5.0 IMPACTS OF OPERATION

5.1 LAND USE IMPACTS

The following sections describe the impacts of Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 operations on land use at the CCNPP site, the 8 mi (13 km) vicinity, and associated transmission line corridors, including impacts to historic and cultural resources. The operation of CCNPP Unit 3 is not anticipated to affect any current or planned land uses.

5.1.1 THE SITE AND VICINITY

Land use impacts from construction are described in Section 4.1.1. The only additional impacts to land use from operations will be the impacts of solids deposition from cooling tower drift. The cooling system for CCNPP Unit 3 will be a closed-cycle, wet cooling system, consisting of a single combination dry and wet (hybrid) cooling tower for heat dissipation. The tower will be approximately 164 ft (50 m) high with an overall diameter of 528 ft (161 m). Makeup water for the proposed unit will be taken from the Chesapeake Bay at a rate of ~~37,748~~38,032 gpm (~~131,535~~143,968 lpm), assuming two cycles of concentration.

The cooling tower system will occupy an area of approximately 5 acres (2 hectares). Details of cooling tower design are discussed in Section 3.4.2 and impacts of the heat dissipation system, including salt deposition, are discussed further in Sections 5.3.3.1 and 5.3.3.2. The cooling tower for CCNPP Unit 3 will be located south-southeast of the CCNPP Unit 3 power block. The cooling tower will be approximately 3,200 ft (970 m) from the center of the tower to the nearest site boundary to the south-southeast and approximately 1,545 ft (471 m) to the closest portion of the 1,000 ft (305 m) Chesapeake Bay Critical Area (CBCA) zone located to the northeast along the Chesapeake Bay.

Ordinarily a visible mist or plume is created because of the microscopic droplets of water that are entrained in the air discharged from the cooling tower. These droplets will eventually evaporate at some distance from the tower denoted as the visible plume length. The CCNPP Unit 3 cooling tower is a hybrid design and will not create any visible plume. The SPX Cooling Technologies design includes the injection of heated ambient air above the demisters at approximately the same rate (scfm) as in the wet section. (SPX. 2008) The hot water from the main condenser will increase the temperature of the air above the demisters to above the new dew point. i.e., at a temperature that will decrease the relative humidity and allow for the microscopic water droplets to evaporate completely. This evaporation process will be carefUlly controlled by monitoring a number of ambient parameters including the temperature, atmospheric pressure and humidity. Adding the right amount of heat above the demisters will prevent the formation of a visible plume at the tower exit or further downwind from the tower.

Because there will be no water droplets emitted from the tower, there is no potential for shadowing, fogging, icing, localized increases in humidity. or water deposition.

The eliminat ion of the droplets will not affect the salt or solid particles that are entrained in the moist air and discharged from the demisters. The water droplets evaporate by the time the parcel of air rises from the demisters to the top of the tower, a distance of about 80 ft (24m). The salt particles will be discharged from the tower as part of the approximatelv 130,000,000 scfm air stream that will leave the tower. However, the size of the particle being discharged is a fraction of the size of the water droplet before evaporation and will be carried further downwind than wou ld the drop lets . As a result. there should be little deposition in the immediate vicinity of the tower.

Salt deposition near the tower is predominately due to the larger particles being emitted from the cooling tower, i.e. mainly the particles larger than 10 microns. PM10 represents suspended particulates that are presumed to act like a gas when emitted into the atmosphere. About 80% of the part icles emitted will be in the form of PM10 on a mass basis. Eventually, PM10 will settle out or serve as a nucleus for water droplet formation at significant distances from the source.

The EPA's AERMOD was used to estimate the amount of salt or solids that would be deposited in the immediate area of the site. The maximum salt deposition rate from the cooling tower is provided in Table 5.3-8. The maximum predicted salt deposition rate is below the NUREG-1555 (NRC, 1999) significance level for possible vegetation damage of 8.9 lbs per acre per month (10 kg per hectare per month) in all directions from the cooling tower, during each season and annually. Therefore, impacts to vegetation from the salt deposition are not expected for both onsite and offsite locations.

There will be no visible plume discharged from the CWS cooling tower under any meteorological condition. It is anticipated that the plume abatement system will operate at all times necessary to eliminate the plume.

The electrical switchyard for CCNPP Unit 3 will be located approximately 1,600 ft (500 m) to the northwest of the proposed location for the Circulating water supply system (CWS) cooling tower. A maximum predicted solids deposition rate of ~~0.45~~1.2 pounds per acre per month (~~0.0.504~~1.35 kg per hectare per month) is expected at the CCNPP Unit 3 switchyard during the fall season. Additionally, the electrical switchyard for CCNPP Units 1 and 2 is located approximately 4,600 ft (1,400 m) to the north-northwest, from the proposed location of the CCNPP Unit 3 CWS cooling tower. The maximum predicted solids deposition expected at the CCNPP Units 1 and 2 electrical switchyard due to operation of the CCNPP Unit 3 CWS cooling tower will be 0.~~2~~44 pounds per acre per month (0.~~224~~50 kg per hectare per month) during the summer season.

Based on industry experience, adjustments to maintenance frequencies (e.g., insulator washing) may be necessary due to solids deposition; however, the expected deposition rates will not affect switchyard component reliability or increase the probability of a transmission line outage at CCNPP Units 1 and 2, or CCNPP Unit 3. Figure 5.3-2 shows the extent of solids deposition during the summer months.

Impacts from salt deposition from the CCNPP Unit 3 cooling tower would be SMALL. The modeling predicts salt deposition at rates below the NUREG-1555 significance level of 8.9 lbs per acre per month (10.0 kgs per hectare per month), Section 5.3.3.2, Terrestrial Ecosystems, presents information on the sensitivity of specific species to salts.

The four smaller ESWS cooling tower will have a considerably smaller impact than the CWS. Normal heat loads to the ESWS cooling tower are approximately 3% of the heat load to the CWS cooling tower. The maximum heat load is less than 7% of the CWS cooling tower heat load. Any impacts from the heat dissipation to the atmosphere by the EWS cooling towers will be negligible. Moreover, the ESWS cooling towers are intended for freshwater use and therefore will cause negligible salt drift and particu late emissions. Therefore, the ESWS cooling towers are not considered further in this analysis.

Land use at the CCNPP site is indicated in Table 5.1-1. Forest is the most common land use at the CCNPP site. The forested area represents 78.7% of the CCNPP site acreage. Urban/built-up is the next highest land use area classification at the CCNPP site. The urban/built-up area represents 16.1% of the CCNPP site acreage.

Land use data for the 8.0 mi (13 km) site vicinity is presented in Table 5.1-2. Water is the largest land use category and represents 59.7% of the area in the 8.0 mi (13 km) site vicinity radius. Forest is the next largest land use and represents approximately 22% of the land area, with the Urban/Built-up category representing 10.3% of the land area. Section 2.2.1 presents land use on the CCNPP site and its vicinity extending 8 mi (13 km) beyond the site boundary and includes maps showing land use and transportation routes.

As described in Section 2.5, the impact evaluation assumes that the residences of CCNPP Unit 3 employees will be distributed across the region in the same proportion as those of the CCNPP Units 1 and 2 employees. It is estimated that an additional operational work force of 363 onsite employees will be needed for CCNPP Unit 3. Section 5.8.2 describes the impact of 363 new employees on the region's housing market and the increases in tax revenues.

Approximately 91% (330) of the new employees are expected to settle in Calvert and St. Mary's Counties. Sixty-seven percent (562) of current CCNPP Units 1 and 2 employees live in Calvert County. The area is rural, with utilities and amenities generally supplied by the townships in the county. It is likely that the new employees who choose to settle near the CCNPP site will purchase homes or acreage in the Calvert County and St. Mary's County area. Based on the 20 years of experience of the existing units, increased tax revenues will not spur development in the vicinity of the CCNPP site. There is some land within the vicinity in Calvert County and St. Mary's County owned by the Federal government and unavailable for development.

It is therefore concluded that impacts to land use in the vicinity will be SMALL and not warrant mitigation.

5.1.2 TRANSMISSION CORRIDORS AND OUTSIDE AREAS

As discussed in Section 2.2.2, the additional electricity generated from CCNPP Unit 3 will not require the addition of new offsite transmission lines. As discussed in Section 2.2.2.2, CCNPP Unit 3 construction activities will include the following onsite changes at the CCNPP site (PJM, 2006):

- One new 500 kV substation to transmit power from CCNPP Unit 3.
- Two new 500 kV, 3500 MVA circuits connecting CCNPP Unit 3 substation to the existing CCNPP Units 1 and 2 substation.

Numerous breaker upgrades and associated modifications will also be required at Waugh Chapel, Chalk Point, and other substations, but all of the changes will be implemented within the boundaries of the existing substations. There will be no operational impact to land use along the corridors as the result of the proposed action.

The onsite transmission line work necessary to support CCNPP Unit 3 will require new towers and a transmission line to connect a new switchyard for CCNPP Unit 3 to the existing CCNPP Units 1 and 2 switchyard. Line routing will be conducted to avoid or minimize impact on the existing Independent Spent Fuel Storage Installation, wetlands, and threatened and endangered species identified in the local area. No new operational land use impacts will occur as the result of the operation of the new connector transmission lines or the CCNPP Unit 3 substation.

In general, the transmission line owner (Baltimore Gas and Electric (BGE)) ensures that land use in the corridors and underneath the high voltage lines is compatible with the reliable transmission of electricity. Vegetation communities in these corridors are kept at an early successional stage by mowing and application of herbicides and growth-regulating chemicals. In some instances, BGE could allow agricultural activities in these rights-of-way. BGE could also allow hunt clubs and individuals to plant wildlife foods for quail, dove, wild turkey, and white-tailed deer. However, BGE's control and management of these rights-of-way precludes virtually all residential and industrial uses of the transmission corridors. As described in Section 3.7, BGE has established corridor vegetation management and line maintenance procedures that will continue to be used to maintain the corridor and transmission lines.

There will be no need for additional access roads along the existing offsite transmission corridors. Offsite corridor maintenance activities will be in accordance with existing right-of-way agreements between BGE and current landowners, where applicable. Should additional access be warranted, BGE will negotiate/renegotiate access agreements with the appropriate landowner. Therefore, it is concluded that land use impacts to offsite transmission corridors from operation of CCNPP Unit 3 will be identical to impacts from the existing CCNPP Units 1 and 2.

Onsite transmission corridor activities are limited to tying about 1 mi (1.6 km) of onsite transmission line from a new CCNPP Unit 3 switchyard to the existing CCNPP Units 1 and 2 switchyard. The basic transmission system electrical and structural design parameters for this new onsite transmission corridor are addressed in Section 3.7. Land use impacts from construction of the new onsite transmission corridor and new CCNPP Unit 3 switchyard are described in Section 4.1.

It is therefore concluded that impacts to land use in the existing transmission corridors or offsite areas would be SMALL and not require mitigation.

5.1.3 HISTORIC PROPERTIES AND CULTURAL RESOURCES

Tables 2.5-41 and 2.5-42 list historic properties within the project Areas of Potential Effect that are ~~potentially eligible or~~ eligible for listing on the National Register of Historic Places as well as resources that have been evaluated as ineligible based on Phase II studies. These tables reflect the comments received from the Maryland SHPO (MHT, 2007 and MHT, 2009). As described in Section 2.5.3, the cultural resource survey of the CCNPP site identified ~~fourteen~~seventeen archaeological sites, ~~four~~ one of which ~~are~~ is considered eligible for inclusion on the National Register of Historic~~al~~ Places. The survey also identified five architectural resources, four of which are considered eligible for the National Register of Historical Places.

~~Five of the eight historic properties would not be affected by operation of CCNPP Unit 3 due to the mitigation actions that will be taken during construction activities. All four of the potentially eligible archaeological sites will be addressed during construction as described in Section 4.1.3, thus operation of CCNPP Unit 3 would have no effect on these resources. Although the Eagle's Den building at Camp Conoy would remain, because the rest of the property would be affected during construction, this building would not retain National Register of Historic Places eligibility. Thus there would be no effect to this property from operation of the plant.~~

~~Portions of the roadbed for the former Baltimore and Drum Point Railroad will be affected during construction of CCNPP Unit 3, resulting in a a potentially adverse effect to this property. However, other portions both on and off the CCNPP site property will remain intact and remain eligible to the National Register of Historic Places.~~ Three of the five historic properties (Site 18Cv474, the Baltimore and Drum Point Railroad, and Camp Conoy) will be mitigated prior to project construction. Project construction will have no adverse effect to the remaining two historic properties (Preston's Cliffs and Parran's Park). The Preston's Cliff property and the

Parran's Park property will also remain intact and eligible to the National Register of Historic Places post-construction of CCNPP Unit 3. Potential sources of effects to these three properties would be maintenance activities and operation of the cooling tower which are addressed below.

Maintenance activities will occur in areas previously disturbed during CCNPP Unit 3 construction. Thus, effects to the three properties from maintenance activities are expected to be SMALL and not warrant mitigation. As discussed in Section 5.3.3.1, operation of the cooling tower would not produce a visible plume.Salt deposition could effect the settings or materials of historic properties. Due to the nature of the Baltimore and Drum Point Railroad property, the effects of saltdeposition on the railroad are expected to be SMALL and not warrant mitigation. Effects to the Preston's Cliff property's setting from the visible plume and fog are expected to be SMALL and not warrant mitigation due to the property's location near CCNPP Units 1 and 2 and the location of the property adjacent to salt water. The same levels of effect are expected for the Parran's Park property, for the same reasons.

Previously recorded historic or archaeological resources located within 10 mi (16 km) of the CCNPP site were also identified through research of existing records. Research identified 1,029 previously inventoried cultural resources. These resources are provided in Appendix A of Section 2.5. There are no anticipated impacts from the operation of CCNPP Unit 3 on these sites.

Consultation on the Phase I and II cultural resources investigations survey with Native American tribes is pending. This consultation could result in changes to the recommended National Register of Historical Places eligibility of the ~~19~~ 22 identified resources. Phase III data recovery ~~II archaeological~~ investigations and subsequent SHPO consultation will be conducted on ~~potentially~~ NRHP-eligible archaeological resources that are located within the proposed project area and cannot be avoided, to ~~determine their eligibility. Upon completion of Phase II investigations and SHPO consultations, assessments of effect on the National Register of Historical Places eligible resources on the project site will be determined and consultation conducted with the SHPO to identify measures to avoid,~~ minimize, or mitigate any adverse effects, per Section 106 of the National Historic Preservation Act (USC, 2007). A Memorandum of Agreement (MOA) will be prepared for three NRHP-eligible resources that will be adversely effected by the proposed project.

With maintenance and operations activities, there is always the possibility for inadvertent discovery of previously unknown cultural resources or human remains. Prior to initiating land disturbing activities, procedures will be developed which include actions to protect cultural, historic, or paleontological resources or human remains in the event of discovery. These procedures would comply with applicable Federal and State laws. Section 106 of the National Historic Preservation Act (USC, 2007) and Article 83B Section 5-617 and 5-618 of the Maryland Code, respectively, require any project requiring licenses, permits, or that are funded by State and Federal agencies to examine the impact of their undertaking on significant cultural resources and to take steps to avoid, reduce or mitigate any adverse effects. The Code of Maryland, Criminal Law Title 10, Subtitle 4, Sections 10-401 through 10-404 (MD, 2007a) requires consultation with the State of Maryland for removal and reburial of human remains. The Code of Maryland, Health – General, Title 4, Subtitle 2, Section 4-215 (MD, 2007b) requires a permit to disinter a burial.

The continued use of the existing transmission corridors by the proposed project would not result in new impacts to cultural and historical resources. There would be no new offsite transmission corridors or offsite transmission lines for the proposed project. Because there will be no new corridors or construction of new transmission lines within the existing corridors required for this project, there will be no new impacts as the result of this project. However, should new and significant cultural and historic resources be encountered during maintenance operations along the existing corridors, CalvertCliffs 3 Nuclear Project and UniStar Nuclear Operating Services would contact the Maryland Historic Trust to consult on the discovery.

It is therefore concluded that CCNPP Unit 3 operations would have a SMALL impact on historic or cultural resources and would not require mitigation.

5.1.4 REFERENCES

MD, 2007a. Code of Maryland, Criminal Law, Title 10, Subtitle 4, Sections 10-401 through 10-404, 2007.

MD, 2007b. Code of Maryland, Health – General, Title 4, Subtitle 2, Section 4-215, 2007.

MHT, 2007. Letter from J. Rodney Little, Director/State Historic Preservation Officer, Maryland Historic Trust to R. M. Krich, dated June 7, 2007.

MHT, 2009. Letter from J. Rodney Little, Director-State Historic Preservation Officer, Maryland Historical Trust to William Seib, U.S. Army Corps of Engineers, February 13, 2009.

PJM, 2006. Feasibility Study for Calvert Cliffs Nuclear Power Plant Unit 3 (Draft), PJM Designation Q48, PJM Interconnection, LLC, November, 2006.

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

SPX, 2008. SPX Cooling Technologies, website http://spxcooling.com/enlproductsldetaillhybridcircular-tower/

USC, 2007. Title 16, United States Code, Part 470, National Historic Preservation Act of 1966, as amended, 2007.

Table 5.1-1—Land Use at the CCNPP Site

Land Use Category	Acres (Hectares)	Percent of Site
Forest	1,618.6 (655)	78.7
Urban or Built-up	330.7 (133.8)	16.1
Agriculture	106 (43)	5.1
Water	1.6 (0.7)	0.1
Total	**2,057 (832.5)**	**100**

Table 5.1-2—Land Use Within the 8 mi (13 km) Radius of the CCNPP Site

Land Use Category	Acres (Hectares)	Percent of Area
Open Water	78,237.7 (31,661.8)	59.7
Forest	28,827.5 (11,666.1)	22
Urban or Built-up	13,483.8 (5,456.7)	10.3
Agriculture	9,843 (3,983.4)	7.5
Barren	56.1 (22.7)	0.04
Wetland	690.7 (279.5)	0.53
Not Defined	20.5 (8.3)	0.02
Total	**131,159.3 (53,078.5)**	**100**

5.2 WATER RELATED IMPACTS

This section identifies impacts to surface water and groundwater resources associated with operation of the CCNPP Unit 3 site and transmission corridors. As described in Section 3.3, CCNPP Unit 3 will require water for cooling and operational purposes. The source of this water will be the Chesapeake Bay. Normal plant operations will require an estimated ~~34,748~~38,032 gpm (~~131,535~~143,968 lpm) of surface water for turbine condenser cooling. Approximately half of this water will be lost to the atmosphere as evaporation and cooling tower drift, and the remainder (17,355 gpm, or 65,695 lpm) will be released as blowdown to the Chesapeake Bay.

A desalinization plant will be provided to treat Chesapeake Bay water and will have sufficient capacity to supply the fresh water makeup of the Essential Service Water System (ESWS) cooling towers and Ultimate Heat Sink (UHS), as well as other non-plant uses, such as potable and sanitary needs. It is estimated that ~~3,040~~3,063 gpm (~~11,508~~11,595 lpm) of Chesapeake Bay water will be processed by the desalinization plant, with approximately ~~940~~61 gpm (~~3,558~~231 lpm) returned to the Chesapeake Bay as blowdown from the ESWS cooling towers.

5.2.1 HYDROLOGIC ALTERATIONS AND PLANT WATER SUPPLY

Section 2.3.1 provides a description of surface water bodies and the groundwater aquifers, including their physical characteristics.

5.2.1.1 Regional Water Use

Section 2.3.2 describes surface water and groundwater uses that could affect or be affected by the construction or operation of CCNPP Unit 3. Section 2.3.2.1 describes the potential sources of surface water, the current and future consumptive surface water uses in Calvert County, and the non-consumptive surface water uses. Section 2.3.2.2 describes the sources of groundwater available to the CCNPP site and the current and future trends in groundwater use in the southern Maryland region, Calvert County, and by CCNPP Units 1 and 2.

The standards and regulations applicable to the use of surface water are presented in Section 2.3.2.1.4. The groundwater demands, regulations governing groundwater withdrawal permits, and the ongoing comprehensive assessment of groundwater resources in the Maryland Coastal Plain are described and discussed in Section 2.3.2.2.7.

5.2.1.2 Plant Water Use

The following sections describe sources and uses of water associated with CCNPP Unit 3. Additional detail on water sources, rates of consumption and return, and amounts used by various plant operating systems during normal operations and outages is presented in Section 3.3.

The average water demand from the Chesapeake Bay for plant operation is estimated at ~~37,788~~41,095 gpm (~~143,043~~155,563 lpm) from which ~~3,040~~3,063 gpm (~~11,508~~11,595 lpm) is processed through the desalinization plant to supply fresh water. During ~~refueling outages, which occur approximately every two years and last approximately 1 month~~normal shutdown cooldown, the maximum water demand will rise to ~~43,480~~47,383 gpm (~~164,590~~179,365 lpm) for the initial period of plant cool down and then decrease to include essentially only the fresh water demand for the onsite workforce.

During outages, the permanent onsite workforce of approximately 633 would increase by an estimated 750 additional workers. ~~For the purpose of estimate, a fresh water demand value of 30 gpd (114 lpd) per person is assumed. Using this value, fresh~~ Fresh water demand would increase on a conservative basis from ~~13.2~~93 gpm (~~50~~352 lpm) during normal operations, to ~~28.8~~216 gpm (~~109.0~~818 lpm) during major outages. ~~This increase in fresh water demand correlates to an increase in makeup water demand for the desalinization plant of approximately 39 gpm (148 lpm) at a 40% recovery rate.~~ Any increase in makeup water demand will be provided by the desalination plant additional capacity or on-site storage capacity. Sanitary effluents are estimated at ~~20~~93 gpm (~~76~~352 lpm), during normal operations, and would increase to ~~36~~216 gpm (~~136~~818 lpm) during major outages, which is the design capacity for the conceptual design of the Waste Water Treatment Plant. These increases represent relatively small fractions of the Chesapeake Bay demand and plant effluent.

5.2.1.2.1 Surface Water

CCNPP Unit 3 is designed to use the minimum amount of water necessary to ensure safe, long-term operation of the plant. ~~The intake for CCNPP Unit 3 will be located inside the existing intake structure for CCNPP Units 1 and 2.~~ The intake for the pipes supplying the CWS and UHS intake forebay for CCNPP Unit 3 will be located on a protected section of shoreline adjacent to the south side of the existing intake structure for Units 1 and 2. The discharge outfall piping will enter the bay near the existing barge slip and extend approximately 550 ft (170 m) offshore through a 30 in (80 cm) diameter buried pipe to a multi-port diffuser system. Additional details on the intake and discharge systems are presented in Section 3.4. Water withdrawals for the operation of CCNPP Unit 3 are described in detail in Section 3.3.1.

5.2.1.2.1.1 Plant Construction

The primary water demands during construction are concrete mixing and curing, dust control, and potable water. Water for construction will come from the ~~existing~~ new CCNPP Unit~~s 1 and 2~~ 3 onsite groundwater production wells, trucked in supply, desalinization plant, and storage tanks. Estimated average construction water demand is 250 gpm (946 lpm) during working hours (i.e. 8 hours per day, 265 days per year), and the peak water use is estimated at 1,200 gpm (4,542 lpm). Construction uses of water are described in more detail in Table 5.2 2.

Any groundwater withdrawals made to support CCNPP Unit 3 construction will be performed within the limits of ~~existing groundwater permit for CCNPP Units 1 and 2~~ the new permitted Unit 3 wells. It is anticipated that groundwater needs will be reduced during the final construction years when the desalinization plant becomes operational to meet freshwater supply needs. Groundwater withdrawals will not be made to support operation of CCNPP Unit 3.

Construction water use is assumed to be entirely consumptive. Groundwater withdrawals required for construction of CCNPP Unit 3 will be small and temporary, and the effect on the groundwater supply will be small. Section 4.2 further addresses water-related impacts of plant construction.

5.2.1.2.1.2 Circulating Water Supply System

CCNPP Unit 3 will utilize a closed-loop Circulating Water Supply System (CWS). The system will use a single mechanical draft cooling tower for heat dissipation. The CWS cooling tower is a hybrid design wherein heat is added just above the demisters to evaporate all the entrained water that would pass through the demisters and eliminate the visible plume. The cooling tower system requires makeup water to replace that lost to evaporation, drift (entrained in water vapor), and blowdown (water released to purge solids).

Makeup water for the hybrid mechanical draft CWS cooling tower system will be withdrawn from the Chesapeake Bay. As indicated in Section 3.4, makeup water for the CWS will be pumped at a maximum rate of ~~40,440~~ 44,320 gpm (~~153,082~~167,770 lpm). At the maximum makeup rate, water lost by evaporation and blowdown returned to Chesapeake Bay will each be approximately equal at ~~20,200~~22,121 gpm (~~76,465~~83,737 lpm). Average makeup water flow to the Circulating Water Supply System is expected to be approximately ~~34,748~~38,032 gpm (~~131,535~~143,968 lpm), with water lost by evaporation and blowdown returned to Chesapeake Bay each being approximately ~~equal at 17,355~~19,000 gpm (~~65,695~~71,923 lpm).

The water balance is affected minimally by drift. ~~M~~For water balance purposes, maximum drift losses will be less than ~~0.0005~~0.005% of the circulating water flow (785,80~~0~~2 gpm (~~3.0 million~~2,974,584 lpm)). This results in a maximum drift of ~~3.9~~39 gpm (~~14.8~~148 lpm).

~~The cooling tower will operate at 2 cycles of concentration. Minimum makeup and blowdown values occur at this value. If evaporation and drift are not changed, makeup is reduced to approximately two thirds of its maximum value and blowdown is reduced to approximately one third of its maximum value.~~

The Essential Service Water System (ESWS), under normal plant operations with two trains operating, will operate at a nominal recirculated flow rate of approximately 19,075 gpm (72,207 lpm). The maximum fresh water makeup rate from the desalinization plant required under normal operations is estimated to be 629 gpm (2,381 lpm) to offset maximum evaporation rate (approximately 566 gpm (2,~~.~~142 lpm)), maximum blowdown rate (approximately 61 gpm (~~4,~~231 lpm)), and drift loss (approximately 2 gpm (8 lpm).

Water released to the Chesapeake Bay as blowdown is not lost to downstream users or downstream aquatic communities. Evaporative losses and drift losses are not replaced and are considered "consumptive" losses. The normal makeup rate from the Chesapeake Bay to the ESWS cooling towers will be 1,368 gpm (5,178 lpm) to accomodate the maximum evaporation rate and drift loss for four UHS cooling towers for shutdown or cooldown operations.

5.2.1.2.1.3 Desalinization Plant

During operations, CNPP Unit 3 will not withdraw groundwater for use at the site. Consequently, operation of CCNPP Unit 3 will require a consistent source of fresh water makeup for cooling purposes. A reverse-osmosis (RO) desalinization plant will be used to provide fresh water for the plant demineralized water system, potable and sanitary water systems, and UHS makeup water system. The desalinization plant will use stage media filtration, with a one pass seawater reverse osmosis (SWRO) at 40% recovery. The system will also include seawater feed pumps, multimedia filters, chemical injection system, and an RO permeate tank. The Chesapeake Bay will be the source of water for the desalinization plant.

The desalinization plant will remove the high concentration of salts and minerals from the Chesapeake Bay source water. During the production of desalinated water, a percentage of the source water is concentrated and is unusable. The product water recovery relative to input water flow is 15% to 50% for most seawater desalinization plants. That is, for every 100 gal (379 L) of seawater, 15 to 50 gal (57 to 189 L) of desalinated water is produced along with brine wastewater containing a higher concentration of dissolved solids. A desalinization plant's recovery rate varies, mainly because plant operations and efficiencies depend on site-specific conditions. Depending on the efficiency of the desalinization plant, briny wastewater could represent as much as 85% of the intake water (CCC, 2004).

The general process of reverse osmosis is described as follows. High pressure makeup water enters the RO trains, where the water passes through the membranes, and the dissolved salts are rejected. Permeate, or product water, is collected from the end of each membrane element, and becomes the product of the purification process. As the raw water flows along the "brine channel", or coarse medium, it becomes increasingly more concentrated.

This concentrated raw water is called the reject stream, or concentrate stream. Operation at 50% recovery would result in a reject stream that is twice as concentrated as the feed, which is essentially the same concentration as the blowdown from the CWS cooling tower. The desalinization plant is expected to operate at a 40% recovery rate that will result in a less concentrated reject stream. The reject stream carries the concentrate from the RO trains to the waste water retention basin prior to being released to the Chesapeake Bay along with the cooling tower blowdown.

Preliminary studies indicate that desalinization plant water capacity will be ~~1,750,000~~1,764,000 gpd (~~1,215~~1,225 gpm, or ~~4,599~~4,637 lpm). Desalinization plant demand for CCNPP Unit 3 will be approximately ~~1,250,000~~1,169,280 gpd (~~4,731,000~~4,426,193 lpd), with an additional capacity of ~~500,000~~594,720 gpd (~~1,893,000~~2,251,253 lpd) available. The conceptual water requirements for the systems that will be served by the desalinization are shown in Table 5.2-1.

Makeup water for the desalinization plant will be taken from the makeup line for the CWS, which utilizes the Chesapeake Bay as its source. The desalinization plant will have a membrane filtration pretreatment followed by the reverse osmosis process. Therefore, assuming 10% filtration waste and operation at 40% recovery, ~~3.89~~4.41 million gpd (~~14.7~~16.7 million lpd) of water will be needed.

The desalinization plant reject stream would be directed to a retention pond where it will mix with, and be diluted by, circulating water blowdown from CCNPP Unit 3 prior to discharge to the Chesapeake Bay.

5.2.1.2.2 Groundwater Use

Groundwater monitoring wells are installed on the site to study and model the groundwater in the CCNPP site vicinity as described in Section 2.3. Groundwater withdrawals will not be used to support operation of CCNPP Unit 3. Groundwater withdrawals during construction are discussed in Section 4.2. As discussed in Section 2.3.2, temporary groundwater dewatering controls are expected during construction activities; however, a permanent groundwater dewatering system is not anticipated to be a design feature for the CCNPP Unit 3 facility.

5.2.1.3 Hydrological Alterations

Operational activities that could result in hydrological alterations within the site and vicinity and at offsite areas are described in Sections 3.3, 3.4, and 3.7.

The principal hydrological alteration onsite associated with CCNPP Unit 3 will occur during construction, when at least one impoundment and several tributaries to Johns Creek will be filled. Some onsite streams may be impacted by either sedimentation or reduced water flow due to measures taken to reduce sedimentation, as described in Section 4.3.2. Once construction is completed, and normal operations begin, it is expected that the streams will experience little ongoing impact.

There have been no clearly discernible onsite or offsite effects of hydrologic alterations for operation of CCNPP Units 1 and 2, and the supply of surface water and groundwater has been sufficient. Operation of CCNPP Unit 3 with a closed loop cooling system will result in much smaller effects on withdrawals and discharges and correspondingly reduced operational effects than would be expected for an open loop cooling system. The provision of a desalinization plant will provide adequate fresh water for operation of CCNPP Unit 3 systems, and will have some additional capacity.

~~The CCNPP Unit 3 intake structure will be located within the existing intake area for CCNPP Units 1 and 2. A sheet pile cofferdam and dewatering system will be installed on the south side of the CCNPP Unit 1 and 2 intake structure to facilitate construction of the CCNPP Unit 3 circulating and service makeup water intake structure and pump house.~~ The actual CCNPP Unit 3 intake pumphouse structure will be located in a forebay constructed on the shoreline terrace north of the barge slip within the existing intake area for CCNPP Units 1 and 2. Seawater will be supplied via two pipelines reaching the Chesapeake Bay shoreline near the south side of the CCNPP Unit 1 and 2 curtain wall. A sheet pile cofferdam and dewatering system will be installed on the south side of the CCNPP Unit 1 and 2 intake structure to facilitate construction of in the CCNPP Unit 3 shoreline intake piping and trash rack area. A rip-rap seawall extending approximately 75 ft (22.9 m) north from the shoreline, east of the pipeline entrance, and rip-rap along the shoreline will be used to protect the pipeline entrance point, circulating and service water intake structure and pump house. Pilings may also be driven to facilitate construction of new discharge system piping.

~~Excavation and dredging of the intake structure, pump house erection~~ Excavation and dredging of the shoreline entrance area for the seawater supply pipelines and trash rack, fish return outfall from the new forebay intake structure, pump house erection and the installation of mechanical, piping, and electrical systems follow the piling operations and continue through site preparation into plant construction. Excavated and dredged material will be transported to an onsite spoils area located outside the boundaries of designated wetlands.

The barge slip will be dredged to accommodate the construction shipments. New sheet pile will be installed and ~~15,000~~50,000 yds^3 (~~11,500~~38,228 m^3) of spoils are estimated to be generated from this activity. ~~No maintenance dredging had been performed to keep the slip open and none is anticipated after the construction shipments are received.~~ Placement of the discharge pipeline will require excavating and backfilling a trench on the Chesapeake Bay floor. No additional spoils are expected to be generated.

Dredging of the barge slip, ~~intake, and~~shoreline pipeline entrance and fish return outfall areas are expected to be one time event~~ and are not expected to require maintenance dredging~~. Consequently, any hydrologic alterations, such as disruption of the longshore current and drift mechanism, are expected to be local, transitory, reversible, and small. Additionally, based on operational experience at CCNPP Units 1 and 2, it is expected that no maintenance dredging will be needed to keep the ~~intake area clear.~~ shoreline pipeline entrance clear. However, since the common forebay will also act as a siltation basin, dredging may be required to maintain the forebay depth and intake area clearances.

5.2.2 WATER USE IMPACTS

5.2.2.1 Surface Waters

5.2.2.1.1 Consumptive Use

The maximum evaporation loss for the Unit 3 CWS cooling tower system is estimated to be approximately ~~20,200~~22,160 gpm (~~76,500~~83,885 lpm). Additionally, makeup water for the ESWS cooling towers is normally supplied from the plant potable water system (e.g., desalinization plant). Maximum ~~E~~evaporation from the circulated ESWS flow will occur at the cooling towers, and will be approximately ~~940~~1,364 gpm (~~3,558~~5,163 lpm).

Consumptive uses of water during construction of CCNPP Unit 3 include concrete mixing and curing, dust control, and potable and sanitary water. Peak consumptive water use will occur for several years during construction, and will ~~be 39.3~~ average approximately 30 million gpy (~~148~~113 million lpy). A breakdown of construction water use by year is provided in Table 5.2-2.

The Chesapeake Bay contains nearly 18 trillion gallons (68 trillion liters) of water and is refreshed by rivers at an annual average rate of 77,500 ft^3/s (2,190 m^3/s), and a flowrate of 30,800 ft^3/s (872 m^3/s) during periods of low freshwater input to the Chesapeake Bay. The volume of water that will be lost to evaporation from the CCNPP Unit 3 cooling towers and ESWS cooling towers is negligible compared with the amount of water in the Chesapeake Bay, and consumptive losses of this magnitude will not be discernible. No measurable impact of consumptive water use on the Chesapeake Bay water level is expected, and operation of CCNPP Unit 3 will therefore have a SMALL impact on the availability of water from the Chesapeake Bay.

5.2.2.1.2 Non-Consumptive Use

Non-consumptive uses of water downstream from the plant are described in Section 2.3.2.1.3. The major non-consumptive surface water use categories in the vicinity of the site are recreation, fisheries, marinas, parks, and transportation. The recreational activities include swimming, fishing and boating along the Patuxent River and in the Chesapeake Bay. Fisheries in the Chesapeake Bay are described in Section 2.4.2. Transportation on the Chesapeake Bay will not be affected by the construction or operation of CCNPP Unit 3. No effect on fisheries navigation, or recreational use of the Chesapeake Bay is expected.

~~The existing intake system for CCNPP Units 1 and 2 includes an intake channel, and an embayment established by a curtain wall. The CCNPP Unit 3 intake for the CWS will be located on the southern edge of the intake embayment, while the intake for the UHS makeup system will be located to the east immediately adjacent to the CWS intake. The CCNPP Unit 3 intakes will be set back from the intake embayment and situated at the end of a 123 ft (37 m) long, 100 ft (30 m) wide channel. Based on operational experience at CCNPP Units 1 and 2, it is expected that no maintenance dredging will be needed to keep the intake area clear.~~The Chesapeake Bay water intake system design consists of a wedge-shaped expansion of the CCNPP Units 1 and 2 intake channel forebay, the CCNPP Unit 3 forebay and related piping; the CCNPP Unit 3 non-safety-related CWS makeup water intake structure and associated equipment, including the non-safety related CWS makeup pump; the safety-related UHS makeup water intake structure and associated equipment, including the safety-related UHS makeup water pumps; and the makeup water chemical treatment system.

The Unit 3 forebay is approximately 100 feet by 120 feet by 30 feet deep and located between the Units 1 and 2 intake and the barge slip. It draws water from the extended Units 1 and 2 intake forebay through intake water piping installed for CCNPP Unit 3. The location of the intake system is depicted in Figure 2.3-4. Figure 3.4-3, and Figure 3.4.-4 provide detailed renderings of the intake structure and channel.

The CCNPP Unit 3 CWS makeup water intake structure is approximately 78 feet long, 55 feet wide and 30 feet deep concrete structure with individual pump bays.The UHS makeup water intake structure is approximately 75 feet long, 60 feet wide and 30 feet deep concrete structure with individual pump bays. Four, 100% capacity, makeup pumps are available to provide makeup water.

The CCNPP Unit 3 CWS and UHS makeup intakes will meet the U.S. Environmental Protection Agency (EPA) Phase 1 design criteria, as described in Section 5.3.1.1. The overall percentage of

Chesapeake Bay water entrained will remain less than 1%, with the maximum additional makeup required to meet the CCNPP Unit 3 cooling water requirement of ~~40,440~~44,320 gpm (~~153,082~~167,770 lpm). An additional 3,063 gpm will be required to support desalination plant operation.

While fish impingement and entrainment will occur, CCNPP Unit 3 will employ the impingement/entrainment mitigation techniques (low velocity approach, screens, etc.) currently utilized by CCNPP Units 1 and 2 to minimize the impact on aquatic resources. ~~The fish loss associated with impingement/entrainment will be negligible.~~ A fish return system and outfall will be used at the CCNPP Unit 3 CWS makeup water intake to reduce the mortality of aquatic species. Details of the fish return system are provided in Section 3.4.

Design approach velocities for both CCNPP Unit 3 intake structures will be less than 0.5 ft/s (0.15 m/s). The intake structures will incorporate fish and invertebrate protection measures that maximize impingement survival. The through trash rack and through screen mesh flow velocities will be less than 0.5 ft/s (0.15 m/s). The screen wash system ~~will~~ provides a pressurized spray to remove debris from the water screens. In both intake structures, ~~there is~~ a fish return system is provided, even though the flow velocities through the screens are less than 0.5 ft/s (0.15 m/s) in the worst case scenario (minimum Chesapeake Bay level with highest makeup demand flow). The fish return system and outfall, as described in Section 3.4, will be used at the CCNPP Unit 3 CWS makeup water intake to reduce the mortality of aquatic species.

U.S. EPA declared the Chesapeake Bay an impaired water body in 1998 under the Federal Water Pollution Control Act because of excess nutrients and sediments. The area of the Chesapeake Bay near the CCNPP site is included in the Maryland Clean Water Act Section 303d) list for impaired watersheds. Chesapeake Bay water is required to meet federal regulatory water quality standards by 2010 . The potential effects of the discharge from all CCNPP units will be considered in developing the NPDES Permit for CCNPP Unit 3. CCNPP Unit 3 will comply with the applicable State of Maryland regulations requiring the design of the cool ing water intake and discharge structures to incorporate the Best Technology Available (BTA) to minimize adverse environmental impacts. (COMAR 2007c) The primary external impact will be the discharge of cooling tower blowdown water to the Chesapeake Bay. The CCNPP maximum Unit 3 CWS cooling tower discharge is estimated to be ~~20,200~~22,121 gpm (~~76,500~~83,737 lpm). A common retention basin will hold cooling tower blowdown and effluents from the Desalination Plant and wastewater treatment plant before discharging, further reducing thermal impacts to receiving waters. Effluent from the retention basin, which will contain dilute quantities of chemicals and dissolved solids, and be slightly elevated in temperature. will be discharged to the Chesapeake Bay within the limits of the NPDES permit. When discharged and diluted, this small amount of slightly contaminated water, approximately 0.001% of low flow cond itions in the Chesapeake Bay, would be expected to have SMALL impacts.

5.2.2.2 Groundwater

Groundwater withdrawals will not be used to support operation of CCNPP Unit 3. Limited groundwater withdrawals are anticipated to support CCNPP Unit 3 construction and will be performed within the limits of existing groundwater permit for CCNPP Units 1 and 2. It is anticipated that groundwater needs will be reduced during the final construction years when the desalinization plant becomes operational to meet freshwater supply needs for the operation of CCNPP Unit 3. Thus, the operation of CCNPP Unit 3 will have no impact on the inventory of local groundwater systems.

5.2.3 WATER QUALITY IMPACTS

Water quality data for the Chesapeake Bay are presented in Section 2.3.3. The U.S. EPA declared the Chesapeake Bay as an impaired water body in 1998 based on the Federal Water Pollution Control Act (USC, 2007) because of excess nutrients and sediments. The Chesapeake Bay water is required to meet Federal regulatory water quality standards by 2010.

5.2.3.1 Chemical Impacts

The area of the Chesapeake Bay near the CCNPP site is included on the Maryland Clean Water Act Section 303(d) list. The effects of the discharge from all CCNPP units will be considered in developing the National Pollutant Discharge Elimination System (NPDES) Permit for CCNPP Unit 3.

CCNPP Unit 3 will utilize cooling tower based heat dissipation systems that remove waste heat by allowing water to evaporate to the atmosphere. The water lost to evaporation must be continuously replaced with makeup water. To prevent build up of solids, a small portion of the circulating water stream with elevated levels of solids is drained or blown down.

Because cooling towers concentrate solids (minerals and salts) and organics that enter the system in makeup water, cooling tower water chemistry must be maintained with anti-scaling compounds and corrosion inhibitors. Similarly, because conditions in cooling towers are conducive to the growth of fouling bacteria and algae, biocides must be added to the system. This is normally a chlorine or bromine-based compound, but occasionally hydrogen peroxide or ozone is used. Table 3.3-2 lists water treatment chemicals used for CCNPP Units 1 and 2. It is anticipated that CCNPP Unit 3 will also utilize these water treatment chemicals. Section 5.3 specifically deals with the impacts of the cooling system.

As opposed to the CWS cooling tower, which uses brackish Chesapeake Bay water as its makeup water source, the ESWS cooling towers will be typically be supplied with fresh water makeup from the desalinization plant, and will only use Chesapeake Bay water as an emergency backup source when freshwater makeup from storage tanks or the desalinization plant is not available. The build up of solids and solid scale formation in the ESWS cooling towers will therefore be substantially less than for the CWS cooling tower. The ESWS cooling towers will use the water treatment chemicals described above, as required, but to a lesser degree than the Circulating Water Supply System cooling tower. Based on the ESWS makeup and blowdown rate, it will circulate fresh water concentrated ten times compared to brackish water assumed to have total dissolved solids of 20,000 milligram per liter concentrated two times.

Limited treatment of raw water to prevent biofouling in the intake structures and makeup water piping may be required. Additional water treatment will take place in the cooling tower basin, and will include the addition of biocides, anti-scaling compounds, and foam dispersants. Sodium hypochlorite and sodium bromide are expected to be used to control biological growth in the existing Circulating Water Supply System and will likely be used in the system as well.

The NPDES permit will be acquired prior to the startup of CCNPP Unit 3. This permit will specify threshold concentrations of Free Available Chlorine (when chlorine is used) and Free Available Oxidants (when bromine or a combination of bromine and chlorine is used) in cooling tower blowdown when the dechlorination system is not in use.

Dechlorination is a component of the planned Unit 3 project site wastewater treatment plant, which is discussed below. Lower discharge limits would apply to effluent from the dechlorination system (which is released into Chesapeake Bay) when it is in use. The CCNPP Unit 3 NPDES permit isexpected to contain discharge limits for discharges from the cooling towers for two priority pollutants, chromium and zinc, which are widely used in the U.S. as corrosion inhibitors in cooling towers.

Operation of the CCNPP Unit 3 CWS cooling tower system~~s~~ will be based on 2 cycles of concentration. As a result, levels of solids and organics in cooling tower blowdown will be approximately twice as high as ambient concentrations in Chesapeake Bay. Blowdown wastewater from the CWS cooling tower, and similar waste from the saltwater desalinization plant (membrane filtration pretreatment and saltwater reverse osmosis) and blowdown from the ESWS cooling towers will discharge to a retention basin to allow time for settling of suspended solids and to allow additional chemical treatment of the wastewater, if required, prior to discharge to Chesapeake Bay. The final discharge will consist of cooling tower blowdown from the CWS cooling tower, the ESWS cooling towers, the desalinization plant, and site waste streams, including the domestic water treatment and circulating water treatment systems.

Under normal conditions, ~~19,425~~21,019 gpm (~~73,531~~79,566 lpm) will be discharged by pipe from the retention basin into Chesapeake Bay; a maximum discharge of ~~23,227~~24,363 gpm (~~87,923~~92,224 lpm) is anticipated. Because the discharge stream volume will be small relative to the volume of the Chesapeake Bay, concentrations of solids and chemicals used in cooling tower water treatment will rapidly dilute and approach ambient concentrations in Chesapeake Bay after exiting the discharge pipe.

The cooling tower blowdown and desalinization plant wastewater effluent volume entering Chesapeake Bay from the common CCNPP Unit 3 retention basin will be small and any chemicals it contains low in concentration. The operation of CCNPP Unit 3 will comply with a Maryland Department of Environment issued NPDES permit, and the applicable state water quality standards. All biocides or chemical additives in the discharge will be among those approved by the U.S. EPA and the State of Maryland as safe for humans and the environment.

The area of Chesapeake Bay near CCNPP Unit 3 is included on the Maryland Clean Water Act, Section 303(d) List because of high nutrient levels and low dissolved oxygen (DO) concentration (i.e., <5 mg/L) (MDE, 2004). Section 303(d) of the Federal Water Pollution Control Act (USC, 2007) requires States to identify waters that are impaired by pollution, even after application of pollution controls (USEPA, 2007). For those waters, States must establish a total maximum daily load (TMDL) of pollutants to ensure that water quality standards can be attained.

A State of Maryland regulatory deadline of 2011 exists to establish TMDLs for Chesapeake Bay. Because of this mandate and the State enforcement of environmental design of discharge structures, the effluent from CCNPP Unit 3 will be monitored, and any necessary measures will be taken to mitigate negative impacts from possible pollutants and low dissolved oxygen content in the effluent. As a result, it is not expected that there will be any negative effect on the DO concentration in the Chesapeake Bay due to the CCNPP Unit 3 discharge plume.

Based on the above, impacts of chemicals in the permitted blowdown discharge wastewater to the water quality of Chesapeake Bay will be negligible and are not expected to warrant mitigation.

The CCNPP Unit 3 Wastewater Treatment Plant (WWTP) will also discharge chemically treated water to Chesapeake Bay. Wastewater generated onsite during operation of CCNPP Unit 3 will be treated using standard wastewater treatment plant processes. The treated wastewater will meet all applicable health standards, regulations, and total maximum daily loads (TMDLs) as set by the Maryland Department of the Environment (MDE) and the U.S. EPA.

The CCNPP Unit 3 WWTP will be similar to the existing onsite WWTP that is currently being used for CCNPP Units 1 and 2. It will be designed with a typical two-stage clarifier type treatment system which incorporates a lift station, an anoxic mixing chamber, an oxidation ditch, a series of clarifiers, media filtration, a chlorination system, and a dechlorination system. The treatment process is described below.

Raw sewage generated during the operation of CCNPP Unit 3 will flow into a wet well and then be pumped to the anoxic mixing chamber. The collection of sewage and the subsequent pumping help to grind waste materials to a uniform size and add oxygen to the liquid waste stream. In the anoxic mixing chamber incoming sewage is mixed with activated sludge from the clarifiers. This begins the aerobic digestion process. The activated sludge adds the necessary microorganisms to the incoming sewage and the microorganisms digest the organic constituents in the incoming wastewater. Aerobic microorganisms use the incoming wastes for food, a source of energy, and reproduction. The products of aerobic digestion are water, carbon dioxide, and more microorganisms.

Microorganisms and oxygen must be present in sufficient numbers to consume the incoming organic material and oxidize ammonia and nitrogen. Optimum conditions for the microorganisms are maintained by controlling the pH, oxygen concentration, and biomass in the system.

Sewage then flows into the oxidation ditch and then into the primary clarifier. The primary clarifier separates the solids (sludge) from the clear liquid. The sludge is then pumped back into the anoxic mixing chamber, or collected and sent to the sludge holding tank. The waste sludge is then removed and transported to a waste processing plant. All sludges are tested for radiological contaminants prior to shipping. If any radionuclides are detected, the waste is deemed radioactive and disposed of as low level radioactive waste.

The liquid portion of the waste stream flows into a secondary clarifier which further settles out the remaining suspended particles. The effluent of the secondary chamber then flows into a chlorine contact chamber where any remaining microorganisms are dosed with specified concentration of chlorine. The effluent is allowed to remain in the chlorine contact chamber for a set period which allows time for the chlorine to effectively kill any pathogenic organisms. The effluent flows into a dechlorination chamber. This step removes any residual chlorine which would be toxic to organisms in downstream environments. From the dechlorination chamber, the final effluent, which at this stage is basically water, is gravity fed to the main discharge pipe and released to the Chesapeake Bay.

Based on the above, impacts of chemicals in thoroughly treated, permitted WWTP effluents to the water quality of Chesapeake Bay will be negligible and are not expected to warrant mitigation.

5.2.3.2 Desalinization Impacts

Briny wastewater from the desalinization plant will be treated prior to release to Chesapeake Bay by mixing with site process waters to reduce the salt and metal concentration to ambient Chesapeake Bay water conditions. Briny process wastewater may contain all or some of the following constituents: high salt concentrations, chemicals used during defouling of plant equipment and pretreatment, and toxic metals (which are most likely to be present if the discharge water was in contact with metallic materials used in construction of the plant facilities). Liquid desalinization plant wastes will be discharged to a retention basin before being returned to the Chesapeake Bay.

An RO desalinization system will be utilized. In an RO plant, water is pumped at high pressures through membranes to filter out dissolved particles. The desalinization plant will be located adjacent to the cooling towers for the Circulating Water Supply System. The desalinization plant will withdraw Chesapeake Bay water from the Circulating Water Supply System makeup line. The desalinization plant feed water will be pretreated to protect the membranes of the RO process.

Pretreatment equipment includes holding tanks, strainers, a series of sand filters, coagulation tanks, and an ultraviolet sanitation system. The pretreatment system is periodically backwashed, and the small amount of backwash is combined with a large dilution volume of cooling tower blowdown before it is discharged into Chesapeake Bay through a series of diffusers.

Under normal operation, the product water requirement for the desalinization plant is ~~3,040~~3,063 gpm (~~11,508~~11,595 lpm). The desalinization plant will be able to recover up to 50% of the input bay water as fresh water, and will produce a wastewater stream with a salt concentration that is up to twice the ambient Chesapeake Bay concentration. This is similar to the concentration of the cooling tower blowdown. During plant shutdown conditions, salt concentration will be administratively controlled within discharge limits.

Desalinization plant effluent will be only a small fraction of the total blowdown flow. Approximately ~~18,295~~19,038 gpm (~~69,254~~72,067 lpm) of blowdown will be returned to the Chesapeake Bay from the CWS and ESWS cooling towers, which is equivalent to ~~40.8~~42.4 ft^3/s (1.2 m^3/s). Inclusion of the desalinization plant wastewater and waste treatment system effluent results in a slightly higher total discharge flow of approximately ~~19,425~~21,019 gpm (~~73,531~~79,566 lpm) or ~~43.2~~46.8 ft^3/s (~~1.2~~1.33 m^3/s). The amount of blowdown associated with the desalinization plant is insignificant, even when compared to low flow conditions (30,800 ft^3/s (872 m^3/s)) in the Chesapeake Bay.

5.2.3.3 Thermal Impacts

As noted in Section 5.2.3.1, discharges from CCNPP Unit 3 will be permitted under the NPDES program, which regulates the discharge of pollutants into waters of the state. In this context, waste heat is regarded as a thermal pollutant and is regulated in much the same way as chemical pollutants. Thermal discharges are also regulated under the Code of Maryland Regulations (COMAR, 2007a). Further information describing thermal discharge and the physical impacts associated with operation of CCNPP Unit 3 is presented in Section 5.3.2.1.1.

The CCNPP Unit 3 discharge multi-port diffuser system is designed to minimize the potential impact of the thermal plume as it enters the Chesapeake Bay. The subsurface diffusers create rapid mixing of the thermal effluent with ambient tidal flows. Strong tidal currents driven by the rise and fall of tides in the Chesapeake Bay largely determine plume size and shape. The area occupied by the plume is compared to the Maryland water quality criteria in Table 5.3-5 (COMAR, 2007a). This comparison demonstrates that the CCNPP Unit 3 thermal plume conforms to each of the criteria.

The radial dimension of the 3.6ºF (2ºC) isotherm is less than 3% of the ebb tide excursion, as compared to the less than one-half (50%) ebb tide excursion specified by Maryland regulation. The full capacity of the 3.6ºF (2ºC) isotherm is less than 0.3% of the Chesapeake Bay cross section, and the bottom area affected by the plume is about 0.01% of the average ebb tidal excursion multiplied by the width of the Chesapeake Bay. The temperature plume in the Chesapeake Bay resulting from discharge of blowdown wastewater was modeled, as described in Section 5.3.2.1.

5.2.3.4 Maryland Mixing Zone Regulations

The State of Maryland has established surface water mixing regulations (COMAR, 2007a) and specific thermal mixing zone criteria (COMAR, 2007b). Ther NPDES permit will limit the thermal discharges in accordance with State requirments (COMAR 2007a). These water quality regulations limit the spatial extent of thermal plumes:

- The 24-hour average of the maximum radial dimension measured from the point of discharge to the boundary of the full capacity 2°C (3.S°F) above ambient isotherm (measured during critical periods) may not exceed Y2 of the average ebb tidal excursion.

- The 24-hour average full capacity 2°C (3.S°F) 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.

- The 24-hour average area of the bottom touched by waters heated 3.SoF (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 excurision multiplied by the width of the receiving water body.

Alternate less stringent criteria can be established on a case-by-case basis if it can be demonstrated that the thermal discharge criteria are more stringent than necessary to assure the protection and propagation of a balanced. indigenous community of shellfish, fish, and wildlife in and on the body of water into which the discharge is made.

General temperature requirements for Maryland Class II waters such as the Chesapeake Bay also include a limit on maximum water temperature and zone of passage outs ide the mixing zone (COMAR, 2007c):

- Water temperatures may not exceed gO°F (32°C) or the ambient temperature of surface waters.

- A thermal barrier that adversely affects aquatic life may not be established, and

- Discharge of chlorine from the cooling tower blowdown is limited to 0.2mg/l monthly average and 0.5 mg/l daily maximum of tree available chlorine as determined using the amperometric titration method.

<u>Thermal Plume Model</u>

The spatial configuration of the CCNPP Unit 3 thermal plume was simulated using the Cornell Mixing Zone Expert System (CORMIX) (Jirl<a, 1996). CORMIX is a U.S. EPA supported mathematical modeling tool for the analysis. prediction, and design of agueous toxic or conventional pollutant discharges into diverse water bodies . The model can be used for environmental impact assessment of regulatory mixing zones resulting from continuous point

source discharges such as CCNPP Unit 3. The model accounts for the effects of boundary interactions, and predicts steady state mixing behavior and plume geometry. The CORMIX methodology contains different options used to model single-point. multi-port diffuser discharges. and surface discharge sources. Effluents may be conservative, non-conservative, heated. or brine discharges.

Input parameters used in the CCNPP Unit 3 CORMIX thermal plume simulation are given in Table 5.3-2 and Table 5.3-3, Results are provided in Table 5.3-4 and Figure 5.3-1. The 3.6 F (2 Cl isotherm extends approximately 207 ft (63 m) beyond the discharge multi-ports diffusers on the ebb and flood tides. The slack tide 3.6 °F (2°C) isotherm is predicted to extend less than 20 ft (6.6 m) beyond the diffusers. The modeled plume pred ictions are considered conservative since the CORMIX model constrains the depth of the plume to no more than 30 percent greater than the depth at discharge. or -13 ft (-4 .0 m) in this case. Furthermore. a sensitivity analys is comparing plume size at differential water temperatures below 12°F (6.7° C) demonstrated that plume size decreases as delta-T is reduced.

The area occupied by the plume is compared to the State of Maryland water quality criteria in Table 5.3-5. This comparison demonstrates that the CCNPP Unit 3 thermal plume conforms to each of the criteria. The radial dimension of the 3.6 °F (2°C) isotherm is less than 3% of the ebb tide excursion, as compared to the less than one-half (50%) ebb tide excursion specified by Maryland regulation. The full capacity of the 3.6 °F (2° C) isoltherm is less than 0.3% of the Chesapeake Bay cross section. and the bottom area affected by the plume is about 0.01% of the average ebb tidal excursion multiplied by the width of the Chesapeake Bay.

Concentrations of water treatment chemicals, such as chlorine and anti-foulants that are added to the cooling system and subsequently discharged in the cooling tower blowdown are also expected to meet mixing zone requirements (COMAR, 2007a). Because of the treatment planned for some of the effluent streams and the large dilution factor expected in the CCNPP Unit 3 retention basin prior to discharge, possible impacts on the aquatic communities are also expected to be small.

CCNPP Unit 3 will comply with applicable State of Maryland regulations requiring the design of the cooling water intake and discharge structures to incorporate the Best Technology Available to minimize adverse environmental impacts (COMAR, 2007b).

