9.0 ALTERNATIVES TO THE PROPOSED ACTION

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

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

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

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9.1 NO ACTION ALTERNATIVE

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

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

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

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

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9.2 ENERGY ALTERNATIVES

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

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

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

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

9.2.1 ALTERNATIVES NOT REQUIRING NEW GENERATING CAPACITY

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

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

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

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9.2.1.1 Initiating Conservation Measures

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

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

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

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

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

9.2.1.1.1 Conservation Programs

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

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

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

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

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

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

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

9.2.1.2 Reactivating or Extending Service Life of Existing Plants

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

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

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

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

Retired fossil fuel plants and fossil fuel plants slated for retirement tend to be those old enough to have difficulty economically meeting today’s restrictions on air contaminant emissions. In the face of increasingly stringent environmental restrictions, delaying retirement or reactivating plants in order to forestall closure of a large baseload generation facility would

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require extensive construction to upgrade or replace plant components. Upgrading existing plants would be costly and at the same time would neither increase the amount of available generation capacity, nor alleviate the growing regional need for additional baseload generation capacity. A new baseload facility would allow for the generation of needed power and would meet future power needs within the region of interest (ROI), which is Maryland. This ROI is further evaluated in Section 9.3. Therefore, extending the service life of existing plants or reactivating old plants may not be feasible.

9.2.1.3 Purchasing Power from Other Utilities or Power Generators

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

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

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

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

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

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

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9.2.2 ALTERNATIVES THAT REQUIRE NEW GENERATING CAPACITY

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

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

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

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

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

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

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

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

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

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

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

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

From this review, a reasonable set of alternatives to be examined was identified. These alternatives included wind energy, PV cells, solar thermal energy, hydroelectricity, geothermal energy, incineration of wood waste and municipal solid waste, energy crops, coal, natural gas,

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oil, and delayed retirement of existing non-nuclear plants. These alternatives were considered pursuant to the statutory responsibilities imposed under the National Environmental Policy Act of 1969 (NEPA) (NEPA, 1982).

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

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

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

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

9.2.2.1 Wind

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

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

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

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

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Offshore, especially on the Atlantic side, the wind resource is predicted to reach 16.8 to 19.7 mph (27.0 to 31.7 kph) at 50 m (164 ft), or NREL Class 4-5 (EERE, 2003).

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

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

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

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

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

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

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

  Existing transmission infrastructure may need to be upgraded to handle the additional supply. Soil conditions and the terrain must be suitable for the construction of the towers' foundations. Finally, the choice of a location may be limited by land use regulations and the ability to obtain the required permits from local, regional, and national authorities. The farther a wind energy development project is from

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transmission lines, the higher the cost of connection to the transmission and distribution system.

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

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

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

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

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

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

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

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

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

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

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

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

9.2.2.2 Geothermal

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

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

9.2.2.3 Hydropower

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

According to a study performed by the Idaho National Engineering and Environmental Laboratory (INEEL), Maryland has 36 possible hydropower sites: 1 developed and with a

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power-generating capacity of 20 MWe, 32 developed and without power and a possible generating capacity of 10 MWe, and 3 undeveloped sites with a possible 0.10 MWe of generating capacity. Only one site had the potential generating capacity of 20 MWe or more (INEEL, 1998). Therefore, hydropower is non-competitive with a new nuclear unit at the CCNPP site.

9.2.2.4 Solar Power

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

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

9.2.2.4.1 Concentrating Solar Power Systems

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

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

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

Concentrating solar power technologies utilize many of the same technologies and equipment used by conventional power plants, simply substituting the concentrated power of the sun for the combustion of fossil fuels to provide the energy for conversion into electricity. This “evolutionary” aspect – as distinguished from “revolutionary” or “disruptive” – allows for easy integration into the transmission grid. It also makes concentrating solar power technologies the most cost-effective solar option for the production of large-scale electricity generation (10 MWe and above).

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

9.2.2.4.2 "Flat Plate" Photovoltaic Cells

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

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

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

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

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

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

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

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

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

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

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

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

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9.2.2.5 Wood Waste and Other Biomass

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

Nearly all of the wood-energy-using electricity generation facilities in the U.S. use steam turbine conversion technology. The technology is relatively simple to operate and it can accept a wide variety of biomass fuels. However, at the scale appropriate for biomass, the technology is expensive and inefficient. Therefore, the technology is relegated to applications where there is a readily available supply of low, zero, or negative cost delivered feedstock.

Construction of a wood-fired plant would have an environmental impact that would be similar to that for a coal-fired plant, although facilities using wood waste for fuel would be built on smaller scales. Like coal-fired plants, wood-waste plants require large areas for fuel storage, processing, and waste (i.e., ash) disposal. Additionally, the operation of wood-fired plants creates environmental impacts, including impacts on the aquatic environment and air (NRC, 1996).

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

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

9.2.2.6 Municipal Solid Waste

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

The decision to burn MSW to generate energy is usually driven by the need for an alternative to landfills, rather than by energy considerations. The use of landfills as a waste disposal option is likely to increase in the near term; however, it is unlikely that many landfills will begin converting waste to energy because of the numerous obstacles and factors that may limit the growth in MSW power generation. Chief among them are environmental regulations and public opposition to siting MSW facilities.

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

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

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

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

9.2.2.7 Energy Crops

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

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

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

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

9.2.2.8 Petroleum Liquids (Oil)

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

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

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

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

9.2.2.9 Fuel Cells

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

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

As market acceptance and manufacturing capacity increase, natural-gas-fueled fuel-cell plants in the 50 to 100 MWe range are projected to become available. This will not meet the proposed 1,600 MW(e) baseload capacity. At the present time, fuel cells are not economically or

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technologically competitive with other alternatives for baseload electricity generation and that the fuel cell alternative non-competitive with a new nuclear unit at the CCNPP site.

9.2.2.10 Coal

Coal-fired steam electric plants provide the majority of electric generating capacity in the U.S., accounting for about 52% of the electric utility industry's total generation, including co-generation, in 2000 (EIA, 2001a). Conventional coal-fired plants generally include two or more generating units and have total capacities ranging from 100 MWe to more than 2,000 MWe. Coal is likely to continue to be a reliable energy source well into the future, assuming environmental constraints do not cause the gradual substitution of other fuels (EIA, 1993).

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

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

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

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

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

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

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

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9.2.2.11 Natural Gas

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

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

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

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

9.2.2.12 Integrated Gasification Combined Cycle (IGCC)

Integrated Gasification Combined Cycle (IGCC) is an emerging, advanced technology for generating electricity with coal that combines modern coal gasification technology with both gas turbine and steam turbine power generation. The technology is substantially cleaner than conventional pulverized coal plants because major pollutants can be removed from the gas stream prior to combustion.

The IGCC alternative generates substantially less solid waste than the pulverized coal-fired alternative. The largest solid waste stream produced by IGCC installations is slag, a black, glassy, sand-like material that is potentially a marketable byproduct. Slag production is a function of ash content. The other large-volume byproduct produced by IGCC plants is sulfur, which is extracted during the gasification process and can be marketed rather than placed in a landfill. IGCC units do not produce ash or scrubber wastes.

At present, IGCC technology still has insufficient operating experience for widespread expansion into commercial-scale, utility applications. Each major component of IGCC has been broadly utilized in industrial and power generation applications. But the integration of coal gasification with a combined cycle power block to produce commercial electricity as a primary output is relatively new and has been demonstrated at only a handful of facilities around the world, including five in the U.S. Experience has been gained with the chemical processes of gasification, coal properties and their impact on IGCC design, efficiency, economics, etc.

