. Woodlands and wetlands are not extensive on the site, and these high-quality habitats exist in small, isolated patches. Adequate land area exists to avoid ecologically high-value lands during development of a nuclear plant at this site, limiting the potential to affect most important species. The Eastalco site does not contain suitable bald eagle habitat. The nearest water source large enough to supply cooling water, the Potomac River, is approximately 5.8 mi from the site. A pipeline capable of supplying about 50 MGD would be required. Although bald eagles are known to nest along the Potomac River, only one active nest is known to occur in Frederick County (MDNR 2008). Therefore, it is unlikely impacts related to the building and operation of a nuclear power plant would result in significant impacts to bald eagles.

Upland sandpipers may occur in grass-dominated habitats, but pre-disturbance surveys, design modifications, and mitigation would be used to minimize the potential to affect this species (UniStar 2009a). Potential nesting habitat could be lost if fallow fields are converted to facilities. Distribution and abundance of the green-patterned tiger beetle is undetermined, but this species could be affected by building activities related to the cooling water system along the Potomac River (UniStar 2009a) or within suitable upland habitat. Surveys, design modifications, and mitigation could minimize the potential to affect these beetles (UniStar 2009a), and adequate agricultural land exists to avoid forested habitats. The blackburnian warbler is unlikely to nest on the site, but may occasionally use forested areas during migration. Avoidance of forest habitats would preclude impacts to this bird species. The loggerhead shrike, Bewick’s wren, and most of the 49 State-listed plants would be found within forests, wetlands, and along streams and fence lines. Building a nuclear power plant within agricultural lands would also minimize the potential to affect these species as well. The yellowfruit horse-gentian, potato dandelion, and tall dock may occur in disturbed habitats, but pre-disturbance surveys and mitigation, if needed, would minimize effects to these species (UniStar 2009a). Habitat available to the white-tailed deer, wild turkey, northern bobwhite, and ring-necked pheasant would decrease and individuals would be displaced. However, these effects are not expected to be noticeable beyond a very local scale and would not destabilize county-level populations.

Building a new unit at Eastalco and the installation of a cooling system pipeline to the Potomac River and transmission systems would affect terrestrial resources, including wetlands. However, land use on the Eastalco site is typical of the region, with much of the surrounding land area already disturbed by agriculture. Few ecologically high-value habitats are likely present, and sufficient disturbed land area exists to avoid relatively undisturbed habitats during installation of a pipeline and transmission system. Route adjustments based on data from pre-disturbance surveys and mitigation measures that would be implemented during and after building of a plant would minimize impacts (UniStar 2009a). Operational activities within the transmission corridors might include visual inspection and appropriate maintenance of transmission line corridors. Maintenance activities might include clearing vegetation and tree trimming or removal. For maintenance purposes, wooded sections of the corridors would be cleared to the full width through mechanical clearing, hand cutting, or herbicide application using industry standard BMPs and are not expected to substantially affect terrestrial resources.

Terrestrial ecological impacts that may result from operation of a new nuclear unit at the Eastalco alternative site include those associated with the cooling system, transmission system structures, and maintenance of transmission line corridors. For impacts related to cooling system operations, the review team assumed the same type of cooling tower proposed for Unit 3 at the Calvert Cliffs site would be used at any of the alternative sites. In NUREG-1437 (NRC 1996), the NRC staff evaluated terrestrial ecological impacts resulting from operation of existing nuclear power plants and transmission line operation and maintenance. The types of terrestrial ecological impacts resulting from operation of a new nuclear unit would be similar to those of existing nuclear power plants. When more specific information was not available, conclusions in the NUREG-1437 (NRC 1996) were used to assess terrestrial impacts resulting from the operation of the cooling towers and impacts from transmission line corridor maintenance and operation. Similarly, the effects of cooling tower drift, avian collisions, noise, and transmission lines would be similar to those described in Section 5.3.1.1 in which the operational impacts were determined to be undetectable at the population level.

Cooling Towers

The operation of a cooling tower results in the loss of water through evaporative loss and drift. Drift is described as small, unevaporated water droplets that are exhausted out the top of the tower. These droplets may carry minerals, debris, microorganisms, and chemicals that may affect crops, ornamental vegetation, and native plants. Adverse impacts from cooling tower drift cannot be evaluated in detail without knowing the specific location of the cooling tower at each alternative site. However, general guidelines for predicting effects of drift deposition on plants suggest that many species have thresholds for visible leaf damage in the range of 9 to 18 lb/ac/mo of salt deposition on leaves during the growing season (NRC 1996). The Potomac River near the Eastalco site is a freshwater source; therefore, the review team expects even less salt deposition at the Eastalco site because the salt content in the cooling water source would be lower. Because the maximum salt deposition for the proposed Unit 3 is far below the level that could cause leaf damage in many common species, the impacts would be negligible both on the Calvert Cliffs site and in the vicinity. Therefore, these impacts would be even less at the Eastalco site. In general, the impacts of drift on crops, ornamental vegetation, and native plants were evaluated for existing nuclear power plants and were found to be of minor significance (NRC 1996).

Similarly, predicting mortality from bird collisions with cooling towers depend on the type (mechanical or natural draft for a wet cooling system; dry for a dry system) and number of cooling towers at each alternative site. In this case, a single, large mechanical draft cooling tower is proposed. The impacts of bird collisions for existing power plants were evaluated and found to be of minor significance for all operating nuclear plants, including those with various numbers and types of cooling towers (NRC 1996). On this basis, the review team concludes, for the purpose of comparing the alternative sites, that the impacts of cooling tower drift and bird collisions with cooling towers resulting from operation of a new nuclear unit at Eastalco would be minor.

Typical noise levels that can be expected at a distance of 1300 ft from the cooling tower are 65 dBA (UniStar 2009a). Noise from plant operation would also be quickly attenuated by surrounding forest cover, further limiting its impact on wildlife. Local wildlife would likely adapt to noise levels, while cooling tower and transformer noise may also serve to limit the potential for avian collision. Consequently, the review team concludes the impacts of cooling tower noise on wildlife would be minimal at Eastalco.

Transmission Lines

The impacts associated with transmission line operation consist of bird collisions with transmission lines and EMF effects on flora and fauna. The impacts associated with building transmission lines and corridor maintenance activities are alteration and/or conversion of habitat due to tree cutting and herbicide application and similar related impacts, such as use of temporary matting, where corridors cross floodplains, wetlands, and other important habitats.

Direct mortality resulting from birds colliding with tall structures has been observed (Avatar 2004). Factors that appear to influence the rate of avian impacts with structures are diverse and related to bird behavior, structure attributes, and weather. Migratory flight by flocking birds during darkness has contributed to the largest mortality events. Tower height, location, configuration, and lighting also appear to play roles in avian mortality. Weather, such as low cloud ceilings, advancing fronts, and fog also contribute to this phenomenon. Waterfowl may be particularly vulnerable due to low, fast flight and flocking behavior (Brown 1993). However, in NUREG-1437, the NRC staff concluded that the threat of avian collision as a biologically significant source of mortality is very low as only a small fraction of total bird mortality could be attributed to collision with nuclear power plant structures, including transmission corridors with multiple transmission lines (NRC 1996). Although collision may contribute to local losses, thriving bird populations can withstand these losses without threat to their existence (Brown 1993). Although additional transmission lines would be required for a new nuclear unit at Eastalco, increases in bird collisions would be minor and these would likely not be expected to cause a measurable reduction in local bird populations. Consequently, the incremental direct mortality posed by the addition of new transmission lines for a new nuclear unit would be negligible at the Eastalco alternative site.

EMFs are unlike other agents that have an adverse impact (e.g., toxic chemicals and ionizing radiation) in that dramatic acute effects cannot be demonstrated and long-term effects, if they exist, are subtle (NRC 1996). A careful review of biological and physical studies of EMFs did not reveal consistent evidence linking harmful effects with field exposures (NRC 1996). The impacts of EMFs on terrestrial flora and fauna are of small significance at operating nuclear power plants, including transmission systems with variable numbers of power lines and lines energized at levels less than 765 kV (NRC 1996). Since 1997, more than a dozen studies have been published that looked at cancer in animals that were exposed to EMFs for all or most of their lives (Moulder 2003). These studies have found no evidence that EMFs cause any specific types of cancer in rats or mice (Moulder 2003). Therefore, the incremental EMF impact posed by operation of existing transmission lines and the addition of new lines for a new nuclear unit would be negligible at the Eastalco alternative site.

Existing roads providing access to the existing transmission line corridors at Eastalco would likely be sufficient for use in any expanded corridors; however, new roads would be required during the development of new transmission line corridors. Transmission line corridor management activities (cutting and herbicide application) and related impacts to floodplains and wetlands in transmission line corridors are of minor significance at operating nuclear power plants, including those with transmission line corridors of variable widths (NRC 1996). Consequently, the incremental effects of transmission line corridor maintenance and associated impacts to floodplains and wetlands for a new nuclear unit would be negligible at Eastalco.

For reasons discussed above, impacts to important terrestrial species and habitat would be minimal, if any, at the Eastalco site. Therefore, impacts to terrestrial resources, including wetlands, from building and operation of a nuclear power plant at the Eastalco site would be minor.

Cumulative Impacts

The geographic area of interest for the assessment of the potential cumulative terrestrial ecology impacts of building and operating a new reactor at the Eastalco site in addition to other past, present, and reasonably foreseeable other projects on terrestrial resources and wetlands is defined as Frederick County, Maryland, because the extent of terrestrial impacts is mostly localized and the site is several miles from neighboring counties. Numerous projects, facilities, and activities could contribute to cumulative impacts on terrestrial resources and wetlands within the County. The PATH Project, a 280-mi long transmission line, is proposed to pass through central Frederick County to the Kemptown substation near Frederick, Maryland. It is likely that terrestrial habitats and wetlands within Frederick County would be affected by this project, but much of the route within the county is proposed to parallel or lie within existing transmission lines, limiting impacts to valuable resources (PATH 2009a). In 2001, Duke Energy applied for an application to build a natural gas-fired power plant north of Point of Rocks, Maryland. This project was cancelled in 2002, but land has been retained by Duke Energy and may be used for this purpose. If this land is eventually developed, impacts to terrestrial resources and wetlands would be likely, but the extent is unknown (MDNR PPRP 2006). Expansion of Fort Detrick, which occupies more than 1200 ac near Frederick, and subsequent infrastructure upgrades could also contribute to cumulative impacts. It is unknown to what extent this activity would affect resources. This facility lies mainly within an urban landscape, so it is unlikely valuable terrestrial resources still persist. The Eastalco site lies within highly disturbed, highly fragmented agricultural landscape. The incremental contribution of cumulative impacts resulting from the building of a nuclear power plant would be inconsequential and undetectable in the geographic area of interest.

Continued urbanization and GCC have the potential to alter and reduce the amount of terrestrial habitat and wetlands available to flora and fauna. GCC effects near the Eastalco site could result in regional increases in the frequency of severe weather, in annual precipitation, and in average temperature (GCRP 2009). Such factors would affect the terrestrial resources in the geographic area of interest through reduced open lands and wetlands as a result of inundation of low-lying areas and river shoreline. Forest growth may increase as a result of more carbon dioxide in the atmosphere (GCRP 2009). The impacts of GCC on plants and wildlife in the geographic area of interest are not precisely known. Changes in climate could alter and fragment key terrestrial habitats and result in substantial northward shifts in species' ranges, diversity, and abundance in the geographic area of interest for the Eastalco site (GCRP 2009).

Based on the information provided by UniStar and the review team's independent evaluation, the review team concludes the cumulative impacts to terrestrial and wetland resources of building and operating a new nuclear unit at the Eastalco alternative site, including impacts attributable to cooling towers, transmission lines, and transmission line corridors would be SMALL.

9.3.4.4 Aquatic Resources

The following impact analysis includes impacts from building activities and operations on aquatic ecology resources. The Potomac River, which is about 5.8 mi from the site, would provide the cooling water for a new nuclear power plant at Eastalco (UniStar 2009a). The Potomac River near the Eastalco site is non-tidal freshwater and is within the Upper Potomac River watershed upstream of Great Falls, which is a natural barrier to most anadromous fish migrations. A new reactor on the Eastalco site would require a new cooling water intake and discharge system, which would include a pipeline from the Potomac River to the plant that would be at least 5.8 mi long.

The Potomac River is the largest and most important aquatic resource near this alternative site. During the site visit in August 2009, it was observed that water depth in the vicinity of the site is relatively shallow. Other aquatic communities within the site include wetlands areas, as discussed in Section 9.3.5.4, and two small streams, Tuscarora Creek and Horsehead Run. These streams are within the Monocacy River watershed. The onsite resources have not been characterized, but there are approximately 33,000 linear ft of streams contained within the banks of Tuscarora Creek, its tributaries, and Horsehead Run (UniStar 2009a). However, during a site visit in August 2009, it was observed that flow in the streams was low, banks were incised and undercut, and some farm roads cross directly through the streams.

Recreationally Important Species

Recreational fishing on the Potomac River often targets the smallmouth bass (*Micropterus dolomieu*) and walleye (*Sander vitreus*), but also includes channel catfish (*Ictalurus punctatus*), and largemouth bass (*Micropterus salmoides*) (MDNR 2009g).

<u>Smallmouth Bass (*Micropterus dolomieu*)</u>. Smallmouth bass are not native to Maryland, but have become widespread in the State (MDNR 2007m). Smallmouth occur in streams and rivers with moderate currents, rocky substrates, shade, and pools. Smallmouth feed on fish, crayfish, and insects. Spawning occurs in late spring with adhesive eggs laid in nests built on the substrate nearshore.

<u>Walleye (*Sander vitreus*)</u>. The walleye is a large perch that is common across the northern U.S. and Canada, but has been widely introduced in the U.S., including Maryland (MDNR 2007n). Walleye live in large waterbodies that are clear and have rocky substrates. Walleye are

primarily predators on fish but also eat crayfish. Spawning occurs in early spring with adhesive eggs attaching to rocky substrates in shallower water.

Channel Catfish (*Ictalurus punctatus*). Channel catfish are large fish that have become established in non-tidal and tidal waters throughout Maryland, although the species is not native to the State (MDNR 2007f). Catfish live in deep pools that are sheltered by large rocks and logs. These catfish feed at night on bottom-dwelling prey, such as crayfish, mollusks, and insects. They also eat plants. Spawning occurs in late spring with the eggs being deposited in nests that are protected within depressions, holes, or undercut banks.

Largemouth Bass (*Micropterus salmoides*). Largemouth bass are widespread in Maryland, living in fresh and brackish waters (MDNR 2007g). Largemouth bass live in large rivers where flow is slow, and the bottom is soft. These bass are long-lived predators that primarily eat fish, but also occasionally eat frogs and snakes. Spawning occurs from March through June with eggs being deposited into nests that are guarded by males.

Non-Native and Nuisance Species

The zebra mussel and Asian clam are two introduced nuisance species that have not yet been recorded in the middle Potomac River near the Eastalco site. There is one record of the zebra mussel in the Potomac watershed in Prince William County, Virginia (MDNR 2009a). Asian clams have been found in Potomac waters in Charles, Prince Georges, and Montgomery Counties, Maryland (Foster et al. 2009). The rusty crayfish is native to the Ohio River basin, but has been found in Marsh Creek, a tributary of the upper Monocacy River (MDNR 2007l). Maryland banned the possession of any crayfish species in the Middle Potomac River basin in 2008 (MDNR 2009e).

Federally and State-Listed Species

There are no Federally listed threatened or endangered aquatic species or critical habitat near the Eastalco site (MDNR 2007d). Three State-listed fish species – the State-threatened pearl dace (*Margariscus margarita*), comely shiner (*Notropis amoenus*) and the Highly State Rare/State Rare checkered sculpin (*Cottus* n. sp. cf. *C. cognatus*) – are reported for Frederick County (MDNR 2007d). Seven State-listed freshwater mussel species are reported for Frederick County. These are the triangle floater (*Alasmidonta undulata*), brook floater (*A. varicosa*), yellow lance (*Elliptio lanceolata*), Atlantic spike (*E. producta*), yellow lampmussel (*Lampsilis cariosa*), green floater (*Lasmigona subviridis*), and creeper.

Pearl Dace (*Margariscus margarita*). The pearl dace is a moderately sized minnow that can reach a length of about 4 in. (Cunningham 2006). The pearl dace generally occurs across Canada and the northern portion of the U.S. from Montana to Maine, but its range also extends south through Pennsylvania to Virginia. The species is listed as threatened by the State of

Maryland (MDNR 2007d). Pearl dace generally live in slow moving, winding streams that have vegetated banks and many pool habitats (Cunningham 2006). Dace feed on zooplankton, benthic invertebrates, detritus, and plants. In Maryland, pearl dace occur only in limestone streams, which extend from the southern part of Frederick County near the Potomac River northeastward near the Eastalco site (MDNR 2005). The streams on the Eastalco site have not been characterized, and it is not known whether they are limestone streams. The occurrence of the pearl dace near or on the Eastalco site is uncertain.

Comely Shiner (*Notropis amoenus*). The comely shiner is a small minnow that reaches a length of about 4 in. It lives in moderate to large streams where the water is at least 2 ft deep (NYSDEC 2008b). It may occur in lakes and reservoirs. Spawning occurs in late spring and summer. Feeding habits are not known, but it is likely that the comely shiner feeds in the water column on aquatic and terrestrial arthropods (NYSDEC 2008b). The comely shiner is listed as threatened in Maryland (MDNR 2007d). Its possible occurrence near the Eastalco site is not known.

Checkered Sculpin (*Cottus* n. sp. cf. *C. cognatus*). The checkered sculpin is an undescribed species, formerly assigned to the slimy sculpin (*C. cognatus*), that is known from Virginia, Maryland, West Virginia, and Pennsylvania (PANHP 2009b). The species lives only in limestone streams (MDNR 2005, PANHP 2009b). Maryland lists the species as Highly State Rare/State Rare (MDNR 2007d). During stream surveys conducted in 1995 to 2002, the checkered sculpin occurred at only two sites within Frederick County (MDNR 2009d). Its possible occurrence near the Eastalco site is not known.

Freshwater Mussels (Family Unionidae). Maryland State-Endangered mussels include the triangle floater, brook floater, and the green floater. The Atlantic spike and the creeper are Maryland State-Imperiled. The yellow lampmussel and yellow lance are listed as State Uncertain (MDNR 2007d). The creeper, triangle floater, brook floater, and green floater all inhabit highland and piedmont streams and rivers in Frederick County, many of which are near the Eastalco site (MDNR 2005). The Atlantic spike ranges from the Potomac River basin to the Savannah River (Bogan and Alderman 2008) and is poorly known. The species has been confused with *E. lanceolata* and several similar species (Price 2009). These mussels are often considered as a mussel community that inhabits rivers and large streams (Walsh et al. 2007). The yellow lampmussel inhabits highland and piedmont rivers, and the yellow lance lives in piedmont streams and rivers in Frederick County (MDNR 2005). Although the occurrence of these mussels in the Potomac River near the Eastalco site is uncertain, there are historical records that document the occurrence of all of the species, except the yellow lance, in the Middle Potomac River (Pearce and Evans 2008). The possible occurrence of these mussels in the Potomac River near the Eastalco site or in the streams in the site is uncertain, but the possibility that they occur in either location cannot be discounted.

Building and Operational Impacts

Building a nuclear unit on the Eastalco site would affect about 1311 linear ft of streams (UniStar 2009a). Assuming that the plant design would be similar to that proposed for Calvert Cliffs Unit 3, a new plant would permanently add about 130 ac of impervious surface to the Eastalco site, which would increase runoff during storms, potentially increasing erosion and adding pollutants to aquatic resources. The potential impacts of the building on the onsite aquatic resources primarily would be loss of stream habitat, but it would not adversely affect the overall aquatic resources in the region.

New cooling water intake and discharge structures would be required for a new reactor located at the Eastalco site. The intake and discharge structures are assumed to be designed like those at the proposed site having no screens or return system at the intake pipe openings, which lead to a common forebay (see Chapter 3). The structures would be built on the Potomac River and would require a new pipeline at least 5.8 mi long. An exact pipeline route has not been determined, but the pipeline would most likely cross one or more small streams en route to the Potomac River. Building of a new intake would result in the temporary displacement of aquatic biota within the vicinity of the intake. It is expected these biota would return to the area after building is complete. Some silt runoff could occur during development and could affect local fish and benthic populations. However, the impacts on aquatic organisms would be temporary and largely mitigated through the use of BMPs. The type of substrate on the Potomac River bottom at possible intake and discharge locations is not known but, most likely, is substantially rocky. Installation of the intake and discharge structures on hard-bottom substrates could involve the use of cofferdams and dewatering, which would introduce pile-driving noise, discussed in Section 4.3.2.1, as a potential impact. The installation of the intake and discharge system in soft sediment areas would involve dredging, the potential impacts of which are discussed in Section 4.3.2.1.

New transmission lines would be needed to connect a new reactor on the Eastalco site to existing lines that are within 5 mi of the site (UniStar 2009a). A specific route for the new right-of-way has not been specified. The severity of impacts would depend on the characteristics of the aquatic resources within the corridor, but the use of BMPs during building and operation would lessen the potential impacts.

The most likely effects on aquatic populations from operation of a new nuclear unit at the Eastalco site would be the impingement, entrainment, and entrapment of organisms from the Potomac River. However, assuming that a new reactor at the Eastalco site would use a closed-cycle cooling system that meets the EPA's Phase I regulations for new facilities (66 FR 65256), would have a maximum through-screen velocity of 0.5 ft/s (0.15 m/s) at the cooling water intake, and would meet the appropriate EPA intake flow to source water volume criterion, then substantial adverse impacts to most Potomac River aquatic populations from entrainment, impingement, and entrapment would not be anticipated. Many of the aquatic species in the Potomac River have benthic eggs that are adhesive or laid in nests, which lessens the potential for entrainment of this life stage. The species most likely to be impinged, entrained or entrapped at the Eastalco site would be those affected by the Dickerson Generating Plant downstream from the Eastalco site. McLean et al. (2002) concluded that entrainment and impingement impacts at Dickerson were minor. However, as for the proposed Unit 3 at the Calvert Cliffs site (see Chapter 4), the review team recognizes that potential mitigation measures could be implemented at the intake pipeline openings at the Eastalco site to reduce entrainment, impingement, and entrapment effects on aquatic species in the Potomac River. Most notably, creation of a recessed intake and installation of small-mesh traveling screens or wedgewire screens and a fish-return system at the intake pipeline openings in the river would further reduce adverse effects on aquatic organisms.

Although a discharge plume has not been modeled for the Eastalco site, the plume area would be relatively small compared to the river size unless the water depth is shallow enough to result in a plume with an areal extent greater than that modeled for the Calvert Cliffs site. Without a site-specific modeled thermal plume, the potential existence of a thermal barrier to fish passage cannot be evaluated. The potential for adverse impacts from cold shock or heat shock because of exposure to the thermal plume likely would be minor. Chemical concentrations in the effluents from the Eastalco site would be required to follow permitted guidelines.

Overall, the combined impact of building and operation of a new reactor on the Eastalco site to aquatic resources on the site and in the Potomac River would be minor, but could be noticeable if State-listed species do occur in onsite waterbodies.

Cumulative Impacts

The geographic area of interest for the assessment of the potential cumulative impacts of building and operating a new reactor at the Eastalco site and from other past, present, and reasonably foreseeable projects on aquatic resources is defined as parts of the Upper and Middle Potomac River watersheds that extend through parts of Washington, Frederick, Montgomery, and Carroll Counties and includes the Lower Monocacy River watershed (MDNR 2007j, 2007h). Water quality in the Potomac River at Point of Rocks, near the possible location of the intake/discharge system, for 2003 to 2005 was rated poor (suspended solids) to fair (nitrogen, phosphorus) (MDNR 2007j). Streams in the Upper Potomac watershed were rated from fair to poor during Maryland Biological Stream Survey monitoring conducted in 2003 (MDNR 2003a). The main activities that could interact with those related to a new reactor at the Eastalco site include the Dickerson Generating Plant, the PATH Project, and the Brunswick Wastewater Treatment Plant. The Dickerson Generating Plant, which is located on the Potomac River about 7 mi downriver from the Point of Rocks area, consumes about 1.5 MGD of water from the Potomac. The primary species entrained or impinged at the plant include spottail and spotfin shiners, channel catfish, and redbreast sunfish. The ecological impacts were estimated to be minor (McLean et al. 2002). Thermal discharges from the plant were found to have localized impacts on benthic communities, but these impacts did not result in adverse effects to fish populations that exploit benthic communities (MDNR PPRP 2008).

The PATH project would build a transmission line from Amos, West Virginia to Kemptown, Maryland. The route crosses the Potomac River upriver of Point of Rocks and proceeds through lower Frederick County, approximately 2 mi south of the Eastalco site. The method of crossing the river is not available, but probably would avoid direct effects on the river. The Brunswick Treatment Plant, which is about 6 mi upriver from the Point of Rocks area, discharged about 0.6 MGD of effluent into the Potomac River in 2004 and 2005 with nitrogen and phosphorus being the primary nutrients in the discharge stream (MDNR 2007j). The plant has recently installed technologies to reduce the nutrient discharges. A new reactor on the Eastalco site would affect the Potomac River primarily by the entrainment and impingement of biota and the thermal discharge. These effects would not significantly add to those from the downriver Dickerson plant. A new reactor would not add significant discharges of nutrients to those discharged by the Brunswick Treatment Plant. In addition, urbanization in the vicinity could adversely affect water quality and, therefore, aquatic habitat, through increases in both point and nonpoint source pollution.

In addition to direct anthropogenic activities, GCC would impose additional stressors on aquatic communities. The presence of natural environmental stressors (e.g., short- or long-term changes in precipitation or temperature) would contribute to the cumulative environmental impacts to the Potomac River and onsite streams. GCC could lead to increased precipitation, increased pollution from nonpoint source runoff, increased temperatures, and greater intensity of storms in the geographic area of interest (GCRP 2009). Such changes could alter flow rates and reduce dissolved oxygen, which directly affect aquatic habitat. These stressors would result in shifts in species' ranges, habitats, and migratory behaviors and also alter ecosystem processes (GCRP 2009).

Based on the information from UniStar and the review team's independent evaluation, the review team concludes that the cumulative impacts of building and operating a nuclear generation unit at the Eastalco site in addition to other past, present, and reasonably foreseeable projects on most aquatic resources in the area of interest would be SMALL to MODERATE. The incremental contribution of building and operating a new reactor at the Eastalco site would likely be SMALL for most aquatic species but could be MODERATE for State-listed aquatic species if they occur onsite.

9.3.4.5 Socioeconomics

In evaluating the socioeconomic impacts of development and operation at the Eastalco site in Frederick County, Maryland, the review team undertook a review of the site using data sources discussed in Section 9.3.2. The analysis also considers, past, present, and reasonably foreseeable future actions that would affect the same environmental resources as a nuclear reactor at the Eastalco site, including other Federal and non-Federal projects and those projects listed in Table 9-8 within the geographic area of interest.

Physical Impacts

Many of the physical impacts of building and operation would be similar regardless of the site. Building activities can cause temporary and localized physical impacts such as noise, odor, vehicle exhaust, vibration, shock from blasting (if used), and dust emissions. The use of public roadways, railways, and waterways would be necessary to transport construction materials and equipment. Offsite areas that would support building activities (for example, borrow pits, quarries, and disposal sites) would be expected to be already permitted and operational. Impacts on those facilities from building a new nuclear unit would be minimal.

Potential impacts from station operation include noise, odors, exhausts, emissions, and visual intrusions (aesthetics). A new unit would produce noise from the operation of pumps, cooling towers, transformers, turbines, generators, and switchyard equipment. Traffic at the site also would be a source of noise. Any noise coming from this site would be controlled in accordance with standard noise protection and abatement procedures. By inference, this practice also would be expected to apply to all alternative sites. Commuter traffic would be controlled by speed limits. Good road conditions and appropriate speed limits would minimize the noise level generated by the workforce commuting to the alternative site.

Any new unit at an alternative site would have standby diesel generators and auxiliary power systems. Permits obtained for these generators would confirm that air emissions comply with applicable regulations. In addition, the generators would be operated on a limited, short-term basis. During normal plant operation, a new unit would not use a significant quantity of chemicals that could generate odors exceeding odor threshold values. Good access roads and appropriate speed limits would minimize the dust generated by the commuting workforce.

Building activities would be temporary and would occur mainly within the boundaries of the Eastalco site. Offsite impacts would represent minimal changes to offsite services supporting the building activities. During facility operations, noise levels would be managed to State and local ordinances. Air quality permits would be required for the diesel generators, and chemical use would be limited, which should limit odors. Based on the information provided by UniStar and the review team’s independent evaluation, the review team concludes that the physical impacts of building and operating a nuclear unit at the Eastalco site would be minimal.

Demography

The Eastalco site is located near the town of Frederick (2008 population 59,213) in Frederick County, central Maryland. The U.S. Census indicates that Frederick County had a 2008 population of 225,721, which was a 16 percent increase from 2000 (USCB 2009d). Baltimore is approximately 53 mi east, and Washington, D.C. is 54 mi southeast.

At the peak of the site development period, UniStar would expect an onsite workforce of 3950 construction workers (UniStar 2009a). Based on the analysis of impacts presented in Section 4.4.2, the total maximum number of construction workers migrating into the region (within 50 mi of the site) from outside of the region would be between 790 and 1383 workers (20 to 35 percent of the total workforce) at the peak of the building period. Using an average household size of 2.61, the total in-migrating population would be between 2062 and 3608 people. The majority of impacts would be expected to occur in Frederick County because it contains the site. The impacts are more dispersed farther away from the site due to the large populations of the other Counties within commuting distance of the Eastalco site. Considering that the maximum estimation of in-migrating population would be less than 6 percent of the total population for Frederick County, the demographic impacts of building a nuclear plant at the Eastalco are expected to be minimal.

If the facility were built and commenced operations, the operational workforce would number at least 363 workers, half (182 workers) of whom may migrate into the region. The Eastalco site would likely have a larger workforce than the Calvert Cliffs site because Calvert Cliffs has an existing security and administrative workforce. At the Eastalco site, a larger number of security and administrative workers would need to be hired, but because this is not specialized labor, they would likely already reside in the 50-mi region. Given the small number of in-migrating workers and the large population in the 50-mi region, the review team concludes that the demographic impact during operations would be minor.

Economy and Taxes

According to the U.S. Census Bureau 2005–2007 American Community Survey, the labor force in Frederick County was 123,907 persons and, of these, 118,721 were employed. The four industries in Frederick County that accounted for more than 50 percent of employment were educational services, health care, and social assistance (18 percent); professional, scientific, management, administrative, and waste management services (15 percent); retail trade (11 percent); and construction (11 percent) (USCB 2009e). The 2005-2007 estimated unemployment rate for Frederick County was 2.5 percent, compared to 5.6 percent for the State of Maryland (USCB 2009b, 2009f).

Economic impacts would be spread across the 50-mi region, but would likely be the greatest in Frederick County. Impacts are generally considered minimal if plant-related employment is less than 5 percent of the study area's total employment (NRC 1996). During development of the new unit, up to 3950 construction workers would be required to build the plant (at the peak period). While some of these workers may need to in-migrate to the region, many would be drawn from the approximate 140,000–150,000 construction workers in the workforce of more than 2.5 million in the greater MSA (USBLS 2007a, b). The peak site development workforce would represent less than 5 percent of the current workforce in the region. Therefore, the review team concludes that the impacts of building a nuclear plant on the economy of the region would be minimal and beneficial, but temporary.

The wages and salaries of the construction workforce would have a multiplier effect that could result in increases in business activity, particularly in the retail and service sectors. This would have a positive impact on the business community and could provide opportunities for new businesses to get started and increase job opportunities for local residents. During operations, approximately 182 new operations jobs would be added to the local economy. Based on the analysis in Section 5.4.3.1 for the proposed Calvert Cliffs site, the review team concludes the impact of these new jobs would constitute a small percentage of the total number of jobs in Frederick County and would have a minimal and beneficial economic impact.

As with the new proposed unit at the Calvert Cliffs site, there would be some positive sales, use, income, and property tax revenue benefits that would be generated as a result of the building and operation of a new nuclear unit at the Eastalco site (Sections 4.4.2.2 and 5.4.3.2). Tax revenues would accrue to the State primarily from income and sales taxes and to local governments from taxes on property and income (see Section 2.5.2.2). The primary tax impacts would occur once the unit becomes valued as property and property tax revenues are collected by Frederick County according to the millage rate and the negotiated value of the plant. In fiscal year 2008, Frederick County tax revenues totaled $395.2 million (FCBCB 2008). The tax revenues from a unit in Frederick County are unknown but likely to be similar to the revenues for the Calvert Cliffs site. Tax estimates for Unit 3 at the Calvert Cliffs site would be up to $71 million during building and at $57 million once operations commence. Impacts would not have as large an impact in Frederick County because of the County’s already large tax base. The review team concludes that the impact on tax revenues would be greatest in Frederick County, with a noticeable and beneficial impact during building and operation of a nuclear unit. The revenue impacts from building and operating a nuclear unit at the Eastalco site for the remainder of the 50-mi region would be minimal and beneficial.

Transportation and Housing

The local transportation network in Frederick County includes I-70, which runs from Baltimore to Pennsylvania, and I-270, which runs from Frederick to Virginia by connecting to I-495. Other major roads connected the region with Pennsylvania, Virginia, and West Virginia. Roads in Frederick County can be congested with commuter traffic to Frederick and to Washington D.C. and it suburbs (UniStar 2009a). A fairly developed system of roads already exists within the Eastalco site. The site does not have barge access, but the main line of the Baltimore and Ohio (B&O) railroad is located approximately 0.7 mi from the site, while a rail spur runs 0.5 mi from the site (UniStar 2009a). The review team expects traffic impacts from building activities, including both construction workers and deliveries, would be minimal for the region, yet could be significant, but not destabilizing, on the local roads near the site during shift change when the construction workforce is at its peak. During operations, impacts would be minimal, except during outages when an additional 800 to 1000 workers would be employed onsite and impacts would be noticeable but not destabilizing.

Based on the analysis in Section 4.4.2, and 5.4.2, up to 1383 construction workers and 182 operations workers and their families would in-migrate to the 50-mi region during the building of a unit at the Eastalco site and the subsequent operation. According to the 2005-2007 American Community Survey data, there are 4386 vacant housing units in Frederick County alone, which is adequate to accommodate the expected influx of construction workers. Workers could also find housing in other parts of the 50-mi region. The review team expects that the in-migrating site development and operations workforce would have a minimal impact on housing demand in Frederick County and the larger 50-mi region.

Public Services and Education

The influx of construction workers and plant operations staff in-migrating into the region could impact local municipal water and water treatment plants and other public services (police, fire, and medical) in the region. There are approximately five hospitals, five police stations, and 25 fire stations located in Frederick County (UniStar 2009a). There are 14 water treatment plants providing 1700 MGD and 14 wastewater treatment facilities with a capacity of 7.7 MGD. Excess capacity exists within the current systems to support the expected increase of 186,000 gpd to 325,000 gpd increase in water supply needs and wastewater treatment. Therefore, the review team concludes that the impacts of building and operating a nuclear unit on public services in Frederick County would be minimal. The much smaller operations workforce is expected to also have a minimal impact on public services.

Frederick County has one school district, which includes 64 schools and a 2006–2007 student body population of 40,224 students. The average student/teacher ratio was 15.6 (NCES 2009). As stated in Section 4.4.4.5, approximately 361 to 632 students are expected to in-migrate into the 50-mi region during building activities. Though they could in-migrate anywhere within the 50-mi region, if they were to all go into Frederick County schools, it would only raise their student population less than 2 percent. Students related to building and operations activities would represent a small percentage increase in the student body population. Given the number of schools in Frederick County and the large student body populations, it is likely the new students would be absorbed easily and education impacts would be minimal for Frederick County and the larger 50-mi region.

Aesthetics and Recreation

Sixty-three parks and other recreational areas and the stadium for one minor league baseball team (the Frederick Keys) are located within 10 mi of the site (UniStar 2009a). Multiple nationally protected areas are located within 25 mi of the site, including Monocacy National Battlefield, Chesapeake and Ohio Canal National Historical Park, Antietam National Battlefield, and Catoctin Mountain Park, which includes the presidential retreat Camp David. Recreational users in the vicinity of the site may be impacted by traffic near the plant during shift change. Impacts on recreation resulting from building and operating a nuclear unit on the Eastalco site would be minimal.

The site is already visually altered by the Eastalco aluminum smelter facility. However, the reactor building and other associated structures may be visible to surrounding areas as most of the land is agricultural and does not provide much viewshed protection. An underdetermined number of miles of transmission lines would need to be added, but this likely would not require new corridors. Impacts on aesthetics resulting from building and operating a nuclear unit on the Eastalco site would be noticeable but not destabilizing.

Cumulative Impacts

For the analysis of cumulative socioeconomic impacts at the Eastalco site, the geographic area of interest is the 50-mi region centered on the Eastalco site with special consideration for Frederick County, as it is where the review team expects socioeconomic impacts to be the greatest. Historically, Frederick County had an agricultural-based economy, and, although it still retains some of its agricultural base, it has diversified its economy recently. Frederick County's population was 150,208 in 2000, but, by 2005, the population was near 219,000 (MDBED 2009).

In addition to socioeconomic impacts from building and operating a nuclear unit at the Eastalco site, the analysis also considers other past, present, and reasonably foreseeable future actions that could contribute to the cumulative socioeconomic impacts. The projects identified in Table 9-8 within the geographic area of interest have or would contribute to the demographics, economic climate, and community infrastructure of the region and generally result in increased urbanization and industrialization. However, many impacts, such as those on housing or public services, are able to adjust over time, particularly with increased tax revenues. Furthermore, State and County plans, along with modeled demographic projections, include forecasts of future development and population increases. Because the projects within the geographic area of interest identified in Table 9-8 would be consistent with applicable land-use plans and control policies, the review team considers the cumulative socioeconomic impacts from the projects to be manageable. Physical impacts on workers and the general public include impacts on existing buildings, transportation, aesthetics, noise levels, and air quality. Social and economic impacts span issues of demographics, economy, taxes, infrastructure, and community services.