5.2.3.5 CCNPP Units 1 and 2 Discharge

Descriptions of the discharge location for CCNPP Units 1 and 2 and the discharge location for CCNPP Unit 3 are provided in Section 5.3.2. The discharge for CCNPP Units 1 and 2 influences the discharge location for CCNPP Unit 3 due to its discharge mixing zone. The two discharge locations must meet environmental regulations in order to be permitted.

5.2.3.6 Discharge Mixing Zone

The discharge outfall for CCNPP Unit 3 will be located on the shoreline of the Chesapeake Bay, approximately approximately ~~1,200 ft (366 m) southeast of the CCNPP Unit 3 intake structures~~400 ft (122 m) north of the barge slip. The discharge piping will extend approximately 550 ft (168 m) east from the outfall into the Chesapeake Bay. The discharge structure will utilize a single 30 in (76 cm) diameter pipe having three final outlet nozzles. The preliminary centerline elevation of the discharge nozzles are 3 ft (0.9 m) above the bay bottom. Riprap will be placed around the discharge point to resist potential scour due to the discharge jet from the nozzles.

5.2.3.7 Site Surface Water Impacts

The existing and proposed surface water bodies within the CCNPP site are described in Sections 2.3.1 and 4.2.1. The potential for these bodies to be impacted by site operations are dependent upon operational conditions related to: site safety and spill containment training, a spill pollution prevention plan (SPPP), and a stormwater pollution prevention plan (SWPPP). These plans are addressed in Section 1.3.

Spills or operational debris potentially occurring on outdoor facilities could mix with site precipitation or washing wastewater and be conveyed to downstream impoundments, creeks, rivers, and eventually the Chesapeake Bay. If proper spill and stormwater pollution prevention plans are implemented and practiced, the majority of polluted runoff can be controlled and prevented from escaping the CCNPP site. A monitoring plan implemented under the regulatory guidance for surface and groundwater monitoring could identify future sources of pollution which are above established TMDLs. Those areas could be addressed and point-sources of pollution removed before the area water bodies are impacted further.

Environmental impacts on water quality during construction and operations for CCNPP Unit 3 would be minimal. Groundwater would not be used for CCNPP Unit 3 operation, and will only be used during construction within the withdrawal limits of the existing groundwater permit for CCNPP Units 1 and 2. Surface water runoff and sedimentation effects will be minimized by implementation of a site safety and spill prevention plan and a stormwater pollution prevention plan. Effluent from the planned wastewater treatment plant will meet all applicable health standards, regulations, and total maximum daily loads (TMDLs) as set by the Maryland Department of the Environment (MDE) and the U.S. EPA.

A common retention basin would collect cooling tower blowdown and effluent from the proposed desalinization plant. Effluent from the retention basin, which will contain dilute quantities of chemicals and dissolved solids, and be slightly elevated in temperature, will be discharged to Chesapeake Bay within the limits of the site NPDES permit. When discharged and diluted, this small amount of slightly contaminated water, approximately 0.001% of low flow conditions in Chesapeake Bay, would be expected to have small impacts.

5.2.4 REFERENCES

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Table 5.2-1—Desalinization Plant Demand

System	Demand	
	gpm	lpm
Essential Service Water System Cooling Towers	~~1882~~629	~~7,124~~2,381
Potable Water System	~~20~~93	~~76~~352
Makeup to Demineralizer	80	303
Fire Protection	~~3~~5	~~11~~19
~~Additional Capacity~~Floor Wash Drains	~~2,335~~5	~~8,839~~19
~~Total~~Additional Capacity	~~350~~413	~~1,325~~1,563
Total	1,225	4,637

Table 5.2-2—Estimated Fresh Water Demand During CCNPP Unit 3 Construction

Construction Year	Year 1 gal (L)	Year 2 gal (L)	Year 3 gal (L)	Year 4 gal (L)	Year 5 gal (L)	Year 6 gal (L)
Potable and Sanitary	8,550,000[a] (32,361,750)	25,650,000[b] (97,085,250)	25,650,000[b] (97,085,250)	25,650,000[b] (97,085,250)	25,650,000[b] (97,085,250)	--
Concrete Mixing and Curing[c]	2,219,844 (8,402,110)	2,219,844 (8,402,110)	2,219,844 (8,402,110)	2,219,844 (8,402,110)	2,219,844 (8,402,110)	--
Dust Control[d]	11,400,000 (43,149,000)	11,400,000 (43,149,000)	11,400,000 (43,149,000)	11,400,000 (43,149,000)	11,400,000 (43,149,000)	--
Total	**22,169,844 (83,912,860)**	**39,269,844 (148,636,360)**	**39,269,844 (148,636,360)**	**39,269,844 (148,636,360)**	**39,269,844 (148,636,360)**	**26,179,896[e] (99,090,906)**

Notes:

a. Estimated at 1,000 persons using 30 gallons per day for 285 days per year.

b. Estimated at 3,000 persons using 30 gallons per day for 285 days per year.

c. Estimated at 6,700 cubic yards per month using 27.61 gallons per cubic yard and 12 months per year.

d. Estimated at 40,000 gallons per day for 285 days per year.
Estimated at two-thirds of the amount used in years 2 through 5.

5.3 COOLING SYSTEM IMPACTS

This section describes potential impacts from operation of the cooling systems at CCNPP Unit 3. The CCNPP Unit 3 Circulating Water Supply System (CWS) and Essential Service Water System (ESWS) (Ultimate Heat Sink (UHS)) will be closed-cycle systems. Water is recirculated through cooling towers to remove waste heat. Thus, the amount of water necessary for these systems is small compared to that of once-through cooling systems. To replace evaporative losses, blowdown, and drift losses, makeup water from the Chesapeake Bay is supplied to the CWS and to the ESWS under post-accident conditions lasting longer than 72 hours. In addition, Chesapeake Bay waters are supplied to the desalinization plant, which, in turn, supplies makeup water to the cooling towers associated with the ESWS during normal and shutdown/coldown conditions.

Potential physical and aquatic impacts are associated with water withdrawal at the intake structures, heat dissipation to the atmosphere, and elevated temperature of the blowdown as it ~~is~~ return~~ed~~s to the Chesapeake Bay.

5.3.1 INTAKE SYSTEM

The existing intake system consists of the CCNPP Units 1 and 2 intake channel, and an embayment established by a curtain wall. The CCNPP Unit 3 intake for the CWS makeup will be ~~located on the southern edge of the intake embayment, and the intake for the UHS makeup will be located to the east immediately adjacent to the CWS intake. The CCNPP Unit 3 intakes will be set back from the intake embayment and situated at the end of a 123 ft (38 m) long, 100 ft (31 m) wide channel.~~ located in a forebay constructed on the shoreline terrace approximately 500 ft (154.2 m) south of the southern edge of the Units 1 and 2 curtain wall. Seawater will be supplied to the forebay via two intake pipes running south from a protected area of the shoreline. The CWS pumphouse will be at the northern end of the forebay and the UHS pumphouse will be at the southern end. Section 3.4 provides the details regarding the design of these structures and systems.

The desalinization plant is the source of the makeup water for the ESWS during normal and shutdown/cooldown conditions. The desalinization plant is supplied by the Chesapeake Bay via the intake structure for the CWS.

Section 3.4.1.1.1 identifies that the maximum makeup rate from Chesapeake Bay to the CWS and desalinization plant is ~~43,480~~47,383 gpm (~~164,590~~179,365 lpm). This accommodates the maximum evaporation rate, maximum blowdown rate, and drift loss for the CWS cooling tower, and the demand for the desalinization plant.

Section 3.4.1.2 identifies that the maximum makeup rate from the Chesapeake Bay to the ESWS cooling towers will be ~~3,748~~629 gpm (~~14,188~~2,381 lpm) to accommodate the maximum evaporation rate and drift loss for two ESWS cooling towers (UHS) during ~~design basis accident conditions~~normal operation.

The flow velocity into the existing intake channel from the Chesapeake Bay is no more than 0.5 ft/sec (0.15 m/sec). The flow through the CCNPP intake ~~channel~~pipes is determined by plant operating conditions. Velocities also depend on the water level of the Chesapeake Bay. At the minimum Chesapeake Bay operating level (-4.0 ft NGVD 29 (-1.2 m NGVD 29)), the flow velocity along the CCNPP Unit 3 intake ~~channel~~forebay would be less than 0.5 ft/sec (0.15 m/sec), based on the CCNPP Unit 3 maximum cooling water intake flow as discussed in Section 3.4.2.1. ~~The flow velocities at the CWS and UHS makeup intake structures would be less than 0.3 ft/sec (0.09~~

~~m/sec), and less than 0.1 ft/sec (0.03 m/sec), respectively as flow velocities are discussed in Section 3.4.2.1.~~

~~For the CWS makeup water intake structure, flow from two traveling band screens and trash racks flows to a common forebay that feeds the three CWS makeup pumps. The through-trash rack and through-screen mesh flow velocities will be less than 0.5 ft/sec (0.15 m/sec). The screen wash system consists of two screen wash pumps that provide a pressurized spray to remove debris from the water screens. In both intake structures, there is a fish return system, and the~~ The flow velocities through the screens are less than 0.5 ft/sec (0.15 m/sec) in the worst case scenario (minimum Chesapeake Bay level with highest makeup demand flow) as discussed in Section 3.4.2.1.

The CCNPP Unit 3 inlet area is located in a protected area along the shoreline just south of the CCNPP Units 1& 2 intake channel. The Unit 3 intake cannel is an approximate 9,000 square foot (836 square meters) wedge shaped pool area formed by a sheet pile wall extending approximately 180 feet from the shoreline to the baffle wall and approximately 90 feet channelward from the mean high water shoreline. The Unit 3 intake piping consists of two runs of 60-inch diameter safety related pipe approximately 490 feet (144.4 meters) long. These pipes convey water from the CCNPP Unit 3 intake channel formed with sheet pile to a common forebay structure. A rip-rap seawall extends 75 feet (22.9 meters) north from the shoreline, east of the pipeline entrance, rip-rap along the shoreline, and a trash rack provide additional protection to the intake system.

The CWS and UHS intake pumps are located on opposite side of the common forebay. Both the CWS and UHS are equipped with trash racks and travelling screens.

The CCNPP Unit 3 CWS intake has a fish collection and holding facility similar to that of Units 1 and 2. It is located on the east side of the CCNPP Unit 3 intake fore bay. Screen wash water and fish collected from CCNPP Unit 3 ~~cooling water makeup~~ CWS intake structure traveling screens are diverted to the CCNPP Unit 3 fish return facility and released to the bay via a buried conduit to the shoreline. ~~Conduit~~ The conduit outfall is submerged below tide level to minimize drop at the exit and facilitate fish return to the bay. The pipe will be installed 4 ft (1.22 m) below the Chesapeake Bay bottom and will emerge 40 ft (12.2 m) channelward. The outfall location will be protected with a 10 ft (3.1 m) by 10 ft (3.1 m) riprap apron extending approximately 48 ft (14.63 m) channelward. The installation of the pipe will require removal of 40 linear ft (12.2 m) of the existing shoreline revetment and approximately 500 yd^3 (582.3 m^3) of material within the dredged work area. The dredged material will be returned to the trench after the pipe is placed and existing revetment will be restored to its original design. Section 3.4 provides the details of the fish return system as well as construction activities.

~~In the UHS makeup water intake structure, one makeup pump will be located in each pump bay, along with one dedicated traveling band screen and trash rack.~~

5.3.1.1 Hydrodynamic Descriptions and Physical Impacts

Physical impacts of cooling water intake operation could include alteration of site hydrology and increased sediment scour. Given that the amount of additional cooling water withdrawn for CCNPP Unit 3 is small compared to that of CCNPP Units 1 and 2 and that the CCNPP Unit 3 intake pipes~~s~~ are located within the existing intake embayment, any incremental effects will be small. Design of the intake configuration for CCNPP Units 1 and 2 followed extensive hydrodynamic modeling including development of a physical scale model of the Chesapeake Bay area potentially affected by the facility. The purpose was to develop an intake system that would minimize hydraulic and ecological impacts on the Chesapeake Bay (BGE, 1970).

Hydrographic information relevant to potential physical impacts attributable to the CCNPP intakes includes water temperature, salinity, tidal excursion, depth, ambient velocities and circulation in the area of the intake. Maximum tidal flow past CCNPP was estimated to be about 1,500,000 ft^3/sec (42,475 m^3/sec), and the average flow was about 800,000 ft^3/sec (22,653 m^3/sec). Tidal excursion in the vicinity of CCNPP site was determined to extend about 6 mi (9.6 km). The CCNPP Units 1 and 2 design cooling water withdrawal rate (5,400 ft^3/sec (152 m^3/sec)) was found to represent less than one percent of the tidal flow and about six percent of non-tidally influenced flow (BGE, 1970). In-situ monitoring indicated salinity and temperature stratification during summer. Salinity increased with depth and temperature decreased. The additional cooling water intake flow required for CCNPP Unit 3 will increase the total site withdrawal from Chesapeake Bay by about 2%.

Design criteria that resulted from the model study included: 1) a limitation on change in temperature rise across the condensers; 2) the withdrawal of cooler waters from below the thermocline; 3) limiting impact on organisms in the upper photosynthetic zone; and 4) intake velocities less than 0.5 ft/sec (0.15 m/sec). Construction of a curtain wall outboard of the intake structures was undertaken to address these design criteria (BGE, 1970). Collectively, these mitigating measures serve to limit the potential impact of the addition of a closed-cycle unit to the CCNPP site.

Because the intake velocities approaching the CCNPP Unit 3 intake structures are expected to be low, periodic dredging may not be required to maintain intake ~~channel~~forebay elevation as discussed in Section 3.4.2.1. Dredging activities will be performed in accordance with U.S. Army Corps of Engineers and Maryland State requirements, if needed.

ER Section 4.3.2.2 discusses potential dredging effects both physical and ecological. This discussion is specific to intake construction but the information also applies to maintenance dredging. Siltation rate determines the amount of sediment disturbed during maintenance dredging. ~~The channel to be dredged for CCNPP Unit 3 is approximately 123 ft (37.49m) long and 100 ft (30.48m) wide.~~ The incremental amount of dredged material related to CCNPP Unit 3 will be small assuming that CCNPP Unit 3 maintenance dredging in conducted in conjunction with that for CCNPP Units 1 and 2. Dredging will cause temporary suspended sediment in the immediate area but studies of similar activities as discussed in ER Section 4.3.2.2 demonstrate that CCNPP Unit 3 dredging, for either cnstruction or maintenance, will have no significant biological effect on Chesapeake Bay. The area near Calvert Cliffs does not provide critical spawning habitat for any federally managed marine fish species, thus CCNPP Unit 3 dredging is expected to have no significant effect on their eggs or larvae. Moreover, the dominant fish species in the area have no designated Habitat Areas of Particular Concern (HAPC). Studies demonstrate that the CCNPP site area is not a major spawning area for invertebrates, such as the American Oyster, thus they will not be significantly affected. Neither the shortnose sturgeon nor the loggerhead turtle are commonly found in the CCNPP area. No threatened or endangered species are expected to be significantly affected by the CCNPP Unit 3 dredging.

The potential physical impacts associated with nuclear plant cooling water intakes were considered by the NRC in developing its generic environmental impact statement for license renewal and in its site-specific supplement for CCNPP Units 1 and 2 (NRC, 1996) (NRC, 1999). Potential intake physical impacts considered to be Category 1 issues at CCNPP Units 1 and 2 included altered current patterns and salinity gradients, scouring and water use conflicts. The NRC concluded that the impacts related to these issues are small, and that plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted (NRC, 1999). The comparatively small incremental water use and the placement of the intakes for CCNPP Unit 3 inside the existing embayment should not alter this determination.

Based on the facts that (1) the amount of additional cooling water withdrawn for CCNPP Unit 3 is small compared to that of CCNPP Units 1 and 2, (2) ~~CCNPP Unit 3 intakes for the CWS and the UHS are to be located within the existing intake embayment, and (3)~~ intake velocities will be less than 0.5 ft/sec (0.15 m/sec), it is concluded that the physical impacts of the intakes for the CCNPP Unit 3 CWS and UHS will be SMALL and will not warrant mitigation measures beyond the design features previously discussed.

5.3.1.2 Aquatic Ecosystems

Aquatic impacts attributable to operation of the CCNPP Unit 3 intake structures and cooling water systems are impingement and entrainment. Impingement occurs when larger organisms become trapped on the intake screens and entrainment occurs when small organisms pass through the traveling screens and subsequently through the cooling water system. Factors that influence impingement and entrainment include cooling system and intake structure location, design, construction and capacity. Clean Water Act Section 316(b) requires that cooling water intakes represent "Best Technology Available" for these criteria. The U.S. Environmental Protection Agency (EPA) promulgated regulations implementing Section 316(b) in 2001 for new facilities (Phase I) (USEPA, 2001). The CCNPP Unit 3 intake and cooling water systems conform to these criteria.

The U.S. EPA design criteria for Phase I new facilities are as follows:

- Reduce intake flow, at a minimum, to a level commensurate with that which can be attained by a closed-cycle recirculating cooling water system,
- Achieve a maximum through screen intake velocity of 0.5 ft/sec (0.15 m/sec),
- For intake structures located in a tidal estuary or tidal river, the total design flow over one tidal cycle of ebb and flow must be no greater than 1% of the 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,
- Select and implement design and construction technologies or operational measures for minimizing impingement mortality of fish and shellfish, if:
    - There are threatened, endangered or otherwise protected species potentially impacted
    - Migratory, sport or commercial species pass through the hydraulic zone of influence
- Select and implement design and construction technologies or operational measures for minimizing entrainment of entrainable life stages of fish and shellfish, if:
    - There are threatened, endangered or otherwise protected species potentially impacted
    - There would be undesirable cumulative stressors affecting entrainable life stages of species of concern.

Maryland cooling water system requirements (COMAR, 2007) require that "the location, design, construction and capacity of the cooling water intake structures shall reflect the best available technology (BTA) for minimizing adverse environmental impact" determined by:

- Installation and operation of functional modifications to mitigate impingement loss based on economic considerations including the value of the resource compared to corrective actions and,

- Determination of the extent to which entrainment loss affects a spawning or nursery area for representative important species, and corrective actions if necessary.

The CCNPP Unit 3 CWS and UHS intakes will meet the U.S. EPA Phase 1 design criteria as discussed above. The overall percentage of Chesapeake Bay water entrained will remain less than 1% with the maximum additional CCNPP Unit 3 cooling water demand of ~~43,480~~47,383 gpm (~~164,582~~179,365 lpm) and intake design approach velocities of less than 0.5 ft/sec (0.15 m/sec).

The intake structures for CCNPP Unit 3 will incorporate fish and invertebrate protection measures that maximize impingement survival including fish return systems similar to those employed by CNPP Unit 1 and 2. The through-trash rack and through-screen mesh flow velocities will be less than 0.5 ft/sec (0.15 m/sec). The screen wash system provides a pressurized spray to remove debris from the water screens. In both intake structures, the flow velocities through the screens are less than 0.5 ft/sec (0.15 m/sec) in the worst case scenario (minimum Chesapeake Bay level with highest makeup demand flow). This represents the Best Technology Available.

An extensive impingement and entrainment data base exists for CCNPP Units 1 and 2 with which to evaluate potential impacts on sensitive or otherwise protected species (ANSP, 1981) (Ringger, 2000). Impingement monitoring was performed at CCNPP Units 1 and 2 from 1974 through 1995 (Ringger, 2000). Seventy-three species of fish were identified. The most commonly impinged species of fish were Bay Anchovy, Hogchoker, Weakfish, Stickleback, Skilletfish, Summer Flounder and Northern Searobin. The abundance of fish and shellfish in impingement samples was generally consistent with their relative abundance in the CCNPP site area as determined from bottom and mid-water trawls conducted between 1968 and 1979 (MMC, 1979).

Between 1975 and 1995, the total annual number of fish impinged ranged between 70,000 and 9.6 million. The number of blue crab ranged between 82,000 and 1.8 million, annually. The annual average number of fish impinged was approximately 1.3 million fish weighing 20,000 lbs (9,100 kg). The average number of Blue Crabs impinged was 627,700, weighing 63,900 lbs (29,200 kg) (Ringger, 2000).

The impingement estimates reported above do not account for the apparent high survival experienced by many key species. Survival studies showed that of the 14 dominant species impinged, 11 species demonstrated survival rates greater than 50%, including the Blue Crab with a survival rate in excess of 99%. The Blue Crab is the species most frequently impinged (Ringger, 2000).

Entrainment and related plankton studies were performed between 1975 and 1981. The dominant species in ichthyoplankton and entrainment samples included Hogchoker, Bay Anchovy and Naked Goby (MMC, 1980). Twenty-two species of fish larvae and eggs were collected by CCNPP personnel in entrainment samples collected from 1978 through 1980. Hogchoker accounted for almost 75% of all organisms and life stages. Bay Anchovy eggs and post larvae accounted for 19% and Naked Goby larvae another 3%. Recreationally and commercially important species discussed in Section 2.4.2, such as Striped Bass, Bluefish, Spot, Croaker, and Herring, may be found around the CCNPP site area on a seasonal basis during migrations, but are not susceptible to entrainment as they do not spawn in the area and larvae mature elsewhere (NRC, 1999).

Important ecological impact findings reported by Martin Marietta (MMC, 1980) and later supported by the State of Maryland Power Plant Research Program (PPRP, 2002) are as follows:

- The CCNPP site area was not a spawning area for species of commercial or recreational value,
- Field data showed no consistent detectable depletions of ichthyoplankton in the plant vicinity,
- The magnitude of impingement appeared insufficient to substantially modify the ecosystem in the CCNPP site region, and
- Ecological and economic projections suggested entrainment impacts would be very limited in magnitude and spatial extent.

The evaluation of compliance with the State of Maryland power plant cooling water intake regulations (COMAR, 2007) requires an assessment of the relative value of the resource to be protected compared to the cost of additional measures that may be needed to further reduce impingement and entrainment impacts.

Estimated annual dollar value of fish impinged between 1993 and 1995 ranged from a maximum $18,000 in 1993 to a low of approximately $1,300 in 1994 and 1995 depending on the methods used. Total value of impingement organisms between 1977 and 1979 ranged between $26,140 and $23,270 (NRC, 1999).

The relative impact of impingement and entrainment can also be assessed by comparison to commercial and recreational fisheries statistics. Historical accounts of harvest for species of special interest within the Chesapeake Bay program are provided in Section 2.4.2. The key recreational and/or commercial fish and shellfish in Maryland marine waters potentially affected by power plant operations include Atlantic Croaker, Bluefish, Weakfish, Summer Flounder, and Blue Crab (MDNR, 2006a). Sport catches for Weakfish from 2000 through 2005 ranged between 475,000 and 22,000 fish. A total of 85,000 Summer Flounder were harvested in 2005. Commercial fishermen landed 35,700 lbs (16,190 kg) of Weakfish in Maryland during 2005 while over 333,300 lbs (151,180 kg) of Summer Flounder were landed. Approximately 35 million lbs (15.8 million kg) of Blue Crab were reported caught (MDNR, 2006a). Total commercial landings of fish and invertebrates in Maryland during 2005 were approximately 67.4 million lbs (30.5 million kg) representing an estimated value of $63.6 million (NMFS, 2007)

The impact of CCNPP Units 1 and 2 intake represent less than 0.1% of commercial landings. Given the relatively small amount of cooling water flow required for CCNPP Unit 3, the incremental effects of impingement and entrainment should be a small fraction of recreational and commercial harvest rates.

A summary of over 10 years of macrobenthic studies conducted from 1968 through 1978 also provided evidence that potential impacts of entrainment on key commercial and recreational species including the American Oyster, Soft Shell Clam and Blue Crab were minimal (MMC, 1979). Conclusions were as follows:

- The CCNPP site area was not a major oyster spawning area,

- After CCNPP Unit 1 and 2 operation began, soft shell clam production was consistently higher at the plant sampling site than at reference locations,
- Very few planktonic stages of Blue Crabs occurred as far up the Chesapeake Bay as the CCNPP site area.

Protected aquatic species potentially found in the vicinity of the intake structures include the Shortnose Sturgeon (*Acipenser brevirostrum*), Atlantic Sturgeon (*Acipenser oxyrhynchus*) and the Spotfin Killifish (*Fundulus luciae*) (NRC, 1999) (BGE, 1998) (CGG, 2005) (MDNR, 2003). Both the Shortnose and Atlantic Sturgeon spawn in fresh waters and the migration of young downstream does not occur until the late larval stage. As a result, the eggs and young larvae of these two species are unlikely to be affected by entrainment in the cooling water intake of CCNPP Unit 3.

In the many years of sampling at CCNPP site area, only one Shortnose Sturgeon was caught in trawls (NRC, 1999). The Spotfin Killifish frequents tidal marshes in saline systems and is unlikely to be abundant within the unique habitat found along the Calvert Cliffs shoreline. The NRC consulted with the U.S. Fish and Wildlife Service and the National Marine Fisheries Services regarding additional protective measures relative to the CCNPP Unit 1 and 2 license renewal and determined that there is little likelihood for adverse impacts to endangered or threatened aquatic species and that no additional measure beyond those already implemented at the CCNPP site were necessary (NRC, 1999). Operation of CCNPP Unit 3 with closed-cycle cooling systems and fish protection measures incorporated into the intake should limit any incremental effect beyond that already evaluated.

Additional regulatory protection has been provided by the National Marine Fisheries Service under the Magnuson-Stevens Fishery Conservation Management Act (16 USC Sections 1801-1883) for certain species with unique or otherwise "essential fish habitat" requirements as shown in Table 5.3-1 (NOAA, 2007). Impingement and entrainment data collected at the CCNPP site indicate that certain of these species occur at some life stage in the vicinity of the site. However, their overall abundance in impingement and entrainment samples has been low, and in most cases represents less than 1% of species composition. The dominant species that occur in monitoring at CCNPP have not been identified as requiring Habitat Areas of Particular Concern (HAPCs) designations.

Of the species listed with HAPCs, Summer Flounder was identified as having nursery requirements that may be found in Chesapeake Bay (NOAA, 2001). The specific habitat considered for protection was submerged aquatic vegetation (SAVs) that provide food and protection for larval and juvenile stages. A survey of SAVs conducted throughout Chesapeake Bay since the early 1970s found no discernible beds in the vicinity of the CCNPP site (VIMS, 2007). As identified in Section 2.4.2.2.5.1, no SAV were located during the surveys conducted in the immediate vicinity of the CCNPP site during 2006.

Potential impacts from impingement and entrainment of key representative important species have been reviewed by the Nuclear Regulatory Commission (NRC) and the Maryland Department of Natural Resources (MDNR) Power Plant Research Program (NRC, 1999) (MDNR, 2006b) (PPRP, 2002). The MDNR concluded that after many years of study, potential impacts encompassing all of the various power generation facilities in the State of Maryland waters have not resulted in a depletion of populations. The NRC concluded in its Environmental Impact Statement regarding the license renewal for CCNPP Units 1 and 2 that any impacts were small and that mitigative measures beyond those already implemented at CCNPP Units 1 and 2 were not warranted.

Based on the facts that (1) the proposed cooling tower-based heat dissipation system will under normal circumstances, withdraw small amounts of Chesapeake Bay water compared to CCNPP Units 1 and 2, (2) the design of the intake structures and cooling water system incorporates a number of features that will reduce impingement and entrainment, and (3) the experience that suggests that the Chesapeake Bay fish and shellfish populations have not been adversely affected by operation of CCNPP Units 1 and 2, it is cincluded that the imapcts of the intakes for the cooling water systems will be SMALL and will not warrant mitigation measures beyond the design features previously discussed.

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5.3.2 DISCHARGE SYSTEM

5.3.2.1 Thermal Description and Physical Impacts

The thermal discharge from CCNPP Unit 3 will return blowdown from the cooling towers and site wastewater streams to the Chesapeake Bay. A description of the cooling water system including the discharge is provided in Section 3.4. The average discharge flow is approximately ~~19,400~~21,019 gpm (~~73,500~~79,566 lpm). The offshore discharge structure will consist of a subsurface multi-port diffuser located approximately 1,200 ft (366 m) south of the CCNPP Unit 3 intake structure, extending about 550 ft (168 m) into the Chesapeake Bay at a depth of -10 ft (-3 m) msl. The diffuser will consist of three nozzles located approximately 3 ft (0.9 m) off the bottom.

The differential temperature rise (delta-T) across the cooling water system from intake to discharge will vary with electrical generation and seasonal changes in intake water temperature. For purposes of thermal plume modeling, a delta-T of 12°F (6.7°C) was assumed, consistent with the current NPDES permit limit for CCNPP Units 1 and 2.

The CCNPP Unit 3 discharge multi-port diffuser system is designed to minimize the potential impact of the thermal plume as it enters the Chesapeake Bay. The subsurface diffusers create rapid mixing of the thermal effluent with ambient tidal flows. Tidal currents driven by the rise and fall of tides in the Chesapeake Bay largely determine plume size and shape.

5.3.2.1.1 Chesapeake Bay Hydrology

Information describing the hydrology of Chesapeake Bay in the vicinity of the CCNPP site is found in Section 2.3.1. Average rise and fall of the semidiurnal tides is approximately 1 ft (0.3 m) as determined from the NOAA Cove Point gauging station just south of the CCNPP site (NOAA, 2007a). Velocities can vary based on tide stage and have been measured as high as 0.78 ft/sec (0.24 m/sec) in previous thermal plume studies (Lacy, 1979). Tidal excursion was estimated to range from 3.1 to 3.7 mi (5 to 6 km).

Water temperatures measured from 1984 through 2006 ranged between 36.5°F (2.5°C) and 80.6°F (27°C). Salinities measured during 2005 and 2006 varied from just above 5 to 20 ppt, averaging 15 ppt. Depth at the discharge structure will be approximately -10 ft (-3.05 m) msl with the substrate dropping off to a depth of approximately -40 ft (12.2m) msl at 4,800 ft (1,463m) east of the intake structures. In the region of the CCNPP site, the Chesapeake Bay is approximately 6 mi (9.6 km) wide. Sands predominate in waters less than 13.1 ft (4.0 m), mud predominates in waters greater than 26 ft (8.0 m), and a mixture of each appears in the intermediate depths.

5.3.2.1.2 Discharge Thermal Plume Regulations

The State of Maryland has established thermal discharge water quality regulations that limit the spatial extent of thermal plumes

- The 24 hour average of the maximum radial dimension measured from the point of discharge to the boundary of the full capacity 3.6°F (2°C) above ambient isotherm (measured during the critical periods) may not exceed one-half of the average ebb tidal excursion,

- The 24 hour average full capacity 3.6°F (2°C) above ambient thermal barrier (measured during the critical periods) may not exceed 50% of the accessible cross section of the receiving water body. Both cross sections shall be taken in the same plane,

- The 24 hour average area of the bottom touched by waters heated 3.6°F (2°C) or more above ambient at full capacity (measured during the critical periods) may not exceed 5% of the bottom beneath the average ebb tidal excursion multiplied by the width of the receiving water body.

Alternate, less stringent criteria can be established on a case-by-case basis if it can be demonstrated that the thermal discharge criteria are more stringent than necessary to assure the protection and propagation of a balanced, indigenous community of shellfish, fish and wildlife in and on the body of water into which the discharge is made.

General temperature requirements for Maryland Class II waters that encompass Chesapeake Bay also include a limit on maximum water temperature and zone of passage outside the mixing zone (COMAR, 2007b):

- Water temperatures may not exceed 90°F (32°C) or the ambient temperature of surface waters, and

- A thermal barrier that adversely affects aquatic life may not be established.

- Discharge of chlorine from the cooling tower blowdown is limited to 0.2 mg/l monthly average and 0.5 mg/l daily maximum of free available chlorine as determined using the amperometric titration method (MD, 2007c).

5.3.2.1.3 Discharge Plume Model

The spatial configuration of the CCNPP Unit 3 thermal plume was simulated using the Cornell Mixing Zone Expert System (CORMIX). The mathematical modeling tool CORMIX (Cornell Mixing Zone Expert System) is a U.S. Environmental Protection Agency (EPA) supported computer code for the analysis, prediction, and design of aqueous toxic or conventional pollutant discharges into diverse water bodies. The model can be used for environmental impact assessment of regulatory mixing zones resulting from continuous point source discharges such as CCNPP Unit 3. The system accounts for the effects of boundary interactions, and predicts steady-state mixing behavior and plume geometry. The CORMIX methodology contains different options used to model single-port, multi-port diffuser discharges, and surface discharge sources. Effluents considered may be conservative, non-conservative, heated, or brine discharges.

Input parameters used in the CCNPP Units 3 CORMIX thermal plume simulation are given in Table 5.3-2 and Table 5.3-3 (NOAA, 2007a) (Lacy, 1979) (BGE, 1970) (Fofonoff, 1983). Results are provided in Table 5.3-4 and Figure 5.3-1 (Schreiner, 2003). The 3.6°F (2°C) isotherm extends approximately 148 ft (45 m) beyond the discharge multi-port diffusers on the ebb and flood tides. The slack tide 3.6°F (2°C) isotherm is predicted to extend less than 20 ft (6.6 m) beyond the diffusers. The modeled plume predictions are considered conservative since the CORMIX model constrains the depth of the plume to no more than 30 percent greater than the depth at discharge, or -13 ft (-4.0 m) in this case. Further, a sensitivity analysis comparing plume size at differential water temperatures below 12°F (6.7°C) demonstrated that plume size decreases as delta-T is reduced.

The area occupied by the plume is compared to the State of Maryland water quality criteria in Table 5.3-5. This comparison demonstrates that the CCNPP Unit 3 thermal plume conforms to each of the criteria. The radial dimension of the 3.6°F (2°C) isotherm is less than 4% of the ebb tide excursion, compared to the one-half specified by the State of Maryland regulation. The full capacity of the 3.6°F (2°C) isotherm is less than 0.4% of the Chesapeake Bay cross section, and the bottom area affected by the plume is about 0.02% of the average ebb tidal excursion multiplied by the width of the Chesapeake Bay.

5.3.2.2 Aquatic Ecosystems

Power plant discharge effects could include attraction of fish to the thermal plume, cold shock, blockage to movement and migration, changes in benthic species composition, growth of nuisance species, alteration of reproductive patterns and chemical effects of biocides. These effects have been studied extensively at CCNPP Units 1 and 2 and provide a basis for assessing the potential ecological consequences of the CCNPP Unit 3 discharge (MMC, 1979) (MMC, 1980) (PPRP, 2002) (MDNR, 2006).

The absence of harm caused by the CCNPP Units 1 and 2 discharge to key species of concern including recreationally and commercially important species provides evidence that the incremental discharge of cooling tower blowdown and wastewaters from CCNPP Unit 3 will have minimal impact on Chesapeake Bay in the CCNPP site area.

5.3.2.2.1 Thermal Effects

The CCNPP Unit 3 plume is predicted to be a small fraction of the CCNPP Units 1 and 2 plume. Based on its location, the CCNPP Unit 3 plume will have little or no interaction with the CCNPP Units 1 and 2 plume. Its small cross sectional area is unlikely to provide a barrier to fish migration and its transient nature should limit attraction of fish such that they become acclimated and entrapped there particularly during winter when fish are susceptible to cold shock from plant shutdown. Since fish are unlikely to become acclimated to the small plume, gas bubble disease should not occur. The potential for fish kills resulting from attraction of fish to the CCNPP Units 1 and 2 thermal plume were studied in 1987 with no winter fish kills observed during the period of the study.

Assuming that the benthic area is potentially exposed to the entire 3.6°F (2°C) isotherm, that area would be less than 0.4 acres (0.2 hectares), well within the State of Maryland regulatory criteria for benthic area affected, which in this case would be approximately 296 acres (120 hectares). In addition, since the plume is largely a surface phenomenon, benthic species are not likely to be affected.

It is concluded that the thermal impacts to aquatic communities will be SMALL, and will not warrant mitigation.

5.3.2.2.2 Chemical Effects

Chemical effects of the discharge include the addition of biocides to limit fouling within the cooling water systems and other chemical agents to limit scaling and to treat the CCNPP Unit 3 sewage treatment system. The chemicals used and potentially discharged into the Chesapeake Bay via the submerged offshore discharge are listed and discussed in ER Section 3.6. The discharge will receive inputs including cooling tower blowdown, desalination system waste water treatment and effluent from the sewage treatment system (ER Section 3.6.2). Reject waste waters from the desalination facility are given in Table 3.6-2. The desalination reject water is expected to have a salt concentration of 2 to 1 times that of seawater. This effluent will be mixed with cooling tower blowdown as it is discharged.

The concentration of treatment chemicals in the various discharges that contribute to the offshore thermal discharge is provided in Table 3.6-1. Substances used include sodium bisulfate, sodium hypochorite, soda ash, antifoam and disperant agents, and sulfuric acid and sodium hydroxide for pH control. Within the circulating water system blowdown, total residual chlorine (TRC) is expected to be less than 0.1 mg/l. TSS at approximately 5 mg/l, total organic carbon at 1.4 mg/l. Within the waste water treatment plant discharge. TSS is expected to average 3.4 mg/l with a maximum of 45 mg/l. Concentration limits for the offshore thermal discharge that contains these various inputs will be determined by way of the NpDES discharge permit for Unit 3.

Discharge concentrations of these constituents will be limited by the Maryland State National Pollutant Discharge Elimination System (NPDES) permit (MDNR, 2004). Bioassay testing required by the NPDES permit will assess the potential toxicity of the discharge and provide for corrective action if necessary. To date, the testing performed for CCNPP Units 1 and 2 has not indicated any toxicity to test organisms. Similar results are expected during operation of CCNPP Unit 3. (COMAR 2007b)

It is concluded that any impacts to aquatic biota will be SMALL, and will not warrant mitigation.

5.3.2.2.3 Physical Effects

Physical and related ecological impacts of the CCNPP Units 1 and 2 thermal discharge have been limited to sediment scour in the vicinity of the high velocity discharge ports. It is expected that the physical impacts associated with CCNPP Unit 3 will also be limited to sediment scour of a small area.

With CCNPP Units 1 and 2, the sand substrate present prior to station operation was scoured leaving a hard-pan clay substrate. The benthic community changed from one dominated by burrowing organisms to one dominated by fouling organisms. For CCNPP Unit 3, the same results are anticipated (i.e., recolonize with epibenthic organisms similar to that observed at the CCNPP Units 1 and 2 discharge).

Past studies (MMC, 1979) (MMC, 1980) at the CCNPP site area concluded that there were no effects of significance to food web interactions between benthic and finfish communities. Food web structure was similar at the reference site, suggesting that measurable changes in the benthic community had no impact on higher trophic levels. Thus, it is anticipated that there will be little or no ecological impact on the food base.

As discussed in Section 5.3.1, several fish and invertebrate species that may occur within the CCNPP site area of the Chesapeake Bay have designated essential habitat or Habitat Areas of Particular Concern (HAPCs), or are otherwise protected. A review of the species listed in Table 5.3-1 having designated HAPCs suggests that the small size of thermal plume and its limited impact on substrate are unlikely to impact any life history stage of these species. In large measure, their presence in the CCNPP site area is transient (NOAA, 2007b). The dominant fish species found in the CCNPP site area have no designated HAPCs. Of the species listed as threatened or endangered, occurrence in the CCNPP site area is rare (NRC, 1999).

Studies of finfish in the CCNPP site area were conducted from 1969 through 1981 using otter trawls towed monthly at three depths. The studies were designed to examine long-term trends including explanatory environmental variables. The three most abundant fish in trawls were the Anchovy, Spot and Croaker. Also common were White Perch, Winter Flounder, Hogchocker, and Menhaden. The Anchovy and Spot were also common in impingement samples reflecting their local abundance. Annual and long-term changes in recruitment were explained by factors other than power plant operation.

The most common fish species fed on a combination of benthic organisms, zooplankton and detritus. Their relative dominance in trawls increased over the study period while those fish species that fed primarily on piscivores and mysids decreased. The loss of submerged aquatic vegetation (SAVs) in the area was given as a possible explanation for the decrease in fish that feed among vegetation. The loss of SAVS was common throughout Chesapeake Bay during the study period (VIMS, 2007). In general, there were no strong positive or negative correlations among ecologically related groups that might indicate response to varying ecological conditions in the study area.

In addition, observations regarding the Oyster, Soft Shell Clam, and Blue Crab populations near the CCNPP Units 1 and 2 discharge have been documented (MMC, 1979) (MMC, 1980). Settlement of oyster spat continued to occur in the discharge zone for CCNPP Units 1 and 2 during power plant operation. Young oysters were equally abundant there compared to other areas of the CCNPP site region. This has occurred despite the relocation of oysters from the discharge area to other areas prior to operation of CCNPP Units 1 and 2. Abundance and growth rates of the Soft Shell Clam (*Mya arenaria*) were greater in the discharge area during plant operations compared to the pre-operational period. No effect on the Blue Crab was noted. Similar observations following the operation of CCNPP Unit 3 are expected.

It is concluded that the impacts to aquatic communities will be SMALL, and will not warrant mitigation.

5.3.2.3 References

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5.3.3 HEAT DISCHARGE SYSTEM

5.3.3.1 Heat Dissipation to the Atmosphere

CCNPP Unit 3 requires water for cooling and operational uses. Primary water consumption is for turbine condenser cooling. Cooling water for the turbine condenser and closed cooling heat exchanger for normal plant operating conditions is provided by the Circulating Water Supply System (CWS). The excess heat from the CWS is dissipated to the environment with a closed loop cooling system. A closed loop cooling system recirculates water through the plant components and cools this water for reuse by transferring excess heat to air, or the atmosphere, with a cooling tower. CCNPP Units 1 and 2 uses an open loop cooling system, or once through, where water is drawn in from the Chesapeake Bay, heated in plant components that provide the necessary cooling, and then returned to the Chesapeake Bay.

The cooling system for CCNPP Unit 3 will be a closed-cycle, dry cooling system, consisting of a single mechanical draft cooling tower for heat dissipation. The CWS cooling tower is a hybrid design wherein heat is added just above the demisters to evaporate all of the entrained water that would pass through the demisters and eliminates the the visible plume.

There will also be four smaller Essential Service Water System (ESWS) cooling towers to dissipate heat from system. The ESWS provides cooling water to the Component Cooling Water System heat exchangers and the Emergency Diesel Generators heat exchangers. Each of these four safety-related trains uses a safety-related two-cell mechanical draft cooling tower to dissipate heat. Heated ESWS water returns through piping to the spray distribution header of the UHS cooling tower. Water exits the spray distribution piping through spray nozzles and falls through the tower fill. Two fans provide upward air flow to remove latent heat and sensible heat from the water droplets. The heated air exits the tower and mixes with ambient air, completing the heat rejection process. The cooled water is collected in the tower basin for return to the pump suction for recirculation through the system. Table 3.4-1 provides nominal heat loads and flow rates in different operating modes for the ESWS. Makeup water is normally provided from the plant potable water system but can also be supplied from the safety-related UHS makeup water system pumps housed in their own intake structure near the CWS makeup intake structure. Table 3.4-3 provides the UHS cooling tower design specifications.

5.3.3.1.1 Circulating Water Supply System Cooling Tower Plume

A visible mist or plume is created when the evaporated water from a cooling tower undergoes partial recondensation. In addition to evaporation, small water droplets drift out of the tops of a cooling tower. The drift of water droplets can deposit dissolved solids on vegetation or equipment.

For CCNPP Unit 3, the impacts from drift deposition were modeled using the Electric Power Research Institute's Seasonal/Annual Cooling Tower Impact (SACTI) prediction code. This code incorporates the modeling concepts (Policastro, 1993) which were endorsed by the NRC in NUREG-1555 (NRC, 1999). The model provides predictions of seasonal, monthly, and annual cooling tower impacts from mechanical or natural draft cooling towers. It predicts average plume length, rise, drift deposition, fogging, icing, and shadowing, providing results that have been validated with experimental data (Policastro, 1993).

Detailed cooling tower design information is provided in Section 3.4. This information was used to develop input to the SACTI model. A summary of the design parameters are provided in Table 5.3-6. The meteorological data came from the CCNPP site meteorological tower for the years 2001 through 2005. Additional meteorological data for the years 2001 through 2005 was acquired from the National Climatic Data Center meteorological data for the nearby Patuxent River Naval Air Station.

The National Climatic Data Center in association with the National Oceanographic and Atmospheric Administration was used to obtain hourly surface data for the Patuxent River Naval Air Station. Missing or bad data was replaced with values from the first previous hour with good data. Using the dry bulb temperature from the site and the dew point temperature from Patuxent River Naval Air Station, the wet bulb temperature and relative humidity was calculated. In the cases where the dew point temperature supplied was greater than the dry bulb temperature, the dew point temperature was set equal to the dry bulb temperature for the calculation of the wet bulb temperature and relative humidity. The only other modification to the meteorological data was to convert units from those supplied to those used by the SACTI code.

The normal heat loads from the ESWS cooling towers are approximately 3% of the heat load to the CWS cooling tower. The maximum heat load is less than 7% of the CWS cooling tower heat load. Any impacts from the heat dissipation to the atmosphere by the ESWS cooling towers would be much less than the CWS cooling tower. In addition, a cumulative effect would be negligible. Therefore, the ESWS cooling towers are not considered further in the analysis.

5.3.3.1.2 Salt Deposition

Cooling tower drift is water droplets in the cooling tower that get entrained in the buoyant air of the cooling tower exhaust and leave the tower. These droplets eventually evaporate or settle out of the plume onto the ground, vegetation or equipment nearby. The amount of drift from the CCNPP Unit 3 cooling tower is reduced with the use of a drift eliminator. A drift eliminator is a physical barrier that limits the amount and modifies the size of droplets that drift from the top of the cooling tower. This analysis credits the drift eliminator and plume abatement to be installed on the CCNPP Unit 3 cooling tower.

The drift rate using this drift eliminator was assumed to be 0.0005% of the Circulating Water Supply System flow. The makeup water for the CWS was assumed to have a maximum total dissolved solids a TDS) concentration of 17,500 milligrams per liter of water. The ~~I~~TDS in the Chesapeake Bay are almost entirely associated with its salinity, principally sodium chloride. The equivalent chloride concentration for this T~~O~~DS level was estimated to be 10,~~.~~616 milligrams per liter of water. The Circulating Water Supply System was assumed to have two cycles of concentration. Water droplets drifting from the cooling tower would have the same concentration of salt as the water in the Circulating Water Supply System. Therefore, as these droplets evaporate, either in the air or on vegetation or equipment, they deposit these salts.

The maximum salt deposition rate from the cooling tower is provided in Table 5.3-7. The maximum predicted salt deposition is below the NUREG-1555, Section 5.3.3.2 (NRC, 1999) significance level for possible vegetation damage of 8.9 pounds per acre per month (10 kg per hectare per month) in all directions from the cooling tower during each season and annually. Therefore, impacts to vegetation from the salt deposition would not be expected for both onsite and offsite locations.

The electrical switchyard for CCNPP Unit 3 will be located approximately 1,600 ft (500 m) to the northwest of the proposed location for the circulating water supply system (CWS) cooling tower. A maximum predicted solids deposition rate of 1.2 pounds per acre per month (1.44 kg per hectare per month) is expected at the CCNPP Unit 3 switchyard. Additionally, the electrical switchyard for CCNPP Units 1 and 2 is located approximately 4,600 ft (1,400 m) to the north-northwest, from the proposed location of the CCNPP Unit 3 CWS cooling tower. The maximum predicted solids deposition expected at the CCNPP Units 1 and 2 electrical switchyard due to operation of the CCNPP Unit 3 CWS cooling tower will be 0.~~25~~44 pounds per acre per month (0.~~28~~50 kg per hectare per month).

Based on industry experience, adjustments to maintenance frequencies (e.g., insulator washing) may be necessary due to salt deposition; however, the expected deposition rates will not affect switchyard component reliability or increase the probability of a transmission line outage at CCNPP Units 1 and 2, or CCNPP Unit 3.

The ESWS cooling towers are typically operated using fresh water. However, instances where ESWS makeup water would be taken directly from the Chesapeake Bay and processed through the ESWS cooling towers could occur if stored fresh water supplies were exhausted during an extended loss of offsite power event or outage affecting the desalinization plant. It is expected that operation of the ESWS cooling towers using brackish make-up water from the Chesapeake Bay will be infrequent and of brief duration. In either case, salt deposition at the CCNPP Units 1 and 2, and CCNPP Unit 3 electrical switchyards resulting from operation of the CCNPP Unit 3 ESWS cooling towers will be small, and is bounded by the salt deposition estimates for the CCNPP Unit 3 CWS cooling tower.

In summary, impacts from salt deposition from the CCNPP Unit 3 cooling tower would be SMALL. The modeling predicts salt deposition at rates below the NUREG-1555 significance level where visible vegetation damage may occur for both onsite and offsite locations.

5.3.3.1.3 ~~5.3.3.1.2~~Ground-Level Humidity Increase

The relative humidity in the vicinity of the site is typically high. The relative humidity at the Patuxent River Naval Air Station was above 75% for nearly 50% of the time during the years of 2001 through 2005. The relative humidity is between 50% and 75% for 35% of the time and less than 50% for less than 15% of the time. The relative humidity data for Baltimore Washington International Airport was similar during the same time period. The relative humidity was above 75% for 44% of the time, between 50% and 75% for 34% of the time, and less than 50% for less than 22% of the time. Since the relative humidity in the vicinity of the CCNPP site is typically high, increases in the ground level relative humidity from the operation of the cooling tower would not be noticeable. Increases in the ground level humidity during periods when the ambient relative humidity is low would only increase the humidity to more typical levels.

Therefore, the potential for increases in absolute and relative humidity exist where there are visible plumes. However, the increase in ground level humidity at the CCNPP site would be SMALL and mitigation would not be warranted.

5.3.3.1.4 ~~5.3.3.1.3~~Noise

The noise levels generated by the CWS cooling tower are approximately 65 dBA or less at the distance of approximately 1,300 feet (396 m) from the cooling tower. The State of Maryland stipulates noise limits based on the classification of the receiving land (55 dBA Ldn for residential land). Ldn is a calculated day-night time average noise level based on an hourly average of the equivalent noise level (Leq) over a 24 hour period. As a rule of thumb for a continuously and invariant operating noise source, the Ldn value is 6.4 dB higher than the average Leq value. The Leq noise limit is therefore 55 dBA to 6.4 dB or 48.6 dBA. Based on distance losses, the 48.6 dBA (Leq) noise limit will be met within a 7,700 ft (2,347 m) radius from the towers. The noise attributable to the plume-abated cooling tower has been evaluated. (Hessler, 2008) As such, impact would be SMALL and would not require mitigation. ~~The noise attributable to the plume-abated cooling tower has been evaluated. (Hessler, 2008)~~

5.3.3.1.5 ~~5.3.3.1.4~~Similar Operating Heat Dissipation Systems

Data and information on similar heat dissipation systems within a 31 mi (50 km) radius or similar climate are available for the Chalk Point coal fired plant located on the Patuxent River and the Hope Creek Nuclear Plant. The Chalk Point coal fired plant and Hope Creek Nuclear Plant both use a natural draft cooling tower with salt or brackish water as the makeup water. At these plants, impacts from salt drift were not observed. There are no large cooling tower systems in the vicinity of the CCNPP site that would create any synergistic effects with the proposed CWS cooling tower with respect to mixing fog or drift.

The NRC described impacts from mechanical and natural draft cooling towers in the Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NRC, 1996). The plants identified in the study did not include a plant that used a mechanical draft cooling tower with salt or brackish water, as designed for CCNPP Unit 3.

5.3.3.1.6 Interaction with Existing Pollution Sources

There are no major sources of air pollution in the vicinity of the CCNPP Unit 3 site. Existing diesel generators and boilers at CCNPP Units 1 and 2 operate for limited periods. Diesel generators that are associated with CCNPP Unit 3 will also operate for limited periods. Interactions between pollutants emitted from these sources and the plumes from the cooling towers for CCNPP Unit 3 would be intermittent and would not have a significant impact on air quality. Impacts would be SMALL and would not require mitigation.

5.3.3.1.7 ~~5.3.3.1.5~~References

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5.3.3.2 Terrestrial Ecosystems

Heat dissipation systems associated with nuclear power plants have the potential to impact terrestrial ecosystems through salt drift, vapor plumes, icing, precipitation modifications, noise, and avian collisions with cooling towers.

5.3.3.2.1 Potential Impacts Due to Salt Drift

The cooling tower constructed to provide heat dissipation for CCNPP Unit 3 would release drift capable of depositing as much as 1.96 lb/acre per month (2.~~42.1~~2 kg/hectare per month) of dissolved solutes, primarily salt originating from the proposed brackish makeup water, per month on terrestrial ecosystems at the eastern edge of the CCNPP site. Analyses have shown that the cooling tower drift is primarily to the east over the open water of the Chesapeake Bay, thereby minimizing impacts to terrestrial ecosystems, especially terrestrial ecosystems outside of the CCNPP site. The component of terrestrial ecosystems most vulnerable to cooling tower drift is vegetation, especially the upper stratum of vegetation whose foliage lies directly under the released droplets of water forming the drift (NRC, 1996). Most areas of natural vegetation in the terrestrial areas subject to the greatest drift consist of forest (TTNUS, 2007a). Hence woody vegetation forming the tree canopy and woody understory is subject to the greatest exposure.

Acute vegetation damage from drift-based salt deposition originating at cooling towers whose makeup water is brackish has been shown to be minor (NRC, 1996), but greater uncertainty remains because of the limited information in the published scientific literature regarding the sensitivity of individual plant species to salt deposition. This is especially true with respect to low level chronic injury such as stunted growth that is not as visually apparent as acute injury such as browned leaves. The following analysis therefore focuses primarily on describing the risk of potential injury, especially low level chronic injury, to vegetation caused by the salt deposition rates projected for the CCNPP Unit 3 cooling tower in Section 5.3.3.1.

5.3.3.2.1.1 Plant Communities Potentially Affected by Salt Deposition Isopleths

Figure 2.4-1 depicts the areas of each plant community, as mapped and described in a flora survey report (TTNUS, 2007a). Figure 5.3-2 shows the maximum expected salt deposition rates in the vicinity of CCNPP Unit 3. No vegetation anywhere outside the Unit 3 construction footprint would be exposed to monthly salt deposition rates exceeding 0.7~~0~~1 lb/acre per month (0.~~7~~8~~5~~0 kg/hectare per month). The maximum predicted impact is south of the CWS Cooling Tower.

Less than 10 acres (4.1 hectares) of mixed deciduous forest are exposed to the highest deposition rates between 0.9 to 1.4 lb/acre per month of 1.0 to 1.6 kg~~l~~/hectare per month). The affected area is situated entirely within the CCNPP site. south of the CWS Cooling Tower location. The rest of the site and all areas offsite would be exposed to projected deposition rates less than 0.9 lbs/acre per month (1.0 kg/hectare per month), decreasing rapidly as you move away from the CWS Cooling Tower.

5.3.3.2.1.2 Potential Effects of Salt Deposition to Specific Plant Species

Information on the sensitivity of native plant species on the CCNPP site to salt drift is summarized in Table 5.3-8. This table is based on the results of the flora survey (TTNUS, 2007a) and information provided in NUREG-1437 (NRC, 1996). According to NUREG-1437, the most sensitive native plant species on the CCNPP site is flowering dogwood (*Cornus florida*), which experiences acute injury at salt deposition rates of exceeding approximately 1.1lb/acre (1.2 kg/hectare) per week (or 4.6 lb/acre (5.2 kg/hectare) per month). The threshold level is based on observational data from forest vegetation affected by salt drift from cooling towers at the Chalk Point power plant, located less than 25 mi (40 km) west of the CCNPP site (NRC, 1996), and thus reflective of locally adapted flowering dogwood growing under similar climate and physiographic conditions. Flowering dogwood occurs occasionally in the understory of mixed deciduous forest and mixed deciduous regeneration forest on the CCNPP site but is not dominant in any vegetative stratum (TTNUS, 2007a).

Because the highest salt deposition rate projected for the proposed cooling tower is only 1.96 lb/acre (2.20 kg/hectare) per month, the risk of acute injury to flowering dogwood appears to be very low. Although acute injury is unlikely, there still may be a small area with limited risk of chronic injury to flowering dogwood such as reduced growth rate and reduced vigor. Chronic injury might not be visible, but could leave affected trees more susceptible to environmental stresses such as drought or biotic stresses such as dogwood anthracnose, a fungal disease that has killed many dogwoods in Maryland. Because flowering dogwood is not a dominant tree in either the canopy or understory of forests on the CCNPP site (TTNUS, 2007a), the overall character of the affected forest vegetation would not be substantially changed even if the few flowering dogwoods in the affected areas were to eventually die. The ability of the affected forest vegetation to provide habitat for forest interior dwelling (FID) species and other wildlife favoring forest habitat would not be substantially diminished.

Of the dominant tree species in the potentially affected vegetation, NUREG-1437 provides information only for chestnut oak (*Quercus prinus*), which is dominant in mixed deciduous forest; black locust (*Robinia pseudoacacia*), which is dominant in successional hardwood forest; and red maple (*Acer rubrum*), which is dominant in the well-drained and poorly-drained bottomland hardwood forest cover that occurs in wetlands and floodplains as shown in Table 5.3-8. The minimum salt deposition rates reported to cause acute injury to each of these three species is more than two orders of magnitude higher than the maximum deposition of 1.96 lb/acre (2.20 kg/hectare) per month projected for the CCNPP Unit 3 cooling tower. Although the potential for chronic injury to these species can not be definitively ruled out, the risk appears to be substantially lower than for flowering dogwood.

The salt tolerance of other dominant tree species in the affected vegetation is not addressed in NUREG-1437. Of particular importance are tulip poplar (*Liriodendron tulipifera*), American beech (*Fagus grandifolia*), and various upland oak species, which are dominant in mixed deciduous forest; and sweet gum (*Liquidambar styraciflua*), black gum (*Nyssa sylvatica*), and black willow (*Salix nigra*), which are dominant in bottomland forests (poorly drained bottomland deciduous forest) (UniStar, 2007a). Table 5.3-9 presents information on the relative salt tolerance of several tree and shrub species not addressed in NUREG-1437. The information in Table 5.3-10 is less directly applicable than that in NUREG-1437. It is mostly based on reported tolerance to salt spray generated by vehicles traveling on roadways treated with deicing salt. Deicing salt exposure differs from cooling tower salt deposition in that the former occurs only episodically during the winter, when most deciduous trees are leafless, while the latter occurs more evenly throughout the year. Furthermore, the designations in Table 5.3-9 are based on empirical observations of visible stress along salt-treated roadways and are not tied to quantified salt deposition rates. Nevertheless, the information in Table 5.3-9 provides at least some information on the relative salt tolerance of species in the affected area that can help reduce uncertainty over their expected response to cooling tower drift.