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

Overall, IGCC plants are estimated to be about 15% to 20% more expensive than comparably sized pulverized coal plants, due in part to the coal gassifier and other specialized equipment. Recent estimates indicate that overnight capital costs for coal-fired IGCC power plants range

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from $1,400 to $1,800 per kilowatt (EIA, 2005). The production cost of electricity from a coal-based IGCC power plant is estimated to be about $0.033 to $0.045 per kilowatt-hour. The projected cost associated with operating a new nuclear facility similar to CCNPP Unit 3 is in the range of $0.031 to $0.046 cents per kWh.

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

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

9.2.3 ASSESSMENT OF REASONABLE ALTERNATIVE ENERGY SOURCES AND SYSTEMS

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

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

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

- LARGE - Environmental effects are clearly noticeable and are sufficient to destabilize any important attributes of the resource (NRC, 1996).

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

9.2.3.1 Coal-Fire Generation

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

9.2.3.1.1 Air Quality

The air quality impacts of coal-fired generation are considerably different from those of nuclear power. A coal-fired plant would emit sulfur dioxide (SO_2, as SO_x surrogate), oxides of nitrogen (NO_x), particulate matter (PM), and carbon monoxide (CO), all of which are regulated pollutants. Air quality impacts from fugitive dust, water quality impacts from acidic runoff, and aesthetic and cultural resources impacts are all potential adverse consequences of coal mining.

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Air emissions were estimated for a coal-fired generation facility based on the emission factors contained in NETL document DOE/NETL-2007/1281 (NETL, 2007)EPA document, AP-42 (USEPA, 1995). The emissions from this facility are based on a power generation capacity of 1,600 MWe. The coal-fired generation facility assumes the use of bituminous coal fired in a supercritical pulverized coal (PC) wall-fired unitcirculating fluidized bed combustor (FBC). The sulfur content of the coal was assumed to be 2% by weight. Emissions control was assumed to include the use of a flue gas desulfurization system to control acid gas emissions,included the use of lime in the combustor unit, a wet scrubber system to control acid gas emissions, selective catalytic reduction to minimize NOx emissions and a baghouse to control PM. Table 9.2-2 summarizes the air emissions produced by a 1,600 MWe coal-fired facility.

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

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

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

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

9.2.3.1.2 Waste Management

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

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

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

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9.2.3.1.3 Economic Comparison

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

9.2.3.1.4 Other Impacts

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

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

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

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

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

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

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

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

9.2.3.1.5 Summary

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

9.2.3.2 Natural Gas Generation

Most environmental impacts related to constructing natural gas-fired plants should be approximately the same for steam, gas-turbine, and combined-cycle plants. These impacts, in

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turn, generally will be similar to those of other large central generating stations. The environmental impacts of operating gas-fired plants are generally less than those of other fossil fuel technologies of equal capacity.

9.2.3.2.1 Air Quality

Natural gas is a relatively clean-burning fossil fuel. Also, because the heat recovery steam generator does not receive supplemental fuel, the combined-cycle operation is highly efficient (56% vs. 33% for the coal-fired alternative). Therefore, the gas-fired alternative would release similar types of emissions, but in lesser quantities than the coal-fired alternative. Control technology for gas-fired turbines focuses on the reduction of NO_x emissions.

Human health effects are SMALL based on decreased air quality impacts. Natural gas technologies produce fewer pollutants than other fossil technologies, and SO_2, a contributor to acid rain, is not emitted in significant quantities ~~at all~~ (NRC, 1996). Air emissions were estimated for a natural gas-fired generation facility based on the emission factors contained in the NETL document DOE/NETL-2007/1281 (NETL, 2007)~~EPA document, AP-42 (USEPA, 1995)~~. Emissions from the facility were based on a power generation capacity of 1,600 MWe.

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

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

9.2.3.2.2 Waste Management

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

9.2.3.2.3 Economic Comparison

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

9.2.3.2.4 Other Impacts

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

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

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

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

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

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

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

9.2.3.2.5 Summary

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

9.2.3.3 Combination of Alternatives

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

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

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

9.2.3.3.1 Determination of Alternatives

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

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

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

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

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

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

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

The analysis accounts for the reduction in environmental impacts from a gas-fired facility when generation from the facility is displaced by the renewable resource. The impact associated with the combined-cycle natural gas-fired unit is based on the gas-fired generation impact assumptions discussed in Section 9.2.3.2. Additionally, the renewable portion of the

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combination alternative would be any combination of renewable technologies that could produce power equal to or less than CCNPP Unit 3 at a point when the resource was available.

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

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

9.2.3.3.2 Environmental Impacts

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

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

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

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

Parabolic trough plants require a significant amount of land; typically the use is preemptive because parabolic troughs require the land to be graded level. A report, developed by the California Energy Commission (CEC), notes that 5 to 10 acres (2 to 4 hectares) per MWe is necessary for concentrating solar power technologies such as trough systems (CEC, 2003).

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

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

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

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

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

9.2.3.3.3 Economic Comparison

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

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

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9.2.3.3.4 Summary

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

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

9.2.4 CONCLUSION

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

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

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Table 9.2-1—Impacts Comparison Table

Impact Category	CCNPP Unit 3	Coal-Fired Generation	Gas-Fired Generation	Combinations
Air Quality MT (tons)/yr	Small	Moderate to Large SO_2 = 415 (457)4,700 (5,177) NO_2 = 734 (809)3,884 (4,278) CO = 4,402 (4,852)	Moderate SO_2 = 17 (19)83 (92) NO_2 = 661 (729)385 (424) CO = 152 (168)	Small to Large
Waste Management MT (tons)/yr	Small	Moderate Substantial amount scrubber sludge and fly ash produced	Small	Small to Moderate
Land Use mi^2 (km^2)	Small	Moderate Waste disposal -- 0.94 (2.43) Coal storage and power block area 0.47 (1.21)	Small	Small to Large
Water Quality	Small	Moderate to Large Cooling water system losses to biota through impingement/entrainment, discharge of cooling water to natural water bodies	Moderate to Large Cooling water system losses to biota through impingement/entrainment, discharge of cooling water to natural water bodies	Small to Large
Aesthetics m (ft)	Small to Moderate Plant structures	Large Plant structures 61(200) high Stacks 183 (600) high	Moderate Turbine building 30 (100) high Stacks 70 (230) high	Small to Large
Cultural Resources	Small	Small	Small	Small
Ecological Resources	Small	Small	Small	Small
Threatened & Endangered Resources	Small	Small	Small	Small
Socioeconomics	Small	Moderate Staff needed to operate facility, several hundred mining jobs and additional tax revenues	Small	Small to Moderate
Accidents	Small	Small	Small	Small
Human Health	Small	Moderate (see air quality)	Small	Small to Moderate

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

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

Fuel	Bituminous Coal	Natural Gas
Combustion Facility	~~Circulating FBC~~Supercritical, Pulverized Coal, Wall Fired	Combined Cycle GTG, No Duct Firing
Generation Capacity	1,600 MWe	1,600 MWe
Air Pollutant Emissions – metric tons (tons) per year		
Sulfur Dioxide (SO_2)	~~415 (457)~~4,700 (5,177)	~~17 (19)~~83 (92)
Nitrogen Dioxide (NO_2)	~~734 (809)~~3,884 (4,278)	661 (729)385 (424)
~~Carbon Monoxide (CO)~~	~~4,402 (4,852)~~	~~152 (168)~~
Particulate Matter (PM)	~~21 (23)~~722 (795)	~~34 (37)~~Negligible
~~PM less than 10μm (PM10)~~	~~15 (17)~~	~~24 (26)~~
Carbon Dioxide, equiv. (CO_2e)	~~1,731,000 (1,908,000)~~11,260,000 (12,407,000)	~~565,000 (623,000)~~5,086,000 (5,603,000)

~~CO_2e – CO_2 equivalent~~
~~FBC – fluidized bed combustor~~
GTG – gas turbine generator

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9.3 ALTERNATIVE SITES

This section identifies and evaluates a set of alternative site locations to the Calvert Cliffs Nuclear Power Plant (CCNPP) site. The object of this evaluation is to verify that there are no "obviously superior" sites to build and operate the CCNPP Unit 3 facility.