In summary, based on the information provided by UniStar and the review team's independent evaluation, the review team concludes that the cumulative socioeconomic impacts of building and operating a new nuclear unit at the Eastalco site would be SMALL in terms of physical impacts, demography, housing, public service, educational, and recreational impacts – except for a SMALL to MODERATE impact on aesthetics and a MODERATE impact on transportation near the site. The cumulative impacts to Frederick County economy and tax base would be beneficial and MODERATE. Building and operating a new nuclear unit at the Eastalco site would be a significant contributor to these impacts.

9.3.4.6 Environmental Justice

The 2000 Census block groups were used for ascertaining minority and low-income populations in the region. There were a total of 4600 census block groups within the 50-mi region (which included portions of Washington D.C., Maryland, Virginia, West Virginia, and Pennsylvania). Approximately 1307 of these census block groups were classified as aggregate minority populations with 1145 of them African American mostly in the Washington D.C. and Baltimore areas. Frederick County has two census block groups with aggregate minority populations, one African American classified block group and one Hispanic classified block group. There are 312 census block groups classified as low income in the 50-mi region, two of which are in Frederick County. Figure 9-9 shows the geographic locations of the minority populations of significance within the 50-mi radius of the Eastalco site, and Figure 9-10 shows the geographic locations of the low-income populations of significance within the 50-mi radius of the Eastalco site.

Building activities (noise, fugitive dust, air emissions, traffic) would not disproportionately adversely affect minority populations because of their distance from the Eastalco site. The operation of the proposed project at the Eastalco site is also unlikely to have a disproportionate adverse impact on minority or low-income populations. See Sections 4.5 and 5.5 for more information about environmental justice criteria and impacts.

The projects identified in Table 9-8 likely did not or would not contribute to environmental justice impacts of the region. Housing rental rates can be an area of concern with regards to low-income populations. If projects commence and cause a rise in rental rates, there may be a disproportionate adverse impact on low-income populations. Therefore, based on information provided by UniStar and the review team's independent evaluation, the review team concludes there would not be any disproportionate and adverse environmental justice cumulative impacts from the building and operation of a new generating unit at the Eastalco site in addition to other past, present, and reasonably foreseeable projects, and the cumulative environmental justice impacts would be SMALL.

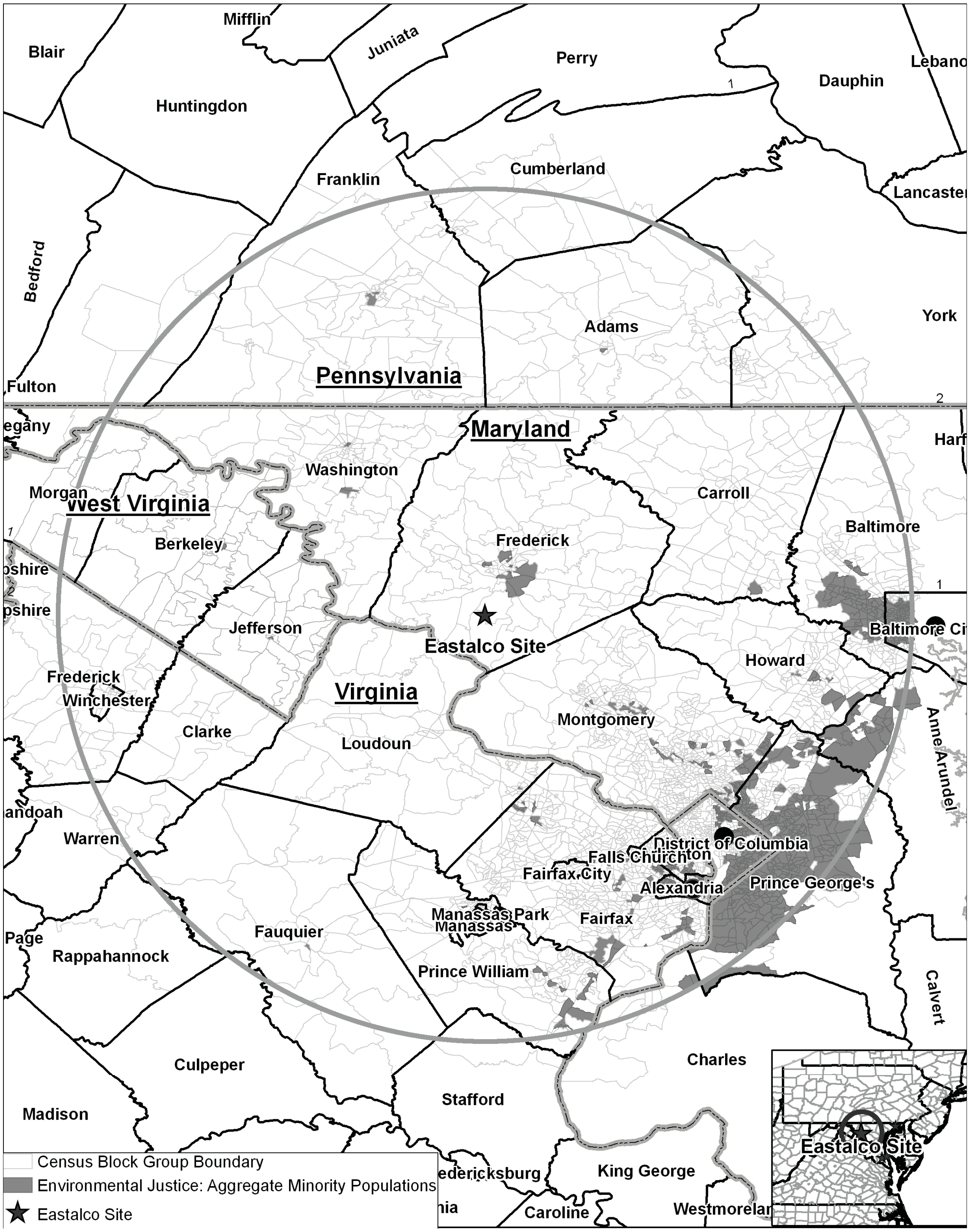

Figure 9-9. Distribution of Aggregate Minority Populations of Significance in 2000 for the Eastalco Site

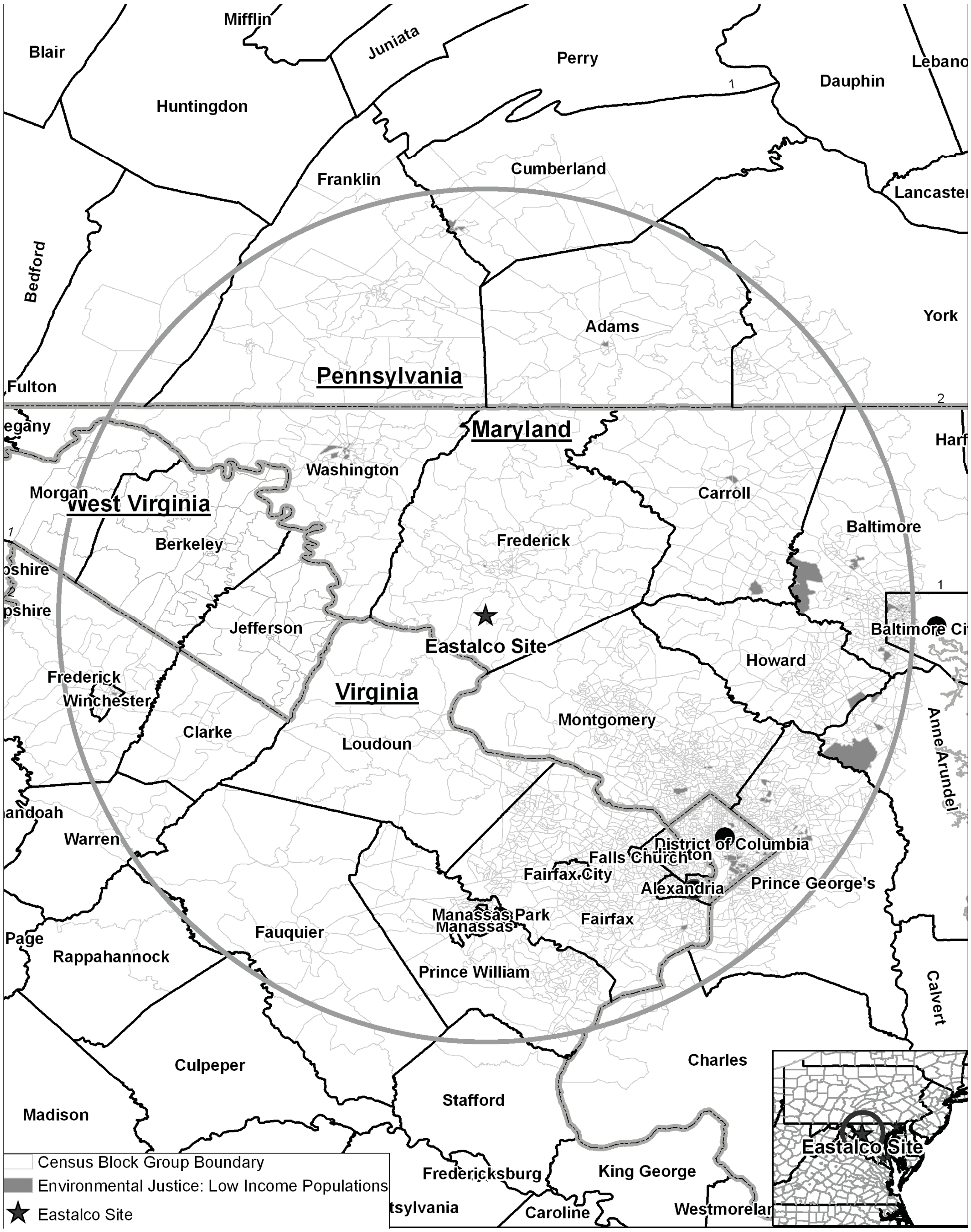

Figure 9-10. Distribution of Aggregate Low-Income Populations of Significance in 2000 for the Eastalco Site

9.3.4.7 Historic and Cultural Resources

UniStar conducted a literature review at the MHT and found there are 16 properties and one historic district listed on the National Register of Historic Places within 5 mi of the site (UniStar 2009a). One listed property, Carrollton Manor, is within 1 mi of the Eastalco site. The Carrollton Manor was the home of Charles Carroll, an American Revolutionary statesman and a signer of the Declaration of Independence.

Development of a pipeline to the Potomac River would cross the Chesapeake and Ohio Canal (C&O Canal), which is a historic linear resource and would require consultation with the MHT, as well as the National Park Service of the U.S. Department of the Interior. The C&O Canal has played a significant role in American history relative to western expansion, transportation engineering, the Civil War, immigration, industry, and commerce (NPS 2009).

Consultation with the MHT would be necessary regarding the need for systematic archaeological and architectural surveys to identify historic and archaeological resources prior to any ground-disturbing activities to address impacts to historic, cultural, and archaeological resources at this particular site. UniStar would be expected to put protective measures in place to secure discoveries in the event that historic or archaeological materials are found during building or operating of a new plant. In the event that an unanticipated discovery is made, site personnel should be instructed to notify the MHT and consult with them in conducting an assessment of the discovery to determine if additional work is needed.

Cumulative Impacts

The following cumulative impact analysis includes building and operating a nuclear generating unit at the Eastalco site. The analysis also considers other past, present, and reasonably foreseeable future actions that could impact cultural resources, including other Federal and non-Federal projects within the geographic area of interest and those projects listed in Table 9-8 within the geographic area of interest. For the analysis of cultural impacts at the Eastalco site, the geographic area of interest is the APE that would be defined for this considered undertaking. This includes the physical APE, defined as the area that would be directly affected by the site development and operation activities at the site and transmission lines, and the visual APE. The visual APE is defined as an additional 1-mi radius around the physical APE consistent with the discussion in Section 2.7 about the maximum distance from which the structures can be seen.

Reconnaissance activities in a cultural resource review have particular meaning. Typically, for example, it includes preliminary field investigations to confirm the presence or absence of cultural resources. However, in developing this EIS, the review team relied upon reconnaissance-level information to perform its evaluation of alternative sites. Reconnaissance-level information is data that are readily available from agencies and other public sources. It can also include information obtained through visits to the site area. To identify the historic and cultural resources at the Eastalco site, the following information was used:

- UniStar ER (UniStar 2009a)
- NRC-Alternative Sites Visit August 2009 (NRC 2010a).

Cultural resources are non-renewable; therefore, the impact of destruction of cultural resources is cumulative. No projects were identified in Table 9-8 within the geographic area of interest that would contribute to cumulative impacts to historic and cultural resources.

Based on reconnaissance-level information regarding historic and cultural resources at the site, specifically the rich history in the area, the close proximity to Carrollton Manor, and the crossing of the C&O Canal, the review team concludes that the cumulative impacts on historic properties of building and operating a new generating unit at the Eastalco site would be MODERATE to LARGE. Building and operating a new nuclear unit at the Eastalco site would be a significant contributor to these impacts. No archaeological and/or architectural surveys have been conducted in the area where the nuclear plant would be built.

9.3.4.8 Air Quality

The emissions related to building and operating a nuclear power plant at the Eastalco site in Frederick County would be similar to those at the Calvert Cliffs site described in Chapters 4 and 5 of the EIS. However, Frederick County is in the Central Maryland Intrastate Air Quality Control Region (40 CFR 81.155). The air quality attainment status for Frederick County as set forth in 40 CFR 81.321 reflects the effects of past and present emissions from all pollutant sources in the region. Frederick County is in non-attainment of both the 8-hour ozone standard and the PM 2.5 (particulate matter with a diameter of less than 2.5 microns) standard.

Reflecting on the projects listed in Table 9-8, most of the effects on air quality would be to maintain the status quo. Any new industrial projects would either have de minimis impacts or would be subject to regulation by the Maryland DNR. Given these institutional controls, it is unlikely that the air quality in the region would degrade significantly (i.e., degrade to the extent that the region is in nonattainment of national standards).

The cooling tower for the power plant would be a source of small particles. As a result, although the air quality impacts of building and operating a nuclear power plant at the Eastalco site would probably be minor, it is possible that the cumulative impacts of the cooling tower particulate emissions could be MODERATE. Building and operating a new nuclear unit at the Eastalco site would be a significant contributor to these impacts.

Greenhouse gas emissions related to nuclear power are discussed in Chapters 4, 5, and 6 for building and operating a nuclear power plant and for the fuel cycle, respectively. As described in Chapter 7, the impacts of greenhouse gas emissions are not sensitive to location of the source. Consequently, the discussions in the previous chapters and in Section 9.2.5 are applicable to a nuclear power plant located at the Eastalco site. The impacts of greenhouse gas emissions from a nuclear plant considered in isolation would be SMALL, but the cumulative impact of greenhouse gas emissions would be MODERATE. Building and operating a new nuclear unit at the Eastalco site would be a significant contributor to these impacts.

9.3.4.9 Nonradiological Health Impacts

The following impact analysis includes nonradiological health impacts from building activities and operations to the public and workers from a nuclear unit at the Eastalco alternative site. The analysis also considers other past, present, and reasonably foreseeable future actions that impact nonradiological health, including other Federal and non-Federal projects and those projects listed in Table 9-8 within the geographic area of interest. The building-related activities that have the potential to impact the health of members of the public and workers include exposure to dust and vehicle exhaust, occupational injuries, noise, and the transport of construction materials and personnel to and from the site. The operation-related activities that have the potential to impact the health of members of the public and workers includes exposure to etiological agents, noise, EMFs, and impacts from the transport of workers to and from the site. For the analysis of nonradiological health impacts at the Eastalco alternative site, the geographic area of interest is considered to include projects within a 5-mi radius from the site's center based on the localized nature of the impacts. For impacts associated with transmission lines, the geographic area of interest is the transmission line corridor.

Building Impacts

Nonradiological health impacts to construction workers and members of the public from building a new nuclear unit at the Eastalco site would be similar to those evaluated in Section 4.8 for the Calvert Cliffs site. The impacts include noise; vehicle exhaust; dust; occupational injuries; and transportation accidents, injuries, and fatalities. Applicable Federal and State regulations on air quality and noise would be complied during the site preparation and building phase. The incidence of construction worker accidents would not be expected to be different from the incidence of accidents estimated for the Calvert Cliffs site. The Eastalco site is located in a rural area, and building impacts would likely be minimal on the surrounding area.

There are no past or current actions in the geographic areas of interest that have similarly impacted nonradiological health. Proposed future actions would include the Fort Detrick BRAC expansion recommendations and construction of the National Interagency Biodefense Campus; transportation upgrades to US 15, MD 85, I-70, and I-270; and transmission line development and/or upgrading, including the PATH project. Future urbanization would also be expected to occur throughout the geographical area of interest. These actions would likely result in nonradiological health impacts similar to those discussed in Chapter 4 for the building at the Calvert Cliffs site.

Operational Impacts

Nonradiological health impacts from the operation of a new nuclear unit on occupational health and members of the public at the Eastalco site would be similar to those evaluated in Section 5.8 for the Calvert Cliffs site. Occupational health impacts to workers (e.g., falls, electric shock, or exposure to other hazards) at the Eastalco site would likely be the same as those evaluated for workers at a new unit at the Calvert Cliffs site. Based on the configuration of the proposed new unit at the Eastalco site (closed-cycle, wet cooling system with mechanical draft cooling towers), etiological agents would not likely increase the incidence of water-borne diseases in the vicinity of the site. Noise and EMF exposure would be monitored and controlled in accordance with applicable OSHA regulations. Effects of EMF on human health would be controlled and minimized by conformance with NESC criteria. Nonradiological impacts of traffic associated with the operations workforce would be less than the impacts during building. Mitigation measures taken during building to improve traffic flow would also minimize impacts during operation of a new unit.

The past and present actions in the geographic area of interest associated with existing transmission lines are the only nonradiological impacts from operations to the public and workers. Proposed future actions that would impact nonradiological health in a similar way to operation activities at the Eastalco site would include transmission line systems and future urbanization, which would both occur throughout the designated geographical areas of interest.

The review team is also aware of the potential climate changes that could affect human health; a recent compilation of the state of the knowledge in this area (GCRP 2009) has been considered in the preparation of this EIS. Projected changes in the climate for the region include an increase in average temperature and an increase in precipitation, which may alter the presence of microorganisms and parasites. In view of the water source characteristics, the review team did not identify anything that would alter its conclusion regarding the presence of etiological agents or change in the incidence of water-borne diseases.

Summary

Based on the information provided by UniStar and the review team’s independent evaluation, the review team expects that the impacts to nonradiological health from building and operation of a new unit at the Eastalco site would be similar to the impacts evaluated for the Calvert Cliffs site. While there are past, present, and future activities in the geographic area of interest that could affect nonradiological health in ways similar to the building and operation of a new unit at the Eastalco site, those impacts would be localized and managed through adherence to existing regulatory requirements. Therefore, the review team concludes that the cumulative impacts of building and operation of a nuclear unit at Eastalco on nonradiological health would be SMALL.

9.3.4.10 Radiological Impacts of Normal Operations

The following impact analysis includes radiological impacts to the public and workers from building activities and operations for one nuclear unit at the Eastalco alternative site. The analysis also considers other past, present, and reasonably foreseeable future actions that impact radiological health, including other Federal and non-Federal projects and those projects listed in Table 9-8 within the geographical area of interest. As described in Section 9.3.4, the Eastalco site includes an inactive aluminum production facility; there are currently no nuclear facilities on the site. The geographic area of interest is the area within a 50-mi radius of the Eastalco site. A facility potentially affecting radiological health within this geographic area of interest is the operating research reactor at the existing National Institute of Standards and Technology (NIST) in Gaithersburg, Maryland. Also there are likely to be hospitals and industrial facilities within 50 mi of the Eastalco site that use radioactive materials.

The radiological impacts of building and operating the proposed U.S. EPR plant at the Eastalco site include doses from direct radiation and liquid and gaseous radioactive effluents. These pathways would result in low doses to people and biota offsite that would be well below regulatory limits. These impacts are expected to be similar to those estimated for the Calvert Cliffs Unit 3 site.

The radiological impacts of the NIST reactor include doses from direct radiation and liquid and gaseous radioactive effluents. These pathways result in low doses to people and biota offsite that are well below regulatory limits as demonstrated by the ongoing REMP conducted around this facility. The NRC staff concludes the dose from direct radiation and effluents from hospitals and industrial facilities that use radioactive materials would be an insignificant contribution to the cumulative impact around the Eastalco site. This conclusion is based on data from the REMPs conducted around currently operating nuclear power plants.

Based on the information provided by UniStar and the NRC staff’s independent analysis, the NRC staff concludes the cumulative radiological impacts from building and operating the proposed U.S. EPR unit and other existing and planned projects and actions in the geographic area of interest around the Eastalco site would be SMALL.

9.3.4.11 Postulated Accidents

The following impact analysis includes radiological impacts from postulated accidents from operations for one nuclear unit at the Eastalco alternative site. The analysis also considers other past, present, and reasonably foreseeable future actions that impact radiological health from postulated accidents, including other Federal and non-Federal projects and those projects listed in Table 9-8 within the geographic area of interest. As described in Section 9.3.4, the Eastalco site includes an inactive aluminum production facility; there are currently no nuclear facilities on the site. The geographic area of interest considers all existing and proposed nuclear power plants that have the potential to increase the probability-weighted consequences (i.e., risks) from a severe accident at any location within 50 mi of the Eastalco site. Existing facilities potentially affecting radiological accident risk within this geographic area of interest are Calvert Cliffs Units 1 and 2, North Anna Units 1 and 2, Peach Bottom Units 2 and 3, and Three Mile Island Unit 1. Within the geographic area of interest, an additional nuclear power plant is planned at the North Anna site. Also in the geographic area of interest is the operating research reactor at the NIST in Gaithersburg, Maryland.

As described in Section 5.10.1, the NRC staff concludes that the environmental consequences of DBAs at the Calvert Cliffs site would be minimal for an U.S. EPR. DBAs are addressed specifically to demonstrate that a reactor design is robust enough to meet NRC safety criteria. The U.S. EPR design is independent of site conditions and the meteorology of the Eastalco and Calvert Cliffs sites are similar; therefore, the NRC staff concludes that the environmental consequences of DBAs at the Eastalco site would be minimal. Because the meteorology, population distribution, and land use for the Eastalco alternative site are expected to be similar to the proposed Calvert Cliffs site, risks from a severe accident for a U.S. EPR reactor located at the Eastalco alternative site are expected to be similar to those analyzed for the proposed Calvert Cliffs site. These risks for the proposed Calvert Cliffs site are presented in Table 5-16 and 5-17 and are well below the median value for current-generation reactors. In addition, estimates of average individual early fatality and latent cancer fatality risks are well below the Commission's safety goals (51 FR 30028). For existing plants within the geographic area of interest, which are Calvert Cliffs Unit 1 and 2, North Anna Units 1 and 2, Peach Bottom Units 2 and 3, and Three Mile Island Unit 1, the NRC has determined the probability-weighted consequences of severe accidents are small (10 CFR 51, Appendix B, Table B-1). In addition, the EIS for the North Anna Power Station Unit 3 (NUREG-1917, NRC 20010b) shows that risks for the other proposed unit within the geographic area of interest are also well below current-generation reactors and meet the NRC's safety goals. The research reactor at NIST operates at a much lower power (roughly one percent) than any of the nuclear power plants discussed above; therefore, the additional risk is not significant in the evaluation of the cumulative severe accident risk for a nuclear power plant at the Eastalco site. On these bases, the NRC staff concludes that the cumulative risks of severe accidents at any location within 50 mi of the Eastalco alternative site would be SMALL.

9.3.5 Former Thiokol Brownfield Site

This section covers the review team's evaluation of the potential environmental impacts of siting a new nuclear unit at a brownfield site once owned by Thiokol and referred to here as the former Thiokol brownfield site or simply the Thiokol site. The Thiokol site is located in southern Maryland across the Patuxent River from the Calvert Cliffs site.

The following sections describe the cumulative impact assessment conducted for each resource area. The specific resources and components that could be affected by the incremental effects of the proposed action if it were sited at the Thiokol site and other actions in the same geographical area were assessed. This assessment includes the impacts of construction and operations and impacts of preconstruction activities. Also included are past, present, and reasonably foreseeable Federal, non-Federal, and private actions that could have meaningful cumulative impacts with the proposed action. Other actions and projects considered in this cumulative analysis are described in Table 9-10.

9.3.5.1 Land Use

The following impact analysis includes impacts to land use from building and operations at the Thiokol site and within the geographic area of interest, which is the 15-mi region surrounding the Thiokol site. The analysis also considers past, present, and reasonably foreseeable future actions that affect land-use, including other Federal and non-Federal projects (Table 9-10).

The Thiokol site is a 619-ac brownfield tract of land located about 1.5 mi northwest of Hillville, Maryland near Mechanicsville in St. Mary's County, Maryland. It is approximately 10 mi west-southwest of the Calvert Cliffs site across the Patuxent River (Figure 9-11). The site is bordered by MD State Route 235 to the north and Friendship School Road to the west (Figure 9-12) (UniStar 2009a). Rich Neck Creek and Tom Swamp Run and their tributaries flow through the property, generally to the south and southwest toward the Potomac River (MDE 2009b). The current property owner is PB II, LLC (MDE 2009b).

The Thiokol site was used in the early to mid-1950s as a manufacturing and testing facility for detonators and initiators for military ordnance (UniStar 2009a). Thiokol Corporation, now known as Cordant Technologies, purchased the site in 1959, but did not resume munitions production and sold the property in 1999. Buildings were removed from the site in the early 1980s, timber was harvested, and the site was reforested (MDE 2007). MDE placed the property on its list of potentially hazardous waste sites in 1985.

Site remediation with a focus on finding and removing any unexploded ordnance and any other hazardous material was conducted from 1992 to 1994 (MDE 2007). Nineteen of 26 areas with suspected explosives were unearthed, and the 1360 lb of explosives found were detonated onsite. Soil contaminated with explosive materials or fuel oil was removed from the site (MDE 2007). The remaining seven areas (about 22 ac) with suspected explosives were inspected between September 1999 and June 2000 (MDE 2007). These sites were excavated, suspect soils were sifted with a mechanical sifter, and ground-penetrating radar was used to identify debris (UniStar 2009a). Eleven pounds of explosives were found and removed during this investigation. MDE confirmed the areas sampled contained no significant chemical contamination.

Table 9-10. Past, Present, and Reasonably Foreseeable Projects and Other Actions Considered in the Thiokol Site Cumulative Analysis

Project Name or Other Action	Summary of Project	Location	Status
Energy Projects			
CCNPP Units 1 and 2	CCNPP consists of two existing nuclear generating units, Units 1 and 2, with a combined net electric generating capacity of 1700-1780 MW(e).	Approximately 14 mi east-northeast of the Thiokol site.	Operational. In 2000, the NRC extended the license of Unit 1 to July 31, 2034 and the license of Unit 2 to August 31, 2036.[a]
Dominion Cove Point Liquefied Natural Gas (LNG) Facility	LNG is unloaded at an off-shore dock, then stored and transported onshore through a pipeline.	Approximately 11 mi east of the Thiokol site.	Operational. An expansion project, completed in 2009, increased storage and capacity by approximately 80%.[b]
Dominion Cove Point Pier Reinforcement Project	Upgrades and modifications to existing offshore pier to allow docking of larger-sized LNG vessels.	Approximately 11 mi east of the Thiokol site.	Planned.[c][d] Original schedule called for project to be completed in spring 2011.
Operation of Chalk Point Generating Station	Chalk Point consists of 11 fossil fuel-based power-generating units with a listed capacity of 2413 MW.	Approximately 12 mi northwest of the Thiokol site.	Operational.[e]
Morgantown Generating Station	Morgantown Generating Station consists of six generating units. Two units are coal-fired and four are oil-fired with a listed capacity of 1486 MW.	Approximately 23 mi west of the Thiokol site.	Operational.[f]
Mid-Atlantic Power Pathway (MAPP) Transmission Line Project	Proposed new 500-kV transmission line.	From Possum Point Substation in Virginia to the Calvert Cliffs Substation, with subsequent lines constructed under Chesapeake Bay terminating at the Vienna Substation in MD and the Indian River Substation in Delaware.	Proposed. June 2014 in-service date proposed by Pepco. Under consideration by MPSC as Case 9179.[g]

Table 9-10. (contd)

Project Name or Other Action	Summary of Project	Location	Status
Transportation Projects			
MD Route 4/Thomas Johnson Bridge Upgrade, Maryland SHA	Study to upgrade MD 4 between MD 2 and MD 235, including the Thomas Johnson Bridge and MD 235 intersection. Sidewalks would be provided (where appropriate) for pedestrians. Shoulders or wide curb lanes will accommodate bicycles.	Approximately 7 to 10 mi southeast of the Thiokol site, in Calvert and St. Mary's County.	Planned.[h]
MD Route 5 near Leonardtown, Maryland SHA	Study to upgrade MD 5 from MD 243 to MD 245, approximately 1.4 mi in length.	Approximately 6 mi south of the Thiokol site.	Planned.[i]
MD Route 237, Maryland SHA	Study to upgrade and widen MD 237 to a multi-lane highway from Pegg Road to MD 235 (2.80 mi).	Approximately 10 to 12 mi southeast of the Thiokol site.	Planned.[j]
Other Actions/Projects			
Leonardtown Wastewater Treatment Plant	Expand capacity and upgrade facility with enhanced nutrient removal technology.	Approximately 6 mi south of Thiokol site.	Phased construction; expected completion in 2013.[k]
Patuxent River Naval Air Station Complex	Large facility for the U.S. Navy's research, development, testing, training, and evaluation of aircraft and related components and operations.	Approximately 9 mi south of proposed CCNPP Unit 3.	Operations.[l]
Star-Spangled Banner National Historic Trail	The trail traces four major events from the Chesapeake Campaign of the War of 1812. The trail, which includes forested and open water areas, provides opportunity for recreation, interpretation, and learning.	A portion of the trail is close to or adjacent to the Thiokol site.	In development. A management plan and environmental assessment (MP/EA) for the Star-Spangled Banner National Trail will be published in 2010.[m]
Captain John Smith Chesapeake National Historic Trail	The trail, which is on open water, provides opportunities for recreation, interpretation, and learning.	A portion of the trail is close to or adjacent to the Thiokol site.	A comprehensive management plan will be published in 2010.[n]

Table 9-10. (contd)

Project Name or Other Action	Summary of Project	Location	Status
Potomac Heritage National Scenic Trail	A network of locally managed trails that extends from the mouth of the Potomac River to the Allegheny highlands. Trails provide opportunities for recreation, interpretation, and learning.	A portion of the trail is close to or adjacent to the Thiokol site.	Currently exists and a comprehensive management plan will be published in the future.[o]
Various hospitals and industrial facilities that use radioactive materials	Medical and other isotopes.	Within 50 mi.	Operational.
Future urbanization	Construction of housing units and associated commercial buildings; roads, bridges, and rail; and water and/or wastewater treatment and distribution facilities and associated pipelines as described in local land-use planning documents.	Throughout region.	Construction would occur in the future, as described in State and local land-use planning documents.
Waterfront development	A variety of residential and commercial waterfront property development, including potential pier facilities, dredging, and shoreline erosion control structures; controlled commercial and residential development outside and within the limits of the town center designated areas of the various county master plans.	Throughout region.	Construction would occur in the future, as described in State and local land-use planning documents.

(a) Source: NRC 2000b.
(b) Source: Dominion 2009.
(c) Source: FERC 2009a.
(d) Source: FERC 2009b.
(e) Source: Mirant 2009b.
(f) Source: Mirant 2009c.
(g) Source: MAPP 2009.
(h) Source: MD SHA 2009c.
(i) Source: MD SHA 2009d.
(j) Source: MD SHA 2009e.
(k) Source: MDE 2009a.
(l) Source: DOD 2010.
(m) Source: NPS 2010a.
(n) Source: NPS 2010b.
(o) Source: NPS 2010c.

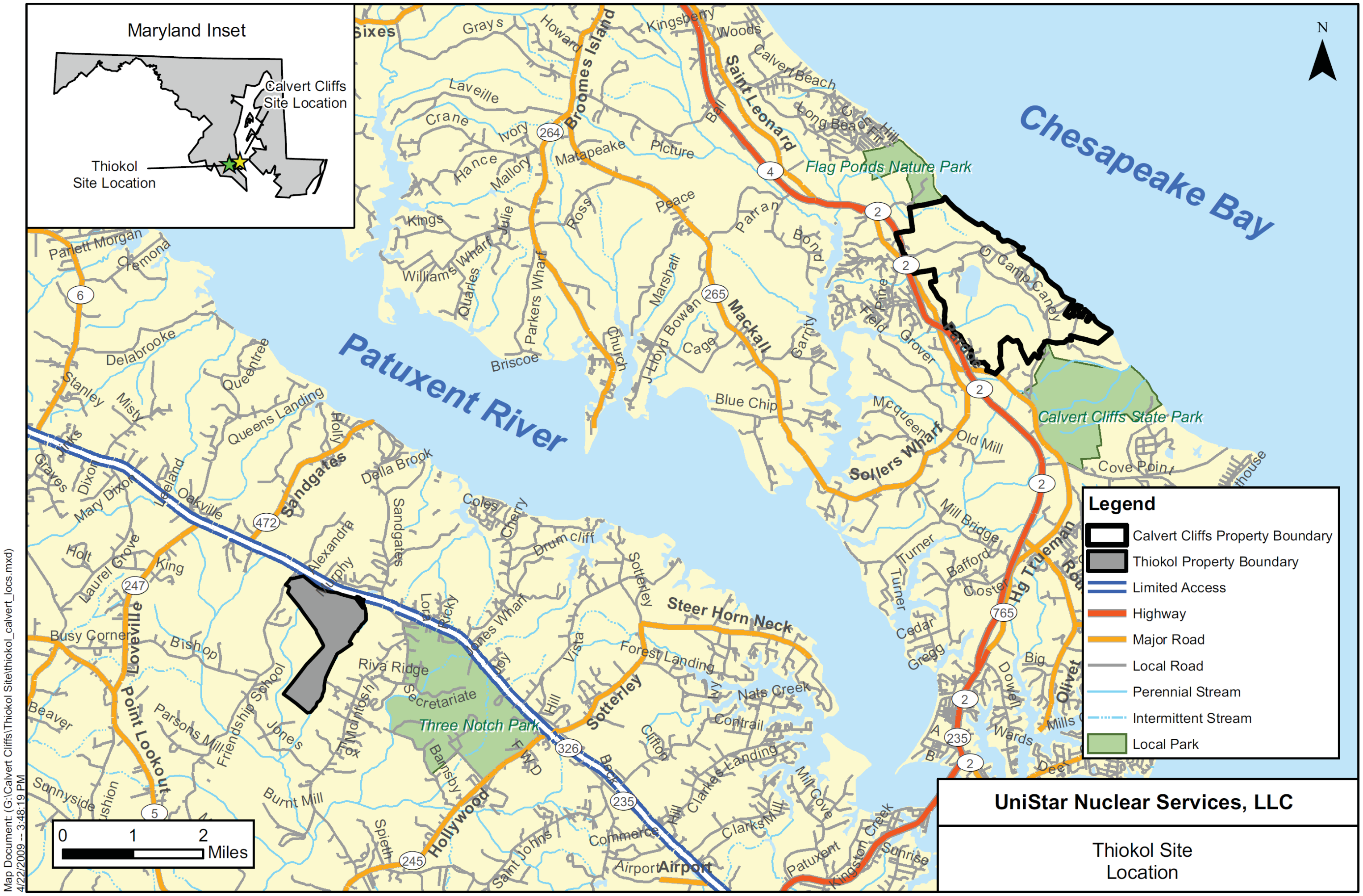

Figure 9-11. Thiokol Site Location (UniStar 2009a)

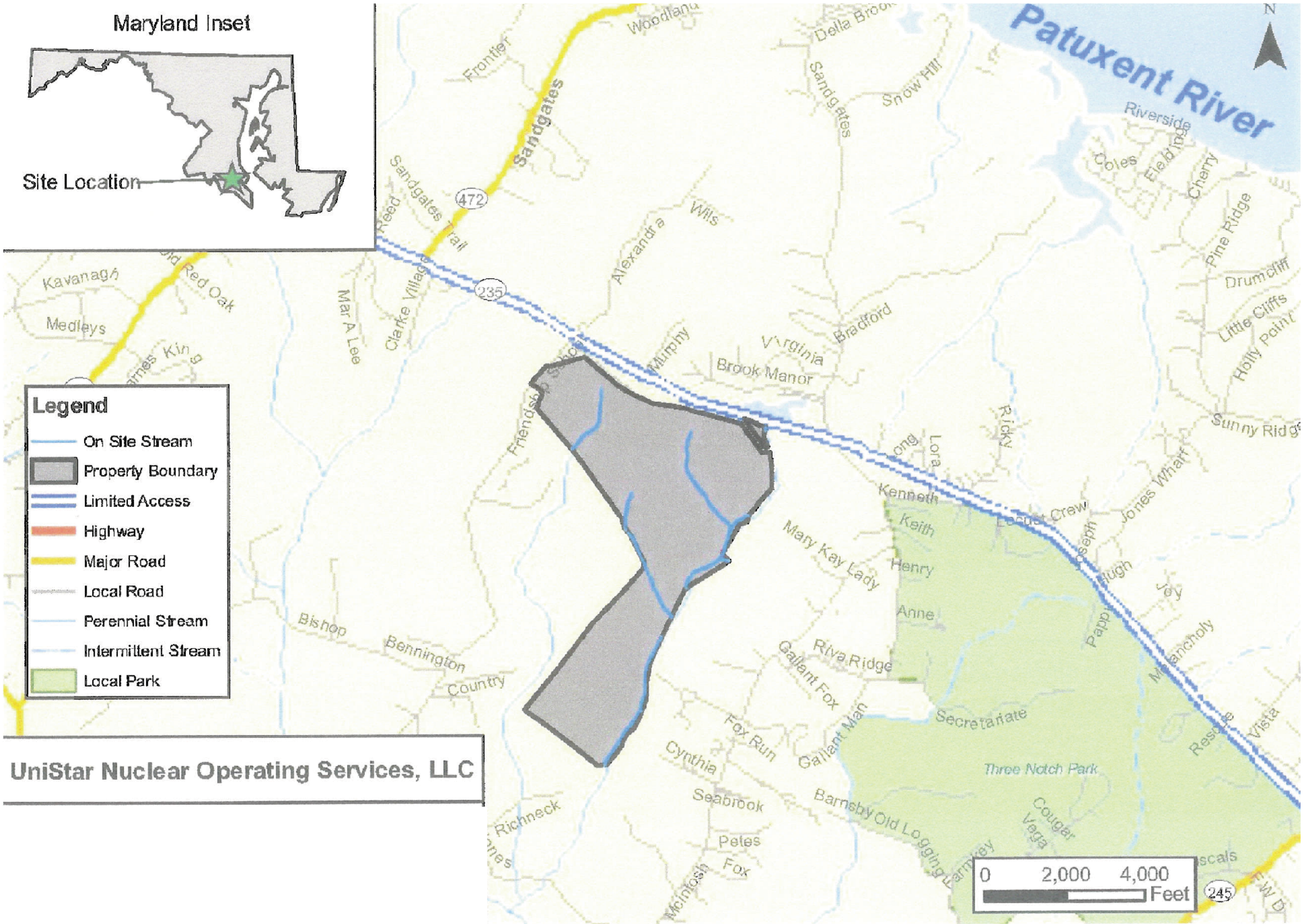

Figure 9-12. Thiokol Site and Surrounding Area (UniStar 2009a)

The explosives were classified as "combat safe," meaning they would not explode from shock, hammer, or bullet impact. During the cleanup phases, there was no evidence of live rounds or rounds outside of the suspected areas. In addition, no accidents occurred for explosives removal during any cleanup, suggesting that the level of hazard posed by any previously unrecovered explosive material is low.