Table 5.3-9 notes several reports of salt tolerance by white oak, although it also notes contrasting reports of salt sensitivity. The information on white oak in Table 5.3-9, combined with the general salt drift tolerance reported in NUREG-1437 for chestnut oak, suggests that areas of mixed deciduous forest (and mixed deciduous regeneration forest) dominated by oaks have a relatively low risk of experiencing substantial injury from the expected cooling tower drift.

No information is available in either NUREG-1437 or Table 5.3-9 on tulip poplar, which is codominant with oaks in the mixed deciduous forest, especially in the eastern part of the CCNPP site where the projected salt drift exposure would occur. The lack of information on tulip poplar may reflect its more southerly range, where use of deicing salt is less frequent. Tulip poplar leaves are broader and less leathery than oak leaves, which might suggest a greater risk of injury. However, the distribution of tulip poplar in the mixed deciduous forest on the CCNPP site tends to favor areas of deeper, richer soils (TTNUS, 2007a). It may therefore be able to better resist environmental stresses caused by salt drift.

Table 5.3-10 and NUREG-1437 suggests that each of the dominant species in poorly drained bottomland deciduous forest (forested wetlands) on the CCNPP site is relatively resistant to salt spray. Red maple is addressed in NUREG-1437, where data suggests that it is tolerant of salt deposition rates more than two orders of magnitude higher than the maximum projected rate for the new cooling tower. Table 5.3-9 notes several reports of salt tolerance for black gum, one report of tolerance for sweet gum, multiple reports of intermediate salt tolerance for black willow. The combined data suggest that there is less risk to wetland forest vegetation than upland forest vegetation. Additionally, the wetland vegetation is less susceptible than upland vegetation to drought, which could act synergistically with the projected low salt deposition levels to injure trees.

5.3.3.2.1.3 Potential Overall Effects on Terrestrial Ecosystems

Because the highest projected salt deposition rate (1.96 lb/acre (2.20 kg/hectare) per month) is below the rates reported in the scientific literature to cause acute injury to woody vegetation, the likelihood of salt drift causing rapid or extensive changes to the general structure and composition of affected vegetation is low. The tree canopy in forested areas is unlikely to die rapidly or extensively. Hence, conversion of forest to scrub-shrub vegetation unsuited to wildlife favoring forested habitat, including FID species, is unlikely. The ability of affected forest vegetation to stabilize soil on steep slopes is unlikely to be impaired.

Occasional trees or shrubs, especially in the area of higher salt deposition (0.3 to 1.96 lb/acre (0.3 to 2.20 kg/hectare) per month), could experience chronic injury such as reduced vigor, reduced growth rate, or slow and gradual die off. The risk is greatest for individuals that are simultaneously of a salt-sensitive species (such as flowering dogwood), old, or subject to localized environmental stresses such as sandy soils subject to greater drought stress. Small gaps in the tree canopy resulting from the death of individual trees would mimic the natural die-off of individual trees in mature forests and not substantially alter the suitability of the forests for most wildlife species. Dead trees would be left in place to provide nesting cavities and snags for wildlife.

The potential for injury to terrestrial vegetation or to terrestrial wildlife inhabiting areas of terrestrial vegetation, as a result of salt drift, is low. Thus, the impacts of salt drift on terrestrial ecology would be small, and would not warrant mitigation.

5.3.3.2.2 Potential Impacts of increased Fogging, Humidity, and Precipitation

The CCNPP site occurs in a naturally humid climate where natural vegetation is already adapted to frequent fog and high humidity, as well as occasional glaze ice (freezing rain) during the winter. As indicated in Section 5.3.3.2, the relative humidity at Patuxent River Naval Air Station, approximately 12 mi (19 km) south of the CCNPP site, was above 75% for nearly 50% of the time from 2001 to 2005, between 50% and 75% for 37% of the time during that period, and less than 50% for only about 15% of the time. Similar relative humidity data was reported for Baltimore Washington International Airport over the same time period. Increases in ground level relative humidity from the operation of the cooling tower would therefore not be substantial. Natural vegetation close to the cooling tower might benefit from the slightly increased humidity during drought periods. During wet periods, the slightly increased humidity might create a more favorable microenvironment for growth of fungal plant pathogens such as the causal agent of dogwood anthracnose. However, the generally humid climate in forest settings around the Chesapeake Bay already provides a favorable environment for fungal plant pathogens, whose distribution is mostly a factor of conveyance by wind, animals, or human-carried nursery stock. The potential impacts from the slight increases in ground level humidity are therefore expected to be small and not require mitigation.

The hybrid cooling tower will not create a visible plume and therefore will not reduce the amount of sun light reaching the ground. Because the water vapor plume is released at a temperature above the dew point. additional precipitation in the form of rain or snow from the cooling tower is not expected. Data and information on similar heat dissipation systems within a 31 mi (50 km) radius or similar climate are available for the Chalk Point coal-fired plant located on the Patuxent River and the Hope Creek Nuclear Plant. The Chalk Point coal-fired plant and Hope Creek Nuclear Plant both use a natural draft cooling tower with salt or brackish water as the makeup water. At these plants, impacts from salt drift have not been observed. These are no large cooling tower systems in the vicinity of the CCNPP site that would create any synergistic effects with the CCNPP Unit 3 CWS cooling towre with respect to drift.

5.3.3.2.3 Potential Impacts from Cooling Tower Noise

Noise caused by human and vehicular activity at the CCNPP Unit 3 could discourage use by terrestrial wildlife of adjoining natural habitats on the CCNPP site. However, noise generated by operation of the cooling tower is unlikely to have deleterious effects on wildlife. Like other mechanical draft cooling towers, the proposed cooling tower would emit broadband noise, which is considered to be largely indistinguishable and nonobtrusive. Wildlife is generally more sensitive to sudden and random noise events, which can induce a startle response similar to that induced by a predator, than to the steady continuous noise produced by operation of a cooling tower (Manci, 1988). Furthermore, the typical noise level expected at a distance of 1,300 ft (396 m) from theCSW cooling tower is 65 dB(A). State of Maryland stipulates noise limits based on the classification of the receiveinq land (55 dBA Ldn for residential land). Ldn is a calculated day-night time average noise level based on an hourly average of the equivalent noise level (Leg) over a 24 hour period. As a rule of thumb for continuously and invariant operatinq noise source, the Ldn value is 6.4 dBA higher than the average Leg value . The Leg noise limit is therefore 55dBA to 6.4 dB or 48.6 dB. Based on distance losses, the 48.6 dBA (Leg) noise limit will be met within a 7,700 ft (2,417 m) radius from the towers. Most of the documented adverse noise-related impacts to mammals, birds, and other terrestrial wildlife are greater than 80 to 90 dB (Manci, 1988). The potential adverse impacts to terrestrial wildlife caused by cooling tower noise are therefore expected to be small and not require mitigation. The noise attributable to the plume-abated cooling tower has been evaluated. (Hessler, 200B).

5.3.3.2.4 Potential Impacts Due to Bird Collisions with Cooling Towers

As summarized in Section 4.3.1, the proposed cooling tower would not be expected to cause substantially elevated bird mortality due to collisions.The CWS cooling tower is a low-profile design, as compared to other cooling tower systems, and, therefore, poses less of a threat to flying birds. Although infrequent bird collisions with the proposed cooling tower are possible, the overall mortality potentially resulting from bird collisions with cooling towers are reported to have only minor impacts on bird species populations (NRC, 1996). The forest interior bird species would not find suitable habitat close to the cooling towers, which would be constructed on a cleared, treeless pad. Lights would be installed on the cooling towers to reduce the probability of collision by eagles or raptors migrating parallel to the western shore of the Chesapeake Bay. No other mitigation appears to be necessary to prevent substantial adverse impacts to bird species populations caused by collisions with the cooling tower.

5.3.3.2.5 References

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5.3.4 IMPACTS TO MEMBERS OF THE PUBLIC

Operation of the CCNPP Unit 3 cooling water systems includes heat transfer to the atmosphere from the cooling towers and the discharge of blowdown to Chesapeake Bay. Potential impacts to the public include the release of thermophilic bacteria from within the towers and noise from tower operation.

5.3.4.1 Thermophilic Microorganism Impacts

Thermophilic organisms are typically associated with fresh water. Health consequences of thermally enhanced microorganisms have been linked to plants that use cooling ponds, lakes, or canals that discharge to small rivers. Elevated temperatures within cooling tower systems are known to promote the growth of thermophilic bacteria including the enteric pathogens *Salmonella* sp. and *Shigella* sp, as well as *Pseudomonas aeruginosa* and fungi. The bacteria *Legionella* sp, and the amoeba *Naegleria and Acanthamoeba* have also been found in these systems. The presence of the amoeba *N. fowleri* in fresh water bodies adjacent to power plants has also been identified as a potential health issue linked to thermal discharges (CDC, 2007) (NRC, 1999).

The Center for Disease Control (CDC) maintains records of outbreaks of waterborne diseases and reported 16 cases of *Legionella* sp.infection in Maryland between 2002 and 2004, all associated with drinking water (CDC, 2006).

Water temperature entering the Circulating Water System (CWS) cooling tower is designed to be approximately 10ºF (5.5ºC) above ambient as discussed in Section 3.4.2 and Section 5.3.3. CWS makeup water withdrawn from Chesapeake Bay for tower makeup at CCNPP Unit 3 will be saline. In the area of the CCNPP site, the Chesapeake Bay is mesohaline; salinities range from 5 to 18 parts per thousand. In addition, biocide treatment of the inlet water should minimize the propagation of micro-organisms. As a result, pathogenic thermophilic organisms are not expected to propagate within the CCNPP Unit 3 condenser cooling tower system and should not create a public health issue.

Normal makeup water for the Essential Service Water System (ESWS) and mechanical draft towers will be supplied by a desalinization plant. The ESWS cooling towers will require approximately ~~1,082~~629 gpm (~~7,124~~2,381 lpm) of makeup water. Of this, approximately ~~540~~61 gpm (~~3,558~~231 lpm) will be used in blowdown. Biocide treatment of the service water system will limit the propagation of thermophilic organisms. Blowdown will combine with the saline discharge from the condenser cooling tower prior to its discharge to the Chesapeake Bay as discussed in Section 3.4.2 and Section 5.2.

Potential health impacts to workers from routine maintenance activities associated with the towers will be controlled through the application of industrial hygiene practices including the use of appropriate personal protective equipment.

It is concluded that the risk to public health from thermophilic microorganisms will be SMALL and will not warrant mitigation, except for the noted biocide treatment of the condenser cooling and service water systems.

5.3.4.2 Noise Impacts

Operation of the CWS cooling towers for CCNPP Unit 3 will generate additional noise.

The Maryland Department of the Environment's noise level standards for a residence are 65 dB(A) during daytime and 55 dB(A) during evening. The State of Maryland's environmental goals are 70 dB(A) for industrial zoned districts (expressed as a 24 hour equivalent sound level), 64 dB(A) and 55 dB(A) for commercial and residential zoned districts (expressed as the 24 hour day-night average sound level with a 10 decibel penalty applied to noise occurring during the nighttime period) (MD, 2007).

The U.S. Environmental Protection Agency (EPA) developed human health noise guidelines to protect against hearing loss and annoyance and established an outdoor activity guideline of 55 dB(A).

To determine ambient noise levels in the vicinity of the CCNPP site, a survey was conducted during the December 2006 leaf-off period at various locations on and adjacent to the CCNPP site, including locations representative of nearby residences. There were no observed audible levels from the operations of CCNPP Units 1 and 2 at any of the sampling stations. The major environmental noise at most sampling stations was attributed to a nearby four-lane highway (Hessler, 2006). The 24 hour average ambient noise levels found during this survey ranged between 65 and 49 dB(A).

As indicated in Section 5.8.1.1, modeled noise contours show that the Maryland Department of the Environment's residence noise standards will be met at the CCNPP site boundary. The modeling accounted for the additional noise generated by cooling tower operations. The varying topographical features of the site, the 2 mi (3.2 km) long frontage along the Chesapeake Bay and the 1,000 ft (305 m) set back of the facility minimize noise transmission. In addition, the plant is located in a rural setting as discussed in Section 2.2.1 and Section 2.5.1 with the nearest residential area in excess of 3,000 ft (914 m) from the CCNPP Unit 3 power block.

Power plants generally do not result in offsite noise levels greater than 10 dB(A) above background and that noise at levels between 60 and 65 dB(A) were generally considered of small significance (NRC, 1999). As a result, the impact of noise generation associated with the operation of cooling towers at CCNPP Unit 3 on members of the public will be SMALL, and will not warrant any mitigation.

5.3.4.3 References

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Table 5.3-1—Species Identified as Having Essential Fish Habitat Requirements in the Chesapeake Bay

Species	Eggs	Larvae	Juveniles	Adults	Spawning Adults
Windowpane Flounder (Scopthalmus aquosus)			X	X	
Bluefish (Pomatomus saltatrix)			X	X	
Atlantic Butterfish (Peprilus triacanthus)	X	X	X	X	
Summer Flounder (Paralicthys dentatus)		X	X	X	
Black Sea Bass (Centropristus striata)			X	X	
King Mackerel (Scomberomorus cavalla)	X	X	X	X	
Spanish Mackerel (Scomberomorus maculatus)	X	X	X	X	
Cobia (Rachycentron canadum)	X	X	X	X	
Red Drum (Sciaenops occelatus)	X	X	X	X	
Red Hake (Urophycis chuss)			X	X	
Scup (Stenotomus chysops)			X	X	
Atlantic Sea Herring (Clupea Harengus)				X	

Table 5.3-2—CORMIX Thermal Plume Simulation Receiving Water Baseline Input Parameters

Input Quantity/Data	Parameter Value
Bathymetry Surrounding Project Site	NOAA Navigational Chart
Minimum Water Surface Elevation at Discharge Location	-10 ft = MSL – 0.6 ft (MLW -3.05 m)
Tidal Excursion	Mean Range = 1 ft (0.305 m) Spring Range = 1.1 ft (0.335 m)
Maximum Ebb and Flow Tidal Velocities	1 ft/s (0.305 m/s)
Receiving Water Temperature(s)	Average annual Temperature 57.5ºF (14.3ºC)
Average Wind Speed	3.28 ft/s (1.00 m/s)
Salinity	13.0%
Receiving Water Density 57.5ºF (14.3ºC), 13.0%	63.004 lb/ft^3 (1009.22 kg/m^3)
MLW – mean low water MSL – mean sea level	

Table 5.3-3—Baseline Discharge Structure Input Data CORMIX Thermal Plume Prediction

Input Quantity/Data	Parameter Value
Location	approximately 150 ft (46 m) north of the existing barge slip~~1,200 ft (366 m) south of the CCNPP Unit 3 intake structure~~
Discharge Water Temperature ΔT	12°F (6.67°C)
Discharge Water Density (69.5°F, 13.0~~%~~‰)	~~21,019 gpm (1.3261 m^3/s)~~62.919 lbm/ft^3 (1007.87 kg/m^3)
Discharge Flow Rate	~~17,633 gpm (1.1125 m^3/s)~~21,019 gpm (1.3261 m^3/s)
Diffuser Type	Multi-port
Number of Discharge Ports	3
Distance of Shore	550 ft (167.6 m)
Orientation	Parallel to Shoreline
Height of Discharge Ports above Bottom	3 ft (0.91 m)
Angle of Inclination	22.5 degrees
Nozzle Diameters	16 in (0.406 m)
Active Diffuser Length	18.75 ft (5.715 m)

Table 5.3-4—CORMIX Thermal Plume Predictions for the 3.6°F (2°C) Isotherm

Plume No.	Description	Length	Width
1	Max. Ebb	148 ft (45 m)	46 ft (14 m)
2	Max. Flood	148 ft (45 m)	46 ft (14 m)
3	Slack	19 ft (6 m)	6 ft (2 m)
4	Mid. Ebb (before and after slack)	72 ft (22 m)	30 ft (9 m)
5	Mid. Flood (before and after slack)	79 ft (24 m)	33 ft (10 m)
Overall	Thermal Plume Envelope	296 ft (126 m)	56 ft (17 m)

Table 5.3-5—Comparison of Predicted Thermal Plume to the Maryland Power Plant Thermal Plume Compliance Criteria

Quality Water Standard	Permissible Limit	Calculated
The 24 hour average of the maximum racial dimension measured fron the point of discharge to the boundary of the full capacity 3.6°F (2°c) above ambient isotherm (measured during the critical period) may not exceed one-half of the average ebb tidal excursion.	4,101 ft (1250 m)	<207 ft (63 m)
The 24 hour average full capacity 3.6°F (2°c) above ambient termal barrier (measured during the ritical period) may not exceed 50% of the accessible cross section of the recieving water body. Both cross sections shall be taken in the same plan.	16,00 ft (4,800 m)	69 ft (21 m)
The 24 hour average area of the bottom touched by water heated 3.6°F (2°c) or more above ambient at the full capacity (measure during the critical point) may not exceed 5% of the bottom beneath the average ebb tidal excursion multiplied by the width of the recieving water body.	1.3E07 ft^2 (1.2E06 m^2)	2.9E04 ft^2 (2.7E03 m^2)

Table 5.3-6—CWS Cooling Tower Design Parameters

Parameter	Value
Number of cooling towers	1
Diameter overall	528 ft (161 m)
Diameter outlet	344 ft (105m)
Height total	164 ft (50 m)
Altitude (above mean sea level)	75 ft (23 m) (74.4 ft NGVD 29)
Design duty	1.1081 E10BTU/hr (3,238 MW) (2.792E09 Kcal/hr)
Maximum drift rate (percentage of circulating water flow rate)	0.0005%
Circulating water flow rate	785,802 gpm (49.6 m^3/sec)
Cooling range	28°F (15.6°C)
Approach	10F (5.6°C)
Entering air wet bulb temperature, summer	80°F (26.6°C)
Entering air wet bulb temperature, winter	23.3°F (-4.85°C)
Entering air dry bulb temperature, summer	98.6°F (37.0°C)
Entering air dry bulb temperature, winter	25°F (-3.9°C)
Air flow rate total	66,454,900 ft^3/min (31,400 m^3/sec)
Air mass flow rate	68,689 lb/sec (31,157 kg/sec)
Cycles of concentration	2
Salt (NaCl) concentration	18,133 mg/L

Table 5.3-7—Maximum Salt Deposition Rate

Maximum on-site deposition	~~0.90~~1.96 lb/acre per month (~~1.01~~2.2 kg/hectare per month)
Directionand location of maximum off-site deposition	South site boundary
Maximum off-site deposition	~~1.96.~~0.71 lbs/acre per month (0.~~0.785~~80 kg/hectare per month)
Maximum deposition at the CCNPP Unit 3 switchyard	~~0.~~1.2 lbs/acre per month (~~0.~~1.~~44~~35 kg/hectare per month)

Table 5.3-8—Salt Drift Deposition Rates Estimated to Cause Acute Injury to Vegetation

Native Plant Species			Reported Deposition Rate Threshold for Acute Injury to Vegetation	
Scientific Name	**Common Name**	**Occurrence on CCNPP Site**	**lb/acre/week (kg/ha/week)**	**lb/acre/week (kg/ha/month)**
Cornus florida	Flowering Dogwood	MDF-Occasional MDRF-Occasional	1.1 (1.2) (MD) 42.2 (47.4) (NY)	4.6 (5.2) (MD) 184.1 (206.7) (NY)
Fraxinus americana	White Ash	None. However, Green Ash (*F. pennsyvanicum*) is occasional in PDBDF and WDBDF.	1.2 (1.3) (MD) 16.8 (18.9) (NY)	5.1 (5.7) (MD) 73.4 (82.4) (NY)
Tsuga canadensis	Eastern Hemlock	None	8.4 (9.4)	36.5 (41.0)
Pinus strobus	White Pine	None. However, Virginia Pine (*P. virginiana*) is dominant in MDRF and SFV and occasional in MDF and OFV; and Loblolly Pine (*P. taeda*) is occasional in OFV, MDF, MDRF, and SFV.	168.9 (189.6)	736.3 (826.7)
Quercus prinus	Chestnut Oak	MDF-Dominant MDRF-Dominant	337.7 (379.2)	1,472.6 (1653.3)
Robinia pseudoacacia	Black Locust	SFV-Dominant OFV-Occasional	337.7 (379.2	1,472.6 (1653.3)
Acer rubrum	Red Maple	PDBDF-Dominant WDBDF-Dominant MDF-Occasional MDRF-Occasional	422.2 (474.0)	1,840.7 (2066.6)
Hammamelis virginiana	Witch Hazel	None	928.8 (1042.8)	4,049.6 (4546.6)

Notes:

L/DA: Lawns/Developed Areas
OFV: Old Field Vegetation
MDF: Mixed Deciduous Forest
MDRF: Mixed Deciduous Regeneration Forest
WDBDF: Well-Drained Bottomland Deciduous Forest
PDBDF: Poorly Drained Bottomland Deciduous Forest
HMV: Herbaceous Marsh Vegetation
SFV: Successional Forest Vegetation

Table 5.3-9—Salt Spray Tolerance Data for Plant Species Observed on the CCNPP Site
(Page 1 of 3)

Scientific Name	Common Name	L/DA	OFV	MD F	MDR F	WD BD F	PD BD F	HM V	Salt Spray Tolerance
Trees									
Acer rubrum	Red Maple			X	X	X	X	X	(NRC, 1996) (NUREG-1437): Tolerant Below 1844 lb/acre/month (2,066 kg/ha/mo) (Dirr, 1976): Poor to Moderate Salt Tolerance (Canada, 2001): Intermediate Tolerance to Tolerance of Salt Spray (Hightshoe, 1988): Sensitive to salt
Ailanthus altissima	Tree of Heaven		X						No data identified regarding salt spray tolerance.
Albizzia julibrissin	Mimosa		X						No data identified regarding salt spray tolerance.
Betula lenta	Black Birch			X	X				(Dirr, 1976): Good salt tolerance (Hightshoe, 1988): Intermediate salt tolerance
Carpinus caroliniana	Ironwood			X	X	X			(Dirr, 1976): Poor salt tolerance
Carya cordiformis	Bitternut Hickory			X					(Dirr, 1976): Poor salt tolerance for Genus *Carya*. Hightshoe, 1988): Sensitive to salt
Carya glabra	Pignut Hickory			X	X				(Dirr, 1976): Poor salt tolerance for Genus *Carya*. Hightshoe, 1988): Sensitive to salt
Cornus florida	Flowering Dogwood			X	X				(NRC, 1996) (NUREG-1437): Tolerant Below 4.6 lb/acre/month (5.2 kg/ha/mo)
Fagus grandifolia	American Beech			X	X	X			(Dirr, 1976): Poor to Moderate Salt Tolerance (Canada, 2001): Sensitive to Salt Spray (Hightshoe, 1988): Sensitive to salt
Fraxinus pennsylvanicus	Green Ash					X	X		(Dirr, 1976): Moderate to Good Salt Tolerance (Appleton, 2003): Tolerant of Salt Spray (Hightshoe, 1988): Intermediate salt tolerance
Ilex opaca	American Holly			X	X	X			(Dirr, 1976): Good salt tolerance (Appleton, 2003): Tolerant of Salt Spray
Juniperus virginiana	Eastern Redcedar		X						(Dirr, 1976): Moderate to Good Salt Tolerance (Appleton, 2003): Tolerant of Salt Spray (Hightshoe, 1988): Resistant to salt
Liquidambar styraciflua	Sweet Gum		X	X	X	X	X	X	(Appleton, 2003): Tolerant of Salt Spray
Liriodendron tulipifera	Tulip Poplar			X	X	X			(Dirr, 1976): Poor salt tolerance
Magnolia virginiana	Sweetbay						X		No data identified regarding salt spray tolerance.
Nyssa sylvatica	Black Gum			X	X	X	X	X	(Dirr, 1976): Good salt tolerance (Appleton, 2003): Tolerant of Salt Spray (Hightshoe, 1988): Resistant to salt
Paulownia tomentosa	Paulownia		X						No data identified regarding salt spray tolerance.
Pinus taeda	Loblolly Pine		X	X	X				No data identified regarding salt spray tolerance.
Pinus virginiana	Virginia Pine		X	X	X				No data identified regarding salt spray tolerance.

Table 5.3-9—Salt Spray Tolerance Data for Plant Species Observed on the CCNPP Site
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Scientific Name	Common Name	L/DA	OFV	MD F	MDR F	WD BD F	PD BD F	HM V	Salt Spray Tolerance
Platanus occidentalis	American Sycamore					X	X		No data identified regarding salt spray tolerance.
Prunus serotina	Black Cherry		X	X	X				(Appleton, 2003): Tolerant of Salt Spray (Hightshoe, 1988): Resistant to salt
Quercus alba	White Oak			X	X	X			(Dirr, 1976): Mostly good salt tolerance, one report of poor tolerance (Canada, 2001): Sensitive to Intermediate Tolerance to Salt Spray (Hightshoe, 1988): Resistant to salt
Quercus coccinea	Scarlet Oak			X	X				No data identified regarding salt spray tolerance.
Quercus falcata	Southern Red Oak			X	X				No data identified regarding salt spray tolerance.
Quercus michauxii	Swamp Chestnut Oak					X			No data identified regarding salt spray tolerance.
Quercus palustris	Pin Oak					X	X		(Canada, 2001): Sensitive to Intermediate Tolerance to Salt Spray
Quercus prinus	Chestnut Oak			X	X				(NRC, 1996) (NUREG-1437): Tolerant Below 1,475 lb/acre/mo (1,653 kg/ha/mo)
Quercus shumardii	Shumard's Oak					X			No data identified regarding salt spray tolerance.
Quercus stellata	Post Oak		X						No data identified regarding salt spray tolerance.
Quercus velutina	Black Oak			X	X				(Canada, 2001): Sensitive to Intermediate Tolerance to Salt Spray
Robinia pseudoacacia	Black Locust		X						(NRC, 1996) (NUREG-1437): Tolerant Below 1,464 lb/acre/month (1,653 kg/ha/mo) (Dirr, 1976): Good salt tolerance (Hightshoe, 1988): Resistant to salt
Salix nigra	Black Willow		X				X	X	(Dirr, 1976): Moderate salt tolerance (Canada, 2001): Intermediate Tolerance to Tolerance of Salt Spray (Hightshoe, 1988): Intermediate salt tolerance
Sassafras albidum	Sassafras		X	X	X	X			No data identified regarding salt spray tolerance.
Ulmus rubra	Slippery Elm					X	X		No data identified regarding salt spray tolerance.
Shrubs									
Alnus serrulata	Common Alder						X	X	(Hightshoe, 1988): Sensitive to salt
Amalanchier sp.	Shadbush			X		X	X		No data identified regarding salt spray tolerance.
Aralia spinosa	Hercules Club		X						No data identified regarding salt spray tolerance.
Asimina trilobata	Pawpaw			X	X	X			No data identified regarding salt spray tolerance.
Baccharis halimifolia	Groundsel Tree		X						(Hightshoe, 1988): Resistant to salt
Castanea dentata	American Chestnut			X					No data identified regarding salt spray tolerance.
Gaylussacia baccata	Black Huckleberry			X	X				No data identified regarding salt spray tolerance.

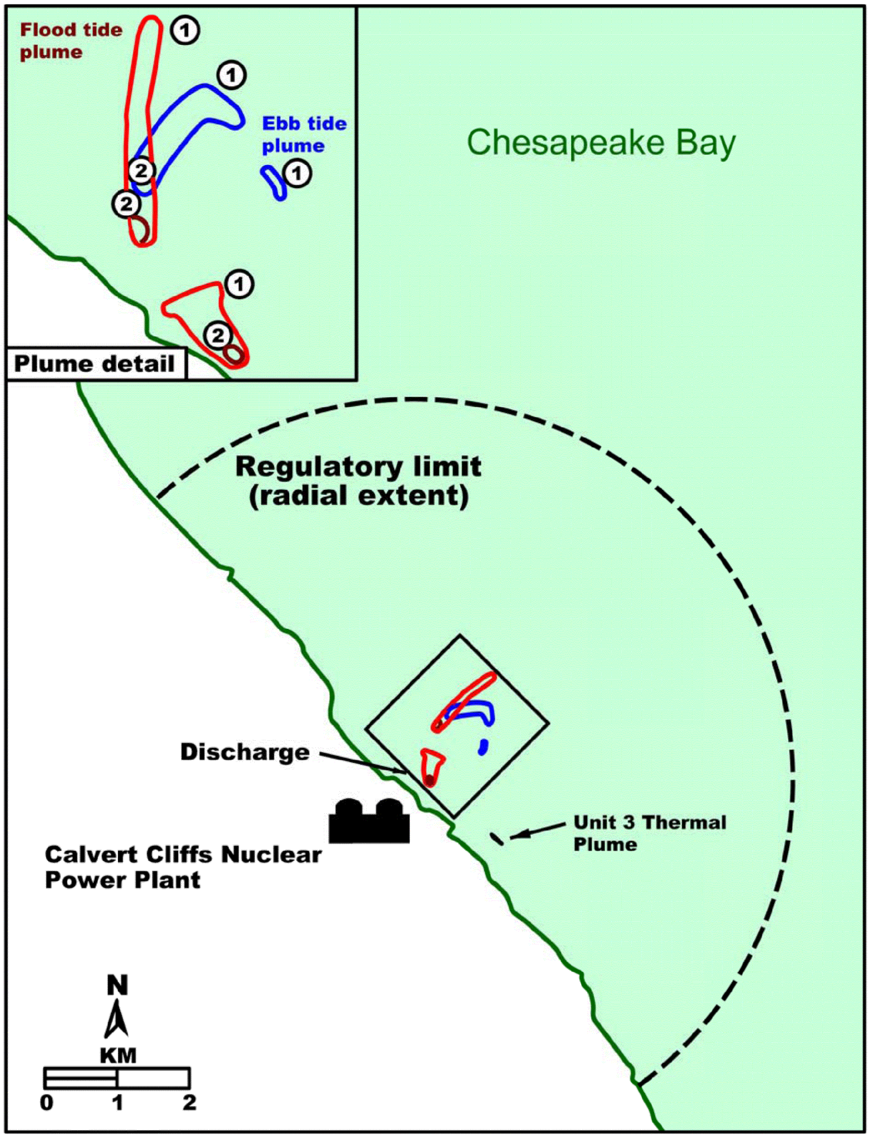
Table 5.3-9—Salt Spray Tolerance Data for Plant Species Observed on the CCNPP Site
(Page 3 of 3)

Scientific Name	Common Name	L/DA	OFV	MDF	MDRF	WDBDF	PDBDF	HMV	Salt Spray Tolerance
Kalmia latifolia	Mountain Laurel			X	X	X			(Hightshoe, 1988): Intermediate salt tolerance
Lindera benzoin	Spicebush			X					(Hightshoe, 1988): Resistant to salt
Lonicera sp.	Bush Honeysuckle		X						No data identified regarding salt spray tolerance.
Lyonia mariana	Staggerbush			X					No data identified regarding salt spray tolerance.
Myrica cerifera	Wax Myrtle		X						(Appleton, 2003): Tolerant of Salt Spray
Rhododendron sp.	White Azalea			X					No data identified regarding salt spray tolerance.
Rosa multiflora	Multiflora Rose		X						No data identified regarding salt spray tolerance.
Vaccinium corymbosum	Highbush Blueberry					X	X		(Hightshoe, 1988): Resistant to salt
Viburnum dentatum	Arrowwood			X		X	X		(Dirr, 1976): Poor salt tolerance for Genus *Viburnum*. (Appleton, 2003): Tolerant of Salt Spray
Viburnum nudum	Possum Haw						X	X	(Dirr, 1976): Poor salt tolerance for Genus *Viburnum*.

Notes:

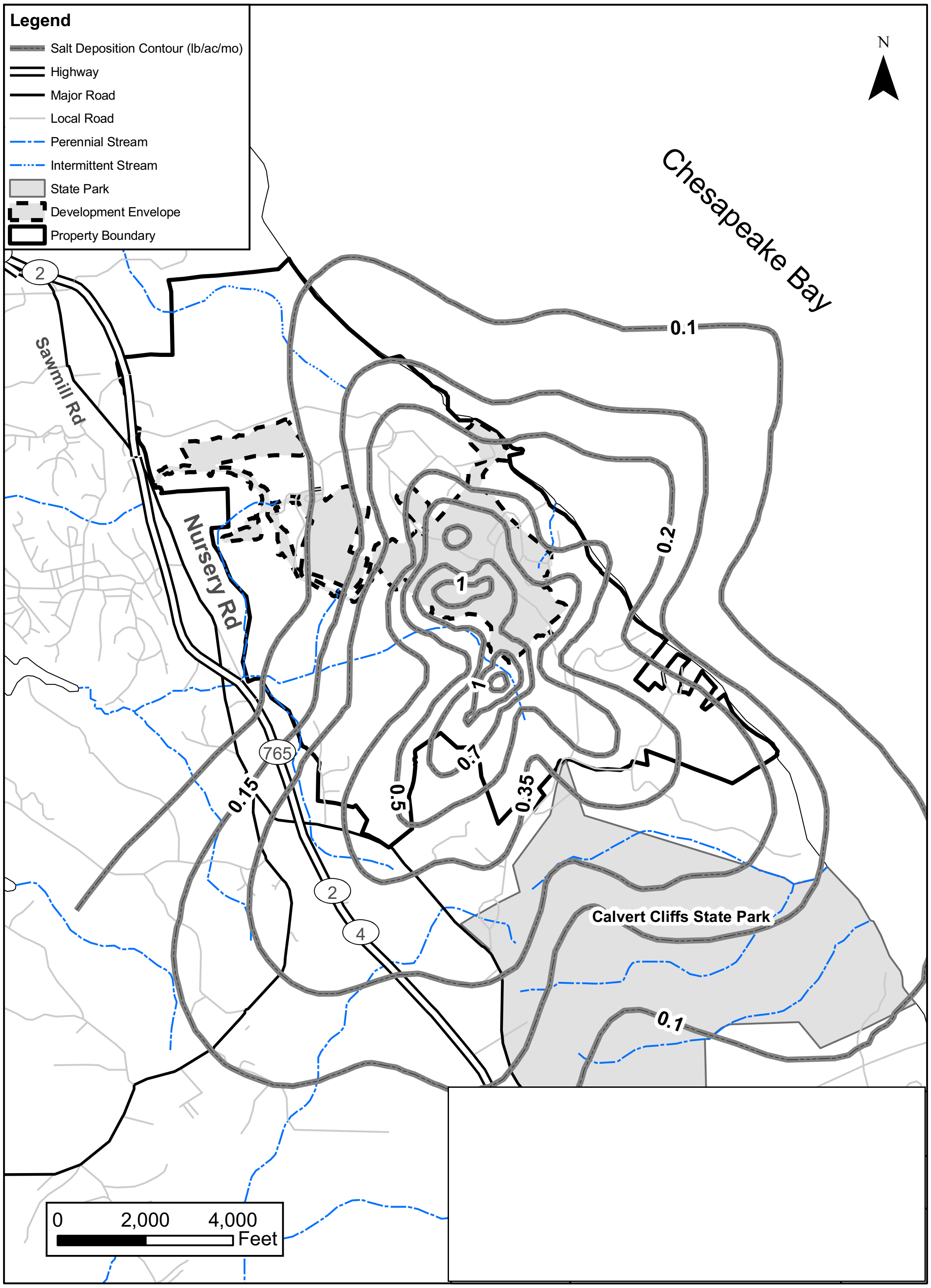
L/DA: Lawns/Developed Areas
OFV: Old Field Vegetation
MDF: Mixed Deciduous Forest
MDRF: Mixed Deciduous Regeneration Forest
WDBDF: Well-Drained Bottomland Deciduous Forest
PDBDF: Poorly Drained Bottomland Deciduous Forest
HMV: Herbaceous Marsh Vegetation

Figure 5.3-1—CCNPP Unit 3 Thermal Plume Predictions



Note:
This figure shows the Unit 3 Thermal Plume Predictions Compared to CCNPP Units 1 and 2 Historical Predictions: The CCNPP Units 1 and 2 plume is shown in the box insert. The CCNPP Unit 3 predicted plume is shown South of the plant.

Figure 5.3-2—Highest Salt Deposition Rate (~~lnlac/mo~~lbs/ac/mo) - Calvert Cliffs Nuclear Power Plant



5.4 RADIOLOGICAL IMPACTS OF NORMAL OPERATIONS

The radioactive waste management systems, as discussed in Section 3.5, are designed such that the radiological impacts due to the normal operational releases from CCNPP Unit 3 are within guidelines established in Appendix I to 10 CFR 50. This section evaluates the impacts of radioactive effluents on human beings and other biota inhabiting the general vicinity of the CCNPP site resulting from expected routine operations. Primary exposure pathways to man are examined and evaluated according to the mathematical model described in Regulatory Guide 1.109 (NRC, 1977a). The resulting radiological impacts for CCNPP Unit 3 are compared to regulatory limits for a single unit.

In addition, the radiological impact of CCNPP Unit 3 in conjunction with CCNPP Units 1 and 2, including direct radiation, is compared to the corresponding regulatory limits under 40 CFR 190.

As part of a radioactive waste system's cost benefit analysis, the dose impact to the general population within 50 mi (80 km) radius from routine operations of CCNPP Unit 3 is also assessed.

Finally, consideration of the dose impact to biota other than man that appear along the exposure pathways or that are on endangered species lists is presented.

5.4.1 EXPOSURE PATHWAYS

Routine radiological effluent releases from CCNPP Unit 3 are a potential source of radiation exposure to both humans and biota other than man. The major pathways are those that could lead to the highest potential radiological dose to humans and biota. These pathways are determined from the amount and isotopic distribution of activity released in liquids and gases, the environmental transport mechanism, and how the CCNPP site environs are utilized (e.g., location of site boundary, residences, gardens, beaches, etc.) and the consumption or usage factors applied to exposed individuals. The environmental transport mechanism includes the CCNPP site-specific meteorological dispersion of airborne effluents and aquatic dispersion in the Chesapeake Bay of liquid releases. This information is used to evaluate how the radionuclides will be distributed within the surrounding area.

The potential exposure pathways are impacted by both aquatic (liquid) and gaseous effluents. The radioactive liquid effluent exposure pathways include internal exposure due to ingestion of aquatic foods (fish and invertebrates), external exposure due to recreational activities on the shoreline and in the water (swimming and boating). Since the liquid effluents are discharged directly to the brackish waters of the Chesapeake Bay, liquid pathways for drinking water and irrigation are not generally considered significant in the analysis. The potential for desalinization of Chesapeake Bay water for potable water use onsite and by ships using the bay have been included in the pathway dose assessment.

The radioactive gaseous effluent exposure pathways include external exposure due to immersion in airborne effluent and exposure to a deposited material on the ground plane. Internal exposures are due to ingestion of food products grown in areas under influence of atmospheric releases, and inhalation.

An additional exposure pathway considered is the direct radiation from the facility structures during normal operation of CCNPP Unit 3.

The description of the exposure pathways and the calculation methods utilized to estimate doses to the maximally exposed individual and to the population surrounding the CCNPP site are based on Regulatory Guide 1.109 (NRC 1977a) and Regulatory Guide 1.111 (NRC 1977b). The source terms used in estimating exposure pathway doses are based on the projected normal effluent values provided in Section 3.5. The source term for both liquids and gases are calculated using the Nuclear Regulatory Commission GALE code for PWRs (NRC, 1985).

5.4.1.1 Liquid Pathways

Treated liquid radwaste effluent is released to the Chesapeake Bay at a flow rate of 1 gpm (4 lpm) via the CCNPP Unit 3 discharge line situated downstream of the waste water retention basin. The average discharge flow rate from the retention basin for waste water streams other than treated liquid radwaste, is approximately 19,425 gpm (73,531 lpm), resulting in a total average flow of 19,426 gpm (73,535 lpm) for all liquid effluents discharged to the bay. Retention basin flow provides dilution flow to discharged treated liquid radwaste. As shown in Table 5.4-22, a near-field dilution factor of 13.3 (a mixing ration of 0.075) was utilized for calculating the maximum individual dose to man for exposures associated with fish and invertebrate ingestion and boating pathways. For swimming and shoreline exposure pathways, an environmental dilution factor of 69 (a mixing ration of 0.014) was applied for the nearest shore with the minimum tidal average mixing. These dilution factors are based on a submerged, multi-port diffuser (with three nozzles), a discharge line situated approximately 550 ft (168 m) off the near shoreline with the nozzles directed out into the Chesapeake Bay and into the overhead water column. Table 5.4-23 provides far-field dilution factors.

The physical description of the cooling water discharge system is provided in Section 3.4. Dilution effects for both near-field and far-field mixing are described in Section 5.3. Table 5.4-31 and Table 5.4-32 provide information on fisheries and major catch locations within 50 mi (80 km) of the CCNPP site. For conservatism, no credit is taken for radioactive decay in the environment during transit time from the release point to the receptors in unrestricted area.

The ability of suspended and bottom sediments to absorb and adsorb radioactive nuclides from solution is recognized as contributing to important pathways to man through the sediment's ability to concentrate otherwise dilute species of ions. The pathways of importance in the site area are by direct contact with the populace such as those persons engaged in shoreline activities, and by transfer to aquatic food chains. Direct ingestion of suspended sediments in water is not considered since the effluent discharge is to a saltwater environment which is not used for irrigation of farm fields.

The potential use of the Chesapeake Bay as a source of plant makeup water, including use as a potable water source onsite, has been considered in assessing the possible dose impact from liquid effluents. A desalinization plant using filtration and reverse osmosis (RO) treatment is the selected option for providing purified water to CCNPP Unit 3. As such, the impact from recirculating radioactive effluents discharged from the plant back to the shoreline cooling water intakes could result in internal exposures from drinking water created by this treatment of Chesapeake Bay water. In addition, ships that use the Chesapeake Bay may also purify sea water for drinking water uses. The dose potential to ship borne users has also been evaluated.

The models used to determine the concentration of radioactivity in sediments and aquatic foods for the purpose of estimating doses were taken from Regulatory Guide 1.109, Appendix A (NRC, 1977a). The concentration of radioactivity in the sediment is assumed to be dependent upon the concentration of activity in the water column plus a transfer constant from water to sediment.

The LADTAP II computer program (NRC, 1986) was used to calculate the doses to the maximum exposed individual (MEI), population groups, and biota other than humans. This program implements the radiological exposure models described in Regulatory Guide 1.109 (NRC, 1977a) for radioactivity releases in liquid effluent. The following exposure pathways are considered in the LADTAP II model for the CCNPP site:

- Ingestion of aquatic foods (fish and invertebrates)
- External exposure to shoreline sediments
- External exposure to water through boating and swimming
- Potable water (via desalinization treatment)

Due to the brackish nature of Chesapeake Bay, water withdrawal for irrigation was not considered as significant pathways. The input parameters for the liquid pathway are presented in Table 5.4-1 and Table 5.4-2 in addition to default maximum individual food consumption factors from Regulatory Guide 1.109 (Table E-5), (NRC, 1977a).

5.4.1.2 Gaseous Pathways

The GASPAR II computer program (NRC, 1987) was used to calculate the doses to the maximum exposed individual (MEI), population groups, and biota. This program implements the radiological exposure models described in Regulatory Guide 1.109 (NRC 1977a) to estimate the radioactivity released in gaseous effluent and the subsequent doses. The following exposure pathways are considered in the GASPAR II model for the CCNPP site:

- External exposure to airborne plume
- External exposure to deposited radioactivity on the ground plane
- Inhalation of airborne radioactivity
- Ingestion of agricultural products impacted by atmospheric deposition

The gaseous effluent is transported and diluted in a manner determined by the prevailing meteorological conditions. Section 2.7 discusses the meteorological modeling which has been used for all dose estimates, including estimated dispersion values for the 50 mi (80 km) radius of the CCNPP site. Dilution factors due to atmospheric dispersion are deduced from historical onsite meteorological data and summarized for the maximum exposed individual in Table 5.4-3. The gaseous source term for CCNPP Unit 3 is expected routine operations provided in Section 3.5. The CCNPP Unit 3 stack is located adjacent to the reactor building and qualifies as a mixed mode release point. All ventilation air from areas of significant potential contamination, along with waste gas processing effluents, is released through the plant stack.

The input parameters for the gaseous pathway are presented in Table 5.4-4 and Table 5.4-5, and the receptor locations are shown in Table 5.4-6 (ORNL, 1983) (NOAA, 2002).

5.4.1.3 Direct Radiation From Station Operations

The U.S. EPR design contains all radioactive sources and systems, including tanks, inside shielded structures such that the radiation levels at the outside surface of the building was not expected to require any radiation protection monitoring for general occupancy beyond the immediate area of the buildings. The nearest shoreline on the Chesapeake Bay (over 1000 ft (305 m) northeast of the CCNPP Unit 3 power block) falls within the control area of the CCNPP site property, thereby limiting access by the general public. For this direction, there are three buildings that could contribute to the dose at the shoreline: the Fuel Building; the Nuclear Auxiliary Building; and the Radioactive Waste Processing Building. The shielding design for these buildings limit the projected annual dose at the shoreline to not more than 2.41 μSv/yr (0.241 mrem/yr), assuming an occupancy time from Regulatory Guide 1.109 (NRC 1977a) of 67 hrs/year for a maximum exposed individual. With respect to the CCNPP site boundary bordered by land, the Fuel Building is the only structure which contains significant radiation sources that could contribute to direct dose at the boundary line. This is due to the shielding effect of other plant structures that are situated between buildings with radiation sources and the CCNPP site boundary line. The exterior walls of the Fuel Building provide sufficient shielding to limit the exterior dose rate to 2.5 μSv/hr (0.25 mrem/hr) at 1 ft (30 cm) from the exterior walls. The projected direct annual dose at the CCNPP site boundary (approximately 6,000 ft (1,829 m) southeast) from CCNPP Unit 3 would not exceed 1.11E-04 μSv/yr (1.11E-05 mrem/yr) for uninterrupted occupancy over the year.

The primary fixed source of direct radiation associated with CCNPP Units 1 and 2 is the Independent Spent Fuel Storage Installation (ISFSI), the resin storage building, and large component (steam generators) storage area located approximately 2000 ft (610 m) from the center of the CCNPP Unit 3 Reactor Building. Radiological impacts to construction workers at CCNPP Unit 3 from the operation of CCNPP Units 1 and 2 are discussed in Section 4.5, including dose rate projections for direct sources associated with CCNPP Units 1 and 2.

Implementation of a radiation environmental monitoring program for the new facility, compliance with requirements for maintaining dose ALARA, and attention to design of plant shielding to ensure dose is ALARA, will result in doses to the public and to construction workers due to direct radiation being minimal.

5.4.2 RADIATION DOSES TO MEMBERS OF THE PUBLIC

For members of the public, doses to MEIs from liquid and gaseous effluents from routine operation of CCNPP Unit 3 are estimated using the methodologies and parameters specified in Section 5.4.1. Additionally, the collective occupational doses to plant workers at CCNPP Unit 3 during normal operations and the performance of in-service inspections and maintenance activities is expected to be less than 0.5 person-Sv/yr (50 person-Rem/yr) for the U.S. EPR design.

5.4.2.1 Liquid Pathway Doses

CCNPP Unit 3 liquid radioactive effluent is periodically mixed with the cooling tower blowdown discharge downstream of the cooling tower blowdown retention basin. As discussed in Section 3.4.2 and Section 5.3.2, discharge from CCNPP Unit 3 is not combined with the discharge from CCNPP Units 1 and 2, but has its own discharge line approximately several hundred yards south of the CCNPP Units 1 and 2 outfall in the Chesapeake Bay.

Mixing of the diluted radioactive effluent with the Chesapeake Bay water provides for both near and far field mixing zones as described in Section 5.3.2. The isotopic releases in the liquid effluent and the concentration at the point of discharge to the environment are given in Section 3.5.

Maximum dose rate estimates to man due to liquid effluent releases were determined for the following activities:

- Eating fish or invertebrates caught near the point of discharge;
- Swimming and using the shoreline for recreational activities at the nearest shoreline of maximum impact;
- Boating on the Chesapeake Bay near the point of discharge; and
- Potable water (via desalinization treatment)

The estimates for whole-body and critical organ doses from each of these interactions are presented in Table 5.4-7 and Table 5.4-8. These doses are within the limits given in 10 CFR 50, Appendix I, and would only occur under conditions that maximize the resultant dose. It is unlikely that any individual would receive doses of the magnitude calculated because of little or no shoreline activities at the CCNPP site. Table 5.4-9 summarizes the annual liquid dose impact to the maximum exposed individual compared to the dose objectives of 10 CFR 50, Appendix I (CFR, 2007a).

5.4.2.2 Gaseous Pathway Doses

Dose rates for the maximum exposed individual via the gaseous pathways are evaluated based on the models and dose factors given in Regulatory Guide 1.109, Appendices B and C (NRC, 1977a), and according to site area land use information listed in Table 5.4-6.

Three locations for maximum radiological impact are specified, as shown in Table 5.4-3, according to the dose pathway being evaluated: the site boundary, nearest garden, and the nearest meat cow. The CCNPP annual land use census indicates that there are no milk animal locations within 5 mi (8 km) of the CCNPP site. Only sectors where populations or gardens would be expected are evaluated, therefore, sectors extending into Chesapeake Bay are not considered. The locations for the CCNPP site boundary and vegetable gardens selected for analysis correspond to the respective locations with the most limiting atmospheric dispersion and deposition factors, not necessarily the location of the site boundary or garden closest to the reactor centerline. It is conservatively assumed that meat animals exist at the CCNPP site boundary with the most limiting dispersion characteristics.

5.4.3 IMPACTS TO MEMBERS OF THE PUBLIC

Appendix I to 10 CFR Part 50 (CFR, 2007a) provides design objectives on the levels of exposure to the general public from routine effluent releases that may be considered to be "as low as reasonably achievable" (ALARA). The estimated doses to individuals in the general public in the site vicinity, for the pathways described in Section 5.4.2.1 and Section 5.4.2.2, demonstrate that the proposed plant design is capable of keeping radiation exposures consistent with the ALARA objectives. In addition to the ALARA dose objectives for individuals, 10 CFR 50 Appendix I also requires that an evaluation of alternate radwaste system designs be made to determine the most cost-benefit effective system to keep total radiation exposures to the public as low as reasonably achievable. This cost-benefit evaluation, comparing costs of alternate radwaste systems against their ability to reduce the population doses from plant effluents, is discussed in Section 3.5.2.3 for liquid waste systems process options, and Section

3.5.3.3 for the gaseous waste system alternative design. The cost-benefit ratios for the alternative radwaste augments investigated indicate that no alternate system to the present plant design can be justified on a cost effective basis.

For gaseous effluent ingestion pathways of exposure, the production of milk, meat and vegetables grown within 50 mi (80 km) has been included in the estimation of dose along with plume, ground plane exposures and inhalation. For liquid pathways, the population that can be supported by the recorded harvest of fish and shellfish (invertebrates) within 50 mi (80 km), along with estimated recreational uses of beaches and boating activities, are factored into the aquatic pathway population dose impact assessment.

The population dose assessments which were used in the cost-benefit analysis are based on the models and dose factors given in Regulatory Guide 1.109 (NRC, 1977a). The population which is projected to be contained within 50 mi (80 km) of the site for in the year 2080 has been used for calculating annual population doses for the gaseous releases.

In addition to the CCNPP Unit 3 dose impacts assessed for the maximum exposed individual and general population, the combined historical dose impacts of CCNPP Units 1 and 2 are added to the CCNPP Unit 3 projected impacts to compare to the uranium fuel cycle dose standard of 40 CFR 190 (CFR, 2007b). Since there are no other fuel cycle facilities within 5 mi (8.0 km) of the CCNPP site, the combined impacts for three units can be used to determine the total impact from liquid and gaseous effluents along with direct radiation from fixed radiation sources onsite to determine compliance with the dose limits of the standard (25 mrem/yr (0.25 Sv/yr) whole body, 75 mrem/yr (0.75 Sv/yr) thyroid, and 25 mrem/yr (0.25 Sv/yr) for any other organ). Table 5.4-14 illustrates the impact from CCNPP Units 1 and 2 over the recent six year historical period. Using the highest observed annual dose impact from CCNPP Units 1 and 2, Table 5.4-15 shows the combined impact along with the projected contributions from CCNPP Unit 3.

5.4.3.1 Impacts From Liquid Pathways

Release of radioactive materials in liquid effluents to the discharge flow, from where they mix with the Chesapeake Bay waters, results in minimal radiological exposure to individuals and the general public. Due to the brackish nature of the Chesapeake Bay, water irrigation of farm fields is not assumed for the pathway assessments around the CCNPP site.

With respect to drinking water, the dose impact associated with the use of an onsite desalinization plant to create plant makeup and potable water has been estimated for the CCNPP Unit 3 site staff. The desalinization plant would use the cooling water intake for CCNPP Unit 3 which is located on the shoreline approximately 1,200 ft (3,937 m) north of the offshore CCNPP Unit 3 discharge. The estimated tidal average dilution value between the discharge and the intake point is over 100 to 1. In addition, the RO membranes of the desalinization plant are expected to provide a decontamination factor for the permeate of at least 10 to 1 for all radionuclides (except tritium which is taken as 1). Assuming that onsite personnel would drink at least 730 liters/year, the maximum potential potable water whole body dose would be 2.07E-02 mrem/yr (2.07E-01µSv/yr), with a critical organ dose to the thyroid of 2.24E-02 mrem/yr (2.24E-01 µSv/yr). As part of the onsite work force, these individuals are not considered members of the public under the dose objectives of Appendix I to 10 CFR Part 50, but are limited per the dose requirements of 10 CFR Part 20.1301.

For members of the public under Appendix I to 10 CFR 50 (CFR, 2007a) who may be associated with ships in the Chesapeake Bay that use desalinization of sea water to create drinking water, a conservative discharge dilution factor of 365 to 1 was applied to the annual consumption quantities for four ages groups (730, 510, 510 and 330 liters/year for adults, teens, children and infants, respectively). The maximum offsite potable water whole body dose is 7.56E-03 mrem/yr (7.56E-02 µSv/yr) to a child, with the critical organ dose occurring to an infant's thyroid of 8.94E-03 mrem/yr (8.94E-02 µSv/yr). These dose impacts are a small fraction of the dose limits of 10 CFR 50, Appendix I.

The environmental impacts of utilizing a desalinization plant includes disposal of the brine extracted from the Chesapeake Bay water. A desalinization plant can take up to 50% of the water out of the supply, leaving a salt (radioactivity) concentration of 2 to 1 above normal Chesapeake Bay levels taken in at the circulating water intake. The desalinization reject stream is mixed with and diluted by the cooling water system blow down in the retention basin and released back to the Chesapeake Bay. Based on the diluted (100 to 1) inlet stream feeding the RO unit, the discharge stream back to the Chesapeake Bay from the retention would be a small fraction of the original effluent concentration released via this pathway.

The CCNPP Unit 3 annual radiation exposures to the maximum exposed individual via the pathways of aquatic foods and shoreline deposits, are provided in Table 5.4-7 for total body dose to four ages groups (Adult, Teen, Child, Infant) from each dose pathway of exposure, and Table 5.4-8 for the limiting organ dose for each pathway and age group. Table 5.4-9 summarizes the liquid effluent dose to the MEI. Population dose impacts within a 50 mi (80 km) radius of the CCNPP site are listed in Table 5.4-10.

For the cost-benefit assessment of liquid radwaste equipment options, the annual release source terms produced with and without demineralizer processing of evaporator and centrifuge treated liquid waste streams are listed in Section 3.5.2.3. The cost-benefit population dose assessment evaluated the "unadjusted" releases from the two waste processing options in order to assess the relative difference between the two cases of processing with and without a waste demineralizer. However, total expected annual radioactivity release used to determine the expected liquid population dose in Table 5.4-10 includes an adjustment to account for the potential anticipated operational occurrences that add to the expected treated discharge stream. This adjustment factor adds 0.16 curies per year to the normal effluent. The liquid effluent population doses provided in Section 3.5.2.3 uses the unadjusted releases so as not to be dominated by the adjustment factor which is not impacted by any treatment option.

As can be seen from Table 5.4-9, the maximum exposed individual annual doses from the discharge of radioactive materials in liquid effluents projected from Unit 3 meets the design objectives of Appendix I to 10 CFR Part 50. In addition, Section 3.5 shows that the effluent concentration being discharged to the Chesapeake Bay also meets the effluent release standards of 10 CFR Part 20, (Appendix B, Table 2, Column 2). The maximally exposed individual dose calculated from liquids was also included in the CCNPP site assessment of 40 CFR 190 criteria as shown in Table 5.4-15.

Based on this, the release of radioactive materials in liquid effluents results in minimal radiological exposure to individuals and the general public. As such, the impacts would be SMALL and do not warrant mitigation.

5.4.3.2 Impacts From Gaseous Pathways

The release of radioactive materials in gaseous effluents from CCNPP Unit 3 to the environment results in minimal radiological impacts. Annual radiation exposures to the maximum exposed individual near the CCNPP site via the pathways of submersion, ground contamination, inhalation and ingestion are provided in Table 5.4-11 for the four age groups of interest.