Siting new units at existing nuclear sites has provided another option to the way alternatives are reviewed and selected. Existing sites offer decades of environmental and operational information about the impact of a nuclear plant on the environment. Because these sites are licensed nuclear facilities, the Nuclear Regulatory Commission (NRC) has already found them to be acceptable relative to other undeveloped sites in the region of interest. The NRC recognizes (in NUREG-1555, (NRC, 1999), Section 9.3(III)(8)) that proposed sites may not be selected as a result of a systematic review:

> Recognize that there will be special cases in which the proposed site was not selected on the basis of a systematic site-selection process. Examples include plants proposed to be constructed on the site of an existing nuclear power plant previously found acceptable on the basis of a NEPA review and/or demonstrated to be environmentally satisfactory on the basis of operating experience, and sites assigned or allocated to an applicant by a State government from a list of State-approved power-plant sites. For such cases, the reviewer should analyze the applicant's site-selection process only as it applies to candidate sites other than the proposed site, and the site-comparison process may be restricted to a site-by-site comparison of these candidates with the proposed site. As a corollary, all nuclear power plant sites within the identified region of interest having an operating nuclear power plant or a construction permit issued by the NRC should be compared with the applicant's proposed site (NRC, 1999).

The information provided in this section is consistent with the special case noted in NUREG-1555, (NRC, 1999), Section 9.3(III)(8). This section identifies and discusses the evaluation of a set of alternative locations for the proposed plant and compares the suitability of these alternative sites with the suitability of the proposed site. The objective of this assessment is to verify that no site is "environmentally preferable" (and thus, no site is "obviously superior") for the siting of a new nuclear plant exists. In addition to three existing nuclear sites, this section evaluates the characteristics of a generic greenfield site and a non-nuclear brownfield site.

9.3.1 SITE SELECTION PROCESS

The site selection process focuses on identifying and evaluating locations that represent a range of reasonable alternative sites for the proposed project. The primary objective of the site-selection process is to determine if any alternative site is "obviously superior" to the preferred site for eventual construction and operation of the proposed reactor units. The preferred site is chosen from within the candidate sites, and then compared with the remaining candidate sites to demonstrate that none are "environmentally preferable." The basic constraints and limitations applicable to the site-selection process are the currently implemented rules, regulations, and laws within the federal, state, and local agency levels. These provide a comprehensive basis and an objective rationale under which this selection process is performed.

9.3.1.1 Region of Interest and Candidate Areas

The proposed new nuclear unit will be a merchant plant, that is, a plant that is connected to the grid for the purpose of selling energy to customers in a wholesale market. UniStar Nuclear Operating Services, LLC and ~~Constellation Generation Group~~ Calvert Cliffs 3 Nuclear Project,

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LLC evaluated the market in the northeastern region of the U.S. and chose Maryland and New York as candidate areas based on the location of nuclear and non-nuclear sites to which it had access. Chapter 8 discusses the need for power in this region.

Potential sites within the candidate areas were evaluated further for the proposed new nuclear facility. The potential sites included a brownfield/non-nuclear site, existing nuclear sites, and a greenfield site. The non-nuclear site chosen for further analysis is a coal burning power plant that is currently owned and operated by Constellation Energy.

The nuclear sites include CCNPP and two located in the New York candidate area on the south shore of Lake Ontario. The sites in New York were chosen because they are owned by Constellation (with ready access to the site and other information), are in relatively close proximity to the CCNPP site, and are within the applicant's candidate areas. Other nuclear sites within the candidate area were not evaluated because none of these sites are owned or controlled by Constellation Generation Group or its subsidiaries.

Purchase of, or access to, a competitor's nuclear site would be cost prohibitive and therefore would not be viable options for siting of a new reactor by the applicant. Furthermore, detailed information concerning competitor-owned plants is not readily available for analysis**.**

9.3.1.2 Candidate Sites

An initial review of potential sites was conducted. Due to the cost of acquiring existing generating facilities that are currently owned by competitors, only those locations already owned by Constellation were considered for further evaluation as candidate sites. To be considered as candidate sites, a location must meet the following criteria as outlined in NUREG-1555, (NRC, 1999), Section 9.3 (III)(4c):

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

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In addition to meeting all applicable regulations and guidelines, the following factors influenced the decision to review sites.

- The site would be suitable for the design parameters contemplated for the new plant design.
- The location would be compatible with the applicant's current system and transmission capabilities.
- The site's expected licensing and regulatory potential must minimize the schedule and financial risk for establishing new baseload generation.

Given the factors listed above, three existing nuclear sites and a non-nuclear (or brownfield) site were carried forward as candidate sites for further review. The three existing nuclear sites include the CCNPP site, the Nine Mile Point site, and the R.E. Ginna site. The Crane Generating Station is the non-nuclear site. Additionally, a generic greenfield site was considered.

A greenfield site is a location that has not previously been developed for any use. The NRC has noted that the general environmental impact of new nuclear construction on a greenfield site is generally severe (NRC, 1996), and greater than the impacts associated with construction and operation of a facility at an existing nuclear plant site. However, for the purposes of this site analysis, the possible general impacts of a greenfield site were reviewed.

It was assumed that the greenfield site would be located in an area that met the siting criteria of 10 CFR 100. As a result the characteristics of the site could be largely rural, or at least in an area with low population in Maryland. For the purposes of this analysis, it was also assumed that the site would be near a possible supply of cooling water such as Chesapeake Bay. It was assumed that the site would consist of at least 500 to 1000 acres (200 to 400 hectares) to accommodate construction and operation needs (for comparison, the CCNPP Unit 3 project area requires about ~~420~~460 acres (~~170~~186 hectares). It was also assumed that a supply of cooling water would be available. Additionally, it was assumed that the general environmental considerations associated with construction and operation at a greenfield site would be similar to those discussed in NUREG-1555 (NRC, 1999) and Chapters 4 and 5 of this Environmental Report. The greenfield site was not the environmentally preferable location for several reasons:

- Aesthetic impact will be greater than similar impacts at the other candidate sites. In its analysis. While the environmental impacts of construction and operation would be similar to those described in Chapters 4 and 5, much of the existing infrastructure at the CCNPP site would have to be developed to access the new site. Additionally, large areas of land would be cleared, graded and modified to accommodate construction and operation. Chapters 4 and 5 describe construction, operation, and associated mitigation strategies that rely on existing infrastructure and other CCNPP specific factors to arrive at the predicted impacts. However, these infrastructure advantages would likely not be available at most of the potential greenfield sites in Maryland. Any aesthetic impacts to the greenfield site would thus be MODERATE to LARGE
- Socioeconomic impacts at the postulated greenfield site will generally be equal to or greater than those at the other candidate sites. It was assumed that the general socioeconomic impacts described in Section 4.5 and Section 5.8 would apply at the greenfield site. However, it is notable that in a rural and somewhat undeveloped area of Maryland, housing and transportation impacts would be greater that those postulated for the other sites. Agricultural lands and historically important sites may

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also be adversely affected as the property and necessary cooling water facilities are built. Noise levels are likely to increase during construction and operation. Education, recreation, and other public facilities would likely be adversely affected by the increase in worker population for construction and operation. Air quality will be temporarily affected by construction dust and diesel fuel emissions. On the other hand, tax benefits and increased employment for area residents would be beneficial. With these postulations in mind, it was concluded that socioeconomic impacts at the greenfield site would be MODERATE to LARGE, with an additional MODERATE beneficial impact due to increased tax bases and new employment

- Terrestrial and aquatic resources: Impacts to the terrestrial and aquatic resources at the greenfield site would be greater than the impact at the other candidate sites. Impacts to the terrestrial and aquatic resources were identified based on the descriptions of similar impacts to resources in Chapters 4 and 5. It was further assumed that no endangered or threatened species were present at the site, and that the impacts during construction would temporarily disturb most aquatic habitats, while permanently disturbing some forest and open areas. With these general assumptions in mind, it was concluded that the impacts from construction and operation at a greenfield site would be SMALL to LARGE, depending on the mitigation strategies used at the greenfield site.

- Land use impacts: Impacts to land use are expected to be greater than impacts at the other candidate sites. Given the assumption that the land use in the area would be largely recreational or agricultural, changes in the land use at the site would likely be permanent. Thus, impacts to land use are expected to be MODERATE to LARGE and more significant than developed sites.

- Air Quality Impacts: It was assumed that air quality at the greenfield site would be equal to the impacts of construction and operation at the proposed CCNPP site. During construction, air quality would be short term and include construction dust and diesel emissions. However, impacts would be expected to be SMALL and comparable to other candidate sites during operations.

- Cost of obtaining additional land: UniStar Nuclear Operating Services, LLC and ~~Constellation Generation Group~~ Calvert Cliffs 3 Nuclear Project, LLC do not own an area with the necessary characteristics for siting a nuclear unit within the ROI, the land, or access to it (including any easements), would have to be obtained from one or more third parties. An undeveloped site would require 500 to 1,000 acres (200 to 400 hectares), including an exclusion area. Acquisition of this land would increase the cost of construction and could potentially result in adverse economic impact. In addition, it is likely that new transmission lines and corridors would be necessary to connect the new reactor to the existing transmission system. As such, impacts would not be limited to the immediate vicinity of the new reactor.

In summary, the environmental impacts from construction and operation of a nuclear power plant at a greenfield site range from MODERATE to LARGE, and greater than the impacts at other candidate sites. Therefore, the use of a greenfield site is not carried forward as an Alternative site in this evaluation.

9.3.2 PROPOSED AND ALTERNATIVE SITE EVALUATION

The alternative sites that are compared with the CCNPP site (the preferred site) include the Crane Generating Station Brownfield site, the Nine Mile Point Nuclear Power Plant site, and the R.E. Ginna Nuclear Power Plant site.

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The alternatives sites were compared to the preferred site based on information about the existing nuclear plants and the surrounding area, as well as existing environmental studies and Final Environmental Impact Statements issued by the Atomic Energy Commission and/or the U.S. Nuclear Regulatory Commission. This comparison is preformed to determine whether or not any alternative sites are environmentally preferable to the proposed site.

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

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

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

9.3.2.1 Crane Generating Station Brownfield Site

A brownfield is a site that has been previously developed and can be redeveloped for a more profitable use. The brownfield site chosen for analysis is the Crane Generating Station on the Chesapeake Bay in Baltimore County, Maryland. This site is currently owned and operated by Constellation Energy as a coal burning power plant.

9.3.2.1.1 Land Use

The Crane Generating Station is located in an area of mixed land use. The site area is 157 acres (63 hectares), which is much smaller than the area required for siting a nuclear plant, and both the site and the surrounding land have been designated as critical areas under the 1984 Chesapeake Bay Critical Area (CBCA) law. The adjacent land area is predominantly wetlands and is zoned for resource conservation.

Given the identified size of the proposed plant, additional land would need to be purchased for the siting of a new nuclear plant at this site. Additionally, it would be necessary to obtain some variances from zoning ordinances on surrounding land. The land currently owned by Constellation Energy Group is zoned appropriately for power generation; however, because the use of much of any newly purchased land would likely need to be changed to accommodate the new nuclear site, the impact on land use in this area would be MODERATE.

9.3.2.1.2 Air Quality

Baltimore County is designated in attainment for most air pollutants except ozone and fine particulate matter ($PM_{2.5}$). Non-attainment for these two pollutants is a general problem that

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affects the northeastern U.S. and is not specific to Baltimore County. Closing the coal burning power plant at the Crane site and replacing this generating capacity with a nuclear plant would reduce the amount of particulate matter as well as the amount of greenhouse gases that are released into the atmosphere. It was concluded that the impact of reduced particulates and greenhouse gases on the general air quality in the northeastern U.S. would be SMALL, but the local impact may be MODERATE. In both cases, the overall impact of this transformation would be beneficial.

9.3.2.1.3 Water

Baltimore County is designated in attainment for most air pollutants except ozone and fine particulate matter ($PM_{2.5}$). Non-attainment for these two pollutants is a general problem that affects the northeastern U.S. and is not specific to Baltimore County. Closing the coal burning power plant at the Crane site and replacing this generating capacity with a nuclear plant would reduce the amount of particulate matter as well as the amount of greenhouse gases that are released into the atmosphere. It was concluded that the impact of reduced particulates and greenhouse gases on the general air quality in the northeastern U.S. would be SMALL, but the local impact may be MODERATE. In both cases, the overall impact of this transformation would be beneficial.

9.3.2.1.4 Terrestrial Ecology and Sensitive Species

The Crane site is located in Maryland's Piedmont Plateau Province. As is typical for this region, the area is characterized by rolling hills and steep stream valleys with hardwood and mixed pine-oak forests. Wetlands do occur on the site, but no Special State Concern wetlands, Natural Heritage Areas, agricultural preservation lands, or forest legacy lands are found in the vicinity.

Although no State or Federally listed species or sensitive habitats are located in the immediate vicinity of the site, the adjacent land area is predominantly wetlands and is zoned for resource conservation. Because the new nuclear plant would replace the existing coal plant, little or no additional area would need to be cleared and developed. The impacts to the terrestrial ecosystem at the site would therefore be SMALL and would predominantly occur during the conversion of the plant from coal to nuclear power. Construction Best Management Practices would be followed to minimize these impacts.

9.3.2.1.5 Aquatic Ecology and Sensitive Species

The Gunpowder River and Seneca Creek are tidal estuaries. The average tide at the site is less than 1.5 ft (46 cm). The submergent and emergent vegetation in these tidal wetlands is adapted to the fluctuating water levels at this location. As is common for estuaries, the fauna in this tidal habitat is very diverse and many sport and commercial fish and shellfish use the area for spawning and as a nursery. No State or Federally listed aquatic species occur in the area; however the tidal estuaries have been designated as Chesapeake Bay Critical Areas.