Most of the site has been disturbed, much of it to 4 ft, but it has since been reforested. Future property use has been designated as mixed residential and commercial (MDE 2007). The property contains covenants that restrict residential development, educational facilities, and day care in two areas totaling approximately 67 ac because of the possible presence of unexploded ordnances (UniStar 2009a). The site is currently being monitored by the MDE Land Restoration Program.

The area surrounding the Thiokol site is a mix of suburbs, agriculture, military installation, and parks. Land north and east of the site contains low-density residential development. Land west of the site is a mix of low-density residential development and agriculture. The area south of the site is generally undeveloped, but contains some low-density residential development (UniStar 2009a). The Patuxent River Naval Air Station (approximately 6500 ac) is about 10 mi southeast of the Thiokol site in St. Mary's County, and the Dominion Cove Point liquefied natural gas (LNG) import facility (a little over 100 ac of industrial land use) is about 10 mi northeast of the Thiokol site in Calvert County (DOD 2010; Dominion 2009). In addition, the Thiokol sites abuts or is very close to land and water portions of the Potomac Heritage National Scenic Trail, the Star-Spangled Banner National Historic Trail, and the Captain John Smith Chesapeake National Historic Trail (NPS 2010a, b, c). The National Park Service is still developing portions of the Star-Spangled Banner National Historic Trail and the Captain John Smith Chesapeake National Historic Trail. Otherwise, the nearest dedicated land (Federal, State, or Tribal) is Greenwell State Park located approximately 8 mi southeast of the Thiokol site. Therefore, the addition of a nuclear reactor at the Thiokol site would noticeably alter the land use to include industrial area.

If the proposed project were sited at the Thiokol site, some upland hardwood forest would be lost. In addition, some offsite land would likely be affected to bring water for cooling to the site from the Patuxent River, which is approximately 3 mi north of the site. UniStar estimates that approximately 25 ac would be affected by the water pipeline corridor and associated structures (UniStar 2009b).

There are no existing transmission corridors connecting to the Thiokol site. One or more transmission corridors would be needed to connect to an existing 500-kV transmission line located approximately 2 mi southeast of the site (UniStar 2009b). The corridor(s) would pass through areas that are mostly rural with low population densities. Farmlands that would become part of a corridor could generally continue to be farmed (UniStar 2008b).

Cumulative Impacts

For this cumulative land use analysis, the geographic area of interest is the 15-mi region surrounding the Thiokol site. This geographic area of interest includes the primary communities (Leonardtown, Lexington Park, and Solomons) that would be affected by the proposed project if it were located at the Thiokol site.

The project with the greatest potential for affecting land use in the geographic area of interest would be the Mid-Atlantic Power Pathway (MAPP) transmission line project. The MAPP project is discussed in Section 7.1. Because the transmission line would be built in an existing corridor within the geographic area of interest, it would have limited impact on land use. Some of the other projects identified in Table 9-10 have or would contribute to decreases in open lands, wetlands, and forested areas and generally result in increased urbanization and industrialization consistent with applicable land-use plans and control policies. In addition, GCC could increase precipitation, sea level, storm surges, and flooding events in the area of interest (GCRP 2009), thus changing land use through inundation of low-lying areas and river shoreline. Forest growth may increase as a result of more carbon dioxide in the atmosphere (GCRP 2009). Existing parks, reserves, and managed areas would help preserve open lands, wetlands, and forested areas to the extent that they are not affected by the same factors. In addition, GCC could reduce crop yields and livestock productivity (GCRP 2009), which might change portions of agricultural land uses in the area of interest. Direct changes resulting from GCC could cause a shift in land use in the geographic area of interest.

Based on the information provided by UniStar and the review team's independent evaluation, the review team concludes that the cumulative land-use impacts of building and operating a new nuclear generating unit and its associated transmission lines at the Thiokol site would be SMALL to MODERATE. Building and operating a new nuclear unit at the Thiokol site would be a significant contributor to these impacts.

9.3.5.2 Water Use and Quality

Water for the Thiokol site would be obtained primarily from the Patuxent River. According to UniStar (2009a), the proposed plant would require the withdrawal of about 50 MGD for cooling and other uses. Of that total, about 27 MGD would be consumed, and the remainder would be discharged back to the Patuxent River. UniStar (2008b) states that the plant would use closed-cycle cooling with a cooling tower. The plant would have separate intake and discharge structures in the Patuxent River. Discharge water would include cooling tower blowdown, treated process wastewater, treated sanitary wastewater, and some radioactive water. The discharge would be at an elevated temperature relative to the temperature of the Patuxent River.

The site is about 3 mi southwest of the western Patuxent River shoreline and located along the western side of a watershed divide that is nominally aligned with MD State Route 235. The site is drained by Rich Neck Creek and Tom Swamp Run, both of which flow to the west toward Breton Bay on the Potomac River (MDNR 2002a). Regionally, groundwater is pumped primarily from the Aquia aquifer for a variety of uses, including municipal water supplies (MDNR 2002a).

According to UniStar (2008b), the Thiokol site would require significant alterations, including grading and watershed surface revision; building of roads, piers, jetties, and water intake and discharge structures; and dredging in the Patuxent River. Development of the intake/discharge pipes would affect the 3-mi stretch from the site to the river, and it would affect the river bed in the vicinity of the intake and discharge structures. Because of the distance to the water source, UniStar (2008b) would need to construct an onsite impoundment to provide a secure UHS. UniStar estimates that the area and depth would be approximately 4.7 ac and 25 ft, respectively (UniStar 2009a).

The average monthly flow of the Patuxent River measured about 60 mi upstream of the Thiokol site (USGS Station No.01594440 at Bowie, Maryland) is about 384.4 cfs (170,000 gpm) (USGS 2008). Between 1977 and 2007, flow in individual months ranged from 65.2 to 1358 cfs (29,262 and 609,470 gpm). Given that additional flow enters the river downstream of the measurement location and the Patuxent River is a tidal system in the vicinity of the Thiokol site, the water consumed by the plant will be minor with respect to the existing resource.

The Chalk Point Generating Station is a non-nuclear facility located on the Patuxent River about 10 mi north of the potential location for an intake structure for the Thiokol plant. Chalk Point has two once-through cooling units and two closed-cycle units (MDNR PPRP 2008). Water withdrawal in 2006 was approximately 419,400 gpm, or 604 MGD (MDNR PPRP 2008). Total water withdrawal by the Thiokol plant would be less than 10 percent of the withdrawal by the Chalk River Generating Plant. Given the small amount of withdrawal at the Thiokol site relative to the Chalk River Generating Plant and the small amount of water consumed relative to the existing resource in the tidal portion of the Patuxent River, the review team concludes that the hydrological alterations to the Patuxent River from plant operations would be minor.

UniStar (2009a) would temporarily need water for building, but the source and quantity of water are not known. If surface water or groundwater is used, permits would be required and the permitting process would ensure no adverse impacts from this limited and temporary withdrawal of water.

Water quality alterations to both the surface water and groundwater would be regulated by NPDES discharge and stormwater permits. BMPs would prevent or mitigate spills from altering surface or groundwater resource’s quality. The nutrient load from the plant’s sanitary effluent system would be a minor contribution to the Patuxent River’s cumulative nutrient load.

Building activities, including surface alterations and dewatering, have the potential to affect the local hydrology significantly because the available surface water and surficial aquifer resources are small; however, impacts would be temporary and localized. Groundwater from deeper aquifers would not be affected.

Based on the information provided by UniStar and the review team's independent evaluation, the review team concludes that, although the local hydrology would be altered, the impacts on the regional surface water and groundwater resources of constructing and operating a nuclear generating unit at the Thiokol site would be minor.

Cumulative Impacts

For the cumulative analysis of impacts on surface water, the geographic area of interest for the Thiokol site is the drainage basin of the Patuxent River upstream and downstream of the site and the portion of Chesapeake Bay near the outlet of the Patuxent River because this is the resource that would be impacted by the proposed project if it were sited at the Thiokol site. Key actions that have past, present, and future potential impacts to water supply and water quality in the Patuxent River basin include the operation of the Chalk Point Generating Station and other municipal and industrial activities in the Patuxent River basin. For the cumulative analysis of impacts on groundwater, the geographic area of interest is the extent within St. Mary's County of the confined aquifers beneath the site.

<u>Water Use</u>. The surface water-use impacts of building and operating a nuclear power plant at this site are dominated by the demands that would occur under normal operation. The consumptive water use of the plant is projected to be about 42 cfs, which would be approximately 11 percent of the average river discharge reported at the nearest gauge upstream on the Patuxent River. However, the intake would be located in the tidal portion of the Patuxent River, so water would controlled by the water level in the Chesapeake Bay. Based on the small volume of water consumed relative to the Bay's water volume and the Bay's freshwater inflow, the review team concludes the impact of withdrawing surface water to operate a nuclear unit at the Thiokol site would be SMALL.

The review team determined that the consumptive use of surface water by the operation of a nuclear reactor at the Thiokol site (surface water would not be used for building activities) would remain undetectable within the geographic area of interest. In the Chesapeake Bay, the predominant surface water user within a 20-mi radius of the Calvert Cliffs site is CCNPP Units 1 and 2, but that withdrawal is not consumptive and does not impact surface water availability in the Patuxent River basin. The Chalk Point Generating Station, currently the largest power plant in Maryland, is a fossil fuel facility located on the Patuxent River about 15 mi upstream of the Thiokol site. Chalk Point is near the center of the Patuxent River estuary and experiences large tidal exchanges. The mean tidal range is about 1.6 ft and the maximum flood and ebb currents in mid-channel are about 1.0 and 1.25 ft per second.

The review team determined the consumptive use of water by the operation of a nuclear reactor at the Thiokol site and all other consumptive uses (existing or likely future uses) within the geographic area of interest could not alter the volume of water in the Patuxent River in the vicinity of the Thiokol site. Based on its evaluation, the review team concludes that the cumulative impacts to surface water would be SMALL.

The review team is also aware of the potential climate changes that could affect the water resources available for cooling and the impacts of reactor operations on water resources for other users. The impact of climate change on the water available at the Thiokol site would be minor because of the availability of water from Chesapeake Bay.

Increases in consumptive use of water in the Patuxent River drainage is anticipated in the future. The impacts of the other operational projects listed in Table 9-10 are considered in the analysis included above or would have little or no impact on surface water use.

As indicated, groundwater could be used temporarily as a water source for building needs at the Thiokol site. Given the high yields of the aquifers in this region, no significant impact is anticipated to regional users of groundwater. Regionally, the potentiometric surfaces in the Piney Point-Nanjemoy and Aquia aquifers have been declining due to increases in regional groundwater withdrawals. Because of the declining trend in groundwater potentiometric surfaces, the review team determined that the cumulative impact is MODERATE. Building and operating a new nuclear unit at the Thiokol site would not be a significant contributor to these impacts.

Water Quality. Point and non-point pollution sources have impacted the water quality of the Patuxent River upstream and downstream of the site and the Chesapeake Bay at the mouth of the Patuxent River. Although nutrient loads have impaired the ability to support biota, they have not impaired water quality in a manner that limits the ability of the River and Bay to support other functions, including serving as a supply of cooling water. Based on its evaluation, the review team concludes that the cumulative surface water quality impacts would be SMALL.

There are no reports of water quality issues in the regional Aquia aquifer, which is the primary aquifer in the region. There are no known contaminant plumes in the Aquia aquifer in the vicinity of the Thiokol site that might be affected by groundwater withdrawals at the site. The MDE regulates groundwater withdrawal rates in all aquifers to ensure aquifer stability and water quality. Because (1) there is no evidence of a decrease in groundwater quality as a result of the regional use of groundwater, (2) there are no known contaminant plumes, and (3) there would be no discharges to groundwater, the review team concludes that the cumulative groundwater quality impacts would be SMALL.

9.3.5.3 Terrestrial and Wetland Resources

St. Mary's County, where the Thiokol site is located, is a mix of forest, agriculture, and residential development. Most of the Thiokol site has been previously disturbed. Industrial use occurred on a portion of the site, and, during the 1980s, much of the forest was harvested. The site is currently dominated by upland hardwood forest similar to the Mixed Deciduous Regeneration Forest found on the Calvert Cliffs site. Common tree species present include Virginia pine (*Pinus virginiana*), tulip poplar, sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), white ash (*Fraxinus americana*), quaking aspen (*Populus tremuloides*), and oaks. Some bottomland deciduous forest may be found in lowlands, likely containing more red maple and sweetgum than upland sites. Small Virginia pine stands are also present. Although harvested, forest regrowth with limited development or fragmentation has resulted in a relatively large patch of unfragmented forest that provides suitable habitat for forest interior-dwelling species (FIDS). This suite of species has been identified as ecologically important in the region as discussed in Section 2.4.1 for the Calvert Cliffs site (CAC 2000).

Wetlands have not been delineated at the Thiokol site, but National Wetland Inventory data maintained by the U.S. Fish and Wildlife Service (FWS) indicates that approximately 49 ac of forested wetlands and about 14,400 linear ft of stream channel are present (UniStar 2009c) (Figure 9-13). Most wetlands are associated with Rich Neck Creek and Tom Swamp Run that generally flow southward. Parts of both stream systems are intermittent.

No formal biota sampling has been conducted at or around the Thiokol site. Flora and fauna inhabiting Thiokol are expected to be representative of those found regionally within similar habitat types. Fauna inhabiting the site would include those common to upland and lowland forests in the region. The FWS does not list any Federally threatened or endangered or candidate species as occurring in St. Mary's County, Maryland. However, the State of Maryland lists the northeastern beach tiger beetle as a Federally listed species that has been found in the county. It is highly unlikely this beetle would occur as no suitable habitat exists on the Thiokol site for this species, although suitable habitat may occur along the nearby Patuxent River.

In addition, the Maryland DNR Natural Heritage Program's list of rare, threatened, and endangered species for St. Mary's County, Maryland, contains four terrestrial wildlife and 19 terrestrial plant species (Table 9-11). The sedge wren (*Cistothorus platensis)* is also unlikely to occur, as stands of tall, dense sedges that it prefers (Cornell Lab of Ornithology 2009) are not present on the site. These habitats may be present where water intake structures could be placed. The eastern narrow-mouthed toad (*Gastrophryne carolinensis)* breeds in still or very slow-moving water and may use both temporary and permanent water sources (NatureServe 2007). This species also uses a variety of upland habitats, including those available on the Thiokol site and in the vicinity. Bald eagles prefer to nest in forested habitat near open water and likely occur along the Patuxent River. The least tern (*Sternula antillarum)* nests on open, sandy beaches (Thompson et al. 1997). This habitat is not found on the Thiokol site and was not observed along the Patuxent River in the vicinity of the site during the NRC staff's visit. The distribution and abundance of the 19 State-listed plants within St. Mary's County and within the Thiokol site is unknown. Most occur exclusively in various wetland habitats. Wetland habitats are somewhat limited on the Thiokol site, and the occurrence of many of these species may also be limited.

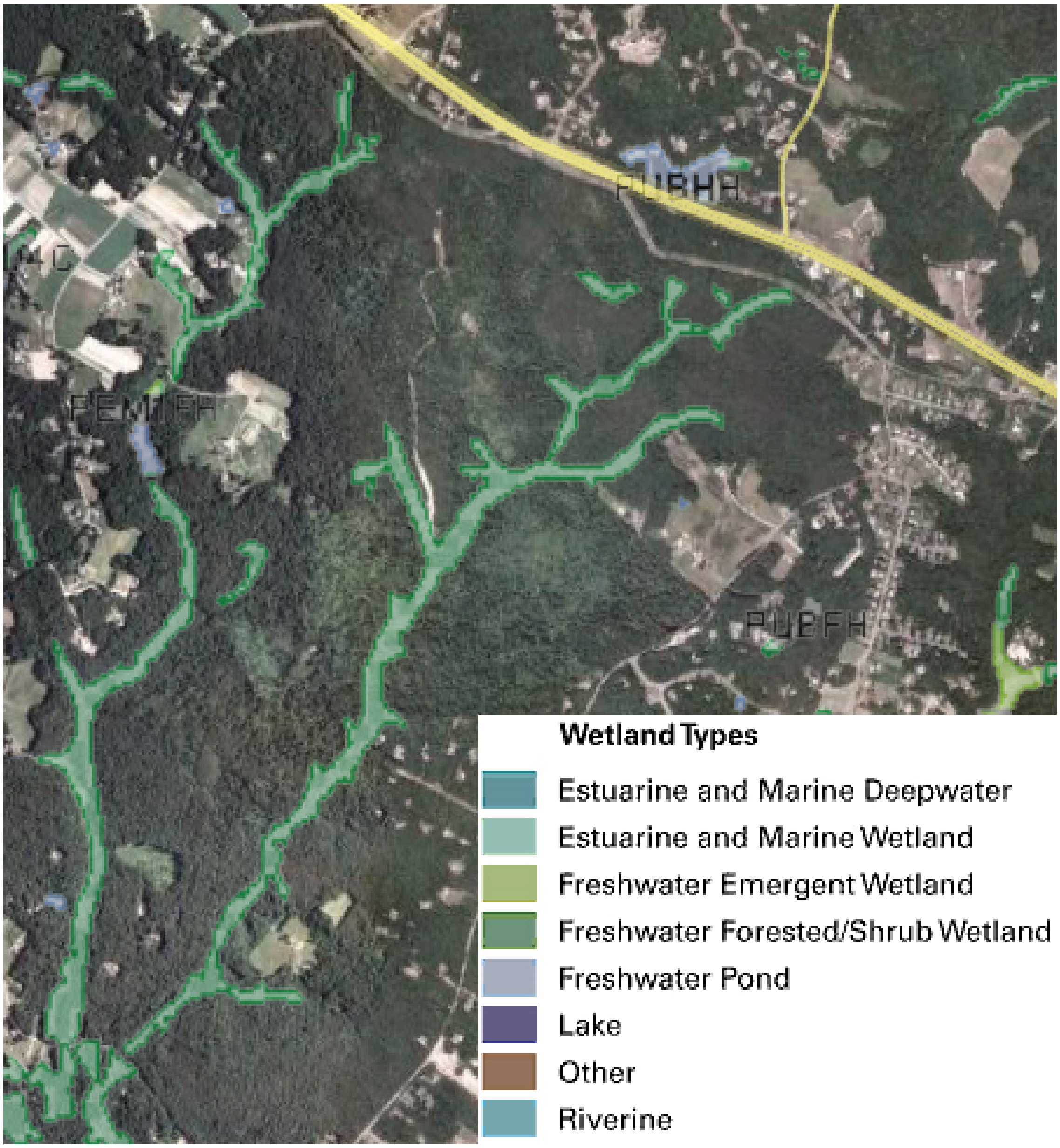

Figure 9-13. Distribution and Abundance of Wetlands Documented by the National Wetlands Inventory as Occurring On and Around the Thiokol Site (FWS 2008a)

Table 9-11. Federally and State-Listed Terrestrial Species that Occur in St. Mary's County and May Occur on the Thiokol Site or in the Immediate Vicinity (MDNR 2007c)

Scientific Name	Common Name	Federal Status	State Status
Cicendela dorsalis dorsalis	Northeastern Beach Tiger Beetle	Threatened	Endangered
Cistothorus platensis	Sedge Wren		Endangered
Gastrophryne carolinensis	Eastern Narrow-mouthed Toad		Endangered
Haliaeetus leucocephalus	Bald Eagle		Threatened
Sternula antillarum	Least Tern		Threatened
Arnica acaulis	Leopard's-bane		Endangered
Carex buxbaumii	Buxbaum's Sedge		Threatened
Carex venusta	Dark Green Sedge		Threatened
Chelone obliqua	Red Turtlehead		Threatened
Desmodium pauciflorum	Few-flowered Tick-trefoil		Endangered
Drosera capillaris	Pink Sundew		Endangered
Eleocharis albida	White Spikerush		Threatened
Elephantopus tomentosus	Tobaccoweed		Endangered
Gratiola viscidula	Short's Hedge-hyssop		Endangered
Iris prismatica	Slender Blue Flag		Endangered
Kyllinga pumila	Thin-leaved Flatsedge		Endangered
Linum intercursum	Sandplain Flax		Threatened
Polygonum glaucum	Seaside Knotweed		Endangered
Prunus maritima	Beach Plum		Endangered
Sarracenia purpurea	Northern Pitcher-plant		Threatened
Symphyotrichum concolor	Silvery Aster		Endangered
Torreyochloa pallida	Pale Mannagrass		Endangered
Trachelospermum difforme	Climbing Dogbane		Endangered
Utricularia inflata	Swollen Bladderwort		Endangered

Species identified by UniStar as ecologically important at the Thiokol site include mountain laurel, tulip poplar, chestnut oak, and New York fern (UniStar 2009a). As with the Calvert Cliffs site and the other alternative sites, these species are likely widespread and abundant in suitable habitat. Forest cover on the Thiokol site is fairly contiguous, providing interior forest that may contain FIDS. The recreationally important white-tail deer, wild turkey, and northern bobwhite are also likely present as habitat appears suitable.

Building and Operational Impacts

Although the placement of the project footprint has not been specified on this site, approximately 420 ac would be affected by building a nuclear unit. Virtually the entire site is currently undeveloped and covered in forest. The forest appears contiguous and represents moderately valuable wildlife habitat, but most forest stands exist in an intermediate seral stage, thereby limiting their value to some species. Development and operation of a new nuclear unit would likely result in the loss of wildlife habitats including wetlands and forest. Clearing of forest would result in fragmentation and habitat loss for FIDS. In addition, the installation of a 3-mi-long water intake pipeline and building of a 2-mi, 500-kV transmission corridor would increase the overall project footprint and likely affect other habitats and wetlands. Approximately 61.5 ac of wetlands would be permanently affected during building of the plant, intake pipeline, and transmission corridor (UniStar 2009a). Many of the listed species are not likely present at the site or in the vicinity, and impacts to these species would be limited. Eastern narrow-mouthed toads may be present, and individuals and habitat would be lost, but the extent cannot be determined. Bald eagles may lose habitat or be displaced by building-related activities, especially near the Patuxent River. Impacts to State-listed plants may also occur, but the extent of impacts on these 19 plants cannot be determined. Wetlands are limited in distribution on the site, so impacts to State-listed wetland plants could also be limited. Individual mountain laurel, tulip poplar, chestnut oak, and New York fern plants would likely be lost, but populations are not expected to be destabilized. White-tailed deer, wild turkey, and northern bobwhite would also lose habitat during land clearing, but these species could benefit from disturbance and subsequent revegetation on the site as well as the maintenance of open habitats during operation.

Terrestrial ecological impacts that may result from operation of a new nuclear unit at the Thiokol alternative site include those associated with the cooling system, transmission system structures, and maintenance of transmission line corridors. For impacts related to cooling system operations, the review team assumed the same type of cooling tower proposed for Unit 3 at the Calvert Cliffs site would be used at each of the alternative sites. In NUREG-1437 (NRC 1996), the NRC staff evaluated terrestrial ecological impacts resulting from operation of existing nuclear power plants and transmission line operation and maintenance. The types of terrestrial ecological impacts resulting from operation of a new nuclear unit would be similar to those of existing nuclear power plants. When more specific information was not available, conclusions in the NUREG-1437 (NRC 1996) were used to assess terrestrial impacts resulting from the operation of the cooling tower and impacts from transmission line corridor maintenance and operation. Similarly, the effects of cooling tower drift, avian collisions, noise, and transmission lines would be similar to those described in Section 5.3.1.1 in which the operational impacts were determined to be undetectable at the population level.

Cooling Towers

The operation of a cooling tower results in the loss of water through evaporative loss and drift. Drift is described as small, unevaporated water droplets that are exhausted out the top of the tower. These droplets may carry minerals, debris, microorganisms, and chemicals that may affect crops, ornamental vegetation, and native plants. Adverse impacts from cooling tower drift cannot be evaluated in detail without knowing the specific location of the cooling tower at each alternative site. However, general guidelines for predicting effects of drift deposition on plants suggest that many species have thresholds for visible leaf damage in the range of 9 to 18 lb/ac/mo of salt deposition on leaves during the growing season (NRC 1996). The Unit 3 cooling tower at Calvert Cliffs, which includes plume abatement, would be drawing salt/brackish water for cooling from the Chesapeake Bay through a desalination facility. Thiokol would use brackish cooling water from the Patuxent River. Because the maximum deposition for the proposed unit is far below the level that could cause leaf damage in many common species, the impacts would be negligible both on the Thiokol site and in the vicinity. In general, the impacts of drift on crops, ornamental vegetation, and native plants were evaluated for existing nuclear power plants and found to be of minor significance (NRC 1996).

Similarly, detailed mortality from bird collisions with cooling towers depend on factors such as height, location, and lighting at the Thiokol site. The impacts of bird collisions for existing power plants were evaluated and found to be of minor significance for all operating nuclear plants, including those with various numbers and types of cooling towers (NRC 1996). On this basis, the review team concludes, for the purpose of comparing the alternative sites, that the impacts of bird collisions with cooling towers resulting from operation of a new nuclear unit at Thiokol would be minor.

Typical noise levels that can be expected at a distance of 1300 ft from the cooling tower are 65 dBA (UniStar 2009a). Noise from plant operation would also be quickly attenuated by surrounding forest cover, further limiting any impact to wildlife. Local wildlife would likely adapt to noise levels, while cooling tower noise may also serve to limit the potential for avian collision. Consequently, the review team concludes the impacts of cooling tower noise on wildlife would be minimal at Thiokol.

Transmission Lines

The impacts associated with transmission line operation consist of bird collisions with transmission lines and EMF effects on flora and fauna. The impacts associated with building transmission lines and corridor maintenance activities are alteration and/or conversion of habitat due to cutting and herbicide application and similar related impacts, such as temporary matting, where corridors cross floodplains, wetlands, and other important habitats.

Direct mortality resulting from birds colliding with tall structures has been observed (Avatar 2004). Factors that appear to influence the rate of avian impacts with structures are diverse and related to bird behavior, structure attributes, and weather. Migratory flight by flocking birds during darkness has contributed to the largest mortality events. Tower height, location, configuration, and lighting also appear to play a role in avian mortality. Weather, such as low cloud ceilings, advancing fronts, and fog also contribute to this phenomenon. Waterfowl may be particularly vulnerable due to low, fast flight and flocking behavior (Brown 1993). However, in NUREG-1437, the NRC staff concluded that the threat of avian collision as a biologically significant source of mortality is very low as only a small fraction of total bird mortality could be attributed to collision with nuclear power plant structures, including transmission corridors with multiple transmission lines (NRC 1996). Although collision may contribute to local losses, thriving bird populations can withstand these losses without threat to their existence (Brown 1993). Although additional transmission lines would be required for a new nuclear unit at Thiokol, increases in bird collisions would be minor, and these would likely not be expected to cause a measurable reduction in local bird populations. Consequently, the incremental direct mortality posed by the addition of new transmission lines for a new nuclear unit would be negligible at Thiokol.

EMFs are unlike other agents that have an adverse impact (e.g., toxic chemicals and ionizing radiation) in that dramatic acute effects cannot be demonstrated and long-term effects, if they exist, are subtle (NRC 1996). A careful review of biological and physical studies of EMFs did not reveal consistent evidence linking harmful effects with field exposures (NRC 1996). The impacts of EMFs on terrestrial flora and fauna are of small significance at operating nuclear power plants, including transmission systems with variable numbers of power lines and lines energized at levels less than 765 kV (NRC 1996). Since 1997, more than a dozen studies have been published that looked at cancer in animals exposed to EMFs for all or most of their lives (Moulder 2003). These studies have found no evidence that EMFs cause any specific types of cancer in rats or mice (Moulder 2003). Therefore, the incremental EMF impact posed by operation of existing transmission lines and the addition of lines for a new nuclear unit would be negligible at the Thiokol alternative site.

Existing roads providing access to the existing transmission line corridors at Thiokol would likely be sufficient for use in any expanded corridors; however, new roads would be required during the development of new transmission line corridors. Transmission line corridor management activities (cutting and herbicide application) and related impacts to floodplains and wetlands in transmission line corridors are of minor significance at operating nuclear power plants, including those with transmission line corridors of variable widths (NRC 1996). Consequently, the incremental effects of transmission line corridor maintenance and associated impacts to floodplains and wetlands for a new nuclear unit would be negligible at the Thiokol alternative site.

Cumulative Impacts

The geographic area of interest for the assessment of the potential cumulative impacts of building a new reactor at the Thiokol site on terrestrial resources and wetlands is defined as St. Mary's County, Maryland, because the extent of terrestrial impacts is mostly localized and the site is several miles from neighboring counties with the exception of Calvert County, which is closer but on the other side of the Patuxent River, which is a natural barrier isolating most terrestrial impacts. No major development activities are proposed that would significantly contribute to the loss or degradation of terrestrial resources or wetlands within the foreseeable future in St. Mary's County. Like at the Calvert Cliffs site, building a power plant at this site would require the removal of relatively intact, albeit early-successional, forest cover. Unlike the Calvert Cliffs site, the Thiokol site is not located within the Chesapeake Bay Critical Area (CBCA), but removal of forest cover would still contribute to cumulative forest fragmentation within St. Mary's County and the surrounding region.

Continued urbanization and GCC have the potential to alter and reduce the amount of terrestrial habitat and wetlands available to flora and fauna. Urbanization within the region has been identified as a contributing factor to forest fragmentation. GCC effects near the Thiokol site would result in regional increases in the frequency of severe weather, in annual precipitation, and in average temperature (GCRP 2009). Such factors would affect the terrestrial resources in the geographic area of interest through reduced open lands and wetlands as a result of inundation of low-lying areas and river shoreline. Forest growth may increase as a result of more carbon dioxide in the atmosphere (GCRP 2009). The impacts of GCC on plants and wildlife in the geographic area of interest are not precisely known. Changes in climate could alter and fragment key terrestrial habitats and result in substantial northward shifts in species' ranges, diversity, and abundance in the geographic area of interest for the Thiokol site (GCRP 2009).

Building and operation of a new nuclear unit would likely result in the loss of important plants, wildlife, and wildlife habitats including a large extent of interior forest. Based on the information provided by UniStar and the review team's independent evaluation, the review team concludes the cumulative impacts on terrestrial and wetland resources of building and operation of a new nuclear unit at the Thiokol site and other past, present, and reasonably foreseeable projects would be SMALL to MODERATE. Building and operating the new unit would be a significant contributor to these impacts.

9.3.5.4 Aquatic Resources

The following impact analysis includes impacts from building activities and operations on aquatic ecology resources. The Thiokol site is located about 3 mi from the western shore of the Patuxent River, which is the largest and most important aquatic resource in the vicinity. The Thiokol site is located within the Breton Bay watershed, which is part of the Lower Potomac

River watershed. The location of the cooling water intake and discharge facilities would be in the Lower Patuxent River watershed, which provides migratory habitat for anadroumous species and provides foraging and nursery habitat, including EFH, for commercially important estuarine species.

Other aquatic resources on the Thiokol site include two small streams, Rich Neck Creek and Tom Swamp Run, that flow south and southwest through the property (MDE 2007). The two streams drain about 2565 ac within the Breton Bay watershed and join with Burnt Mill Creek to flow into McIntosh Run that empties into Breton Bay, which is a tidal bay on the Potomac River (MDNR 2002a). About 620 ac of the streams' area is listed as highly erodible. Tom Swamp Run has a small channel and intermittent flow. Rich Neck Creek is larger and probably perennial, but quite shallow. Flow in both likely depends on storms. Most of the length of each stream is within the Maryland's Sensitive Species Project Review Area within the Breton Bay watershed (MDNR 2002a). The sensitive species area also includes most of Burnt Mill Creek and McIntosh Run. McIntosh Run provides important habitat for the Federally endangered dwarf wedgemussel (*Alasmidonta heterodon*), which is described later in this section. The lower reaches of Rich Neck Creek and Tom Swamp Run were included in the Maryland DNR nutrient synoptic survey conducted in April 2002 (MDNR 2002b). Characterization of the benthic invertebrate communities in the streams resulted in Benthic Index of Biotic Integrity (B-IBI) scores of 4.14, which the State rates as "good" (MDNR 2002b). The two onsite streams likely provide habitat for female American eels and are upstream of yellow perch (*Perca flavescens*) and white perch (*Morone americana*) spawning areas (NMFS 2009).

The potential for impacts from building and operating a nuclear generating unit at Thiokol to aquatic biota would be primarily to organisms inhabiting Rich Neck Creek, Tom Swamp Run, and the Patuxent River.

Commercially or Recreationally Important Species

The important commercial or recreational species in the Patuxent River are generally among those included in the Chesapeake Bay. These are described in Section 2.4.2. One important commercial species is the eastern oyster (*Crassostrea virginica*). The Patuxent River has many historical and current oyster beds, including Natural Oyster Bars that stretch about 5.5 mi along the western shore where the new intake and discharge systems would likely be located (MDNR 2003b, MDNR 2009h). The Maryland DNR is considering at least two areas in the Patuxent River that are near the Thiokol site as potential oyster Aquaculture Enterprise Zones designed to help restore oyster populations in the Bay (MDNR 2009f).

The lower Patuxent watershed contains spawning and nursery areas for several anadromous fish species, including striped bass (*Morone saxatilis*), river herring (*Alosa* spp.), white perch, and yellow perch (MDNR 2003b; NMFS 2009). The area where the cooling water intake pipes would likely be located is downstream from the spawning areas but is within the migratory path of these fish (NMFS 2009).

Non-Native and Nuisance Species

The non-native and nuisance species most likely occurring in the Patuxent River include species such as those listed for the Chesapeake Bay near the Calvert Cliffs site. Potential invasive estuarine invertebrate species of concern that eventually may occur in the Patuxent River are the green crab (*Carcinus maenas*) and the Chinese mitten crab (*Eriocheir sinensis*) (see Section 2.4.2). *Pfiesteria* (*Pfiesteria piscicida*) is a nuisance dinoflagellate algal species known to produce toxins. *Pfiesteria* is most commonly found low in the water column and close to bottom sediments but is not yet known in the Patuxent River (Bowers et al. 2006). Other potential nuisance species are sea nettles (*Chrysaora quinquecirrha*) and comb jellies (*Mnemiopsis leidyi*, *Beroe ovata*) (see Section 2.4.2).

Federally and State-Listed Species

Federally listed species that may occur in the Patuxent River include the shortnose sturgeon, loggerhead turtle (*Caretta caretta*), and Kemp's ridley turtle (*Lepidochelys kempii*). Federally listed species of concern that may occur in the river include the Atlantic sturgeon (*Acipenser oxyrinchus*), alewife, and blueback herring. Two other endangered marine turtles, the green turtle (*Chelonia mydas*) and the leatherback turtle (*Dermochelys coriacea*), may occur in Chesapeake Bay, but usually stay in the lower part of the Bay. These Federally protected species are discussed in Section 2.4.2.

One Federally endangered species, the dwarf wedgemussel, occurs in a creek near the Thiokol site (FWS 2007). This species is also listed as endangered by the State of Maryland (MDNR 2007f). No critical habitat has been designated by the FWS or NMFS in the vicinity of the Thiokol site.

State-listed aquatic plants in St. Mary's County include the swollen bladderwort (*Utricularia inflata*) and the claspingleaf pondweed (*Potamogeton perfoliatus*) (MDNR 2007f). State-listed aquatic animals, in addition to the dwarf wedgemussel, listed for St. Mary's County that may occur near the Thiokol site include the Atlantic spike, the comely shiner, the flier (*Centrarchus macropterus*), and the ironcolor shiner (*Notropis chalybaeus*) (MDNR 2007f). The spotfin killifish (*Fundulus luciae*) is listed by the State of Maryland as State "Rare(?)" (uncertain), and the white catfish (*Ameiurus catus*) is listed as State uncertain (possibly rare). The spotfin killifish is discussed in Section 2.4.2.

<u>Swollen Bladderwort (*Utricularia inflata*)</u>. The swollen bladderwort is a rootless, perennial aquatic plant that floats just above the bottom sediment (Urban et al. 2006). The species occurs

from Texas to New York and is an introduced species in Washington State (USDA 2008a). It is endangered in several states, including Maryland. Bladderworts are carnivorous, trapping prey with a suction trap comprised of a hollow bladder that has negative internal pressure and is anoxic (Peroutka et al. 2008). A recent study showed that microscopic algae are included in the bladderwort diet (Peroutka et al. 2008). Bladderworts typically inhabit small lakes and ponds.

<u>Claspingleaf Pondweed (*Potamogeton perfoliatus*)</u>. The claspingleaf pondweed is distributed primarily in northeastern North America with a scattered occurrence across the southeastern United States (USDA 2008b). It is listed as State rare in Maryland. This species is found in brackish (oligohaline to mesohaline waters) within the Chesapeake Bay (Brush and Hilgartner 2000). Its occurrence in the Patuxent River is uncertain because no seeds were found in sediment cores that were dated from the early 1700s to the late 1980s, and plants were not seen in the river during the core collections in 1987 (Brush and Hilgartner 2000).