Table 5.4-12 provides a summary of the dose to the MEI compared to the dose limits of 10 CFR 50, Appendix I. Table 5.4-12 indicates that the critical organ dose to the MEI is 5.54 µSv/yr (0.554 mrem/yr) to a child's bone via the identified exposure pathways in the CCNPP site vicinity. All projected dose impacts are well within the design objects of Appendix I. If a hypothetical individual is postulated to be exposed to all potential pathways (ground plane, inhalation, vegetable gardens, goat's milk and meat) at the same limiting CCNPP site boundary location, the maximum critical organ (child bone) dose increases to 14.3 µSv/yr (1.43 mrem/yr) which is still below the dose objective of 10 CFR 50, Appendix I, Section II.C (CFR, 2007a).

Population dose impacts within a 50 mi (80 km) radius of the CCNPP site from atmospheric releases from CCNPP Unit 3 are listed in Table 5.4-13. Annual production rates of milk, meat, and vegetables for the 50 mi (80 km) radius are provided in Tables 5.4-24 through 5.4-30. For the cost-benefit assessment of gaseous radwaste equipment options, the annual release source terms produced by processing the waste purge gas through the base configuration of three charcoal delay beds, as well as the effect of adding a fourth delay bed in series, are provided in Section 3.5.3.3. The estimated holdup times for decay before release are also provided along with the estimated reduction in the population dose afforded by the treatment option.

The estimated population distribution in the year 2080 within a 50 mi (80 km) radius of the CCNPP site is given in Section 2.5.1. The total effective dose equivalent to individuals living in the U.S. from all sources of natural background radiation averages about 3 mSv/yr (300 mrem/yr) (NCRP, 1987). Therefore, the 50 mi (80 km) population (8,124,000) in year 2080 projected in the CCNPP site area will receive a collective population dose of 24,000 person-Sv/yr (2.4E+07 person-rem/yr) from natural background radiation.

Since the guidelines of Appendix I to 10 CFR Part 50 for maximum individual exposures via atmospheric pathways are much more restrictive (by a factor of 100) than the standards of 10 CFR Part 20, it can be inferred that radioactive releases via gaseous effluents from CCNPP Unit 3 meet the standards for concentrations of released radioactive materials in air (at the locations of maximum annual dose to an individual and hence, at all locations accessible to the general public), as specified in Column 1 of Table 2 of 10 CFR Part 20.

In addition, the maximally exposed individual dose calculated was also compared to 40 CFR 190 (CFR, 2007b) criteria as shown in Table 5.4-15.

Based on this, the release of radioactive materials in gaseous effluents from CCNPP Unit 3 to the environment results in SMALL radiological impacts and do not warrant mitigation.

5.4.3.3 Direct Radiation Doses

Direct radiation doses are discussed in Section 5.4.1.3. Table 5.4-15 includes a projected direct dose (assuming time occupancy) to the nearest land bordered site boundary from CCNPP Unit 3 as part of the CCNPP site dose assessment for compliance with the uranium fuel cycle dose standard of 40 CFR 190.

Based on these projections, direct radiation doses from CCNPP Unit 3 to the environment results in SMALL radiological impacts and do not warrant mitigation.

5.4.4 IMPACTS TO BIOTA OTHER THAN MEMBERS OF THE PUBLIC

Environmental exposure pathways in which biota other than humans could be impacted by plant radiological effluents were examined to determine if doses to biota could be significantly greater than those predicted for humans. This assessment was based on the use of surrogate species that provide representative information on the various dose pathways potentially affecting broader classes of living organisms. Surrogates are used since important attributes are well defined and are accepted as a method for judging doses to biota.

Site specific important biological species include any endangered, threatened, commercial, recreationally valuable, or important to the local ecosystem. Section 2.4 identifies important biota for the CCNPP site. Surrogate biota used includes algae (surrogate for aquatic plants), invertebrates (surrogate for fresh water mollusks and crayfish), fish, muskrat, raccoon, duck, and heron. Table 5.4-21 identifies the important species near the CCNPP site and the assigned surrogate species employed in the assessment of radiation doses.

This assessment uses dose pathway models adopted from Regulatory Guide 1.109 (NRC 1977a). Exposure pathways are outlined in Table 5.4-16.

Internal exposures to biota from the accumulation of radionuclides from aquatic food pathways are determined using element-dependent bioaccumulation factors. The terrestrial doses are calculated as total body doses resulting from the consumption of aquatic plants, fish, and invertebrates. The terrestrial doses are the result of the amount of food ingested, and the previous uptake of radioisotopes by the “living” food organism. The total body doses are calculated using the bioaccumulation factors corresponding to the “living” food organisms and dose conversion factors for adult man, modified for terrestrial animal body mass and size. The use of the adult factors is conservative since the full 50 year dose commitment predicted by the adult ingestion factors would not be received by biota due to their shorter life spans. These models show that the largest contributions to biota doses are from liquid effluents via the food pathway.

5.4.4.1 Liquid Pathways

The model used for estimating nuclide concentrations in the near-field discharge environment is similar to that used in the analysis for doses to man described in Section 5.4.2. The dose to biota that can swim (fish, invertebrate, algae, muskrat and duck) is based upon the near-field mixing credit of 13.3 to 1. The dose to biota that are confined to the shoreline (raccoon and heron) is based upon the minimum shoreline mixing credit of 69 to 1. The calculation of biota doses was performed using LADTAP II (NRC, 1986). The near-field concentrations are used in estimating the dose of aquatic biota (fish, invertebrates, algae) and of biota that could swim into the near-field (muskrat and duck). The far-field concentrations are used in estimating the dose of biota that primarily inhabit the shoreline (heron and raccoon). Ingestion rates, body mass, and effective size used in the dose calculations are shown in Table 5.4-17 (NRC 1986). Residence times for the surrogate species are shown in Table 5.4-18. Surrogate biota doses from liquid effluents are shown in Table 5.4-19.

Gaseous pathway doses for wildlife populations in the CCNPP site area are estimated at the site boundary with the highest calculated human exposure potential. Though onsite locations may have higher dose rates due to being closer to the plant facilities, the site boundary provides a reasonable reference distance away from the human occupied spaces of the plant proper for estimating the dose impact to biota as they tend to avoid human contact. The cooling tower retention basin, as an open water source, may attract some birds and mammals. However, the nature of the retention basin will provide little feed material to support wildlife, while the release of liquid radioactive waste is to a point downstream of the basin thereby limiting the potential exposure to any biota that finds their way to it.

5.4.4.2 Gaseous Pathway

Gaseous effluents also contribute to terrestrial biota total body doses. External exposures occur due to immersion in a plume of noble gases, and deposition of radionuclides on the ground from a passing gas plume. The inhalation of radionuclides followed by the subsequent transfer from the lung to the rest of the body also contributes to total body doses. Inhaled noble gases are poorly absorbed into the blood and do not contribute significantly to the total body dose. The noble gases do contribute to a lung organ dose but do not make a contribution via this path to the total body dose. Immersion and ground deposition doses are largely independent of organism size and the doses for the maximally exposed individual located at the site boundary as described in Section 5.4.2 can be applied to all terrestrial biota doses. The external ground doses described in Section 5.4.2 calculated by GASPAR II (NRC, 1987) are increased by a factor of 2 to account for the closer proximity to the ground of terrestrial species. This approach is similar to the adjustments made for biota exposures to shoreline sediment performed in LADTAP II (NRC 1986). The inhalation pathway doses for biota are the internal total body doses calculated by GASPAR II as described in Section 5.4.2 for man (NRC, 1987). The total body inhalation dose (rather than organ specific doses) is used since the biota doses are assessed on a total body basis. Surrogate biota doses from gaseous effluents are shown in Table 5.4-19.

5.4.4.3 Biota Doses

Doses to biota from both liquid and gaseous effluents from CCNPP Unit 3 are shown in Table 5.4-19. Table 5.4-20 compares the biota doses to the criterion given in 40 CFR 190. These dose criteria are applicable to man, and are considered conservative when applied to biota. The total body dose is taken as the sum of the internal and external dose for all pathways considered as outlined in Table 5.4-16. Table 5.4-20 shows that annual doses to four of the seven surrogate biota species meet the dose criterion of 40 CFR 190. The total pathway doses for all surrogate biota are less than 1 mSv/yr (100 mrem/yr).

Use of exposure guidelines, such as 40 CFR 190, which apply to members of the public in unrestricted areas, is considered very conservative when evaluating calculated doses to biota. The International Council on Radiation Protection states that "...if man is adequately protected then other living things are also likely to be sufficiently protected" and uses human protection to infer environmental protection from the effects of ionizing radiation. This assumption is appropriate in cases where humans and other biota inhabit the same environment and have common routes of exposure. It is less appropriate in cases where human access is restricted or pathways exist that are much more important for biota than for humans. Conversely, it is also known that biota with the same environment and exposure pathways as man can experience higher doses without adverse effects. Species in most ecosystems experience dramatically higher mortality rates from natural causes than man. From an ecological viewpoint, population stability is considered more important to the survival of the species than the survival of individual organisms. Thus, higher dose limits could be permitted. In addition, no biota have been discovered that show significant changes in morbidity or mortality to radiation exposures predicted for nuclear power plants.

The NRC reports in NUREG-1555, Section 5.4.4, that existing literature including the "Recommendations of the International Commission on Radiological Protection (ICRP, 1977), found that appreciable effects in aquatic populations would not be expected at doses lower than 1 rad/day (10 mGy/day) and that limiting the dose to the maximally exposed individual organisms to less than this amount would provide adequate protection of the population. The NRC also reports in NUREG-1555 that chronic dose rates of 0.1 rad/day (1 mGy/day) or less do not appear to cause observable changes in terrestrial animal populations. The assumed lower threshold occurs for terrestrials rather than for aquatic animals primarily because some species of mammals and reptiles are considered more radiosensitive than aquatic organisms. The permissible dose rates are considered screening levels and higher species-specific dose rates could be acceptable with additional study or data.

Based on this, operation of CCNPP Unit 3 will result in SMALL radiological impacts to biota and do not warrant mitigation.

5.4.4.4 References

CFR, 2007a. Title 10, Code of Federal Regulations, Part 50, Domestic Licensing Of Production And Utilization Facilities, 2007.

CFR, 2007b. Title 40, Code of Federal Regulations, Part 190, Environmental Radiation Protection Standards For Nuclear Power Operations, 2007.

ICRP, 1977. Recommendations of the International Commission on Radiological Protection, ICRP Publication 26, International Commission on Radiological Protection, 1977.

NRC, 1977a. 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, Regulatory Guide 1.109, Revision 1, Nuclear Regulatory Commission, October 1977.

NRC, 1977b. Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors, Regulatory Guide 1.111, Revision 1, Nuclear Regulatory Commission, July 1977.

NRC, 1985. Revision 1, Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors, PWR-GALE Code, NUREG-0017, Nuclear Regulatory Commission, April 1985.

NRC, 1986. LADTAP II – Technical Reference and User Guide, Nuclear Regulatory Commission, NUREG/CR-4013, (by Pacific Northwest Laboratory), April 1986.

NRC, 1987. GASPAR II – Technical Reference and User Guide, NUREG/CR-4653, Nuclear Regulatory Commission (by Pacific Northwest Laboratory), March 1987.

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

NOAA, 2002. 2002 Local Climatological Data, Annual Summary with Comparative Data, Baltimore, MD (BWI), National Climatic Data Center, 2002.

ORNL, 1983. Radiological Assessments, A Textbook on Environmental Dose Analysis, NUREG/CR-3332 (ORNL-5968), Nuclear Regulatory Commission, September 1983.

Table 5.4-1—Liquid Pathway Parameters

Description	Parameter
Effluent Discharge Flow (normal)[1]	19,426 gpm (73,535 lpm)
Source Term[2]	See Section 3.5
Mixing Ratios (in Chesapeake Bay)	See Tables 5.4-22 and 5.4-23
Shore Width factor[3]	1.0
Transit Time; shoreline, boating swimming	0.0 (assumed in calculations) See Table 5.4-AA for transit times
Commercial Fish harvest[4]	152.2E+06 kg/yr (3.36E+08 lbs/yr)
Commercial invertebrate harvest[5]	26.4E+06 kg/yr (5.82E+07 lbs/yr)
Sport Fishing harvest[6]	1.29E+06 kg/yr (2.84E+06 lbs/yr)
Sport Invertebrate harvest[7]	1.58E+06 kg/r (3.48E+06 lbs/yr)
Recreational Usage for 50 mi (80 km) population : Shoreline[8]	37,843,909 Person-hrs/yr
Recreational Usage for 50 mi (80 km) population : Boating[9]	44,285,377 Person-hrs/yr
Recreational Usage for 50 mi (80 km) population : Swimming[8]	30,133,372 Person-hrs/yr

Notes:

1. See Section 3.3.
2. See Section 3.5 for annual expected effluent releases per the GALE code.
3. From Regulatory Guide 1.109, Table A-2 for a tidal basin.
4. Projected Maryland and Virginia edible total commercial fish landings from Table 2.2-8.
5. Projected Maryland and Virginia edible total commercial shellfish (invertebrate) landings from Table 2.2-8.
6. Projected Maryland and Virginia edible total recreational fish landings from Table 2.2-9.
7. Projected Maryland and Virginia edible total recreational shellfish (invertebrate) landings from Table 2.2-9.
8. Derived from NOAA National Ocean Survey data and average individual usage factors plus age distributions from Regulatory Guide 1.109.
9. Derived from Virginia and Maryland boat registrations and U.S. Coast Guard usage statistics.

Table 5.4-2—Recreational Liquid Pathway Usage Parameters for MEI

Usage Parameter	Age Group	Value Used in Calculations(1) (hrs/yr)
Shoreline Usage	Adult	200
	Teen	200
	Child	200
	Infant	200
Swimming Usage	Adult	100
	Teen	100
	Child	100
	Infant	100
Boating Usage	Adult	200
	Teen	200
	Child	200
	Infant	200

Note:

The shoreline usage values used in the MEI calculation are conservative compared to the default values cited in Regulatory Guide 1.109, Table E-5 for maximum individual. Regulatory Guide 1.109 does not provide usage figures for swimming or boating, but are reasonably conservative based on the population usage noted on Table 5.4-1.

Table 5.4-3—Locations for Gaseous Effluent Maximum Dose Evaluations

Location (Distance, Sector)	Dose Pathways Evaluated	Undecayed χ/Q (sec/m^3)	Depleted χ/Q (sec/m^3)	D/Q (1/m^2)
Site Boundary 0.88 mi (1.4 km) SE	Plume Ground Plane Inhalation	1.05E-06	9.49E-07	1.05E-08
Nearest Garden[1] 1.1 mi (1.8 km) SW	Vegetables	4.97E-07	4.58E-07	5.51E-09
Nearest Meat Cow[1] 0.88 mi (1.4 km) SE[2]	Meat	1.05E-06	9.49E-07	1.05E-08

Notes:

1. The term *nearest garden* and *nearest meat cow* refers to the most limiting locations. No milk animals were identified within 5 miles (8 km) of CCNPP.
2. Assumed to exist at the site boundary with most limiting atmospheric dispersion (excluding sectors bordering or extending over water). Specific locations for beef cattle are not available. Therefore, it is conservatively assumed that beef cattle exist at the site boundary.

Table 5.4-4—Gaseous Pathway Parameters

Parameter Description	Value
Growing season, fraction of year (April – October)[1]	0.583
Fraction time animals on pasture per year	0.583
Intake from Pasture when on Pasture	1.0
Absolute Humidity (g/m[3])	8.4
Average Temperature in growing Season: °F (°C)[1]	66.8 (19.3)
Population Distribution	Section 2.5.1
Milk Production within 50 mi (80 km): kg/yr (lbs/yr)[2]	2.34E+08 (5.16E+08)
Meat Production within 50 mi (80 km): kg/yr (lbs/yr)[3]	3.58E+07 (7.89E+07)
Vegetable/Grain Production within 50 mi (80 km): kg/yr (lbs/yr)[4]	5.62E+11 (1.24E+12)

Notes:

1. The growing season is the span of months when the temperature is above freezing for all days during the month. This occurs from April through October.
2. From 50 mi (80 km) cow and goat milk production shown on Table 2.2-1 and Table 2.2-2.
3. From 50 mi (80 km) meat and poultry production shown on Table 2.2-3 and Table 2.2-4.
4. From 50 mi (80 km) grain and leafy vegetable production shown on Table 2.2-5 and Table 2.2-6.

Table 5.4-5—Gaseous Pathway Consumption Factors for MEI

Consumption Factor	Adult	Teen	Child	Infant
Leafy vegetables: kg/yr (lbs/yr)	64 (141)	42 (93)	26 (57)	0
Meat Consumption: kg/yr (lbs/yr)	110 (243)	65 (143)	41 (90)	0
Milk Consumption: liter/yr (gal/yr)	310 (82)	400 (106)	330 (87)	330 (87)
Vegetable/fruit consumption: kg/yr (lbs/yr)	520 (1147)	630 (1389)	520 (1147)	0

Table 5.4-6—Distance to Nearest Gaseous Dose Receptors[3]

Sector	Site Boundary (m/mi)	Residence (km/mi)	Vegetable Garden (km/mi)
N[2]	623/0.39	-	-
NNE[2]	429/0.27	-	-
NE[2]	443/0.28	-	-
ENE[2]	471/0.29	-	-
E[2]	554/0.34	-	-
ESE[2]	693/0.43	-	-
SE	1413/0.88	2.7/1.7	2.7/1.7
SSE	1607/1.0	2.1/1.3	2.1/1.3
S	1385/0.86	2.9/1.8	2.9/1.8
SSW	1371/0.85	2.4/1.5	2.7/1.7
SW	1759/1.09	1.8/1.1	1.8/1.1
WSW	1662/1.03	1.9/1.2	2.4/1.5
W	1732/1.08	2.1/1.3	2.4/1.5
WNW	2313/1.44	4.0/2.5	4.0/2.5
NW	1662/1.03	3.4/2.1	3.4/2.1
NNW[2]	762/0.47	-	-

Notes:

1. Distance measure from the center of containment to site boundary.
2. Sector includes portions bordering or over water; distance measured are to the nearest shoreline property boundary.
3. No milk animals (cows or goats) identified within 5 miles (8 km) of the site. Meat animals assumed to be at location of critical receptor for dose assessment projections.

Table 5.4-7—Total Body Dose from Liquid Effluent to MEI

Dose Pathway	Adult µSv/yr (mrem/yr)	Teen µSv/yr (mrem/yr)	Child µSv/yr (mrem/yr)	Infant µSv/yr (mrem/yr)
Fish	5.32E-02 (5.32E-03)	3.95E-02 (3.95E-03)	3.09E-02 (3.09E-03)	0
Invertebrates	2.12E-02 (2.12E-03)	1.85E-02 (1.85E-03)	1.82E-02 (1.82E-03)	0
Shoreline	9.19E-03 (9.19E-04)	9.19E-03 (9.19E-04)	9.19E-03 (9.19E-04)	9.19E-03 (9.19E-04)
Swimming	9.61E-05 (9.61E-06)	9.61E-05 (9.61E-06)	9.61E-05 (9.61E-06)	9.61E-05 (9.61E-06)
Boating	4.98E-04 (4.98E-05)	4.98E-04 (4.98E-05)	4.98E-04 (4.98E-05)	4.98E-04 (4.98E-05)
Potable Water[1]	5.59E-02 (5.59E-03)	3.94E-02 (3.94E-03)	7.56E-02 (7.56E-03)	7.42E-02 (7.42E-03)
Total	1.40E-01 (1.40E-02)	1.07E-01 (1.07E-02)	1.34E-01 (1.34E-02)	8.40E-02 (8.40E-03)

Note:

Drinking water assumed for desalination of Chesapeake Bay water by ship borne water treatment facilities.

Table 5.4-8—Limiting Organ Dose from Liquid Effluent to MEI

Dose Pathway	Adult (GI-LLI) µSv/yr (mrem/yr)	Teen (GI-LLI) µSv/yr (mrem/yr)	Child (Thyroid) µSv/yr (mrem/yr)	Infant (Thyroid) µSv/yr (mrem/yr)
Fish	1.33E-01 (1.33E-02)	9.75E-02 (9.75E-03)	3.21E-01 (3.21E-02)	0
Invertebrates	7.03E-01 (7.03E-02)	5.61E-01 (5.61E-02)	3.71E-01 (3.71E-02)	0
Shoreline	9.19E-03 (9.19E-04)	9.19E-03 (9.19E-04)	9.19E-03 (9.19E-04)	9.19E-03 (9.19E-04)
Swimming	9.61E-05 (9.61E-06)	9.61E-05 (9.61E-06)	9.61E-05 (9.61E-06)	9.61E-05 (9.61E-06)
Boating	4.98E-04 (4.98E-05)	4.98E-04 (4.98E-05)	4.98E-04 (4.98E-05)	4.98E-04 (4.98E-05)
Potable Water[1]	5.63E-02 (5.63E-03)	3.96E-02 (3.96E-03)	8.52E-02 (8.52E-03)	8.94E-02 (8.94E-03)
Total	9.02E-01 (9.02E-02)	7.08E-01 (7.08E-02)	7.87E-01 (7.87E-02)	9.92E-02 (9.92E-03)

Note:

1. Drinking water assumed for desalination of Chesapeake Bay water by shipborne water treatment facilities.

Table 5.4-9—Summary Liquid Effluent Annual Dose to MEI

Type of Dose	CCNPP Unit 3 Calculated Dose µSv (mrem)	10 CFR 50, Appendix I Limit[1] µSv (mrem)	Fraction of Appendix I Objective
Total Body	1.40E-01 (1.40E-02) adult	30 (3)	4.67E-03
Maximum Organ	9.02E-01 (9.02E-02) GI-LLI adult	100 (10)	9.02E-03

Note:

1. Numerical dose objectives from 10 CFR 50, Appendix I, Section II.A.

Table 5.4-10—General Population Doses from Liquid Effluents[1]

Total Body Person-Sieverts (Person-Rem)	Thyroid Person-Thyroid-Sieverts (Person-Thyroid-Rem)
1.86E-03 (1.86E-01)	7.75E-03 (7.75E-01)

Note:
Includes dose contribution from commercial and sport harvest of fish and shellfish, shoreline, swimming and boating exposures to the 50 miles (80 km) population.

Table 5.4-11—Gaseous Pathway Doses for Maximally Exposed Individuals (MEI)[1]

Location	Pathway	Total Body µSv/yr (mrem/yr)	Max Organ (Bone) µSv/yr (mrem/yr)	Skin µSv/yr (mrem/yr)
Site Boundary	Plume	2.14 (0.214)	2.14 (0.214)	20.5 (2.05)
0.88 mi (1.4 km) SE	Ground Plane	1.49E-02 (1.49E-03)	1.49E-02 (1.49E-03)	1.74E-02 (1.74E-03)
	Inhalation			
	Adult	4.13E-02 (4.13E-03)	7.36E-04 (7.36E-05)	4.30E-02 (4.30E-03)
	Teen	4.36E-02 (4.36E-03)	8.98E-04 (8.98E-05)	4.34E-02 (4.34E-03)
	Child	3.85E-02 (3.85E-03)	1.10E-03 (1.10E-04)	3.83E-02 (3.83E-03)
	Infant	2.22E-02 (2.22E-03)	5.76E-04 (5.76E-05)	2.20E-02 (2.20E-03)
Nearest Garden	Vegetable			
1.3 mi (2.1 km) SSE	Adult	2.34E-01 (2.34E-02)	1.07E+00 (1.07E-01)	2.29E-01 (2.29E-02)
	Teen	3.71E-01 (3.71E-02)	1.76E+00 (1.76E-01)	3.62E+00 (3.62E-02)
	Child	8.63E-01 (8.63E-02)	4.22E+00 (4.22E-01)	8.53E-01 (8.53E-02)
Nearest Beef	Meat			
0.88 mi (1.4 km) SE	Adult	1.74E-01 (1.74E-02)	8.18E-01 (8.18E-02)	1.72E-01 (1.72E-02)
	Teen	1.44E-01 (1.44E-02)	6.91E-01 (6.91E-02)	1.44E-01 (1.44E-02)
	Child	2.67E-01 (2.67E-02)	1.30E+00 (1.30E-01)	2.67E-01 (2.67E-02)

Note:
Results for milk ingestion are not presented as there are no milk producing animals for human consumption within 5 mi (8 km).
Nearest meat animal assumed to be at limiting site boundary location since actual location of animals within 5 mi (8 km) is not available.

Table 5.4-12—CCNPP Unit 3 Gaseous Effluent MEI Dose Summary

10 CFR 50; Appendix I Section	Type of Dose	Calculated Dose	10 CFR 50; Appendix I Limit
II.B.1	Beta Air Dose µGy/yr (mrad/yr)	27.9 (2.79)	200 (20)
	Gamma Air Dose µGy/yr (mrad/yr)	3.41 (0.341)	100 (10)
II.B.2	External Total Body Dose µSv/yr (mrem/yr)(1)	2.15 (0.215)	50 (5)
	External Skin Dose µSv/yr (mrem/yr)(1)	20.5 (2.05)	150 (15)
II.C	Organ Dose µSv/yr (mrem/yr)(2)	5.54 (0.554) (child bone)	150 (15)

Notes:
1. Exposure from plume and ground plane pathways at site boundary.
2. Exposure from ground plane and inhalation pathways at site boundary; ingestion pathways at location of nearest garden and nearest meat cow.

Table 5.4-13—50 Mi (80 km) Population Doses from Gaseous Effluents[1] Person-Sieverts (Person-Rem)

Pathway	Total Body	Skin	Thyroid	Critical Organ Bone
Plume	3.63E-02 (3.63E+00)	4.68E-01 (4.68E+01)	3.63E-02 (3.63E+00)	3.63E-02 (3.63E+00)
Ground Plane	2.72E-04 (2.72E-02)	3.19E-04 (3.19E-02)	2.72E-04 (2.72E-02)	2.72E-04 (2.72E-02)
Inhalation	1.01E-03 (1.01E-01)	1.00E-03 (1.00E-01)	2.40E-03 (2.40E-01)	1.77E-05 (1.77E-03)
Vegetable Ingestion	1.62E-02 (1.62E+00)	1.61E-02 (1.61E+00)	1.64E-02 (1.64E+00)	7.42E-02 (7.42E+00)
Milk	1.17E-03 (1.17E-01)	1.17E-03 (1.17E-01)	2.40E-03 (2.40E-01)	5.36E-03 (5.36E-01)
Meat	1.89E-04 (1.89E-02)	1.89E-04 (1.89E-02)	2.05E-04 (2.05E-02)	8.98E-04 (8.98E-02)
Total	5.52E-02 (5.52E+00)	4.87E-01 (4.87E+01)	5.80E-02 (5.80E+00)	1.17E-01 (1.17E+01)

Notes:

1. Based on projected 50 mi (80 km) population for year 2080 (decade following 60 year operating life of CCNPP Unit 3). Food production within 50 mi (80 km) is presented in Tables 2.2-1 through 2.2-6.

Table 5.4-14—Annual Historical Dose Compliance with 40 CFR 190 for CCNPP Units 1 and 2

Year	Whole Body μSv (mrem)	Thyroid μSv (mrem)	Maximum Organ μSv (mrem)
2005	0.05 (0.005)	0.06 (0.006)	0.95 (0.095)
2004	0.02 (0.002)	0.07 (0.007)	0.06 (0.006)
2003	0.04 (0.004)	0.06 (0.006)	0.23 (0.023)
2002	0.07 (0.007)	0.03 (0.003)	1.74 (0.174)
2001	0.10 (0.010)	0.05 (0.005)	3.51 (0.351)
2000	0.18 (0.018)	0.18 (0.018)	2.11 (0.211)
Max value any year	0.18 (0.018)	0.18 (0.018)	3.51 (0.351)

Table 5.4-15—40 CFR 190 Annual Site Dose Compliance(6)

CCNPP Unit 3		Whole Body µSv (mrem)	Thyroid µSv (mrem)	Max. Organ(6) µSv (mrem)
CCNPP Unit 3 Liquids		1.40E-01 (1.40E-02)	7.87E-01 (7.87E-02)	9.02E-01 (9.02E-02)
CCNPP Unit 3 Gaseous External	Plume(1)	2.14E+00 (2.14E-01)	2.14E+00 (2.14E-01)	2.14E+00 (2.14E-01)
	Ground Plane(2)	1.49E-02 (1.49E-03)	1.49E-02 (1.49E-03)	1.49E-02 (1.49E-03)
Ingestion	Meat(2)	2.67E-01 (2.67E-02)	3.13E-01 (3.13E-02)	1.30E+00 (1.30E-01)
	Vegetable(3)	8.63E-01 (8.63E-02)	2.71E+00 (2.71E-01)	4.22E+00 (4.22E-01)
Inhalation(2)		3.85E-02 (3.85E-03)	1.23E-02 (1.23E-03)	1.10E-03 (1.10E-04)
Direct		1.11E-04 (1.11E-05)	1.11E-04 (1.11E-05)	1.11E-04 (1.11E-05)
Total (CCNPP Unit 3)(4)		3.46E+00 (3.46E-01)	5.98E+00 (5.98E-01)	8.58E+00 (8.58E-01)
Total (CCNPP Units 1 and 2)(5)		1.8E-01 (1.8E-02)	1.8E-01 (1.8E-02)	3.51E+00 (3.51E-01)
CCNPP Site Total		3.64E+00 (3.64E-01)	6.16E+00 (6.16E-01)	1.21E+01 (1.21E+00)

Notes:

1. External Dose from plume is calculated at the SE site boundary (0.88 mi (1.4 km)) only for noble gases and is used for assessment of compliance with 40 CFR 190.
2. Exposure pathway assumed to exist at maximum site boundary (SE, 0.88 mi).
3. Exposure pathway calculated at nearest real garden (SW, 1.1 mi).
4. Unit 3 doses projected based on design performance calculations using the GALE code, and both real and potential maximum pathway locations.
5. Unit 1 & 2 doses based on actual plant recorded effluents and exposure pathways (different basis from that applied to Unit 3 projected assessments).
6. For liquid effluents critical organ is adult GI-LLI (gastro-intestinal – lower large intestine); for gaseous effluents, critical organ is Child bone. These are conservatively added to represent maximum dose.

Table 5.4-16—Biota Exposure Pathways

Biota	Pathways
Fish	(a) Internal exposure from Bioaccumulation radionuclides from aquatic foods. (b) External exposure from swimming and shoreline deposits.
Invertebrates	(a) Internal exposure from Bioaccumulation radionuclides from aquatic foods. (b) External exposure from swimming and shoreline deposits.
Algae	(a) Internal exposure from Bioaccumulation radionuclides from aquatic foods. (b) External exposure from water immersion.
Muskrat	(a) Internal exposure from ingestion of aquatic plants. (b) External exposure from swimming and shoreline deposits. (c) External gaseous plume immersion. (d) External exposure to ground plane deposition. (e) Gaseous effluent inhalation.
Raccoon	(a) Internal exposure from ingestion of invertebrates. (b) External exposure from shoreline deposits. (c) External gaseous plume immersion. (d) External exposure to ground plane deposition. (e) Gaseous effluent inhalation.
Heron	(a) Internal exposure from ingestion of fish. (b) External exposure from swimming and shoreline. (c) External gaseous plume immersion. (d) External exposure to ground plane deposition. (e) Gaseous effluent inhalation.
Duck	(a) Internal exposure from ingestion of fish. (b) External exposure from swimming and exposure to shoreline deposits. (c) External gaseous plume immersion. (d) External exposure to ground plane deposition. (e) Gaseous effluent inhalation.

Table 5.4-17—Terrestrial Biota Parameters

Terrestrial Biota	Food Organism	Food Intake Lb/day (gm/day)	Body Mass Lb (gm)	Effective Body Radius in (cm)
Muskrat	Aquatic Plants	0.22 (100)	2.21 (1,000)	2.36 (6)
Raccoon	Invertebrates	0.44 (200)	26.5 (12,000)	5.51 (14)
Heron	Fish	1.32 (600)	10.1 (4,600)	4.33 (11)
Duck	Aquatic Plants	0.22 (100)	2.21 (1,000)	1.97 (5)

Table 5.4-18—Biota Residence Time

Biota	Shoreline / Sediment Exposure (hr/yr)	Swimming Exposure Time (hr/yr)
Fish	4,380	8,760
Invertebrates	8,760	8,760
Algae	--	8,760
Muskrat	2,922	2,922
Raccoon	2,191	--
Heron	2,922	2,920
Duck	4,383	4,383

Table 5.4-19—Dose to Biota from Liquid and Gaseous Effluents

	Liquid	Effluents	Gaseous	Effluents	Total
Biota	**Internal Dose[1] µGy/yr (mrad/yr)**	**External Dose[1] µGy/yr (mrad/yr)**	**Internal Dose µSv/yr (mrem/yr)**	**External Dose µSv/yr (mrem/yr)**	**Liquid & Gas Dose[1] µSv/yr (mrem/yr)**
Fish	1.11 (0.111)	2.15 (0.215)	NA	NA	3.26 (0.326)
Invertebrate	21.9 (2.19)	4.28 (0.428)	NA	NA	26.2 (2.62)
Algae	51.2 (5.12)	0.0203 (0.00203)	NA	NA	51.3 (5.13)
Muskrat	11.4 (1.14)	1.43 (0.143)	0.0436 (0.00436)	2.16 (0.216)	15.4 (1.54)
Raccoon	0.269 (0.0269)	0.202 (0.0202)	0.0436 (0.00436)	2.16 (0.216)	3.00 (0.300)
Heron	1.47 (0.147)	0.27 (0.027)	0.0436 (0.00436)	2.16 (0.216)	4.27 (0.427)
Duck	11.0 (1.10)	2.14 (0.214)	0.0436 (0.00436)	2.16 (0.216)	15.6 (1.56)

Note:

1. For approximations of total doses, assume that 1 mrad = 1 mrem (1mGy = 1mSv).

Table 5.4-20—Biota Doses Compared to 40 CFR 190 Whole Body Dose Criterion (25 mrem/yr)

Biota Meeting 40 CFR 190	Biota Exceeding 40 CFR 190
Fish	None
Invertebrates	
Raccoon	
Heron	
Algae	
Muskrat	
Duck	

Table 5.4-21—Important Biota Species and Analytical Surrogates

Ecology	Specie Type	Species	Status	Surrogate Species
Terrestrial	Mammal	White-tail deer	Recreationally valuable	Raccoon
	Birds	Bald Eagle	~~Endangered~~Protected	Heron
		Scarlet Tanager	Biological indicator of forest fragmentation	Heron
	Insect	Puritan Tiger Beetle	Threatened	(1)
		Northeastern Beach Tiger Beetle	Threatened	(1)

Note:

1. No direct surrogate species for terrestrial insects.

Table 5.4-22—Near Field Environmental Dilution Values For CCNPP Unit 3 Discharges to the Chesapeake Bay

Minimum Dilution at Mixing Zone Perimeter(1)	Area of Mixing Zone(2) Acres (km^2)	Length of Mixing Zone vs. CCNPP Shoreline Boundaries(3)	Width of Mixing Zone vs. Chesapeake Bay Width(4)
13.3	9.0 (0.036)	13%	0.9%

Notes:

1. The near-field mixing zone, as defined by the 0.5°C (0.9°F) delta isotherm, represents that volume of the water where prompt or rapid entrainment of the effluent discharges from the submerged effluent diffuser ports with bay water occurs. This rapid mixing is due to the exchange of momentum between the relatively high velocity discharge water and the relatively low velocity receiving water.
2. The “Area of Mixing Zone” is the largest area covered by the mixing zone during the tidal cycle.
3. The “Length of Mixing Zone” is the greatest along-shore distance covered by the mixing zone during the tidal cycle.
4. The “Width of Mixing Zone” is the greatest cross-shore distance covered by the mixing zone during the tidal cycle.

Table 5.4-23—Far Field Environmental Dilution Values For CCNPP Unit 3 Discharges to the Chesapeake Bay(1)

Location	Transit Time (hrs)	Time Average Dilution
Calvert Beach[2]	N/A	N/A
Long Beach[2]	N/A	N/A
Northern CCNPP Property Boundary[3]	3.5 (conservative)	377 (conservative)
Nearest Shoreline[4] (opposite discharge point)	0.8	93
Southern CCNPP Property Boundary	1.4	74
Minimum Shoreline Dilution (approximately 8,900 ft (2,713 m) south)	4.0	69
Cove Point Beach (approximately 23,000 ft (7,010 m) south)	77	93
Tidal Waters 50 mi (80 km) Downstream[5]	550 (estimated)	365
Shoreline of Chesapeake Bay Opposite CCNPP[6]	N/A	N/A

Notes:

1. The time-average flow of water past the discharge location is based on upstream freshwater inflows equal to 60,000 cfs. The calculated time average dilution values do not account for freshwater inflows downstream (i.e., seaward) of the discharge point and is therefore conservative.
2. Calvert Beach and Long Beach are located beyond the upstream limit of tidal excursion.
3. The Northern Property Boundary is located near the upstream limit of the tidal excursion.
4. Transit time is based on wind-driven surface current of 0.2 ft/sec (about 1/10th of typical wind speed.
5. The calculated time-average dilution credit assumes that the plume is not laterally well-mixed 50 miles downstream of the discharge point and is therefore conservative.
6. The plume does not contact the shoreline of the Chesapeake Bay opposite CCNPP.

Table 5.4-24—Cow Milk Production lb/year (kg/year)

(Page 1 of 2)

	Distance miles (kilometers)										
Sector	0-1 (0-1.6)	1-2 (1.6-3.2)	2-3 (1.6-4.8)	3-4 (4.8-6.4)	4-5 (6.4-8.1)	5-10 (8.1-16.1)	10-20 (16.1-32.2)	20-30 (32.2-48.3)	30-40 (48.3-64.4)	40-50 (64.4-80.5)	Total
N	0	0	0	0	0	0	0	1,833,513	5,133,834	10,230,997	17,198,342
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(833,415)	(2,333,561)	(4,650,453)	(7,817,428)
NNE	0	0	0	0	0	0	297,909	2,979,097	15,199,549	18,640,325	37,116,880
	(0)	(0)	(0)	(0)	(0)	(0)	(135,413)	(1,354,135)	(6,908,886)	(8,472,875)	(16,871,309)
NE	0	0	0	0	0	137,513	2,035,198	4,220,388	34,853,573	44,811,736	86,058,408
	(0)	(0)	(0)	(0)	(0)	(62,506)	(925,090)	(1,918,358)	(15,842,533)	(20,368,971)	(39,117,458)
ENE	0	0	0	0	0	687,566	5,390,526	7,334,048	34,853,573	11,831,477	60,097,189
	(0)	(0)	(0)	(0)	(0)	(312,530)	(2,450,239)	(3,333,658)	(15,842,533)	(5,377,944)	(27,316,904)
E	0	0	0	0	0	687,566	5,500,537	9,167,561	12,834,584	16,501,608	44,691,854
	(0)	(0)	(0)	(0)	(0)	(312,530)	(2,500,244)	(4,167,073)	(5,833,902)	(7,500,731)	(20,314,479)
ESE	0	0	0	0	0	137,513	4,950,482	4,583,779	8,984,208	15,676,527	34,332,511
	(0)	(0)	(0)	(0)	(0)	(62,506)	(2,250,219)	(2,083,536)	(4,083,731)	(7,125,694)	(15,605,687)
SE	0	0	0	0	0	412,540	1,100,108	1,833,513	3,208,645	6,600,642	13,155,448
	(0)	(0)	(0)	(0)	(0)	(187,518)	(500,049)	(833,415)	(1,458,475)	(3,000,292)	(5,979,749)
SSE	0	0	0	0	0	893,838	1,100,108	1,833,513	617,991	794,559	5,240,006
	(0)	(0)	(0)	(0)	(0)	(406,290)	(500,049)	(833,415)	(280,905)	(361,163)	(2,381,821)
S	0	0	0	0	0	1,168,864	4,950,482	2,207,108	4,943,924	7,151,034	20,421,412
	(0)	(0)	(0)	(0)	(0)	(531,302)	(2,250,219)	(1,003,231)	(2,247,238)	(3,250,470)	(9,282,460)
SSW	0	0	0	0	0	1,100,108	4,125,403	2,736,815	6,179,906	6,356,473	20,498,705
	(0)	(0)	(0)	(0)	(0)	(500,049)	(1,875,183)	(1,244,007)	(2,809,048)	(2,889,306)	(9,317,593)
SW	0	0	0	0	0	1,168,864	4,675,455	1,765,687	6,179,906	7,945,593	21,735,505
	(0)	(0)	(0)	(0)	(0)	(531,302)	(2,125,207)	(802,585)	(2,809,048)	(3,611,633)	(9,879,775)
WSW	0	0	0	0	0	962,595	5,500,537	4,583,779	5,252,920	7,945,593	24,245,421
	(0)	(0)	(0)	(0)	(0)	(437,543)	(2,500,244)	(2,083,536)	(2,387,691)	(3,611,633)	(11,020,646)
W	0	0	0	0	0	1,100,108	4,950,482	8,250,803	10,267,666	6,356,473	30,925,534
	(0)	(0)	(0)	(0)	(0)	(500,049)	(2,250,219)	(3,750,365)	(4,667,121)	(2,889,306)	(14,057,061)
WNW	0	0	0	0	0	1,375,134	4,675,455	9,167,561	5,561,915	6,753,754	27,533,818
	(0)	(0)	(0)	(0)	(0)	(625,061)	(2,125,207)	(4,167,073)	(2,528,143)	(3,069,888)	(12,515,372)
NW	0	0	0	0	0	1,237,621	4,950,482	9,167,561	12,834,584	0	28,190,246
	(0)	(0)	(0)	(0)	(0)	(562,555)	(2,250,219)	(4,167,073)	(5,833,902)	(0)	(12,813,748)

Table 5.4-24—Cow Milk Production lb/year (kg/year)

(Page 2 of 2)

Sector	Distance miles (kilometers)										
	0-1 (0-1.6)	**1-2 (1.6-3.2)**	**2-3 (1.6-4.8)**	**3-4 (4.8-6.4)**	**4-5 (6.4-8.1)**	**5-10 (8.1-16.1)**	**10-20 (16.1-32.2)**	**20-30 (32.2-48.3)**	**30-40 (48.3-64.4)**	**40-50 (64.4-80.5)**	**Total**
NNW	0	0	0	0	0	412,540	4,675,455	8,709,182	12,834,584	16,501,608	43,133,369
	(0)	(0)	(0)	(0)	(0)	(187,518)	(2,125,207)	(3,958,719)	(5,833,902)	(7,500,731)	(19,606,077)
Totals	0	0	0	0	0	11,482,368	58,878,618	80,373,902	179,741,360	184,098,400	514,574,652
	(0)	(0)	(0)	(0)	(0)	(5,219,258)	(26,763,008)	(36,533,592)	(81,700,618)	(83,681,091)	(233,897,569)

Table 5.4-25—Goat Milk Production lb/year (kg/year)

(Page 1 of 2)

	Distance miles (kilometers)										
Sector	0-1 (0-1.6)	1-2 (1.6-3.2)	2-3 (1.6-4.8)	3-4 (4.8-6.4)	4-5 (6.4-8.1)	5-10 (8.1-16.1)	10-20 (16.1-32.2)	20-30 (32.2-48.3)	30-40 (48.3-64.4)	40-50 (64.4-80.5)	Total
N	0	0	0	0	0	0	0	1,698	4,756	9,480	15,937
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(772)	(2,162)	(4,309)	(7,244)
NNE	0	0	0	0	0	0	510	5,097	7,731	9,480	22,818
	(0)	(0)	(0)	(0)	(0)	(0)	(232)	(2,317)	(3,514)	(4,309)	(10,372)
NE	0	0	0	0	0	128	1,885	7,220	11,893	15,292	36,419
	(0)	(0)	(0)	(0)	(0)	(58)	(857)	(3,282)	(5,406)	(6,951)	(16,554)
ENE	0	0	0	0	0	638	4,996	6,796	11,893	11,823	36,144
	(0)	(0)	(0)	(0)	(0)	(290)	(2,271)	(3,089)	(5,406)	(5,374)	(16,429)
E	0	0	0	0	0	638	5,097	8,494	11,893	15,292	41,415
	(0)	(0)	(0)	(0)	(0)	(290)	(2,317)	(3,861)	(5,406)	(6,951)	(18,825)
ESE	0	0	0	0	0	128	4,587	4,248	8,325	14,527	31,814
	(0)	(0)	(0)	(0)	(0)	(58)	(2,085)	(1,931)	(3,784)	(6,603)	(14,461)
SE	0	0	0	0	0	383	1,019	1,698	2,974	6,116	12,190
	(0)	(0)	(0)	(0)	(0)	(174)	(463)	(772)	(1,352)	(2,780)	(5,541)
SSE	0	0	0	0	0	827	1,019	1,698	554	711	4,811
	(0)	(0)	(0)	(0)	(0)	(376)	(463)	(772)	(252)	(323)	(2,187)
S	0	0	0	0	0	1,082	4,587	1,976	4,429	6,404	18,480
	(0)	(0)	(0)	(0)	(0)	(492)	(2,085)	(898)	(2,013)	(2,911)	(8,400)
SSW	0	0	0	0	0	1,019	3,824	2,451	5,535	5,694	18,520
	(0)	(0)	(0)	(0)	(0)	(463)	(1,738)	(1,114)	(2,516)	(2,588)	(8,418)
SW	0	0	0	0	0	1,082	4,332	1,582	5,535	7,115	19,648
	(0)	(0)	(0)	(0)	(0)	(492)	(1,969)	(719)	(2,516)	(3,234)	(8,931)
WSW	0	0	0	0	0	891	5,097	4,248	4,704	7,115	22,057
	(0)	(0)	(0)	(0)	(0)	(405)	(2,317)	(1,931)	(2,138)	(3,234)	(10,026)
W	0	0	0	0	0	1,019	4,587	7,645	9,515	5,694	28,459
	(0)	(0)	(0)	(0)	(0)	(463)	(2,085)	(3,475)	(4,325)	(2,588)	(12,936)
WNW	0	0	0	0	0	1,274	4,332	8,494	4,981	6,048	25,133
	(0)	(0)	(0)	(0)	(0)	(579)	(1,969)	(3,861)	(2,264)	(2,749)	(11,424)
NW	0	0	0	0	0	1,146	4,587	8,494	11,893	0	26,123
	(0)	(0)	(0)	(0)	(0)	(521)	(2,085)	(3,861)	(5,406)	(0)	(11,874)

Table 5.4-25—Goat Milk Production lb/year (kg/year)

(Page 2 of 2)

Sector	Distance miles (kilometers)										
	0-1 (0-1.6)	**1-2 (1.6-3.2)**	**2-3 (1.6-4.8)**	**3-4 (4.8-6.4)**	**4-5 (6.4-8.1)**	**5-10 (8.1-16.1)**	**10-20 (16.1-32.2)**	**20-30 (32.2-48.3)**	**30-40 (48.3-64.4)**	**40-50 (64.4-80.5)**	**Total**
NNW	0	0	0	0	0	383	4,332	8,070	11,893	15,292	39,970
	(0)	(0)	(0)	(0)	(0)	(174)	(1,969)	(3,668)	(5,406)	(6,951)	(18,168)
Totals	0	0	0	0	0	10,641	54,795	79,917	118,503	136,083	399,940
	(0)	(0)	(0)	(0)	(0)	(4,837)	(24,907)	(36,326)	(53,865)	(61,856)	(181,791)

Table 5.4-26—Meat Production lb/year (kg/year)

(Page 1 of 2)

Sector	Distance miles (kilometers)										
	0-1* (0-1.6)	1-2 (1.6-3.2)	2-3 (1.6-4.8)	3-4 (4.8-6.4)	4-5 (6.4-8.1)	5-10 (8.1-16.1)	10-20 (16.1-32.2)	20-30 (32.2-48.3)	30-40 (48.3-64.4)	40-50 (64.4-80.5)	Total
N	0	0	0	0	0	0	0	29,546	82,727	164,861	277,134
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(13,430)	(37,603)	(74,937)	(125,970)
NNE	0	0	0	0	0	0	0	81,622	123,794	494,780	700,198
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(37,101)	(56,270)	(224,900)	(318,272)
NE	0	0	0	0	0	200	2,979	115,632	190,452	949,674	1,258,939
	(0)	(0)	(0)	(0)	(0)	(91)	(1,354)	(52,560)	(86,569)	(431,670)	(572,245)
ENE	0	0	0	0	0	1,005	7,889	108,830	190,452	949,674	1,257,852
	(0)	(0)	(0)	(0)	(0)	(457)	(3,586)	(49,468)	(86,569)	(431,670)	(571,751)
E	0	0	0	0	0	1,005	8,050	136,037	276,687	355,740	777,522
	(0)	(0)	(0)	(0)	(0)	(457)	(3,659)	(61,835)	(125,767)	(161,700)	(353,419)
ESE	0	0	0	0	0	200	7,245	68,020	193,681	300,960	570,104
	(0)	(0)	(0)	(0)	(0)	(91)	(3,293)	(30,918)	(88,037)	(136,800)	(259,138)
SE	0	548	548	638	821	8,210	1,610	27,207	61,600	126,720	227,900
	(0)	(249)	(249)	(290)	(373)	(3,732)	(732)	(12,367)	(28,000)	(57,600)	(103,591)
SSE	0	1,096	1,824	2,554	3,285	17,789	37,611	62,685	43,879	293,060	463,782
	(0)	(498)	(829)	(1,161)	(1,493)	(8,086)	(17,096)	(28,493)	(19,945)	(133,209)	(210,810)
S	0	1,096	1,824	2,554	3,285	23,263	169,248	156,713	1,823,488	2,637,545	4,819,012
	(0)	(498)	(829)	(1,161)	(1,493)	(10,574)	(76,931)	(71,233)	(828,858)	(1,198,884)	(2,190,460)
SSW	0	1,096	1,824	2,554	2,627	21,894	141,040	61,446	129,386	133,082	494,952
	(0)	(498)	(829)	(1,161)	(1,194)	(9,952)	(64,109)	(27,930)	(58,812)	(60,492)	(224,978)
SW	0	1,096	1,186	1,661	1,313	23,263	159,845	39,642	129,386	166,355	523,745
	(0)	(498)	(539)	(755)	(597)	(10,574)	(72,657)	(18,019)	(58,812)	(75,616)	(238,066)
WSW	0	1,096	1,368	2,554	1,971	19,158	188,054	156,713	250,070	378,257	999,238
	(0)	(498)	(622)	(1,161)	(896)	(8,708)	(85,479)	(71,233)	(113,668)	(171,935)	(454,199)
W	0	1,096	1,459	2,554	3,285	21,894	169,248	138,299	172,106	451,330	961,268
	(0)	(498)	(663)	(1,161)	(1,493)	(9,952)	(76,931)	(62,863)	(78,230)	(205,150)	(436,940)
WNW	0	1,096	1,824	2,554	3,285	27,368	93,049	313,423	253,814	308,202	1,004,610
	(0)	(498)	(829)	(1,161)	(1,493)	(12,440)	(42,295)	(142,465)	(115,370)	(140,092)	(456,641)
NW	0	711	1,186	1,789	2,464	24,631	98,520	153,666	176,447	0	459,413
	(0)	(323)	(539)	(813)	(1,120)	(11,196)	(44,782)	(69,848)	(80,203)	(0)	(208,824)
NNW	0	0	0	0	0	8,210	93,049	140,340	206,818	265,907	714,322
	(0)	(0)	(0)	(0)	(0)	(3,732)	(42,295)	(63,791)	(94,008)	(120,867)	(324,692)

Table 5.4-26—Meat Production lb/year (kg/year)

(Page 2 of 2)

	Distance miles (kilometers)										
Sector	**0-1* (0-1.6)**	**1-2 (1.6-3.2)**	**2-3 (1.6-4.8)**	**3-4 (4.8-6.4)**	**4-5 (6.4-8.1)**	**5-10 (8.1-16.1)**	**10-20 (16.1-32.2)**	**20-30 (32.2-48.3)**	**30-40 (48.3-64.4)**	**40-50 (64.4-80.5)**	**Total**
Totals	0	8,921	13,046	19,413	22,332	198,090	1,177,436	1,789,819	4,304,788	7,976,153	15,509,996
	(0)	(4,055)	(5,930)	(8,824)	(10,151)	(90,041)	(535,198)	(813,554)	(1,956,722)	(3,625,524)	(7,049,998)

* Meat production assumed to be zero in the 0-1 mile radius.

Table 5.4-27—Poultry Meat Production lb/year (kg/year)
(Page 1 of 2)

Sector	Distance miles (kilometers)										
	0-1* (0-1.6)	**1-2 (1.6-3.2)**	**2-3 (1.6-4.8)**	**3-4 (4.8-6.4)**	**4-5 (6.4-8.1)**	**5-10 (8.1-16.1)**	**10-20 (16.1-32.2)**	**20-30 (32.2-48.3)**	**30-40 (48.3-64.4)**	**40-50 (64.4-80.5)**	**Total**
N	0	0	0	0	0	0	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
NNE	0	0	0	0	0	0	0	96,624	146,546	162,936	406,107
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(43,920)	(66,612)	(74,062)	(184,594)
NE	0	0	0	0	0	5,872	86,891	136,884	225,456	1,203,897	1,658,998
	(0)	(0)	(0)	(0)	(0)	(2,669)	(39,496)	(62,220)	(102,480)	(547,226)	(754,090)
ENE	0	0	0	0	0	29,355	230,144	128,832	225,456	1,203,897	1,817,684
	(0)	(0)	(0)	(0)	(0)	(13,343)	(104,611)	(58,560)	(102,480)	(547,226)	(826,220)
E	0	0	0	0	0	29,355	234,841	161,040	1,400,971	1,801,248	3,627,455
	(0)	(0)	(0)	(0)	(0)	(13,343)	(106,746)	(73,200)	(636,805)	(818,749)	(1,648,843)
ESE	0	0	0	0	0	5,872	211,356	80,520	980,681	1,294,623	2,573,052
	(0)	(0)	(0)	(0)	(0)	(2,669)	(96,071)	(36,600)	(445,764)	(588,465)	(1,169,569)
SE	0	0	0	0	0	0	46,968	32,208	264,981	545,105	889,262
	(0)	(0)	(0)	(0)	(0)	(0)	(21,349)	(14,640)	(120,446)	(247,775)	(404,210)
SSE	0	0	0	0	0	0	90,851	151,417	408,082	524,676	1,175,027
	(0)	(0)	(0)	(0)	(0)	(0)	(41,296)	(68,826)	(185,492)	(238,489)	(534,103)
S	0	0	0	0	0	0	408,828	1,457,436	3,264,655	4,722,091	9,853,010
	(0)	(0)	(0)	(0)	(0)	(0)	(185,831)	(662,471)	(1,483,934)	(2,146,405)	(4,478,641)
SSW	0	0	0	0	0	0	340,690	1,807,221	4,080,820	4,197,415	10,426,143
	(0)	(0)	(0)	(0)	(0)	(0)	(154,859)	(821,464)	(1,854,918)	(1,907,916)	(4,739,156)
SW	0	0	0	0	0	0	386,115	1,165,949	4,080,820	5,246,767	10,879,651
	(0)	(0)	(0)	(0)	(0)	(0)	(175,507)	(529,977)	(1,854,918)	(2,384,894)	(4,945,296)
WSW	0	0	0	0	0	0	454,254	378,545	3,468,696	5,246,767	9,548,264
	(0)	(0)	(0)	(0)	(0)	(0)	(206,479)	(172,066)	(1,576,680)	(2,384,894)	(4,340,120)
W	0	0	0	0	0	0	408,828	11	15	1,090,210	1,499,065
	(0)	(0)	(0)	(0)	(0)	(0)	(185,831)	(5)	(7)	(495,550)	(681,393)
WNW	0	0	0	0	0	0	0	757,090	3,672,737	4,459,752	8,889,580
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(344,132)	(1,669,426)	(2,027,160)	(4,040,718)
NW	0	0	0	0	0	0	0	13	31	0	44
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(6)	(14)	(0)	(20)
NNW	0	0	0	0	0	0	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)

Table 5.4-27—Poultry Meat Production lb/year (kg/year)

(Page 2 of 2)

Sector	Distance miles (kilometers)										
	0-1* (0-1.6)	**1-2 (1.6-3.2)**	**2-3 (1.6-4.8)**	**3-4 (4.8-6.4)**	**4-5 (6.4-8.1)**	**5-10 (8.1-16.1)**	**10-20 (16.1-32.2)**	**20-30 (32.2-48.3)**	**30-40 (48.3-64.4)**	**40-50 (64.4-80.5)**	**Total**
Totals	0	0	0	0	0	70,453	2,899,767	6,353,791	22,219,947	31,699,384	63,243,343
	(0)	(0)	(0)	(0)	(0)	(32,024)	(1,318,076)	(2,888,087)	(10,099,976)	(14,408,811)	(28,746,974)

*Meat production assumed to be zero in the 0-1 mile radius.