These areas are considered essential to the water quality and ecological health of the Chesapeake Bay. Because the site is already being used for power generation and construction Best Management Practices would be followed, the impacts of plant conversion on the aquatic ecology would be SMALL to MODERATE and temporary. These impacts would primarily be related to runoff and siltation. However, the impacts of operation would be much greater. The impact of impingement and entrainment from the cooling water intake system and the thermal impact that would result from cooling water discharge would likely be MODERATE or even LARGE despite permit restrictions and mitigation requirements.

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9.3.2.1.6 Socioeconomics

Baltimore County is a relatively populated area, and is the third most populated county in Maryland with a population of approximately 787,384. Other socioeconomic facts related to Baltimore County are as follows (USCB, 2007a) :

- The county has experienced a 4.4% population increase since the 2000 census.
- Median household income is $52,308 per year.
- 8.2% of the county's population lives below the poverty level.
- The nearest large city is Baltimore, Maryland.
- The mean value of owner-occupied housing units was $127,300.
- There were 63,064 firms doing business in the county in 2002.

The Crane Generating Station site is currently being used for power generation, and it expected that the shift from coal to nuclear power would not initiate any substantial shifts in population or real estate, therefore, the effect of the proposed new facility on the population and demographics of Baltimore County, Maryland is expected to be SMALL.

9.3.2.1.7 Transportation

The site is located in a developed area of suburban Baltimore, Maryland. The site is characterized by commercial and residential development, highways, roads, and railroad tracks. The project site is located in relative close proximity to major roadways, including Highway 150, Interstate 95, and Interstate 695. Some modest traffic increase on Carroll Island Road, which is a rural, two-lane highway may be noticeable during construction.

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

There are several ways to mitigate the potential transportation impacts during construction such as developing a construction traffic management plan prior to construction to address potential impacts on local roadways. If necessary, coordinating with local planning authorities for the upgrading of local roads, intersections, and signals to handle increased traffic loads could be considered. Schedules during workforce shift changes and for the delivery of larger pieces of equipment or structures could be coordinated to limit impacts on local roads.

In addition the use of shared (e.g., carpooling) and multi-person transport (e.g., buses) during construction and/or operation of the facility could be encouraged. By implementing the appropriate measures, it is expected that there would be SMALL to MODERATE impacts on transportation during construction activities and SMALL impact during operation of the facility.

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9.3.2.1.8 Historic, Cultural, and Archeological Resources.

No known archeological or historical resources are located in the immediate vicinity of the site. It is assumed that no impacts to these resources would occur during construction or operation of a nuclear facility at this site. Therefore, the impacts would be classified as SMALL.

9.3.2.1.9 Environmental Justice

Table 9.3-1 (USCB, 2007b) presents demographic information for Baltimore County, Maryland, and the U.S. These data demonstrate that the population of this area is similar in composition to the State of Maryland and to the U.S. as a whole. Although the Crane site is located in a largely urban area, the likelihood of minority communities being disproportionately and adversely affected by this plant is low. Furthermore, this site has been operating as a power generating facility for a number of years. Therefore, it is anticipated that environmental justice impacts at this site would be SMALL.

9.3.2.1.10 Transmission Corridors

The site has been in use for electrical generation for many years. Although it may be necessary to build new infrastructure to accommodate the new output for the plant, it is anticipated that existing corridors would be sufficient to accommodate construction. The plant site and surrounding corridors are generally developed or are limited from much further development by zoning and land use designations. In addition, the current transmission system could be used with few or no modifications. It is anticipated that the impacts due to transmission corridors would be SMALL.

9.3.2.2 Evaluation of Existing Nuclear Sites

Collocating the new reactor is preferable to both the brownfield alternative, and the greenfield alternative. Collocation reduces the costs when compared to either greenfield or brownfield development because the new reactor will be able to take advantage of the infrastructure that serves the existing reactor(s). In addition to reducing costs, collocation negates the need for many of the preliminary analyses because these analyses have already been performed for the existing site license.

Preliminary analyses of site suitability, appropriate seismicity and geological setting, federal, state, and local regulatory restrictions, and many other significant issues have already been conducted for the existing unit(s). This further reduces both costs and uncertainties associated with construction and operation of the new unit. Discussion of resource commitments for the preferred alternative site is provided in Section 10.1 through Section 10.3.

A cost-benefit analysis for the preferred site is detailed in Section 10.4. The costs and resource commitments needed for construction and operation of the new facility would be similar regardless of the site at which the unit is collocated. The information presented in Section 10.1 through Section 10.4 is therefore applicable to the candidate sites described below.

9.3.2.2.1 CCNPP (Preferred Location)

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

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9.3.2.2.1.1 Land Use

Land use in the area surrounding the CCNPP site is predominantly rural. Hunting is common in the region surrounding the plant because large areas are rural and forested. Less than 5% of the county land uses are classified as commercial or industrial. Calvert County has open space and land preservation plans in place that direct commercial development toward town centers in order to preserve the rural character. The impacts to land use at this site would be expected to be SMALL because the new reactor would be placed near existing nuclear.

9.3.2.2.1.2 Air Quality

Calvert County is in attainment with all National Ambient Air Quality Standards except for ozone. Because of its proximity to Washington, DC, the county is classified as a serious non-attainment zone for ozone. Moreover, because the CCNPP site is located in a serious non-attainment zone for ozone and has the potential to emit greater than 50 tons per year for both volatile organic compounds and nitrogen oxides, the facility is classified as a major source of these substances). Based on the design of the new nuclear unit and the actions that will be taken to comply with permit requirements for emissions, it is expected that siting the unit at this location would have a SMALL impact on air quality.

9.3.2.2.1.3 Water

The CCNPP site is located on the western shore of the Chesapeake Bay, which is an estuary approximately 200 mi (320 km) long and up to 35 mi (56 km) wide.

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

Operational fresh water needs will be provided by desalination of Chesapeake Bay water, so there will be no impacts on groundwater.

Additional groundwater withdrawals required for constructing the new reactor are not expected to destabilize offsite groundwater resources. Due to the large size of both the surface water and groundwater resources and the current rural nature of the area and resultant low usage of these resources, impacts to water resources at the site from construction and operation of the new reactor unit are anticipated to be SMALL.

9.3.2.2.1.4 Terrestrial Ecology and Sensitive Species

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

The federally listed threatened puritan tiger beetle *(Cicindela puritana)* and the northeastern beach tiger beetle *(Cicindela dorsaliscan)* can be found at the base of the cliffs on the CCNPP site

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along the beach south of the barge dock. The federally listed ~~threatened~~ protected bald eagle has active nests on the CCNPP site. The Maryland Natural Heritage Program lists species that are rare to uncommon, and lists one terrestrial species, a showy goldenrod *(Solidago speciosa)* as present at the site.

No significant impacts to the terrestrial ecosystems would be expected once construction of the new reactor is complete. Therefore, the impacts of construction may be MODERATE; however, the impacts of operation would be SMALL.