<u>Dwarf Wedgemussel (*Alasmidonta heterodon*)</u>. The dwarf wedgemussel is a small freshwater clam that reaches a length of about 1.5 in. (FWS 2005). These mussels live in clear-water creeks and streams that have firm sand, clay, or gravel substrates. Mussel survival depends on the streams being silt free, having stable substrates, and having high dissolved oxygen content. The reproductive biology of the species involves the initial development of the fertilized eggs within the gills of the female mussel. The eggs mature into a larval stage that is released into the water and attaches to the gills of a fish. After a period of development, the larvae release from the fish and settle to the stream bottom. Dwarf wedgemussels live as long as 10 years. The principal causes of the mussel's decline are habitat degradation from pollution and land-use changes that increase siltation in streams.

Dwarf wedgemussels occur from North Carolina to New Hampshire and are becoming increasingly rare throughout the southern part of the region (FWS 2005). In Maryland, the species occurs in two creeks in Queen Anne's County, one creek in Charles County, and McIntosh Run in St. Mary's County (FWS 2007). A large population of dwarf wedgemussels lives in the mainstem portion of McIntosh Run, below its confluence with Burnt Mill Creek, which is about 2 mi downstream of the Thiokol site (CWP 2003). It is not known whether mussel populations occur farther upstream or in streams on the Thiokol site. The mussel population in McIntosh Run is one of the three most viable populations in Maryland (FWS 2007). A restoration strategy for the Breton Bay watershed suggested that any development affecting the tributaries that feed lower McIntosh Run has the potential to affect the Run, and appropriate precautions need to be taken (CWP 2003).

<u>Atlantic Spike (*Elliptio producta*)</u>. The Atlantic spike is discussed in Section 9.3.5.5 (Eastalco). Because these mussels typically inhabit rivers and large streams, they are not likely to occur near the Thiokol site.

Flier (*Centrarchus macropterus*). The flier is a moderately sized sunfish that can reach a length of about 7.5 in. (USGS 2009). The flier is native to the southern Mississippi River area, the Gulf coastal area, and the southern Atlantic coastal plain (USGS 2009). The St. Mary's County area represents the northernmost part of the species' known range on the coastal plain. There is one historical record of the flier, which is listed as threatened in Maryland, from a farm pond in St. Mary's County, and it is thought the species may not be native to Maryland (Lee et al. 1981; USGS 2009).

Comely Shiner (*Notropis amoenus*). The comely shiner is a small minnow that reaches a length of about 4 in. It is discussed in Section 9.3.5.5 (Eastalco). Its possible occurrence near the Thiokol site is not known.

Ironcolor Shiner (*Notropis chalybaeus*). The ironcolor shiner only grows to about 2.5 in. in length and lives in deeper pools in creeks and streams (NYSDEC 2008a). It lives with aquatic plants, such as bladderwort and pondweed. Spawning occurs over sandy areas from spring to summer. Eggs are broadcast into the water column, where they are fertilized. Ironcolor shiners feed on aquatic and terrestrial insects. It is listed as endangered in Maryland.

White Catfish (*Ameiurus catus*). The white catfish is one of the smaller of the North American catfish, rarely growing larger than 24 in. long and 6 lb in weight (MDNR 2007o). Although white catfish have been introduced in many regions, they are native to the Chesapeake Bay region. They live in slow-moving brackish waters that have mud substrates in small to large rivers. White catfish eat a variety of fish, crustaceans, and insects. Spawning occurs in early summer.

Based on the habitat information provided, building or operating a new unit on the Thiokol site would not result in impacts to most of these Federally and State-listed species. However, building or operating a new unit on this site could affect an important population of the Federally endangered dwarf wedgemussels, which occur just downstream from the site.

Building and Operation Impacts

Building a new nuclear unit at the Thiokol site would be expected to affect about 420 ac. An additional 25.1 ac along the potential cooling water pipeline route would be affected (UniStar 2009a). Building the new unit would adversely affect about 3435 linear ft of stream channels (UniStar 2009g). Assuming that the plant design would be similar to that proposed for Calvert Cliffs Unit 3, a new plant would permanently add about 130 ac of impervious surface to the Thiokol site, which would increase runoff during storms, potentially increasing erosion and adding pollutants to aquatic resources. The potential impacts of the building activities on the onsite aquatic resources primarily would be loss of stream habitat. Impacts on the two onsite streams could affect downstream populations of the endangered dwarf wedgemussel. However, given that the known dwarf wedgemussel population is a couple of miles from the site and if other populations do not exist closer to or on the site, it is probable that such effects would not destabilize the population. In addition, construction BMPs would likely be implemented that would minimize downstream effects, and it is expected that FWS would require implementation of protective measures to minimize adverse effects on the dwarf wedgemussel if a new reactor is proposed at the Thiokol site.

The main source of water for the new plant would be the Patuxent River, which drains a 932-mi^2 area and is the largest river completely within Maryland (MDNR 2007i). A new nuclear generating unit would require new, separate intake and discharge structures located offshore in the river and a screenwell and pumphouse structure located onshore at the common forebay (UniStar 2009a). Building a new intake would result in the temporary displacement of aquatic biota within the vicinity of the intake. It is expected that these biota would return to the area after building was complete. UniStar (2009a) stated that a cooling water intake structure for a plant at the Thiokol site would need to be located about 1000 ft into the Patuxent River. Such an installation would affect about 2.25 ac of bottom on the river and would require the placement of about 8000 yds^3 of sediment. Installation of the intake and discharge systems, which most likely would involve dredging and the use of cofferdams (UniStar 2009a), would cause impacts similar to those discussed for Chesapeake Bay in Section 4.3.2.1 and could interrupt migratory pathways of anadromous fish. However, the impacts on aquatic organisms probably would be temporary, except where riprap would be installed to protect the pipeline systems. Benthic invertebrates likely would recolonize the disturbed sediments. Sedimentation from trenching or dredging can be mitigated through the use of appropriate BMPs. Installation of the intake and discharge systems may affect potential aquaculture and restoration oyster beds. The severity of impacts on the aquatic ecology of the Patuxent River depends on the location of the intake and discharge structures in relation to location and resource values of the many oyster beds in the river near the Thiokol site.

A new 500-kV transmission line with a new transmission line corridor would be needed to connect the new plant to existing or proposed transmission lines. The new transmission corridor would extend from the southern portion of the Thiokol site to an existing 500-kV line located about 2 mi to the southeast (UniStar 2009c). About 4201 linear ft of stream channel are included within this new corridor (UniStar 2009a). The aquatic resources of this stream channel have not been characterized. The severity of impacts would depend on the characteristics of the aquatic resources within the corridor, but the use of BMPs during building and operation would lessen the potential impacts.

The most likely effect on aquatic populations from operation of a new nuclear unit at the Thiokol site would be impingement, entrainment, and entrapment of organisms from the Patuxent River. Assuming that a new reactor at the Thiokol site would use a closed-cycle cooling system that meets the EPA's Phase I regulations for new facilities (66 FR 65256), has a maximum through-screen velocity of 0.5 ft/s (0.15 m/s) at the cooling water intake structure on the Patuxent River, and meets the appropriate EPA intake flow-to-source water volume criterion, adverse impacts at the population level of many Patuxent River aquatic species from impingement, entrainment, and entrapment would not be anticipated. Operation of the intake could affect establishment of oyster populations by entraining the oyster larvae (NMFS 2009). The review team examined the results of entrainment studies conducted at the nearby Chalk Point Generating Station to aid in the assessment of impacts to aquatic resources at the Thiokol site.

The Chalk Point Generating Station is a non-nuclear facility located on Patuxent River about 10 mi north of the Thiokol site area. Chalk Point has two once-through cooling units and two closed-cycle units (MDNR PPRP 2008). McLean et al. (2002) described the entrainment at Chalk Point as potentially affecting several forage fish in the Patuxent River, including the bay anchovy (*Anchoa mitchilli*), silversides (*Menidia* spp.), naked goby (*Gobiosoma bosc*), and hogchokers (*Trinectes maculatu*s). However, the water withdrawal in 2006 for Chalk Point was about 604 MGD (MDNR PPRP 2008), which is more than 10 times what would be withdrawn by the type of plant proposed by UniStar. Thus, the effects of impingement, entrainment, and entrapment at the Thiokol site would be smaller than those at Chalk Point. Several anadromous species that inhabit the Patuxent River are known to have been entrained or impinged by CCNPP Units 1 and 2 (Ringger 2000; EA Engineering 2008) and could be impinged, entrained, or entrapped by operating the cooling water system at the Thiokol site. As for the proposed Unit 3 at the Calvert Cliffs site (see Chapter 4), the review team recognizes that potential mitigation measures could be implemented at the intake pipeline openings at the Thiokol site to reduce entrainment, impingement, and entrapment effects on aquatic species in the Patuxent River. Most notably, installation of small-mesh traveling screens or wedgewire screens and a fish-return system at the intake pipeline openings in the river would significantly reduce adverse effects on aquatic organisms.

Although a discharge plume has not been modeled for the Thiokol site, the Patuxent River is a large and deep waterbody at that location, and the review team assumes the plume would be similar in areal extent and depth to that modeled for the Calvert Cliffs site. Therefore, the plume would likely be relatively small compared to the river size in the area, and there would not likely be a thermal barrier to fish passage. In addition, the potential for adverse impacts from cold shock or heat shock because of exposure to the thermal plume would minor. Chemical concentrations in the effluents from the Thiokol site would be required to follow permitted guidelines.

Overall, the impact of building and operation of a new reactor on the Thiokol site to most aquatic resources would be substantial because of potential effects on several important anadromous fish species, benthic impacts from installation of pipelines, and potential disruption of important oyster aquaculture and restoration beds and potential adverse effects on the Federally endangered dwarf wedgemussel.

Cumulative Impacts

The geographic area of interest for the assessment of the potential cumulative impacts of building a new reactor at the Thiokol site on aquatic resources is defined as the Breton Bay and Lower Patuxent River watersheds, the mainstem of the Patuxent River, and the mesohaline (salinity ranges from about 5 to 19 ppt) western portion of the Chesapeake Bay. The extent of the mesohaline zone in the Chesapeake Bay varies seasonally, but, at its maximum, it includes the western Bay shore from about the mouth of the Rappahannock River to Baltimore and includes the tidal Patuxent River (MDNR PPRP 2008; CBP 2009). One concern with building and operating a new reactor on the Thiokol site is the potential for the entrainment, impingement, and entrapment of biota from the Patuxent River. Because the river in the area where the intake and discharge system would be located is mesohaline and contains biota similar to the Chesapeake Bay, the general entrainment, impingement, and entrapment impacts would be similar to those from operating a new unit at the Calvert Cliffs site. However, the Patuxent River is a more restricted waterbody than the Chesapeake Bay and is a valuable spawning and nursery area. Historically, entrainment at the Chalk Point Generating Station Power Plant removed an estimated 20 to 30 percent of the bay anchovy population in the Patuxent estuary, but the losses could range as large as 50 percent (McLean et al. 2002). The bay anchovy is the most heavily entrained species at CCNPP Units 1 and 2 (see Table 5-2). The additional entrainment by a new reactor at Thiokol could exacerbate the losses from Chalk Point and CCNPP Units 1 and 2. Some entrainment by ships that use the LNG facility at Cove Point would occur, but would likely be relatively small because of the comparatively small volumes withdrawn by the ships. Dominion proposes to reinforce the pier at the Cove Point LNG facility to allow for the docking larger tankers (USCG and USACE 2009). This project would primarily involve dredging of an area of Bay bottom near the present pier, the installation of mooring and breasting dolphins, and the disposal of the dredged material. The effects of these actions would not intersect with the building and operating of a new plant at the Thiokol site. Thermal impacts from existing plants in mesohaline waters, including Chalk Point and Calvert Cliffs, have not had significant effects on the Chesapeake Bay (MDNR PPRP 2008). The plume from the Thiokol discharge would likely be small and would not significantly modify the temperature regime in the Patuxent River.

The Breton Bay watershed is part of the Lower Potomac River watershed. Streams in the Breton Bay watershed drain into Breton Bay, which is affected by suspended sediments, nutrient loads, and high bacteria counts (MDNR 2002a). Discharge from the Leonardtown Wastewater Treatment Plan was the main source of nutrient loads into Breton Bay, but discharge loads have decreased since 2003 after plant upgrades began (MDE 2009a). Building a new reactor at Thiokol would increase sediment loads in onsite streams, and those loads could be transferred to Breton Bay. In addition, urbanization in the vicinity could adversely affect water quality and, therefore, aquatic habitat, in the Chesapeake and Breton Bays through increases in both point and nonpoint source pollution.

In addition to direct anthropogenic activities, GCC would impose additional stressors on aquatic communities. The presence of natural environmental stressors (e.g., short- or long-term changes in precipitation or temperature) would contribute to the cumulative environmental impacts to the Patuxent River, Breton Bay, and the Chesapeake Bay. GCC could lead to increased precipitation, increased sea levels, varying freshwater inflow, increased pollution from nonpoint source runoff, increased temperatures, increased storm surges, and greater intensity of coastal storms in the geographic area of interest (GCRP 2009). Such changes could alter salinity, change freshwater inflow, and reduce dissolved oxygen, which directly affect aquatic habitat. Rising sea water due to GCC could affect water levels in the Patuxent River and the Bays and subsequently change the water quality associated with the mixing of freshwater and estuarine waters (GCRP 2009). These stressors would result in shifts in species' ranges, habitats, and migratory behaviors and also alter ecosystem processes (GCRP 2009).

Based on the information from UniStar and the review team's independent evaluation, the review team concludes that the cumulative impacts of past, present, and reasonably foreseeable future activities, including building and operating a new reactor at the Thiokol site, on the aquatic resources in the geographical area of interest would be MODERATE primarily because of potential adverse effects on anadromous and other important forage and commercially valuable fish. The incremental contribution of building and operating a new reactor at the Thiokol site would be MODERATE for most aquatic species.

9.3.5.5 Socioeconomics

In evaluating the socioeconomic impacts of site development and operation at the Thiokol site near Mechanicsville, Maryland in St. Mary's County, the review team undertook a review of the site using data sources discussed in Section 9.3.2. The analysis also considers past, present, and reasonably foreseeable future actions that affect the same environmental resources, including other Federal and non-Federal projects and those projects listed in Table 9-10 within the geographic area of interest. Impacts from both building and station operation are discussed.

Physical Impacts

Many of the physical impacts of building and operation would be similar regardless of the site. Building activities can cause temporary and localized physical impacts such as noise, odor, vehicle exhaust, vibration, shock from blasting (if used), and dust emissions. The use of public roadways, railways, and waterways would be necessary to transport construction materials and equipment. Offsite areas that would support building activities (e.g., borrow pits, quarries, and disposal sites) would be expected to be already permitted and operational. Impacts on those facilities from building a new unit would be minimal.

Potential impacts from station operation include noise, odors, exhausts, emissions, and visual intrusions (aesthetics). A new unit would produce noise from the operation of pumps, cooling towers, transformers, turbines, generators, and switchyard equipment. Traffic at the site also would be a source of noise. Any noise coming from the site would be controlled in accordance with standard noise protection and abatement procedures. By inference, this practice also would be expected to apply to all alternative sites. Commuter traffic would be controlled by speed limits. Good road conditions and appropriate speed limits would minimize the noise level generated by the workforce commuting to the alternative site.

Any new unit at an alternative site would have standby diesel generators and auxiliary power systems. Permits obtained for these generators would confirm that air emissions comply with applicable regulations. In addition, the generators would be operated on a limited, short-term basis. During normal plant operation, a new unit would not use a significant quantity of chemicals that could generate odors that exceed odor threshold values. Good access roads and appropriate speed limits would minimize the dust generated by the commuting workforce.

Building activities would be temporary and would occur mainly within the boundaries of the Thiokol site. Offsite impacts would represent minimal changes to offsite services supporting the building activities. During facility operations, noise levels would be managed to State and local ordinances. Air quality permits would be required for the diesel generators, and chemical use would be limited, which should inhibit odors. Based on the information provided by UniStar and the review team's independent evaluation, the review team concludes that the physical impacts of building and operating a nuclear unit at the Thiokol site would be minimal.

Demography

The Thiokol site is located in St. Mary's County, near the towns of Hillville and Mechanicsville. The U.S. Census Bureau indicates that St. Mary's County had a 2008 population of 101,568 people, which was a 16 percent increase from 2000. Washington, D.C. (2008 population 591,833) is located 40 mi north of the Thiokol site (USCB 2009g, h). The population within the 50-mi region is approximately 3,702,936 people (UniStar 2009a).

At the peak of the site development period, UniStar would expect an onsite workforce of 3950 construction workers (UniStar 2009a). Based on the analysis of impacts presented in Section 4.4.2, the total maximum number of construction workers migrating into the region (within 50 mi of the site) from outside of the region would be between 790–1383 (20 to 35 percent of the total workforce) workers at the peak of the building period. Using an average household size of 2.61, the total in-migrating population would be between 2062 and 3608 people. The majority of impacts would be expected to occur in St. Mary's County because it contains the site. The impacts are more dispersed the farther away from the site due to the large populations of the other counties within commuting distance of the Thiokol site. Many of the impacts for the Thiokol site would be similar to those of the proposed Calvert Cliffs site due to their close proximity. Considering that the maximum estimation of in-migrating population would be less than 2 percent of the total population for St. Mary's County, the demographic impacts of building a nuclear unit at the Thiokol site are expected to be minimal.

If the facility were to be built and commenced operations, the operational workforce would number at least 363 workers, half (182 workers) of whom may migrate into the region. The Thiokol site would likely have a larger workforce then the Calvert Cliffs site because Calvert Cliffs has an existing security and administrative workforce. At the Thiokol site, a larger number of security and administrative workers would need to be hired, but because this is not specialized labor, they would likely already reside in the 50-mi region. Given the small number of in-migrating workers and the large population in the 50-mi region, the review team concludes that the demographic impact during operation would be minimal.

Taxes and Economy

In 2006, the labor force in St. Mary's County was 52,371 persons, and, of these, 49,794 were employed. The three industries in St. Mary's County that accounted for more than 50 percent of employment were public administration (19 percent); professional, scientific, management, administrative, and waste management services (18 percent); and educational services, health care, and social assistance (16 percent) followed by construction (11 percent) and retail trade (10 percent) (USCB 2006b). The unemployment rate for St. Mary's County in 2006 was 4.9 percent, compared to 5.6 percent for the State of Maryland (USCB 2006a, b).

Economic impacts would be spread across the 50-mi region but would be greatest in St. Mary's County. Impacts are generally considered minimal if plant-related employment is less than 5 percent of the study area's total employment (NRC 1996). During site development of a new unit, up to 3950 construction workers would be required to build the plant (at the peak building period). While some of these workers may need to in-migrate to the region, many would be drawn from the approximate 140,000–150,000 construction workers in the workforce of more than 2.5 million in the greater MSA (USBLS 2007a, b). The peak construction workforce would represent less than 5 percent of the current workforce in the region. Therefore, the review team concludes that the impacts of site development on the economy of the region would be minimal and beneficial, but temporary.

The wages and salaries of the construction and operating workforce would have a multiplier effect that could result in increases in business activity, particularly in the retail and service sectors. This would have a positive impact on the business community and could provide opportunities for new businesses to get started and increase job opportunities for local residents. During operations, approximately 182 new operations jobs would be added to the local economy. Based on the analysis in Section 5.4.3.1 for the proposed Calvert Cliffs site, the review team concludes that the impact of these new jobs would constitute a small percentage of the total number of jobs in St. Mary's County and would have a minimal and beneficial economic impact.

As with the new proposed unit at the Calvert Cliffs site, there would be some positive sales, use, income, and property tax revenue benefits that would be generated as a result of building and operating a new nuclear unit at the Thiokol site (Sections 4.4.2.2 and 5.4.3.2). Tax revenues would accrue to the State primarily from income and sales taxes and to local governments from taxes on property and incomes (Section 2.5.2.2). The primary tax impacts would occur once the new unit becomes valued as property and property tax revenues are collected by St. Mary's County according to the millage rate and the negotiated value of the plant. In fiscal year 2005, St. Mary's County tax revenues totaled $145.2 million. The tax revenues from a unit in St. Mary's County are unknown, but likely to be similar to the revenues for the Calvert Cliffs site. Tax estimates for Unit 3 at the Calvert Cliffs site would be up to $71 million during building and at $57 million once operations commence. The review team concludes that the impact on tax revenues would be greatest in St. Mary's County, with a significant and beneficial impact during building and operations of a nuclear unit. The revenue impacts from building and operating a nuclear unit at the Thiokol site for the remainder of the 50-mi region would be minimal.

Transportation and Housing

Road access to the Thiokol site is provided by MD State Route 235, which runs on the north side of the Thiokol site. MD State Route 235 is a four-lane highway with unsignalized intersections, is the main transportation route in this area of the County, and provides the primary connection between many of the smaller communities. The transportation network in the 50-mi region also includes State highways and County roads (see Figure 2-16), as well as three major airports serving Baltimore and Washington, D.C., and St. Mary's County Airport. The site does not have barge access and is 17 mi from the nearest rail line (UniStar 2009a). The review team expects traffic impacts from building a unit at the Thiokol, including both construction workers and deliveries, would be minimal for the region. However, it could be noticeable but not destabilizing in the local vicinity during peak building. During operations, impacts would be minimal except during outages when an additional 800 to 1000 workers would be employed onsite and impacts could be noticeable but not destabilizing.

Based on the analysis in Section 4.4.2 and 5.4.2, up to 1383 construction workers and 182 operations workers and their families would in-migrate to the 50-mi region during the building of a new nuclear unit at the Thiokol site and the subsequent operation. According to the 2005–2007 American Community Survey data, there are 3808 vacant housing units in St. Mary's County alone, which is adequate to accommodate the expected influx of construction workers. Workers could also find housing in other parts of the 50-mi region, which has approximately 145,957 housing units available (UniStar 2009a). The review team expects that the in-migrating construction and operations workforce would have a minimal impact on housing demand in St. Mary's County and the larger 50-mi region.

Public Services and Education

The influx of construction workers and plant operations staff in-migrating into the region could impact local municipal water and water treatment plants and other public services (police, fire, and medical) in the region. The public services of St. Mary's are described in Section 2.2.2.6. St. Mary's County has 117 police officers with a total number of police calls of 66,006 in 2006 (UniStar 2009a). St. Mary's County has 9fire stations and 7 volunteer rescue squads manned by approximately 730 volunteer fire fighters. St. Mary's has one hospital, with 108 beds and, on average; the hospital housed 76.7 patients for an average excess capacity of about 29 percent (UniStar 2009a). St. Mary's County Metropolitan Commission provides water and sewer systems to 41,000 and 36,000 residents respectively. The water supply and wastewater systems operate at approximately 43 and 58 percent average capacity with an excess capacity of 4.8 million gpd and 2.9 million gpd, respectively. Therefore, the review team concludes that the impacts of building and operating a nuclear unit on public services in St. Mary's County and the larger 50-mi region would be minimal.

St. Mary's County has one school district, which includes five high schools, four middle schools, 18 elementary schools and two special-needs schools (SMCPS 2008). The 2005–2006 student population was 16,649 students and had a student/teacher ratio range between 11 and 21 (MSDE 2005; GS 2008). Building and operations related students would represent a small percentage increase in the student body population. Given the number of schools in St. Mary's County and the large student body populations, it is likely that the new students will be absorbed easily and education impacts would be minimal for St. Mary's County and the larger 50-mi region.

Aesthetics and Recreation

In St. Mary's County there are four state parks that provide summer camps and special events, horseback riding, camping, fishing, biking, hiking, and picnicking (SMTT 2008, SMCBCC 2005). Calvert County's two main parks are Calvert Cliffs State Park and Flag Ponds Nature Park, which provide hiking, swimming, picnicking, fishing, bird watching, and wildlife viewing opportunities (MDNR 2007a, UniStar 2009a). Recreational users may be impacted by traffic in the near vicinity of the plant during shift change. Some plant structures could be visible from nearby locations, and new transmission lines would be constructed. Impacts on recreation would be minimal. Likewise, the aesthetic impacts during building and operation of a nuclear plant on the Thiokol site would be minimal.

Cumulative Impacts

For the analysis of socioeconomic impacts at the Thiokol site, the geographic area of interest is the 50-mi region centered on the Thiokol site with special consideration for St. Mary's County as that is where the review team expects socioeconomic impacts to be the greatest. Historically, St. Mary's County's economy was based on tobacco and water-related jobs. Those have decreased significantly in recent years with the State tobacco buyout program and a shift to technology-oriented jobs. The Patuxent River Naval Air Station, built in the 1940s, has had long-lasting effects on the economy, and the County continues to build its defense industry jobs. St. Mary's is now designated a "Technology Corridor" by the State (SMCTD 2009).

In addition to socioeconomic impacts from building and operating a nuclear unit at the Thiokol site, this analysis also considers other past, present, and reasonably foreseeable future actions that could contribute to the cumulative socioeconomic impacts. The projects identified in Table 9-10 have or would contribute to the demographics, economic climate, and community infrastructure of the region and generally result in increased urbanization and industrialization. However, many resource areas, such as housing or public services, are able to adjust over time, particularly with increased tax revenues. Because the projects within the review area identified in Table 9-10 would be consistent with applicable land-use plans and control policies, the review team considers the cumulative socioeconomic impacts from the projects to be manageable. Physical impacts on workers and the general public include impacts on existing buildings, transportation, aesthetics, noise levels, and air quality. Social and economic impacts span issues of demographics, economy, taxes, infrastructure, and community services.

In summary, based on information provided by UniStar and the review team's independent evaluation, the review team concludes that the cumulative impacts of building and operating a new nuclear unit at the Thiokol site and other past, present, and reasonably foreseeable projects on socioeconomics would be SMALL in terms of adverse physical impacts, demography, housing, public service, educational, aesthetics, and recreation and MODERATE for transportation. The cumulative impacts on the St. Mary's County economy and tax base during plant operation likely would be beneficial and LARGE. Building and operating the new unit would be a significant contributor to these impacts.

9.3.5.6 Environmental Justice

The 2000 Census block groups were used for ascertaining minority and low-income populations in the region. There were a total of 2639 census block groups within the 50-mi region (which includes portions of Washington, D.C., Maryland, and Virginia). Approximately 804 were classified as aggregate minority, 688 African American and 183 Hispanic. As discussed in Section 2.6, there are no minority block groups in Calvert County and two (one aggregate minority and one African American) in St. Mary's County. There are 66 census block groups classified as low income in the 50-mi region, one of which is in St. Mary's County. Figure 9-14 shows the geographic locations of the minority populations of significance within the 50-mi radius of the Thiokol site, and Figure 9-15 shows the geographic locations of the low-income populations of significance within the 50-mi radius of the Thiokol site.

Building activities (noise, fugitive dust, air emissions, traffic) would not disproportionately adversely affect minority populations because of their distance from the Thiokol site. The operation of the proposed project at Thiokol is also unlikely to have a disproportionate adverse impact on minority or low-income populations. See Sections 4.5 and 5.5 for more information about environmental justice criteria and impacts.

The projects identified in Table 9-10 likely did not or would not contribute to environmental justice impacts of the region. Housing rental rates can be an area of concern with regards to low-income populations. If projects commence and cause a rise in rental rates, there may be a disproportionate adverse impact on low-income populations. Further, the determinations reached for the Calvert Cliffs site (Sections 4.5 and 5.5) are believed to be generally applicable to the Thiokol site. Therefore, based on information provided by UniStar and the review team's independent evaluation, the review team concludes that there would likely not be any disproportionate and adverse environmental justice cumulative impacts from building and operating a new nuclear unit at the Thiokol site, and the cumulative environmental justice impacts, including building and operation of a nuclear power plant at the Thiokol site, would be SMALL.

9.3.5.7 Historic and Cultural Resources

The former Thiokol site has a history of manufacturing munitions and burying some of them onsite. Prior to 1950, a company called the Federal Ordnance Corporation operated a munitions plant on the property. In the 1950s, a company, Hunter Manufacture, purchased the property and continued to produce munitions until the late 1950s (MDE 2007). When the factory was in operation in the 1950s, employees were directed to bury unexploded ordnances on the property. The locations of the buried ordnances were not recorded (MDE 2007). In 1959, Thiokol Corporation (today known as Cordant Technologies) purchased the property, but did not continue with the production of munitions. In the 1980s, Thiokol razed buildings, harvested timber, and later reforested parts of the property. In 1999, South Resource Management purchased the property from Cordant with a declaration of covenant prohibiting residential construction at two special reserve areas in suspected burial regions of the property. The 719-ac property was split and 619 ac, along with the reserve areas, were sold to PB II, LLC in 2006 (MDE 2007).

UniStar conducted a literature review at the MHT. One report on file was specific to Mechanicsville related to historic properties. There are no known National Register of Historic Properties in St. Mary's County (UniStar 2008a). No buildings remain on the Thiokol site. Due to the building removal, soil removal, and overall land disturbance associated with the production of munitions on the property, historical resources that may be encountered at the site would most likely be disturbed and located below surface, and the probability would be low of finding resources above ground (UniStar 2009a).

Figure 9-14. Distribution of Aggregate Minority Populations of Significance in 2000 for the Thiokol Site

Figure 9-15. Distribution of Aggregate Low-Income Populations of Significance in 2000 for the Thiokol Site

Cumulative Impacts

The following cumulative impact analysis includes building and operating a nuclear generating unit at the Thiokol site. The analysis also considers other past, present, and reasonably foreseeable future actions that could impact cultural resources including other Federal and non-Federal projects and those projects listed in Table 9-10 within the geographic area of interest. For the analysis of cultural impacts at the Thiokol site, the geographic area of interest is the APE that would be defined for this considered undertaking. This includes the physical APE, defined as the area that would be directly affected by the site development and operation activities at the site and transmission lines, and the visual APE. The visual APE is defined as an additional 1-mi radius around the physical APE consistent with the discussion in Section 2.7 about the maximum distance from which the structures can be seen.

Reconnaissance activities in a cultural resource review have particular meaning. Typically, for example, it includes preliminary field investigations to confirm the presence or absence of cultural resources. In developing this EIS the review team relied upon reconnaissance-level information to perform its evaluation of alternative sites. Reconnaissance-level information is data that are readily available from agencies and other public sources. It can also include information obtained through visits to the site area. To identify the historic and cultural resources at the Thiokol site, the following information was used:

- UniStar ER (UniStar 2009a)
- NRC-Alternative Sites visit October 2008 (NRC 2010a).

Cultural resources are non-renewable; therefore, the impact of destruction of cultural resources is cumulative. No projects were identified in Table 9-10 that would contribute to cumulative impacts to historic and cultural resources.

Based on reconnaissance-level information regarding historic and cultural resources at the site and the overall land disturbance associated with the production of munitions at the site and the extensive remediation activities, the review team concludes that cumulative impacts on historic properties of building and operating a new nuclear generating unit at the Thiokol site and other past, present, and reasonably foreseeable projects are likely to be SMALL. No archaeological and/or architectural surveys have been conducted.

9.3.5.8 Air Quality

The emissions related to building and operating a nuclear power plant at the Thiokol site in St Mary's County would be similar to those at the Calvert Cliffs site. St. Mary's County is in the Central Maryland Intrastate Air Quality Control Region (40 CFR Part 81.155). It is in attainment of all air quality standards.

Reflecting on the projects listed in Table 9-10, most of the effects on air quality would be to maintain the status quo. Any new industrial projects would either have de minimis impacts or would be subject to regulation by the Maryland DNR. Given these institutional controls, it is unlikely that the air quality in the region would degrade significantly (i.e., degrade to the extent that the region is in nonattainment of national standards). As a result, because the emissions would be the same as at the Calvert Cliffs site, the review team concludes that the air quality impacts of building and operating a nuclear power plant at the Thiokol site would be minimal and that the cumulative impacts would be SMALL.

Greenhouse gas emissions related to nuclear power are discussed in Chapters 4, 5, and 6 for building and operating a nuclear power plant and for the fuel cycle, respectively. As described in Chapter 7, the impacts of greenhouse gas emissions are not sensitive to location of the source. Consequently, the discussions in the previous chapters and in Section 9.2.5 are applicable to a nuclear power plant located at the Eastalco site. The impacts of greenhouse gas emissions considered in isolation would be minor, but the cumulative impact of greenhouse gas emissions would be MODERATE. Building and operating the new unit would not be a significant contributor to these impacts.

9.3.5.9 Nonradiological Health Impacts

The following impact analysis includes nonradiological health impacts from building activities and operations to the public and workers from a nuclear unit at the Thiokol alternative site. The analysis also considers other past, present, and reasonably foreseeable future actions that impact nonradiological health, including other Federal and non-Federal projects and those projects listed in Table 9-10 within the geographic area of interest. The building-related activities that have the potential to impact the health of members of the public and workers include exposure to dust and vehicle exhaust, occupational injuries, noise, and the transport of construction materials and personnel to and from the site. The operation-related activities that have the potential to impact the health of members of the public and workers includes exposure to etiological agents, noise, EMFs, and impacts from the transport of workers to and from the site. For the analysis of nonradiological health impacts at the Thiokol alternative site, the geographic area of interest is considered to include projects within a 5-mi radius from the site's center based on the localized nature of the impacts. For impacts associated with transmission lines, the geographic area of interest is the transmission line corridor.

Building Impacts

Nonradiological health impacts to construction workers and members of the public from building a new nuclear unit at the Thiokol site would be similar to those evaluated in Section 4.8 for the Calvert Cliffs site. The impacts include noise; vehicle exhaust; dust; occupational injuries; and transportation accidents, injuries, and fatalities. Applicable Federal and State regulations on air quality and noise would be complied with during the site preparation and building phase. The incidence of construction worker accidents would not be expected to be different from the incidence of accidents estimated for the Calvert Cliffs site. Thiokol site is located in a rural area and building impacts would likely be minimal on the surrounding populations.

Past and present actions in the geographic area of interest that have similarly impacted nonradiological resources include the construction and operation of the Dominion Cove Point Liquid Natural Gas Facility. Proposed future actions would include the proposed Dominion Cove Point Pier Reinforcement Project, and transportation projects to upgrade MD Route 4 and the Thomas Johnson Bridge. Transmission line development and/or upgrading and urbanization would both occur throughout the designated geographical area of interest.

Operational Impacts

Nonradiological health impacts from operation of a new nuclear unit on occupational health and members of the public at the Thiokol site would be similar to those evaluated in Section 5.8 for the Calvert Cliffs site. Occupational health impacts to workers (e.g., falls, electric shock, or exposure to other hazards) at the Thiokol site would likely be the same as those evaluated for workers at a new unit at the Calvert Cliffs site. Based on the configuration of the proposed new unit at the Thiokol site (closed-cycle, wet cooling system with mechanical draft cooling towers), etiological agents would not likely increase the incidence of water-borne diseases in the vicinity of the site. Noise and EMF exposure would be monitored and controlled in accordance with applicable OSHA regulations. Effects of EMF on human health would be controlled and minimized by conformance with NESC criteria. Nonradiological impacts of traffic associated with the operations workforce would be less than the impacts during building. Mitigation measures taken during building to improve traffic flow would also minimize impacts during operation of a new unit.

The nonradiological impacts from operations to the public and workers in the geographic areas of interest would be associated with cooling towers and existing transmission lines. The only past and current project in the geographical area of interest that has been identified for cumulative impacts is the operation of CCNPP Units 1 and 2. Proposed future actions that would impact nonradiological health in a similar way to operation activities at the Thiokol site would include transmission line systems and future urbanization, which would both occur throughout the designated geographical areas of interest.

The review team is also aware of the potential climate changes that could affect human health; a recent compilation of the state of the knowledge in this area (GCRP 2009) has been considered in the preparation of this EIS. Projected changes in the climate for the region include an increase in average temperature and an increase in precipitation, which may alter the presence of microorganisms and parasites. In view of the water source characteristics, the review team did not identify anything that would alter its conclusion regarding the presence of etiological agents or change in the incidence of water-borne diseases.

Summary

Based on the information provided by UniStar and the review team's independent evaluation, the review team expects that the impacts to nonradiological health from building and operation of a new unit at the Thiokol site would be similar to the impacts evaluated for the Calvert Cliffs site. While there are past, present, and future activities in the geographic area of interest that could affect nonradiological health in ways similar to the building and operation of a new unit at the Thiokol site, those impacts would be localized and managed through adherence to existing regulatory requirements. The review team concludes that those cumulative impacts would be SMALL.

9.3.5.10 Radiological Impacts of Normal Operations

The following impact analysis includes radiological impacts to the public and workers from building activities and operations for a nuclear unit at the Thiokol alternative site. The analysis also considers other past, present, and reasonably foreseeable future actions that impact radiological health, including other Federal and non-Federal projects and those projects listed in Table 9-10 within the geographic area of interest. As described in Section 9.3.5, the Thiokol site is a brownfield site; there are currently no nuclear facilities on the site. The geographic area of interest is the area within a 50-mi radius of the Thiokol site. Facilities potentially affecting radiological health within this geographic area of interest are the existing CCNPP Units 1 and 2. Also within a 50-mi radius of the Thiokol site, there are likely to be hospitals and industrial facilities that use radioactive material.

The radiological impacts of building and operating the proposed U.S. EPR unit at the Thiokol site include doses from direct radiation and liquid and gaseous radioactive effluents. These pathways would result in low doses to people and biota offsite that would be well below regulatory limits. These impacts are expected to be similar to those estimated for the Calvert Cliffs Unit 3 site.

The radiological impacts of CCNPP Units 1 and 2 also include doses from direct radiation and liquid and gaseous radioactive effluents. These pathways would result in low doses to people and biota offsite that would be well below regulatory limits, as demonstrated by the ongoing REMPs conducted around these nuclear power plants. The NRC staff concludes the dose from direct radiation and effluents from hospitals and industrial facilities that use radioactive material would be an insignificant contribution to the cumulative impact around the Thiokol site. This conclusion is based on data from the REMPs conducted around currently operating nuclear power plants.

Based on the information provided by UniStar and the NRC staff's independent analysis, the NRC staff concludes that the cumulative radiological impacts from building and operating the proposed U.S. EPR unit and other existing and planned projects and actions in the geographic area of interest around the Thiokol site would be SMALL.