Table 5.4-28—Grain Production lb/year (kg/year)

(Page 1 of 2)

	Distance miles (kilometers)										
Sector	**0-1* (0-1.6)**	**1-2 (1.6-3.2)**	**2-3 (1.6-4.8)**	**3-4 (4.8-6.4)**	**4-5 (6.4-8.1)**	**5-10 (8.1-16.1)**	**10-20 (16.1-32.2)**	**20-30 (32.2-48.3)**	**30-40 (48.3-64.4)**	**40-50 (64.4-80.5)**	**Total**
N	0	0	0	0	0	0	0	827,171,176	2,316,079,293	4,615,615,165	7,758,865,635
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(375,986,898)	(1,052,763,315)	(2,098,006,893)	(3,526,757,107)
NNE	0	0	0	0	0	0	0	21,815,522,931	56,119,044,034	68,822,915,539	146,757,482,505
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(9,916,146,787)	(25,508,656,379)	(31,283,143,427)	(66,707,946,593)
NE	0	0	0	0	0	531,439,258	7,865,301,028	30,905,324,153	86,336,990,819	111,004,702,481	236,643,757,742
	(0)	(0)	(0)	(0)	(0)	(241,563,299)	(3,575,136,831)	(14,047,874,615)	(39,244,086,736)	(50,456,682,946)	(107,565,344,428)
ENE	0	0	0	0	0	2,657,196,293	20,832,418,937	29,087,363,910	50,902,886,841	111,004,702,481	214,484,568,463
	(0)	(0)	(0)	(0)	(0)	(1,207,816,497)	(9,469,281,335)	(13,221,529,050)	(23,137,675,837)	(50,456,682,946)	(97,492,985,665)
E	0	0	0	0	0	2,657,196,293	21,257,570,345	36,359,204,886	49,600,997,470	40,696,328,116	150,571,297,111
	(0)	(0)	(0)	(0)	(0)	(1,207,816,497)	(9,662,531,975)	(16,526,911,312)	(22,545,907,941)	(18,498,330,962)	(68,441,498,687)
ESE	0	0	0	0	0	531,439,258	19,131,813,309	18,179,602,443	34,720,698,230	38,661,511,709	111,225,064,951
	(0)	(0)	(0)	(0)	(0)	(241,563,299)	(8,696,278,777)	(8,263,455,656)	(15,782,135,559)	(17,573,414,413)	(50,556,847,705)
SE	0	9,429,116	9,429,116	11,000,636	14,143,675	141,436,748	4,251,514,069	7,271,840,976	12,400,249,367	10,602,227,757	34,711,271,465
	(0)	(4,285,962)	(4,285,962)	(5,000,289)	(6,428,943)	(64,289,431)	(1,932,506,395)	(3,305,382,262)	(5,636,476,985)	(4,819,194,435)	(15,777,850,666)
SSE	0	18,858,233	31,430,388	44,002,543	56,574,698	306,446,290	1,084,445,395	1,807,408,992	2,682,040,231	3,448,337,440	9,479,544,213
	(0)	(8,571,924)	(14,286,540)	(20,001,156)	(25,715,772)	(139,293,768)	(492,929,725)	(821,549,542)	(1,219,109,196)	(1,567,426,109)	(4,308,883,733)
S	0	18,858,233	31,430,388	44,002,543	56,574,698	400,737,454	4,880,004,279	9,578,715,111	21,456,321,850	31,035,036,960	67,501,681,520
	(0)	(8,571,924)	(14,286,540)	(20,001,156)	(25,715,772)	(182,153,388)	(2,218,183,763)	(4,353,961,414)	(9,752,873,568)	(14,106,834,982)	(30,682,582,509)
SSW	0	18,858,233	31,430,388	44,002,543	45,259,760	1,084,445,395	4,066,670,232	11,428,975,708	25,807,364,504	20,760,068,498	63,287,075,262
	(0)	(8,571,924)	(14,286,540)	(20,001,156)	(20,572,618)	(492,929,725)	(1,848,486,469)	(5,194,988,958)	(11,730,620,229)	(9,436,394,772)	(28,766,852,392)
SW	0	18,858,233	20,429,752	28,601,654	22,629,880	1,152,223,233	4,608,892,928	7,373,532,716	25,807,364,504	25,950,085,623	64,982,618,523
	(0)	(8,571,924)	(9,286,251)	(13,000,752)	(10,286,309)	(523,737,833)	(2,094,951,331)	(3,351,605,780)	(11,730,620,229)	(11,795,493,465)	(29,537,553,874)
WSW	0	18,858,233	23,572,791	44,002,543	33,944,819	948,889,720	5,422,226,975	4,518,522,479	21,936,259,827	8,058,217,895	41,004,495,288
	(0)	(8,571,924)	(10,714,905)	(20,001,156)	(15,429,463)	(431,313,509)	(2,464,648,625)	(2,053,873,854)	(9,971,027,194)	(3,662,826,316)	(18,638,406,949)
W	0	18,858,233	25,144,310	44,002,543	56,574,698	1,084,445,395	4,880,004,279	4,900,953,952	6,098,964,918	7,841,526,321	24,950,474,650
	(0)	(8,571,924)	(11,429,232)	(20,001,156)	(25,715,772)	(492,929,725)	(2,218,183,763)	(2,227,706,342)	(2,772,256,781)	(3,564,330,146)	(11,341,124,841)
‘WNW	0	18,858,233	31,430,388	44,002,543	56,574,698	471,455,829	4,608,892,928	9,037,044,960	6,861,335,532	8,331,621,718	29,461,216,831
	(0)	(8,571,924)	(14,286,540)	(20,001,156)	(25,715,772)	(214,298,104)	(2,094,951,331)	(4,107,747,709)	(3,118,788,878)	(3,787,100,781)	(13,391,462,196)
‘NW	0	12,257,852	20,429,752	30,801,780	42,431,024	424,310,247	4,880,004,279	5,445,504,390	5,238,829,158	0	16,094,568,483
	(0)	(5,571,751)	(9,286,251)	(14,000,809)	(19,286,829)	(192,868,294)	(2,218,183,763)	(2,475,229,268)	(2,381,285,981)	(0)	(7,315,712,947)

Table 5.4-28—Grain Production lb/year (kg/year)

(Page 2 of 2)

	Distance miles (kilometers)										
Sector	0-1* (0-1.6)	1-2 (1.6-3.2)	2-3 (1.6-4.8)	3-4 (4.8-6.4)	4-5 (6.4-8.1)	5-10 (8.1-16.1)	10-20 (16.1-32.2)	20-30 (32.2-48.3)	30-40 (48.3-64.4)	40-50 (64.4-80.5)	Total
NNW	0	0	0	0	0	141,436,748	1,602,949,817	3,929,063,087	5,238,829,158	6,735,637,491	17,647,916,304
	(0)	(0)	(0)	(0)	(0)	(64,289,431)	(728,613,553)	(1,785,937,767)	(2,381,285,981)	(3,061,653,405)	(8,021,780,138)
Totals	0	153,694,600	224,727,279	334,419,334	384,707,957	12,533,098,160	109,372,708,799	202,465,751,873	413,524,255,738	497,568,535,202	1,236,561,898,939
	(0)	(69,861,182)	(102,148,763)	(152,008,788)	(174,867,253)	(5,696,862,800)	(49,714,867,636)	(92,029,887,215)	(187,965,570,790)	(226,167,516,001)	(562,073,590,427)

* Grain production assumed to be zero in the 0-1 mile radius.

Table 5.4-29—Leafy Vegetable Production lb/year (kg/year)

(Page 1 of 2)

	Distance miles (kilometers)										
Sector	**0-1* (0-1.6)**	**1-2 (1.6-3.2)**	**2-3 (1.6-4.8)**	**3-4 (4.8-6.4)**	**4-5 (6.4-8.1)**	**5-10 (8.1-16.1)**	**10-20 (16.1-32.2)**	**20-30 (32.2-48.3)**	**30-40 (48.3-64.4)**	**40-50 (64.4-80.5)**	**Total**
N	0	0	0	0	0	0	0	19,741	55,273	110,152	185,167
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(8,973)	(25,124)	(50,069)	(84,167)
NNE	0	0	0	0	0	0	0	59,222	89,819	110,152	259,195
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(26,919)	(40,827)	(50,069)	(117,816)
NE	0	0	0	0	0	1,481	21,912	83,897	138,184	177,665	423,141
	(0)	(0)	(0)	(0)	(0)	(673)	(9,960)	(38,135)	(62,811)	(80,757)	(192,337)
ENE	0	0	0	0	0	7,403	58,038	78,962	138,184	177,665	460,253
	(0)	(0)	(0)	(0)	(0)	(3,365)	(26,381)	(35,892)	(62,811)	(80,757)	(209,206)
E	0	0	0	0	0	7,403	59,222	98,703	138,184	1,128,096	1,431,608
	(0)	(0)	(0)	(0)	(0)	(3,365)	(26,919)	(44,865)	(62,811)	(512,771)	(650,731)
ESE	0	0	0	0	0	1,481	53,299	49,353	96,730	168,782	369,644
	(0)	(0)	(0)	(0)	(0)	(673)	(24,227)	(22,433)	(43,968)	(76,719)	(168,020)
SE	0	297	297	345	444	4,442	11,845	19,741	34,547	71,067	143,022
	(0)	(135)	(135)	(157)	(202)	(2,019)	(5,384)	(8,973)	(15,703)	(32,303)	(65,010)
SSE	0	592	988	1,382	1,778	9,623	11,845	19,741	13,818	7,526	67,291
	(0)	(269)	(449)	(628)	(808)	(4,374)	(5,384)	(8,973)	(6,281)	(3,421)	(30,587)
S	0	592	988	1,382	1,778	12,584	53,299	49,353	46,834	67,742	234,551
	(0)	(269)	(449)	(628)	(808)	(5,720)	(24,227)	(22,433)	(21,288)	(30,792)	(106,614)
SSW	0	592	988	1,382	1,421	11,845	44,416	25,927	58,542	60,216	205,328
	(0)	(269)	(449)	(628)	(646)	(5,384)	(20,189)	(11,785)	(26,610)	(27,371)	(93,331)
SW	0	592	642	898	711	12,584	50,338	16,727	58,542	75,269	216,304
	(0)	(269)	(292)	(408)	(323)	(5,720)	(22,881)	(7,603)	(26,610)	(34,213)	(98,320)
WSW	0	592	739	1,382	1,067	10,364	59,222	49,353	49,762	75,269	247,749
	(0)	(269)	(336)	(628)	(485)	(4,711)	(26,919)	(22,433)	(22,619)	(34,213)	(112,613)
W	0	592	790	1,382	1,778	11,845	53,299	88,834	110,548	142,133	411,198
	(0)	(269)	(359)	(628)	(808)	(5,384)	(24,227)	(40,379)	(50,249)	(64,606)	(186,908)
WNW	0	592	988	1,382	1,778	14,806	50,338	98,703	124,366	151,017	443,967
	(0)	(269)	(449)	(628)	(808)	(6,730)	(22,881)	(44,865)	(56,530)	(68,644)	(201,803)
NW	0	385	642	968	1,333	13,325	53,299	98,703	138,184	0	306,838
	(0)	(175)	(292)	(440)	(606)	(6,057)	(24,227)	(44,865)	(62,811)	(0)	(139,472)
NNW	0	0	0	0	0	4,442	50,338	93,768	138,184	177,665	464,398
	(0)	(0)	(0)	(0)	(0)	(2,019)	(22,881)	(42,622)	(62,811)	(80,757)	(211,090)

Table 5.4-29—Leafy Vegetable Production lb/year (kg/year)

(Page 2 of 2)

Sector	Distance miles (kilometers)										
	0-1* (0-1.6)	1-2 (1.6-3.2)	2-3 (1.6-4.8)	3-4 (4.8-6.4)	4-5 (6.4-8.1)	5-10 (8.1-16.1)	10-20 (16.1-32.2)	20-30 (32.2-48.3)	30-40 (48.3-64.4)	40-50 (64.4-80.5)	Total
Totals	0	4,827	7,058	10,503	12,080	123,627	630,714	950,723	1,429,705	2,700,421	5,869,657
	(0)	(2,194)	(3,208)	(4,774)	(5,491)	(56,194)	(286,688)	(432,147)	(649,866)	(1,227,464)	(2,668,026)

*Leafy vegetable production assumed to be zero in the 0-1 mile radius.

Table 5.4-30—Feed Production lb/year (kg/year)

(Page 1 of 2)

	Distance miles (kilometers)										
Sector	0-1* (0-1.6)	1-2 (1.6-3.2)	2-3 (1.6-4.8)	3-4 (4.8-6.4)	4-5 (6.4-8.1)	5-10 (8.1-16.1)	10-20 (16.1-32.2)	20-30 (32.2-48.3)	30-40 (48.3-64.4)	40-50 (64.4-80.5)	Total
N	0	0	0	0	0	0	0	5,167,314	14,468,478	28,833,609	48,469,401
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(2,348,779)	(6,576,581)	(13,106,186)	(22,031,546)
NNE	0	0	0	0	0	0	0	15,501,941	23,511,277	28,833,609	67,846,827
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(7,046,337)	(10,686,944)	(13,106,186)	(30,839,467)
NE	0	0	0	0	0	387,548	5,735,719	21,961,082	36,171,197	46,505,822	110,761,367
	(0)	(0)	(0)	(0)	(0)	(176,158)	(2,607,145)	(9,982,310)	(16,441,453)	(21,139,010)	(50,346,076)
ENE	0	0	0	0	0	1,937,742	15,191,902	20,669,255	36,171,197	24,186,391	98,156,485
	(0)	(0)	(0)	(0)	(0)	(880,792)	(6,905,410)	(9,395,116)	(16,441,453)	(10,993,814)	(44,616,584)
E	0	0	0	0	0	1,937,742	15,501,941	25,836,569	36,171,197	24,186,391	103,633,838
	(0)	(0)	(0)	(0)	(0)	(880,792)	(7,046,337)	(11,743,895)	(16,441,453)	(10,993,814)	(47,106,290)
ESE	0	0	0	0	0	387,548	13,951,747	12,918,283	25,319,837	44,180,532	96,757,949
	(0)	(0)	(0)	(0)	(0)	(176,158)	(6,341,703)	(5,871,947)	(11,509,017)	(20,082,060)	(43,980,886)
SE	0	77,510	77,510	90,429	116,266	1,162,645	3,100,387	5,167,314	9,042,799	18,602,329	37,437,187
	(0)	(35,232)	(35,232)	(41,104)	(52,848)	(528,475)	(1,409,267)	(2,348,779)	(4,110,363)	(8,455,604)	(17,016,903)
SSE	0	155,019	258,366	361,713	465,058	2,519,066	3,100,387	5,167,314	3,617,119	5,047,946	20,691,988
	(0)	(70,463)	(117,439)	(164,415)	(211,390)	(1,145,030)	(1,409,267)	(2,348,779)	(1,644,145)	(2,294,521)	(9,405,449)
S	0	155,019	258,366	361,713	465,058	3,294,163	13,951,747	12,918,283	31,409,437	45,431,509	108,245,295
	(0)	(70,463)	(117,439)	(164,415)	(211,390)	(1,497,347)	(6,341,703)	(5,871,947)	(14,277,017)	(20,650,686)	(49,202,407)
SSW	0	155,019	258,366	361,713	372,046	3,100,387	11,626,457	17,387,368	39,261,798	40,383,563	112,906,717
	(0)	(70,463)	(117,439)	(164,415)	(169,112)	(1,409,267)	(5,284,753)	(7,903,349)	(17,846,272)	(18,356,165)	(51,321,235)
SW	0	155,019	167,937	235,112	186,023	3,294,163	13,176,649	11,217,657	39,261,798	50,479,453	118,173,814
	(0)	(70,463)	(76,335)	(106,869)	(84,556)	(1,497,347)	(5,989,386)	(5,098,935)	(17,846,272)	(22,945,206)	(53,715,370)
WSW	0	155,019	193,774	361,713	279,035	2,712,840	15,501,941	12,918,283	33,372,528	50,479,453	115,974,588
	(0)	(70,463)	(88,079)	(164,415)	(126,834)	(1,233,109)	(7,046,337)	(5,871,947)	(15,169,331)	(22,945,206)	(52,715,722)
W	0	155,019	206,692	361,713	465,058	3,100,387	13,951,747	23,252,911	28,936,956	37,204,658	107,635,143
	(0)	(70,463)	(93,951)	(164,415)	(211,390)	(1,409,267)	(6,341,703)	(10,569,505)	(13,153,162)	(16,911,208)	(48,925,065)
WNW	0	155,019	258,366	361,713	465,058	3,875,485	13,176,649	25,836,569	32,554,075	39,529,950	116,212,884
	(0)	(70,463)	(117,439)	(164,415)	(211,390)	(1,761,584)	(5,989,386)	(11,743,895)	(14,797,307)	(17,968,159)	(52,824,038)
NW	0	100,762	167,937	253,198	348,795	3,487,937	13,951,747	25,836,569	36,171,197	0	80,318,139
	(0)	(45,801)	(76,335)	(115,090)	(158,543)	(1,585,426)	(6,341,703)	(11,743,895)	(16,441,453)	(0)	(36,508,245)
NNW	0	0	0	0	0	1,162,645	13,176,649	24,544,740	36,171,197	46,505,822	121,561,053
	(0)	(0)	(0)	(0)	(0)	(528,475)	(5,989,386)	(11,156,700)	(16,441,453)	(21,139,010)	(55,255,024)

Table 5.4-30—Feed Production lb/year (kg/year)

(Page 2 of 2)

	Distance miles (kilometers)										
Sector	**0-1* (0-1.6)**	**1-2 (1.6-3.2)**	**2-3 (1.6-4.8)**	**3-4 (4.8-6.4)**	**4-5 (6.4-8.1)**	**5-10 (8.1-16.1)**	**10-20 (16.1-32.2)**	**20-30 (32.2-48.3)**	**30-40 (48.3-64.4)**	**40-50 (64.4-80.5)**	**Total**
Totals	0	1,263,407	1,847,314	2,749,010	3,162,397	32,360,302	165,095,671	266,301,453	461,612,083	530,391,041	1,464,782,680
	(0)	(574,276)	(839,688)	(1,249,550)	(1,437,453)	(14,709,228)	(75,043,487)	(121,046,115)	(209,823,674)	(241,086,837)	(665,810,309)

*Feed production assumed to be zero in the 0-1 mile radius.

Table 5.4-31—Maryland and Virginia Landings, Commercial Fisheries[a, b, c]

(Page 1 of 6)

Species	1994 (past)				2004 (present)				2005+ (projected)			
	Maryland		Virginia		Maryland		Virginia		Maryland		Virginia	
	lbs	kg	lbs	kg	lbs	kg	lbs	kg	lbs	kg	lbs	kg
Finish												
Alewife	106,860	48,514	178,713	81,136	8,861	4,023	222,755	101,131	57,861	26,269	200,734	91,133
Amberjack	N/A	N/A	319	145	N/A	N/A	340	154	160	73	170	77
Bass, Striped	977,182	443,641	283,681	128,791	896,754	407,126	2,130,194	967,108	936,968	425,383	1,206,938	547,950
Bluefish	164,822	74,829	627,566	284,915	N/A	N/A	481,074	218,408	82,411	37,415	554,320	251,661
Bonito, Atlantic	13	6	3,672	1,667	N/A	N/A	N/A	N/A	7	3	1836	834
Butterfish	17,853	8,105	218,709	99,294	N/A	N/A	111,060	50,421	89,265	40,526	164,885	74,858
Carp, Common	101,069	45,885	44,280	20,103	4,269	1,938	17,531	7,959	52,669	23,912	30,906	14,031
Catfish, Blue	N/A	N/A	N/A	N/A	41,399	18,795	37,692	17,112	20,670	9,384	18,846	8,556
Catfishes & Bullheads	2,010,558	912,793	1,083,288	491,813	242,451	110,073	1,921,703	872,453	1,126,505	511,433	1,502,496	682,133
Cobia	29	13	7,817	3,549	N/A	N/A	6,143	2,789	15	7	6,980	3,169
Cod, Atlantic	20	9	8	4	N/A	N/A	N/A	N/A	10	5	4	2
Crappie	3,270	1,485	N/A	N/A	88	40	N/A	N/A	1,635	742	44	20
Croaker, Atlantic	218,744	99,310	5,773,430	2,621,137	1,800,940	817,627	9,487,635	4,307,386	1,009,842	458,468	7,630,533	3,464,262
Dealfish	N/A	N/A	274	124	N/A	N/A	4,062	1,844	137	62	2031	922
Dolphinfish	6,642	3,015	6,087	2,763	N/A	N/A	N/A	N/A	3321	1,508	3044	1,382
Drum, Black	8,956	4,066	153,202	69,554	1,082	491	88,605	40,227	5,019	2,279	120,904	54,890
Drum, Red	1,152	523	4,080	1,852	N/A	N/A	816	370	576	262	2,448	1,111
Eel, American	523,169	237,519	427,575	194,119	137,668	62,501	141,326	64,162	330,419	150,010	284,451	129,141
Eel, Conger	612	278	1,229	558	N/A	N/A	10,012	4,545	306	139	5,621	2,552
Finfishes, Unclassified bait and animal food	44,630	20,262	7,201,225	3,269,356	34	15	4,272,508	1,939,719	22,332	10,139	5,736,867	2,604,538
Finfishes, Unclassified for food	536	243	3,291	1,494	587,989	266,947	310,543	140,987	294,263	133,595	156,917	71,240
Finfishes, Unclassified General	N/A	N/A	33,738	15,317	N/A	N/A	N/A	N/A	N/A	N/A	16,869	7,659
Finfishes, Unclassified Spawn	N/A	N/A	N/A	N/A	N/A	N/A	5	2	N/A	N/A	3	1
Flatfish	N/A	N/A	N/A	N/A	284,785	129,292	11,498	5,220	142,393	64,646	5,749	2,610
Flounder, Summer	180,429	81,915	3,119,168	1,416,102	N/A	N/A	3,909,080	1,774,722	90,215	40,958	3,514,124	1,595,412
Flounder, Windowpane	N/A	N/A	51	23	N/A	N/A	N/A	N/A	N/A	N/A	26	12

Table 5.4-31—Maryland and Virginia Landings, Commercial Fisheries[a, b, c]
(Page 2 of 6)

Species	1994 (past)				2004 (present)				2005+ (projected)			
	Maryland		Virginia		Maryland		Virginia		Maryland		Virginia	
	lbs	kg	lbs	kg	lbs	kg	lbs	kg	lbs	kg	lbs	kg
Flounder, Winter	3,391	1,540	4,999	2,270	N/A	N/A	N/A	N/A	1,696	770	2,500	1,135
Flounder, Witch	1,918	871	23,052	10,466	N/A	N/A	N/A	N/A	959	435	11,526	5,233
Flounder, Yellowtail	N/A	N/A	773	351	N/A	N/A	N/A	N/A	N/A	N/A	387	176
Gars	3,546	1,610	5,497	2,496	N/A	N/A	33,470	15,195	1,773	805	19,484	8,846
Goosefish	168,356	76,434	1,453,602	659,935	97,570	44,297	1,002,460	455,117	132,963	60,365	1,228,031	557,526
Groupers	N/A	N/A	406	184	N/A	N/A	N/A	N/A	N/A	N/A	203	92
Grunts	N/A	N/A	12	5	N/A	N/A	N/A	N/A	N/A	N/A	6	3
Hake, Red	8,771	3,982	5,564	2,526	N/A	N/A	N/A	N/A	4,386	1,991	2,782	1,263
Hake, Silver	3,220	1,462	10,451	4,745	N/A	N/A	2,002	909	1,610	731	6,227	2,827
Harvestfish	55	25	35,244	16,001	N/A	N/A	46,573	21,144	28	13	40,899	18,568
Herring, Atlantic	2,595	1,178	1,255,389	569,947	N/A	N/A	1,672	759	1,298	589	628,531	285,353
Hogchoker	124	56	N/A	N/A	N/A	N/A	N/A	N/A	62	28	N/A	N/A
Hogfish	N/A	N/A	71	32	N/A	N/A	N/A	N/A	N/A	N/A	36	16
Jack, Crevalle	N/A	N/A	404	183	N/A	N/A	46	21	N/A	N/A	224	102
King Whiting	949	431	42,792	19,428	N/A	N/A	18,985	8,619	475	216	30,889	14,024
Leatherjackets	N/A	N/A	879	399	N/A	N/A	1,184	538	N/A	N/A	1,032	469
Mackerel, Atlantic	2,465	1,119	48,409	21,978	N/A	N/A	N/A	N/A	1,233	560	24,205	10,989
Mackerel, King and Cero	28	13	3,557	1,615	N/A	N/A	N/A	N/A	14	6	1,779	808
Mackerel, Spanish	3,363	1,527	376,818	171,075	4,881	2,216	66,979	30,408	4,122	1,871	221,899	100,742
Menhaden, Atlantic	3,512,417	1,594,637	513,269,653	233,024,422	3,336,180	1,514,626	399,797,922	181,508,257	3,424,299	1,554,632	456,533,788	207,266,340
Mullet, Striped (Liza)	70	32	4,613	2,094	N/A	N/A	937	425	35	16	5,550	2,520
Mullets	N/A	N/A	N/A	N/A	N/A	N/A	11,029	5,007	N/A	N/A	5,515	2,504
Perch, White	974,652	442,492	82,489	37,450	452,562	205,463	144,370	65,544	713,607	323,978	113,430	51,497
Perch, Yellow	71,421	32,425	5,935	2,694	13,585	6,168	17,171	7,796	42,503	19,296	11,553	5,245
Pigfish	N/A	N/A	127	58	N/A	N/A	29	13	N/A	N/A	78	35
Pollock	N/A	N/A	6,524	2,962	N/A	N/A	31	14	N/A	N/A	3,278	1,488
Pompano, Florida	N/A	N/A	1,899	862	N/A	N/A	1,416	643	N/A	N/A	1,658	753
Porgy, Red	N/A	N/A	N/A	N/A	N/A	N/A	98	44	N/A	N/A	49	22
Puffers	660	300	66,215	30,062	90	41	1,110	504	375	170	33,663	15,283
Red Fish or Ocean Perch	N/A	N/A	17	8	188	85	N/A	N/A	94	43	9	4

Table 5.4-31—Maryland and Virginia Landings, Commercial Fisheries[a, b, c]

(Page 3 of 6)

Species	1994 (past)				2004 (present)				2005+ (projected)			
	Maryland		Virginia		Maryland		Virginia		Maryland		Virginia	
	lbs	kg	lbs	kg	lbs	kg	lbs	kg	lbs	kg	lbs	kg
Rosefish, Blackbelly	N/A	N/A	175	79	N/A	N/A	N/A	N/A	N/A	N/A	88	40
Scups or Porgies	15,408	6,995	202,808	92,075	N/A	N/A	448,574	203,653	7,704	3,498	325,691	147,864
Sea Bass, Black	220,492	100,103	389,967	177,045	N/A	N/A	498,204	226,185	110,246	50,052	444,086	201,615
Searobins	7	3	N/A	N/A	N/A	N/A	N/A	N/A	4	2	N/A	N/A
Seatrout, Spotted	30	14	44,636	20,265	342	155	17,290	7,850	186	84	30,964	14,058
Shad, American	21,933	9,958	377,780	171,512	8,367	3,799	55,307	25,109	15,150	6,878	216,544	98,311
Shad, Gizzard	608,462	276,242	1,483,404	673,465	78,206	35,506	365,823	166,084	343,334	155,874	924,614	419,775
Shad, Hickory	9,110	4,136	158	72	212	96	8,071	3,664	4,661	2,116	4,115	1,868
Shark, Blacktip	31	14	6,376	2,895	N/A	N/A	72,434	32,885	16	7	39,405	17,890
Shark, Bull	260	118	N/A	N/A	N/A	N/A	N/A	N/A	130	59	N/A	N/A
Shark, Dogfish	1,662,247	754,660	138,631	62,938	17,734	8,051	1,069,600	485,598	839,991	381,356	604,116	274,269
Shark, Dusky	269	122	9,216	4,184	N/A	N/A	N/A	N/A	135	61	4,608	2,092
Shark, Hammerhead	1,540	699	53	24	N/A	N/A	N/A	N/A	770	350	27	12
Shark, Longfin Mako	7,053	3,202	184	84	N/A	N/A	N/A	N/A	3,527	1,601	92	42
Shark, Makos	4,725	2,145	3,768	1,711	N/A	N/A	N/A	N/A	2,363	1,073	1,884	855
Shark, Sand Tiger	129	59	8,727	3,962	N/A	N/A	N/A	N/A	65	30	4,364	1,981
Shark, Sandbar	19,476	8,842	6,154	2,794	N/A	N/A	N/A	N/A	9,738	4,421	3,077	1,397
Shark, Shortfin Mako	2,538	1,152	13,227	6,005	N/A	N/A	N/A	N/A	1,269	576	6,614	3,003
Shark, Smooth Dogfish	N/A	N/A	300,921	136,618	N/A	N/A	N/A	N/A	N/A	N/A	150,461	68,309
Shark, Spiny Dogfish	N/A	N/A	308,821	140,205	N/A	N/A	N/A	N/A	N/A	N/A	154,411	70,103
Shark, Silky	172	78	N/A	N/A	N/A	N/A	N/A	N/A	86	39	N/A	N/A
Shark, Thresher	3,372	1,531	10,676	4,847	456	207	7,119	3,232	1,914	869	8,898	4,040
Shark, Tiger	805	365	394	179	N/A	N/A	N/A	N/A	403	183	197	89
Sharks	7,239	3,287	66,555	30,216	10,042	4,559	238,500	108,279	8,641	3,923	152,528	69,248
Sheepshead	N/A	N/A	571	259	N/A	N/A	4,555	2,068	N/A	N/A	2,563	1,164
Skates	102,668	46,611	14,114	6,408	N/A	N/A	N/A	N/A	51,334	23,306	7,057	3,204
Snapper, Red	N/A	N/A	5	2	N/A	N/A	N/A	N/A	N/A	N/A	3	1
Spadefishes	N/A	N/A	4,961	2,252	N/A	N/A	9,177	4,166	2,481	1,126	4,589	2,083
Spot	166,246	75,476	4,269,402	1,938,309	N/A	N/A	4,338,082	1,969,489	83,123	37,738	4,303,742	1,953,899
Sturgeons	757	344	N/A	N/A	5	2	N/A	N/A	381	173	N/A	N/A
Suckers	620	281	N/A	N/A	355	161	N/A	N/A	488	222	N/A	N/A

Table 5.4-31—Maryland and Virginia Landings, Commercial Fisheries[a, b, c]
(Page 4 of 6)

Species	1994 (past)				2004 (present)				2005+ (projected)			
	Maryland		Virginia		Maryland		Virginia		Maryland		Virginia	
	lbs	kg	lbs	kg	lbs	kg	lbs	kg	lbs	kg	lbs	kg
Sunfishes	690	313	N/A	N/A	32	15	14	6	361	164	7	3
Swordfish	135,280	61,417	N/A	N/A	N/A	N/A	N/A	N/A	67,640	30,709	N/A	N/A
Tautog	1,718	780	11,441	5,194	N/A	N/A	13,123	5,958	859	390	12,282	5,576
Tilefish	38	17	107	49	N/A	N/A	N/A	N/A	19	9	54	25
Tripletail	N/A	N/A	N/A	N/A	N/A	N/A	22	10	N/A	N/A	11	5
Tuna, Albacore	9,934	4,510	3,063	1,391	N/A	N/A	N/A	N/A	4,967	2,255	1,532	696
Tuna, Bigeye	49,140	22,310	16,919	7,681	N/A	N/A	N/A	N/A	24,570	11,155	8,460	3,841
Tuna, Bluefin	3,697	1,678	1,052	478	N/A	N/A	N/A	N/A	1,849	839	526	239
Tuna, Little Tunny	113	51	4,766	2,164	N/A	N/A	196	89	57	26	2,481	1,126
Tuna, Skipjack	220	100	N/A	N/A	N/A	N/A	N/A	N/A	110	50	N/A	N/A
Tuna, Yellowfin	106,131	48,183	26,067	11,834	N/A	N/A	N/A	N/A	53,066	24,092	13,034	5,917
Tunas	118	54	361	164	77,708	35,279	10,463	4,750	38,913	17,667	5,412	2,457
Wahoo	1,279	581	67	30	N/A	N/A	N/A	N/A	640	291	34	15
Weakfish	140,907	63,972	1,294,224	587,578	N/A	N/A	357,100	162,123	70,454	31,986	825,662	374,851
Subtotal 1	12,429,401	5,637,976	544,896,545	247,165,073	8,104,835	3,676,353	431,825,720	195,876,147	10,267,118	4,657,165	488,361,133	221,520,610
Subtotal 2 (Factor A, Factor C)[d, e]	11,310,755	5,130,558	490,406,891	222,448,566	7,375,400	3,345,481	388,643,148	176,288,532	9,343,077	4,238,020	439,525,020	199,368,549
Subtotal 3 (Factor E)[g]	N/A	N/A	475,694,684	215,775,109	N/A	N/A	376,983,854	170,999,876	N/A	N/A	426,339,269	193,387,492
Edible Total (Factor F)[g]	870,928,135	395,053,002	366,284,907	166,146,834	5,679,058	2,576,021	290,277,568	131,669,905	7,194,169	3,263,275	328,281,237	148,908,369
												Shellfish
Clam, Arc, Blood	N/A	N/A	9,370	4,254	N/A	N/A	7,118	3,232	N/A	N/A	8,244	3,743
Clam, Atlantic Jackknife	37,466	17,010	N/A	N/A	N/A	N/A	N/A	N/A	18,733	8,505	N/A	N/A
Clam, Atlantic Surf	6,903,732	3,134,294	N/A	N/A	N/A	N/A	N/A	N/A	3,451,866	1,567,147	N/A	N/A
Clam, Softshell	448,667	203,695	N/A	N/A	N/A	N/A	N/A	N/A	224,334	101,848	N/A	N/A
Clam, Quahog	N/A	N/A	1,163,209	528,097	N/A	N/A	341,535	155,057	N/A	N/A	752,372	341,577
Clams or Bivalves	1,884,160	855,409	154,700	70,234	3,675,808	1,668,817	169,344	76,882	2,779,984	1,262,113	162,022	73,558
Crab, Blue	44,937,722	20,401,726	34,020,062	15,445,108	32,378,861	14,700,003	26,000,461	11,804,209	38,658,292	17,550,865	30,010,262	13,624,659
Crab, Blue, Peeler	24,794	11,256	1,257,974	571,120	4,582	2,080	1,614,061	732,784	14,688	6,668	1,436,018	651,952
Crab, Blue, Soft	N/A	N/A	146,934	66,708	352	160	28,132	12,772	176	80	87,533	39,740

Table 5.4-31—Maryland and Virginia Landings, Commercial Fisheries[a, b, c]

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Species	1994 (past)				2004 (present)				2005+ (projected)			
	Maryland		Virginia		Maryland		Virginia		Maryland		Virginia	
	lbs	kg	lbs	kg	lbs	kg	lbs	kg	lbs	kg	lbs	kg
Crab, Blue, Soft and Peeler	1,645,658	747,129	N/A	N/A	1,442,337	654,821	N/A	N/A	1,543,998	700,975	N/A	N/A
Crab, Horseshoe	N/A	N/A	15,136	6,872	N/A	N/A	232,069	105,359	N/A	N/A	123,603	56,116
Crab, Jonah	882	400	N/A	N/A	N/A	N/A	N/A	N/A	441	200	N/A	N/A
Crabs	N/A	N/A	6,729	3,055	253	115	N/A	N/A	127	58	3,365	1,528
Lobster, American	N/A	N/A	N/A	N/A	14,931	6,779	N/A	N/A	7466	3,390	N/A	N/A
Mussel, Blue	N/A	N/A	588	267	N/A	N/A	N/A	N/A	N/A	N/A	294	133
Octopus	N/A	N/A	3,117	1,415	N/A	N/A	N/A	N/A	N/A	N/A	1,559	708
Oyster, Eastern	817,829	371,294	300,581	136,464	42,791	19,427	44,442	20,177	430,310	195,361	172,512	78,320
Scallop, Bay	506	230	N/A	N/A	N/A	N/A	N/A	N/A	253	115	N/A	N/A
Scallop, Sea	1,914	869	6,260,654	2,842,337	93,121	42,277	19,650,546	8,921,348	47,518	21,573	12,955,600	5,881,842
Shellfish	667,947	303,248	460	209	3,767,549	1,710,467	27,048	12,280	2,217,748	1,006,858	13,754	6,244
Snails (Conchs)	N/A	N/A	3,526,785	1,601,160	N/A	N/A	274,071	124,428	N/A	N/A	1,900,428	862,794
Squid, Longin	13,166	5,977	N/A	N/A	N/A	N/A	113,703	51,621	6,583	2,989	56,852	25,811
Squids	9,719	4,412	699,718	317,672	8,092	3,674	1,276,067	579,334	8,906	4,043	987,893	448,503
Turtle, Snapping	1,800	817	N/A	N/A	24,694	11,211	4,240	1,925	13,247	6,014	2,120	962
Turtle, Terrapin	N/A	N/A	N/A	N/A	200		N/A	N/A	100	45	N/A	N/A
Subtotal 1	57,395,962	26,034,808	47,566,017	21,575,945	41,453,571	18,803,340	49,782,837	22,581,495	49,424,767	22,419,074	48,674,427	22,078,720
Subtotal 2 (Factor B, Factor D)[d,ei]	49,934,487	22,650,283	32,820,552	14,887,402	36,064,607	16,358,906	34,350,158	15,581,232	42,999,547	19,504,595	33,585,355	15,234,317
Subtotal 3 (Factor E)[f]	N/A	N/A	31,835,935	14,440,780	N/A	N/A	33,319,653	15,113,795	N/A	N/A	32,577,794	14,777,287
Edible Total (Factor F)[g]	38,449,555	17,440,718	24,513,670	11,119,401	27,769,747	12,596,357	25,656,133	11,637,622	33,109,651	15,018,538	25,084,901	11,378,511

Table 5.4-31—Maryland and Virginia Landings, Commercial Fisheries[a, b, c]
(Page 6 of 6)

Species	1994 (past)				2004 (present)				2005+ (projected)			
	Maryland		Virginia		Maryland		Virginia		Maryland		Virginia	
	lbs	kg	lbs	kg	lbs	kg	lbs	kg	lbs	kg	lbs	kg

Key: N/A – Not Applicable
Notes:

a. Landings represent round (live) weight of all species except univalve and bivalve mollusks (i.e., clams, mussels, oysters and scallops) which are reported as pounds of meat, excluding the shell. Principle fishing areas are the Chesapeake Bay and coastal areas off the shores of Maryland and Virginia.

b. Landings data for Maryland are for Ocean City Port (approximately 50 miles (81 kilometers) east of the subject site).

c. Landings data for Virginia are for Cape Charles-Oyster, Chincoteague, Hampton Roads Area and Reedville Ports. The approximate distances and directions between the subject site and the indicated ports are as follows: 60 miles (97 kilometers) southeast, 45 miles (72 kilometers) southeast, 65 miles (105 kilometers) south and 30 miles (48 kilometers) south, respectively. Also see Note "j"

d. Landings are reported in distance from the U.S. shoreline (i.e., '0 to 3 miles' ('0 to 4.8 kilometers), '3 to 200 miles' ('4.8 to 322 kilometers') and 'High Seas'). Based on 2004 data (i.e., 1994 data not available), poundage by distance from U.S. shores for Maryland is as follows:
   - Finfish overall total = 8,105,000 pounds (3,679,670 kg); Finfish total for '0 to 3 miles' ('0 to 4.8 kilometers') = 7,133,000 pounds (3,238,382 kg) (i.e., 88% of overall total); Finfish total for '3 to 200 miles' ('4.8 to 322 kilometers') = 972,000 pounds (441,288 kg) (i.e., 12% of overall total). Therefore, to estimate landings for finfish within 50 miles (81 kilometers) of the subject site discharge, Factor A = [0.88 + 0.25(0.12)] = 0.91 has been applied to the finfish subtotal for Maryland. [N.B.: A factor of 0.25 was applied to the finfish total for landings '3 to 200 miles' ('4.8 to 322 kilometers) from shore since 50 (miles) (81 kilometers) is ¼ of 200 (miles) (322 kilometers).]
   - Shellfish overall total = 41,454,000 pounds (18,820,116 kg); Shellfish total for '0 to 3 miles' ('0 to 4.8 kilometers') = 34,286,000 pounds (15,565,844 kg) (i.e., 83% of overall total); Shellfish total for '3 to 200 miles' ('4.8 to 322 kilometers') = 7,168,000 pounds (3,254,272 kg) (i.e., 17% of overall total). Therefore, to estimate landings for shellfish within 50 miles (81 kilometers) of the subject site discharge, Factor B = [0.83 + 0.25(0.17)] = 0.87 has been applied to the shellfish subtotal for Maryland. [N.B.: A factor of 0.25 was applied to the shellfish total for landings '3 to 200 miles' ('4.8 to 322 kilometers') from shore since 50 (miles) (81 kilometers) is ¼ of 200 (miles) (322 kilometers).]

e. Referring to Note "d," based on 2004 data (i.e., 1994 data not available), poundage by distance from U.S. shores for Virginia is as follows:
   - Finfish overall total = 431,826,000 pounds (196,049,004 kg); Finfish total for '0 to 3 miles' ('0 to 4.8 kilometers') = 375,546,000 pounds (170,497,884 kg) (i.e., 87% of overall total); Finfish total for '3 to 200 miles' = 56,280,000 pounds (25,551,120 kg) (i.e., 13 % of overall total). Therefore, to estimate landings for finfish within 50 miles (81 kilometers) of the subject site discharge, Factor C = [0.87 + 0.25(0.13)] = 0.90 has been applied to the finfish subtotal for Virginia. [N.B.: A factor of 0.25 was applied to the finfish total for landings '3 to 200 miles' ('4.8 to 322 kilometers') from shore since 50 (miles) (81 kilometers) is ¼ of 200 (miles) (322 kilometers).]
   - Shellfish overall total = 49,783,000 pounds (22,601,482 kg); Shellfish total for '0 to 3 miles' ('0 to 4.8 kilometers') = 28,653,000 pounds (13,008,462 kg) (i.e., 58% of overall total); Shellfish total for '3 to 200 miles' ('4.8 to 322 kilometers') = 21,129,000 pounds (9,592,566 kg) (i.e., 42% of overall total). Therefore, to estimate the landings for shellfish within 50 miles (81 kilometers) of the subject site discharge, Factor D = [0.58 + 0.25(0.42)] = 0.69 has been applied to the shellfish subtotal for Virginia. [N.B.: A factor of 0.25 was applied to the shellfish total for landings '3 to 200 miles' ('4.8 to 322 kilometers') from shore since 50 (miles) (81 kilometers) is ¼ of 200 (miles) (322 kilometers).]

f. Referring to Note "c," for the two ports greater than 50 miles (81 kilometers) from the subject site, Cape Charles-Oyster represents 0.1% of the total landings and Hampton Roads Area represents 3.9% of the total landings. Assuming that approximately 80% of landings for these two ports are in waters within 50 miles (81 kilometers) of the subject station discharge (i.e., 50 miles / 60 miles and 50 miles / 65 miles) (81 kilometers / 97 kilometers and 81 kilometers / 105 kilometers), Factor E = [1.0 – 0.8(0.001 + 0.039)] = 0.97 has also been applied to the landings for Virginia.

g. The U.S. supply of edible fishery products to the U.S. supply of edible and industrial fishery products between 1994 and 2004 ranges between 73 to 81 percent with an average percent of 77 for the 11 year span. Therefore, the total weight of edible fish was derived by multiplying 'subtotal' weights by Factor F = 0.77.

Table 5.4-32—Maryland and Virginia Landings, Recreational Fisheries[a, b]

(Page 1 of 2)

Species	2004 (present)[c]				2005 (present)[c]				2006+ (projected)[d]			
	Maryland		Virginia		Maryland		Virginia		Maryland		Virginia	
	lbs	kg	lbs	kg	lbs	kg	lbs	kg	lbs	kg	lbs	kg
Finfish												
Barracudas	0	0	0	0	0	0	10,780	4,894	0	0	5,390	2,447
Bluefish	90,270	40,983	189,025	85,817	186,917	84,860	288,296	130,886	138,594	62,922	477,321	216,704
Cartilaginous Fishes	29,539	13,411	721	327	37,540	17,043	28,717	13,038	33,540	15,227	14,714	6,680
Cods and Hakes	0	0	0	0	75	34	0	0	38	17	0	0
Dolphins	79,458	36,074	109,205	49,579	41,830	18,991	5,035	2,286	60,644	27,532	57,120	25,932
Drums	122,245	55,499	493,412	224,009	85,565	38,847	967,156	439,089	103,905	47,173	730,284	331,549
Eels	0	0	0	0	0	0	0	0	0	0	0	0
Flounders	19,284	8,755	48,391	21,970	52,659	23,907	88,133	40,012	35,972	16,331	68,262	30,991
Grunts	0	0	309	140	26	12	2,643	1,200	13	6	1,476	670
Herrings	0	0	483	219	0	0	8,867	4,026	0	0	4,675	2,122
Jacks	0	0	14,716	6,681	0	0	6,799	3,087	0	0	10,758	4,884
Mullets	0	0	0	0	0	0	0	0	0	0	0	0
Other Fishes	0	0	255,983	116,216	0	0	239,239	108,615	0	0	247,611	112,415
Porgies	108	49	340	154	0	0	7	3	54	25	174	79
Puffers	0	0	0	0	0	0	0	0	0	0	0	0
Sea Basses	183,383	83,256	50,840	23,081	86,641	39,335	115,503	52,438	135,012	61,295	83,172	37,760
Searobins	0	0	0	0	55	25	0	0	28	13	0	0
Temperate Basses	17,652	8,014	634,883	288,237	23,583	10,707	778,255	353,328	20,618	9,361	706,569	320,782
Toadfishes	0	0	0	0	0	0	0	0	0	0	0	0
Triggerfishes/Filefishes	5,011	2,275	2,515	1,142	16,673	7,570	62,560	28,402	10,842	4,922	32,538	14,772
Tunas and Mackerels	366,193	166,252	689,927	313,227	1,177,874	534,755	424,374	192,666	772,034	350,503	557,151	252,947
Wrasses	45,933	20,854	126,304	57,342	28,012	12,717	14,345	6,513	36,973	16,786	70,325	31,928
Subtotal 1	959,076	435,037	2,617,052	1,187,095	1,737,450	788,107	3,040,710	1,379,266	1,348,263	611,572	2,828,881	1,283,180
Subtotal 2 (Factor A, Factor C)[c]	872,759	395,883	2,355,347	1,068,385	1,581,080	717,178	2,736,639	1,241,339	1,226,919	556,530	2,545,993	1,154,862
Subtotal 3 (Factor E)[d]	N/A	N/A	2,284,687	1,036,334	N/A	N/A	2,654,540	1,204,099	N/A	N/A	2,469,613	1,120,216
Edible Total (Factor F)[e]	672,024	304,830	1,759,209	797,977	1,217,432	552,227	2,043,996	927,157	944,728	428,529	1,901,602	862,567

Table 5.4-32—Maryland and Virginia Landings, Recreational Fisheries[a, b]

(Page 2 of 2)

Species	2004 (present)[c]				2005 (present)[c]				2006+ (projected)[d]			
	Maryland		Virginia		Maryland		Virginia		Maryland		Virginia	
	lbs	kg	lbs	kg	lbs	kg	lbs	kg	lbs	kg	lbs	kg
Shellfish[f,g]												
Clams	1,658,143	752,797	99,565	45,203	1,658,143	752,797	99,565	45,203	1,658,143	752,797	99,565	45,203
Crabs	1,658,143	752,797	99,566	45,203	1,658,143	752,797	99,566	45,203	1,658,143	752,797	99,566	45,203
Oysters	1,658,143	752,797	99,566	45,203	1,658,143	752,797	99,566	45,203	1,658,143	752,797	99,566	45,203
Subtotal 1	4,974,429	2,256,401	298,697	135,489	4,974,429	2,256,401	298,697	135,489	4,974,429	2,256,401	298,697	135,489
Subtotal 2 (Factor B, Factor D)[c]	4,327,753	1,963,069	206,101	93,487	4,327,753	1,963,069	206,101	93,487	4,327,753	1,963,069	206,101	93,487
Subtotal 3 (Factor E)[d]	N/A	N/A	199,918	90,683	N/A	N/A	199,918	90,683	N/A	N/A	199,918	90,683
Edible Total (Factor F)[je]	3,332,370	1,511,563	153,937	69,826	3,332,370	1,511,563	153,937	69,826	3,332,370	1,511,563	153,937	69,826

Notes:

a. Weights of finfish are estimates and do not reflect an adjustment for a ‘proportional standard error (PSE)’ factor which varies among species, year of catch and by state. Finfish landings are based on both observed and reported harvests. No readily available statistics were found for recreational shellfish landings. Refer to Notes “f” and “g” for estimated shellfish poundage.

b. Principle fishing areas include Chesapeake Bay and coastal areas off the shores of Maryland and Virginia.

c. To estimate recreational finfish and shellfish landings within 50 miles (81 kilometers) of the subject site discharge, factors similar to those computed to estimate commercial landings within 50 miles (81 kilometers) were applied to the overall recreational finfish and shellfish subtotals**.** Referring to the Maryland and Virginia Landings, Commercial Fisheries Table 2.2-8, Factor A = 0.91 and Factor B = 0.87 were applied to the Maryland finfish and shellfish subtotals, respectively. Factor C = 0.90 and Factor D = 0.69 were applied to the Virginia finfish and shellfish subtotals, respectively.

d. To account for fishing areas greater than 50 miles (81 kilometers) from the subject site discharge, Factor E = 0.97 (see Maryland and Virginia Landings, Commercial Fisheries Table 2.2-8) has been applied to the Virginia landings for finfish and shellfish.

e. To estimate the edible totals for recreational finfish and shellfish landings, Factor F = 0.77 (see Maryland and Virginia Landings, Commercial Fisheries Table 2.2-8) has been applied to the Maryland and Virginia landings.

f. To estimate recreational shellfish landings, the ratios of recreational finfish landings for 2004 to commercial finfish landings for 2004 (see Maryland and Virginia Landings, Commercial Fisheries Table 5.4-31, Subtotal 1 for finfish) was first determined as follows:
   - Maryland ratio = (959,076 lbs / 8,104,835 lbs) = 0.12
   - Virginia ratio = (2,617,052 lbs / 431,825,720 lbs) = 0.006

   Ratios between recreational shellfish landings and commercial shellfish landings are assumed to be comparable. Therefore, these ratios were applied to the Maryland and Virginia 2004 commercial shellfish landings (see Maryland and Virginia Landings, Commercial Fisheries Table 2.2-8, Subtotal 1 for shellfish) to estimate the recreational shellfish landings in 2004 as follows:
   - Maryland = (0.12)(41,453,571 lbs) = 4,974,429 lbs (2,258,391 kg)
   - Virginia = (0.006)(49,782,837 lbs) = 298,697 lbs (135,608 kg)

g. Based on commercial landings (see Maryland and Virginia Landings, Commercial Fisheries Table 2.2-8), for the three most common caught shellfish species (i.e., clams, crabs and oysters), the total estimated poundage for recreational shellfish landings in 2004 was divided equally between the three species. The estimated poundage for recreational shellfish landings in 2005 was assumed to be the same as 2004.

5.5 ENVIRONMENTAL IMPACT OF WASTE

This section describes the potential environmental impacts that may result from the operation of the nonradioactive waste system and from storage and disposal of mixed wastes. As demonstrated in the following subsections, environmental impacts from CCNPP Unit 3 operational wastes will be minimal because of regulatory control and the small quantities generated.

5.5.1 NONRADIOACTIVE WASTE SYSTEM IMPACTS

A detailed description of nonradioactive waste management and effluents is provided in Section 3.6, which also includes estimates of nonradioactive liquid and gaseous effluents, and solid waste quantities.

All nonradioactive waste generated at CCNPP Unit 3 (i.e., solid wastes, liquid wastes, air emissions) will be managed in accordance with applicable federal, State of Maryland, and local laws, regulations, and permit requirements. Management practices will be similar, if not the same as those implemented for CCNPP Units 1 and 2, and will include the following:

- Nonradioactive solid wastes (e.g., office waste, recyclables) would be collected temporarily on the CCNPP site and disposed of at offsite licensed disposal and recycling facilities.

- Debris (e.g., vegetation, aquatic fish, and invertebrates) collected on trash racks and screens at the water intake structure would be disposed of as solid waste in accordance with the National Pollutant Discharge Elimination System (NPDES) permit applicable at the time of operation.

- Scrap metal, used oil, antifreeze (ethylene or propylene glycol), and universal waste will be collected and stored temporarily on the CCNPP site and recycled or recovered at an offsite permitted recycling or recovery facility, as appropriate. Used oil and antifreeze are not controlled hazardous substances in the State of Maryland unless they have been combined or mixed with characteristic or listed hazardous wastes. Typically, used oil and antifreeze are recycled. If they are not recyclable or recoverable, they will be disposed of as solid waste in accordance with the applicableregulations at the time of operation.

- Sewage sludge will be transported to a permitted offsite waste treatment plant for disposal.

Nonradioactive waste systems for CCNPP Unit 3 include the Circulating Water Treatment System, the Ultimate Heat Sink Water Treatment System, the Liquid Waste Processing System and the Waste Water Treatment System. Quantities, composition, and frequency of waste discharges to water, land, and air are shown in Section 3.6.

5.5.1.1 Desalinization Plant Brine

Potable water for CCNPP Unit 3 will be supplied by a desalinization plant that uses a reverse osmosis (RO) process. Chesapeake Bay water will be pumped at high pressures through membranes to filter out dissolved particles. The potential environmental impact of using such a system includes disposal of the brine extracted from the Chesapeake Bay water. However, the discharge effluent will be directed into the CCNPP Unit 3 Circulating Water Supply System (CWS) retention basin, thus reducing brine concentrations. As such, the discharge of brine is enveloped by the CWS system effluent discharge, which will be controlled and regulated as part of the CCNPP Unit 3 NPDES permit.

5.5.1.2 Impacts of Discharges to Water

Nonradioactive wastewater discharges from CCNPP Unit 3 to surface water will include cooling tower blowdown, permitted wastewater from the CCNPP Unit 3 auxiliary systems, and storm water runoff from impervious surfaces. In addition, potential impacts from chemical constituents in the cooling water and plant auxiliary systems discharges from CCNPP Unit 3 will be minimal via NPDES permit compliance. CCNPP Unit 3 will maintain engineering controls that prevent or minimize the release of chemical constituents to the Chesapeake Bay. Concentrations in the cooling water discharge will be limited by NPDES requirements and will be minimal or non-detectable in the Chesapeake Bay as discussed in Section 5.3.2.

The NPDES permit will also require a Storm Water Pollution Prevention Plan (SWPPP), which prevents or minimizes the discharge of potential pollutants with the storm water discharge, to reflect the addition of new paved areas and facilities and changes in drainage patterns. Impacts from increases in volume or pollutants in the storm water discharge will be minimized by implementation of best management practices (BMPs). As such, impacts are expected to be SMALL.

5.5.1.3 Impacts of Discharges to Land

Operation of CCNPP Unit 3 will result in an increase in the total volume of nonradioactive solid waste generated at the CCNPP site. Anticipated volumes of nonradioactive solid wastes are discussed in Section 3.6. However, there will be no expected fundamental change in the characteristics of these wastes or the way in which they are currently managed at CCNPP Units 1 and 2. Applicable Federal, State, and Local requirements and standards will be met for handling, transporting, and disposing of the solid waste. Solid waste will be reused or recycled to the extent possible. Solid wastes appropriate for recycling or reclamation (e.g., used oil, antifreeze [e.g., ethylene or propylene glycol], scrap metal, and universal waste) will be managed using approved and licensed contractors. Nonradioactive solid waste destined for offsite land disposal will be disposed of at approved and licensed offsite commercial waste disposal sites. Therefore, potential impacts from land disposal on nonradioactive solid waste will be SMALL.

5.5.1.4 Impacts of Discharges to Air

Operation of CCNPP Unit 3 will increase gaseous emissions to the air, primarily from equipment associated with the diesel generators. Six diesel generators (four to provide emergency power and two to provide power in the event of a station blackout) will be utilized by CCNPP Unit 3. The impact of air emissions from the diesel generators is addressed in Section 5.8. Emissions from these systems are addressed in Section 3.6. Cooling tower impacts on terrestrial ecosystems are addressed in Section 5.3.3.2.

All air emission sources associated with CCNPP Unit 3, as described in Section 5.8.1, will be managed in accordance with Federal, State, and Local air quality control laws and regulations. Hence, impacts to air quality will be SMALL and would not warrant mitigation.

The CCNPP Unit 3 will operate in full compliance with all applicable air pollution control requirements (MDPSC, 2008). In summation, this includes:

- National and State Ambient Air Quality Standards (NAAQS) — The addition of the new CWS and ESWS cooling towers and the EDG and SBO emergency generators will qualify for permitting as a major modification under the Prevention of Significant Deterioration (PSD) regulations with no significant impact to the current air quality levels or Maryland's plans for providing attainment and maintenance for the NAAQS.

- Federal or State Emission Standards — The new cooling towers will easily comply with the particulate matter (PM) emission requirements that apply to process sources. The fuel quality that will be available to the generators at time of installation will exceed the requirements for fuel sulfur content in Maryland regulations. There are no other Maryland emission limits that apply to the fuel combustion by the emergency generators. These sources will be in full compliance with Maryland's federally enforceable emission standards.

- Federal New Source Performance Standards — The emergency generators will be in compliance with the New Source Performance Standards (NSPS) for Stationary Compression Ignition Internal Combustion Engines. No NSPS applies to cooling towers.

- Federal Emission Standards for Hazardous Air Pollutants (HAP) — CCNPP Units 1 and 2 are not a major source of HAP emissions and, therefore, is not subject to the Maximum Achievable Control Technology (MACT) standard for cooling towers or the MACT standard for reciprocating internal combustion engines.

- Prevention of Significant Deterioration — Because the potential-to-emit (PTE) for the existing Units 1 and 2 categorizes the current plant as a major source, the addition of Unit 3 qualifies as a major modification to an existing major source subject to the PSD regulations. Because only PM and PM_{10} are emitted in significant quantities, Unit 3 is subject to PSD only for those pollutants. In accordance with the PSD regulations, an air quality modeling analyis was conducted to demonstrate that CCNPP Unit 3 in combination with nearby background sources will comply with the NAAQS and PSD increments for PM_{10}. In conformance with current EPA and state policy, the Co-Applicants will use compliance with the NAAQS for PM_{10} as a surrogate for compliance with the $PM_{2.5}$ NAAQS to meet PSD modeling requirements.

- State Construction Permit — Because CO, NO_x and SO_2 are not emitted in significant quantities, Unit 3 is subject to state permitting requirements for these pollutants. In accordance with Maryland requirements, an air quality modeling analysis was conducted to demonstrate that CCNPP Unit 3 will have an insignificant impact for CO, NO_x, and SO_2 and thus will not affect current compliance with the corresponding NAAQS and PSD increments.

- Nonattainment New Source Review — Because the PTE for NO_x and Volatile Organic Compound (VOC) from the sources at Unit 3 is less than 25 tpy, Unit 3 qualifies as a minor source not subject to the requirements of Nonattainment New Source Review.