9.3.2.2.1.5 Aquatic Ecology and Sensitive Species

The area of the Chesapeake Bay where the CCNPP site is located is in the mesohaline zone, which is characterized by moderate salinity. Recreationally and commercially important shellfish and finfish found in large numbers in the vicinity of the plant during pre-operational surveys included the eastern oyster (Crassostrea virginica), blue crab (Callinectes sapidus), striped bass (Morone saxatilis), and weakfish (Cynoscion regalis). One aquatic state-listed endangered species, the shortnose sturgeon (Acipenser brevirostrum), is known to inhabit the Chesapeake Bay. However, impingement studies conducted at the CCNPP site area over the past 30 years have never collected a shortnose sturgeon.

Federal and state agencies are working to reintroduce the Atlantic sturgeon (Acipenser oxyrhynchus), a species that the Maryland Natural Heritage Program lists as rare, into the Chesapeake Bay. There is no record of this species at the CCNPP site.

Construction impacts would be primarily due to runoff and siltation and will be controlled by best management practices and compliance with permit requirements. Because no sensitive species are known to occur in the vicinity and the new reactor is expected to have a similar impact to the existing reactor, construction and operation of the new reactor at this site would have a SMALL impact on the aquatic ecology in the Chesapeake Bay.

9.3.2.2.1.6 Socioeconomics

The estimated population of Calvert County in 2005 was nearly 88,000 people. Other socioeconomic facts related to Baltimore County are as follows (USCB, 2007a):

- Calvert County experienced an 18% population increase from the 2000 census population of nearly 75,000 people.
- The median household income is slightly higher than $70,000 per year.
- Approximately 5% of the county's population lives below the poverty level.
- The nearest large city is Washington, D.C.

By the year 2010, the estimated population within 10 mi (16 km) of the CCNPP site is estimated to be approximately 63,000 people. By 2040, the population estimate for the same area is increased to approximately 124,000 people. Estimates for population growth within a 50 mi (80 km) radius of the plant are 4,757,810 for the year 2010, with a drop to 4,719,000 for the year 2040. Calvert County also has a large transient seasonal population. These people are attracted to the county's recreational opportunities such as the area parks and marinas. The seasonal population is estimated to increase the county population by nearly 25% (BGE, 1998).

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

9.3.2.2.1.7 Transportation

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

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

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

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

9.3.2.2.1.8 Historic, Cultural, and Archeological Resources

There are eight historic sites within a 5 mi (8.0 km) radius of CCNPP site listed on the National Register of Historic Places. As described in Sections II.D and XII.E of the Final Environmental Statement for CCNPP Units 1 and 2, two historic dwellings located on the original Calvert Cliffs site were evaluated by the Maryland Historical Trust and found to be too derelict to be nominated for inclusion on the National Register (BGE, 1998). However, photographs and some architectural elements of the structures were salvaged and are displayed in the Visitors Center (a remodeled old tobacco barn) onsite.

During 1992 and 1993, archeological surveys were conducted along a proposed South Circuit transmission line and right-of-way. As a result, two archeological sites were examined extensively during an evaluatory testing phase. One prehistoric site was found to retain sufficient subsurface integrity to be considered eligible for inclusion on the National Register of Historic Places. The impact areas of the site were evaluated extensively, and towers were located in areas that would not affect any intact subsurface deposits (BGE, 1998).

From the air, the principal visual features of the CCNPP site region are the Chesapeake Bay, the Patuxent River, and countryside that is generally wooded. The distance across the Chesapeake Bay in the vicinity of CCNPP site is approximately 6 mi (10 km) and, from the shore, the far shore

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is a dark line on the horizon; the view up-Bay or down-Bay is water to the horizon. From the Chesapeake Bay, the shoreline is wooded with widely spaced small housing developments and marinas. The CCNPP site has a 1,500 ft (457 m) wide developed area approximately in the middle of 6 mi (9.7 km) of undeveloped, wooded shoreline featuring 100 ft (30 m) cliffs. These scenic resources have remained unchanged since the construction of CCNPP Units 1 and 2.

Scenic resources inland have changed since the construction of CCNPP Units 1 and 2 due to area population growth. This growth has resulted in housing, commercial, and road development supplanting agricultural and wooded areas. However, Maryland State Highway 2/4, which transects the area, is a scenic highway, affording views of gently rolling, wooded countryside with interspersed development and occasional agricultural areas. It is anticipated that historic and cultural impacts would be SMALL given the secluded location of the CCNPP site and that appropriate mitigation will occur with the State Historic Preservation Officer prior to and during construction of the facility.

9.3.2.2.1.9 Environmental Justice

Table 9.3-2 presents demographic information for Calvert County, Maryland, and the U.S. These data demonstrate that the population of this area is similar in composition to the State of Maryland and to the U.S. as a whole. Although the CCNPP site is located in a largely rural area, the likelihood of minority communities being disproportionately and adversely affected by this plant is low. Furthermore, this site has been operating as a nuclear power generating facility for a number of years. Therefore, it is anticipated that environmental justice impacts would be SMALL.

9.3.2.2.1.10 Transmission Corridors

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

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

9.3.2.2.2 Nine Mile Point

The Nine Mile Point (NMP) nuclear plant is located in Scriba, New York, in Oswego County. The site is adjacent to the J.A. Fitzpatrick nuclear plant. Currently, NMP consists of two boiling water reactor units with a combined net capacity of approximately 1,750 MW(e). The site, on the southeastern shore of Lake Ontario, encompasses approximately 900 acres (364 hectares) with about a mile of shoreline. Approximately 188 acres (70 hectares) are used for power generation and support facilities, while the remaining area is largely undeveloped (NMPNS, 2004).

9.3.2.2.2.1 Land Use

Oswego County has developed a comprehensive growth management plan that sets standards for growth and development. However, land use planning and zoning are primarily the responsibility of individual municipalities within the county, and there are no county-wide measures to limit residential growth. Land use within a 1 mi (1.6 km) radius of NMP is

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designated as either industrial or as a Valued Natural Resource, so residential growth within this area is limited.

In addition to the adjacent J.A. Fitzpatrick nuclear plant, there is a natural gas-fueled power plants approximately 2 mi (3.2 km) from NMP. There are also several state and national parks and natural areas in the vicinity of NMP (NMPNS, 2004). The impacts to land use at this site would be expected to be SMALL because the new reactor would be placed near existing nuclear facilities in an area that is currently zoned appropriately for power generation.

9.3.2.2.2.2 Air Quality

NMP is not located in an area designated as a maintenance or nonattainment area for any air pollutants by the U.S. Environmental Protection Agency (NMPNS, 2004). Localized emissions sources include commercial, residential, and transportation sources. Emissions are low enough at the existing NMP facilities to be exempt from any permit requirements (NRC, 2006a). Based on the design of the new reactor and the actions that will be taken to comply with permit requirements for emissions, it is expected that siting the unit at this location would have a SMALL impact on air quality.

9.3.2.2.2.3 Water

NMP is not located in an area designated as a maintenance or nonattainment area for any air pollutants by the U.S. Environmental Protection Agency (NMPNS, 2004). Localized emissions sources include commercial, residential, and transportation sources. Emissions are low enough at the existing NMP facilities to be exempt from any permit requirements (NRC, 2006a). Based on the design of the new reactor and the actions that will be taken to comply with permit requirements for emissions, it is expected that siting the unit at this location would have a SMALL impact on air quality.

9.3.2.2.2.4 Terrestrial Ecology and Sensitive Species

The predominant land cover at the NMP site is woodlands. Federal and State designated wetlands (including shrub wetlands, bogs, emergent marshes, and forested wetlands) and inactive agricultural lands also occur on the site. Flora and fauna found on or near the site are typical of disturbed areas in the coastal communities of the region.