9.3.5.11 Postulated Accidents

The following impact analysis includes radiological impacts from postulated accidents from operations for one nuclear unit at the Thiokol alternative site. The analysis also considers other past, present, and reasonably foreseeable future actions that impact radiological health from postulated accidents, including other Federal and non-Federal projects and those projects listed in Table 9-10 within the geographic area of interest. As described in Section 9.3.5, the Thiokol site is a brownfield test site; there are currently no nuclear facilities on the site. The geographic area of interest considers all existing and proposed nuclear power plants that have the potential to increase the probability-weighted consequences (i.e., risks) from a severe accident at any location within 50 mi of the Thiokol site. Existing facilities potentially affecting radiological accident risk within this geographic area of interest are the existing CCNPP (Units 1 and 2, North Anna Units 1 and 2, Surry Units 1 and 2, Salem Units 1 and 2, Hope Creek Unit 1, and Peach Bottom Units 2 and 3. Within the geographic area of interest, an additional nuclear power plant is planned at the North Anna site.

As described in Section 5.10.1, the NRC staff concludes that the environmental consequences of DBAs at the Calvert Cliffs site would be minimal for an U.S. EPR. DBAs are addressed specifically to demonstrate that a reactor design is robust enough to meet NRC safety criteria. The U.S. EPR design is independent of site conditions and the meteorology of the Thiokol alternative and Calvert Cliffs sites are similar; therefore, the NRC staff concludes that the environmental consequences of DBAs at the Thiokol alternative site would be minimal. Because the meteorology, population distribution, and land use for the Thiokol alternative site are expected to be similar to the proposed Calvert Cliffs site, risks from a severe accident for a U.S. EPR reactor located at the Thiokol alternative site are expected to be similar to those analyzed for the proposed Calvert Cliffs site. These risks for the proposed Calvert Cliffs site are presented in Table 5-16 and Table 5-17 and are well below the median value for current-generation reactors. In addition, estimates of average individual early fatality and latent cancer fatality risks are well below the NRC’s safety goals (51 FR 30028).

For existing plants within the geographic area of interest, which are Calvert Cliffs Unit 1 and 2, North Anna Units 1 and 2, Surry Units 1 and 2, Salem Units 1 and 2, Hope Creek Unit 1, and Peach Bottom Units 2 and 3, the NRC has determined the probability-weighted consequences of severe accidents are small (10 CFR 51, Appendix B, Table B-1). In addition, the EIS for the North Anna Power Station Unit 3 (NRC 2010b) shows that risks for the proposed Unit 3 at that site would also be well below current-generation reactors and meet the NRC’s safety goals. Because of the NRC’s safety review criteria, it is expected that risks for any new reactors at the Salem/Hope Creek site would be well below risks for current-generation reactors and meet the

Commission's safety goals. On these bases, the NRC staff concludes that the cumulative risks of severe accidents at any location within 50 mi of the Thiokol alternative site would be SMALL.

9.3.6 Comparison of the Impacts of the Proposed Action and Alternative Sites

This section summarizes the NRC staff's impact characterizations for cumulative impacts related to locating one new U.S. EPR nuclear unit at the proposed site and each alternative site. The three Maryland sites selected for detailed review as part of the alternative sites environmental analysis included the Bainbridge site in Cecil County, the Eastalco site in Frederick County, and the Former Thiokol Site in St. Mary's County. Comparisons are made between the proposed site and alternatives to determine if one of the alternative sites is environmentally preferable to the proposed site. The NRC's determination as to whether an alternative site is environmentally preferable to the proposed site for Calvert Cliffs Unit 3 is independent of the Corps' determination of a least environmentally damaging practible alternative (LEDPA) pursuant to the Clean Water Act Section 404(b)(1) Guidelines at 40 CFR Part 230. The Corps will conclude its analysis of both offsite and onsite alternatives in its Record of

The need to compare the proposed site with alternative sites arises from the requirement in Section 102(2)(c)(iii), 42 U.S.C. 4332 of NEPA that environmental impact statements include an analysis of alternatives to the proposed action. The NRC criteria to be employed in assessing whether a proposed site is to be rejected in favor of an alternative site is based on whether the alternative site is "obviously superior" or "environmentally preferable" to the site proposed by the applicant (Public Service Co. of New Hampshire 1977). An alternative site is "obviously superior" to the proposed site if it is "clearly and substantially" superior to the proposed site (Rochester Gas & Electric Corp. 1978). The standard of obviously superior "...is designed to guarantee that a proposed site will not be rejected in favor of an alternate unless, on the basis of appropriate study, the Commission can be confident that such action is called for" (New England Coalition on Nuclear Pollution 1978).

The "obviously superior" test is appropriate for two reasons. First, the analysis performed by the NRC staff in evaluating alternative sites is necessarily imprecise. Key factors considered in the alternative site analysis, such as population distribution and density, hydrology, air quality, aquatic and terrestrial ecological resources, aesthetics, land use, and socioeconomics, are difficult to quantify in common metrics. Given this difficulty, any evaluation of a particular site must have a wide range of uncertainty. Second, the applicant's proposed site has been analyzed in detail, with the expectation that most adverse environmental impacts associated with the site have been identified. The alternative sites have not undergone a comparable level of detailed study. For these reasons, a proposed site may not be rejected in favor of an alternative site when the alternative site is marginally better than the proposed site, but only when it is obviously superior (Rochester Gas & Electric Corp. 1978). NEPA does not require that a nuclear plant be constructed on the single best site for environmental purposes. Rather, "...all that NEPA requires is that alternative sites be considered and that the effects on the environment of building the plant at the alternative sites be carefully studied and factored into the ultimate decision" (New England Coalition on Nuclear Pollution 1978).

The NRC staff's review of alternative sites consists of a two-part sequential test (NRC 2000a). The first part of the test determines whether any of the alternative sites are environmentally preferable to the applicant's proposed site. The NRC staff considers whether the applicant has (1) reasonably identified candidate sites, (2) evaluated the likely environmental impacts of building and operation at these sites, and (3) used a logical means of comparing sites that led to the applicant's selection of the proposed site. Based on NRC's own independent review, the NRC staff then determines whether any of the alternative sites are environmentally preferable to the applicant's proposed site. If the NRC staff determines that one or more alternative sites are environmentally preferable, then it would compare the estimated costs (i.e., environmental, economic, and time) of constructing the proposed plant at the proposed site and at the environmentally preferable site or sites (NRC 2000a). The second part of the test determines if an environmentally preferable alternative site is obviously superior to the proposed site. The NRC staff must determine that (1) one or more important aspects, either singly or in combination, of an environmentally preferable alternative site are obviously superior to the corresponding aspects of the applicant's proposed site and (2) the alternative site does not have offsetting deficiencies in other important areas. A NRC staff conclusion that an alternative site is obviously superior to the applicant's proposed site would normally lead to a recommendation that the application for the license be denied.

Section 9.3.6.1 discusses the process the NRC staff used to compare the alternative sites to the proposed Calvert Cliffs site. Sections 9.3.6.2 and 9.3.6.3, respectively, discuss the environmental impacts of proposed site in relation to the alternative sites as they relate to environmentally preferable and obviously superior evaluations.

9.3.6.1 Comparison of Propose Site and Alternative Site Cumulative Impacts

The NRC staff's characterizations of the cumulative environmental impacts of building and operating a new nuclear generating unit at the proposed site (impact levels from Chapter 7) and three alternatives sites (from Sections 9.3.3 through 9.3.5) are listed in Table 9-12.

The NRC staff reviewed UniStar's ER (2009a) and its supplemental Alternative Site Evaluation document (UniStar 2009e). The NRC staff conducted site visits at the proposed Calvert Cliffs site and each of the alternative sites. The NRC staff found that UniStar implemented a reasonable process to select alternative sites and used a logical process to compare the impacts at the proposed site to those at the alternative sites. The following discussion summarizes the staff's independent assessment of the proposed and alternative sites.

The NRC staff's characterization of the expected cumulative environmental impacts of building and operating a new unit at the Calvert Cliffs site and alternative sites are summarized by impact category level in Table 9-12. Full explanations for the particular characterizations are provided in Chapter 7 for the proposed site and in Sections 9.3.3, 9.3.4, and 9.3.5 for the alternative sites. The staff's impact category levels are based on professional judgment, experience, and consideration of controls likely to be imposed under required Federal, State, or local permits that would not be acquired until an application for a COL is underway. These considerations and assumptions were similarly applied at each of the alternative sites to provide a common basis for comparison. In the following discussion, the NRC staff compares the impact levels between the proposed site, and each alternative site.

The environmental impact areas listed in Table 9.12 have been evaluated using the NRC's three-level standard of significance – SMALL, MODERATE, or LARGE – as set forth in the footnotes to Table B-1 of 10 CFR Part 51, Subpart A, Appendix B:

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

> 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.

9.3.6.2 Environmentally Preferable Sites

None of the four sites appears to have any flaws that would prohibit building a nuclear power plant at that location. However, as shown in Table 9-12, there are some differences in the NRC staff's impact characterizations among the sites. The cumulative impacts of building and operating a new unit at the proposed site and the alternative sites are generally SMALL for most impact categories. The categories for which the impact level at an alternative site would be the same as the proposed site would not cause the alternative site to be environmentally preferable to the proposed site. Therefore, these categories are not discussed further in determining whether an alternate site is environmentally preferable to the proposed site. The categories for which an alternative site would have a higher or lower impact level than the proposed site are discussed further to determine if an alternative site is environmentally preferable to the proposed site. Where there is a range of impacts for a resource, the upper value of the impacts is used for the comparison. In addition, for those cases in which the cumulative impacts for a resource are greater than SMALL, consideration is given to those cases in which the impacts of the project at the specific site do not make any significant contribution to the cumulative impact level.

1 **Table 9-12**. Comparison of Cumulative Impacts at the Proposed and Alternative Sites

Resource Category	Calvert Cliffs	Bainbridge	Eastalco	Former Thiokol
Land-Use	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE
Water-Related				
Surface Water Use	SMALL	SMALL	SMALL to MODERATE	SMALL
Groundwater Use	MODERATE	SMALL	SMALL	MODERATE
Surface Water Quality	SMALL	MODERATE	SMALL	SMALL
Groundwater Quality	SMALL	SMALL	SMALL	SMALL
Ecology				
Terrestrial Ecosystems	MODERATE	SMALL	SMALL	SMALL to MODERATE
Aquatic Ecosystems	MODERATE	MODERATE to LARGE	SMALL to MODERATE	MODERATE
Socioeconomic				
Physical Impacts	SMALL	SMALL	SMALL	SMALL
Demography	SMALL	SMALL	SMALL	SMALL
Taxes and Economy	SMALL to LARGE Beneficial	SMALL to LARGE Beneficial	SMALL to MODERATE Beneficial	SMALL to LARGE Beneficial
Housing and Transportation	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Public Services and Education	SMALL	SMALL	SMALL	SMALL
Aesthetics and Recreation	SMALL	SMALL	SMALL to MODERATE	SMALL
Environmental Justice	SMALL	SMALL	SMALL	SMALL
Historic and Cultural Resources	LARGE	MODERATE to LARGE	MODERATE to LARGE	SMALL
Air Quality	SMALL to MODERATE	MODERATE	MODERATE	SMALL to MODERATE
Nonradiological Health	SMALL	SMALL	SMALL	SMALL
Radiological Health	SMALL	SMALL	SMALL	SMALL
Postulated Accidents	SMALL	SMALL	SMALL	SMALL

The Bainbridge site is characterized by the staff more favorably than the Calvert Cliffs site in Table 9-12 for the resource categories groundwater use and terrestrial ecosystems. Conversely, the Calvert Cliffs site is characterized more favorably than the Bainbridge site in Table 9-12 for the following resource categories: surface water quality and aquatic ecosystems. The impacts of building and operating a nuclear unit at the Bainbridge site would be a significant contributor to the impacts. The same is true at the Calvert Cliffs site for the impacts to terrestrial ecosystems. However, regarding the MODERATE impact to groundwater use for the Calvert Cliffs site and the MODERATE impact to surface water quality at the Bainbridge site, building and operating a new unit at the site is not a significant contributor to the impacts. Finally, although both sites have up to a MODERATE impact level for air quality, at the Calvert Cliffs site building and operating a new nuclear unit is not a significant contributor to the impacts while at Bainbridge it is. The potential for LARGE impacts to aquatic resources is the most significant differentiator among these categories. On balance, and based on the impact characterizations shown in Table 9-12, the NRC staff concludes that the Bainbridge site would not be environmentally preferable to the Calvert Cliffs site for a new nuclear generating unit.

The Eastalco site is characterized by the staff more favorably than the Calvert Cliffs site in Table 9-12 for the following resource categories: groundwater use and terrestrial and aquatic ecosystems. Conversely, the Calvert Cliffs site is characterized more favorably than the Eastalco site in Table 9-12 for the resource categories: land use, surface water use, taxes and economy, and aesthetics and recreation. Although Eastalco has an impact level of SMALL to MODERATE for land use, building and operating a new nuclear unit at the site is not a significant contributor to that impact. So there is really no appreciable difference between the sites for this resource area. Similarly, regarding the MODERATE impact to groundwater use for the Calvert Cliffs site, building and operating a new unit there is not a significant contributor to that impact, so the impact of the project at both sites is minimal. For surface water use and aesthetics and recreation, the higher impacts at the Eastalco site are related to building and operating a new nuclear unit there, which means there is a measurable difference in impacts between the sites. The difference in the ratings for taxes and the economy (which favors Calvert Cliffs) and terrestrial ecosystems (which favors Eastalco) are also directly related to the project. In addition, although both sites have up to a MODERATE impact level for air quality, at Calvert Cliffs building and operating a new nuclear unit is not a significant contributor to the impacts while it is at Eastalco. Finally, for aquatic ecosystems the rating of SMALL to MODERATE for Eastalco is based on uncertainty whether there are state-listed species in the affected areas while for Calvert Cliffs the rating of MODERATE is based on impacts that will occur if the project is built. On balance, the NRC staff concludes that the Eastalco site and the Calvert Cliffs site rank closely and it would be difficult through a comparison of impacts in different resource categories to precisely state that one is better than the other from an environmental perspective. In such a case, the proposed site prevails because the alternative is not clearly environmentally preferable.

The Former Thiokol site is characterized by the staff more favorably than the Calvert Cliffs site in Table 9-12 for historic and cultural resources. Conversely, the Calvert Cliffs site is characterized more favorably than the Former Thiokol site in Table 9-12 for land use. In all other resource categories, the impacts at the two sites would be similar. The LARGE impact to cultural resources at the Calvert Cliffs site versus a SMALL impact at the Thiokol site is a significant difference. Building and operating a new nuclear reactor at the Calvert Cliff site would be a significant contributor to the site's LARGE rating. However, the other difference between the Calvert Cliffs and Thiokol sites is that land use would be SMALL at the Calvert Cliffs site versus SMALL to MODERATE at the Former Thiokol site. On balance, the NRC staff concludes that the Thiokol site and the Calvert Cliffs site rank closely, and it would be difficult through a comparison of impacts in different resource categories to precisely state that one is better than the other from an environmental perspective. In such a case, the proposed site prevails because the alternative is not clearly environmentally preferable.

Although there are differences and distinctions between the cumulative environmental impacts of building and operating a new nuclear generating unit at the Calvert Cliffs site and the alternative sites, the NRC staff concludes that none of these differences is sufficient to determine that any of the alternative sites is environmentally preferable to the Calvert Cliffs site.

9.3.6.3 Obviously Superior Sites

Because none of the alternative sites is environmentally preferable to the proposed site, none could be obviously superior and no additional evaluation is required.

9.4 System Design Alternatives

The review team considered a variety of heat dissipation systems and circulating water systems alternatives for the proposed Unit 3. Although other heat dissipation systems and water systems exist, by far the largest and the most likely to dominate the environmental consequences of operation is the normal heat sink cooling system. Other water systems, such as service water and ultimate heat sink cooling systems, are much smaller than the normal heat sink cooling system. However, because the structures to support safety-related functions, such as the ultimate heat sink, must be hardened to ensure safe operation during design basis events, the review team considers the intakes of both the normal and ultimate heat sinks independently. In this evaluation, the review team only considered alternative heat dissipation for the normal heat sink cooling system, because it is the dominant heat dissipation system. The review team considered the possibility of separate water supplies for the normal heat sink and the service water. The proposed system is a mechanical draft cooling tower with plume abatement as discussed in Section 9.4.1.4.

9.4.1 Heat Dissipation Systems

About two-thirds of the heat from a commercial nuclear reactor is rejected as heat to the environment. The remaining one-third of the reactor's generated heat is converted into electricity. Normal heat sink cooling systems transfer this reject heat load into the atmosphere and/or nearby waterbodies, primarily as latent heat exchange (evaporating water) or sensible heat exchange (warmer air or water). Different heat dissipation systems rely on different exchange processes. The following sections describe alternative heat dissipation systems considered by the review team for proposed Unit 3.

9.4.1.1 Once-Through Cooling

Once-through cooling systems withdraw water from the source waterbody and return the same volume of water to the receiving waterbody at an elevated temperature. Typically the source waterbody and the receiving waterbody are the same body and the intake and discharge structures are separated to limit recirculation. While there is no consumptive use of water in a once-through heat dissipation system, the elevated temperature of the receiving waterbody would result in some induced evaporative loss that decreases the net water supply. The large intake and discharge flows associated with once-through cooling systems require large intake and discharge structures, result in higher levels of impingement and entrainment, and may result in hydrological alterations in the source/receiving waterbodies. Based on rulemaking by EPA regarding Section 316(b) of the Clean Water Act, the review team has determined that once-through cooling systems for new nuclear reactors are unlikely to be permitted in the future, except in rare situations.

The existing CCNPP Units 1 and 2 use once-through cooling with an onshore intake structure and an offshore discharge structure. Separate intake and discharge structures would be required for proposed Unit 3, since the capacity of the existing intake system is inadequate to meet the combined needs of Units 1, 2, and 3. Either onshore or offshore intake and discharge structures are possible. In the ER (UniStar 2009a), UniStar stated once-through cooling design was not considered feasible due to the cost that would be required to construct the intakes and discharges and make them compliant with Clean Water Act Section 316(b) rules. The review team determined that once-through cooling would not be environmentally preferable based on the environmental sensitivity of the Chesapeake estuary and the magnitude of the activities in building such large intake structures and operational impacts of such large flows.

9.4.1.2 Wet Mechanical Draft Cooling Towers without Plume Abatement

A wet mechanical draft cooling tower transfers heat to the environment via evaporation and conduction. These towers can be relatively low profile compared to their natural draft counterparts and rely on large fans to force air through walls of falling water. Drift abatement features limit the amount of water suspended as droplets in the air to later come down to the ground outside the tower. Wet mechanical draft towers often generate visible plumes when the moisture in the cooling tower exhaust air cools and the moisture condenses. The proposed heat dissipation system uses plume abatement features to reduce aesthetic issues associated with the plume. The review team determined that the advantage of the mitigation of the visible plume aesthetic issue offsets the increased cost and land use with the preferred alternative. Therefore, the review team determined that a wet mechanical draft cooling tower without plume abatement would not be environmentally preferable to the proposed cooling system design.

9.4.1.3 Mechanical Draft with Plume Abatement

A mechanical draft plume abatement tower is the proposed heat dissipation system for Unit 3 and is discussed in Chapter 3 of this EIS.

9.4.1.4 Combination Wet-Dry Mechanical Draft Cooling

A combination wet/dry mechanical draft cooling tower system uses both wet and dry cooling cells to limit consumption of cooling water. Water used to cool the turbine generators generally passes first through the dry portion of the cooling tower, where heat is removed by drawing air at ambient temperature over tubes through which the water is moving. Cooling water leaving the dry portion of the tower then passes through the wet tower where the water is sprayed into a moving air stream, and additional heat is removed through evaporation and sensible heat transfer. When ambient air temperatures are low, the dry portion of these cooling towers may be sufficient to meet cooling needs. When ambient temperatures are high, the dry portion of these cooling towers would only be able to satisfy a small portion of the cooling need. The use of the dry portion of the system would result in a loss in generating efficiency that would translate into increased fuel cycle impacts. A combination wet/dry mechanical draft cooling tower system could reduce water-related impacts. However, as discussed in Chapter 5, the review team determined that the impacts associated with aquatic ecology, water use, and water quality for the operation of the proposed cooling system were SMALL. Therefore, any reduction in water use would not result in a lower impact level determination. The review team concluded, given the increased fuel cycle impacts, a combination wet/dry mechanical draft cooling tower system would not be an environmentally preferable alternative for Unit 3.

9.4.1.5 Natural Draft Cooling Towers

Natural draft cooling towers, which use about the same amount of water as the proposed design, induce airflow up through large (500 ft tall and 400 ft in diameter) towers by cascading hot water downward in the lower portion of the cooling tower. As heat transfers from the water to the air in the tower, the air becomes more buoyant and moves upward. This buoyant movement induces more air to enter the tower through its open base. The size of the cooling towers results in a large visual impact on the viewshed. The review team determined that this aesthetic issue makes the natural draft cooling tower alternative not environmentally preferable to the proposed design for a site such as Calvert Cliffs.

9.4.1.6 Dry Cooling Towers

Dry cooling towers would eliminate all water-related impacts from the cooling system operation. No makeup water would be needed, and no blowdown water would be generated. However, dry cooling systems require much larger cooling systems and result in both a loss in electrical generation efficiency (because the theoretical approach temperature is limited to the dry-bulb temperature and not the lower wet-bulb temperature) and greater parasitic energy losses for the large array of fans involved. This loss in generation efficiency translates into increased fuel cycle impacts. Because the impacts associated with aquatic ecology, water use, and water quality for the proposed cooling system have been determined to be SMALL in Chapters 4 and 5, respectively, the review team determined that although dry cooling eliminates water-related impacts, it is not environmentally preferred to the proposed alternative.

9.4.1.7 Cooling Pond and Spray Ponds

Cooling pond cooling systems circulate water in man-made ponds. Heat transfer from the cooling pond surface to the atmosphere occurs primarily through evaporation, black-body radiation, and conduction. Cooling ponds generally result in less consumptive water use than a conventional wet mechanical or natural draft cooling tower. Spray ponds enhance evaporative cooling by spraying water into the air over the pond. Although spray ponds require substantiality less area than cooling ponds, both require a significant parcel of contiguous level property. Based on the relief of the proposed site, the review team determined that neither cooling ponds nor spray ponds were feasible alternatives for the Calvert Cliffs site.

9.4.2 Intake and Discharge Systems

The review team evaluated alternatives related to the balance of the circulating water system, specifically the intakes and discharges for the normal heat sink cooling system. The evaluation was based on the proposed heat dissipation system water requirements. The capacity requirements of the intake and discharge system are defined by the proposed heat dissipation system. For proposed Unit 3, the proposed heat dissipation system is a closed-cycle mechanical draft cooling tower with plume abatement. The review team also considered alternatives for the water supply sources for both the normal heat sink cooling system and the service water systems in Section 9.4.3.

9.4.2.1 Intake Alternatives

Alternative intakes can be constructed either along the shoreline or offshore. With either shoreline or offshore intakes, the structures containing the pumps and screens would not be offshore due to the difficulty of maintaining them. For the U.S. EPR design, two independent intake systems are required to meet the water supply needs of normal operation and safety-related functions, respectively. Using a common forebay near the shoreline for UniStar's proposed intake design consolidates the impacts to one area and limits dredging to a small part of the Chesapeake Bay to install the intake pipelines. Therefore, the review team determined that there were no alternative intake designs that were environmentally preferable to proposed intake design.

9.4.2.2 Discharge Alternatives

Discharges for the normal or ultimate heat sink cooling system can be constructed either along the shoreline or offshore. Shoreline discharges release water into the shallow tidal zone with more limited mixing than an offshore discharge. These shallow tidal areas can be important habitat, and due to the limited mixing, a shoreline discharge can influence the temperature and chemistry for a relatively large amount of this habitat. Therefore, the review team determined there were no alternative intake designs that were environmentally preferable to UniStar's proposed offshore discharge design.

9.4.3 Water Supplies

The review team considered alterative sources for both normal heat sink cooling water and service water.

9.4.3.1 Water Reuse

Sources of water for reuse can either come from the plant itself or from other local water users. Sanitary wastewater treatment plants are the most ubiquitous source of water for reuse. Agricultural processing, industrial processing, and oilfield production can also provide significant supplies of water for reuse. Additional treatment (e.g., tertiary treatment, chlorination) may be required to provide water of appropriate quality for the specific plant need. Sources of water for reuse near the Calvert Cliffs site are limited, and, obtaining water from larger, more distant metropolitan areas would require installing considerable lengths of pipeline. Given the virtually unlimited water supply from the Chesapeake Bay, the review team determined that water reuse was not an environmentally preferable alternative to UniStar's proposed water supply for Unit 3.

9.4.3.2 Groundwater

Either freshwater, brackish, or hypersaline aquifers can provide water supplies for various water uses. Radial collector wells slowly draw surface water through sediments and, thereby, filter out some sediment that might have required treatment had the water been directly withdrawn from the surface waterbody. In general, groundwater withdrawals eliminate most direct operational impacts to aquatic ecosystems (e.g., entrainment and impingement) associated with water withdrawal and eliminate some of the building impacts (e.g., dredging). The review team determined that radial collector wells, inducing flow through the sediments beneath the Chesapeake Bay into lateral subterranean pipes extending from the shoreline out beneath the Chesapeake Bay, would require multiple large structures and pipelines near the shoreline. The space required for these structures would be greater that for the proposed system and would need to extend into the cliff area that is inhabited by the Federally listed Puritan tiger beetle (*Cicindela puritana*). UniStar did not consider such an alternative water source, but the review team independently determined that, even if such a system were feasible, a radial collector well design, although effectively eliminating impingement and entrainment, is not environmentally preferable to the proposed direct withdrawal of Chesapeake Bay water due to the requirement for multiple shoreline structures. UniStar proposes to not use groundwater for operation and would install a desalination system to provide freshwater for the needs of both the existing and proposed facilities. This would eliminate the existing demands for freshwater to the regional aquifer that has experienced considerable increase in local demand and, therefore, is environmentally preferable to any alternative that would rely on local freshwater aquifers.

9.4.4 Water Treatment

Both inflow and effluent water may require treatment to confirm they meet plant water needs and effluent water standards. UniStar proposes to add chemicals to plant water to meet appropriate water quality process needs. The effluent water chemistry is regulated by EPA through the NPDES permitting process. The largest chemical inputs are required to maintain the appropriate chemistry in the cooling towers to preclude biofouling. Mechanical treatment is generally not a viable option in cooling tower designs. Other alternatives to preclude biofouling, such as UV treatment, are feasible, but would not eliminate the need for some chemical treatment. Chemical treatment is a reliable and well-established engineering practice that has been shown to provide minimal impacts in a variety of settings. The review team identified no environmentally preferable alternative to UniStar's proposed chemical water treatment. The effluents from cooling tower blowdown are specifically regulated in 40 CFR 423 by the EPA to protect the environment.

9.4.5 Summary of System Design Alternatives

The review team considered a variety of heat dissipation systems, intake and discharge systems, water source, and water treatment alternatives. As previously discussed, the review team identified no environmentally preferable alternative to UniStar's proposed design.

9.5 References

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

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

10 CFR Part 52. Code of Federal Regulations, Title 10, *Energy*, Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

10 CFR Part 100. Code of Federal Regulations, Title 10, *Energy*, Part 100, "Reactor Site Criteria."

33 CFR Part 325. Code of Federal Regulations, Title 33, *Navigation and Navigable Waters*, Part 325, "Processing of Department of the Army Permits."

40 CFR Part 50. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 50, "National Primary and Secondary Ambient Air Quality Standards."

40 CFR Part 51. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 51, "Requirements for Preparation, Adoption, and Submittal of Implementation Plans."

40 CFR Part 60. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 60, "Standards of Performance for New Stationary Sources."

40 CFR Part 63. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 63, "National Emission Standards for Hazardous Air Pollutants for Source Categories."

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

40 CFR Part 230. Code of Federal Regulations, Title 40, *Protection of Environment, Part 230,* "Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material."

40 CFR Part 423. Code of Federal Regulations, Title 40, *Protection of Environment, Part 423,* "Stream Electric Power Generating Point Source Category."

40 CFR Part 1502. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 1502, "Environmental Impact Statement."

40 CFR Part 1508. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 1508, "Terminology and Index."

51 FR 30028. August 21, 1986. "Safety Goals for the Operations of Nuclear Power Plants; Policy Statement; Republication." *Federal Register*. U.S. Nuclear Regulatory Commission.

53 FR 3120. February 3, 1988. "Environmental Quality; Procedures for Implementing the National Environmental Policy Act (NEPA)." *Federal Register.* U.S. Army Corps of Engineers.

65 FR 32214. May 22, 2000. "Notice of Regulatory Determination on Wastes from the Combustion of Fossil Fuels." *Federal Register*. U.S. Environmental Protection Agency.

66 FR 65256. December 18, 2001. "National Pollutant Discharge Elimination System: Regulations Addressing Cooling Water Intake Structures for New Facilities." *Federal Register*. U.S. Environmental Protection Agency.

74 FR 19638. April 29, 2009. "Renewable Energy and Alternate Uses of Existing Facilities on the Outer Continental Shelf." *Federal Register*. U.S. Department of the Interior.

AES Corporation (AES). No date. *Mid-Atlantic Express Project Information, Maryland/Pennsylvania*. Accessed November 9, 2009 at http://www.mid-atlanticexpress.com/PDFs/AES%20Brochure%20all%202ndround%20changes%20Mid-Atlantic_handout_Rev2a_final_email.pdf.

Allegheny Energy, Inc. 2009. *Generating Facilities.* Accessed December 12, 2009 at http://www.alleghenyenergy.com/GenFacilities.asp.

American Recovery and Reinvestment Act of 2009. Public Law 111-5.

Avatar Environmental LLC (Avatar). 2004. *Notice of Inquiry Comment Review Avian/Communication Tower Collisions Final*. Prepared for Federal Communications Commission (FCC).

Bald and Golden Eagle Protection Act. 1992. 16 U.S.C. 668 et seq.

Bogan, A.E. and J. Alderman. 2008. *Workbook and Key to the Freshwater Bivalves of South Carolina*. Revised Second Edition. U.S. Fish and Wildlife Service, Charleston, South Carolina.

Bowers, H.A., T.M. Trice, R.E. Magnien, D.M. Goshorn, B. Michael, E.F. Schaefer, P.A. Rublee, and D.W. Oldach. 2006. "Detection of *Pfiesteria* spp. by PCR in Surface Sediments Collected from Chesapeake Bay Tributaries (Maryland)." *Harmful Algae* 5:342-351.

Brown, W.M. 1993. "Avian Collisions with Utility Structures: Biological Perspectives." In *Proceedings: Avian Interactions with Utility Structures, International Workshop*, pp. 12-1–3. Electric Power Research Institute (EPRI), Palo Alto, California.

Brush, G.S. and W.B. Hilgartner. 2000. "Paleoecology of Submerged Macrophytes in the Upper Chesapeake Bay." *Ecological Monographs* 70(4):645-667.

Cecil County Tourism (CCT). 2009. *Cecil County, Maryland Tourism, Recreation.* Perryville, Maryland. Accessed August 12, 2009 at http://www.ccgov.org/tourism/things_to_do.cfm.

Center for Watershed Protection (CWP). 2003. *The Breton Bay Watershed Restoration Action Strategy.* Prepared for St. Mary's County and The Town of Leonardtown: Maryland Department of Natural Resources, Maryland Coastal Zone Management Program publication prepared by the Center for Watershed Protection, Ellicott City, Maryland.

Chamblin, H.D., P.B. Wood and J.W. Edwards. 2004. "Allegheny Woodrat (*Neotoma magister*) Use of Rock Drainage Channels on Reclaimed Mines in Southern West Virginia." *American Midland Naturalist* 151:346-354.

Chesapeake Bay Program (CBP). 2009. *Water Quality – Maps*. Accessed September 1, 2009 at http://www.chesapeakebay.net/maps.aspx?menuitem=15165.

City of Brunswick. 2009. *City of Brunswick Water Resource Element.* Brunswick, Maryland. Accessed December 29, 2009 at http://www.mdp.state.md.us/PDF/OurWork/CompPlans/Frederick/Brunswick/09_Draft_WRE_Brunswick.pdf.

Clean Air Act. 42 U.S.C. 7401 et seq.

Clean Water Act. 33 U.S.C. 1251, et seq. (also referred to as the Federal Water Pollution Control Act (FWPCA)).

ConEdison Development. 2009. *Rock Springs Generation Facility.* Accessed December 18, 2009 at http://www.coneddev.com/con_edison_development/projects/rock.asp.

Conner, A.M. and J.E. Francfort. 1997. *U.S. Hydropower Resource Assessment for Maryland*. DOE/ID-10430(MD). Idaho National Engineering and Environmental Laboratory. Idaho Falls, Idaho. Available at hydropower.inel.gov/resourceassessment/pdfs/states/md.pdf.

Cornell Lab of Ornithology. 2009. "Sedge Wren." In *All About Birds.* Cornell Lab of Ornithology, Ithaca, New York.

Cunningham, G.R. 2006. *Pearl Dace* (Margariscus margarita) *A Technical Conservation Assessment*. USDA Forest Service, Rocky Mountain Region. Accessed October 30, 2009 at http://www.fs.fed.us/r2/projects/scp/assessments/pearldace.pdf. Accession No. 100481436.

Dominion. 2009. *Dominion Cove Point LNG.* Accessed December 16, 2009 at http://www.dom.com/business/gas-transmission/cove-point/index.jsp.

EA Engineering, Science, and Technology (EA Engineering). 2008. *Entrainment Characterization Data Report for Calvert Cliffs Nuclear Power Plant*. Prepared for Constellation Energy. Accession No. ML083110678.

Electric Power Research Institute (EPRI). 2002. *Siting Guide: Site Selection and Evaluation Criteria for an Early Site Permit Application, Final Report*. Product ID: 1006878, EPRI, Palo Alto, California.

EmPOWER Maryland Energy Efficiency Act. 2008. Maryland Laws page 892.

Energy Policy Act of 2005. 45 U.S.C. 15801 et seq.

Exelon Corporation. 2009. *Conowingo Hydroelectric Station.* Accession No. ML093080206.

Federal Aviation Administration (FAA). 2007. *Obstruction Marking and Lighting*. Advisory Circular AC 70/7460-1K. U.S. Department of Transportation, Federal Aviation Administration, Washington D.C. Accessed November 24, 2009 at https://oeaaa.faa.gov/oeaaa/external/content/AC70_7460_1K.pdf. Accession No. ML093280428.

Federal Regulatory Commission (FERC). 2008. *Environmental Impact Statements (EISs) – Final Environmental Impact Statement for the Holtwood Hydroelectic Project, No. 1881-050.* Accessed December 21, 2009 at http://www.ferc.gov/industries/hydropower/enviro/eis/2008/11-14-08.asp. Accession No. ML100540808.

Federal Energy Regulatory Commission (FERC). 2009a. *Application for Pipeline Certificate of Dominion Cove Point LNG, LP in CP09-60*. Docket numbers CP09-60-000, CP09-60-001.

Federal Energy Regulatory Commission (FERC). 2009b. *Request for Rehearing of Washington Gas Light Company under CP09-60, et al.* Docket numbers CP09-60-002.

Fort Detrick. 2009. *Fort Detrick, Maryland.* Accessed December 28, 2009 at http://www.detrick.army.mil.

Foster, A.M., P. Fuller , A. Benson, S. Constant, and D. Raikow. 2009. "*Corbicula fluminea*." *USGS Nonindigenous Aquatic Species Database*, Gainesville, Florida. Accessed October 29, 2009 at http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=92.

Frederick County Board of County Commissioners (FCBCB). 2008. *Frederick County, Maryland Summary of the Proposed Operating & Capital Budgets Fiscal Year 2009.* Frederick, Maryland.

Gabbard, A. 1993. "Coal Combustion: Nuclear Resource or Danger." *Oak Ridge National Laboratory Review*. Oak Ridge National Laboratory, Oak Ridge, Tennessee. Accessed November 24, 2009 at http://www.ornl.gov/ORNLReview/rev26-34/text/colmain.html.

Gazzette.Net. 2009. "Land-use changes could thwart Eastalco plans." Accessed October 23, 2009 at http://www.gazette.net/stories/08272009/busiflo135922_32521.shtml.

Grabarkiewicz, J.D. and W.S. Davis. 2008. *An Introduction to Freshwater Mussels as Biological Indicators, Including Accounts of Interior Basin, Cumberlandian, and Atlantic Slope Species*. EPA-260-R-08-015. U.S. Environmental Protection Agency, Office of Environmental Information, Washington, D.C.

Great Schools (GS). 2008. *Great Schools*. Accessed September 4, 2008 at http://www.greatschools.net/.

Historic Port Deposit (HPD). 2009. Fishing Around Port Deposit. Accessed October 30, 2009. at http://www.portdeposit.com/nature/fishing.htm.

Houston, C.S. and D.E. Bowen Jr. 2001. "Upland Sandpiper." In *Birds of North America Online.* Cornell Lab of Ornithology, Ithaca, New York.

James D.A. and A.R. Green. 2009. *A Status Assessment of the Eastern Subspecies of Bewick's Wren (*Thryomanes bewickii bewickii *and* Thryomanes bewickii altus). University of Arkansas, Fayetteville, Arkansas.

Lee, D.S., S.P. Platania, C.R. Gilbert, R. Franz, and A. Norden. 1981. "A Revised List of the Freshwater Fishes of Maryland and Delaware." *Southeastern Fishes Council Proceedings* 3(3).

Magnuson-Stevens Fishery Conservation and Management Act. 16 U.S.C. 1801 et seq.

Maine Department of Inland Fisheries & Wildlife (ME DIFW). 2003. *Tidewater Mucket* (*Leptodea ochracea*). Accessed November 2, 2009 at http://www.maine.gov/ifw/wildlife/species/endangered_species/tidewater_mucket/index.htm.

Maryland Critical Area Commission for the Chesapeake and Atlantic Coastal Bays (Maryland CAC). 2000. *A Guide to the Conservation of Forest Interior Dwelling Birds in the Chesapeake Bay Critical Area.* Annapolis, Maryland.