5.5.1.5 Sanitary Waste

The liquid waste treatment plant for CCNPP Unit 3 will be utilized to dispose of the sanitary wastes that will be generated. The Waste Water Treatment Plant will be monitored and controlled by trained operators. Site sanitary wastes will be contracted to a private company whose personnel are licensed by the State of Maryland as Waste Treatment Operators. The waste sludge will be removed by the private company and transported to a waste treatment plant via State issued permits. Section 3.6 lists anticipated liquid and solid effluents.

5.5.2 MIXED WASTE IMPACTS

Mixed waste contains hazardous waste and a low level radioactive source, special nuclear material, or byproduct material. Currently, CCNPP manages mixed waste at CCNPP Units 1 and 2 in accordance with a Memorandum of Understanding (MOU) with the Maryland Department of the Environment (CGG, 2002). The MOU is patterned after the Environmental Protection Agency (EPA) 1991 Mixed Waste Enforcement Policy (EPA, 1991).

Nuclear power plants, in general, are not significant generators of mixed waste, with quantities accounting for less than 3% of the annual low level radioactive waste generated (NRC, 1996). Typical types of mixed waste generated include:

- Waste oil from pumps and other equipment
- Chlorinated fluorocarbons resulting from cleaning, refrigeration, degreasing, and decontamination activities
- Organic solvents, reagents, and compounds, and associated materials such as rags and wipes
- Metals such as lead from shielding applications and chromium from solutions and acids
- Metal-contaminated organic sludges and other chemicals
- Aqueous corrosives consisting of organic and inorganic acids

Mixed waste generation at CCNPP Units 1 and 2, in particular, is very limited. For example, the last mixed waste shipment was in 2004, which included one 55 gallon (208 liter) drum (CGG, 2004). Prior to that, the previous mixed waste shipment was in 1999 (BGE, 1999). NUREG 1437, Supplement 1 (NRC, 1999) determined such mixed waste quantities as having a small impact.

Based on the size of CCNPP Unit 3 compared to CCNPP Units 1 and 2, the types and quantities of mixed waste generation are anticipated to be equal to or less than CCNPP Units 1 and 2. As a result, the potential impacts will be the same or less, i.e., minimal. The small quantities of mixed waste will be temporarily stored onsite, similar to CCNPP Units 1 and 2, and then shipped for treatment and disposal to an offsite permitted facility.

Minimal environmental impacts would result from storage or shipment of mixed wastes. In the event of a spill, emergency procedures would be implemented to limit any onsite impacts. Emergency response personnel would be properly trained and would maintain a current facility inventory, which would include types of waste, volumes, locations, hazards, control measures, and precautionary measures to be taken in the event of a spill.

5.5.2.1 References

BGE, 1999. CCNPP Mixed Waste – Quarterly Update #19, Baltimore Gas and Electric Company to Maryland Department of the Environment, October 29. 1999.

CGG, 2002. Amended MOU – Mixed Wastes at Calvert Cliffs Nuclear Power Plant, Constellation Generation Group LLC to Maryland Department of the Environment, November 12, 2002.

CGG, 2004. CCNPP Mixed Waste – Interim Update 2004, Constellation Generation Group LLC to Maryland Department of the Environment, April 6, 2004.

EPA, 1991. 1991 Mixed Waste Enforcement Policy, Volume 56, U.S. Environmental Protection Agency, August 29, 1991.

MDPSC, 2008. Calvert Cliffs 3 Nuclear Project, LLC – UniStar Nuclear Operating Services, LLC – Supplemental Information Regarding Air Modeling, October 13, 2008.
Case No. 9127, Maryland Public Service Commission, August 13, 2008, Website: http://webapp.psc.state.md.us/Intranet/CaseNum/CaseAction.cfm?CaseNumber=9127. Date accessed: September 16, 2008.

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

NRC, 1999. Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 1, Regarding the Calvert Cliffs Nuclear Power Plant, NUREG-1437, Nuclear Regulatory Commission, October 1999.

5.6 TRANSMISSION SYSTEM IMPACTS

This section discusses transmission system operation and maintenance impacts on terrestrial and aquatic ecosystems and members of the public. The significance of these predicted impacts are evaluated and alternative practices to mitigate the impacts are proposed, as needed. The discussion is limited to the transmission facilities associated with CCNPP Unit 3 and modifications or upgrades to the existing transmission system required to connect the additional generation capacity from the unit. Impacts from the existing transmission system, constructed and operated for CCNPP Units 1 and 2, were addressed in the Environmental Report submitted with the original plant license application (BGE, 1970) and re-evaluated in the Environmental Report submitted with the license renewal application (BGE, 1998).

5.6.1 TERRESTRIAL ECOSYSTEMS

This section considers the effects of transmission facility operation and maintenance on the terrestrial ecosystem. The review evaluates the significance of these predicted impacts on important terrestrial species and habitats, and evaluates alternative practices to mitigate the impacts, as needed.

5.6.1.1 Terrestrial Ecosystems

The terrestrial ecology of the CCNPP site was characterized in a series of field studies conducted between May 2006 and May 2007. Field studies included a flora survey (TTNUS, 2007a), a faunal survey (TTNUS, 2007b), a rare tiger beetle survey (Knisley, 2006), a rare plant survey (TTNUS, 2007c), and a Wetland Delineation Report (TTNUS, 2007d).

Vegetation of the CCNPP Unit 3 project area was recently surveyed. Major plant communities comprise lawns and developed areas, old field, successional hardwood forest, mixed deciduous forest, mixed deciduous regeneration forest, well drained bottomland deciduous forest, poorly drained bottomland deciduous forest, and herbaceous marsh vegetation. A number of invasive exotic plant species occur, especially in association with disturbed areas. The Common Reed (Phragmites australis) and Japanese Stiltgrass (Microstegium vimineum) are abundant enough to degrade biodiversity and possibly prevent the occurrence of rare species. However, most of the project site landscape consists of regionally typical forest in various stages of maturation.

5.6.1.2 Important Terrestrial Species and Habitats

As noted in Section 2.4.1, the following species and habitats of the project site have been designated as important according to Federal and State of Maryland criteria:

Species important because of rarity:

- Bald Eagle (Haliaeetus leucocephalus): USA ~~Threatened~~Protected, State ~~Endangered~~Threatened
- Puritan Tiger Beetle (Cicindela puritana): USA Threatened
- Northeastern Beach Tiger Beetle (Cicindela dorsalis dorsalis): USA Threatened
- Showy Goldenrod (Solidago speciosa): State Threatened
- Shumard's Oak (Quercus shumardii): State Threatened

- Spurred Butterfly Pea (Centrosema virginianum): State Rare (unprotected)

Commercially or recreationally valuable species:

- White-tailed Deer (Odocoileus virginianus)

Species critical to the structure and function of local terrestrial ecosystems:

- Tulip Poplar (Liriodendron tulipifera)
- Chestnut Oak (Quercus prinus)
- Mountain Laurel (Kalmia latifolia)
- New York Fern (Thelypteris noveboracensis)

Species that could serve as biological indicators of effects on local terrestrial ecosystems:

- Scarlet Tanager (Piranga olivacea)

Important habitats:

- Herbaceous marsh – jurisdictional wetland
- Poorly drained bottomland deciduous forest – jurisdictional wetland
- Well drained bottomland deciduous forest – Federal floodplain status

5.6.1.3 Potential Adverse Effects of Operation and Maintenance Practices

The transmission system is described in Section 3.7 and consists of a new approximately 20 acre (8 hectare) onsite substation and two 1 mi (1.6 km) connecting circuit lines with associated towers, also on the CCNPP site. These facilities would connect to the existing offsite Baltimore Gas and Electric transmission system via the existing onsite CCNPP Units 1 and 2 substation. Modifications to offsite transmission facilities will be implemented within the existing substations.

The CCNPP site follows the standard industry practices for operation and maintenance of transmission line right-of-ways. Vegetation management is practiced to avoid any power outages and injury to the public and company employees from overgrown or diseased trees. Trees are pruned or cut, and integrated vegetation management performed, according to the relevant ANSI standards (ANSI, 2001) (ANSI, 2006).

Routine maintenance in and along the transmission corridor right-of-way requires cutting of herbaceous and low woody growth once a year, and cutting of saplings, larger shrubs and small trees once every five years. Herbicide applications are used only on an occasional basis, if at all. Access roads for construction and subsequent maintenance are stabilized wherever necessary with a course of stones to prevent formation of ruts and gullies in the exposed soil. These road surfaces will be allowed to grass over and cut only as necessary to maintain occasional vehicular access.

Additional adverse impacts would ensue from erosion of poorly stabilized soil if left exposed by excavation and the movement of heavy equipment and workers during construction. These effects can be prevented by implementation of best management practices to control stormwater runoff. Erosion and sedimentation impacts are subject to project control, and are not anticipated to be significant with the adoption of the mitigation measures described in Section 4.2. As noted above, herbaceous vegetation will be encouraged to cover road surfaces within the transmission line corridor to improve long-term post-construction stability.

Impacts on land use and scenery are considered to remain virtually unaltered by the proposed changes to power line corridor operation and maintenance activities, and do not warrant mitigation as discussed in Section 4.1.

Maintenance of the newly cleared segment of the onsite power line corridor might provide new opportunities for the Brown-headed Cowbird, a nest parasite, to penetrate the forest edge and impair the nesting success of host birds, including some forest-interior bird species like the Scarlet Tanager. Although considered a slight impact, this adverse impact would persist as long as the power line corridor is maintained in a primarily old-field stage of ecological succession adjoining sizeable forest tracts. The power line corridor is subject to direct adverse impacts in the form of intermittent disruptions associated with control of corridor vegetation by maintenance cutting activities. These impacts could include the mortality of small, relatively sedentary vertebrates and invertebrates, and the reduction of breeding success for other animal species, none of which are listed as important species in Section 2.4.1.

White-tailed Deer should continue to benefit over the long term from operation and maintenance of the power line right-of-way as a permanent old-field habitat, with its abundant supply of low vegetation for grazing and browsing.

Operation and maintenance activities for the transmission system lie outside a 1,500 ft (457 m) radius setback around the nearest four Bald Eagle nest sites. Hunting activities by Bald Eagles concentrate on the coastline and large water bodies. It was recently reported that an immature Bald Eagle died from electrocution on a power line (CEG, 2004). Based on over 30 years of CCNPP plant operation, repetition of this kind of accident appears unlikely.

The two listed tiger beetle species breed exclusively on the coastal bluff and immediately below it, and consequently would not be disturbed by power line operations and maintenance.

As described above, the Scarlet Tanager may undergo a slight negative effect of nest parasitism in proximity to the right-of-way. There also may be continuously adverse impacts on this and other forest-interior bird species from competition with and predation by forest-edge vertebrate species.

Management of the power line right-of-way as a permanent opening may eventually prove to have beneficial impacts on the three rare herbaceous plants listed in Section 5.6.1.2. These three species grow in a well-drained bottomland deciduous forest environment where the forest canopy is broken (TTNUS, 2007c). Shumard's Oak was possibly observed near the CCNPP Unit 3 project area. Shumard's Oak may regenerate in the right-of-way, but would not survive to maturity under the 5 year cutting schedule for vegetation control. It should not be disturbed during construction and operation of CCNPP Unit 3. The Spurred Butterfly Pea was possibly observed near the CCNPP Unit 3 project area but should not be disturbed during construction and operation. The Showy Goldenrod is inside the construction footprint and could be transplanted to the transmission right-of-way. However, the cutting schedule for the right-of-way necessitates this rare plant is transplanted to open field areas onsite that are outside the construction footprint and new transmission line right-of-way. The four plant species critical to the structure of the local terrestrial ecosystem discussed in Section 5.6.1.2

would have no significant interaction, either positive or negative, with power line operation and maintenance activities. The four plant species are the:

- Tulip Poplar (Liriodendron tulipifera),
- Chestnut Oak (Quercus prinus),
- Mountain Laurel (Kalmia latifolia), and
- New York Fern (Thelypteris noveboracensis)

As discussed in Section 2.4.1, all four species are key contributors to the overall structure and ecological function of the CCNPP site plant communities. They serve as an indicator of the ecological stability of the CCNPP site. The Tulip Poplar and Chestnut Oak together comprise the majority of the tree canopy in the forested areas on or surrounding the CCNPP site. Both tree species prefer moist, slightly acidic soil in full sun (UCONN, 2007). The Mountain Laurel is the most widespread shrub on the CCNPP site and forms dense shrub thickets in the understory of the upland forest. It grows best in cool, moist, acidic soil with partial shade to full sun (UCONN, 2007). The New York Fern is the most widespread ground cover plant and forms large dense patches throughout most of the forested floodplain. It grows best in moist woods in filtered light and moist areas along banks and streams (CTBS, 2007). Therefore, an open field environment in the transmission line right-of-way would not be conducive to or hinder the growth of these four dominant plant species.

Wetland habitats typical of the naturally forested landscapes throughout the CCNPP Unit 3 project area gain in biodiversity when exposed to the frequent cutting regime of the power line right-of-way. Indirect impacts on all three of the above mentioned forest habitats would be negligible, given observance of sound erosion-control measures.

As noted in Section 3.7.2.2, the height of the transmission lines will meet the National Electric Safety Code requirements (ANSI/IEEE, applicable version) to prevent induced current due to electrostatic effects for any ecological species by assuming a large truck or farm machinery may travel underneath the transmission lines. Therefore, there are no adverse effects due to induced current.

Also, as noted in Section 3.7.3.1, noise impacts associated with the transmission system lines are due to corona discharge (a crackling or hissing noise). Corona noise for a 500 kV line has been estimated to be 59.3 dBA during a worst case rain with heavy electrical loads (SCE, 2006). For reference, normal speech has a sound level of approximately 60 dB. Therefore, noise from the transmission lines will not have an adverse effect on the terrestrial ecology.

5.6.1.4 Measures and Controls to Mitigate Potential Impacts

Project design attempts first to avoid impacts on wetlands, and on other important habitats as well as important species. Where impacts are unavoidable, they are minimized to the greatest possible extent. Unavoidable impacts are then mitigated as part of the overall project plan.

The bare soil exposed on access roads will be rendered stable by covering it with a permeable cover of loose stone through which vegetation will be encouraged to grow to improve long-term post-construction stability. All other areas of disturbed soil will be similarly revegetated and maintained in such condition as a routine part of right-of-way management.

As noted in ER Section 4.3.1.1, the Showy Goldenrod population identified at Camp Conoy will be relocated to the open field areas to avoid destruction by the CCNPP Unit 3 site preparation and construction. Since the open old-field herbaceous plant community accommodates the goldenrod's habitat requirement for strong light, ~~transplantation~~relocation of the goldenrod to an open field areas, followed by periodic monitoring, is a cost-effective form of mitigation. As noted earlier, construction and transmission line activities should not disturb the site areas where the Shumard's Oak and Spurred Butterfly Pea are possibly located.

Biocides will be used sparingly if ever, in response to highly selective problems, and away from water, under the exclusive control of a licensed biocide applicator.

Streams and wetlands in the right-of-way that are connected with water bodies containing fish will be maintained in as well-shaded a state as possible to minimize the warming effect of direct sunlight on surface water.

5.6.1.5 Wildlife Management Practices

There are no ongoing formal wildlife management practices on the project site.

5.6.1.6 Consultation with Agencies

Affected Federal, State and Regional agencies will be contacted regarding the potential impacts to the terrestrial ecosystem resulting from transmission system operation and maintenance. The Maryland Natural Heritage Program, operated by the Maryland Department of Natural Resources, was consulted for information on known occurrences of Federally-listed and State-listed threatened, endangered, or special status species and critical habitats (MDNR, 2006). Identification of the important species discussed above was based in part on information provided by that consultation.

5.6.1.7 References

ANSI, 2001. Pruning Standard, A300 (PART 1), American National Standards Institute (ANSI), 2001.

ANSI, 2006. Integrated Vegetation Management Standard, A300 (PART 7), American National Standards Institute (ANSI), 2006.

ANSI/IEEE, applicable version. National Electric Safety Code, ANSI/IEEE C2, American National Standards Institute/Institute of Electrical and Electronic Engineers, version in effect at time of design.

BGE, 1970. Environmental Report, Calvert Cliffs Nuclear Power Plant, Baltimore Gas & Electric Company, November, 1970.

BGE, 1998. Environmental Report – Operating License Renewal Stage, Calvert Cliffs Units 1 & 2, Baltimore Gas & Electric Company, April 1998.

CEG, 2004. Letter from K. J. Nietmann (Constellation Energy Group) to U.S. Nuclear Regulatory Commission, Re: Report on mortality of a species protected by the Endangered Species Act of 1973, Calvert Cliffs Nuclear Power Plant, Attachment 1, July 28, 2004.

CTBS, 2007. Connecticut Botanical Society, Website: www.ct.botanical-society.org/ferns/index.html, Date accessed: 2007.

Knisley, 2006. Current Status of Two Federally Threatened Tiger Beetles at Calvert Cliffs Nuclear Power Plant, C. Barry Knisley, October 26, 2006.

MDNR, 2006. Letter from L. A. Byrne (Maryland Department of Natural Resources) to R. M. Krich (UniStar Nuclear), Re: Environmental Review for Constellation Energy's Calvert Cliffs Nuclear Power Plant Site, Lusby, Calvert County, Maryland, July 31, 2006.

SCE, 2006. SCE Devers-Palo Verde 500 kV No. Project (Application No. A.05-04-015), Final Environmental Impact Report/ Environmental Impact Statement, Southern California Edison (SCE), October 2006.

TTNUS, 2007a. Final Flora Survey Report for Proposed UniStar Nuclear Project Area Calvert Cliffs Nuclear Power Plant Site, Calvert County, Maryland, TetraTech NUS, May 2007.

TTNUS, 2007b. Final Faunal Survey Report for Proposed UniStar Nuclear Project Area Calvert Cliffs Nuclear Power Plant Site, Calvert County, Maryland, TetraTech NUS, May 2007.

TTNUS, 2007c. Final Rare Plant Survey Report for Proposed UniStar Nuclear Project Area Calvert Cliffs Nuclear Power Plant Site, Calvert County, Maryland, TetraTech NUS, May 2007.

TTNUS, 2007d. Final Wetland Delineation Report for Proposed UniStar Nuclear Project Area Calvert Cliffs Nuclear Power Plant Site, Calvert County, Maryland, TetraTech NUS, May 2007.

UCONN, 2007. University of Connecticut Plant Data base by Mark. H. Brand, Website: www.hort.uconn.edu/plants/index.html, Date accessed: 2007.

5.6.2 AQUATIC ECOSYSTEMS

This section considers the effects of transmission facility operation and maintenance on the aquatic ecosystems. The review evaluates the significance of these predicted impacts on important aquatic species and habitats, and evaluates alternative practices to mitigate the impacts, as needed.

5.6.2.1 Aquatic Ecosystems

As described in Section 2.4.2.1, surveys of benthic macroinvertebrates and fish were conducted during September 2006. At the same time, habitat quality was assessed. Results of the surveys are summarized for each water body in Section 2.4.2.1.

Water bodies that are impacted by the project are identified in Section 2.3 and listed below:

- Two unnamed streams (Branch 1 and Branch 2) on the eastern side of the drainage divide, Branch 1 being downstream of the Camp Conoy Fishing Pond;
- Johns Creek, Branch 3 and Branch 4, and the unnamed headwater tributaries;
- Goldstein Branch;
- Laveel Branch;
- Camp Conoy Fishing Pond and two downstream impoundments;

- Lake Davies and two unnamed impoundment(s) within the Lake Davies dredge spoils disposal area; and
- Chesapeake Bay and Patuxent River.

5.6.2.2 Important Aquatic Species and Habitats

As described in Section 2.4.2, extensive surveys of these water bodies were conducted. No rare or unique aquatic species were identified in freshwater systems in the project vicinity. The aquatic species that are present onsite are ubiquitous, common, and easily located in nearby waters. Typical fish species include the eastern mosquitofish, bluegill, and the American eel. The most important aquatic invertebrate species in the impoundments and streams are the juvenile stages of flying insects. Section 2.4.2 also provides a discussion on the physical, chemical, and biological factors known to influence distribution and abundance of aquatic life. No important aquatic habitats were identified in the freshwater systems in the project vicinity.

Table 2.4-6 provides a list of important species and habitats found in the Chesapeake Bay. Figure 2.4-1 is a map of important species and habitats.

One important species, because it is commercially harvested, is the American eel (*Anguilla rostrata*). It is found in most of the water bodies onsite and in the Chesapeake Bay. The American eel is abundant year round in all tributaries to the Chesapeake Bay (CBP, 2007).

5.6.2.3 Potential Impacts from Operation and Maintenance

The proposed transmission system is described in Section 3.7 and consists of a new approximately 20 acre (8 hectare) substation on the CCNPP site and two 1 mi (1.6 km) connecting circuit lines with associated towers, also on the CCNPP site. These facilities would connect to the existing offsite Baltimore Gas and Electric transmission system via the existing onsite CCNPP Units 1 and 2 substation. Modifications to the offsite transmission facilities will be implemented within the existing substations.

The CCNPP Unit 3 substation and transmission lines would be constructed in areas that, at present, are vegetated, contain delineated wetlands and have steep topography.

The new transmission lines do not cross over any onsite water bodies. At one point, the transmission corridor right-of-way is near Johns Creek.

Transmission system operations and maintenance have the potential to cause impacts to water bodies and aquatic ecology.

The CCNPP site follows the standard industry practices for operation and maintenance of transmission line right-of-ways. Vegetation management is practiced to avoid any power outages and injury to the public and company employees from overgrown or diseased trees. Trees are pruned or cut, and integrated vegetation management performed, according to the relevant ANSI standards (ANSI, 2001) (ANSI, 2006).

Regular inspections and maintenance of the transmission system and right-of-way corridors are performed. A patrol is performed twice annually of all transmission corridors, while more comprehensive inspections are performed on a rotating 5 year schedule. Maintenance is performed on an as needed basis as dictated by the results of the line inspections.

Routine maintenance in and along the transmission corridor right-of-way requires cutting of herbaceous and low woody growth once a year, and cutting of saplings, larger shrubs and small trees once every five years. Herbicide applications are used only on an occasional basis, if at all. Access roads for construction and subsequent maintenance are stabilized wherever necessary with a course of stones to prevent formation of ruts and gullies in the exposed soil. These road surfaces will be allowed to grass over and cut only as necessary to maintain occasional vehicular access.

Increased runoff from 20 acres (8 hectares) of impervious surfaces from the switchyard could cause a modification to the hydrograph and increases in temperature, sediment and nutrients in receiving water bodies, and corresponding impacts to aquatic invertebrates, plants, and fish. Impacts from these affects would be mitigated by the provision of storm water retention facilities downstream. There is also the potential to increase stream temperatures from the removal of shade from ground and water bodies in the transmission corridor, but this is anticipated to be of minor significance.

Runoff of defoliants and herbicides could potentially contaminate water bodies and affect aquatic species. As previously noted, application of these chemicals is anticipated to be very infrequent and the impact, if any, would be temporary.

No access for recreation is permitted within the transmission system area, so no impacts to water-based recreational use are anticipated. Although the new transmission right-of-way will not cross over any water bodies, a portion does run near Johns Creek.

Since the transmission facilities are not proximal to the Chesapeake Bay, no direct impacts to the aquatic ecosystem in the Chesapeake Bay from transmission system operations are anticipated. Indirect impacts from increased heat and sediment flow in tributary streams may occur, but would be mitigated by storm water retention facilities.

The juvenile stages of flying insects readily recolonize available surface waters, and so would not be lost to the area from any intermittent operational impacts, such as transmission line maintenance. Species and other resources in the Chesapeake Bay are not anticipated to be adversely affected by transmission system operations.

In summary, measures will be established such that sedimentation from transmission corridor access roads and the CCNPP Unit 3 substation will not reach Johns Creek. As such, the operational and maintenance impacts of the onsite transmission system to the American eel, other fish species and macroinvertebrates will be SMALL.

5.6.2.4 Measures and Controls to Mitigate Potential Impacts

The bare soil exposed on transmission facility access roads will be rendered stable by covering it with a permeable cover of loose stone through which vegetation will be encouraged to grow to improve long-term post-construction stability. All other areas of disturbed soil will be similarly revegetated and maintained in such condition as a routine part of right-of-way management.

Biocides will be used sparingly if ever, in response to highly selective problems, and away from water, under the exclusive control of a licensed biocide applicator.

Small streams and wetlands in the right-of-way that are connected with water bodies containing fish, such as Johns Creek, will be maintained in as well-shaded a state as possible to minimize the warming effect of direct sunlight on surface water.

As described in Section 2.4.2, the only important aquatic species found near the new transmission facilities is the American eel in Johns Creek. Important species and habitats are found in the Chesapeake Bay. However, no adverse impacts to these species or habitats are anticipated from operation of the transmission facilities.

5.6.2.5 Consultation with Agencies

Affected Federal, State and Regional agencies have already been or will be contacted regarding the potential impacts to the terrestrial ecosystem resulting from transmission system operation and maintenance. The Maryland Natural Heritage Program, operated by the Maryland Department of Natural Resources, was consulted for information on known occurrences of Federally-listed and State-listed threatened, endangered, or special status species and critical habitats (MDNR, 2006). Identification of the important species discussed above was based in part on information provided by that consultation.

5.6.2.6 References

ANSI, 2001. Pruning Standard, A300 (PART 1), American National Standards Institute (ANSI), 2001.

ANSI, 2006. Integrated Vegetation Management Standard, A300 (PART 7), American National Standards Institute (ANSI), 2006.

CBP, 2006a. Chesapeake Bay Program (CBP), Website: http://www.chesapeakebay.net/baybio.htm, Date accessed: 2007.

MDNR, 2006. Letter dated July 31, 2006 from L. A. Byrne (of the Maryland Department of Natural Resources) to R. M. Krich (of UniStar Nuclear), Re: Environmental Review for Constellation Energy's Calvert Cliffs Nuclear Power Plant Site, Lusby, Calvert County, Maryland, July 31, 2006.

5.6.3 IMPACTS TO MEMBERS OF THE PUBLIC

This section describes the transmission system impacts from the CCNPP Unit 3 substation to its connection with existing systems. The description is limited to the transmission facilities associated with the new CCNPP Unit 3 and modifications or upgrades to the existing transmission system required to connect the additional generation capacity from the proposed unit. Impacts from the existing transmission system, constructed and operated for CCNPP Units 1 and 2, were addressed in the Environmental Report submitted with the original plant license application (BGE, 1970) and re-evaluated in the Environmental Report submitted with the license renewal application (BGE, 1998).

5.6.3.1 Electrical Design Parameters

As described in Section 3.7, the CCNPP Unit 3 substation will be electrically integrated with the existing 500 kV station by constructing two 1.0 mi (1.6 km), 500 kV, 3,500 MVA lines on individual towers entirely within the boundary of the CCNPP site. The detailed design of the transmission lines circuits has not begun but the conductors would be selected to meet the power delivery requirements. The two, 500 kV lines connecting the existing CCNPP Units 1 and 2 and the new CCNPP Unit 3 substation would be rated at 3,500 MVA (normal rating) (PJM, 2006). Each phase would use the same three-subconductor bundles comprised of three 1590 circular mills, 45/7 aluminum conductor, steel reinforced (ACSR) conductors with 18 in (46 cm) separation. There would typically be two overhead ground wires of 19#9 Alumoweld® or 7#8 Alumoweld®, but the final design could specify OPGW fiber optic cable in place of the

Alumoweld® ground wire. The new lines would be designed to preclude crossing of lines wherever possible.

The design of the new transmission circuits would consider the potential for induced current as a design criterion. The National Electric Safety Code (NESC) has a provision that describes how to establish minimum vertical clearances to the ground for electric lines having voltages exceeding 98 kV alternating current to ground (NESC, 2007). The clearance must limit the induced current due to electrostatic effects to 5 mA if the largest anticipated truck, vehicle, or equipment were short-circuited to ground. For this determination, the NESC specifies that the lines be evaluated assuming a final unloaded sag at 120°F (49°C). The calculation is a 2-step process in which the analyst first calculates the average field strength at 1 m (3.3 ft) above the ground beneath the minimum line clearance, and second calculates the steady-state current value. The design and construction of the CCNPP Unit 3 substation and transmission circuits would comply with this NESC provision. At a minimum, conductor clearances over the ground would equal or exceed 29 ft (9 m) phase-to-ground over surfaces that could support a large truck or farm machinery, while clearance over railroad lines would equal or exceed 37 ft (11 m) phase-to-ground.

Environmental impacts are limited to the proposed plant and construction area on the CCNPP site. No new corridors, or crossings over main highways, primary and secondary roads, waterways, or railroad lines is required.

5.6.3.2 Structural Design Parameters

As described in Section 3.7, the number and location of the transmission towers between the existing CCNPP Units 1 and 2 substation and the CCNPP Unit 3 substation will be determined during the detailed design of CCNPP Unit 3. The CCNPP Unit 3 substation would occupy a 700 ft (213 m) by 1,200 ft (366 m) tract of land approximately 1,000 ft (305 m) southeast of the CCNPP Unit 3 power block and 2,000 ft (610 m) east-southeast of the CCNPP Unit 1 and 2 switchyard as shown in Figure 3.7-2. The CCNPP Unit 3 substation would be electrically integrated with the existing 500 kV substation by constructing two 1.0 mi (1.6 km), 500 kV, 3,500 MVA lines on individual towers. At the existing substation, the two line positions previously used for 500 kV circuits 5052 (Calvert Cliffs to Waugh Chapel) and 5072 (Calvert Cliffs to Chalk Point) would be upgraded for use with the two lines to the CCNPP Unit 3 substation. The 5052 and 5072 circuits would be connected to the CCNPP Unit 3 substation, while the 5051 circuit to Waugh Chapel would remain connected to the CCNPP Units 1 and 2 substation (PJM, 2006). The existing 500 kV transmission towers are designed and constructed to National Electric Safety Code (NESC) and State of Maryland standards. The new towers added to support CCNPP Unit 3 will also conform to these criteria. The new towers will be steel tubular or lattice designs, and will provide minimum clearances in accordance with the aforementioned standards. The two 1.0 mi (1.6 km) circuits connecting the CCNPP Units 1 and 2 substation and the CCNPP Unit 3 substation will be carried on separate towers. All structures will be grounded with a combination of ground rods and a ring counterpoise system. None of the transmission structures will exceed a height of 200 ft (61 m) above ground surface; thus, Federal Aviation Administration permits (FAA, 2000) will not be required.

5.6.3.3 Maintenance Practices

The new transmission lines and towers for CCNPP Unit 3 are located entirely within the boundary of the CCNPP site. Environmental impacts would be limited to the proposed project plant and construction area on the CCNPP site. Thus, no new corridors and associated vegetation buffer zones would be required to minimize visual impacts along roadways.

The use of pesticides and herbicides for vegetation control is described in the BGE transmission vegetation management program. The aim of the vegetation management program is to promote the safe and reliable transmission of electricity. The prescription on chemical mixes, application methods, and rates would be made by a licensed pesticide applicator. All chemicals would be registered by the appropriate federal and state regulatory agencies. Special care would be exercised when working around streams, crops, lawns, and wetlands so as not to allow any chemical contact with these areas. A Regional Letter of Authorization to use herbicides in nontidal wetlands or waters has been authorized by the Maryland Department of the Environment (MDE) and compliance with the label requirements and the MDE regulations is required. Adherence to these policies and procedures would minimize any additional impacts to the ecosystem in the onsite transmission corridor. The rate of control of targeted vegetation is a minimum of 90% by span. Inspections to identify areas requiring herbicide treatments are performed annually.

5.6.3.4 Aircraft Visibility

The Federal Aviation Administration normally requires that structures that exceed a height of 200 ft (61 m) above ground level be marked and/or lighted for "increased conspicuity to ensure safety to air navigation" (FAA, 2000). The transmission structures connecting the CCNPP Unit 3 substation with existing systems will be designed with sufficient height to eliminate impacts to personnel or equipment on the ground at the CCNPP site but would be less than the 200 ft (61 m) criterion.

Helicopters, however, may land periodically at the CCNPP site and the design of the transmission towers and lines will include lights and markers, where appropriate, to alert helicopter traffic to potential hazards created by the proposed structures. For example, lighting may be incorporated into tower design and painted spherical markers may be attached to overhead lines for increased conspicuity to ensure air safety (FAA, 2000).

Aesthetic impacts are also considered in the design of the new transmission structures. Buildings and equipment will be painted to blend with the existing facilities and will not significantly increase the visual impact of the CCNPP site. While the new transmission towers will be of sufficient height to avoid safety impacts on the ground, the towers will not be excessively high such that aircraft safety is compromised or unnecessary visual impacts result from excessive tower height.

5.6.3.5 Electric Field Gradients

The maximum electric field gradients for the proposed transmission lines can be predicted through calculation. While there are no specific criteria for maximum electric field gradients, induced currents resulting from high electric fields created by overhead transmission lines are a concern and must be considered in the system design in accordance with the NESC (ANSI/IEEE, applicable version).

As part of the design process, the transmission lines will be analyzed to determine electrical-field strengths and to verify conformance with NESC requirements on line clearance to limit shock from induced currents. The minimum clearance to the ground, for lines having voltages exceeding 98 kV alternating current, must limit the potential induced current due to electrostatic effects to 5 milliamperes if the largest anticipated truck, vehicle, or other equipment were short-circuited to ground. For this determination, the NESC specifies that the lines be evaluated assuming a final unloaded sag at 120°F (49°C). The calculation is a 2-step process in which the average field strength at 1.0 m (3.3 ft) above the ground beneath the minimum line clearance is calculated, and then the steady-state current value is determined.

The 500 kV lines to be constructed between the CCNPP Unit 3 substation and the CCNPP Units 1 and 2 substation will be designed to meet the NESC (ANSI/IEEE, applicable version).

5.6.3.6 Proposed Transmission Corridors

The transmission lines to support CCNPP Unit 3 will be constructed within the CCNPP site, thus no new corridors or widening of existing corridors is required. A map showing the routes for the existing two 500 kV circuits from the CCNPP site to the Waugh Chapel Substation and the single 500 kV circuit from the CCNPP site to the Chalk Point Generating Station is shown in Figure 3.7-1. The site topography and generalized route for the transmission line on the CCNPP site is shown in Figure 3.7-2. The onsite transmission lines are anticipated to cross over a construction road and laydown areas associated with the project. Since these lines are not expected to be constructed until the end of the project, exposure of the construction phase work force to field gradients would be minimal. Areas under the transmission lines would be cleared of any vegetation that might pose a safety threat. Any maintenance access roads are not anticipated to increase the public's exposure to electric field gradients. The anticipated re-establishment of native grasses and shrub vegetation, rather than tall trees, in the corridor will also limit wildlife exposure for smaller animal species.

5.6.3.7 Impacts to Communication Systems

Generally, the cause of radio or television interference from transmission lines is from corona discharge from defective insulators or hardware. Complaints on electromagnetic interference with radio or television reception have not been received on the lines running from the CCNPP site to the Waugh Chapel Substation and the Chalk Point Generating Station. Complaints that occur are investigated for cause and, as necessary, defective components replaced to correct the problem. The existing CCNPP transmission lines are designed and constructed to minimize corona. The lines supporting CCNPP Unit 3 will also be designed and constructed to minimize corona. As such, it is expected that radio and television interference from these new lines will be minimal.

5.6.3.8 Grounding Procedures for Stationary Objects

There are no new offsite lines and associated rights-of-way required for CCNPP Unit 3. The structures and equipment on the CCNPP site will be adequately grounded in the course of designing and constructing the proposed CCNPP Unit 3. No new offsite rights-of-way and associated grounding of stationary objects is required.

5.6.3.9 Electric Shock Potentials to Moving Vehicles

There is minimal potential for electric shock in moving vehicles such as buses or cars since the vehicles are insulated from ground by their rubber tires. As a result, occupants in cars and buses are generally safe from potential shock from overhead high voltage lines. In addition, since the vehicle is moving, there is little opportunity for the vehicle to become "capacitively charged" due to immersion in a transmission line's electrical field. In the unlikely event that a moving vehicle becomes charged, it is also unlikely that a grounded person outside the moving car or bus will touch the vehicle, thereby discharging a current through the person's body.

5.6.3.10 Noise Levels

Corona discharge is the electrical breakdown of air into charged particles caused by the electrical field at the surface of the conductors, and is increased by ambient weather conditions such as humidity, air density, wind, and precipitation and by irregularities on the energized surfaces. During wet conditions audible noise from the corona effect can exceed 50 dBA for a 500 kV line. Corona noise for a 500 kV line may range between 59 and 64 dBA during a worst case rain with heavy electrical loads (CA, 2006). For reference, normal speech has a sound level of approximately 60 dBA and a bulldozer idles at approximately 85 dBA. The State of Maryland Environmental Noise Standard for industrial zoning districts is 70 dBA (COMAR, 2005).

CCNPP transmission lines are designed and constructed with hardware and conductors that have features to eliminate corona discharge. Nevertheless, during wet weather, the potential for corona discharge increases, and nuisance noise could occur if insulators or other hardware have any defects. Corona-induced noise along the existing transmission lines is very low or inaudible, except possibly directly below the line on a quiet, humid day. Such noise does not pose a risk to humans. Complaints on transmission line noise are monitored but reports of nuisance noise have not been received from members of the public.

As shown in Figure 3.7-2, the CCNPP Unit 3 substation and transmission lines connecting the CCNPP Unit 3 substation with the CCNPP Units 1 and 2 substation will be constructed entirely on the CCNPP site. Substations include transformer banks and circuit breakers that create “hum,” normally around 60 dBA, and occasional instantaneous sounds in the range of 70 to 90 dBA during activation of circuit breakers (SCE, 2006). The proposed CCNPP Unit 3 substation will introduce these new noise sources (transformers and circuit breakers) to its location. The noise levels surrounding the substation would likely be close to 60 dBA near the substation fence, but would be significantly reduced near the site boundary, approximately 2,800 ft (850 m) to the south.

According to NUREG-1437 (NRC, 1996), noise levels below 60 to 65 decibels are considered to be of small significance.

5.6.3.11 References

ANSI/IEEE, applicable version. National Electric Safety Code, ANSI/IEEE C2, American National Standards Institute/Institute of Electrical and Electronics Engineers, version in effect at time of design.

BGE, 1970. Environmental Report, Calvert Cliffs Nuclear Power Plant, Baltimore Gas and Electric Company, November 1970.

BGE, 1998. Applicant’s Environmental Report – Operating License Renewal Stage, Calvert Cliffs Nuclear Power Plant Units 1 and 2, Baltimore Gas and Electric Company, April 1998.

CA, 2006. Southern California Edison’s Devers-Palo Verde 500 kV Project (Application Number A.05-04-015), Final Environmental Impact Report/Environmental Impact Statement, California Public Utilities Commission, October 2006.

COMAR, 2005. Code of Maryland Regulation, Title 26, Subtitle 2, Chapter 3, Control of Noise Pollution, July 2005.

FAA, 2000. Advisory Circular: Obstruction Marking and Lighting, Federal Aviation Commission, U.S. Department of Transportation, August 2000.

NESC, 2007. National Electric Safety Code, Part 2, Rules 232C.1.c and 232D.3.c, 2007.

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

PJM, 2006. PJM Generator Interconnection Q48 Calvert Cliffs 1640 MW Feasibility Study, DMS #390187, PJM Interconnection LLC, October 2006.

5.7 URANIUM FUEL CYCLE IMPACTS

This section discusses the environmental impacts from the uranium fuel cycle for the U.S. EPR. The uranium fuel cycle is defined as the total of those operations and processes associated with provision, utilization, and ultimate disposal of fuel for nuclear power reactors.

The regulations in 10 CFR 51.51(a) (CFR, 2007a) state that:

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

NRC Table S-3 is used to assess environmental impacts. Its values are normalized for a reference 1,000 MWe light water reactor (LWR) at an 80% capacity factor. The 10 CFR 51.51(a), Table S-3 (CFR, 2007a) values are reproduced as the "Reference Reactor" column in Table 5.7-1. A typical U.S EPR unit has been evaluated operating at a 95% capacity factor. The results of this evaluation are also included in Table 5.7-1.

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

Because the U.S. does not currently reprocess spent fuel, only the "no recycle" option is considered here. Natural uranium is mined from either open-pit or underground mines or by an in-situ leach solution process. In-situ leach mining, the primary form used in the U.S. today, 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 in-situ leach solution containing uranium is transferred to mills where it is processed to produce uranium oxide (UO_2) or "yellowcake". A conversion facility prepares the uranium oxide from the mills for enrichment by converting it to uranium hexafluoride, which is then processed to separate the non-fissile isotope uranium-238 from the fissile isotope uranium-235. At a fuel fabrication facility, the enriched uranium, which is approximately 4-5 percent uranium-235, is converted to UO_2. The UO_2 is pelletized, sintered, and inserted into tubes to form fuel assemblies. The fuel assemblies are placed in the reactor to heat water to steam which turns turbines which produce power. The nuclear reaction reduces the amount of uranium-235 in the fuel. When the uranium-235 content of the fuel reaches a point where the nuclear reaction becomes inefficient, the fuel assemblies are withdrawn from the reactor. After onsite storage for a time sufficient to allow the short-lived fission products to decay thus reducing the heat generation rate, the fuel assemblies would be available for transfer to a permanent waste disposal facility for internment. Disposal of spent fuel elements in a repository constitutes the final step in the “no recycle” option.

The following assessment of the environmental impacts of the fuel cycle for a U.S. EPR at the Calvert Cliffs Nuclear Power Plant (CCNPP) site is based on the values in NRC Table S-3 and the NRC’s analysis of the radiological impacts from radon-222 and technetium-99 provided in NUREG-1437 (NRC, 1996). NUREG-1437 (NRC, 1996) and Supplement 1 to the Generic Environmental Impact Statement to NUREG-1437 (NRC, 1999a) provide a detailed analysis of the environmental impacts from the uranium fuel cycle. Although these references are specific to impacts related to license renewal, the information is relevant to this review because the U.S. EPR design uses the same type of fuel.

The fuel impacts in NRC Table S-3 are based on a reference 1,000 MWe LWR operating at an annual capacity factor of 80% for a net electric output of 800 MWe. As discussed in Chapter 1, CCNPP Unit 3 is being proposed to be located on the CCNPP site. The proposed unit will be located south of the existing CCNPP Units 1 and 2. The U.S. EPR standard configuration of 4,590 MWt with a gross electrical output of 1,710 MWe is used to evaluate uranium fuel cycle impacts relative to the reference reactor. In the following evaluation of the environmental impacts of the fuel cycle, a standard configuration and a capacity factor of 95% for a total gross electric output (i.e., 1,710 MWe) of approximately 1,625 MWe for the U.S. EPR is used. The U.S. EPR output is approximately twice the output used to estimate impact values in NRC Table S-3 (reproduced here as the first column of Table 5.7-1) for the reference reactor. Analyses presented here are scaled from the 1,000 MWe reference reactor impacts to reflect the output of a single U.S. EPR.

Recent changes in the fuel cycle may have some bearing on environmental impacts. As discussed below, the contemporary fuel cycle impacts are bounded by values in NRC Table S-3 even considering that the generating capacity of the U.S. EPR would be 100% higher than the NRC Table S-3 reference 1,000 MWe LWR.

The NRC calculated the values in NRC Table S-3 from industry averages for the performance of each type of facility or operation associated with the fuel cycle. The NRC chose assumptions so that the calculated values would not be under-estimated. This approach was intended to ensure that the actual values are less than the quantities shown in NRC Table S-3 for all LWR nuclear power plants within the widest range of operating conditions. Since NRC Table S-3 was promulgated, changes in the fuel cycle and reactor operations have occurred. For example, the estimate of the quantity of fuel required for a year’s operation of a nuclear power plant can now reasonably be calculated assuming a 60 year lifetime (40 years of initial operation plus a 20 year license renewal term). This is described in NUREG-1437 (NRC, 1996), for both BWRs and PWRs, and the highest annual requirement, 35 MTU made into fuel for a BWR, was used as the basis for the reference reactor year.

However, Table 5.7-2 shows that the U.S. EPR requires slightly more than 35 MTU per year. It also shows the fuel cycle requirements assuming it is scaled to the net (i.e., 1,000 MWe with an 80% capacity factor) generating capacity of the reference 1,000 MWe LWR. The uranium requirements slightly exceed 35 MTU because the generating capacity is significantly greater than any of the reactor designs that were considered when NUREG-1437 (NRC, 1996) was issued. The U.S. EPR is sized for significantly higher generating capacity than its predecessors to achieve the benefit of the economy of scale offered by a larger plant. Nearly two of the reference 1,000 MWe LWRs would be required to provide the generating capacity of a single U.S. EPR.

Also, a number of fuel management improvements have been adopted by nuclear power plants to achieve higher performance and to reduce fuel and enrichment requirements, reducing annual fuel requirements. For example, the U.S. EPR is expected to employ such improvements as axial blankets to reduce axial neutron leakage which will reduce uranium-235 enrichment requirements, and consequently the quantity of uranium required for the U.S. EPR.

Therefore, NRC Table S-3 remains a reasonably conservative estimate of the environmental impacts of the fuel cycle fueling nuclear power reactors operating today.

Another change is the elimination of the restrictions in the U.S. on the importation of foreign uranium. The economic conditions of the uranium market now and in the foreseeable future favor full utilization of foreign uranium at the expense of the domestic uranium industry. These market conditions have forced the closing of most uranium mines and mills in the U.S., substantially reducing the environmental impacts from these activities although with the recent dramatic increase in the price of uranium, there is likely to be some recovery of the uranium mining industry. However, the NRC Table S-3 estimates have not been adjusted accordingly so as to ensure that these impacts, which have been experienced in the past and may be fully experienced in the future, are considered.

With the recent sharp increase in price of uranium it is likely there will be a reduction in the uranium enrichment tails assay. The uranium tails assay can best be described as the degree of depletion of uranium-235 in the depleted uranium waste that remains following the enrichment process. It is a parameter that can be adjusted to economical needs, depending on the cost of natural uranium and enrichment. As the price of uranium increases, it is generally more cost effective to remove more of the uranium-235 isotope from the natural uranium even though more separative work is required to do so. There is also some environmental gain to the extent that there are fewer uranium tails to dispose with the lower tails assay. Thus, with a lower tails assay less uranium is required reducing the effect of mining and milling operations on the environment. Although an increase in the amount of separative work is required, it is likely that the gaseous diffusion process will be replaced by centrifuge enrichment, and the overall impact on the environment will be less.

For the enrichment operation, the gaseous diffusion process is largely being replaced with the centrifuge process. NUREG-1437 (NRC, 1996) addresses this issue and notes that the centrifuge process uses 90% less energy than gaseous diffusion. Since the major environmental impacts for the entire fuel cycle are from the emissions from the fossil fueled plants needed to supply the energy demands of the gaseous diffusion plants, this reduction in energy requirements results in a fuel cycle with much less environmental impact. A transition to centrifuge enrichment will also result in a significant reduction in the cooling water discharges associated with the use of the fossil fuel plants as well as the large amount of cooling water required for the gaseous diffusion plant process equipment.

Factoring in changes to the fuel cycle suggests that the environmental impacts of mining and tail millings could drop to levels below those in NRC Table S-3. Section 6.2 of NUREG-1437 (NRC, 1996) discusses the sensitivity of these changes in the fuel cycle on the environmental impacts.

Finally, the “no recycle” option might not always be the only option for spent fuel disposition in this country. The Energy Policy Act of 2005 (PLN, 2005) directs the Department of Energy (DOE) to conduct an advanced fuel recycling technology research, development, and demonstration program to evaluate proliferation-resistant fuel recycling and transmutation technologies. DOE has reported to Congress on a plan to begin limited recycling of fuel with current reactors by 2025, and transitional recycling with current reactors by 2040 (DOE, 2005). Therefore, it is possible that recycling may be available during the 40 year initial term of the license to operate the U.S. EPR in the U.S. However, many actions will be required by the federal government before this research and development concept becomes a technological reality. For this reason, it has been has concluded that this option is too speculative to warrant further consideration for the U.S. EPR.

5.7.1 LAND USE

The total annual land requirements for the fuel cycle supporting a U.S. EPR (as scaled up from the reference reactor and provided in Table 5.7-1) is approximately 229 acres (93 hectares). Approximately 26 acres (11 hectares) is permanently committed land, and 203 acres (82 hectares) is 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 decommissioning, the land could be released for unrestricted use. "Permanent" commitments represent land that may not be released for use after decommissioning.

In comparison, a coal plant of 1,600 MWe (1,520 MWe net) capacity using strip-mined coal requires about 370 acres (150 hectares) per year for fuel alone. As a result, the impacts on land use for the U.S. EPR are deemed so minor as to not warrant mitigation.

5.7.2 WATER USE

Principal water use for the fuel cycle is that required to remove waste heat from the power stations supplying electricity to the enrichment process. Scaling from NRC Table S-3, Table 5.7-1 shows that of the total annual water use of 2.310×10^{10} gal (8.7×10^{10} L) for the U.S. EPR fuel cycle, about 2.252×10^{10} gal (8.5×10^{10} L) is required for the removal of waste heat. Evaporative losses from fuel cycle process cooling are approximately 3.2×10^{8} gal (1.2×10^{9} L) per year and mine drainage is approximately for 2.6×10^{8} gal (9.8×10^{8} L) per year.

Although the water use associated with the fuel cycle for the U.S. EPR would be greater than for the reference reactor, on a comparative basis obtained by scaling the reference reactor to the U.S. EPR, the Table S-3 data are applicable to the U.S. EPR.

NUREG-1437 (NRC, 1996) indicates that on a thermal-effluent basis, annual discharges from the nuclear fuel cycle are about 4% of those from the reference 1,000 MW(e) LWR using once-through cooling. The consumptive water use is about 2% of that from the model 1,000 MW(e) LWR using cooling towers. The maximum consumptive water use (assuming that all plants supplying electrical energy to the nuclear fuel cycle used cooling towers) would be about 6% of that of the model 1,000 MW(e) LWR using cooling towers. Under this condition, thermal effluents would be negligible, and as a result do not warrant mitigation.

Further, as noted earlier in this application, with the likelihood that centrifuge enrichment will be used for the U.S. EPR, water use will decline significantly because less than 10% of the energy used for the gaseous diffusion process will be required for the centrifuge enrichment.

5.7.3 FOSSIL FUEL IMPACTS

Electric energy and process heat are required during various phases of the fuel cycle process. The electric energy is usually produced by the combustion of fossil fuel at conventional power plants. Electric energy associated with the fuel cycle represents about 5% of the annual electric power production of the reference 1,000 MWe LWR. The original analysis (AEC, 1974) shows that the environmental impacts are almost totally from the electrical generation needed for the gaseous diffusion process. These impacts result from the emissions from the electrical generation that is assumed to be from coal plants, the water needed to cool the coal plants and the water needed to cool the gaseous diffusion plant equipment.

However, the process used for enrichment is undergoing a transition from gaseous diffusion to centrifuge enrichment. Centrifuge enrichment technology requires less than 10% of the energy needed for the gaseous diffusion process.

In the U.S., Louisiana Energy Services (LES), and the United States Enrichment Corporation (USEC) are in the process of constructing new centrifuge enrichment plants. LES broke ground for a new centrifuge enrichment plant at a site near Eunice, New Mexico in August 2006. The USEC centrifuge enrichment plant license was issued by the NRC in April 2007.

By the time enrichment services are required for the U.S. EPR, it is possible that the majority of U.S. supplied enrichment services will utilize centrifuge technology. As such, the environmental impacts associated with the electrical generation would be correspondingly less for the U.S. EPR.

Process heat is primarily generated by the combustion of natural gas. As concluded in NUREG-1437 (NRC, 1996), this gas consumption, if used to generate electricity, is less than 0.4% of the electrical output from the reference reactor. As a result, the direct and indirect consumption of electrical energy for fuel cycle operations are deemed to be minor relative to the power production of the U.S. EPR.

The natural gas consumption associated with the fuel cycle for the U.S. EPR will be greater than for the reference reactor since the U.S. EPR has a significantly higher generating capacity. However, if a comparative basis is established by scaling the reference reactor to the U.S. EPR, it is anticipated that this figure will remain at less than 0.4% of the U.S. EPR output.

5.7.4 CHEMICAL EFFLUENTS

The quantities of liquid, gaseous and particulate discharges associated with the fuel cycle processes are given in NRC Table S-3 (Table 5.7-1) for the reference 1,000 MWe LWR. The quantities of effluents for a U.S. EPR is approximately twice those in NRC Table S-3 (Table 5.7-1). The principal effluents are SOx, NOx, and particulates. Based on the Environmental Protection Agency Latest Findings on National Air Quality, 2002 Status and Trends (EPA, 2003), the U.S. EPR emissions constitute a very small fraction of the national sulfur and nitrogen oxide annual emissions.

Liquid chemical effluents produced in the fuel cycle processes are related to fuel enrichment and fabrication and may be released to receiving waters. All liquid discharges into navigable waters of the U.S. from facilities associated with fuel cycle operations are subject to requirements and limitations set by a National Pollutant Discharge Elimination System (NPDES) regulatory discharge permit, thus assuring minimum impact.

As concluded in NUREG-1555 (NRC, 1999b) tailing solutions and solids are generated during the milling process, but are not released in quantities sufficient to have a significant impact on the environment.

Impacts from the above listed chemical effluents for the U.S. EPR, therefore, are minor and will not warrant mitigation.

5.7.5 RADIOACTIVE EFFLUENTS

Radioactive gaseous effluents estimated to be released to the environment from waste management activities and certain other phases of the fuel cycle are set forth in NRC Table S-3 as shown in Table 5.7-1. From these data the 100 year environmental dose commitment to the population in the U.S. is calculated for one year of the fuel cycle for the U.S. EPR (excluding reactor releases and dose commitments due to radon-222 and technetium-99). The dose commitment to the population is approximately 800 person-rem (8 person-Sv) per year of operation of the U.S. EPR based on scaling up the referenced 1,000 MWe LWR.

The additional whole body dose commitment to the population from radioactive liquid wastes effluents due to all fuel cycle operations other than reactor operation is approximately 400 person-rem (4 person-Sv) per year of operation. Thus, the estimated 100 year environmental dose commitment to the population from the fuel cycle for radioactive gaseous and liquid effluents is approximately 1,200 person-rem (12 person-Sv) to the whole body per reactor-year for the U.S. EPR.

The radiological impacts of radon-222 and technetium-99 releases are not included in NRC Table S-3. However, Section 6.2 of NUREG-1437 (NRC, 1996), estimates radon-222 releases from mining and milling operations, and from mill tailings for a year of operation of the reference 1,000 MWe LWR. The estimated releases of radon-222 for one U.S. EPR reactor year are 11,500 Ci (4.3×10^5 GBq). Of this total, about 78% is from mining, 15% from milling, and 7% from inactive tails before stabilization. Radon releases from stabilized tailings were estimated to be 2.0 Ci (74 GBq) per year for the U.S. EPR. This is twice the NUREG-1437 (NRC, 1996) estimate for the reference reactor year. The major risks from radon-222 are from exposure to the bone and lung, although there is a small risk from exposure to the whole body. The organ-specific dose weighting factors from 10 CFR 20 (CFR, 2007b) were applied to the bone and lung doses to estimate the 100 year dose commitment from radon-222 to the whole body.

NUREG-1437 (NRC, 1996) considers the potential health effects associated with the releases of technetium-99. The estimated release for the U.S. EPR is 0.015 Ci (0.55 GBq) from chemical processing of recycled uranium hexafluoride before it enters the isotope enrichment cascade or centrifuge plant and 0.011 Ci (0.39 GBq) into groundwater from a high level waste repository. The major risks from technetium are from exposure of the gastrointestinal tract and kidneys, and a small risk from whole-body exposure. The total-body 100 year dose commitment from technetium-99 is estimated to be 222 person-rem (2.22 person-Sv) for the U.S. EPR.

Although radiation can cause cancer at high doses and high dose rates, no data unequivocally establish a relationship between cancer and low doses or low dose rates, below about 10,000 mrem (100 mSv). However, to be conservative, radiation protection experts assume that any amount of radiation may pose some risk of cancer, or a severe hereditary effect, and that higher radiation exposures create higher risks. Therefore, a linear, no-threshold dose response relationship is used to describe the relationship between radiation dose and detrimental effects. Based on this model, risk to the public from radiation exposure can be estimated using the nominal probability coefficient (730 fatal cancers, non-fatal cancers or severe hereditary effects per 1,000,000 person-rem (10,000 person-Sv)) provided in the International Commission of Radiological Protection Publication 60 (ICRP, 1991). This coefficient, multiplied by the sum of the estimated whole-body population doses of approximately 3,500 person-rem/yr (35 person-Sv per year) provided above for the U.S. EPR, estimates that the population in the U.S. could incur a total of approximately 2.6 fatal cancers, non-fatal cancers or severe hereditary effects from the annual fuel cycle for the U.S. EPR.

This risk is small compared to the number of fatal cancers, non-fatal cancers and severe hereditary effects that are estimated to occur in the population annually from exposure to natural sources of radiation using the same risk estimation methods.

Based on these analyses, the environmental impacts of radioactive effluents from the fuel cycle for the U.S. EPR are deemed to be minor and, therefore, will not warrant mitigation.

5.7.6 RADIOACTIVE WASTES

For low level waste disposal at land burial facilities, Table S–3 indicates that there will be no significant radioactive releases to the environment. The basis for this conclusion is that only shallow land burial is considered. The U.S. EPR operates at a cleaner level than the reference LWR discussed in NUREG-0116 (NRC, 1976) as evidenced by lower volumes of low level radioactive waste discussed in Section 3.5. Improvements in fuel integrity and differences in fuel form are responsible for contributing to both a lower level of waste generated during operation and less overall contamination to be managed during the decontamination and decommissioning process. The plants with higher thermal efficiency would produce less heavy metal waste. The main radionuclides identified for low level waste are Co-60 and Fe-55 with half-lives of 5.26 years and 2.73 years, respectively. Based on these half-lives, after about 20 years, the activity would be less than the reference LWR.