The area is part of the Atlantic Flyway, so bird numbers and species vary seasonally as birds migrate through or return to breed. There are no designated critical terrestrial habitats for endangered species in the vicinity of the NMP site; however, three areas in the vicinity of the NMP site or the transmission line corridor are considered to be significant habitats by the New York State Department of Environmental Conservation (NYSDEC) (NYSDEC, 2007).

The impacts of construction would be MODERATE, but would be minimized by searching for sensitive species and complying with permit and mitigation requirements before beginning work. Because no land will be disturbed once construction is complete, the impacts of operation would be SMALL.

9.3.2.2.2.5 Aquatic Ecology and Sensitive Species

There are no Federally-listed threatened or endangered aquatic species in the vicinity of the NMP site. The potential for occurrence of the state-endangered deepwater sculpin (*Myoxocephalus thompsoni*) exists in the NMP site vicinity in Lake Ontario; however, it is a deepwater species (NYSDEC, 2007). No state-listed endangered aquatic species, including the deepwater sculpin, has been collected in the extensive lake sampling and impingement

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monitoring efforts at the NMP site or the nearby J.A. Fitzpatrick nuclear plant and Oswego Steam Station (NMPNS, 2004).

Construction impacts would be primarily due to runoff and siltation and will be controlled by best management practices and compliance with permit requirements. Because no sensitive species are known to occur in the vicinity and the new reactor is expected to have a similar impact to the existing reactor, siting a new reactor at NMP would have a SMALL impact on the aquatic ecology in the area.

9.3.2.2.2.6 Socioeconomics

The estimated population of Oswego County in 2005 was slightly more than 123,000 people. Other socioeconomic facts related to Oswego County are as follows:

- According to the U.S. Census Bureau, the number of people living in Oswego County in 2005 was up only 1,000 people from the 2000 census.
- The median household income is about $38,000.
- 13% of the population lives below the poverty level (USCB, 2007b).
- The closest large city to the NMP site is Syracuse, New York, which falls within the plant's 50 mi (80 km) radius. An estimated 914,668 people live within 50 mi (80 km) of NMP; however, only approximately 109,440 live within 20 mi (32 km) (NMPNS, 2004).
- Small seasonal fluctuations in regional population occur because of the number of colleges and recreational facilities in the area (NMPNS, 2004).

The number of jobs created by the construction and operation of a second nuclear reactor at NMP are insignificant in comparison with the number of jobs currently available in the area. Therefore, the construction and operation of a new reactor would have a SMALL impact on the area's population.

9.3.2.2.2.7 Transportation

Land access to NMP is Lake Road (County Route 1A), a two-lane paved roadway that is formed east of the intersection of County Route 1A and Lakeview Road, approximately 1 mi (1.6 km) from the NMP site. County Road 1 is another major throughway that intersects with both County Route 1A and Lakeview Road in the vicinity of the site. It is likely that the proposed work force (construction and operation) would use these routes to gain access to the site.

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

There are several ways to mitigate the potential transportation impacts during construction such as developing a construction traffic management plan prior to construction to address potential impacts on local roadways. If necessary, coordinating with local planning authorities

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for the upgrading of local roads, intersections, and signals to handle increased traffic loads could be considered.

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

9.3.2.2.2.8 Historic, Cultural, and Archeological Resources

No significant historic, cultural, or archeological resources have been found at the NMP site during previous site surveys or previous construction activities. The State Historic Preservation Officer lists no known historic sites at NMP; however, portions of the site have high potential for discovery of archeological resources (NRC, 2006a). Investigation would be required before siting a new reactor at this location.

Consultation with the State Historic Preservation Officer would occur if any significant historic, cultural, or archeological resources were identified and any appropriate mitigation measures put in place prior to construction and operation. Therefore, it is expected that the impacts of constructing and operating an additional reactor at this site would be SMALL.

9.3.2.2.2.9 Environmental Justice

Table 9.3-3 (USCB, 2007b) presents demographic information for Oswego County, New York, and the U.S. These data demonstrate that the population of this area is similar in composition to the state of New York and to the U.S. as a whole. Therefore, minority and low income communities would not be disproportionately affected. Furthermore, this site has been operating as a power generating facility for a number of years. Therefore, it is anticipated that environmental justice impacts would be SMALL.

9.3.2.2.2.10 Transmission Corridors

This site is capable of supporting the required 345 kV transmission lines, but will require upgrades to the switchgear. However, the tie in is currently congested with limited transmission corridor space. Further evaluation would be required to determine the need for additional transmission corridors, but existing right-of-ways would be used for any necessary upgrades, so impacts are expected to be SMALL from the development of new transmission corridors.

9.3.2.2.3 R. E. Ginna

The R.E. Ginna Nuclear Power Plant (Ginna) site is located in Ontario, in the northwest corner of Wayne County, New York. Like NMP, Ginna is situated on the south shore of Lake Ontario and includes about 1.5 mi (2.4 km) of shoreline. The site encompasses 488 acres (197 hectares), approximately half of which is currently leased for agricultural uses. The power station and accompanying support facilities occupy an additional quarter of the area. The remaining quarter is left largely undisturbed. The existing facility consists of a single unit, pressurized light water reactor, with a net capacity of 490 MW(e) (NRC, 2004).

9.3.2.2.3.1 Land Use

Agriculture plays a large and important role in Wayne County. The majority of the land surrounding the Ginna site is used for growing apples, cherries, grapes, and field crops.. The

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Ginna site and the transmission right-of-ways are zoned industrial, and the majority of the surrounding land is zoned for large lot residential use. Nearby Monroe County is home to Rochester and is much more urbanized than Wayne County. None of the Wayne County towns along the Lake Ontario shoreline have overly restrictive growth ordinances, so it is likely that building will continue to increase in these areas in the foreseeable future. Despite this expected growth, the impacts to land use at this site would still be expected to be SMALL because the new reactor would be placed near existing nuclear facilities on land currently appropriately zoned for power generation.

9.3.2.2.3.2 Air Quality

Air quality in the Ginna region exceeds national standards for all measured parameters. There are no nearby areas designated as areas of nonattainment or maintenance. Emissions from plant activities are below state and federal thresholds; therefore operations at Ginna do not require any air quality permits. Based on the design of the new reactor and the actions that will be taken to comply with permit requirements for emissions, it is expected that siting the unit at this location would have a SMALL impact on air quality.

9.3.2.2.3.3 Water

The features of Lake Ontario are described in the previous section. In addition to Lake Ontario, surface water features at the Ginna site include Mill Creek, which enters the site from the south, and Deer Creek, which enters the site from the west. Mill Creek has a continuous yield, while Deer Creek dries up during the summer months. Ginna does not use groundwater resources for plant operations or domestic purposes.

Impacts from construction of a new reactor at the Ginna site would be SMALL to MODERATE and would depend on the location of the new reactor relative to the streams. Because of the size of the surface water body and the expected compliance with any permit requirements, anticipated operational impacts of a new reactor unit on the surface and groundwater at this location would be SMALL.

9.3.2.2.3.4 Terrestrial Ecology and Sensitive Habitat

The Ginna site is surrounded by a variety of habitat types, such as mature woodlands, meadows, and abandoned farm fields, all typical of central and western New York. There is no State or Federal regulated wetlands at Ginna, and no federally-listed threatened or endangered terrestrial breeding species are known to occur at the site. Occasionally, bald eagles will be observed in the vicinity, but the nearest known nesting site is approximately 55 mi (88 km) away (NYSDEC, 2007).