Maryland Department of Business & Economic Development (MDBED). 2009. *Frederick County, Maryland – Brief Economic Facts*. Baltimore, Maryland.

Maryland Department of the Environment (MDE). 2007. *Facts About… PB II, LLC (Voluntary Cleanup Program)*. Available through http://www.mde.state.md.us.

Maryland Department of the Environment (MDE). 2008. *Water Quality Analysis of Cadmium in Lower Susquehanna River, Cecil and Harford County, Maryland*. Final Report. Baltimore, Maryland. Available at http://www.mde.maryland.gov/programs/waterprograms/tmdl/approvedfinaltmdl/wqa_final_lowersusquehanna_cd.asp.

Maryland Department of the Environment (MDE). 2009a. *Facts About Leonardtown Wastewater Treatment Plant*. Accessed November 10, 2009 at http://www.google.com/search?hl=en&source=hp&q=leonardtown+wastewater+treatment+plant&aq=f&oq=&aqi=.

Maryland Department of the Environment (MDE). 2009b. *Facts About PB II, LLC (Voluntary Cleanup Program)*. Accessed October 21, 2009 at: http://textonly.mde.state.md.us/Programs/LandPrograms/ERRP_Brownfields/mapping/errp_factsheets.asp.

Maryland Department of Natural Resources (MDNR). 2001. *Physiographic Provinces and Their Subdivisions in Maryland.* Maryland Geological Survey.

Maryland Department of Natural Resources (MDNR). 2002a. *Breton Bay Watershed Characterization*. Maryland Department of Natural Resources, Annapolis, Maryland.

Maryland Department of Natural Resources (MDNR). 2002b. *Report on Nutrient and Macroinvertebrtate Synoptic Surveys in the Breton Bay Watershed, St. Mary's County, Maryland, April 2002 as Part of the Watershed Restoration Action Strategy*. Chesapeake and Coastal Watershed Service, Annapolis, Maryland.

Maryland Department of Natural Resources (MDNR). 2003a. *Basin Overview, Upper Potomac*. Annapolis, Maryland.

Maryland Department of Natural Resources (MDNR). 2003b. *Lower Patuxent River in Calvert County Watershed Characterization*. Annapolis, Maryland. Accession No. ML093210624.

Maryland Department of Natural Resources (MDNR). 2005. Maryland Wildlife Diversity Conservation Plan. Maryland Department of Natural Resources, Wildlife and Heritage Service, Annapolis, Maryland.

Maryland Department of Natural Resources (MDNR). 2006. *Hellbender (*Cryptobranchus alleganiensis). Accessed on October 29, 2009 at http://www.dnr.state.md.us/wildlife/rtehellbender.asp. Accession No. ML100191072.

Maryland Department of Natural (MDNR). 2007a. *Calvert Cliffs State Park*. Accessed November 19, 2008 at http://www.dnr.state.md.us/publiclands/southern/calvertcliffs.html.

Maryland Department of Natural Resources (MDNR). 2007b. *Channel Catfish,* Ictalurus punctatus *(A.K.A. Forked Tail, Blue-channel Cat, Spotted Cat, River Cats)*. Accessed November 2, 2009 at http://www.dnr.state.md.us/fisheries/fishfacts/channelcatfish.asp.

Maryland Department of Natural Resources (MDNR). 2007c. *Current and Historical Rare, Threatened, and Endangered Species of Cecil County, Maryland*. Maryland Department of Natural Resources, Wildlife and Heritage Service, Annapolis, Maryland.

Maryland Department of Natural Resources (MDNR). 2007d. *Current and Historical Rare, Threatened, and Endangered Species of Frederick County, Maryland*. Maryland Department of Natural Resources, Wildlife and Heritage Service, Annapolis, Maryland.

Maryland Department of Natural Resources (MDNR). 2007f. *Current and Historical Rare, Threatened, and Endangered Species of St. Mary's County, Maryland*. Maryland Department of Natural Resources, Wildlife and Heritage Service, Annapolis, Maryland.

Maryland Department of Natural Resources (MDNR). 2007g. *Largemouth Bass,* Micropterus salmoides. Accessed November 2, 2009 at http://www.dnr.state.md.us/fisheries/fishfacts/lgmouthbass.asp.

Maryland Department of Natural Resources (MDNR). 2007h. *Maryland Tributary Strategy Middle Potomac River Basin Summary Report for 1985-2005 Data*. Maryland Department of Natural Resources, Tidewater Ecosystem Assessment, Annapolis, Maryland.

Maryland Department of Natural Resources (MDNR). 2007i. *Maryland Tributary Strategy Patuxent River Basin Summary Report for 1985-2005 Data*. Maryland Department of Natural Resources, Annapolis, Maryland.

Maryland Department of Natural Resources (MDNR). 2007j. *Maryland Tributary Strategy Upper Potomac River Basin Summary Report for 1985-2005 Data*. Maryland Department of Natural Resources, Tidewater Ecosystem Assessment, Annapolis, Maryland.

Maryland Department of Natural Resources (MDNR). 2007l. *Rusty Crayfish*, (Orconectes rusticus). Accessed October 29, 2009 at http://www.mdinvasivesp.org/archived_invaders/archived_invaders_2007_11.html

Maryland Department of Natural Resources (MDNR). 2007m. *Smallmouth bass,* Micropterus dolomieu. Accessed November 2, 2009 at http://www.dnr.state.md.us/fisheries/fishfacts/smallmouthbass.asp.

Maryland Department of Natural Resources (MDNR). 2007n. *Walleye*, Stizostedion vitreum. Accessed November 2, 2009 at http://www.dnr.state.md.us/fisheries/fishfacts/walleye.asp.

Maryland Department of Natural Resources (MDNR). 2007o. *White Catfish*, Ameiurus catus*, (A.K.A. – Mudcats, cats)*. Accessed October 23, 2008 at http://www.dnr.state.md.us/fisheries/fishfacts/whitecatfish.asp.

Maryland Department of Natural Resources (MDNR). 2008. *Maryland 2004 Bald Eagle Nesting Summaries by County and by Select Watersheds.* Accessed September 25, 2009 at http://www.dnr.state.md.us/wildlife/2004benestsum.asp.

Maryland Department of Natural Resources (MDNR). 2009a. *Are there zebra mussels in the Chesapeake Bay Watershed?* Accessed October 30. 2009 at http://www.dnr.state.md.us/IRC/zebra/zm_bay.html.

Maryland Department of Natural Resources (MDNR). 2009b. *Bald Eagle.* Accessed at http://dnr.maryland.gov/wildlife/baldeagle.html.

Maryland Department of Natural Resources (MDNR). 2009c. *Bainbridge CWMA.* Accessed August, 12, 2009 at http://www.dnr.maryland.gov/publiclands/central/bainbridge.asp.

Maryland Department of Natural Resources (MDNR). 2009d. *Checkered Sculpin*. Accessed October 30, 2009 at http://mddnr.chesapeakebay.net/mbss/SA_spec6.cfm?species=Checkered%20sculpin.

Maryland Department of Natural Resources (MDNR). 2009e. *Crayfish Ban in Effect for Middle Potomac and Susquehanna River Basins.* Accessed November 2, 2009 at http://dnr.maryland.gov/fisheries/recreational/index.asp#4e. Accession No. ML100481359.

Maryland Department of Natural Resources (MDNR). 2009f. *Elements of MD's Oyster Recovery Initiative*. Accessed October 12, 2009 at http://www.dnr.state.md.us/fisheries/oysters/mtgs/071509/OysterrestorationplanJuly152009%5B1%5D.pdf.

Maryland Department of Natural Resources (MDNR). 2009g. *Maryland's Inland Fisheries Hotspots*. Accessed November 2, 2009 at http://www.dnr.state.md.us/fisheries/recreational/fwhot.html.

Maryland Department of Natural Resources (MDNR). 2009h. *Oyster Advisory Committee Meeting*. Accessed October 12, 2009 at http://www.dnr.state.md.us/fisheries/oysters/mtgs/052009/DNR52009OACpresentation.pdf.

Maryland Department of Natural Resources, Power Plant Research Program (MDNR PPRP). 2006. *Environmental Review of the Proposed Catoctin Power Project.* Maryland Power Plant Research Program, DNR 12-8112006-156, PPSE-CAT-01. Annapolis, Maryland.

Maryland Department of Natural Resources, Power Plant Research Program (MDNR PPRP). 2008. Maryland Power Plants and the Environment. A Review of the Impacts of Power Plants and Transmission Lines on Maryland's Natural Resources. Maryland Cumulative Environmental Impact Report — 14th Edition. MDNR Publication No. 12-1142008-271, PPRP-CEIR-14.

Maryland Public Service Commission (MPSC). 2007. *Electric Supply Adequacy Report of 2007*. Accessed August 29, 2008 at http://webapp.psc.state.md.us/Intranet/psc/Reports_new.cfm.

Maryland Public Service Commission (MPSC). 2008a. *Ten-Year Plan (2007-2016) of Electric Companies in Maryland*. Accessed August 29, 2008 at http://webapp.psc.state.md.us/Intranet/psc/Reports_new.cfm.

Maryland Public Service Commission (MPSC). 2008b. *Final Report Under Senate Bill 400: Options for Re-Regulation and New Generation*. Accessed December 22, 2008 at http://webapp.psc.state.md.us/Intranet/sitesearch/whats_new/MD%20PSC%20Slide%20Presentation_12.16.08_Re%20SB%20400%20Final%20Report.pdf.

Maryland Public Service Commission (MPSC). 2008c. *In the Matter of Baltimore Gas and Electric Company's Energy Efficiency, Conservation and Demand Response Programs Pursuant to the Empower Maryland Energy Efficiency Act of 2008*. Order No. 82384. Case No. 9154.

Maryland Public Service Commission (MPSC). 2009a. *In the Matter of the Application of UniStar Nuclear Energy, LLC and UniStar Nuclear Operating Services, LLC for a Certificate of Public Convenience and Necessity to Construct a Nuclear Power Plant at Calvert Cliffs in Calvert County, Maryland*. Case Number 9127. Order Number 82741.

Maryland Public Service Commission (MPSC). 2009b. *Ten-Year Plan (2008-2017) of Electric Companies in Maryland*. Accessed October 8, 2009 at http://webapp.psc.state.md.us/Intranet/psc/Reports_new.cfm.

Maryland State Department of Education (MSDE). 2005. *Maryland State Department of Education, Maryland Public School Enrollment by Race/Ethnicity and Gender and Number of Schools, September 30, 2005*. Accessed December 2, 2008 at http://www.marylandpublicschools.org/NR/rdonlyres/85E7723B-CB82-46B0-AD4B-EAD45A69B4F2/8628/enroll05.pdf.

Maryland State Highway Administration (MD SHA). 2009a. *Frederick County – Pre-Construction.* Accessed December 28, 2009 at http://www.sha.state.md.us/WebProjectLifeCycle/countyProjects.asp?county=10.

Maryland State Highway Administration (MD SHA). 2009b. *Project Information – IS 0270 Shady Grove Metro to North of Biggs Ford Road*. Accessed December 10, 2009 at http://www.marylandroads.com/WebProjectLifeCycle/ProjectInformation.asp?projectno=FR1921110.

Maryland State Highway Administration (MD SHA). 2009c. *MD 0004 Solomons Island Rd/Patuxent Beach Rd Upgrade Between MD 2 and MD 235.* Accessed December 28, 2009 at http://www.sha.state.md.us/WebProjectLifeCycle/ProjectInformation.asp?projectno=SM351114.

Maryland State Highway Administration (MD SHA). 2009d. *MD 0005 Point Lookout Road MD 243 (Newtowne Neck Road/Maypole Rd) and MD 245 (Hollywood Rd).* Accessed December 10, 2009 at http://www.marylandroads.com/WebProjectLifeCycle/ProjectInformation.asp?projectno=SM3521118.

Maryland State Highway Administration (MD SHA). 2009e. MD 0237 Chancellor's Run Road RI – MD 235 to Pegg Road. Accessed December 10, 2009 at http://www.marylandroads.com/WebProjectLifeCycle/ProjectInformation.asp?projectno=SM7575118.

Massachusetts Institute of Technology (MIT). 2006. *The Future of Geothermal Energy*. Accessed November 6, 2008 at http://geothermal.inel.gov/publications/future_of_geothermal_energy.pdf.

Mayasich, J., D. Grandmaison, and C. Phillips. 2003. *Eastern Hellbender Status Assessment Report.* NRRI/TR-2003/09. U.S. Fish and Wildlife Service, Region 3.

McLean, R., W.A. Rickhus, S.P. Schreiner, and D. Fluke. 2002. *Maryland Power Plant Cooling Water intake Regulations and Their Application in Evaluation of Adverse Environmental Impact*. PPRP-127, Maryland Department of Natural Resources, Annapolis, Maryland.

Mid-Atlantic Power Pathway (MAPP). 2009. *Project Schedule*. Accessed November 4, 2009 at http://www.powerpathway.com/schedule.html.

Millard, C.J., P.F. Kazyak, and D.M. Boward. 1999. *Lower Susquehanna Basin Environmental Assessment of Stream Conditions*. Maryland Department of Natural Resources, Resource Assessment Service, Annapolis, Maryland.

Mirant. 2009a. *Dickerson Generating Plant.* Accessed December 21, 2009 at http://www.mirant.com/our_business/where_we_work/dickerson.htm.

Mirant. 2009b. *Chalk Point Generating Plant.* Accessed December 16, 2009 at http://www.mirant.com/our_business/where_we_work/chalkpoint.htm.

Mirant. 2009c. *Morgantown Generating Plant*. Accessed December 28, 2009 at http://www.mirant.com/our_business/where_we_work/morgantown.htm.

Montgomery County. 2009. *Division of Solid Waste Services – Resource Recovery Facility.* Accessed December 21, 2009 at http://www.montgomerycountymd.gov/swstmpl.asp?url=/content/dep/solidwaste/facilities/rrf.asp.

Morse, D.H. 2004. “Blackburnian Warbler.” In *Birds of North America Online.* Cornell Lab of Ornithology, Ithaca, New York.

Moulder, J.E. 2003. *Powerlines & Cancer FAQs.* Accessed October 31, 2008 at http://www.faqs.org/faqs/medicine/powerlines-cancer-faq/.

National Center for Education Statistics (NCES). 2009. *Frederick County Public Schools.* Common Core of Data. Accessed at http://nces.ed.gov/ccd/districtsearch/district_list.asp?Search=1&State=24&County=frederick.

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

National Energy Technology Laboratory (NETL). 2007. *Cost and Performance Baseline for Fossil Energy Plants. Volume 1: Bituminous Coal and Natural Gas to Electricity*. DOE/NETL-2007/1281. Available at http://www.netl.doe.gov/energy-analyses/pubs/Bituminous%20Baseline_Final%20Report.pdf. Accession No. ML093280556.

National Marine Fisheries Service (NMFS). 2007. *Species of Concern, River herring (Alewife and Blueback herring),* Alosa pseudoharengus *and* A. aestivalis. Accessed October 7, 2008 at www.nmfs.noaa.gov/pr/pdfs/species/riverherring_detailed.pdf. Accession No. ML100481337.

National Marine Fisheries Service (NMFS). 2009. Letter from J. Nichols (NMFS) to L. Quinn (NRC) dated December 10, 2009, “Subject: Calvert Cliffs Nuclear Power Plant, Unit 3 Alternative Sites Analysis. Accession No. ML093520687.

National Park Service (NPS). 2009. *Chesapeake and Ohio Canal: History and Cultural.* National Park Service, U.S. Department of the Interior. Accessed on October 10, 2009 at http://www.nps.gov/choh/historyculture/index.htm. Accession No. ML100481428.

National Park Service (NPS). 2010a. Star-Spangled Banner National Historic Trail. Accessed on January 20, 2010 at http://www.nps.gov/stsp/index.htm. Accession No. ML100750370.

National Park Service (NPS). 2010b. Captain John Smith Chesapeake National Historic Trail. Accessed on January 29, 2010 at http://www.nps.gov/cajo/index.htm. Accession No. ML100750366.

National Park Service (NPS). 2010c. Potomac Heritage National Scenic Trail. Accessed on January 29, 2010 at http://www.nps.gov/pohe/index.htm. Accession No. ML100820308.

National Register of Historical Places (NRHP). 2006. *Maryland – Cecil County – Historic Districts – Tome School for Boys Historic District.* Accessed March 17, 2010 at http://www.nationalregisterofhistoricplaces.com/MD/cecil/districts.html.

NatureServe. 2007. "*Gastrophryne carolinensis*, Eastern Narrowmouth Toad." In *NatureServe Explorer*. Accessed February 7, 2008 at http://www.natureserve.org/explorer/servlet/NatureServe?searchName=Gastrophryne+carolinensis.

NatureServe. 2009. "*Cicindela patruela patruela*, Northern Barrens Tiger Beetle." In *NatureServe Explorer*. Accessed October 20, 2009 at http://www.natureserve.org/explorer/servlet/NatureServe?searchName=CICINDELA+PATRUELA+PATRUELA.

Near, T.J. 2008. "Rescued from Synonymy: A Redescription of *Percina bimaculata* Haldeman and a Molecular Phylogenetic Analysis of Logperch Darters (Percidae: Etheostomatinae)." *Bulletin of the Peabody Museum of Natural History* 49:3-18.

Nedeau, E. 2007. *Creeper*, Strophitus undulatus. Massachusetts Division of Fisheries & Wildlife, Westborough, Massachusetts. Accessed November 2, 2009 at http://www.mass.gov/dfwele/dfw/nhesp/species_info/nhfacts/strophitus_undulatus.pdf.

Neely, D.A. and A.L. George. 2006. Range extensions and rapid dispersal of *Etheostoma blennioides* (Teleostei: Percidae) in the Susquehanna River drainage. *Northeastern Naturalist* 13:391-402.

New England Coalition on Nuclear Pollution. 1978. *New England Coalition on Nuclear Pollution v. NRC*. 582 F.2d 87 (1st Circuit 1978).

New York State Department of Environmental Conservation (NYSDEC). 2008a. *Comely Shiner* (Notropis Amoenus). Accessed October 23, 2008 at http://pond.dnr.cornell.edu/nyfish/cyprinidae/s_comely_shiner.html.

New York State Department of Environmental Conservation (NYSDEC). 2008b. *Ironcolor Shiner Fact Sheet.* Accessed October 23, 2008 at http://www.dec.ny.gov/animals/26037.html.

NextEra Energy. 2009. "SEGS III, IV, V, VI, VII, VIII, and IX." Accessed November 24, 2009 at http://www.nexteraenergyresources.com/content/where/portfolio/solar/facts.shtml#glance.

Northwest Power and Conservation Council (NPCC). 2005. *The Fifth Northwest Electric Power and Conservation Plan*. Accessed November 6, 2008 at http://www.nwcouncil.org/energy/powerplan/5/Default.htm.

Northwest Power and Conservation Council (NPCC). 2006. *Biennial Assessment of the Fifth Power Plan: Assessment of Other Generating Technologies*. Accessed November 6, 2008 at http://www.nwppc.org/energy/Biennial/BiennialOther%20gen.pdf.

Northwest Power and Conservation Council (NPCC). 2009. *Draft Northwest 6th Power Plan*. Accessed September 29, 2009 at http://www.nwppc.org/energy/powerplan/6/default.htm.

Nuclear Energy Institute (NEI). 2009. *U.S. Nuclear Industry Capacity Factors (1971 - 2008*). Accessed November 24, 2009 at http://www.nei.org/resourcesandstats/documentlibrary/reliableandaffordableenergy/graphicsandcharts/usnuclearindustrycapacityfactors/.

Patty, S.S., N. Roth, and D. Mountain. 1999. Maryland, the Power Plant Research Program, and the Chesapeake Bay watershed. *The Science of the Total Environment* 240:171-188.

Pearce, T.A. and R. Evans. 2008. "Freshwater Mollusca of Plummers Island, Maryland." *Bulletin of the Biological Society of Washington* May 2008(15):20-30.

Pennsylvania Natural Heritage Program (PANHP). 2009a. *Eastern Lampmussel (*Lampsilis radiata). Accessed May 19, 2009 at http://www.naturalheritage.state.pa.us/factsheets/12218.pdf.

Pennsylvania Natural Heritage Program (PANHP). 2009b. *Checkered Sculpin* (Cognatus *n.sp.*). Accessed October 30, 2009 at http://www.naturalheritage.state.pa.us/factsheets/11258.pdf.

Peroutka, M., W. Adlassnig, M. Volgger, T. Lendl, W.G. Url, and I.K. Lichtscheidl. 2008. "*Utricularia*: a vegetarian carnivorous plant? Algae as prey of bladderwort in oligotrophic bogs." *Plant Ecology* 199(2):153–162.

Port Deposit Chamber of Commerce (PDCC). 2009a. *Mark your Calendar's* [sic] *for the 4th Annual Lower Susquehanna Rockfish Tournament*. Accessed October 30, 2009 at http://www.portdepositcc.org/?a=10_tournament.

Port Deposit Chamber of Commerce (PDCC). 2009b. 2009 Classes and Course Map. Accessed October 30, 2009 at http://www.portdepositcc.org/ragin/?a=race_classes.

Potomac-Appalachian Transmission Highline Project (PATH). 2009a. *PATH - Potomac-Appalachian Transmission Highline*. Accessed January 5, 2010 at http://www.pathtransmission.com/.

Potomac-Appalachian Transmission Highline Project (PATH). 2009b. “Maps.” Accessed December 10, 2009 at http://pathtransmission.com/maps/default.asp#County.

Price, J. 2009. *Atlantic Spike* Elliptio producta. South Carolina Department of Natural Resources. Accessed October 28, 2009 at www.dnr.sc.gov/cwcs/pdf/AtlanticSpike.pdf.

Public Service Company of New Hampshire. 1977. *Public Service Co. of New Hampshire (Seabrook Station, Units 1 & 2*), CLI-77-8, 5 NRC 503, 526 (1977), affirmed, *New England Coalition on Nuclear Pollution v. NRC,* 582 F.2d 87 (1st Circuit 1978).

Recovery Accountability and Transparency Board. 2009. *Contracts – Award Summary – Great Lakes Dredge & Dock Company, LLC*. Accessed December 19, 2009 at http://www.recovery.gov/Transparency/RecipientReportedData/pages/RecipientProjectSummary508.aspx?AwardIdSur=44790&AwardType=Contracts.

Reliability First Corporation (RFC). 2009. Long Term Resource Assessment 2009-2018. Accessed November 24, 2009 at http://www.rfirst.org/Reliability/ReliabilityHome.aspx.

Resource Conservation and Recovery Act. (RCRA). 42 U.S.C. 6901 et seq.

Reuven, Y. 1996. “Loggerhead Shrike.” In *Birds of North America Online.* Cornell Lab of Ornithology, Ithaca, New York.

Richards, T. and R. Seigel. 2009. Habitat use of Northern Map Turtles (*Graptemys geographica*) in an altered system, the Susquehanna River, Maryland (USA). Poster, Ecological Society of America 2009 Annual Meeting. Albuquerque, New Mexico.

Ringger, T.G. 2000. “Investigations of Impingement of Aquatic Organisms at the Calvert Cliffs Nuclear Power Plant, 1975-1995.” *Environmental Science and Policy* 3:S261-S273.

Roche, B. 2002. *COSEWIC Assessment and Status Report on the Northern Map Turtle* Graptemys geographica *in Canada*. Committee on the Status of Endangered Wildlife in Canada. Ottawa.

Rochester Gas & Electric Corp. 1978. Rochester Gas & Electric Corp. (Sterling Power Project Nuclear Unit No. 1). ALAB-502, 8 NRC 383, 39 (1978), affirmed, CLI-80-23, 11 NRC 731 (1980).

Sage Policy Group, Inc. 2007. *The Cecil County Growth Study.* Baltimore, Maryland.

St. Mary's County Board of County Commissioners (SMCBCC). 2005. *St. Mary's County 2005 Land Preservation, Parks, and Recreation Plan*. Accessed November 19, 2008 at http://www.co.saint-marys.md.us/recreate/docs/2005R&PLandPreservationPlan.pdf.

St. Mary's County Tourism Department (SMCTD). 2009. "History and Heritage." *St. Mary's Travel & Tourism.*

St. Mary's County Public Schools (SMCPS). 2008. *St. Mary's County Public Schools*. Accessed December 2, 2008 at http://www.smcps.k12.md.us/.

St. Mary's Travel and Tourism (SMTT). 2008. *State Parks*. Accessed November 19, 2008 at http://tour.co.saint-marys.md.us/tourismtemplate.asp?content=stateparkscontent.asp.

Sage Policy Group, Inc. 2007. *The Cecil County Growth Study.* Baltimore, Maryland.

Southern Co. and Georgia Institute of Technology (Southern and GIT). 2007. *Southern Winds: A Study of Wind Power Generation Potential off the Georgia Coast*. Accessed November 6, 2008 at http://www.energy.gatech.edu/news-events/release.php?id=1622.

Steiner, L. 2000. *Pennsylvania Fishes*. Pennsylvania Fish & Boat Commission. Harrisburg, Pennsylvania.

Succar, S. and R. H. Williams. 2008. "Compressed Air Energy Storage: Theory, Resources, and Applications for Wind Power." Princeton University Energy Systems Analysis Group. Accessed September 30, 2009 at http://www.princeton.edu/~ssuccar/caesReport.html.

Susquehanna River Basin Commission (SRBC). 2006. Conowingo Pond Management Plan—A Summary. Accessed November 9, 2009 at http://www.srbc.net/conowingo.htm.

Texas State Energy Conservation Office (TSECO). 2008. *Texas Solar Energy*. Accessed July 21, 2008 at http://www.seco.cpa.state.tx.us/re_solar.htm.

Thompson, B.C., J.A. Jackson, J. Burger, L.A. Hill, E.M. Kirsch, and J.L. Atwood. 1997. "Least Tern." In *Birds of North America Online.* Cornell Lab of Ornithology, Ithaca, New York.

Town of Port Deposit. 2008. "Bainbridge Development News." Accessed October 23, 2009 at http://www.portdeposit.org/?a=bainbridge1.

UniStar Nuclear Energy (UniStar). 2008a. Letter from G. Vanderheyden (UniStar) to NRC dated August 18, 2008, “Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Submittal of Response to Requests for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3 and Request for Withholding of Documents.” In response to NRC’s Request for Additional Information dated May 13, 2008. Accession No. ML100970387.

UniStar Nuclear Energy (UniStar). 2008b. Letter from G Vanderheyden (UniStar) to NRC dated June 12, 2008, “Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Submittal of Response to Requests for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3 and Request for Withholding of Documents.” In response to NRC’s Request for Additional Information dated May 13, 2008. Accession No. ML100040300.

UniStar Nuclear Development, LLC (UniStar). 2009a. *Calvert Cliffs Nuclear Power Plant Unit 3 Combined License Application, Part 3, Environmental Report*. Revision 6, UniStar, Baltimore, Maryland, September 30, 2009. Accession No. ML092880921.

UniStar Nuclear Energy (UniStar). 2009b. Letter from D. Lutchenkov (UniStar) to William Seib (USACE) in response to USACE’s Request for Additional Information dated October 28, 2008, Supplemental Response to Question 2, “Subject: Joint Federal/State Application of Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC, Calvert Cliffs Nuclear Power Plant Site, Lusby, Calvert County, Maryland,” USACE Tracking No. NAB-2007-08123-M05. February 27, 2009. Accession No. ML091480200.

UniStar Nuclear Energy (UniStar). 2009c. Letter from G. Gibson (UniStar) to NRC in response to Request for Additional Information dated February 3, 2009, “Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Calvert Cliffs Nuclear Power Plant, Unit 3, Environmental RAIs No. 1001 through 1011.” In response to NRC’s Request for Additional Information dated February 3, 2009. March 5, 2009. Accession No. ML0907101463.

UniStar Nuclear Energy (UniStar). 2009d. *Calvert Cliffs Nuclear Power Plant Unit 3 Combined License Application, Part 3, Environmental Report*. Revision 5, June 30, 2009, Baltimore, Maryland, June 30, 2009. Accession No. ML092330294.

UniStar Nuclear Energy (UniStar). 2009e. Letter from G. Gibson (UniStar Nuclear Energy) to NRC dated August 29, 2009, “Subject: NRC Docket No. 52-016 Calvert Cliffs Nuclear Power Plant, Unit 3, Alternative Site Evaluation and Environmental Report Chapter 9.3.” Accession No. ML092450557.

UniStar Nuclear Energy (UniStar). 2009f. Letter from G. Gibson (UniStar) to B. Bachur (USACE) dated September 25, 2009. “Subject: Summary of Phase I Compensatory Mitigation plan for Non-Tidal Wetland and Stream Impacts, Calvert Cliffs Nuclear Power Plant Unit 3, Calvert County, Maryland.” Accession No. ML092730188.

UniStar Nuclear Energy (UniStar). 2009g. Letter from G. Gibson (UniStar) to NRC dated October 15, 2009. "Subject: UniStar Nuclear Energy, NRC Docket No. 52-016, Calvert Cliffs Nuclear Power Plant, Unit 3, Supplemental Response to Environmental Report, RAI No. 1019, U.S. Army Corps of Engineers (USACE), Question No. 1 and No. 5." Accession No. ML092920352.

U.S. Army Base Realignment and Closure Division (BRACD). 2005. BRAC 2005 Army Recommendations. Aberdeen Proving Ground, Maryland (Army Recommendation-Fort Monmouth, New Jersey). Available at http://www.hqda.army.mil/acsim/brac/StateInstallationBreakdown/MDAberdeenProvingGround.pdf. Accession No. ML100500717.

U.S. Army Corps of Engineers, Headquarters (HQUSACE). 1989. Memorandum from Patrick J. Kelly, USACE Director of Civil Works, to Commander, U.S. Army Engineer District, New Orleans, regarding "Permit Elevation, Plantation Landing Resort, Inc." April 21, 1989. Available at http://www.epa.gov/owow/wetlands/pdf/PlantationLandingRGL.pdf. Accession No. ML100490592.

U.S. Bureau of Labor Statistics (USBLS). 2007a. *May 2007 State Occupational Employment and Wage Estimates, Maryland*. Accessed October 29, 2008 at http://stats.bls.gov/oes/current/oes_md.htm. Accession No. ML100490592.

U.S. Bureau of Labor Statistics (USBLS). 2007b. *May 2007 Metropolitan and Nonmetropolitan Area Occupational Employment and Wage Estimates, Metropolitan and Nonmetropolitan Area*. Occupational Employment and Wage Estimates, *Washington-Arlington-Alexandria, DC-VA-MD-WV*. Accessed November 18, 2008 at http://www.bls.gov/oes/current/oes_47900.htm. Accession No. ML100780174.

U.S. Census Bureau (USCB). 2006a. *St. Mary's County, Maryland: Selected Economic Characteristics: 2006.* Accessed October 19, 2008 at http://factfinder.census.gov/servlet/ADPTable?_bm=y&-geo_id=05000US24037&-qr_name=ACS_2006_EST_G00_DP3&-ds_name=ACS_2006_EST_G00_&-_lang=en&-_sse=on. Accession No. ML093270594.

U.S. Census Bureau (USCB). 2006b. *Maryland, Selected Economic Characteristics, 2006.* Accessed October 19, 2008 at http://factfinder.census.gov/servlet/ADPTable?_bm=y&-geo_id=04000US24&-qr_name=ACS_2006_EST_G00_DP3&-ds_name=ACS_2006_EST_G00_&-_lang=en&-redoLog=false&-_sse=on. Accession No. ML093270595.

U.S. Census Bureau (USCB). 2009a. *Port Deposit town, Maryland. 2008 Population Estimate.* Population Finder, American FactFinder. Available at http://factfinder.census.gov. Accession No. ML100200426.

U.S. Census Bureau (USCB). 2009b. *Cecil County, Maryland, Selected Economic Characteristics: 2005-2007*. American FactFinder. Accession No. ML100191112.

U.S. Census Bureau (USCB). 2009c. *Maryland, Selected Economic Characteristics, 2006.* American FactFinder. Accession No. ML093270594.

U.S. Census Bureau (USCB). 2009d. *Frederick County, Maryland. 2008 Population Estimate.* Population Finder, American Factfinder. Accession No. ML100200364.

U.S. Census Bureau (USCB). 2009e. *Frederick City, Maryland. 2008 Population Estimate.* Population Finder, American FactFinder. Accession No. ML100200379.

U.S. Census Bureau (USCB). 2009f. *Maryland, Selected Economic Characteristics: 2005-2007*. American FactFinder. Accession No. ML093270595.

U.S. Census Bureau (USCB). 2009g. *St Mary's County, Maryland, 2008 Population Estimate.* Population Finder, American FactFinder. Accession No. ML100760236.

U.S. Census Bureau (USCB). 2009h. *District of Columbia, 2008 Population Estimate.* Population Finder, American FactFinder. Accession No. ML100760240.

U.S. Coast Guard and U.S. Army Corps of Engineers (USCG and USACE or the Corp). 2009. *Cove Point Pier Reinforcement Project Environmental Assessment*. Federal Energy Regulatory Commission, Dominion Cove Point LNG, LP Docket No. CP09-60-000.

U.S. Department of Agriculture (USDA). 2008a. Plants Profile: *Utricularia inflata* Walter, swollen bladderwort. Accessed December 10, 2008 at http://plants.usda.gov/java/profile?symbol=UTIN. Accession No. ML093280668.

U.S. Department of Agriculture (USDA). 2008b. Plants Profile: *Potamogeton perfoliatus* L. claspingleaf pondweed. Accessed December 9, 2008 at http://plants.usda.gov/java/profile?symbol=POPE7. Accession No. ML100481315.

U.S. Department of Defense (DOD). 2010. *CNIC--Naval Air Station Patuxent River*. Accessed January 29, 2010 at https://www.cnic.navy.mil/Patuxent/AboutCNIC/index.htm. Accession No. ML100760365

U.S. Department of Energy (DOE). 2006. *Geothermal FAQs*. Accessed November 6, 2008 at http://www1.eere.energy.gov/geothermal/faqs.html. Accession No. ML100481478.

U.S. Department of Energy (DOE). 2008a. *20% Wind Energy by 2030*. DOE/GO-102008-2567. Accessed November 6, 2008 at http://www1.eere.energy.gov/windandhydro/. Accession No. ML100481467.

U.S. Department of Energy (DOE). 2008b. *Alternative Energy Resources in Maryland*. Accessed November 6, 2008 at http://www.eere.energy.gov/states/alternatives/resources_md.cfm. Accession No. ML100490495.

U.S. Department of Energy (DOE). 2008c. *State Energy Alternatives: Biomass Energy*. Accessed November 6, 2008 at http://www.eere.energy.gov/states/alternatives/biomass.cfm.

U.S. Department of Energy (DOE). 2008d. *Fuel Cell Technology Challenges*. Accessed January 16, 2009 at http://www1.eere.energy.gov/hydrogenandfuelcells/fuelcells/fc_challenges.html. Accession No. ML100500161.

U.S. Department of Energy, Energy Information Administration (DOE/EIA). 2001. *Renewable Energy 2000: Issues and Trends*. DOE/EIA-0628(2000), Washington, D.C. Accessed November 6, 2008 at http://tonto.eia.doe.gov/FTPROOT/renewables/06282000.pdf. Accession No. ML093280377.

U.S. Department of Energy, Energy Information Administration (DOE/EIA). 2007. *Electric Power Annual: Overview*. Accessed December 3, 2008 at: http://www.eia.doe.gov/cneaf/electricity/epa/epa_sum.html. Accession No. ML100490684.

U.S. Department of Energy, Energy Information Administration (DOE/EIA). 2008. *Maryland Quick Facts*. Accessed November 7, 2008 at http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=MD. Accession No. ML093280288.

U.S. Department of Energy, Energy Information Administration (DOE/EIA). 2009. *An Updated Annual Energy Outlook 2009 Reference Case Reflecting Provisions of the American Recovery and Reinvestment Act and Recent Changes in the Economic Outlook.* SR/OIAF/2009-03. Accessed July 22, 2009 at http://www.eia.doe.gov/oiaf/servicerpt/stimulus/index.html. Accession No. ML100490743.

U.S. Department of the Army (U.S. Army). 2007a. *Final Environmental Impact Statement (EIS) BRAC Actions at Aberdeen Proving Ground Harford and Baltimore Counties, Maryland*. Available at: http://www.hqda.army.mil/acsim/brac/eis_docs/APGMD%20FEIS.pdf. Accession No. ML100481100.

U.S. Department of the Army (U.S. Army). 2007b. *Record of Decision Final Environmental Impact Statement Construction and Operation of New U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID) Facilities and Decommissioning and Demolition and/or Re-use of Existing USAMRIID Facilities at Fort Detrick, Maryland*. Available at: http://www.usamriid.army.mil/eis/pdfs/USAMRIID_Facilities_EIS--Record_of_Decision.pdf. Accession No. ML100481112.

U.S. Environmental Protection Agency (EPA). 2000. *EPA Superfund Record of Decision: Naval Training Center Bainbridge EPA ID: MDD985397256, OU 01, 02, Bainbridge, MD, 2/10/2000*. EPA/ROD/R-03/007.

U.S. Environmental Protection Agency (EPA). 2009a. *Municipal Solid Waste*. Accessed November 24, 2009 at http://www.epa.gov/cleanenergy/energy-and-you/affect/municipal-sw.html.

U.S. Environmental Protection Agency (EPA). 2009b. *Mid-Atlantic Superfund – Forth Ritchie – Current Site Information.* Accessed December 28, 2009 at http://www.epa.gov/reg3hscd/npl/MD0000795211.htm. Accession No. ML100490786.

U.S. Fish and Wildlife Service (FWS). 1991. *Swamp Pink (*Helonias bullata*) Recovery Plan*. Newton Corner, Massachusetts. Available at http://ecos.fws.gov/docs/recovery_plans/1991/910930c. Accession No. ML100490629.

U.S. Fish and Wildlife Service (FWS). 1993. *Puritan Tiger Beetle (*Cicindela puritana *G. Horn) Recovery Plan*. Northeast Region, Hadley, Massachusetts. Available at http://ecos.fws.gov/docs/recovery_plans/1993/930929a.pdf. Accession No. ML100490629.

U.S. Fish and Wildlife Service (FWS). 2001. *Bog Turtle* (Clemmys muhlenbergii) *Northern Population Recovery Plan*. Hadley, Massachusetts. Available at www.fws.gov/northeast/nyfo/es/bogturtle.pdf. Accession No. ML100500286.