Federal Law requires that high level and transuranic wastes are to be buried at a repository and 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 no longer present at the time of disposal of the waste. In NUREG-0116 (NRC, 1976), which provides background and context for the high level and transuranic Table S–3 values, the NRC indicated that these high level and transuranic wastes will be buried and will not be released to the environment.

The NRC has already concluded that for applicants seeking an Early Site Permit (ESP), these impacts are acceptable, and would not be sufficiently large to require a NEPA conclusion that the construction and operation of a new nuclear unit at the sites should be denied.

5.7.7 OCCUPATIONAL DOSE

The annual occupational dose for the Reference 1,000 MW(e) reactor attributable to all phases of the fuel cycle is about 600 person-rem (NRC, 1996). Since the fuel cycle for the U.S. EPR is similar to the fuel cycle of the Reference Reactor, the annual occupational dose for all phases of the fuel cycle can be determined by normalizing the rated power of the U.S. EPR to the Reference Reactor. Doing this the annual occupational dose for all phases of the fuel cycle is approximately 1,220 person-rem or approximately a factor of 2 larger than the reference reactor S-3 value. However, on a per MWe basis, the dose would be the same. The environmental impact from this occupational dose is considered minor compared to the dose of 0.05 Sv/yr (5 rem/yr) to any individual worker permitted under 10 CFR Part 20 (CFR, 2007b).

5.7.8 TRANSPORTATION

The transportation dose to workers and the public totals about 0.025 person-Sv (2.5 person-rem) annually for the Reference 1,000 MW(e) LWR per Table S-3. Scaling the data for the U.S. EPR, this corresponds to a dose of approximately 0.051 person-Sv (5.1 person-rem). For comparative purposes, the estimated collective dose from natural background radiation to the U.S. population is 900,000 person-Sv/yr (90 million person-rem/yr (NCRP, 1987). On the basis of this comparison, environmental impacts of transportation will be negligible.

5.7.9 FUEL CYCLE

As previously, only the "no recycle" option is considered here because the U.S. does not currently reprocess spent fuel. The data provided in Table S-3, however, include maximum recycle option impact for each element of the fuel cycle (NRC, 1999b). As a result, the analysis of the uranium fuel cycle performed and the environmental impacts described, as compared to Table S-3 impacts, are not affected by whether a specific fuel cycle is selected ("no recycle" or "uranium only recycle").

5.7.10 REFERENCES

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NCRP, 1987. Ionizing Radiation Exposure of the Population of the United States, Report Number 93, National Council on Radiation Protection, September 1, 1987.

NRC, 1976. Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle, NUREG-0116 (Supplement 1 to WASH-1248), Nuclear Regulatory Commission, October 1976.

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PLN, 2005. Pubic Law No. 109-58, Energy Policy Act of 2005, August 2005.

Table 5.7-1—NRC Table S-3 of Uranium Fuel Cycle Environmental Data[a] Compared to the U.S. EPR Configuration (Normalized to Model LWR Annual Fuel Requirement (WASH-1248) or Reference Reactor Year (NUREG-0116)

(Page 1 of 2)

	Reference Reactor	U.S. EPR
MWe	1,000	1,710
Capacity Factor	0.8	0.95
MWe (Net)	800	1624.5
Environmental Considerations		
NATURAL RESOURCE USE		
Land (acres)(hectares)		
Temporarily committed [b]	100 (40)	203 (82)
Undisturbed area	79 (32)	160 (65)
Disturbed area	22 (9)	45 (18)
Permanently committed	13 (5)	26 (11)
Overburden moved (millions of MT)(millions of tons)	2.8 (3.1)	5.7 (6.3)
Water (millions of gallons)(millions of liters)		
Discharged to air	160 (606)	320 (1,211)
Discharged to water bodies	11,090 (41,980)	22,520 (85,247)
Discharged to ground	127 (481)	258 (977)
Total	11,377 (43,067)	23,102 (87,450)
Fossil fuel		
Electrical energy (thousands of MW-hour)	323	656
Equivalent coal (thousands of MT (thousands of tons))	118 (130)	240 (265)
Natural gas (millions of scf)(millions of cubic meters)	135 (3.82)	274 (7.76)
EFFLUENTS-CHEMICALS (MT)(tons)		
Gases (including entrainment) [c]		
SO_X	4,400 (4,849)	8,935 (9,849)
NO_X [d]	1,190 (1,311)	2,416 (2,663)
Hydrocarbons	14 (15.4)	28 (31)
CO	29.6 (32.6)	60 (66)
Particulates	1,154 (1,272)	2,343 (2,583)
Other gases		
F	0.67 (0.74)	1.36 (1.50)
HCl	0.014 (0.015)	0.028 (0.031)
Liquids		
SO_4	9.9 (10.9)	20.1 (22.2)
NO_3	25.8 (28.4)	52.4 (57.8)
Fluoride	12.9 (14.2)	26.2 (28.9)
Ca^{++}	5.4 (5.95)	11 (12.1)
Cl^-	8.5 (9.4)	17.3 (19.1)
Na^+	12.1 (13.3)	24.6 (27.1)
NH_3	10.0 (11.0)	20.3 (22.4)
Fe	0.4 (0.4)	0.8 (0.9)
Tailings solutions (thousands of MT (thousands of tons))	240 (264)	487.4 (537.3)
Solids	91,000 (100,282)	185,000(203,928)

Table 5.7-1—NRC Table S-3 of Uranium Fuel Cycle Environmental Data[(a)] Compared to the U.S. EPR Configuration (Normalized to Model LWR Annual Fuel Requirement (WASH-1248) or Reference Reactor Year (NUREG-0116)

(Page 2 of 2)

	Reference Reactor	U.S. EPR
EFFLUENTS-RADIOLOGICAL (CURIES)(GBq)		
Gases		
Rn-222 [e]	Note e	
Ra^{226}	0.02 (0.74)	0.04 (1.48)
Th^{230}	0.02 (0.74)	0.04 (1.48)
Uranium	0.034 (1.258)	0.069 (2.553)
Tritium (thousands)	18.1 (669.7)	36.8 (1,361.6)
C^{14}	24 (888)	48.7 (1,801.9)
Kr^{85} (thousands)	400 (14,800)	812.3 (30,055.1)
Ru-106	0.14 (5.18)	0.28 (10.36)
I-129	1.3 (48.1)	2.6 (96.2)
I-131	0.83 (30.71)	1.69 (62.53)
Tc-99 [e]	Note (e)	
Fission products and TRU[f]	0.203 (7.511)	0.412 (15.244)
Liquids		
Uranium and daughters	2.1 (77.7)	4.3 (159.1)
Ra-226	0.0034 (0.1258)	0.0069 (0.2553)
Th-230	0.0015 (0.0555)	0.003 (0.111)
Th-234	0.01 (0.37)	0.02 (0.74)
Fission and activation products	5.9E-06 (2.18E-04)	1.20E-05 (4.44E-04)
Solids		
Other than HLW[f] (shallow)	11,300 (418,100)	22,900 (848,750)
TRU[f] and HLW[f] (deep)	1.1E+07 (4.07E+08)	2.2E+07 (8.26E+08)
Effluents – thermal (billions of Btu (billions of Joules))	4,063 (4,286,465)	8,250 (8,701,600)
Transportation (person rem)(Sv)	12.1(0.121)	24.6 (0.246)
Exposure of workers and the general public	2.5 (0.025)	5.1 (0.051)
Occupational exposure	22.6 (0.226)	45.9 (0.459)

Notes:

a. In some cases where no entry appears in NRC Table S-3 it is clear from the background documents that the matter was addressed and that, in effect, the table should be read as if a specific zero entry had been made. However, there are other areas that are not addressed at all in the table. NRC Table S-3 does not include health effects from the effluents described in the table, or estimates of releases of radon-222 from the uranium fuel cycle or estimates of technetium-99 released from waste management or reprocessing activities. Radiological impacts of these two radionuclides are addressed in NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," dated May 1996, and it was concluded that the health effects from these two radionuclides posed a small significance.
Data supporting NRC Table S-3 are addressed in WASH-1248, "Environmental Survey of the Uranium Fuel Cycle," dated April 1974; NUREG-0116, "Supplement 1 to WASH-1248, Environmental Survey of Reprocessing and Waste Management Portions of the LWR Fuel Cycle," dated October, 1976; NUREG-0216 "Supplement 2 to WASH-1248, Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," dated March 1977; and in the record of final rule making 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 recycle and no recycle). The contribution from

transportation excluded transportation of cold fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor which are considered in NRC Table S-4 of 10 CFR 51.20(g). The contributions from the other steps of the fuel cycle are given in Columns A through E of NRC Table S-3A of WASH-1248.

b. The contributions to temporarily committed land from reprocessing are not prorated over 30 years, since 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 coal for equivalent power generation.

d. 1.2% from natural gas use and processes.

e. Radiological impacts of radon-222 and technetium-99 are addressed in NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," dated May 1996. The Generic Environmental Impact Statement concluded that the health effects from these two radionuclides pose a small risk.

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

Table 5.7-2—Average Nominal Annual Fuel Cycle Requirements (U.S. EPR Scaled to the 1,000 MWe Reference LWR)

	U_3O_8 kg (lbs)	Natural UF_6 kg U (lbs U)	SWUs	Enriched UF_6 kg U (lbs U)
U.S. EPR	393,000 (867,000)	332,000 (732,100)	201,000	35,800 (78,900)
Scaled to the Reference Reactor	194,000 (427,000)	163,000 (360,000)	99,000	17,600 (39,000)

NOTES:

1. U.S. EPR 1,710 MWe; capacity factor 95% = 1,624.5 Net MWe
2. Reference Reactor 1,000 MWe; capacity factor 80% = 800 Net MWe
3. Adjustment factor 1,000 x 800/1,624.5 = 0.492
4. U.S. EPR tails assay is assumed to be 0.3%
5. U.S. EPR average enrichment is 4.3% uranium-235

5.8 SOCIOECOMONIC IMPACTS

5.8.1 PHYSICAL IMPACTS OF STATION OPERATION

This section addresses the direct physical impacts of plant operation on the surrounding community. The impacts evaluated include the effects from noise, odors, exhausts, thermal emissions, and visual intrusion. The discussion evaluates how these impacts should be treated and whether mitigation is needed. As a result of regulatory permits and controls and the remoteness of the site, direct physical impacts from plant operation on the surrounding community are expected to be SMALL.

5.8.1.1 Plant Layout

Potential physical impacts will be controlled through compliance with applicable regulations and woodland screening. The plant layout is provided in Figure 2.2-1. CCNPP Unit 3 will be located in a rural area, relatively remote from population and community centers. The site is also largely forested and situated between two other large forested tracts located to the north and south. Together, these tracts form one of the largest contiguous and predominantly undeveloped forested areas in the region as discussed in Section 2.2.1.

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

The total population within 1 mi (1.6 km) of the site is 30, with no residential properties located within the CCNPP site boundary. Within 2 mi (3.2 km), the total population is less than 2,500 as discussed in Section 2.5.1. Portions of the towns of Lusby and Calvert Beach are within 2 mi (3.2 km) of the CCNPP site. Table 2.5-6 presents population distributions, by residential population and transient population in 2000, within each of the sixteen geographic directional sectors at radii of 0 to 1 mi (0 to 2 km), 1 to 2 mi (2 to 3 km), 2 to 3 mi (3 to 5 km), 3 to 4 mi (5 to 6 km), 4 to 5 mi (6 to 8 km) and 5 to 10 mi (8 to 16 km) from the CCNPP site.

Besides the residential or farm buildings in the surrounding community, there is an elementary school approximately 2 mi (3.2 km) from the CCNPP site. The Town of Lusby located southwest of the CCNPP site has commercial buildings in the town center. Economic development plans include expanding and improving the town center and developing a nearby business park.

Figure 2.2-4 shows roads/highways that are in the vicinity of the CCNPP site. There is no operating rail line within 8 mi (13 km) of the CCNPP site.

Recreational facilities in the immediate area around the CCNPP site are Flag Ponds Park to the north and Calvert Cliffs State Park to the south as denoted in Figure 2.2-4. The onsite former youth camp known as Camp Conoy will be removed as it lies within the construction area footprint.

5.8.1.3 Noise

The principal noise sources associated with operation of the new plant are the switchyard, transformers, and cooling towers. As noted in Section 2.7, a recent baseline ambient noise survey documents that there was no observed, offsite, audible noise from the existing plant, day or night over a 45 hour period, although both units were operating continuously. Similar results can be expected for CCNPP Unit 3, as it relates to general plant noise, including the switchyard and transformers. An added impact due to cooling tower noise, however, would be expected since CCNPP Units 1 and 2 uses an open-cycle heat dissipation system and does not have cooling towers.

The operation of the CWS cooling towers and plume abatement system for CCNP Unit 3 will generate additional noise. MDE's noise level standards for a residence are 65 dBA during the daytime and 55 dBA during evening. The State of Maryland's environmental goals are 70 dBA for industrial zoned districts (expressed as a 24-hour equivalent sould level), 64 dBA and 55dBA for commercial and residential zoned districts (expressed as the 24-hour day-night average sound level, with a 10 decibel penalty applied to noise occurring during the nighttime period (COMAR, 2007a)). U.S. EPA developed noise guidelines to protect against hearing loss and annoyance. This guidance established an outdoor activity guideline of 55 dBA.

The estimated noise generated from the CCNPP Unit 3 cooling tower operation has been modeled to assess the impact to the nea rby community. Estimated sound contours from the anticipated cooling tower noise during the summer leaf-on season and the winter leaf-off season were provided in the Preliminary Environmental Noise Assessment issued in May, 2008 (Hessler, 2008). Table 5.8-1 lists the tabular results. As illustrated, the sound levels beyond the CCNPP site boundary, regardless of the season, are below both the daytime and nighttime maximum allowable levels of 65 db(A) and 55 db(A), respectively. Thus, the impact from noise from operation of the new unit to nearby residences and recreational areas is anticipated to be SMALL.

Noise generated from traffic will increase due to a larger plant workforce and more CCNPP site deliveries and offsite shipments. The traffic noise, however, will be limited to normal weekday business hours. In addition, traffic control and administrative measures, such as staggered shift hours will diminish traffic noise during the weekday business hours. Traffic noise during evenings and weekends will be substantially reduced as only a small fraction of the weekday workforce will be onsite (KLD, 2007). The potential noise impacts to the community, therefore, are expected to be temporary during shift change and manageable. Thus, the impact from noise from traffic due to operation of the new unit to nearby residences and recreational areas is anticipated to be SMALL.

5.8.1.4 Air and Thermal Emissions

The air emissions sources associated with the operation of CCNPP Unit 3 include the cooling tower for the Circulating Water System (CWS), four Essential Service Water System (ESWSI cooling towers, and six standby diesel generators. The CWS cooling tower will be a source of particulate matter as a result of cooling tower drift, i.e., the release of impurities, largely salt, in the water entrained in the air stream and carried out in the cooling tower plume. This is the largest source of emissions at the facility. The diesel generators will emit pollutants from fuel combustion when operating. All air emission sources will be managed in accordance with federal, state, and local air quality control laws and regulations.

There are four steam generators that feed high pressure steam to a manifold and subsequently to the turbine generator. After the steam passes through the turbine it is cooled in the main condenser. The main condenser has three sections. one each for high pressure, medium pressure, and low pressure steam. Chilled water from the CWS (about 85 to ~~95~~ 90°F) is used to ~~cool~~ condense the steam to water before being pumped back to the steam generator. The CWS supplies about ~~790,000~~785,802 gallons per minute to the main condenser. The cooling tower transfers waste heat contained in the CWS cooling water through direct contact with an air stream.

The CWS cooling tower design is based on an air flow of 66.5 acfm in the wet section and, when required for visible plume abatement, air flow ranging up to 53.1 million acfm in the dry section. Makeup water is drawn from the Chesapeake Bay to offset evaporation, drift, and blowdown. The CWS cooling tower will operate continuously. The four smaller ESWS cooling towers are each designed for an air flow rate of 1.1 million acfm and 19,075 gallons per minute relying on water generated from the Desalination Plant. Only two ESWS units are required to be in service during normal operating conditions; the other two are available as backup units.~~million scfm and a water circulation rate of 777.560 gallons per minute, with makeup water drawn from the Chesapeake Bay to offset evaporation, drift, and blowdown. The CWS cooling tower will operate continuously. The four smaller ESWS cooling towers are each designed for an air flow rate of 1.3 million scfm and 18,333 gallons per minute relying on water generated by the Desalination Plant. Only two ESWS units will typically be in service during normal operating conditions.~~

Emergency power will be provided by four 10,130 kWe emergency diesel generators (EDGs) and two 5,000 kWe diesel Station Blackout (SBO~~O~~) generators. Diesel fuel will be stored in tanks, which are considered to be negligible sources of air emissions.

Air emissions sources outside the scope of the CPCN process will also be administratively controlled to comply with Occupational Safety and Health Standards. In particular, 29 CFR 1910.1000 (CFR, 2007a) places limits on certain vapors, dusts, and other air contaminants. Dust suppression methods such as watering areas that have been reseeded will minimize dust emissions. Thus, the impact from air emissions from operation of the new unit to nearby residences and recreational areas is anticipated to be SMALL.

Thermal emission impacts are addressed separately in Section 5.3, Cooling System Impact. The thermal discharge from CCNPP Unit 3 will return blowdown from the cooling towers and site wastewater streams to the Chesapeake Bay. The plume is predicted to be a small fraction of the CCNPP Units 1 and 2 plume. Based on relative distribution, the CCNPP Unit 3 thermal plume will have little or no interaction with the plume from CCNPP Units 1 and 2. The thermal plume increase is limited to 3.6°F (2°C) in accordance with State of Maryland regulations and covers an area of less than 0.7 acres (0.3 hectares). Therefore, any thermal impacts to aquatic communities are expected to be SMALL.

5.8.1.5 Visual Intrusion

CCNPP Unit 3 will not be generally visible at ground level from points north, south, and west of the CCNPP site boundary due to the heavily wooded area surrounding the site area as discussed in Section 3.1. Similarly, recreational users of Chesapeake Bay to the east generally will be unable to view most of CCNPP Unit 3 due to its elevation above the water and the critical area zone setback distance from the shoreline as discussed in Section 2.2.1.

The intake and discharge structures will be visible from the Chesapeake Bay, as they will be located along the shoreline near existing CCNPP Units 1 and 2 structures. The upper portions of the CCNPP Unit 3 containment and cooling tower may also be visible from certain portions of the Chesapeake Bay due to their heights above grade. The impact of these visual intrusions, however, are anticipated to be SMALL because the CCNPP site is already aesthetically altered by the presence of the existing CCNPP Units 1 and 2 structures. Figure 3.1-3 through Figure 3.1-5 show existing site photos with the CCNPP Unit 3 structures superimposed when viewed from offsite.

The water vapor plume from the CCNPP Unit 3 cooling tower will also be noticeable, given the heights to which the plume may rise, especially during the winter months as discussed in Section 5.3.3.1. The frequency of the plume direction, its height, and its extent will vary, depending on the season and wind direction. As a result, potential visual intrusion from the plume will vary according to the viewpoint location, but it will be temporary as weather conditions and wind direction change frequently at the CCNPP site location. Thus, the visual impact from the plume due to operation of CCNPP Unit 3 to nearby residences and recreational areas is anticipated to be SMALL.

5.8.1.6 Standards for Noise and Gaseous Pollutants

The noise levels will be controlled by compliance with regulatory requirements. For worker protection, the Occupational Safety and Health Administration (OSHA) noise-exposure limits identified in 29 CFR 1910.95 (CFR, 2007b) will be met. For residential areas, the Maryland state wide noise level regulations (MD, 2007) will be met. Specifically, the maximum decibel sound level allowed at a residence is 65 db(A) during daytime (7 AM to 10 PM) and 55 db(A) at nighttime (10 PM to 7 AM.)

Air emissions will be controlled by compliance with regulatory requirements, specifically through the CPCN process as denoted in Section 1.3. A CPCN must be obtained from the Maryland PSC to build the new plant and includes air emission permits for construction and operating equipment as part of the integrated permitting process.

Additional air emission control will also result from recently promulgated U.S. Environmental Protection Agency (EPA) regulations relating to non-road diesel engines and diesel fuel (FR, 2004). Because Calvert County is an 8 hour ozone nonattainment area as discussed in Section 2.7, manufacturers of non-road diesel engines must include emission control technologies to meet stringent emission standards. The engine model year and horsepower rating determine the emission levels, which will be phased in over a number of years. For example, NO_x, PM, and HC allowable emissions for large diesel engines, such as those planned for CCNPP Unit 3, will be reduced starting in 2011 and then reduced again in 2015 (FR, 2004) (CFR, 2007c). Similarly, SO_x levels will be reduced through control of the sulfur content in diesel fuel. After June 2007, the maximum sulfur content in diesel fuel is reduced from approximately 3,000 parts per million (ppm) to 500 ppm and then reduced further to 15 ppm, starting in 2010 (FR, 2004) (CFR 2007d).

Air emissions sources outside the scope of the CPCN process will also be administratively controlled to comply with Occupational Safety and Health Standards. In particular, 29 CFR 1910.1000 (CFR, 2007a) places limits on certain vapors, dusts, and other air contaminants.

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

A traffic impact analysis (TIA) was completed as discussed in Section 4.4.1 which showed, in part, that the conditions during CCNPP Unit 3 operation have no significant additional effect on the operating level of service at the intersections along the Maryland State Highway 2/4 and, therefore, does not require any further mitigation. The TIA conclusion, however, is based on the anticipated area future growth rate will require placement of signals at two intersections along Maryland State Highway 2/4 near the CCNPP site presently without signals. Thus, the impact from traffic from operation of the new unit to nearby residences and recreational areas is anticipated to be SMALL.

As discussed in Section 5.8.1.3 through Section 5.8.1.6 the impacts due from noise and other pollutants as well as visual impacts are expected to be SMALL. The noise levels comply with State of Maryland regulations at the CCNPP site boundary and OSHA noise exposure limits for workers outside buildings. Excessive noise inside buildings will require protective equipment to be worn by workers. Thus, the impact from noise to plant workers from operation of CCNPP Unit 3 is anticipated to be MODERATE inside buildings requiring hearing protection and SMALL outside buildings and inside other buildings that do not require hearing protection.

Air emissions will comply with the State of Maryland permit requirements and Federal Air Quality Standards as promulgated through the CPCN process. The diesel generators will be required to meet the applicable emission limits in effect at the time of plant startup with additional air pollution controls as required. The CCNPP Unit 3 cooling tower for the Circulating Water Supply System will include drift eliminators to reduce salt deposition and visual plumes. Additionally, OSHA standards will be adhered to for onsite exposure to vapors, dusts and other air contaminants for workers. Thus, the impact from air emissions to plant workers from operation of CCNPP Unit 3 is anticipated to be MODERATE inside buildings requiring breathing apparatus and SMALL outside buildings and inside other buildings that do not require breathing apparatus.

Thermal emissions will be controlled through the National Pollutant Discharge Elimination System (NPDES) permit process for plant discharges to surface waters including the Chesapeake Bay. Thus, the impact from thermal impacts from operation of CCNPP Unit 3 to the Chesapeake Bay is anticipated to be SMALL. The CCNPP site is largely forested and situated between two other large forested tracts located to the north and south. CCNPP Unit 3 will not be generally visible at ground level from points north, south, and west of the CCNPP site boundary due to the heavily wooded area surrounding the site area. The CCNPP Unit 3 intake and discharge structures will be visible from the Chesapeake Bay, as they will be located along the shoreline near existing CCNPP Unit 1 and 2 structures. The upper portions of the CCNPP Unit 3 containment and cooling tower may also be visible from certain portions of the Chesapeake Bay due to their heights above grade. The impact of these visual intrusions, however, are expected to be SMALL because the CCNPP site is already aesthetically altered by the presence of the existing CCNPP Units 1 and 2 structures. Therefore, no additional landscaping is required.

5.8.1.8 References

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5.8.2 SOCIAL AND ECONOMIC

This section describes the potential demographic, housing, employment and income, tax revenue generation, land value, and public facilities and services impacts of station operations. The comparative geographic area, for the evaluation of socioeconomic impacts extends in a 50 mi (80 km) radius from the proposed CCNPP Unit 3 power plant. Calvert and St. Mary's Counties have been defined as the region of influence (ROI) because 91% of the existing CCNPP Units 1 and 2 operational workforce resides there, and it is assumed that the operational workforce for CCNPP Unit 3 would also primarily reside in and impact this geographic area.

As shown in Table 5.8-2, it is estimated that a total of 363 employees would be added to the onsite workforce to operate CCNPP Unit 3. 330 workers (91%) and their families (i.e., households) would likely reside in the ROI. In addition, an estimated 316 of the indirect jobs located in the ROI would be filled by the spouses of the direct workforce. A total of 1,424 people would migrate into the ROI, representing a 0.89% increase in the total of 160,774 people. It is concluded that the impacts to population levels in the ROI would be SMALL, and would not require mitigation.

5.8.2.1 Demography

5.8.2.1.1 50 Mile (80 km) Comparative Geographic Area

The operational workforce would likely be hired from throughout the east coast and from major population centers in the study area, including the Washington, D.C. Metropolitan Statistical Area (MSA) to the northwest of the CCNPP site; the Lexington Park, Maryland; Micro Area to the south and the cities of Alexandria, Virginia; Annapolis, Maryland; and Baltimore, Maryland. Some of the operational workforce is likely to be drawn from the construction workforce, which would either remain residents in the ROI or would permanently move to the ROI.

5.8.2.1.2 Two-County Region of Influence

As previously stated, 91% of the existing CCNPP Units 1 and 2 operational workforce resides in Calvert County and St. Mary's County. It is assumed that the direct and indirect operational workforce for CCNPP Unit 3 would also be permanent in-migrants primarily residing in and impacting this geographic area.

An additional workforce of up to 1,000 workers may be required for a 15 day period, once every 18 months, to support planned plant outages during refueling and other specialized tasks. This group likely would represent only temporary visitors to the area and would either commute on a weekly basis or for the duration of the tasks, and would reside in area hotels and motels. The scheduled outage for CCNPP Unit 3 would be planned around similar schedules for CCNPP Units 1 and 2, so that they do not overlap.

Because of the relatively small size of the CCNPP Unit 3 operational workforce, the changes in population within the ROI would be SMALL, and would not require mitigation.

5.8.2.2 Housing

The construction workforce would be significantly larger than the operational workforce (Section 4.4.2). Construction would be of sufficient duration that the housing and support services required during CCNPP Unit 3 operation would already be in place so that any incremental CCNPP Unit 3 operational impacts would be SMALL. Thus, the operational workforce would either rent or purchase existing homes in the ROI, or would purchase acreage on which to build new homes. Of the estimated 545 direct and indirect households migrating into the ROI as a result of operating CCNPP Unit 3, it is estimated that 408 households (75%) would reside in Calvert County and 137 (25%) would reside in St. Mary's County. The total number of housing units needed within the ROI would represent 9.8% of the total 5,568 vacant units located in the ROI in 2000.

In addition, scheduling planned outages for CCNPP Unit 3 at times other than when they would occur for CCNPP Units 1 and 2 should minimize the impacts of the availability and cost for hotel/motel rooms and other short-term accommodations.

Thus, the overall ROI and each county within it have enough housing units available to meet the needs of the workforce. Because significantly more units are available than would be needed, the in-migrating workforces alone should not result in an increase in housing prices or rental rates. Thus, it is concluded that the impacts to area housing would be SMALL, and would not require mitigation.

5.8.2.3 Employment and Income

As previously stated, it is estimated that a total of 363 direct employees would be added to the onsite workforce to operate CCNPP Unit 3, and a maximum of 661 indirect job opportunities would be created in the ROI. As stated above, of this total an estimated 330 direct workers (91%) and 661 indirect workers would reside within the Calvert and St. Mary's Counties region of influence. The 991 direct and indirect ROI jobs would result in a noticeable but small impact to the area economy, representing a 1.1% increase in the 39,341 total labor force in Calvert County in 2000 and the 46,032 total labor force in St. Mary's County (USCB, 2000).

It is estimated that CalvertCliffs 3 Nuclear Project and UniStar Nuclear Operating Services would spend $28 million annually on salaries (in 2005 dollars, an average of $77,135/year/worker for direct labor, excluding benefits). The CCNPP Unit 3 estimated average annual salary is only somewhat less than the $84,388 median income for an entire household in Calvert County in 2005, but noticeably larger than $62,939 median household income in St. Mary's County. If income is distributed similar to the population in-migration, Calvert County would experience an estimated $19.0 million increase in annual income and St. Mary's County would receive an estimated $6.4 million annually.

Assuming that the indirect workforce would have annual salaries of $84,388 (based on the 2005 median household income in Calvert County (USCB, 2000), the 408 indirect households migrating into Calvert County would generate over $34.4 million in income and the 137 indirect households in St. Mary's County would generate $11.6 million in household income. This additional income would result in additional expenditures and economic activity in the ROI. However, it would represent a small percentage of overall total income in the ROI. It is concluded that the impacts to employment and income would be SMALL, and would not require mitigation.

5.8.2.4 Tax Revenue Generation

5.8.2.4.1 50 Mile (80 km) Comparative Geographic Area

Additional state income taxes would be generated by the in-migrating residents, although the amount cannot be estimated because of the variability of investment income, retirement contributions, tax deductions taken, applicable tax brackets, and other factors. It is estimated that the 50 mi (80 km) radius and the state would experience a $25.4 million increase in annual wages from the direct workforce and $46.0 million in indirect workforce wages, for a total of $71.4 million. Relative to the existing total wages for the state and 50 mi (80 km) radius, it is concluded that the potential increase in state income taxes represent a SMALL economic benefit.

Additional sales taxes also would be generated by the power plant and the in-migrating residents. It is estimated that UniStar would spend about $9 million annually (in 2005 dollars) on materials, equipment, and outside services (excluding costs for planned outages), which would generate additional state sales and income taxes. The amount of increased sales tax revenues generated by the in-migrating residents would depend upon their retail purchasing patterns, but would only represent a SMALL benefit to this revenue stream for the state and the 50 mi (80 km) radius.

Overall, although all tax revenues generated by the CCNPP Unit 3 and the related workforce would be substantial in absolute dollars, as described above, they would be relatively small compared to the overall tax base in 50 mi (80 km) area and the State of Maryland. Thus, it is concluded that the overall beneficial impacts to state tax revenues would be SMALL.

5.8.2.4.2 Two-County Region of Influence

The facility qualifies for a 50% reduction in assessed personal property value once operation begins in 2016, reducing the personal property assessed value from [ ] billion (excluding financing costs) to [ ] billion. This would result in a drop in total property tax payments for Unit 3 to [ ] million in 2016, which then would slowly decline in following years as a result of taking allowances for depreciation. This would represent a [ ] increase in Calvert County's $78.8 million in annual property (real and personal) tax revenues for fiscal year 2005, and a [ ] increase in total county revenues of $174.1 million (see Section 2.5.2). These increased property tax revenues would either provide additional revenues for existing public facility and service needs or for new needs generated by the power plant and associated workforce. The increased revenues could also help to maintain or reduce future taxes paid by existing non-project related businesses and residents, to the extent that project-related payments provide tax revenues that exceed the public facility and service needs created by CCNPP Unit 3. It is concluded that these increased power plant property tax revenues would be a LARGE economic benefit to Calvert County.

Additional county income taxes would be generated by the in-migrating residents, although the amount cannot be estimated because of the variability of investment income, retirement contributions, tax deductions taken, applicable tax brackets, and other factors. It is estimated that Calvert County would experience a $19.0 million increase in annual wages from the direct workforce and $34.4 million in indirect workforce wages, for a total of $53.4 million. St. Mary's County would experience an estimated annual increase of $6.4 million from the direct workforce and $11.6 million in indirect workforce wages, for a total of $18.0 million.

In 2005, total revenues in Calvert County were about $174.1 million with 45.3% (78.8 million) from property taxes, 31.2% ($54.4 million) from income taxes and 8.3% ($14.5 million) from other taxes. In 2005, St. Mary's received approximately $145 million in revenues. Of this $54.1 million was raised from income taxes, or about 37% (Table 2.5-30). At an income tax rate of 2.8%, the tax increase from $53.4 million additional income in Calvert County would be about $1.5 million. St. Mary's would realize a net tax increase of about $500,000 from an additional

$18.0 million in wages. These increments are relatively small compared to the total income taxes and total wages.

As indicated above, additional sales taxes also would be generated by the power plant and the in-migrating residents. The amount of increased sales tax revenues generated by the in-migrating residents would depend upon their retail purchasing patterns, but would only represent a SMALL benefit to this revenue stream for Calvert and St. Mary's Counties.

Overall, although all tax revenues generated by the CCNPP Unit 3 and the related workforce would be substantial in absolute terms of dollars but, as described above, they would be relatively small compared to the overall tax base in the ROI. Thus, it is concluded that the overall beneficial impacts to tax revenues would be SMALL.

5.8.2.5 Land Values

As discussed in previous sections, a Maryland Department of Natural Resources (MDNR, 2006) study of the effects of large industrial facilities showed that residential property values were not adversely affected by their proximity to the CCNPP site. Overall, Maryland power plants have not been observed to have negative impacts on surrounding property values. This lack of impact is partially attributed to impact mitigation fees imposed in Maryland Power Plant Research Program (PPRP) conditions stipulated in Certificates of Public Convenience and Necessity (CPCNs) (MDNR, 2006). It is concluded that the impacts to land values would be SMALL, and would not require mitigation.

5.8.2.6 Public Facilities

As discussed in Section 4.4.2, the size of the construction workforce, the excess capacity of housing and public facilities in the ROI, and actions taken to meet unforeseen needs would result in enough public facility capacity to meet the smaller direct operational workforce needs. As discussed above, there is a sufficient quantity of vacant housing units in Calvert and St. Mary's Counties to meet the housing needs of the in-migrating direct and indirect operational workforces for CCNPP Unit 3, so no new housing units would likely be required. Thus, water and sewage services would not be affected and would continue to be adequate to meet the needs of the workforces. Although an increase in the population would likely place additional demands on area transportation and recreational facilities, the facilities appear to have enough capacity to accommodate the increased demand and impacts would likely be SMALL. Area highways and roads would have increased traffic levels, particularly during shift changes at the CCNPP, resulting in a SMALL traffic impact.

5.8.2.7 Public Services

Although an increase in population levels from the CCNPP operational workforces would likely place additional demands on area doctors and hospitals, these services have enough capacity to accommodate the increased demand and impacts would likely be SMALL. Although the increased population levels would likely place additional daily demands on constrained police services, fire suppression and EMS services, and schools, those agencies have indicated that additional demands from the power plant would either be easily addressed. The agencies indicated that the additional demands would not reach a level where action would have to be taken, or where mitigation would be required.

5.8.2.7.1 Police, EMS, and Fire Suppression Services

As described in Section 2.5.2 and Section 4.4.2, Calvert County and St. Mary's County have large volunteer fire departments that are meeting the needs of their respective residentsand the relative increase in population would be comparatively small during operations. The increase in In-migrating workers and corresponding population size is about 1,064 in Calvert County and 360 in St. Mary's County (Table 5.8-2). For Calvert County the increased population corresponds to 1.2% of the 2005 population (88,750). Again assuming that EMS and fire calls are proportional to population size, the number of calls is estimated to increase about 200 annually, less than one per day. For St. Mary's County the percent increase represents about a 0.4% increase above the existing 96,550 people residing there. As a result, the impact should be SMALL. Moreover, because additional needs would be met during the construction phase of the power plant, no additional police, EMS or fire suppression services would likely be required for the operational phase, the impact would be SMALL, and no mitigation would be required.

These fire and emergency response departments are supplemented by the CCNPP's onsite emergency response team, which includes a fire brigade. The CCNPP Unit 3 staff will include an onsite emergency response team staff, a fire brigade and emergency medical technician (EMT) responders. A new emergency management plan will be developed for CCNPP Unit 3, similar to that already existing for CCNPP Units 1 and 2, that would address CalvertCliffs 3 Nuclear Project and UniStar Nuclear Operating Services and agency responsibilities, reporting procedures, actions to be taken, and other items should an emergency occur at CCNPP Unit 3.

For additional unforeseen service needs that might arise, as described in Section 5.8.2.4 above, the significant new tax revenues generated in Calvert County by operation of CCNPP Unit 3 would provide additional funding to expand or improve services and equipment to meet the additional daily demands created by the plant. St. Mary's County would also experience increased revenues from operation of the power plant, but to a much lesser extent. Although some departments still might not have enough staff and equipment to respond to an unusual emergency situation, including offsite evacuation, they concluded that the power plant impacts would not reach a level where mitigation would be required. Thus, it is concluded that there would be a SMALL impact on some fire and law enforcement departments, and no mitigation would be required.

5.8.2.7.2 Educational System

As described above, an estimated 408 new households would in-migrate into Calvert County for operation of CCNPP Unit 3. The estimated $37.8 million in increased property taxes that would be paid to Calvert County annually by UniStar for CCNPP Unit 3, which include levies for the Calvert County Public School System, would provide additional funds to meet the educational needs of children for the in-migrating operational workforce. Although increased funding would be derived from county property taxes, it would also result in decreased funds to the State of Maryland. For fiscal year 2006, the atate provided $64.7 million (42.5% of total revenues) in funds to the school district and Calvert County provided 85.7 million (56.2%). The State's current funding formula is based on allocating a set amount of revenues aross all school districts based on the enrollment levels and amount of funds they derive from other sources. This process requires several iterations of exchanging information and finalizing enrollments and other fund ing levels before the State makes its final allocations in January or February of the school year. Thus, this occurs well after teachers and staff have already been hired and the school districts have begun making expenditures. In addition, Calvert County School District does not have a set property tax rate from which to project its annual budget. Instead they have discussion with the Company at the beginning of each school year to determine what funding the County will be providing. A number of factors also enter into the decision making about what funds the County will allocate. Thus, because the funding from the Sate and the County are variable each year, it is not possible to calculate how much increased property taxes from CCNPP Unit 3 might result in reduced state funding levels to the District. However, because of the significant increase in County property taxes from the project , it is concluded that the net impacts to the Calvert County Public School System would be SMALL.

The educational facilities in St. Mary's County Public School System already are operating near capacity. The in-migration of an estimated 137 new households into the county from operation of the CCNPP Unit 3 would place greater demands on the system. Although the school district could receive some additional funding from property taxes generated by these new households (likely to be minimal because adequate housing units are already available in the county and those units are already being taxed), it would not receive additional funding directly from the power plant because CCNPP Unit 3 does not pay property taxes to St. Mary's County. Because the number of in-migrating operational households is small and the educational system already would likely have been expanded to meet the in-migrating construction workforce needs, the impacts of the power plant on the St. Mary's County School District would likely be SMALL and would not require mitigation.

5.8.2.8 References

MDNR, 2006. Maryland Power Plants and the Environment: A Review of the Impacts of Power Plants and Transmission Lines on Maryland's Natural Resources, Economic Development, CEIR-13, Maryland Department of Natural Resources, Power Plant Research Program, January 17, 2006.

USCB, 2000. Profile of Selected Economic Characteristics: 2000, Table DP-3, U.S. Census Bureau, 2000.

5.8.3 ENVIRONMENTAL JUSTICE IMPACTS

This section describes the potential disproportionate adverse socioeconomic, cultural, environmental, and other impacts that operation of CCNPP Unit 3 could have on low-income and minority populations within two geographic areas. The first geographic area is a 50 mi (80 km) radius, where there is a potential for disproportionate employment, income, and radiological impacts, compared to the general population (NRC, 1999). This analysis also evaluates potential impacts within the region of influence (ROI), most of which is encompassed within a 20 mi (32 km) radius of the power plant site, where more localized potential additional impacts could occur to housing, employment, aesthetics, recreation, and other resources, compared to the general population. It also highlights the degree to which each of these populations would disproportionately benefit from operation of the proposed power plant, again compared to the entire population.

Section 2.5.1 provides details about the general population characteristics of the study area and Section 2.5.4 provides details about the number and locations of minority and low-income populations within a 50 mi (80 km) radius of the CCNPP site, and subsistence uses. Potential radiological impacts to the general public are described in Section 5.4 and Section 7.1.

5.8.3.1 50 Mile (80 km) Comparative Geographic Area

As stated in Sections 2.5.4 and 2.5.1, low-income and minority populations primarily reside in the Washington/Arlington/Alexandria MSA and Prince Georges County, Maryland, and in Fairfax County, Virginia, located northwest and within the 50 mi (80 km) radius of the CCNPP Unit 3 site. There are no unique minority or low income populations within the comparative environmental impact area that would likely be disproportionately adversely impacted by operation of the power plant because they reside outside of where environmental impacts (e.g., noise, air quality, water quality, changes in habitat, aesthetic, etc.) would likely occur.

However, the proportion of low-income and minority operational workers from the comparative geographic area that are currently employed but would be willing to move or commute to the power plant site could realize increased income levels.

Because there would not be disproportionate direct physical impacts to minority and low income populations, and some might benefit from increased employment opportunities and income levels, the impacts would be SMALL and would not require mitigation.

5.8.3.2 Two-County Region of Influence

5.8.3.2.1 Employment and Income

There would be an estimated 363 person workforce operating the CCNPP Unit 3 power plant from 2016 to 2076. An estimated 245 workers (68%) would reside in Calvert County and 85 workers (23%) would reside in St. Mary's County. In addition, as described in Section 5.8.2, 661 indirect job opportunities (using a ROI-only multiplier of 2.0000) would be created in the ROI in support of the direct workforce.

No minority or low-income populations were found to exist in Calvert County. However, within St. Mary's County, two census block groups were found to have aggregate concentrations of minorities and one census block group was found to have a low-income population concentration. Minority and low-income residents of these census block groups might benefit from employment at CCNPP Unit 3, to the extent that they are currently unemployed or underemployed, and to the extent that they have the skills required to fill the operational workforce positions. This beneficial impact is likely to be SMALL, would not be disproportionate compared to the general population, and would not require mitigation.

It is estimated that CalvertCliffs 3 Nuclear Project and UniStar Nuclear Operating Services would spend $28 million annually in salaries (an average of $77,135/year/worker for direct labor, excluding benefits). The CCNPP Unit 3 estimated average annual salary is only somewhat less than the $84,388 median income for an entire household in Calvert County in 2005, but noticeably larger than $62,939 median household income in St. Mary's County. Again, minority and low-income residents might benefit from employment at CCNPP Unit 3, to the extent that they can switch from lower paying to higher paying jobs. Given the small number of higher paying jobs created, the beneficial impacts for low-income and minority populations would be SMALL, would not be disproportionate compared to the general population, and would not require mitigation.

5.8.3.2.2 Housing

As described in Section 5.8.2, there are far more vacant housing units available in the ROI than would be needed to house the direct and indirect operational workforces for CCNPP Unit 3. Also, because significantly more units are available than would be needed, the in-migrating workforces alone should not result in an increase in housing prices or rental rates.

In addition, scheduling planned outages for CCNPP Unit 3 at times other than when they would occur for CCNPP Units 1 and 2 should minimize the impacts of the availability and cost for hotel/motel rooms and other short-term accommodations. Thus, CCNPP Unit 3 should not affect the availability or cost of housing for low-income and minority populations. Because the operational workforce would not require significant amounts of the vacant houses or hotel/motel rooms and, thus, would not affect housing or rental prices, the power plant would have a SMALL impact on housing, would not be disproportionate compared to the general population, and would not require mitigation.

5.8.3.2.3 Tax Revenues

Finally, UniStar would pay an estimated [ ] million annually in property taxes (all figures are in 2005 dollars) starting in 2015 when power plant operation would begin. These revenues would slowly decline in the following years as a result of taking allowances for depreciation. These new property taxes from CCNPP Unit 3 would represent a [ ] increase in Calvert County's $78.8 million in annual property (real and personal) tax revenues for fiscal year 2005, and a [ ] increase in total county revenues of $174.1 million.

UniStar also would spend about $9 million annually on materials, equipment, and outside services (excluding costs for planned outages) which would generate additional sales taxes for the county and the state.

The CCNPP Unit 3 operational workforce would generate increased income tax, sales tax, and property tax revenues where they live and where they spend their incomes. Low-income and minority populations might benefit somewhat from these increased tax revenues, either because they might help to avoid some future tax increases or they might fund improvements to or the creation of new public facilities or services. However, the benefits of these additional tax revenues, facilities, or services would be SMALL, would not be disproportionate compared to the general population, and would not require mitigation.

5.8.3.2.4 Subsistence

Existing or traditional subsistence harvesting activities would not likely be affected by operation of CCNPP Unit 3 because these activities do not occur directly on the CCNPP site. Also, CCNPP Unit 3 would not likely affect the surrounding environment where subsistence and other harvesting activities might occur, and thus should not affect harvest rates. Thus, impacts to subsistence uses would be SMALL, would not be disproportionate compared to the general population, and would not require mitigation. Also, potential radiological releases from CCNPP Unit 3 will be a fraction of those already existing for CCNPP Units 1 and 2 combined, and the combined releases of all three units will be well below regulatory limits. Thus, there is no indication based upon the levels of releases that Unit 3 would add significantly to the total radiological releases or ingestion from subsistence harvesting activities.

5.8.3.2.5 Transportation

There is no indication that people in minority or low income census block groups lack personal vehicles or other modes of transportation. Thus, there would likely be a SMALL impact to minority and low income populations if transportation to outside of the ROI would be required, and no mitigation would be required.

5.8.3.3 References

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

Table 5.8-1—Estimated Cooling Tower Sound in A-weighted Levels at Seven Community Receptors

Location	Leaf-on Conditions	Leaf-off Conditions
N1	<<30	<<30
S1	44	48
S2	51	54
S3	49	53
W1	39	43
W2	35	39
W3	<30	32

Table 5.8-2—Estimates of In-Migrating Operational Workforce in Calvert County and St. Mary's County, from 2016 to 2055

In-migration Characteristics	Calvert County	St. Mary's County	Total ROI
Direct Workforce:			
Maximum Direct Workforce			363
Percent of Current CCNPP Units 1 & 2 Workforce Distribution	68%	23%	
Estimated In-migrating Direct Workforce	247	83	330
In-migrating Direct Workforce Population (@2.61 people/household)	644	218	862
Indirect Workforce:			
Estimated Distribution of Peak Direct Workforce	247	83	330
Peak Indirect Workforce (@2.0 multiplier)	494	167	661
Indirect Workforce Needs Met by Direct Workforce Spouses (@59.5% working spouses)	236	80	316
Remaining, Unmet Indirect Workforce Need	161	54	215
In-migrating Indirect Workforce Population (@2.61 people /household)	420	142	562
Total In-migrating Direct and Indirect Workforce People	1,064	360	1,424

Notes:

U.S. Census Bureau 2000 census data indicates that the state of Maryland had 2.61 people per household.

U.S. Census Bureau 2000 census data indicates that, within the state of Maryland, 59.5% of households had a working spouse.

Figure 5.8-1—Predicted Sound Contours (dBA) of Hybrid Cooling Tower during Leaf On conditions

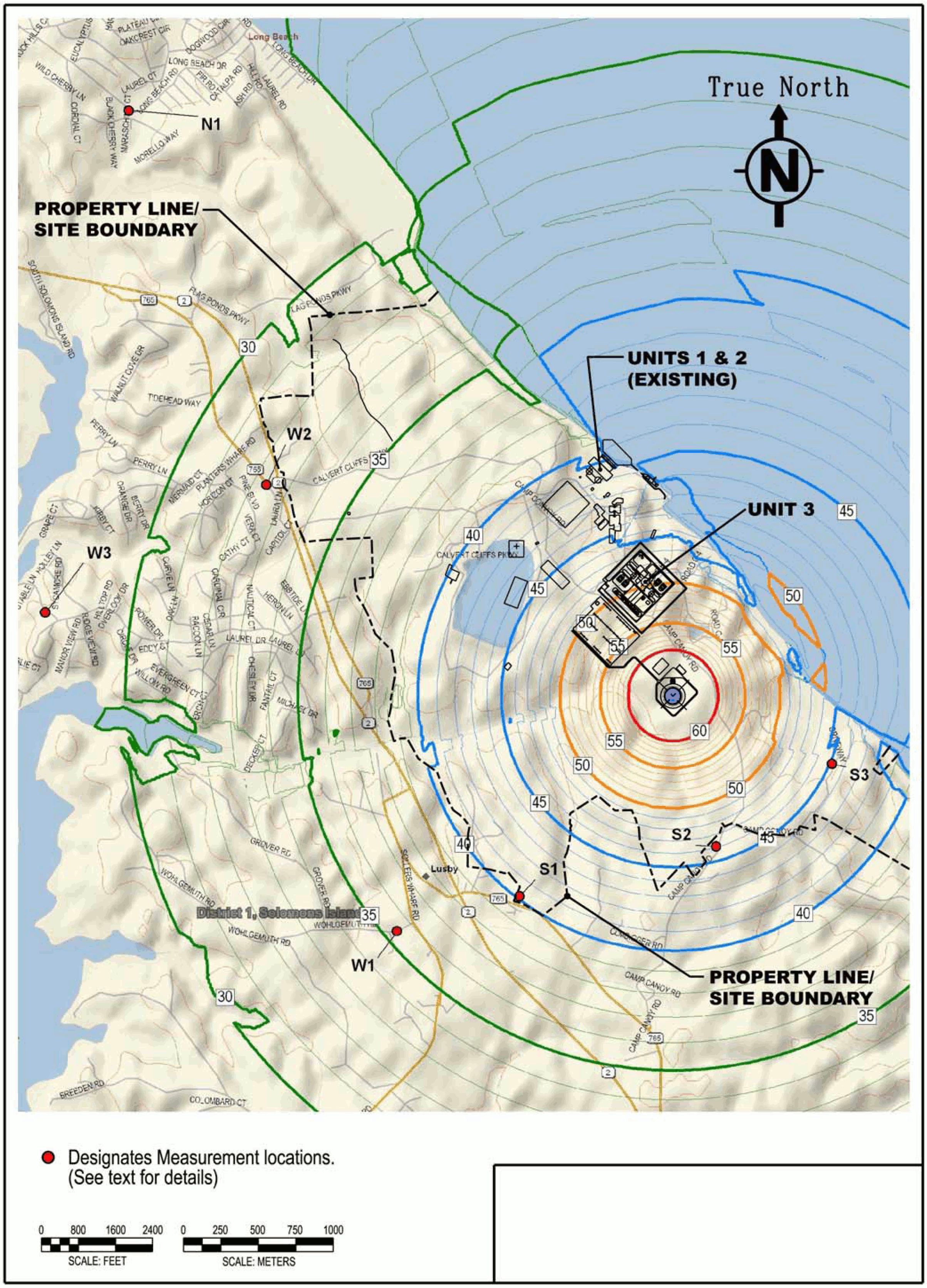
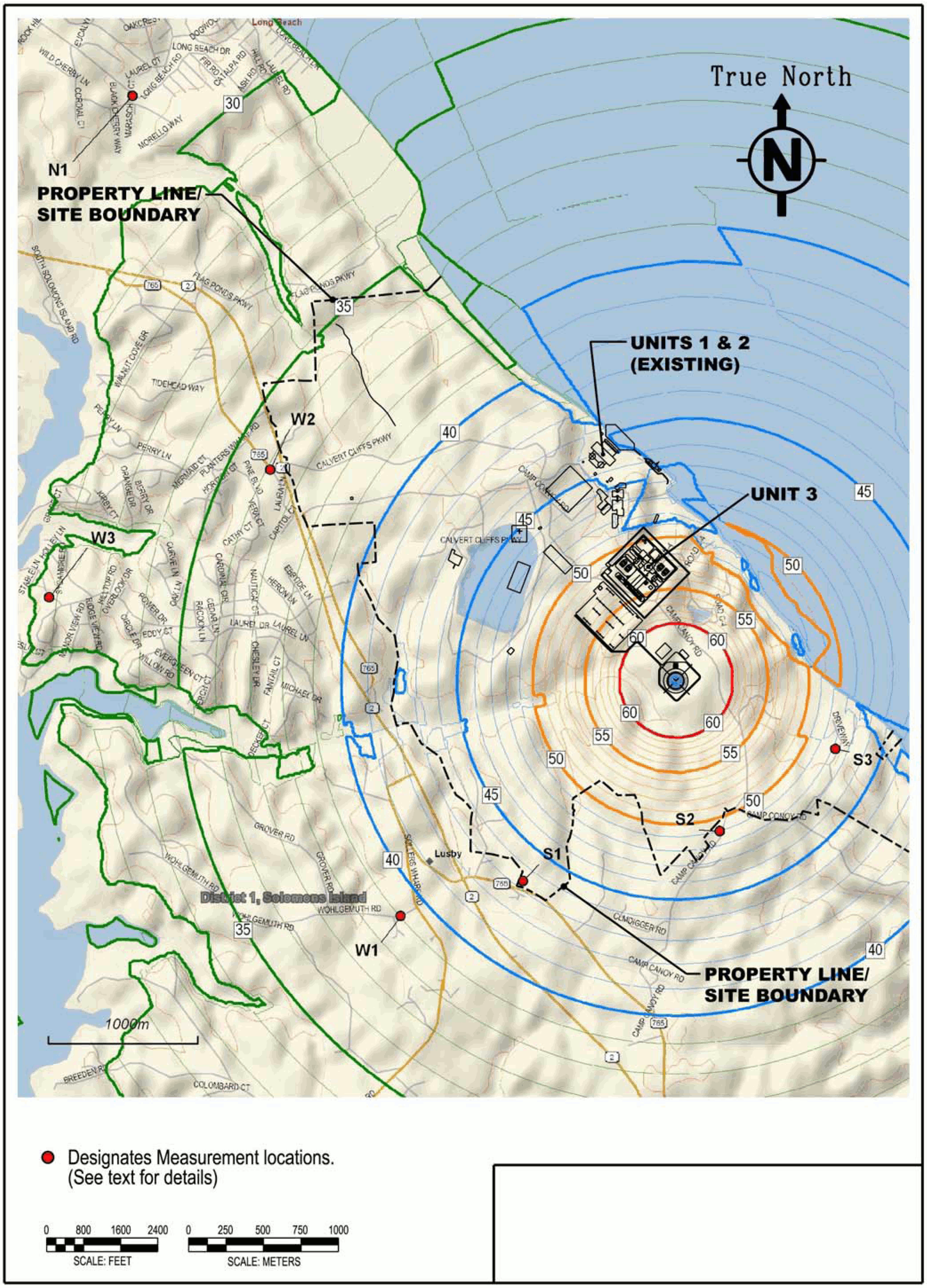


Figure 5.8-2—Predicted Sound Contours (dBA) of Hybrid Cooling Tower during Leaf Off conditions



5.9 DECOMMISSIONING

5.9.1 NRC GENERIC ENVIRONMENTAL IMPACT STATEMENT REGARDING DECOMMISSIONING

As indicated in Appendix A of Section 5.9 of NUREG-1555 (NRC, 2000), studies of social and environmental effects of decommissioning large commercial power generating units have not identified any significant impacts beyond those considered in the Final Generic Environmental Impact statement (GEIS) on Decommissioning (NRC, 2002). The GEIS evaluates the environmental impact of the following three decommissioning methods:

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

NRC regulations do not require a COL applicant to select one of these decommissioning alternatives or to prepare definite plans for decommissioning. These plans are required by 10 CFR 50.82 (CFR, 2007a) after a decision has been made to cease operations. Therefore, general decommissioning environmental impacts are summarized in this section, since detailed plans or a selection of alternatives is not required for a COL applicant.

Decommissioning of a nuclear facility that has reached the end of its useful life has a positive environmental impact. The major environmental impact, regardless of the specific decommissioning option selected, is the commitment of small amounts of land for waste burial in exchange for the potential re-use of the land where the facility is located.

Radiological doses during decommissioning with appropriate work procedures, shielding, and other occupational dose control measures (e.g., remote controlled equipment) similar to those used during plant operation will be controlled. To date, experience with decommissioned power plants has shown that the occupational exposures during the decommissioning period are comparable to those associated with refueling and plant maintenance when it is operational. While each potential decommissioning alternative would have radiological impacts from the transport of materials to their disposal sites, the expected impact from this transportation activity would not be significantly different from normal operations.

5.9.2 DECOMMISSIOINING COST ANALYSIS SUMMARY

While NRC regulations do not require the applicant to submit detailed decommissioning plans (e.g., no detailed analysis of decommissioning is necessary), COL applicants, in accordance with 10 CFR 52.77 (CFR, 2007b), must include as part of their application a report containing a certification that financial assurance for decommissioning will be provided in an amount that may be more, but not less, than the amount stated in the table in 10 CFR 50.75 (CFR, 2007c) paragraph (c)(1). Based on this decommissioning funding report, financial assurance, using a parent guarantee, will be provided in the amount of $376 million (2007 $) consistent with the minimum funding amount established by 10 CFR 50.75 (CFR, 2007c) paragraph (c). This financial assurance will be provided via an acceptable instrument in accordance with 10 CFR 50.75 (CFR, 2007c) paragraph (e) and the guidance provided in Regulatory Guide 1.159 (NRC, 2003). The decommissioning funding report for CCNPP Unit 3 is provided in Part 1, "General Information" of this COL application.

5.9.3 REFERENCES

CFR, 2007a. Title 10, Code of Federal Regulations, Part 50.82, "Termination of License," 2007.

CFR, 2007b. Title 10, Code of Federal Regulations, Part 52.77, "Contents of applications; general information," 2007.

CFR, 2007c. Title 10, Code of Federal Regulations, Part 50.75, "Reporting and recordkeeping for decommissioning planning," 2007.

NRC, 2000. Standard Review Plans for Environmental Reviews for Nuclear Power Plants, NUREG-1555, U.S. Nuclear Regulatory Commission, March, 2000.

NRC, 2002 Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, NUREG-0586, U.S. Nuclear Regulatory Commission, 1988 and Supplement 1, November 2002.

NRC, 2003. Assuring the Availability of Funds for Decommissioning Nuclear Reactors, Regulatory Guide 1.159, Revision 1, Nuclear Regulatory Commission, October, 2003.