U.S. Fish and Wildlife Service (FWS). 2005. *Dwarf Wedgemussel* Alasmidonta heterodon*. Fact Sheet.* Northeast Region, Hadley, Massachusetts.

U.S. Fish and Wildlife Service (FWS). 2007. *Dwarf Wedgemussel* Alasmidonta heterodon*. 5-Year Review: Summary and Evaluation.* New England Field Office, Concord, New Hampshire.

U.S. Fish and Wildlife Service (FWS). 2008a. *National Wetlands Inventory*. Accessed at http://www.fws.gov/nwi/WetlandsData/GoogleEarth.htm.

U.S. Fish and Wildlife Service (FWS). 2008b. *Delmarva Peninsula Fox Squirrel* Sciurus niger cinereus. Arlington, Virginia. Accessed August 12, 2009 at http://www.fws.gov/speciesProfile/profile/speciesProfile.action?spcode_A00B.

U.S. Fish and Wildlife Service (FWS). 2009. *Shortnose Sturgeon in the Potomac River*. U.S. Fish and Wildlife Service Update. Maryland Fishery Resources Office, Annapolis, Maryland.

U.S. Geological Survey (USGS). 2006. *Tiger Beetles of the United States – No Common Name (*Cicindela Patruela). Accessed October 20, 2009 at http://www.npwrc.usgs.gov/resource/distr/insects/tigb/usa/62.htm. Accession No. ML

U.S. Geological Survey (USGS). 2008. "USGS Surface-Water Monthly Statistics for Maryland*: USGS Gauge 01594440 on the Patuxent River near Bowie, Maryland*." *National Water Information System. Web Interface.* Available at http://waterdata.usgs.gov/nwis/.

U.S. Geological Survey (USGS). 2009. Centrarchus macropterus *(Lacepède, 1801)*. Accessed October 28, 2009 at http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=375.

U.S. Global Change Research Program (GCRP). 2009. *Global Climate Change Impacts in the United States.* T.R. Karl, J.M. Melillo, and T.C. Peterson, eds. Cambridge University Press, New York. Available at http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf.

United States Naval Training Center Bainbridge Association (USNTCB). 2009. *USNTC Bainbridge.* Accessed on October 30, 2009 at http://www.usntcb.org/.

Urban, R.A., J.E. Titus, and W-X Zhu. 2006. "An Invasive Macrophyte Alters Sediment Chemistry Due to Suppression of a Native Isoetid." *Oecologia* 148(3): 455–463.

U.S. Nuclear Regulatory Commission (NRC). 1976. *Preparation of Environmental Reports for Nuclear Power Stations.* Regulatory Guide 4.2, Rev. 2, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*. NUREG-1437, Volumes 1 and 2, Washington, D.C. Available at http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1437/.

U. S. Nuclear Regulatory Commission (NRC). 1998. *General Site Suitability for Nuclear Power Stations.* Regulatory Guide 4.7, Rev. 2, Washington, D.C.

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

U.S. Nuclear Regulatory Commission (NRC). 2000a. *Standard Review Plans for Environmental Reviews for Nuclear Power Plants*. NUREG-1555, Vol. 1, Washington, D.C. Includes 2007 revisions.

U.S. Nuclear Regulatory Commission (NRC). 2000b. *Calvert Cliffs Nuclear Power Plant, Units 1 and 2 – Renewal of Operating License.* Accessed at http://www.nrc.gov/reading-rm/doc-collections/commission/secys/2000/secy2000-0010/2000-0010scy.html.

U.S. Nuclear Regulatory Commission (NRC). 2003. *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, Supplement 10 Regarding Peach Bottom Atomic Power Station, Units 2 and 3.* NUREG-1437, Final Report, NRC, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2008a. Letter from T. Fredrichs (NRC) to G. Wrobel (UniStar), "Subject: RAIS for Calvert Cliffs Environmental Report." May 13, 2008. Accession No. ML081430521.

U.S. Nuclear Regulatory Commission (NRC). 2009a. Letter from T. Fredrichs (NRC) to G. Gibson (UniStar), "Subject: Request for Additional Information Related to the Environmental Report for the Calvert Cliffs Combined License Application." February 3, 2009. Accession No. ML083310256.

U.S. Nuclear Regulatory Commission (NRC). 2009b. Letter from L. Quinn (NRC) to G. Gibson (UniStar), "Subject: Request for Additional Information Related to the Environmental Review for the Calvert Cliffs Combined License Application – Revised Alternative Sites." September 18, 2009. Accession No. ML092450423.

U.S. Nuclear Regulatory Commission (NRC). 2009c. *NRC Renews National Institute of Standards and Technology's Research Reactor License for an Additional 20 Years.* Accessed December 21, 2009 at http://www.nrc.gov/reading-rm/doc-collections/news/2009/09-123.html.

U.S. Nuclear Regulatory Commission (NRC). 2009d. *Hope Creek Generating Station, Unit 1.* Accessed December 28, 2009 at http://www.nrc.gov/info-finder/reactor/hope.html.

U.S. Nuclear Regulatory Commission (NRC). 2009e. *Salem Nuclear Generating Station, Unit 1.* Accessed December 28, 2009 at http://www.nrc.gov/info-finder/reactor/salm1.html.

U.S. Nuclear Regulatory Commission (NRC). 2009f. *Salem Nuclear Generating Station, Unit 2.* Accessed December 28, 2009 at http://www.nrc.gov/info-finder/reactor/salm2.html.http://www.nrc.gov/info-finder/reactor/salm2.html.

U.S. Nuclear Regulatory Commission (NRC). 2009g. *New Reactor Licensing Applications – Schedules by Calendar Year.* Accessed December 09, 2009 at http://www.nrc.gov/reactors/new-reactors.html.

U.S. Nuclear Regulatory Commission (NRC). 2009h. *Three Mile Island Nuclear Station, Unit 1*. Accessed December 28, 2009 at http://www.nrc.gov/info-finder/reactor/tmi1.html.

U.S. Nuclear Regulatory Commission (NRC). 2009i. *Limerick Generating Station, Unit 1*. Accessed December 28, 2009 at http://www.nrc.gov/info-finder/reactor/lim1.html.

U.S. Nuclear Regulatory Commission (NRC). 2009j. *Limerick Generating Station, Unit 2.* Accessed December 28, 2009 at http://www.nrc.gov/info-finder/reactor/hope.html.ttp://www.nrc.gov/info-finder/reactor/lim2.html.

U.S. Nuclear Regulatory Commission (NRC). 2009k. *Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants Supplement 36 Regarding Beaver Valley Power Station, Units 1 and 2.* NUREG-1437 Supplement 36. Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2010a. Memorandum from L.M. Quinn (NRC) to R.G. Schaaf (NRC), "Site Audit Summary of Calvert Cliffs Revised Alternatives Sites Analysis for the Combined License Application," March 16, 2010. Accession No. ML100040222.

U.S. Nuclear Regulatory Commission (NRC). 20010b. *Supplemental Environmental Impact Statement for the Combined License (COL) for North Anna Power Station Unit 3 – Final Report for Comment.* NUREG-1917, NRC, Washington, D.C.

Vanesky, T. 2009. *Zebra mussels have some worried about Susquehanna*. Accessed January 7, 2009 at http://www.timesleader.com/sports/Mussels_pose_threat_to_river_01-06-2009.html. Accession No. ML100540798.

Virginia Institute of Marine Science (VIMS). 2010. *SAV in Chesapeake Bay and Coastal Bays: Havre de Grace, MD.* Accessed January 29, 2010 at http://web.vims.edu/bio/sav/sav08/quads/hg003th.html. Accession No. ML100350684.

Walsh, M.C., J. Deeds, and B. Nightingale. 2007. *User's Manual and Data Guide to the Pennsylvania Aquatic Community Classification; Chapter 4 Freshwater Mussel Community Descriptions*. Pennsylvania Natural Heritage Program, Western Pennsylvania Conservancy, Middletown, Pennsylvania, and Pittsburgh, Pennsylvania.

10.0 Conclusions and Recommendations

This chapter provides a discussion of the conclusions reached in earlier parts of this environmental impact statement (EIS), as well as recommendations. Section 10.1 summarizes the impacts of the proposed action, Section 10.2 summarizes the proposed project's unavoidable adverse impacts with an accompanying table, and Section 10.3 discusses the relationship between the short-term use of resources and long-term productivity of the human environment. Section 10.4 summarizes the irretrievable and irreversible use of resources, and Section 10.5 summarizes the alternatives to the proposed action. Section 10.6 discusses benefits and costs. Section 10.7 includes the NRC staff's recommendation, and Section 10.8 provides the references.

On July 13, 2007, the U.S. Nuclear Regulatory Commission (NRC) received Part 1 of an application from UniStar Nuclear Development, LLC, on behalf of Constellation Generation Group, LLC, and UniStar Nuclear Operating Services, LLC for a combined construction and operating license (combined license or COL) for construction of a new Unit 3 at the Calvert Cliffs site located 7.5 mi north of Solomons, Maryland. The NRC received Part 2 of the application on March 14, 2008. A COL is a Commission approval to build and operate one or more nuclear power facilities. On July 7, 2008, Constellation Generation Group, LLC withdrew as an applicant and Calvert Cliffs 3 Nuclear Project, LLC joined as an applicant (UniStar 2008a). UniStar Nuclear Operating Services, LLC is designated in the application as the operator, and Calvert Cliffs 3 Nuclear Project, LLC is designated as the owner (collectively referred to as "UniStar" or "applicant"). In its application, UniStar specified the AREVA NP Inc. (AREVA) U.S. EPR as the proposed reactor design for Unit 3 at the Calvert Cliffs site. The location of the proposed reactor is south of Calvert Cliffs Nuclear Power Plant (CCNPP) Units 1 and 2. The existing facilities at the Calvert Cliffs site are owned by Constellation Energy Nuclear Group, LLC (Constellation).

On May 16, 2008, UniStar submitted a joint Federal/State Application for the Alteration of Any Floodplain, Waterway, Tidal or Nontidal Wetland in Maryland to the U.S. Army Corps of Engineers (USACE or Corps) and the Maryland Department of the Environment (MDE) (UniStar 2008b). The Corps application number is NAB-2007-08123-M05 (Calvert Cliffs 3 Nuclear Project, LLC/UniStar Nuclear Operating Service, LLC) on behalf of co-applicants, Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC. The MDE Tidal Application number is Calvert Cliffs 3 Nuclear Project, LLC/200862371/08-WL-1462. The MDE Nontidal Application number is Calvert Cliffs 3 Nuclear Project, LLC/200862335/08-NT-0191.

The proposed actions related to the Calvert Cliffs Unit 3 application are (1) NRC issuance of a COL for constructing and operating a new nuclear unit at the Calvert Cliffs site, and (2) Corps permit action on a Department of the Army (DA) Individual Permit application pursuant to

Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Appropriation Act of 1899 (River and Harbors Act) (33 U.S.C. 403). The Corps is a cooperating agency with the NRC to ensure that the information presented in the EIS is adequate to fulfill the requirements of Corps regulations and the Clean Water Act Section 404(b)(1) Guidelines. The Corps has the authority to issue permits for work or structures in navigable waters and the discharge of dredged or fill material into waters of the United States. The Corps would regulate activities that would temporarily or permanently affect wetlands and waterbodies affected by the proposed project. The U.S. Environmental Protection Agency (EPA) has the authority to review and veto Corps decisions on Section 404 permits. A COL applicant must also obtain and maintain the necessary permits from other Federal, State, and local agencies and permitting authorities.

Section 102 of the National Environmental Policy Act of 1969, as amended (NEPA) (42 U.S.C. 4321 et seq.), directs that an EIS is required for major Federal actions that significantly affect the quality of the human environment. Section 102(2)(C) of NEPA requires that an EIS include information about the following:

- the environmental impact of the proposed action
- any adverse environmental effects which cannot be avoided should the proposal be implemented
- alternatives to the proposed action
- the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity
- any irreversible and irretrievable commitments of resources which would be involved if the proposed action is implemented.

The NRC has implemented NEPA in Title 10 of the Code of Federal Regulations (CFR) Part 51. In 10 CFR 51.20, the NRC requires preparation of an EIS for issuance of a COL to construct and operate a nuclear power plant. Subpart C of 10 CFR Part 52 contains the NRC regulations related to COLs.

The environmental review described in this EIS was conducted by a team consisting of NRC staff, its contractor's staff, Pacific Northwest National Laboratory (PNNL), and staff from the Corps. During the course of preparing this EIS, the review team reviewed the Environmental Report (ER) submitted by UniStar (2009a) and supplemental letters from UniStar in response to requests by NRC staff and the Corps for additional information; consulted with Federal, State, Tribal, and local agencies; and followed the guidance set forth in NUREG-1555, *Environmental Standard Review Plans* (NRC 2000). In addition, the NRC considered the public comments related to the environmental review received during the scoping process. The in-scope comments and responses are provided in Appendix D of this EIS.

Included in this EIS are (1) the results of the review team's preliminary analyses, which consider and weigh the environmental effects of the proposed action and of constructing and operating a new nuclear unit at the Calvert Cliffs site; (2) mitigation measures for reducing or avoiding adverse effects; (3) the environmental impacts of alternatives to the proposed action; and (4) the NRC staff's recommendation regarding the proposed action based on its environmental review. The Corps will base its evaluation of the DA Individual Permit application on the requirements of Corps regulations, the Clean Water Act Section 404(b)(1) Guidelines, and the Corps public interest review process. The Corps permit decision will be made following issuance of the final EIS.

The Corps permit, if issued, would include special conditions that UniStar must ensure the created and enhanced wetlands meet the Federal wetland criteria outlined in the report entitled "Corps of Engineers Wetlands Delineation Manual," dated January 1987 (USACE 1987), in accordance with Compensatory Mitigation for Losses of Aquatic Resources (33 CFR Parts 325 and 332) (USACE 2008). The Corps requires that mitigation may only be employed after all appropriate and practical steps to avoid and minimize adverse impacts to aquatic resources, including wetlands and streams, have been taken. All remaining unavoidable impacts must be compensated to the extent appropriate and practicable. If the Corps does not find the wetland and stream mitigation satisfactory, the Corps would determine if adverse impacts to the waterway and wetlands are more than minimal and if any project modifications would be warranted. Also, the Corps would require UniStar to assume all liability for accomplishing the corrective work.

In order to consider and evaluate the impacts of UniStar's proposed project, the Corps released a public notice on September 3, 2008, to solicit comments from the public; Federal, State, and local agencies and officials; Indian Tribes; and other interested parties (USACE 2008). The Corps will issue a second public notice upon release of the draft EIS, which will include notification for the public hearing.

Environmental issues are evaluated using the three-level standard of significance – SMALL, MODERATE, or LARGE – developed by the NRC using guidelines from the Council on Environmental Quality (CEQ) (40 CFR 1508.27). Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, provides the following definitions of the three significance levels:

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

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

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

Mitigation measures were considered for each environmental issue and are discussed in the appropriate sections. During its environmental review, the review team considered planned activities and actions that UniStar indicates it and others would likely take should UniStar receive a COL. In addition, UniStar provided estimates of the environmental impacts resulting from the building and operation of a new nuclear unit on the proposed site.

10.1 Impacts of the Proposed Action

In a final rule dated October 9, 2007 (72 FR 57416), the Commission limited the definition of "construction" to those activities that fall within its regulatory authority in 10 CFR 51.4. Many of the activities required to build a nuclear power plant are not part of the NRC action to license the plant. Activities associated with building the plant that are not within the purview of the NRC action are grouped under the term "preconstruction." Preconstruction activities include clearing and grading, excavating, erection of support buildings and transmission lines, and other associated activities. Because the preconstruction activities are not part of the NRC action, their impacts are not reviewed as a direct effect of the NRC action. Rather, the impacts of the preconstruction activities are considered in the context of cumulative impacts. In addition, certain preconstruction activities require permits from the Corps, as well as other Federal, State, and local agencies.

Chapter 4 of this EIS describes the relative magnitude of impacts related to preconstruction and construction activities with a summary of impacts in Table 4-11. Impacts associated with operation of the proposed facilities are discussed in Chapter 5 of this EIS and are summarized in Table 5-20. Chapter 6 describes the impacts associated with fuel cycle, transportation, and decommissioning. Chapter 7 describes the impacts associated with preconstruction and construction activities and operation of Calvert Cliffs Unit 3 when considered along with the cumulative impacts of other past, present, and reasonably foreseeable future projects in the geographical region around the Calvert Cliffs site. Chapter 9 of this EIS includes the review team's review of alternative sites and alternative power generation systems.

10.2 Unavoidable Adverse Environmental Impacts

Section 102(2)(C)(ii) of NEPA requires that an EIS include information on any adverse environmental effects that cannot be avoided should the proposal be implemented. Unavoidable adverse environmental impacts are those potential impacts of the NRC and the Corps' actions that cannot be avoided and for which no practical means of mitigation are available.

10.2.1 Unavoidable Adverse Impacts During Construction and Preconstruction Activities

Chapter 4 discusses in detail the potential impacts from construction and preconstruction of the proposed Unit 3 at the Calvert Cliffs site and presents mitigation and controls intended to lessen the adverse impacts. Table 10-1 presents the adverse impacts associated with construction and preconstruction activities to each of the resource areas evaluated in this EIS and the mitigation measures that would reduce impacts. Those impacts remaining after mitigation is applied are identified in Table 10-1 as unavoidable adverse impacts. The impact determinations in Table 10-1 are for the combined impacts of construction and preconstruction. However, the impact determinations for NRC-regulated construction are the same for all resource areas except terrestrial and wetland ecosystems, aquatic ecosystems, Chesapeake Bay, economic impacts to the community, infrastructure and community services, and historic and cultural resources. For impact determinations that differ for the combined construction and preconstruction activities and the NRC-regulated activities, the impacts from the NRC-regulated activities are also identified in Table 10-1.

The Unavoidable Adverse Impacts are identified in Table 10-1 and are primarily attributable to preconstruction activities due to the initial land disturbance from clearing the land, land use, excavation, filling wetlands and waterways, impervious surface addition, dredging, and removal or demolition of three sites with historic or cultural value. NRC authorized construction activities partially contribute to most of the Unavoidable Adverse Impacts shown in Table 10-1.

All building activities for proposed Unit 3, including ground-disturbing activities, would occur within the existing Calvert Cliffs site boundary. Three local groundwater aquifers (Surficial, Piney Point-Nanjemoy and Aquia) could be impacted during construction. Dewatering systems employed during excavation within the powerblock area would depress water levels in the Surficial aquifer; however, the impacts would be localized and temporary. Within the Calvert Cliffs site boundary, four existing wells in the Piney Point-Nanjemoy aquifer would be removed, while up to two new wells would be installed in the Aquia aquifer. The impacts to the Aquia aquifer are expected to be minor and temporary. In addition, the alteration of the land surface at proposed Unit 3 would cause a localized change in the recharge rate to these aquifers.

Building of proposed Unit 3 and supporting facilities would affect approximately 460 ac of wildlife habitat. Approximately 320 ac would be permanently lost, including approximately 253 ac of forested cover and approximately 12 ac of wetland habitat. Approximately 33.4 ac of the permanently lost habitat is located within the Chesapeake Bay Critical Area. Proposed mitigation actions would create or enhance approximately 25 ac of nontidal wetlands. Additional proposed mitigation actions include planting native forested wetland trees to create a new forest stand, planting trees within forest gaps to reduce fragmentation, and removing invasive plants. Building activities would also fill approximately 8350 ft of intermittent and perennial stream channels and would add 130 ac of impervious surfaces to the watersheds. Proposed mitigation measures would restore or enhance more than 10,000 ft of degraded streams (Appendix J).

Table 10-1. Unavoidable Adverse Environmental Impacts from Construction and Preconstruction Activities

Resource Area	Adverse Impacts	Actions to Mitigate Impacts	Unavoidable Adverse Impacts
Land Use	SMALL	Comply with requirements of applicable Federal, State, and local permits.	Approximately 320 ac of land disturbed permanently; an additional 140 ac would be disturbed on a temporary basis.
Water Use	SMALL	Limit maximum withdrawal from Aquia aquifer per State-issued permit.	Drawdown of Surficial aquifer during excavation and drawdown of Aquia aquifer from increased withdrawal.
Water Quality	SMALL	Best management practices (BMPs) and Stormwater Management Plan.	Increased sediment load in stormwater and potential to contaminate surface and groundwater through inadvertent spills.
Ecological (Terrestrial)	MODERATE (NRC-authorized construction impact level is SMALL)	Implement construction BMPs; plant forest to reduce fragmentation; remove impermeable surfaces; set aside lands for conservation purposes; identify and enhance bald eagle nest locations.	Approximately 320 ac of wildlife habitat permanently lost, including 33.4 ac in the Chesapeake Bay Critical Area; additional 140 ac impacted on a temporary basis.
Ecological (Wetlands)	MODERATE (NRC-authorized construction impact level is SMALL)	Any conditions required by the Corps, such as compensatory mitigation, will be addressed in the Corps permit, if issued. Mitigation may only be employed after all appropriate and practical steps to avoid and minimize adverse impacts to aquatic resources, including wetlands and streams, have been taken. All remaining unavoidable impacts must be compensated to the extent appropriate and practicable. Onsite, in-kind mitigation, such as wetland creation and enhancement, would be used.	The project would affect 7.88 ac of forested nontidal wetlands; 1.21 ac of emergent nontidal wetlands; 2.63 ac of nontidal open water; and 0.08 ac of isolated forested wetland (USACE 2008).

Table 10-1. (contd)

Resource Area	Adverse Impacts	Actions to Mitigate Impacts	Unavoidable Adverse Impacts
Ecological (Aquatic)	MODERATE (NRC-authorized construction impact level is SMALL)	Implement BMPs; control erosion and sedimentation; time-of-year restrictions on dredging or trenching.	Fishing pond eliminated; fill about 8350 ft of intermittent and perennial stream channels; addition of 130 ac impervious surfaces; dredging, trenching, or armoring 5.7 ac subtidal Bay bottom; benthic infauna locally affected by dredging, trenching, or armoring; some gradual recolonization may occur.
Socioeconomic	SMALL to MODERATE	Conduct traffic study and develop Traffic Management Plan.	Local traffic would increase temporarily during construction; Thomas Johnson Memorial Bridge potential traffic chokepoint.
Environmental Justice	SMALL	None	None
Historic and Cultural	LARGE (NRC-authorized construction impact level is SMALL)	Mitigation plans have been developed as part of the Memorandum of Agreement (MOA). UniStar has worked with the Maryland Historical Trust and the Corps on specific mitigation measures identified in the MOA. Procedures to protect cultural and historic resources discovered during construction are also outlined in the MOA.	Three National Register of Historic Places (NRHP)-eligible properties would be adversely affected, including destruction of Camp Conoy, the Baltimore & Drum Point Railroad, and archaeological site 18CV474; potential for discovery of cultural/historic sites during construction.
Air Quality	SMALL	Compliance with Federal, State, and local regulations governing construction activities and construction vehicle emissions. Implementation of a dust control program.	Increased equipment, vehicular, and fugitive dust emissions, but impacts would be temporary.
Nonradiological Health	SMALL	Operational controls, such as fugitive dust suppression. Maintain equipment in good mechanical order.	Inhalation of dust and vehicle exhaust.
		Noise-limiting devices on vehicles and equipment. Restrict noise-related activities to daylight hours.	Noise from construction activities.

Table 10-1. (contd)

Resource Area	Adverse Impacts	Actions to Mitigate Impacts	Unavoidable Adverse Impacts
Radiological Health	SMALL	Doses to construction workers would be maintained below NRC public dose limits.	Small doses to construction workers, less than NRC public dose limits.
Nonradioactive Waste	SMALL	Develop a Sediment and Erosion Control Plan; stabilize disturbed land to prevent erosion. Implement BMPs for surface water and groundwater quality.	Erosion from construction activities and disposal of dredged material may impact water quality.

As part of USACE regulations, UniStar must demonstrate to the Corps why the project proposed could not be reconfigured or reduced in scope to further minimize or avoid adverse impacts to waters of the United States as proposed dredge. Fill activities would not comply with the EPA 404(b)(1) guidelines in the absence of demonstrating that there are no practicable alternatives available with less damaging impacts to the special aquatic site. The Corps may require additional mitigation measures.

Three NRHP-eligible sites would be adversely affected, including the destruction of Camp Conoy. Nearly all unavoidable adverse impacts would be attributable to preconstruction activities. An MOA between the Maryland Historical Trust, the Corps, and UniStar outlines specific mitigation measures, such as data recovery and documentation and interpretive plans (USACE 2010).

No new offsite transmission corridors are planned to support proposed Unit 3 at the Calvert Cliffs site (UniStar 2009a). Required breaker upgrades and associated modifications would be implemented within the boundaries of existing substations (UniStar 2009a). Socioeconomic impacts of construction would include an increase in traffic from construction workers. The Governor Thomas Johnson Memorial Bridge connecting Calvert and St. Mary's Counties may be a significant traffic chokepoint. Air quality impacts include fugitive dust from building activities that can be mitigated by the dust-control plan. Radiological doses to construction workers from the adjacent operating nuclear units are expected to be well below regulatory limits. No unusual resource dependencies for minority and low-income populations in the region were identified. In addition, no environmental pathways related to construction and operation activities were found that would lead to adverse and disproportionate impacts on minority and low-income populations.

Nonradiological health impacts to members of the public from building activities, including public and occupational health; noise; and transportation of materials, equipment, and personnel, would be minimal because of UniStar's application of controls and measures associated with compliance to Federal, State, and local regulations, permits, and authorizations.

Radiological health impacts to members of the public from building of the proposed unit would be below annual exposure limits set to protect the general public. Radiological doses to construction workers at Unit 3 from the adjacent operating units are expected to be well below regulatory limits.

The NRC staff concludes that the potential unavoidable adverse impacts on terrestrial and wetland ecosystems, aquatic ecosystems, Chesapeake Bay, economic impacts to the community, infrastructure and community services, and historic and cultural resources from NRC-authorized construction activities would be SMALL. Nearly all such unavoidable adverse impacts would be attributable to preconstruction activities.

10.2.2 Unavoidable Adverse Impacts During Operation

Chapter 5 of this EIS provides a detailed discussion of the potential impacts from operation of the proposed Unit 3 at the Calvert Cliffs site. Table 10-2 presents the adverse impacts associated with the operation of a new unit to each of the resources evaluated in this EIS and the mitigation measures that would reduce the impacts. Those impacts remaining after mitigation are identified in the table as the unavoidable adverse impacts.

Table 10-2. Unavoidable Adverse Environmental Impacts from Operation

Resource Area	Adverse Impacts	Actions to Mitigate Impacts	Unavoidable Adverse Impacts
Land Use	SMALL	Local land management plans.	Land would not be available for other use until after decommissioning of the entire Calvert Cliffs site, including the proposed new unit.
Water Use	SMALL	BMPs and Stormwater Management Plan.	Increased sediment load in stormwater and potential to contaminate surface and groundwater through inadvertent spills.
Water Quality	SMALL	Compliance with National Pollutant Discharge Elimination System (NPDES) permit limits.	Thermal and chemical discharges to Chesapeake Bay.

Table 10-2. (contd)

Resource Area	Adverse Impacts	Actions to Mitigate Impacts	Unavoidable Adverse Impacts
Ecological (Terrestrial)	SMALL	Cooling tower plume abatement and proper lighting. BMPs to limit potential impacts from vegetation control, road maintenance, and other corridor activities.	Increased risk of bird and bat collisions with structures. Transmission line maintenance would prevent forest succession and maintain habitat fragmentation. Vegetation control may have some minimal impact on vegetation and wildlife. Unavoidable but small impact may occur as a result of keeping the corridors in a safe condition.
Ecological (Aquatic)	SMALL	Stormwater management plan. Limit intake velocity. Implement the use of a fish-return system. Meet all applicable Federal and State regulatory requirements regarding the discharge of heat. Meet all applicable State and Federal Clean Water Act and NPDES permit regulations and limitations.	Increased stormwater runoff. Cooling water withdrawal would result in entrainment, impingement, and entrapment of some Chesapeake Bay species. A small thermal plume may affect some aquatic species abundance and distribution. Small amounts of biofouling and other process control chemicals that may affect aquatic species would be discharged. Periodic maintenance dredging would temporarily affect benthic habitat around barge slip.
Socioeconomic	SMALL	None needed based on mitigation performed under construction and preconstruction phase.	Slight increase in commuter traffic and use of services, especially during outages.
Environmental Justice	SMALL	None	None

Table 10-2. (contd)

Resource Area	Adverse Impacts	Actions to Mitigate Impacts	Unavoidable Adverse Impacts
Historic and Cultural	SMALL		None likely
Air Quality	SMALL	Comply with Federal, State, and local air permits; use cooling-tower drift eliminators.	Slight increase in certain criteria pollutants and CO_2 from plant auxiliary combustion equipment (e.g., diesel generators); plumes and drift from cooling towers.
Nonradiological Health	SMALL	Workers wear personal protective equipment, adhere to Occupational Safety and Health Administration (OSHA) standards.	Worker inhalation of vapors, dusts, and air contaminants.
Radiological Health	SMALL	Doses to members of the public would be maintained below NRC and EPA standards; worker doses would be maintained below NRC limits and as low as reasonably achievable (ALARA); and mitigative actions instituted for members of the public would also ensure doses to biota other than humans would be well below National Council on Radiation Protection and Measurements (NCRP) and International Atomic Energy Agency (IAEA) guidelines.	Small radiation doses to members of the public, below NRC and EPA standards; ALARA doses to workers; and biota doses well below NCRP and IAEA guidelines.
Nonradioactive Waste	SMALL	Meet NPDES permit requirements.	Discharges of wastewater and stormwater to Chesapeake Bay. Increased vehicle emissions from operations personnel.

The unavoidable adverse impacts from operation for land use would be minimal and are associated with offsite development to accommodate new workers at the plant.

Water-related impacts during operation would be mitigated through compliance with the NPDES permit, MDE Water Appropriation and Use, Clean Water Act Section 404 permit, and through

UniStar's adherence to BMPs, the Stormwater Pollution Prevention Plan (SWPPP), and Resource Management Plan. Remaining adverse impacts to hydrological water use and water quality during operation would be minimal and limited to increased surface water use for cooling, potential increases in sedimentation to surface waterbodies, and potential surface and groundwater contamination from inadvertent spills.

Unavoidable adverse impacts to terrestrial ecology resources would include increased risks of bird and bat collisions with structures, wildlife avoidance due to noise, and continued disturbance of habitats within transmission corridors. Assuming that BMPs are followed as proposed, terrestrial impacts during operation would be minor. Unavoidable adverse impacts to aquatic ecology resources would include increased potential entrainment, impingement, entrapment, and thermal loading to the Chesapeake Bay, but operation of the additional unit would not increase them such that they would noticeably alter the aquatic resources of the Bay. Other impacts from operational activities, such as cooling tower drift, maintenance dredging, and transmission corridors maintenance, would be minor, if not negligible.

Unavoidable adverse socioeconomic impacts would include an increase in traffic. There also would be a minimal impact on the regional infrastructure and public services. Because the site is relatively isolated, light industrial in nature, and well masked by vegetation in most directions, the impacts on aesthetics and recreation would be minor.

Unavoidable adverse environmental justice impacts would be minimal based upon the widely dispersed composition of the region's minority and low-income populations and because the review team found no evidence of unique characteristics or practices among current minority and low-income populations that would make them differentially affected by operations activities. No unusual resource dependencies of minority and low-income populations in the region were identified.

The review team did not identify any cultural resources that would be affected by operation of the proposed unit. If an unanticipated discovery is made during operation, similar procedures to that of the unanticipated discovery plan that is contained in the MOA for construction (USACE 2010) would be sufficient for operation.

Unavoidable adverse air quality impacts would be negligible and pollutants emitted during operations would not be significant. Unavoidable adverse nonradiological health impacts to members of the public from operation, including etiological agents, noise, electromagnetic fields, occupational health, and transportation of materials and personnel, would be minimal through UniStar's implementation of controls and measures associated with compliance to Federal and State regulations.

Radiological doses to members of the public from operation of proposed Unit 3 at the Calvert Cliffs site would be below the NRC and EPA standards. Doses to workers from operation of proposed Unit 3 would also be below NRC limits and maintained ALARA. The radiation protection measures designed to maintain doses to members of the public below NRC and EPA standards would also ensure that doses to biota other than humans would be well below NCRP and IAEA guidelines.

10.3 Relationship Between Short-Term Uses and Long-term Productivity of the Human Environment

Section 102(2)(C)(iv) of NEPA requires that an EIS include information on the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity.

The local use of the human environment by the proposed project can be summarized in terms of the unavoidable adverse environmental impacts of building and operation and the irreversible and irretrievable commitments of resources. With the exception of the consumption of depletable resources as a result of building and operation, these uses may be classified as short term. The principal short-term benefit of the proposed project is represented by the production of electrical energy. The economic productivity of the site, when used for this purpose, would be extremely large compared to the productivity from agriculture or other probable uses for the site.

The maximum long-term impact to productivity would result if the plant is not dismantled at the end of the period of plant operation, and, consequently, the land occupied by the plant structures would not be available for any other use for some extended period of time based on the delay in dismantlement. However, the enhancement of regional productivity resulting from the electrical energy produced by the plant is expected to result in a correspondingly large increase in regional long-term productivity that would not be equaled by any other long-term use of the site. In addition, most long-term impacts resulting from land-use preemption by plant structures can be eliminated by removing these structures or by converting them to other productive uses. Once the plant ceases operations, it would be decommissioned according to NRC regulations. Once decommissioning is complete and the NRC license is terminated, the site would be available for other uses.

The NRC staff concludes that the negative aspects of constructing and operating a new unit as they affect the human environment are outweighed by the positive, long-term enhancement of regional productivity through the generation of electrical energy.

10.4 Irreversible and Irretrievable Commitments of Resources

Section 102(2)(C)(v) of NEPA requires that an EIS include information on any irreversible and irretrievable commitments of resources that would occur if the proposed action is implemented. The term “irreversible commitments of resources” refers to environmental resources that would be irreparably changed by the building or operation activities authorized by the Corps or NRC permit and licensing decisions, where the environmental resources could not be restored at some later time to the resource’s state before building or operation. “Irretrievable commitments of resources” refers to materials that would be used for or consumed by the new unit in such a way that they could not, by practical means, be recycled or restored for other uses. The environmental resources are discussed in Chapters 4, 5, and 6 of this EIS. Irretrievable commitments of resources during building of the proposed new unit generally would be similar to that of any major construction project.

10.4.1 Irreversible Commitments of Resources

Irreversible commitments of environmental resources resulting from the construction, preconstruction, and operation of Unit 3, in addition to the materials used for the nuclear fuel, include:

10.4.1.1 Land Use

The review team considers that the proposed preconstruction activities would result in the loss, through infilling, of approximately 12 ac of nontidal wetland habitat and approximately 33.4 ac of nontidal wetland buffer (UniStar 2009a). These losses would be irreversible. Waterbodies such as Camp Conoy Fishing Pond and several streams would be filled in. Land committed to the disposal of radioactive and nonradioactive waste is committed to that use and cannot be used for other purposes. The land used for siting Unit 3, with the exception of any filled wetlands, is not irreversibly committed because once Unit 3 ceases operations and the plant is decommissioned in accordance with NRC requirements, the land supporting the facilities could be returned to other industrial or nonindustrial uses.

10.4.1.2 Water Use

Under average conditions, Unit 3 would withdraw 41,095 gpm from the Chesapeake Bay over 40 years of operation. Nearly half of the cooling water from the Chesapeake Bay would be evaporated during operation.

10.4.1.3 Terrestrial and Aquatic Biota

Construction and preconstruction activities would permanently convert some portions of terrestrial and aquatic habitats, which would temporarily adversely affect the abundance and distribution of local terrestrial and aquatic flora and fauna on the Calvert Cliffs site. Irretrievable commitment of resources include losses of approximately 12 ac of nontidal wetlands, 34 ac of high-value habitat for forest interior dwelling species, filling of Camp Conoy Fishing Pond, and conversion of approximately 6 ac of subtidal Bay soft-bottom habitat to rocky habitat. Portions of designated essential fish habitat and some individuals of Federally managed fish species would be lost during construction, preconstruction, and operation. However, enough suitable habitat likely exists elsewhere in the area that such changes would noticeably alter, but would not destabilize, regional populations despite localized permanent loss of habitat and some individuals. Dredging and pipelaying would temporarily affect benthic habitats. Most of these would recover, although periodic maintenance dredging would interrupt complete recovery near the barge dock. No irretrievable loss of resources detectable at the population level would be expected as a result of operations, and any impacts as a result of operations would cease post operations. The removal of an active bald eagle nest and subsequent abandonment by the pair using the nest may result in the permanent loss of bald eagle productivity. Grading and filling of wetlands would result in the loss of wetland function. The majority of terrestrial and aquatic habitat losses are due to preconstruction activities.

10.4.1.4 Socioeconomic Resources

The review team expects that no irreversible socioeconomic commitments would be made to socioeconomic resources since they will be reallocated for other purposes once the plant is decommissioned.

10.4.1.5 Historic and Cultural Resources

Irreversible commitments to historic and cultural resources are discussed in Chapter 4. These resources include two historic buildings/structures (Baltimore & Drum Point Railroad (CT-1259) and Camp Conoy (CT-1312)) and one archaeological site (18CV474). The State Historic Preservation Office (SHPO) requested an MOA be prepared between UniStar, the Corps, and the Maryland SHPO that stipulates agreed-upon mitigation measures appropriate to each property (MHT 2009). The MOA was finalized on March 16, 2010 (USACE 2010). Nearly all loss of irreversible commitments would be attributable to preconstruction activities.

10.4.1.6 Air and Water

Dust and other emissions, such as vehicle exhaust, would be released to the air during construction and preconstruction activities. During operations, vehicle exhaust emissions would continue, and other air pollutants and chemicals, including very low concentrations of radioactive gases and particulates, would be released from the facility into the air and surface water. Because these releases would conform to applicable Federal and State regulations, their impact to public health and the environment would be limited. The NRC and the Corps expect no irreversible commitment to air or water resources because all Unit 3 releases would be made in accordance with duly issued permits.

10.4.2 Irretrievable Commitments of Resources

Irretrievable commitments of resources during the building of the proposed new unit generally would be similar to that of any major construction project. A study by the U.S. Department of Energy (DOE/EIA 2004a) on new reactor construction estimated that approximately 12,239 yd^3 of concrete, 3107 tons of rebar, 13,000,000 ft of cable, and 275,000 ft of piping would be required for the reactor building of a typical new 1300 MW(e) nuclear power plant. Historical records of operating reactors suggest a total of approximately 182,900 yd^3 of concrete and 20,512 tons of structural steel would be required to construct the reactor building, major auxiliary buildings, turbine generator building, and turbine generator pedestal (DOE 2005). The proposed Calvert Cliffs Unit 3 is rated at 1735 MW(e) net, approximately 30 percent higher than the 1300 MW(e) unit on which the DOE/EIA study is based. However, UniStar (2009a) expects the numbers to be approximately representative of the materials that would be consumed during construction.

U.S. Census Bureau data (USCB 2006a, b) cited by UniStar in its ER (UniStar 2009a) indicate that inventories of construction materials have increased in response to demand, are likely to be available for the foreseeable future, and surplus capacity exists in industrial sectors that may affect nuclear power plant construction. The review team expects that the use of construction materials in the quantities associated with those estimated for Unit 3 at the Calvert Cliffs site, while irretrievable, would be of small consequence with respect to the availability of such resources.

The main resource that would be irretrievably committed during operation of the new nuclear unit would be uranium. The availability of uranium ore and existing stockpiles of highly enriched uranium in the United States and Russia that could be processed into fuel is sufficient (OECD NEA and IAEA 2008) so that the irreversible and irretrievable commitment would be negligible.

10.5 Alternatives to the Proposed Action

Alternatives to the proposed actions are discussed in Chapter 9 of this EIS. Alternatives considered are the no-action alternative, energy production alternatives, system design alternatives, and alternative sites. For the benefit of the Corps, onsite alternatives of facility placement are also addressed in Appendix J.

The no-action alternative, described in Section 9.1, refers to a scenario in which the NRC would deny the COL request, or the Corps would take no action or deny the Section 404 Clean Water Act permit. If no other power plant were built or electrical power supply strategy implemented to take its place, the electrical capacity to be provided by the project would not become available, the benefits (electricity generation) associated with the proposed action would not occur, and the need for power would not be met. Failure to supply the needed electricity would have significant adverse impacts within the region of interest, and the NRC staff expects that the Maryland Public Service Commission (MPSC) would take steps to confirm that the need for power would be met.

Alternative energy sources are described in Section 9.2 of this EIS. Alternatives not requiring additional generating capacity are described in Section 9.2.1. Detailed analyses of coal- and natural gas-fired alternatives are provided in Section 9.2.2, and other energy sources are discussed in Section 9.2.3. The review team concluded that none of the alternative power production options were both practical and environmentally preferable to the proposed action.

Alternative sites are discussed in Section 9.3 of this EIS, and the cumulative impacts of construction, preconstruction, and operation of a nuclear generating unit at the alternative sites are compared in Section 9.3.6 to the impacts at the proposed Calvert Cliffs Unit 3. Table 9-12 contains the review team's characterization of cumulative impacts at the proposed and alternative sites. Based on this review, the NRC staff concludes that while there are differences in cumulative impacts at the proposed and alternative sites, none of the alternative sites would be environmentally preferable or obviously superior to the proposed Calvert Cliffs site. The NRC's determination is independent of the Corps' determination of a Least Environmentally Damaging Practicable Alternative pursuant to Section 404(b)(1) Guidelines. The Corps will conclude its analysis of both offsite and onsite alternatives in its Record of Decision.

Alternative system designs are discussed in Section 9.4 of this EIS, focusing on alternative heat dissipation systems, intake and discharge systems, water supplies, and water treatment systems. The review team identified no environmentally preferable alternative to UniStar's proposed design.

10.6 Benefit-Cost Balance

NEPA (42 U.S.C. 4321 et seq.) requires that all agencies of the Federal government prepare detailed EISs for proposed major Federal actions that can significantly affect the quality of the human environment. A principal objective of NEPA is to require each Federal agency to consider, in its decision-making, the environmental impacts of each proposed major Federal action and the available alternative actions that can achieve the purpose and need for the action. In particular, Section 102 of NEPA requires all Federal agencies to the fullest extent possible:

> "(B) identify and develop methods and procedures, in consultation with the Council on Environmental Quality established by subchapter II of this chapter, which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decisionmaking along with economic and technical considerations."

However, neither NEPA nor CEQ requires the costs and benefits of a proposed action be quantified in dollars or any other common metric.

The intent of this section is not to identify and provide monetary estimates of all the potential societal benefits of the proposed project and compare these to a monetized estimate of the potential costs of the proposed project. Instead, this section focuses on monetized values for only those activities closely related to the building and operation of the proposed new unit. For other benefits and costs of such magnitude or importance that their inclusion in this analysis can inform the NRC and Corps decision-making processes, the review team offers quantified assessments. This section compiles and compares the pertinent analytical conclusions reached in earlier chapters of this EIS. It gathers all of the expected impacts from building and operating the proposed Unit 3 and aggregates them into two final categories: the expected environmental costs and the expected benefits to be derived from approval of the proposed action.

Although the analysis in this section is conceptually similar to a purely economic benefit-cost analysis, which determines the net present dollar value of a given project, the intent of this section is to identify potential societal benefits of the proposed activities and compare these to the potential internal (i.e., private) and external (i.e., societal) costs of the proposed activities. The purpose is to generally inform the COL process by gathering and reviewing information that demonstrates the likelihood that the benefits of the proposed activities outweigh the aggregate costs.

General issues related to UniStar's financial viability are outside the scope of NRC's EIS process and, thus, are not considered in this EIS. Issues related to UniStar's financial qualifications will be addressed in the NRC's safety evaluation report. It is not possible to quantify and assign a value to all benefits and costs associated with the proposed action. This analysis, however, attempts to identify, quantify, and provide monetary values for benefits and costs when reasonable estimates are available.

Section 10.6.1 discusses the benefits associated with the proposed action. Section 10.6.2 discusses the costs associated with the proposed action. A summary of benefits is shown in Table 10-3. In accordance with NRC's guidance in NUREG-1555 (page 10.4.2-4), internal costs of the proposed project are presented in monetary terms. Internal costs include all of the costs included in a total capital cost assessment: the direct and indirect cost of construction and preconstruction plus the annual costs of operation and maintenance. Section 10.6.3 provides a summary of the impact assessments, bringing previous sections together to establish a general impression of the relative magnitude of the proposed project's costs and benefits.

1 **Table 10-3**. Summary of Benefits of the Proposed Action

Benefit Category	Benefit Description	Value of Benefit Over License Period
Net Electrical Generating Benefits		
Net Generating Capacity	~1600 MW(e)	--
Electricity Generated (operating at 90% capacity)	~12,600,000 MW(h) per year	--
Taxes and Other Revenue During Plant Construction, Preconstruction, and Operation Period (transfer payments—not independent benefits)		
Tax Revenues	Property tax payments increase as UniStar's investment increases during construction and preconstruction. Tax payment would increase to approximately $71.3 million a year. During operations tax payments will decline over time due to depreciation, starting at $57 million in the first year. Sales, income, and residential property taxes will have a lesser impact on the local and State economy.	$2.3 Billion
Effects on Regional Productivity		
Construction Workers	Approximately 3950 direct peak workers create an additional increase of 542 to 948 indirect jobs.	SMALL
Operational Workers	Approximately 363 direct workers create an additional increase of 248 indirect jobs within the region for 40 years of operation.	SMALL
Socioeconomics	Increased tax revenue supports improvements to public infrastructure and social services. The increased revenue spurs future growth and development.	SMALL
Technical and Other Non-Monetary Benefits	Fuel diversity reduces exposure to supply risk associated with reliance on any single fuel source.	--
Electricity Price Volatility	Dampens potential for electricity price volatility.	--
Electrical Reliability	Enhances electricity supply reliability.	--

10.6.1 Benefits

The most apparent benefit from building and operating a power plant is that it generates power and provides thousands of residential, commercial, and industrial consumers with electricity. Maintaining an adequate supply of electricity in any given region has social and economic importance because adequate electricity is the foundation for economic stability and growth and is fundamental to maintaining the current standard of living. Because the focus of this EIS is on the proposed expansion of the Calvert Cliffs site's generating capacity, this section focuses primarily on the relative benefits of the proposed option rather than the broader, more generic benefits of electricity supply.

10.6.1.1 Societal Benefits

For the production of electricity to be beneficial to a society, there must be a corresponding demand, or "need for power," in the region. Chapter 8 defines and discusses the need for power in more detail. From a societal perspective, price stability and longevity, energy security, and fuel diversity are the primary benefits associated with nuclear power generation relative to most other alternative generating approaches. These benefits are described in this subsection.

Price Stability and Longevity

Because of relatively low and non-volatile fuel costs (approximately 0.5 cents per kWh) and a projected capacity utilization rate of 85 to 93 percent, nuclear energy is a dependable source of electricity that can be provided at relatively stable prices to consumers over a long period of time. Nuclear power plants are generally not subject to fuel price volatility like natural gas and oil power plants. In addition, uranium fuel constitutes only 3 to 5 percent of the cost of a kilowatt-hour of nuclear-generated electricity. Doubling the price of uranium increases the cost of electricity by about 7 percent, while doubling the price of gas would add about 70 percent to the price of electricity, and doubling the cost of coal would add about 36 percent to the price of electricity (WNA 2010).

Energy Security and Fuel Diversity

Currently, more than 70 percent of the electricity generated in the United States is generated from fossil-based technologies. Thus, non-fossil-based generation, such as nuclear generation, is essential to maintaining diversity in the aggregate power generation fuel mix (DOE/EIA 2007). Nuclear power contributes to the diverse U.S. energy mix, thereby hedging the risk of shortages and price fluctuations for any one generating system.

As discussed in Chapter 8, the MPSC has determined the need for an additional 4000 MW of electric generating capacity to provide a reliable supply and an in-state reserve margin (MPSC 2007). The proposed Unit 3 capacity of 1600 MW would provide 40 percent of the need.

A diverse fuel mix helps to protect consumers from contingencies, such as fuel shortages or disruptions, price fluctuations, and changes in regulatory practices. Maryland's fuel mix for electricity is more than 55 percent coal, 28 percent nuclear, more than 11 percent gas and oil, and 5 percent renewable (MPSC 2007). The addition of proposed Unit 3 would increase the share of nuclear capacity from 13.9 to 23.7 percent (MPSC 2007), which would provide the region with a hedge against risks of future shortages and price fluctuations of alternative generating systems.

Need for Power

The MPSC analyzed the need for power from a new baseload generating unit in Maryland in a 2007 report (MPSC 2007) and in the CPCN proceeding (MPSC 2009a). In June 2009, the MPSC granted a CPCN to UniStar for proposed Unit 3 (MPSC 2009b). As discussed in Chapter 8, the NRC staff relied on the MPSC's determinations to reach its conclusion that there is a need for baseload power from proposed Unit 3 at Calvert Cliffs by 2016.

10.6.1.2 Regional Benefits

Regional benefits of the building and operation of Unit 3 include enhanced tax revenues, regional productivity, and community impacts.

Tax Revenue Benefits

Revenues would accrue to the State and the two-county economic impact area primarily in the form of property, income, and sales taxes over a short-term period due to construction and preconstruction activities and over a long-term period due to operation activities.

For the construction and preconstruction period, it was estimated in Chapter 4 that revenues during the peak in construction and preconstruction activity would increase primarily to Maryland from State income and sales taxes, to St. Mary's County in the form of county income taxes, and in Calvert County due to county income taxes and property taxes from the proposed Unit 3. Tax revenues to the State of Maryland and St. Mary's County are expected to be small compared to their annual revenues. In Calvert County, the property taxes from Unit 3 would be a significant portion of County revenues. As construction and preconstruction activities progress and the taxable value of the property increases, so would the annual property taxes. UniStar estimated Unit 3-related property taxes in 2010 would be $3.5 million, increasing to $71.3 million in the final year of construction and preconstruction. Given that estimated 2009 Calvert County revenues are $221 million, the $71.3 million in the final year of construction and preconstruction represents approximately 32.2 percent of 2009 Calvert County revenues (UniStar 2009b). Once operation commences, Unit 3 would qualify for a 50 percent reduction in assessed personal property value. Therefore, property taxes would be based on half the assessed value of the plant and would continue to decline due to depreciation. UniStar estimates taxes in the first year of operations to be approximately $57.1 million (UniStar 2009b). After the first 15 years of operation, Calvert County could tax the full assessed value of the unit, which would bring tax payments up to $82.1 million in Year 16, then they would continue to decline due to depreciation. Other taxes would be collected during the 40-year operation period, such as state sales tax on goods bought by operations workers employed at the facility and those purchased by UniStar in regards to the new unit, as well as income taxes on operations workers' income and property taxes they pay on their homes. However, these tax revenues are considered to be *de minimis* in comparison to overall revenues from sales, income, and residential property taxes.

Regional Productivity and Community Impacts

The new unit would require construction and operation workforces of about 3950 and 363 workers, respectively. The economic activity of the in-migrating portion of these workforces would stimulate additional indirect jobs for an estimated peak in total employment during construction and preconstruction of 4492 to 4898 (based on 20 to 35 percent in-migration scenario) workers, declining to 545 for the 40 years of operation. Increased spending by the direct and indirect workforce created as a result of the proposed new unit would increase the economic activity in the region, most noticeably in Calvert County (Chapters 4 and 5). The general growth of the economic opportunities in the region would be a positive economic development.

Additional information on the economic impacts of constructing and operating the proposed Unit 3 is provided in Sections 4.4.4 and 5.4.4. A summary of benefits is shown in Table 10-3.

10.6.2 Costs

Internal costs to UniStar, as well as external costs to the surrounding region and environment, would be incurred during construction, preconstruction, and operation of Unit 3 on the Calvert Cliffs site. Internal costs include the costs to physically build the power plant (capital costs), as well as operating and maintenance costs, fuel costs, waste disposal costs, and decommissioning costs. External costs include all costs imposed on the environment and region surrounding the plant that are not internalized by the company and may include such things as a loss of regional productivity, environmental degradation, or loss of wildlife habitat. The external costs listed in Table 10-4 summarize environmental impacts to resources that could result from construction, preconstruction, and operation of Unit 3. Because Table 10-4 includes costs from preconstruction activities, it overestimates the costs of the NRC-authorized portion of the proposed action.

1 **Table 10-4**. Summary of Costs of Preconstruction, Construction, and Operation

Cost Category	Description of Cost
Internal Costs	
Overnight Capital Cost	$7.2–$9.6 billion [$4500 to $6000 per installed kW(e)]
Operation	$391–580 million per year based on $0.031–0.046 per kWh, and $1047–1400 million per year based on $0.083–0.0111 per kWh
Decommissioning	Approximately 0.1 to 0.2 cents per kWh
External Costs	
Land Use	SMALL. Co-located on the Calvert Cliffs site (2070 ac) with CCNPP Units 1 and 2.
Water Use and Water Quality	SMALL. Surface and groundwater use would be mitigated by construction of desalinization plant for cooling water systems. Chesapeake Bay water demand from desalinization equals an estimated total 43,480 gpm.
Terrestrial Ecology	MODERATE for terrestrial ecology. High-value habitats and resources would be permanently lost or degraded. Rectification, enhancement, and conservation set-asides may partially offset losses. NRC-authorized construction impact level is SMALL.
Aquatic Ecology	MODERATE for aquatic species. Construction and preconstruction of Unit 3 would eliminate one fishing pond and 8350 ft of intermittent and perennial stream channels; also 5.7-ac subtidal Bay bottom would be affected by dredging, trenching, or armoring; entrainment, impingement, and entrapment during operation of Unit 3 would affect many species annually during the lifetime of the plant. NRC-authorized construction impact level is SMALL.
Health Impacts (Nonradiological and Radiological)	SMALL. Estimated temperature increases would not significantly increase the abundance of thermophilic microorganisms. Radiological doses and nonradiological health hazards to the public and occupational workers would be monitored and controlled in accordance with regulatory limits. Radiological exposure would be below limits to workers and public.
Hazardous and Radioactive Waste	SMALL. Storage, treatment, and disposal of radioactive waste. Commitment of underground geological resources for disposal of radioactive spent fuel. Compliance with applicable Federal, State, and local laws, ordinances, and regulations intended to prevent or minimize adverse environmental impacts of hazardous wastes.
Air Quality	SMALL. Air emissions from diesel generators, auxiliary boilers and equipment, and vehicles may have a small impact on workers and local residents. Cooling tower drift will deposit some salt on the surrounding vicinity, but the level is unlikely to result in any measurable impact on plants and vegetation. Cooling tower atmospheric plume discharge abated with design.

Table 10-4. (contd)

Cost Category	Description of Cost
Materials, Energy, and Uranium	SMALL. Irreversible and irretrievable commitments of materials and energy, including depletion of uranium.
Socioeconomics	SMALL to MODERATE. Construction and preconstruction of Unit 3 may pose additional costs to public and social services in the area. Some costs may be offset by tax revenues generated by the construction and preconstruction phase. Temporary impacts on the local roads near the Calvert Cliffs site.
Environmental Justice	SMALL. No environmental pathways were identified through which minority or low-income populations could be disproportionately and adversely impacted.
Cultural Resources	LARGE. UniStar has negotiated an MOA with the Corps and the Maryland Historical Trust on the process for data recovery and documentation for three NRHP-eligible sites that would be adversely affected. NRC-authorized construction impact level is SMALL.

10.6.2.1 Internal Costs

Because no new nuclear plants have been built in the United States in many years, there is lack of empirical cost data on recent domestic construction. Therefore, the analyses upon which the review team has relied for its conclusions were based largely upon construction cost evidence for a variety of different designs and in several different countries. Consequently, there is a significant amount of uncertainty regarding the true costs of constructing a new unit. However, the review team determined that there are a number of general aspects about major construction projects that hold for the proposed project and can be used to characterize expected costs. The most substantial monetary cost associated with nuclear energy is the cost of capital. Nuclear power plants typically have relatively high capital costs for building the plant, but low fuel costs relative to alternative power generation systems. Because of the large capital costs for nuclear power plants, servicing the capital costs of a nuclear power plant is the most important factor determining the economic competitiveness of nuclear energy. Construction and preconstruction delays can add significantly to the cost of a plant, which translate directly into higher interest expenses on borrowed funds. Maryland does not allow utilities to pass on the cost of construction to ratepayers until after the plant is online (a process called “allowance for funds used during construction”), which is often used as a strategy for reducing the project’s cost of capital.

Construction and Preconstruction Costs

In evaluating monetary costs related to building Unit 3, UniStar reviewed recently published literature; vendor information; internally generated financial information; and internally generated, site-specific information (UniStar 2009b). The NRC also reviewed recently published literature (MIT 2003; University of Chicago 2004; DOE/EIA 2004b; Keystone 2007; and IEA 2005) and site-specific information. The overnight capital costs in the studies were based primarily on estimated rather than actual construction costs and ranged from a low of approximately $1000/kW(e) to a high of approximately $4000/kW(e). Differences relate to the year that the dollar value was expressed in, the exchange rate, the sample size, the technology, the number of units built, site characteristics, and other assumptions used. UniStar's estimate of the construction and preconstruction cost is discussed below.

UniStar expressed its capital cost estimate in terms of "overnight capital cost," which is a commonly used approach in the construction industry. The following costs are included in the overnight capital costs:

- the engineering, procurement, construction, and preconstruction costs for the U.S. EPR proposed for the site
- the owner's costs, including construction and preconstruction activities, cooling water intake structures and cooling towers, import duties on components, insurance, spare parts, transmission interconnection, development costs, project management costs, owner's engineering, State and local permitting, legal fees, and staffing-related training
- contingency costs.

UniStar concluded $4500/kW to $6000/kW would be applicable to Unit 3, which equates to roughly $7.2 billion to $9.6 billion. Interest and cost escalation during the construction and preconstruction period are excluded from the overnight capital cost. All of these estimates include the cost of both construction and preconstruction activities. Thus, they overestimate the costs of the NRC proposed action and provide a conservative estimate of the costs for the benefit-cost analysis.

Operation Costs

Operation costs are frequently expressed as the levelized cost of electricity, which is the price per kWh of producing electricity, including the cost needed to cover operating costs and annualized capital costs. Overnight capital costs account for a third of the levelized cost, and interest costs on the overnight costs of construction account for another 25 percent (University of Chicago 2004). Levelized cost estimates in recent studies range from $36 to $83 per MWh (3.6 to 8.3 cents per kWh). Factors affecting the range include choices for discount rate, duration of the project, plant life span, capacity factor, cost of debt, the ratio of debt to equity in financing, depreciation (rate and years), tax rates, and premium for uncertainty. Estimates include decommissioning, but due to 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. Also, the Energy Policy Act of 2005 provided a production tax credit for the first advanced reactors brought online in the United States and would tend to lower the estimated operating cost (UniStar 2009a). UniStar concluded that $31 to $46 per MWh ($0.031 to $0.046 per kWh) represents a reasonable range for the expected levelized cost (UniStar 2009a). However, the Keystone Study estimates the levelized cost to range from $0.083 to $0.111 per kWh (Keystone 2007). In addition, the review team examined the update to the MIT study (MIT 2009), which re-evaluated the overnight levelized cost of electricity at 8.4 cents per kWh (2007$). In 2008 dollars, the results of the cited studies yield an overall range of 3.8 to 8.6 cents per kWh for operation costs.

Fuel Costs

From the outset, the basic attraction of nuclear energy has been its low fuel costs compared to coal, oil, and gas-fired plants. Uranium, however, has to be processed, enriched, and fabricated into fuel elements and about half of the cost results from enrichment and fabrication. Allowances must also be made for the management of radioactive spent fuel and the ultimate disposal of this spent fuel or the wastes separated from it. However, even with these costs included, the total fuel costs of a nuclear power plant are typically about a third of those for a coal-fired plant and between a quarter and a fifth of those for a natural gas combined-cycle plant (University of Chicago 2004). For consistency with the operating cost estimates provided, the review team based its fuel cost assumptions on the recent World Nuclear Association's study, which estimated nuclear fuel costs to be $0.449 cents per kWh (WNA 2010).

Waste Disposal

The back-end costs of nuclear power contribute a small share of total cost because of the long lifetime of a nuclear reactor and the fact that provisions for waste-related costs can be accumulated over that time. Spent fuel management costs are estimated to be 0.1 cents per kWh (WNA 2010; DOE 2008).

Decommissioning

The NRC has requirements for licensees at 10 CFR 50.75 to provide reasonable assurance that funds will be available for the decommissioning process. 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 of electricity generated by a nuclear power plant. Decommissioning costs are about 9 to 15 percent of the initial capital cost of a nuclear power plant. However, when discounted, they contribute only a few percent to the investment cost and even less to the generation cost. In the United States, they account for 0.1 to 0.2 cents per kWh, which is no more than 5 percent of the cost of the electricity produced (WNA 2010).

10.6.2.2 External Costs

External costs are social and/or environmental effects caused by the proposed construction, preconstruction, and operation of a new reactor at the Calvert Cliffs site. This COL EIS includes the NRC staff's analysis that considers and weighs the environmental impacts of building and operating a new nuclear unit at the Calvert Cliffs site or at alternative sites and mitigation measures available for reducing or avoiding these adverse impacts. It also includes the staff's recommendation to the Commission regarding the proposed action.

Environmental and Social Costs

Chapter 4 of this EIS describes the impacts of constructing Unit 3 on the environment with respect to the land, water, ecology, socioeconomics, radiation exposure to construction workers, and measures and controls to limit adverse impacts during building activities. Chapter 5 of this EIS examines environmental issues associated with operation of the new Unit 3 for an initial 40-year period. Potential operational impacts on land-use, air quality, water, terrestrial and aquatic ecosystems, socioeconomics, historic and cultural resources, environmental justice, non-radiological and radiological health effects, postulated accidents, and applicable measures and controls that would limit the adverse impacts of station operation during the 40-year operating period are considered. In accordance with 10 CFR Part 51, all impacts identified in Chapters 4 and 5 have been analyzed, and a significance level of potential adverse impacts (i.e., SMALL, MODERATE, or LARGE) has been assigned. Chapter 6 of this EIS addresses the environmental impacts from: (1) the uranium fuel cycle and solid waste management, (2) the transportation of radioactive material, and (3) the decommissioning of Unit 3 at the Calvert Cliffs site. Chapter 7 of this EIS places all of the potential impacts of the new unit in the context of all past, present, and reasonably foreseeable future activities in the general area that may have a nexus to the region. Chapter 9 of this EIS includes the review team's review of alternative sites and alternative power generation systems. A summary of project internal and external costs is shown in Table 10-4.

Unlike generation of electricity from coal and natural gas, normal operation of a nuclear power plant does not result in significant emissions of criteria air pollutants (e.g., oxides of nitrogen or sulfur dioxide), methyl mercury, or greenhouse gases associated with global warming and climate change. Combustion-based power plants are responsible for at least 70 percent of the sulfur dioxide, at least 21 percent of nitrogen oxides, and 51 percent of the mercury emissions from industrial sources in the United States (EPA 2009) and 40 percent of the carbon dioxide (DOE/EIA 2008). Eighty-two percent of the electric power industry's emissions are from coal-fired plants (DOE/EIA 2008). Chapter 9 of this EIS analyzes coal- and natural gas-fired alternatives to building and operating the proposed Unit 3. Air emissions from these alternatives and nuclear power are summarized in Chapters 4, 5, and 9.

As mentioned previously, Table 10-4 summarizes the external costs (i.e., environmental impacts) associated with the preconstruction, construction, and operation of Unit 3. Table 4-11 summarizes the impacts from construction and preconstruction. Impacts to land use, air quality, housing, public services, aesthetics and recreation, and radiological and nonradiological health would all be SMALL. Because the overall impact to these resources from the proposed project in its entirety would be SMALL, the NRC portion of the project (i.e., construction as defined in 10 CFR 51.4, and operation of the proposed new unit) accordingly would also be SMALL.

For terrestrial and wetland ecosystems the impact from the entire project would be MODERATE, and the impact from the NRC-authorized portion of the project would be SMALL. For aquatic ecosystems, the impact from the entire project would be MODERATE, and the impact from the NRC-authorized portion would be SMALL. The socioeconomic impacts for the overall project would be SMALL to LARGE (beneficial), and the impact from the NRC-authorized activities would be SMALL to LARGE (beneficial). Impacts to cultural resources are considered LARGE for the total project but SMALL for the NRC-authorized activities.

10.6.3 Summary of Benefits and Costs

UniStar's business decision to pursue expansion of Calvert Cliffs' generating capacity by adding an additional nuclear reactor is an economic decision based on private financial factors subject to regulation by the MPSC. Although no specific monetary values could reasonably be assigned to the identified societal benefits, the review team believes that the potential societal benefits of the proposed expansion of the Calvert Cliffs site are substantial. In comparison, the external socioeconomic and environmental costs imposed on the region appear to be relatively small.

Table 10-3 and Table 10-4 include a summary of both internal and external costs of the proposed activities at the Calvert Cliffs site, as well as the identified benefits. The tables include references to other sections of this EIS when more detailed analyses and impact assessments are available for specific topics.

On the basis of the assessments in this EIS that the construction and operation of the proposed Calvert Cliffs Unit 3, with mitigation measures identified by the review team, would have accrued benefits that most likely would outweigh the economic, environmental, and social costs associated with constructing and operating Unit 3 at the Calvert Cliffs site. For the NRC-proposed action (NRC-authorized construction and operation) the accrued benefits would also outweigh the costs of construction, preconstruction, and operation of Unit 3.

10.7 NRC Staff Recommendation

The NRC staff's preliminary recommendation to the Commission related to the environmental aspects of the proposed action is that the COL should be issued. The staff's evaluation of the safety and emergency preparedness aspects of the proposed action will be addressed in the staff's safety evaluation report that is anticipated to be published in July 2012.

The staff's preliminary recommendation is based on (1) the ER submitted by UniStar (2009a); (2) consultation with Federal, State, Tribal, and local agencies; (3) the review team's independent review; (4) the NRC staff's consideration of comments related to the environmental review that were received during the public scoping process; and (5) the assessments summarized in this EIS including the potential mitigation measures identified in the ER and in this EIS. In making its preliminary recommendation, the staff determined that none of the alternative sites assessed is obviously superior to the Calvert Cliffs site.

The NRC's determination is independent of the Corps' determination of a Least Environmentally Damaging Practicable Alternative pursuant to Clean Water Act Section 404(b)(1) Guidelines. The Corps will conclude its analysis of both offsite and onsite alternatives in its Record of Decision.

10.8 References

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

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

10 CFR Part 52. Code of Federal Regulations, Title 10, *Energy,* Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

33 CFR Part 325. Code of Federal Regulations. Title 33, *Navigation and Navigable Waters*, Part 325, "Processing of Department of the Army Permits."

33 CFR Part 332. Code of Federal Regulations. Title 33, *Navigation and Navigable Waters*, Part 325, "Compensatory Mitigation for Losses of Aquatic Resources."

40 CFR Part 1508. Code of Federal Regulations. Title 40, *Protection of Environment*, Part 1508, "Terminology and Index."

72 FR 57416. October 9, 2007. "Limited Work Authorizations for Nuclear Power Plants." *Federal Register*, Nuclear Regulatory Commission.

Clean Water Act. 33 U.S.C. 1251, et seq. (also referred to as the Federal Water Pollution Control Act [FWPCA]).

Energy Policy Act of 2005. 45 U.S.C. 15801 et seq.

Maryland Historical Trust (MHT). 2009. Letter from J. Rodney Little (MHT) to William Seib (USACE), "Subject: MHT Review of Phase II National Register Evaluations and Assessment of Effects for Cultural Resources, Calvert Cliffs Nuclear Power Plant Expansion, Calvert County, Maryland." February 13, 2009. Accession No. ML090570416.

Maryland Public Service Commission (MPSC). 2007. *Electric Supply Adequacy Report of 2007*. Accessed October 7, 2009, at http://webapp.psc.state.md.us/Intranet/psc/Reports_new.cfm.

Maryland Public Service Commission (MPSC). 2009a. *In the Matter of the Application of UniStar Nuclear Energy, LLC and UniStar Nuclear Operating Services, LLC for a Certificate of Public Convenience and Necessity to Construct a Nuclear Power Plant at Calvert Cliffs in Calvert County, Maryland*. Case Number 9127. Proposed Order of Hearing Examiner, April 28, 2009.

Maryland Public Service Commission (MPSC). 2009b. *In the Matter of the Application of UniStar Nuclear Energy, LLC and UniStar Nuclear Operating Services, LLC for a Certificate of Public Convenience and Necessity to Construct a Nuclear Power Plant at Calvert Cliffs in Calvert County, Maryland*. Case Number 9127. Order Number 82741, June 26, 2009.

Massachusetts Institute of Technology (MIT). 2003. *The Future of Nuclear Power: An Interdisciplinary MIT Study*. Accessed at http://web.mit.edu/nuclearpower/.

Massachusetts Institute of Technology (MIT). 2009. *Update of the MIT 2003 Future of Nuclear Power*.

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

International Energy Agency (IEA). 2005. *Projected Costs of Generating Electricity: 2005 Update*. Organisation for Economic Cooperation and Development, Paris, France.

The Keystone Center (Keystone). 2007. *Nuclear Power Joint Fact-Finding.* Accessed at http://www.keystone.org/spp/documents/FinalReport_NJFF6_12_2007(1).pdf.

Organisation for Economic Co-Operation and Development Nuclear Energy Agency and International Atomic Energy Agency (OECD NEA and IAEA). 2008. *Uranium 2007.* 22nd ed., Paris.

Rivers and Harbors Appropriation Act of 1899 (Rivers and Harbors Act). 33 U.S.C. 403, as amended.

UniStar Nuclear Development, LLC (UniStar). 2008a. Letter from G.J. Wrobel (UniStar) to, U.S. Nuclear Regulatory Commission "UniStar Nuclear Energy, NRC Docket No. 52-016 Submittal of Corrected Revision 3 to the Combined License Application for the Calvert Cliffs Nuclear Power Plant, Unit 3." August 20, 2008. Accession No. ML082390786.

UniStar Nuclear Development, LLC (UniStar). 2008b. Calvert Cliffs Nuclear Power Plant Unit 3 Joint Federal/State Application to the United States Army Corps of Engineers and the Maryland Department of the Environment for the Alteration of any Floodplain, Waterway, Tidal or Nontidal Wetland in Maryland. Transmittal letters from D. Lutchenkov (UniStar) to Maryland Department of the Environment and to K. Anderson (USACE) for USACE Application Number NAB-2007-08123-M05. May 16, 2008. Accession No. ML081840343.

UniStar Nuclear Development, LLC (UniStar). 2009a. *Calvert Cliffs Nuclear Power Plant Unit 3 Combined License Application, Part 3, Environmental Report*. Revision 6. UniStar, Baltimore, Maryland. Accession No. ML092880921.

UniStar Nuclear Energy (UniStar). 2009b. Letter from G. Gibson (UniStar) to NRC (Document Control Desk), Follow-up response to Environmental Report, RAI No. 127, Estimated Tax Benefit, November 16, 2009. Accession No. ML093220193.

University of Chicago. 2004. *The Economic Future of Nuclear Power*. Accessed at http://www.anl.gov/Special_Reports/NuclEconAug04.pdf.

U.S. Army Corps of Engineers (USACE). 1987. *Corps of Engineers Wetlands Delineation Manual*. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

U.S. Army Corps of Engineers (USACE). 2008. *Public Notice in Reply to Application Number CENAB-OP-RMS NAB-2007-01823-M05 (Calvert Cliff's 3 Nuclear Project, LLC/Unistar Nuclear Operating Services, LLC).* September 3, 2008. Accession No. ML082550288.

U.S. Army Corps of Engineers (USACE). 2010. Letter from K.B. Anderson (USACE) to R.J. Nelson (Office of Federal Agency Programs, Advisory Council on Historic Preservation), *Review of US Army Corps of Engineers and Maryland State Historic Preservation Officer regarding Calvert Cliffs 3 Nuclear Plant (CENAB-OP-RMS) effect on historic properties and Memorandum of Agreement*. March 16, 2010. Accession No. ML100810272.

U.S. Census Bureau (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. Available at http://www.census.gov/wholesale/www/historic_releases/annual_historic_releases.html.

U.S. Census Bureau (USCB). 2006b. U.S. Census Bureau Survey of Plant Capacity: 2006. U.S. Department of commerce, Economics and Statistics Administration. Available at http://www.census.gov/manufacturing/capacity/historical_data/index.html.

U.S. Department of Energy (DOE). 2005. Cost Estimating Guidelines for Generation IV Nuclear Energy Systems, Rev. 2.02 Final. Economic Modeling Working Group. Available at http://nuclear.inl.gov/deliverables/docs/emwgguidelines_rev2.pdf.

U.S. Department of Energy (DOE). 2008. *Yucca Mountain Repository*. Accessed May 22, 2008 at http://www.ocrwm.doe.gov/ym_repository/index.shtml#4. Accession No. ML100600704.

U.S. Department of Energy/Energy Information Administration (DOE/EIA). 2004a. *Application of Advanced Construction Technologies to New Nuclear Power Plants*. MPR-2610, Revision 2. Washington, D.C. Accessed April 1, 2009 at http://www.ne.doe.gov/np2010/reports/mpr2610Rev2Final924.pdf. Accession No. ML093160836.

U.S. Department of Energy/Energy Information Administration (DOE/EIA). 2004b. *Annual Energy Outlook, With Projections to 2025.* DOE/EIA-0383(2004). Washington, D.C. Accessed September 17, 2008 at http://www.eia.doe.gov/oiaf/archive/aeo04/pdf/0383(2004).pdf. Accession No. ML093160831.

U.S. Department of Energy/Energy Information Administration (DOE/EIA). 2007. *Electric Power Annual*. Accessed July 6, 2009 at http://www.eia.doe.gov/cneaf/electricity/epa/epa_sum.html. Accession No. ML093160832.

U.S. Department of Energy/Energy Information Administration (DOE/EIA). 2008. *Emissions of Greenhouse Gases in the United States*. DOE/EIA-0573(2008). Accessed February 3, 2010 at http://www.eia.doe.gov/oiaf/1605/ggrpt/gwp_gases.html. Accession No. ML100580032.

U.S. Environmental Protection Agency (EPA). 2009. *Report on the Environment. A-Z Indicators Lis*t. Accessed on February 3, 2010 at http://cfpub.epa.gov/eroe/index.cfm?fuseaction=list.listByAlpha#E. Accession No. ML100580033.

U.S. Nuclear Regulatory Commission (NRC). 2000. *Environmental Standard Review Plan—Standard Review Plans for Environmental Reviews for Nuclear Power Plants.* NUREG-1555, Washington, D.C. Includes 2007 updates.

World Nuclear Association (WNA). 2010. *The Economics of Nuclear Power*. Accessed March 8, 2010 at http://www.world-nuclear.org/info/inf02.html. Accession No. ML100600712.

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11. ABSTRACT *(200 words or less)*

This EIS has been prepared in response to to an application submitted to the U.S. Nuclear Regulatory Commission (NRC) by Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC (collectively referred to as UniStar) for a combined license (COL). UniStar also submitted a joint Federal/State Application for the Alteration of Any Floodplain, Waterway, Tidal or Nontidal Wetland in Maryland to the U.S. Army Corps of Engineers (Corps). The Corps is a cooperating agency on this EIS. This EIS includes the analysis by the NRC and Corps staff that considers and weighs the environmental impacts of constructing and operating a new nuclear unit at the Calvert Cliffs site and at alternative sites and mitigation measures available for reducing or avoiding adverse impacts.

After considering the environmental aspects of the proposed NRC action, the NRC's staff preliminary recommendation to the Commission is that the COL be issued as requested. This recommendation is based on (1) the application, including the Environmental Report, submitted by UniStar and responses to requests for additional information; (2) consultation with Federal, State, Tribal and local agencies; (3) the staff's independent review; (4) the staff's consideration of comments related to the environmental review that were received during the public scoping process; and (5) the assessments summarized in the EIS, including the potential mitigation measures identified in the ER and this EIS. The Corps' permit decision will be made following the issuance of the final EIS.

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