NRC, 2007. Report on Waste Burial Charges, NUREG-1307, Rev. 12, Nuclear Regulatory Commission, NMSS, February, 2007.

5.10 MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING OPERATION

This section summarizes the measures and controls to be implemented during the operation of CCNPP Unit 3 to limit potential adverse impacts.

5.10.1 IMPACTS DURING OPERATION

In general, potential impacts will be minimized through compliance with applicable Federal, Maryland, and local laws and regulations enacted to prevent or minimize adverse environmental impacts that may be encountered such as air emissions, noise, storm water pollutants, and spills. Principal among these will be the NPDES Permit to protect water quality and compliance with 10 CFR Parts 50, Appendix I, (CFR, 2007a), 10 CFR 51.52(b) (CFR, 2007b) and 40 CFR Part 190 (CFR, 2007c) to minimize radiation. Also included will be required plans such as a Storm Water Pollution Prevention Plan (SWPPP) and associated Best Management Practices (BMPs) to minimize sediment erosion as well as administrative actions to protect air quality and a site Resource Management Plan. ER Section 1.3 lists the various applicable Federal, Maryland, and local laws, regulations, and permits.

Table 5.10-1 lists the potential impacts associated with the operation of CCNPP Unit 3 described in Sections 5.1 through 5.9 as well as Sections 5.11 and 5.12. The table identifies, from the categories listed below, which adverse impact may occur as a result of operation. Supplement 1 of NUREG-0586 (NRC, 2002) and Supplement 1 of NUREG-1437 (NRC, 1999) were also used to evaluate potential impacts. Table 5.10-1 also includes a brief description, by section, of each potential impact and the measures and controls to minimize the impact, if needed.

- Erosion and Sedimentation
- Air Quality (dust, air pollutants)
- Wastes (effluents, spills, material handling)
- Surface Water
- Groundwater
- Land Use
- Water Use and Quality
- Terrestrial Ecosystems
- Aquatic Ecosystems
- Socioeconomic
- Aesthetics
- Noise
- Traffic
- Radiation Exposure

- Other (site specific)

Based on existing site conditions, in-place CCNPP Unit 1 and 2 programs and procedures, proposed measures and controls, the potential adverse impacts identified from the operation of CCNPP Unit 3 are anticipated to be SMALL for all categories evaluated.

5.10.2 REFERENCES

CFR, 2007a. Title 10, Code of Federal Regulations, 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, 2007.

CFR, 2007b. Title 10, Code of Federal Regulations, Part 51.52, Environmental Effects of Transportation of Fuel and Waste-Table S-4, 2007.

CFR 2007c. Title 40, Code of Federal Regulations, Part 190, Environmental Radiation Protection Standards for Nuclear Power Operations, 2007.

NRC, 1999. Generic Environmental Impact Statement for License Renewal of Nuclear Pants, Calvert Cliffs Nuclear Power Plant, NUREG-1437, Supplement 1, October, 1999.

NRC, 2002. Generic Environmental Impact Statement Decommissioning of Nuclear Facilities, NUREG-0586, Supplement 1, Vol. 1, November, 2002.

Table 5.10-1—Summary of Measures and Controls to Limit Adverse Impacts During Operation
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ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
5.1 Land Use Impacts	Erosion/Sediment (ES) Air Quality (AQ) Wastes (WS) Surface Water (SW) Groundwater (GW) Land Use (L) S Water Use & Quality (W) Terrestrial Ecosystems (TE) S Aquatic Ecosystems (AE) S Socioeconomic (S) Aesthetics (A) Noise (N) Traffic (T) Radiation Exposure (R) Other (site specific) (O) S	
5.1.1 The Site and Vicinity	Presence of new permanent structures. (L) (TE) (AE) (O)	CCNPP 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 from cooling tower drift. (TE) (AE)	Solids deposition (assumed as salt) rates below NUREG-1555 significance level, with drift eliminator in place.
	Regional land use increase due to settlement of new workforce in region. (L)	Regional impact expected to be small (see 5.8.2 below)
	Release of fuels, oils, or other chemicals (AE)	Implement Spill Prevention, Control, and Countermeasures (SPCC) Plan
5.1.2 Transmission Corridors and Off-site Areas	No new offsite transmission lines or rights-of-way disturbance (the existing transmission lines have sufficient capacity to carry the total output of existing CCNPP Units 1 and 2, as well as new CCNPP Unit 3). (L)	Use existing transmission corridor maintenance policies and practices to protect terrestrial and aquatic ecosystems.
	New onsite transmission facilities. (L) (TE)	Develop onsite transmission maintenance policies and practices (BMPs) and use site Resource Management Plan to protect site resources such as wetlands and streams in vicinity.
5.1.3 Historic Properties (and Cultural Resources)	Disturbance of archaeological resources. (L)	Perform Phase II Cultural Resource Survey.
		Develop plan and procedures in consultation with the SHPO to manage historic/cultural resources.

Table 5.10-1—Summary of Measures and Controls to Limit Adverse Impacts During Operation
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ER Reference Section	Potential Impact Category and Description		Proposed Measures and Controls or Mitigating Circumstances
5.2 Water-Related Impacts	Erosion/Sediment (ES) Air Quality (AQ) Wastes (WS) Surface Water (SW) Groundwater (GW) Land Use (L) Water Use & Quality (W) Terrestrial Ecosystems (TE) Aquatic Ecosystems (AE) Socioeconomic (S) Aesthetics (A) Noise (N) Traffic (T) Radiation Exposure (R) Other (site specific) (O)	S S S S S S	
5.2.1 Hydrologic Alterations and Plant Water Supply	Storm water runoff from onsite buildings, utilities, and roads. (ES) (SW) (W) (AE)		Implement Storm Water Pollution Prevention Plan (SWPPP) as part of the CCNPP Unit 3 NPDES permit.
	Bay water withdrawal for closed-loop Circulating Water Supply System makeup, Desalinization Plant, and Ultimate Heat Sink makeup. (SW) (W) (AE)		Obtain MDE Water Appropriations and Use Permit.
	Periodic maintenance dredging. (SW) (W) (AE)		Comply with Corps of Engineers 404 Permit.
	Impoundment and stream encroachment. (ES) (SW) (AE)		Develop new storm water impoundments and/or modify existing impoundments as part of plant construction.
	Groundwater withdrawal impact. (GW)		Install Desalination Plant.
5.2.2 Water Use Impacts	Reduced navigational or recreational use. (W) (AE)		Area affected is wholly contained within an existing and restricted nuclear power plant navigation zone.
	Bay water withdrawal for closed-loop Circulating Water Supply System makeup, Desalinization Plant, and Ultimate Heat Sink makeup. (SW) (W)		Comply with MDE Water Appropriations and Use Permit.
	Reduction in available pervious (infiltration) areas. (SW (GW)		Implement Spill Prevention, Control, and Countermeasures (SPCC) Plan.
	Impoundment and stream encroachment. (ES) (SW)		Develop new storm water impoundments and/or modify existing impoundments as part of plant.
	Release of fuels, oils, or other chemicals (SW) (GW)		Implement Spill Prevention, Control, and Countermeasures (SPCC) Plan.
	Groundwater withdrawal impact (GW)		Install Desalination Plant.

Table 5.10-1—Summary of Measures and Controls to Limit Adverse Impacts During Operation
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ER Reference Section	Potential Impact Category and Description		Proposed Measures and Controls or Mitigating Circumstances
5.2.3 Water Quality Impacts	Effluent releases from plant Circulation Water Supply System, cooling tower, Waste Water Treatment Plant, and desalinization operations to the Chesapeake Bay. (SW) (W) (AE)		Obtain CCNPP Unit 3 NPDES permit and comply with EPA effluent limitations.
	Onsite erosion and sediment build up. (ES)		Implement Storm Water Pollution Prevention Plan (SWPPP), which includes sediment and erosion control.
	Temporary increase in turbidity and silt from periodic dredging. (SW) (W) (AE)		Comply with Corps of Engineers 404 Permit requirements.
	Release of fuel, oils, or other chemicals. (SW) (GW)		Implement Spill Prevention, Control, and Countermeasures (SPCC) Plan.
5.3 Cooling System impacts	Erosion/Sediment (ES) Air Quality (AQ) Wastes (WS) Surface Water (SW) Groundwater (GW) Land Use (L) Water Use & Quality (W) Terrestrial Ecosystems (TE) Aquatic Ecosystems (AE) Socioeconomic (S) Aesthetics (A) Noise (N) Traffic (T) Radiation Exposure (R) Other (site specific) (O)	S S S S S S S 	
5.3.1 Intake System			
5.3.1.1 Hydrodynamic Descriptions and Physical Impacts	Alteration of site hydrology. (GW)		Small incremental water withdrawal compared to CCNPP Units 1 and 2, which was considered by NRC to have a small impact in NUREG-1437.
	Sediment scour of Chesapeake Bay bottom. (AE)		Low intake velocity design. Perform periodic dredging, as needed.
5.3.1.2 Aquatic Ecosystems	Impingement increase (AE)		Use BAT (Best Available Technology) intake design.
	Entrainment increase. (AE)		Small incremental water withdrawal compared to CCNPP Units 1 and 2; hence, the resultant impacts are expected to be comparable, which NRC concluded was a small impact to impingement/entrainment per NUREG-1437.
5.3.2 Discharge System			
5.3.2.1 Thermal Description and Physical Impacts	Ambient temperature increase. (AE)		Use closed-cycle system, incorporating a subsurface, multi-port diffuser.
			Thermal modeling results demonstrate that the thermal plume will meet the MDE thermal compliance criteria.

Table 5.10-1—Summary of Measures and Controls to Limit Adverse Impacts During Operation
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ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
5.3.2.2 Aquatic Ecosystems	Attraction of fish to thermal plume. (AE)	All effects studied extensively at CCNPP Units 1 and 2, which collectively demonstrate the absence of harm due to present plant operation. The addition of CCNPP Unit 3 is not expected to change this conclusion due to the small discharge flow as compared to CCNPP Units 1 and 2.
	Heat shock. (AE)	Thermal modeling results show a very small area exposed to elevated temperatures, which is expected to have a small, if any, impact.
	Blockage to migration. (AE)	Thermal modeling results show a very small area exposed to elevated temperatures, which is expected to have a small, if any, impact.
	Changes to benthic species composition. (AE)	Thermal modeling results show a small area exposed to sediment scour, which is expected to recolonize, with little or no impact.
	Growth of nuisance species. (AE)	CCNPP Units 1 and 2 studies and testing provide evidence that the incremental Unit 3 discharge will also have minimal impact.
	Alteration of reproductive patterns. (AE)	CCNPP Units 1 and 2 studies and testing provide evidence that the incremental Unit 3 discharge will also have minimal impact.
	Chemical effects of biocides. (AE)	NPDES chemical and bioassay testing for CCNPP Units 1 and 2 shows no toxicity effects on test organisms.
5.3.3 Heat Discharge System		
5.3.3.1 Heat Dissipation to the Atmosphere	Visible cooling tower plume. (AQ) (A)	Cooling tower modeling results show: plumes occur in all directions, whose lengths and heights vary seasonally, but judged to have small impact and not require mitigation;
	Increase in ground-level fogging and icing. (AQ)	fogging and icing varies seasonally and is localized, reaching the site boundary <30 hrs per yr;
	Solids deposition from cooling tower drift. (TE) (A)	solids deposition (assumed as salt) rates below NUREG-1555 significance level, with a drift eliminator in place;
	Plume (cloud) shadowing, humidity, and precipitation. (AQ) (A)	cloud shadowing, humidity, and precipitation varies seasonally and is localized, having an anticipated small impact.
5.3.3.2 Terrestrial Ecosystems	Plant community (vegetation and trees) disturbance due to:	Natural vegetation is already adapted to frequent fogging, high humidity, and icing due to existing conditions, therefore, the new cooling tower has a small impact on the existing frequent fogging, high humidity, and icing.
	fogging, high humidity, and icing,	Largest area of deposition extends over the Bay water, away from terrestrial vegetation.
	solids deposition (assumed as salt). (TE)	All vegetation exposed to deposition is at rates below NUREG-1555 significance level.
		Low risk of acute injury to sensitive plant species, with some risk of chronic injury.
		Salt deposition is unlikely to convert forest to scrub-shrub vegetation unsuitable to wildlife favoring forested habitat, including forest interior bird species (FBIS)
	Destabilization of soil on steep slopes. (TE) (ES)	Unlikely impairment of forest vegetation that stabilizes soil on steep slopes.
	Avian collisions with man-made structures. (TE) (A)	Low profile tower design and minimal cooling tower lighting, as practicable and allowed by regulation.

Table 5.10-1—Summary of Measures and Controls to Limit Adverse Impacts During Operation

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ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
5.3.4 Impacts to Members of the Public	Release of thermophilic bacteria from within the cooling system. (AE)	Thermophilic organisms are typically associated with fresh water; Circulation Water Supply System water will be withdrawn from Chesapeake Bay, which is saline. As a result, thermophilic organisms are not expected to occur within the cooling tower system and, thus not create a public health issue.
		Makeup of fresh water for the Essential Service Water System and mechanical draft cooling towers will be treated with a biocide.
	Noise from cooling tower operation. (N)	Computer modeled noise contours show State of Maryland residence noise standards will be met at the CCNPP site boundary as discussed in Section 5.8.1.
5.4 Radiological Impacts of Normal Operation	Erosion/Sediment (ES) Air Quality (AQ) S Wastes (wS) Surface Water (SW) Groundwater (GW) Land Use (L) Water Use & Quality (W) Terrestrial Ecosystems (TE) S Aquatic Ecosystems (AE) S Socioeconomic (S) Aesthetics (A) Noise (N) Traffic (T) Radiation Exposure (R) S Other (site specific) (O)	
5.4.1 Exposure Pathways	Liquid and gaseous pathway. (AQ) (TE) (AE) (R)	Note: Proposed measures and controls apply to all marked categories. Calculated doses for all exposure pathways less than guidelines established in 10 CFR Part 50, Appendix I, and regulatory limits set in 40 CFR Part 190.
		Comply with requirements and design to maintain dose ALARA.
	Direct radiation. (TE) (R)	Implement radiological monitoring program.
5.4.2 Radiation Doses to Members of the Public	Liquid and gaseous pathway. (AQ) (R)	Calculated doses for all exposure pathways are less than guidelines established in 10 CFR Part 50, Appendix I, and regulatory limits set in 40 CFR Part 190.
	Direct radiation. (R)	Comply with requirements and design to maintain dose ALARA.
		Implement radiological monitoring program.
5.4.3 Impacts to Members of the Public	Liquid and gaseous pathway. (AQ) (R)	Calculated doses for all exposure pathways less than guidelines established in 10 CFR Part 50, Appendix I, and regulatory limits set in 40 CFR Part 190.
	Direct radiation. (R)	Comply with requirements and design to maintain dose ALARA.
		Implement radiological monitoring program.
5.4.4 Impacts to Biota Other Than Members of the Public	Liquid and gaseous pathway. (TE) (AE) (R)	Note: Proposed measures and controls apply to all marked categories. Calculated doses for all exposure pathways less than regulatory limits set in 40 CFR Part 190, which is conservative for biota as discussed in Section 5.4.4.3.
		Comply with requirements and design to maintain dose ALARA.
		Implement radiological monitoring program.

Table 5.10-1—Summary of Measures and Controls to Limit Adverse Impacts During Operation

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ER Reference Section	Potential Impact Category and Description		Proposed Measures and Controls or Mitigating Circumstances
5.5 Environmental Impact of Waste	Erosion/Sediment (ES) Air Quality (AQ) Wastes (WS) Surface Water (SW) Groundwater (GW) Land Use (L) Water Use & Quality (W) Terrestrial Ecosystems (TE) Aquatic Ecosystems (AE) Socioeconomic (S) Aesthetics (A) Noise (N) Traffic (T) Radiation Exposure (R) Other (site specific) (O)	 S S S S S S 	
5.5.1 Non-radioactive Waste System Impact	Solid waste generation, including hazardous waste and sewage sludge. (WS)		Reuse, recycle and reclaim solid waste and liquids as appropriate; otherwise, use approved transporters and offsite disposal facilities.
	Chemical and other pollutant discharges, including liquid and gaseous effluents. (WS) (AQ) (W) (AE)		Comply with applicable state and federal hazardous waste and air quality regulations.
	Desalination Plant brine. (SW) (W) (AE)		Comply with NPDES permit, including implementing a Storm Water Pollution Prevention Plan (SWPPP).
5.5.2 Mixed Waste Impacts	Chemical and radiation exposure. (WS) (SW) (W) (AE)		CCNPP Unit 3 annual chemical quantities expected to be less than CCNPP Units 1 and 2 due to use of a closed cycle cooling system and cooling tower, which are minimal.
	Accidental releases and cleanup. (SW) (W)		Implement storage, shipment and emergency response procedures.
5.6 Non-Radiological Health Impacts	Erosion/Sediment (ES) Air Quality (AQ) Wastes (WS) Surface Water (SW) Groundwater (GW) Land Use (L) Water Use & Quality (W) Terrestrial Ecosystems (TE) Aquatic Ecosystems (AE) Socioeconomic (S) Aesthetics (A) Noise (N) Traffic (T) Radiation Exposure (R) Other (site specific) (O)	 S S S S S	

Table 5.10-1—Summary of Measures and Controls to Limit Adverse Impacts During Operation
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ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
5.6.1 Terrestrial Ecosystems	Effects from maintenance of offsite transmission lines and corridors. (TE) (O)	Existing offsite transmission lines and corridors will be used for the new unit; mitigation of potential impacts to offsite terrestrial ecosystems would be unchanged.
	Loss of onsite vegetation and existing habitat for FIBS as well as forest cover. (TE) (O)	Use site Resource Management Plan and BMPs to protect resources. Transplant rare plant species to open field areas.
	Disturbance to important terrestrial species. (TE) (O) (N	
	Effects from maintenance of onsite transmission lines and corridors. (TE)	Implement onsite routine transmission system maintenance policy and procedures, including vegetation control, erosion control, and important species protection.
	Avian collisions with man-made structures (TE) (A)	Low profile tower design and minimal cooling tower lighting, as practicable and allowed by regulation.
5.6.2 Aquatic Ecosystems	Effects from maintenance of offsite transmission lines and corridors. (AE) (O)	Existing offsite transmission lines and corridors will be used for the new unit; mitigation of potential impacts to offsite aquatic ecosystems would be unchanged.
	Disturbance of onsite wetlands and streams in vicinity. (AE)	Use site Resource Management Plan and BMPs to protect resources, e.g., wetlands and streams.
	Disturbance to important aquatic species. (AE) (N)	Implement onsite routine transmission system maintenance policy and procedures, including vegetation control, erosion control, and important species protection.
	Effects from maintenance of onsite transmission lines and corridors. (AE)	Implement onsite routine transmission system maintenance policy and procedures, including vegetation control, erosion control, and important species protection.
5.6.3 Impacts to Members of the Public	Public exposure to noise, electric shock, and electric field gradients. (N)	Existing offsite transmission lines and corridors will 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.

Table 5.10-1—Summary of Measures and Controls to Limit Adverse Impacts During Operation
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ER Reference Section	Potential Impact Category and Description		Proposed Measures and Controls or Mitigating Circumstances
5.7 Uranium Fuel Cycle	Erosion/Sediment (ES)		
	Air Quality (AQ)	S	
	Wastes (WS)	S	
	Surface Water (SW)	S	
	Groundwater (GW)		
	Land Use (L)	S	
	Water Use & Quality (W)	S	
	Terrestrial Ecosystems (TE)		
	Aquatic Ecosystems (AE)		
	Socioeconomic (S)		
	Aesthetics (A)		
	Noise (N)		
	Traffic (T)		
	Radiation Exposure (R)	S	
	Other (site specific) (O)		
	Uranium mining and milling. (L) (R) (W) (AQ) (SW) (W)		Note: Proposed Measures and Controls apply to all marked impact categories.
	Production of uranium conversion. (L) (R) (W) (AQ) (SW) (W)		Comparison of the U.S. EPR reactor, which was normalized for a reference 1,000 MWe LWR, to Table S-3 values, as shown in Table 5.7-1, show that the impacts evaluated (land use, water use, fossil fuels, chemical effluents, radioactive effluents and wastes, occupational exposure, and transportation), would all be minor and require no action to warrant mitigation.
	Transportation of radioactive materials. (L) (R) (W) (AQ) (SW) (W)		Possible use of centrifuge uranium enrichment process in lieu of gaseous diffusion process, which significantly reduces energy use and resultant environmental effects.
	Management of low- and high-level radioactive wastes. (L) (R) (W) (AQ) (SW) (W)		
5.8 Socioeconomic Impacts	Erosion/Sediment (ES)		
	Air Quality (AQ)	S	
	Wastes (WS)		
	Surface Water (SW)		
	Groundwater (GW)		
	Land Use (L)		
	Water Use & Quality (W)		
	Terrestrial Ecosystems (TE)		
	Aquatic Ecosystems (AE)		
	Socioeconomic (S)	S	
	Aesthetics (A)	S	
	Noise (N)	S	
	Traffic (T)	S	
	Radiation Exposure (R)		
	Other (site specific) (O)		

Table 5.10-1—Summary of Measures and Controls to Limit Adverse Impacts During Operation
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ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
5.8.1 Physical Impacts	Noise increase due to:	
	♦ Plant operation, including the switchyard,	Minimal, if any, offsite audible operation noise is anticipated based on existing plant baseline noise survey results.
	♦ Cooling tower operation,	Predicted cooling tower noise levels are below regulatory limits.
	♦ Local worker traffic and deliveries. ♦ (N) (S) (A) (T)	Traffic noise limited to normal weekday, business hours
	Air emissions related to diesel generators. (AQ)	Compliance with applicable EPA and MDE air quality regulations and permits.
	Local traffic increase. (T) (N) (S)	Implement administrative traffic management procedures.
	Buildings visible, e.g., Intake and Discharge Structures, Containment, Cooling Tower and related plume. (A) (AQ)	Limited visibility of site from local residences and road traffic due to heavily wooded area. CCNPP site already aesthetically altered on shoreline due to existing plant. Addition of CCNPP Unit 3 is a small impact. Plume rise varies and is temporary, depending on the season, wind direction, and viewpoint location.
5.8.2 Social and Economic Impacts	Operation work force increase. (S) (T)	Operation work force expected to reside in the Region of Influence, which has enough housing to meet the need.
	Public services need (housing, schools, EMS, land use) increase. (S) (T)	Spending on materials, products, and services, including payroll, expected to occur inside the Region of Influence.
	Spending and tax revenue increase. (S)	Minor aggregate socioeconomic impacts inside ROI anticipated (e.g., increase needs of schools, public services and facilities), but mitigation unnecessary due, in general, to sufficient capacity.
		Consistent with Town and County initiatives to increase commercial and industrial development in area.
5.8.3 Environmental Justice Impacts	No disproportionate adverse impacts to minority or low income populations. (S)	None necessary because there are no unique minority or low income populations in the impact area of Calvert County or St. Mary's County where over 90% of the site work force lives.
5.9 Decommissioning	Erosion/Sediment (ES) Air Quality (AQ) Wastes (WS) Surface Water (SW) Groundwater (GW) Land Use (L) Water Use & Quality (W) Terrestrial Ecosystems (TE) Aquatic Ecosystems (AE) S Socioeconomic (S) S Aesthetics (A) Noise (N) S Traffic (T) S Radiation Exposure (R) S Other (site specific) (O) S	
	Radiation exposure related to onsite decommissioning activities and transport of waste materials to disposal sites. (R) (T) (N)	Radiation exposure anticipated to be comparable or less than during operation per NUREG-0586.

Table 5.10-1—Summary of Measures and Controls to Limit Adverse Impacts During Operation

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ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
	Socioeconomic effects due to demands on and contributions to the community by workers. (S) (N)	Socioeconomic are less than during plant construction or operation because level of activity and releases are expected to be smaller per NUREG-0586.
	Environmental effects due to ecology, air quality, and water quality. (AQ) (W) (TE) (AE)	Environmental effects are less than during plant operation because the level of activity and releases are expected to be smaller than NUREG-0586.
	Sufficient funding to complete decommissioning. (O)	Guarantee of certified amount for financial assurance for decommissioning will be provided.
5.11 Transportation of Radioactive Materials, Incident Free	Erosion/Sediment (ES) Air Quality (AQ) Wastes (WS) Surface Water (SW) Groundwater (GW) Land Use (L) Water Use & Quality (W) Terrestrial Ecosystems (TE) Aquatic Ecosystems (AE) Socioeconomic (S) Aesthetics (A) Noise (N) Traffic (T) Radiation Exposure (R) S Other (site specific) (O)	
	General public exposure to radiation during incident-free transport of fuel and wastes. (R)	Performed detailed analysis in accordance with 10 CFR 51.52(b) (CFR, 2007b), yielding conservative results relative to the 3 mrem cumulative dose per reactor year for 1,100 public onlookers.
	Worker exposure to radiation during incident-free transport of fuel and wastes. (R)	Performed detailed analysis in accordance with 10 CFR 51.52(b) (CFR, 2007b), yielding conservative results relative to the 4 mrem cumulative dose per reactor year for 200 transport workers.

Table 5.10-1—Summary of Measures and Controls to Limit Adverse Impacts During Operation
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ER Reference Section	Potential Impact Category and Description		Proposed Measures and Controls or Mitigating Circumstances
5.12 Non-radiological Health Impacts	Erosion/Sediment (ES) Air Quality (AQ) Wastes (WS) Surface Water (SW) Groundwater (GW) Land Use (L) Water Use & Quality (W) Terrestrial Ecosystems (TE) Aquatic Ecosystems (AE) Socioeconomic (S) Aesthetics (A) Noise (N) Traffic (T) Radiation Exposure (R) Other (site specific) (O)	 S S S	
	Public exposure to air emissions, noise, pathogenic organisms, and electric shock. (O) (AQ) (N)		Comply with federal and state air quality requirements or permits.
	Occupational accidents or illnesses from exposures to noise, toxic chemicals or organisms. (AQ) (N) (O)		CCNPP Unit 3 predicted offsite noise levels are below regulatory limits. CCNPP Unit 3 is anticipated to have similar OSHA incident rate of recordable cases as CCNPP Units 1 and 2, which is less than national and state average. Implement site-wide Safety and Medical Program, including safety policies, safe work practices, as well as general and topic-specific training.

5.11 TRANSPORTATION OF RADIOACTIVE MATERIALS

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

The NRC regulations in 10 CFR 51.52 state that:

> Every environmental report prepared for a light-water-cooled nuclear power reactor shall contain a statement concerning transportation of fuel and radioactive wastes to and from the reactor. That statement shall indicate that the reactor and this transportation either meet all of the conditions in paragraph (a) of this section or all of the conditions in paragraph (b) of this section.

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

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

Fuel cladding and heat are discussed in separate sections. Traffic density and dose are discussed in the same section since the calculation of dose is a function of traffic density.

The impact of shipment weight as described in Table S-4 is governed by other restrictions and is unaffected by the U.S. EPR variation from 10 CFR 51.52(a). Table 5.11-1 presents information from Table S-4 of 10 CFR 51.52 (CFR, 2007a).

5.11.1 FUEL CLADDING ENVIRONMENTAL IMPACT

10 CFR 51.52 describes the use of Zircaloy as fuel rod cladding material. More recently, the NRC has also specified, through rule-making, ZIRLO as an acceptable fuel cladding in 10 CFR 50.46 (CFR, 2007b). CCNPP Unit 3 will use AREVA's M5 Advanced Zirconium (M5) fuel rod cladding material.

Several NRC licensees have received approval to use M5 fuel rod cladding with a finding of "no significant impact." For example, NRC approved Davis-Besse Nuclear Power Station, Unit 1 use of M5 cladding, and concluded that the cladding presents no significant environmental impact during transportation (FR, 2000):

With regard to the potential environmental impacts associated with the transportation of the M5 clad fuel assemblies, the advanced cladding has no impact on previous assessments determined in accordance with 10 CFR 51.52.

Further, in 2003, the NRC found M5 fuel rod cladding generally acceptable for use in license applications by compliance with the conditions specified in, and reference to AREVA's Topical Report (TR) (NRC 2003):

The staff has completed its review of the subject TR and finds it is acceptable for referencing in licensing applications to the extent specified and under the limitations delineated in the report and in the associated safety evaluation (SE).

As described above, the use of M5 fuel cladding has been previously evaluated and determined to not result in significant transportation environmental impact at existing facilities. The use of M5 fuel cladding at CCNPP Unit 3 will be equivalent to the M5 fuel cladding previously evaluated at the existing facilities. Therefore it is concluded that the use of M5 cladding at CCNPP Unit 3 will result in no environmental impact during transportation.

5.11.2 HEAT (IRRADIATED FUEL CASK IN TRANSIT) ENVIRONMENTAL IMPACT

This section addresses the decay heat generated in irradiated fuel casks during shipment to a repository.

An irradiated fuel cask has not yet been designed for U.S. EPR fuel; however in NUREG-1811, NUREG-1815, and NUREG-1817 the NRC described and addressed future irradiated fuel casks that may carry up to 1.8 MTU (4000 lbs U) (NRC, 2004; NRC, 2006a; and NRC, 2006b).

Each U.S. EPR fuel assembly contains up to 0.536 MTU (1200 lbs U). ORIGEN2.1 was used to calculate the decay heat from an U.S. EPR fuel assembly using the information provided in Table 5.11-7 (ORNL, 1991). Based on these calculations, an U.S. EPR irradiated fuel assembly will generate 5500 Btu/hr (1.6 kW) of decay heat following 5 years of onsite storage after removal from the reactor core (Table 5.11-2).

Therefore, an irradiated fuel cask designed consistent with that described in the referenced NUREGs could carry up to 3.36 irradiated assemblies (1.8 MTU / 0.536 MTU/assembly.) The total cask decay heat generation would then be 18,600 Btu/hr (5450 kW) (3.36 assemblies times 5500 Btu/hr per assembly.)

10 CFR 51.52(c), Table S-4 (CFR, 2007c) concludes that heat generation of up to 250,000 Btu/hr (73 kW) within a cask is an acceptable environmental impact. This is more than 13 times that which would be generated in a cask transferring the calculated quantity of U.S. EPR irradiated fuel.

An alternative analysis is to assess the maximum number of irradiated fuel assemblies per cask that could be shipped while complying with the 250,000 Btu/hr (73 kW) condition in Table S-4. This method addresses future potential cask designs that could be used to transport greater numbers of assemblies per cask.

The maximum number of U.S. EPR irradiated fuel assemblies based on this evaluation would be 45 assemblies (250,000 Btu/hr / 5500 Btu/hr per assembly). The largest postulated irradiated fuel transfer cask designs have capacities of about half this number and their use for transportation of irradiated U.S. EPR fuel would result in proportionally lower heat generation, well below the Table S-4 value (NRC, 2000b).

Therefore, the decay heat generated by the U.S. EPR fuel per irradiated fuel cask in transit is bounded by 10 CFR 51.52(c), Table S-4 and will not result in significant environmental effects during transportation under normal conditions.

5.11.3 INCIDENT-FREE DOSE AND TRAFFIC DENSITY IMPACT ANALYSIS

This section summarizes the incident-free transportation environmental impacts during normal operations for CCNPP Unit 3. Transportation categories include;

- Transport of unirradiated fuel (new fuel) from fuel fabrication facilities to the site,
- Transport of irradiated fuel from the site to a monitored retrievable storage facility or permanent repository, and
- Transport of radioactive waste

TRAGIS (ORNL, 2003) and RADTRAN (SNL, 2006) computer codes were used to evaluate postulated incident-free dose. Code inputs for each category are presented in Table 5.11-3. The results are summarized in Tables 5.11-5 and 5.11-6.

The results presented in Table 5.11-6 provide a comparison to the reference reactor using an analysis that is consistent with the methodology used previously in the Environmental Impact Statements NUREG-1811, NUREG-1815, and NUREG-1817 (NRC, 2004; NRC, 2006a; and NRC, 2006b).

5.11.3.1 Impact of Unirradiated Fuel (New Fuel)

The radiological dose for the environmental impacts of incident-free new fuel shipments to the reactor site was calculated from the farthest (most conservative) currently existing new fuel fabrication facility near Richland, WA to the CCNPP site.

RADTRAN 5.6 was used to model the CCNPP Unit 3 location specific environmental impact. The model used TRAGIS (ORNL, 2003) generated CCNPP Unit 3 location specific route data to yield dose per shipment. The postulated stop duration was 6.2 hours based on the TRAGIS calculated 2722 mi (4381 km) commercial highway route distance and the 0.0023 hr/mi (0.0014 hr/km), consistent with the stop model assumption used in NUREG-1811, NUREG-1815, and NUREG-1817 (NRC, 2004; NRC, 2006a; and NRC, 2006b).

The RADTRAN 5.6 model calculated radiological impact results per shipment are shown in Table 5.11-5.

The dose per shipment was multiplied by the average number of annual shipments to calculate the average dose per reactor year. New fuel shipments during the life of a reactor are expected to total 298 over the 40 year license period for an average of 7.5 shipments per reactor year. This is consistent with the condition described in Table S-4, which indicates that less than one shipment will occur per day.

At an average of 7.5 shipments per year, the average annual radiological impact from new fuel shipments will be as shown in Table 5.11-6.

5.11.3.2 Impact of Irradiated Fuel

The postulated radiological dose from the incident-free shipment of irradiated fuel from the reactor site to the proposed Yucca Mountain Repository located in Nevada was evaluated by multiplying conservative dose estimates per shipment by the average annual number of shipments.

A RADTRAN 5.6 model was developed using TRAGIS Highway Route Controlled Quantity distance and demographic data specific to the reactor site. Model conservatism is similar to that found in the irradiated fuel RADTRAN 5 models from NUREG-1811, NUREG-1815, and NUREG-1817 (NRC, 2004; NRC, 2006a; and NRC, 2006b). The bounding commercial route distance calculated with TRAGIS was approximately 2680 mi (4313 km) with stop duration of 5.0 hours.

The RADTRAN 5.6 model conservatively calculated radiological impact results per shipment are presented in Table 5.11-5

Shipping cask capacity assumptions are approximations based on current shipping cask designs. The U.S. EPR will require an average of 21 shipments of irradiated fuel per year assuming an irradiated fuel cask capacity of 1.8 MTU (4000 lbs U) consistent with NUREG-1811, NUREG-1815, and NUREG-1817 (NRC, 2004; NRC, 2006a; and NRC, 2006b) and using the highest annual reload for the U.S. EPR of 37.5 MTU (83,000 lbs U), This is consistent with the condition described in Table S-4 of less than 1 shipment per day.

The postulated average annual radiological impact from an average of 21 irradiated fuel shipments per year to the proposed Yucca Mountain Repository is provided in Table 5.11-6.

5.11.3.3 Impact of Radioactive Waste (Radwaste)

The transportation dose of the incident-free radwaste shipments from the reactor site was calculated using the same RADTRAN 5.6 inputs and assumptions as described in 5.11.3.2 above including a bounding disposal location for the CCNPP site. TRAGIS was used to evaluate the highway route to the Hanford, WA commercial low level waste disposal repository. This site is currently not available to Maryland waste generators, but was used because it is bounding (farthest distance) compared to other existing disposal and processing sites. Other sites evaluated were Clive, UT; Beatty, NV; Barnwell, SC; and processors near Oak Ridge and Memphis, TN.

Using the same input parameters as the irradiated fuel model ensured a conservative model and is justified by the similar route demographics and conservatively chosen maximum package and vehicle surface dose rates.

The bounding commercial route distance calculated with TRAGIS was approximately (2700 mi (4400 km) with stop duration of 7.5 hours.

The RADTRAN 5.6 conservatively calculated radiological impact results per shipment are provided in Table 5.11-5

The U.S. EPR average of 15 radwaste shipments per year was derived using current shipping container volume estimates of 55-gallon (0.21 m^3) drums and 90 ft^3 (2.55 m^3) high integrity containers for process wastes and 1000 ft^3 (28.32 m^3) SEALAND containers for dry active waste, similar to the analyses in NUREG-1811, NUREG-1815, and NUREG-1817 (NRC, 2004; NRC, 2006a; and NRC, 2006b). Commercially available containers were matched to the appropriate waste type to determine the total number of containers generated per year. The number of shipments was then determined by dividing the number of containers postulated to be generated by an assumed number of containers that can be transferred per shipment. Table 5.11-4 shows the U.S. EPR container generation rates, realistic container per shipment assumptions, and the subsequent annual number of shipments. The calculated 15 shipments per year is consistent with the condition in Table S-4 which describes less than one shipment per day.

At this average of 15 shipments per year, the average annual radiological impact from radwaste shipments to the bounding disposal site is shown in Table 5.11-6.

5.11.3.4 Comparison with Table S-4 and Conclusion

Table 5.11-6 summarizes the incident-free transportation environmental impacts per reactor year. The table included consideration of:

- Transport of unirradiated fuel (new fuel) from fuel fabrication facilities to the reactor site,
- Transport of irradiated fuel from the reactor site to a monitored retrievable storage facility or permanent repository, and
- Transport of radioactive waste (radwaste) from the reactor site to offsite disposal facilities

The cumulative doses shown in Table 5.11-6 were calculated based on the product of thousands of potentially exposed individuals and the very low doses that each of the could receive.

Although radiation may cause cancers at high doses and high dose rates, currently there are no data that unequivocally establish the occurrence of cancer following exposure to low doses below about 10 rem (100 mSv) or at low dose rates. The individual doses and dose rates calculated to occur during normal transportation are many orders of magnitude less than either of these.

Radiation protection experts conservatively assume that any amount of radiation exposure may pose some risk of causing cancer or a severe hereditary effect and that the risk is higher for higher radiation exposures. I.e., linear, no-threshold dose response model is used to describe the relationship between radiation dose and detriments such as cancer induction. This model has been accepted as a conservative model for estimating health risks from radiation exposure, recognizing that the model probably over-estimates those risks.

The NRC staff estimates the risk to the public from radiation exposure using the nominal probability coefficient for total detriment of 730 fatal cancers, nonfatal cancers, and severe hereditary effects per 1,000,000 person-rem (10,000 person-Sv) from ICRP Publication 60 (ICRP, 1991).

All the population doses presented in Table 5.11-6 are less than 100 person-rem/yr (one person-Sv/yr); therefore, the total detriment estimates associated with these postulated doses would all be less than 0.1 fatal cancers, nonfatal cancers, and severe hereditary effects per year.

These risks are very small compared to the fatal cancers, nonfatal cancers, and severe hereditary effects that would occur annually in the same population from exposure to natural sources of radiation.

Based on this the environmental impacts during normal transportation environmental do not represent a significant environmental impact.

5.11.3.5 Maximally Exposed Individual Impact

The maximally exposed individual impact is the potential dose for individuals exposed to any one shipment given the maximum exposure for all pathways. The shipment dose is independent of source, and is based on the maximum potential package dose rate allowed and postulated exposure scenarios. An analysis of incident-free doses to MEI was performed based on NUREG-1815, Section 6.2.1.1, which in turn references the DOE's Final Environmental Impact Statement (FEIS) for Yucca Mountain (DOE, 2002). An MEI is a person who may receive the highest radiation dose from a shipment to and/or from the reactor site.

The analysis is based on assumptions about exposure times, dose rates, and the number of times an individual may be exposed to an offsite shipment. It was assumed that the shipment dose rate is 0.1 mSv/hr (10 mrem/hr) at 2m (6.6 ft) from the side of the transport vehicle, the maximum dose rate allowed by DOT regulations (49 CFR 173.441). The average annual shipment frequency is based on the total of irradiated fuel and radioactive waste (assuming the dose rate from unirradiated fuel shipments is negligible respective to MEI). The analysis is described below for several different categories of individuals.

Truck crew member:

Truck crew members are trained radiation workers, and 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. Although unlikely, it is assumed that the maximum exposure for a crew member could occur. For irradiated fuel shipments, the crew member doses are limited to 0.02 Sv (2 rem) per year, which is the DOE administrative control level (DOE, 2005). This limit is anticipated to apply to spent nuclear fuel shipments to a disposal facility, as DOE will take title to the spent fuel at the reactor site. For radwaste shipments, the crew member doses are limited to 0.05 Sv (5 rem) per year, which is the NRC limit for occupational exposures (10 CFR 20). Since the NRC limit is higher, a MEI could receive a potential 0.05 Sv/yr (5 rem/yr).

Non-radiation workers, or the general public would receive much less exposure, as demonstrated below.

Inspectors:

Radioactive shipments are inspected by Federal or state vehicle inspectors, for example, at state ports of entry. NUREG-1815 assumed that inspectors would be exposed for 1 hour at a distance of 1-m (3.3 ft) from the package. The dose rate at 1-m is assumed at 0.14 mSv/hr (14 mrem/hr) (Table 5.11-3), so the dose per shipment is 0.14 mSv (14 mrem).

For the EPR, based on 21 annual irradiated fuel shipments (as noted in Section 5.11.3.2) and 15 annual radwaste shipments (as noted in Section 5.11.3.3) (36 total), the annual dose to vehicle inspectors is calculated to be 5 mSv/yr (500 mrem/yr), assuming the same person inspects all shipments of fuel and waste:

MEI annual dose = (21 irradiated fuel + 15 radwaste) shipments/yr x 0.14 mSv/shipment = 5 mSv/yr.

Resident:

NUREG-1815 used the DOE FEIS assumption of a resident living 30-m (100-ft) from shipments that are traveling 24-km/hr (15-mi/hr) for all shipments along a particular route. The FEIS also assumed a resident would be exposed to 5,000 (mostly legal-weight) shipments over 24 years. The dose to the resident over 24 years was estimated at 0.06 mSv (6 mrem) (DOE, 2002). Therefore, the dose per shipment is 0.000012 mSv (0.0012 mrem).

For the EPR with an average of 36 annual shipments, the potential dose to the MEI resident is 0.000432 mSv/yr (0.0432 mrem/yr).

MEI annual dose = 0.06 mSv / 5000 shipments x 36 shipments/yr = 0.000432 mSv/yr.

Individual stuck in traffic:

NUREG-1815 used the DOE FEIS assumption that, for one time only, an individual could become stuck in traffic next to a loaded shipment for one hour at a distance of 1.2m (4-ft). Similar to a resident, it assumed the individual would be exposed to 5,000 (mostly legal-weight) shipments over 24 years. The dose to the resident over 24 years was estimated at 0.16 mSv (16 mrem) (DOE, 2002). Therefore, the dose per shipment is 0.000032 mSv (0.0032 mrem).

For the EPR with an average of 36 annual shipments, the potential dose to the MEI stuck in traffic is 0.00115 mSv/yr (0.115 mrem/yr).

MEI annual dose = 0.16 mSv / 5000 shipments x 36 shipments/yr = 0.00115 mSv/yr.

Person at a truck service station:

NUREG-1815 used the DOE FEIS assumption that an employee at a service station where all truck shipments from the advanced reactors would stop could be exposed for 49 minutes at a distance of 16-m (52-ft) from the loaded shipment. This results in a dose estimate of 0.0007 mSv/shipment (0.07 mrem/shipment).

For the EPR with an average of 36 annual shipments, the potential dose to the MEI at a truck service station is 0.0252 mSv/yr (2.52 mrem/yr).

MEI annual dose = 0.0007 mSv/shipment x 36 shipments/yr = 0.0252 mSv/yr.

5.11.4 SUMMARY AND CONCLUSION

The use of M5 cladding has been previously evaluated and determined not to result in significant environmental impact during normal conditions of transportation.

A conservative and detailed analysis of the environmental impacts for the transportation of unirradiated fuel, irradiated fuel, and radioactive waste to and from CCNPP Unit 3 has been performed in accordance with 10 CFR 51.52(b) (CFR, 2007c). The use of M5 cladding has been previously evaluated and determined not to result in significant environmental impact during normal conditions of transportation. The decay heat generated by U.S. EPR fuel in transit is bounded by 10 CFR 51.52(c), Table S-4 (CFR, 2007c) and will not result in significant environmental effects during transportation under normal conditions. The dose and traffic impact analysis of the incident free transportation of U.S. EPR fuel and radioactive waste generated at the new facility will not result in significant environmental effects during transportation under normal conditions.

Based on this, the U.S. EPR design variation from the conditions of 10 CFR 51.52(a) will not result in significant environmental effects during transportation activities associated with the operation of CCNPP Unit 3. As a result, the impacts would be SMALL.

5.11.5 REFERENCES

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Table 5.11-1—Summary of Environmental Impacts of Transportation of Fuel and Waste to and from One Light Water Reactor, taken from 10 CFR 51.52 Table S-4

Normal Conditions of Transport			
		Environmental Impact	
Heat (per irradiated fuel cask in transit)		250,000 Btu/hr (73 kW)	
Weight (governed by Federal or State Restrictions		73,000 lbs. (33000 kg) per truck; 100 tons (91 MT) per cask per rail car	
Traffic Density:			
Truck		Less than 1 per day	
Rail		Less than 3 per month	
Exposed Population	Estimated Number of Persons Exposed	Range of Doses to Exposed Individuals (per reactor year)	Cumulative Dose to Exposed Population (per reactor year)
Transportation Workers	200	0.01 to 300 mrem (1e-4 to 3 mSv)	4 person rem (40 mSv)
General Public			
Onlookers	1,100	0.003 to 1.3 mrem (0.03 to 13 Sv)	3 person rem (30 mSv)
Along Route	600,000	1E-4 to 6E-2 mrem (1E-3 to 0.6 Sv)	No number provided in 10 CFR 51.52 Table S-4

Table 5.11-2—Decay Heat for EPR Irradiated Fuel Assembly

Decay Time (year)	Decay Heat per Assembly (Btu/hr)			
	GWd/MTU 62	GWd/MTU 52	GWd/MTU 40	GWd/MTU 10
4.75	7.32E+03		4.01E+03	9.17E+02
5.00	7.09E+03	5.52E+03	3.88E+03	8.82E+02
6.34	5.89E+03		3.17E+03	6.95E+02

Note 1: Linear regression used to determine 5 year decay heat at 62, 40, 10 (GWd/MTU).

Note 2: Polynomial Regression used to determine 52 GWd/MTU decay heat at 5 years:

(5.52E+03 = 0.896*(52)^2+54.96*(52)+243)

Table 5.11-3—RADTRAN & TRAGIS Model Input Parameters

Parameter	New Fuel	Spent Fuel	Radwaste
TRAGIS Input:			
Route Mode	Commercial	HRCQ	Commercial
Route Origin	Richland, WA	CCNPP	CCNPP
Route Destination	CCNPP	Yucca Mt, NV	Hanford, WA
RADTRAN Input TRAGIS:			
Total Shipping Distance, mi (km)	2722 (4381)	2680 (4313)	2734 (4400)
Travel Distance - Rural, mi (km)	2065 (3322.5)	2035 (3275.2)	2063 (3320.5)
Travel Distance - Suburban, mi (km)	593 (953.6)	568 (914.0)	594 (955.5)
Travel Distance - Urban, mi (km)	65 (104.9)	77 (123.8)	77 (123.2)
Population Density - Rural, person/mi^2 (person/km^2)	30 (11.7)	30 (11.5)	30 (11.6)
Population Density – Suburban, person/mi^2 (person/km^2)	801 (309.3)	817 (315.5)	835 (322.4)
Population Density – Urban, person/mi^2 (person/km^2)	6020 (2324.3)	6169 (2381.8)	6085 (2349.5)
Stop Time, hr/trip	6.2 [(a)]	5.0 [(b)]	7.5 [(b)]
RADTRAN Input from NRC Models			
Vehicle Speed, mi/hr (km/hr)	55 (88.49)	55 (88.49)	55 (88.49)
Traffic Count - Rural, vehicles/mi (vehicle/km)	853 (530)	853 (530)	853 (530)
Traffic Count - Suburban, vehicles/mi (vehicle/km)	1223 (760)	1223 (760)	1223 (760)
Traffic Count - Urban, vehicles/mi (vehicle/km)	3862 (2400)	3862 (2400)	3862 (2400)
Dose Rate at 3.3 ft (1 m) from Vehicle, mrem/hr (mSv/hr)	0.1 (0.001)	14 (0.14)	14 (0.14)
Packaging Length, ft (m)	24 (7.3)	17 (5.2 [(c)])	17 (5.2)
Number of Truck Crew	2	2	2
Population Density at Stops (radii: 3.3 to 33 ft (1 to10 m)), person/mi^2 (person/km^2)	167,000 (64,300)	78,000 (30,000)	78,000 (30,000)
Population Density at Stops (radii: 33 to 2600 ft (10 to 800 m)), person/mi^2 (person/km^2)	NA	880 (340)	880 (340)
Shielding Factor at Stops (radii: 3.3 to 33 ft (1 to 10 m))	1	1	1
Shielding Factor at Stops (radii: 3.3 to 33 ft (10 to 800 m))	NA	0.2	0.2

Notes:

a. Based on 0.0023 hour/mi (0.0014 hour/km)
b. Based on TRAGIS output: 15 stops at 30 minutes each.
c. Cylinder of 1 m diameter.

Table 5.11-4—Annual EPR Solid Radioactive Waste

Waste Type	Annual Max Quantity ft³ (m³)	Container Internal Volume ft³ (m³)	Maximum Number of Containers	Containers per Shipment	Number of Shipments	
Evaporator Concentrates	140 (4.0)	7.3 (0.21 [a])	19.2	40	1	
Spent Resins (other)	90 (2.5)	90 (2.55 [b])	1.0	1	1	
Spent Resins (Rad Waste Demineralizer System)	140 (4.0)	90 (2.55 [b])	1.6	1	2	
Wet Waste from Demineralizers	8 (0.2)	90 (2.55 [b])	0.1	1	1	
Waste Drum for Solids Collection from Centrifuge System	8 (0.2)	7.3 (0.21 [a])	1.1	40	1	
Filters (quantity)	120 (3.4)	90 (2.55 [b])	1.3	1	2	
Sludge	35 (1.0)	90 (2.55 [b])	0.4	1	1	
Mixed Waste	2 (0.1)	7.3 (0.21 [a])	0.3	40	1	
Non-Compressible Dry Active Waste (DAW)	70 (2.0)	1000 (28.32 [c])	0.1	1	1	
Compressible DAW	1415 (40.1)	1000 (28.32 [c])	1.4	2	1	
Combustible DAW	5300 (150.1)	1000 (28.32 [c])	5.3	2	3	
Overall Totals	(208)				15	

Notes: First two columns from Section 3.5, Table 3.5-10

a. 7.3 ft3, 55 gallon drum.
b. 0 ft3, medium size container such as an 8 to 120 HIC.
c. 1000 ft3, 20 ft. SEALAND container.

Table 5.11-5—Evaluated Transportation Dose per Shipment Under Normal Conditions

New Fuel Shipment

Exposed Population	Dose per Shipment	
Transportation Workers	2.34E-05 person-Sv	2.34E-03 person-rem
General public:		
Onlookers	9.14E-05 person-Sv	9.14E-03 person-rem
Along Route	2.06E-06 person-Sv	2.06E-04 person-rem

Irradiated Fuel

Exposed Population	Dose per Shipment	
Transportation Workers	1.04E-03 person-Sv	1.04E-01 person-rem
General public:		
Onlookers	3.52E-03 person-Sv	3.52E-01 person-rem
Along Route	1.00E-04 person-Sv	1.00E-02 person-rem

Radwaste

Exposed Population	Dose per Shipment	
Transportation Workers	1.06E-03 person-Sv	1.06E-01 person-rem
General public:		
Onlookers	5.11E-03 person-Sv	5.11E-01 person-rem
Along Route	1.06E-04 person-Sv	1.06E-02 person-rem

Table 5.11-6—Evaluated Annual Transportation Dose Under Normal Conditions

New Fuel Shipment

Exposed Population	Cumulative Dose per Year	
Transportation Workers	1.8E-04 person-Sv	1.8E-02 person-rem
General public:		
Onlookers	6.9E-04 person-Sv	6.9E-02 person-rem
Along Route	1.6E-05 person-Sv	1.6E-03 person-rem

Irradiated Fuel

Exposed Population	Cumulative Dose per Year	
Transportation Workers	2.2E-02 person-Sv	2.2 person-rem
General public:		
Onlookers	7.4E-02 person-Sv	7.4 person-rem
Along Route	2.1E-03 person-Sv	2.1E-01 person-rem

Radwaste

Exposed Population	Cumulative Dose per Year	
Transportation Workers	1.6E-02 person-Sv	1.6 person-rem
General public:		
Onlookers	7.7E-02 person-Sv	7.7 person-rem
Along Route	1.6E-03 person-Sv	1.6E-01 person-rem

Annual Total

Exposed Population	Evaluated U.S. EPR Cumulative Dose per Year		10 CFR 51.52(c) Table S-4 Cumulative Dose
Transportation Workers	3.8E-2 person-Sv	3.8 person-rem	4 person-rem
General public:			
Onlookers	0.15 person-Sv	15 person-rem	3 person-rem
Along Route	3.7E-3 person-Sv	0.37 person-rem	Not listed

Table 5.11-7—ORIGEN2.1 Decay Heat Input Parameters for EPR Irradiated Fuel

PARAMETER		VALUE
US EPR core thermal power for design-basis applications	Nominal	4590 MWt
	Measurement Uncertainty	22 MWt (0.48%)
	Total (design-basis)	4612 MWt
Number of fuel assemblies in core		241
Fuel enrichment		5$^{w}/_{o}$ U-235
Mass of U metal in fuel assembly		535.917 kg
Total mass of U metal in core		1.2916E+05 kg
Fuel isotopic composition (based on ORNL/TM-12294/V4)	U-234	4.423E-02 $^{w}/_{o}$
	U-235	5.000E+00 $^{w}/_{o}$
	U-236	2.300E-02 $^{w}/_{o}$
	U-238	9.493E+01 $^{w}/_{o}$
	Total	1.00E+02 $^{w}/_{o}$
Irradiation time interval	5 GWd/MTU	140.026 days
Irradiation times to yield the selected burnups	10 GWd/MTU	280.05 days
	40 GWd/MTU	1120.21 days
	62 GWd/MTU	1736.32 days
Decay time array		0 to 1.0E+09 sec (31.69 yrs)
Computer code and cross-section libraries (RSIC CCC-371, and ORNL/TM-11018)		ORIGEN-2.1 PWRUE

5.12 NONRADIOLOGICAL HEALTH IMPACTS

5.12.1 PUBLIC HEALTH

Nonradiological health impacts and risks to members of the public due to operation of the new power plant and associated new transmission lines are those previously identified.

The impacts to the public from pathogenic organisms in the heated effluent from the plant are addressed in Section 5.3.4, "Impacts to Members of the Public (Cooling System Impacts)".

The impacts to the public from operation of the transmission system due to induced currents in metal fences and vehicles beneath transmission lines are addressed in Section 5.6.3, "Impacts to Members of the Public (Transmission System Impacts).

The impacts and risks due to the transport of nonradiological air emissions and dust and noise propagation offsite through the atmosphere to nearby residences and businesses are addressed in Section 5.8.1 "Physical Impacts of Station Operations".

5.12.2 OCCUPATIONAL HEALTH

Personnel at an operational power generation unit could be susceptible to industrial accidents (e.g., falls, electric shock, burns), or occupational illnesses due to noise exposure, exposure to toxic or oxygen replacing gases, exposure to thermophilic organisms in the condenser bays, and other caustic agents.

During the operations phase of CCNPP Unit 3 a safety and medical program with associated personnel to promote safe work practices and respond to occupational injuries and illnesses will be provided. The safety and medical program will utilize an industrial safety manual providing a set of work practices with the objective of preventing accidents due to unsafe conditions and unsafe acts. These safe work practices address hearing protection, confined space entry, personal protective equipment, respiratory protection, heat stress, electrical safety, excavation and trenching, scaffolds and ladders, fall protection, chemical handling, storage, and use, and other industrial hazards. The safety and medical program provides for employee training on safety procedures. Site safety and medical personnel are provided to handle industrial accidents and occupational illnesses.

The Bureau of Labor Statistics maintains records of a statistic known as total recordable cases (TRC), which are a measure of work-related injuries or illnesses that include death, days away from work, restricted work activity, medical treatment beyond first aid, and other criteria. The incidence rate of recordable cases at CCNPP for its workforce (excluding outage onsite workers) for 2001 through 2005, as calculated from OSHA documentation, averaged 0.6 cases per 100 workers or 0.6%. This compares favorably to the nationwide TRC rate for electrical power generation workers of 3.3% (BLS, 2005a) and to the State of Maryland for electrical power generation, transmission, and distribution workers of 2.7% (BLS, 2005b). It is estimated that 363 onsite employees would be added for CCNPP Unit 3. An additional workforce of up to 1000 workers is estimated during a 15-day period once every 18 months to support plant outages.

The number of total recordable cases per year for CCNPP Unit 3 can be estimated as the number of workers times the TRC rate. The estimated TRC incidences would be:

Number of Workers	TRC Incidence at US Rate	TRC Incidence at MD Rate	TRC Incidence at CCNPP Units 1 and 2 Rate
363 (normal)	12	10	2
1000 (outage)	1 (per outage event)	1 (per outage event)	NA

The estimated total recordable cases for the operations workforce based on the rate for CCNPP Units 1 and 2 is well under the U.S. and Maryland rates, showing that CCNPP's safety program is effective. This same program would be used to guide safe operations at the proposed unit to ensure that employees work in a safe manner and recordable cases are prevented as much as possible.

5.12.3 REFERENCES

BLS, 2005a. Incidence rates of nonfatal occupational injuries and illnesses by industry and case types - Table 1, Bureau of Labor Statistics, 2005, Website: http://www.bls.gov/iif/oshwc/osh/os/ostb1619.pdf, Date accessed: February 27, 2007.

BLS, 2005b. Table 6, Incidence rates of nonfatal occupational injuries and illnesses by industry and case types - Table 1, Bureau of Labor Statistics, 2005, Maryland, Website: http://www.bls.gov/iif/oshwc/osh/os/pr056md.pdf, Date accessed: February 27, 2007.