Of the 3 reptile species, 13 bird species, 4 mammal species, and 8 plant species listed by the State of New York as threatened, endangered, rare, or otherwise of concern, none are known to occur at the Ginna site (NYSDEC, 2005). Surveys for sensitive species would be conducted before constructing a new reactor at the Ginna site and permit and mitigation requirements fulfilled before beginning work. Impacts to the terrestrial ecology at the Ginna site would be MODERATE during the construction of a new reactor. Because no land will be disturbed once construction is complete, operational impacts would be SMALL.

9.3.2.2.3.5 Aquatic Ecology and Sensitive Habitat

Although the Ginna site is situated on the shore of Lake Ontario, there are no aquatic species federally-listed as threatened or endangered in the vicinity of the site. Two state-listed aquatic species are known to occur within Wayne County - the pugnose shiner (*Notropis anogenus*) and

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the lake sturgeon (*Acipenser fulvescens*). The pugnose shiner is not known to exist near the Ginna site. A single lake sturgeon was netted several years ago approximately 6 mi (10 km) from the Ginna site.

Construction impacts would be primarily due to runoff and siltation and will be controlled by best management practices and compliance with permit requirements. Because no sensitive species are known to occur in the vicinity and the new reactor is expected to have a similar impact to the existing reactor. Depending on the proximity of the new reactor to the streams onsite, construction activities would have a SMALL TO MODERATE impact on the aquatic ecology at the Ginna site. Operational impacts would be anticipated to be SMALL.

9.3.2.2.3.6 Socioeconomics

The estimated population of Wayne County in 2005 was just under 94,000 people. Other socioeconomic facts related to Wayne County are as follows (USCB, 2007c):

- The population within 20 mi (32 km) of the Ginna site is approximately 564,000.
- An estimated 1.25 million people live within 50 mi (80 km).
- Rochester, in Monroe County, is the largest city within 50 mi (80 km) of the Ginna site, with a population of 219,773 people.
- There is a Tribal Designated Statistical Area for the Cayuga Nation within 50 mi (80 km) of the facility.
- The estimated 2005 population for Wayne County was nearly the same as the 2000 population.
- The median household income is approximately $44,000
- 10% of the population lives below the poverty level.
- The summertime population near the site increases very slightly because of the proximity to recreational opportunities on Lake Ontario.

It is expected that no significant increase in employment will take place due to the construction or operation of the new reactor, therefore, the impacts to the area's population from construction and operation of a new reactor would be SMALL.

9.3.2.2.3.7 Transportation

There are 13 counties wholly or partially within the 50 mi (80 km) radius of the Ginna site. The 13 county area is served by a network of interstate freeways including Interstate 90 (I-90), I-390, I-490, and I-81. In addition to interstate freeways, the region's transportation network includes the Greater Rochester International Airport in southwest Rochester and a train network. The Port of Rochester, at the mouth of the Genesee River, is also available to a limited number of cargo ships and passenger ferries.

The main east-west transportation routes providing access to the Ginna site are County Route 101 (Lake Road) and NYS Route 104. Lake Road, a two-lane road, provides direct access to Ginna along much of the southern border of the site. NYS Route 104, the predominant east-west corridor near the plant, runs parallel to Lake Road, approximately 3.6 mi (5.8 km)

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south of Ginna. Ontario Center Road in the town of Ontario runs north-south, connecting NYS Route 104 to Lake Road immediately south of Ginna. Several other secondary roads run north-south providing access to Lake Road from NYS Route 104.

Employees commuting from Monroe County and other points west of the Ginna site are likely to use NYS Route 104, Route 441, or Route 286 to access Lake Road. Employees commuting from the south and east are likely to use north-south corridors NYS Route 21 and Route 350 to reach NYS Route 104, and then use Ontario Center Road to Lake Road.

A traffic study prepared for construction at the CCNPP site predicts that construction traffic will peak above 1,450 vehicles per hour (Vph) at key intersections. Heavy vehicle shipments and construction traffic will make up most of the traffic, assuming a peak construction workforce of about 3,950 workers (calculated at 1.3 drivers per vehicle). It is anticipated that roadways will be equally affected by the increased traffic, but the impacts would occur during morning and evening commutes to the plant. Impacts on these roadways would be temporary, and likely end after construction was finished.

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

Schedules during workforce shift changes and for the delivery of larger pieces of equipment or structures could be coordinated to limit impacts on local roads. In addition the use of shared (e.g., carpooling) and multi-person transport (e.g., buses) during construction and/or operation of the facility could be encouraged.

By implementing the appropriate measures, it is expected that there would be SMALL to MODERATE impacts on transportation during construction activities and SMALL impact during operation of the facility.

9.3.2.2.3.8 Historic, Cultural, and Archeological Resources

The area surrounding the Ginna site was historically occupied by Native American tribes. No significant Native American artifacts or evidence of villages has been found or identified on or in close proximity to Ginna. In addition, no archeological sites are known to exist in the vicinity of the plant. However, because archeological sites have been found along the creeks and lakeshore, the New York State Preservation Office considers the area surrounding Ginna an archeologically sensitive area (NRC, 2004).

It is reasonable to expect that, because no historic sites are known to occur at Ginna, impacts to historical, cultural, and archeological resources construction and operation of an additional reactor unit at this site would be SMALL, but investigations of the site would be needed before siting a new reactor at this location.

9.3.2.2.3.9 Environmental Justice

Table 9.3-4 (USCB, 2007c) presents demographic information for Wayne County, New York, and the U.S. These data demonstrate that the population of this area is similar in composition to the state of New York and to the U.S. as a whole. Although the area is somewhat urbanized, there is no indication that minority or low income populations would be more adversely affected by a second plant at the Ginna site than the general population. Furthermore, this site has been

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operating as a power generating facility for a number of years. Therefore, it is anticipated that environmental justice impacts would be SMALL.

9.3.2.2.3.10 Transmission Corridors

Currently, no right of way capable of supporting the necessary 345 kV transmission lines exists. No current right-of-way exists for transmission expansion. The nearest 345 kV substation is near the NYS Thruway, approximately 20 mi (32 km) from the plant. The tie in with the existing 345 kV transmission corridor would require 20 mi (32 km) of new transmission lines and right-of-way. Because new right-of-ways would need to be constructed to accommodate the new transmission lines, it is anticipated that impacts from the development of new transmission corridors would be MODERATE.

9.3.3 SUMMARY AND CONCLUSIONS

The advantages of the CCNPP site over the alternative sites are summarized as follows:

- The postulated consumptive use of water by a new unit at the CCNPP site would be no greater than water use at the alternative sites.
- The CCNPP site contains habitat suitable for ~~three~~ two Federally-listed threatened species: the ~~bald eagle and~~ two tiger beetle species. ~~Four bald eagle nests are present on the site, although all may not be active. One nest is in the construction footprint and would be impacted by the development.~~ The suitable beach habitat for the tiger beetles is south of the barge dock and would not be impacted by the development. Therefore, impacts of development of a new unit at the proposed site on endangered species are not greater than impacts postulated for the alternative sites after the proposed mitigation measures are considered.
- The CCNPP site does not contain spawning grounds for any threatened or endangered species. Thus, the impacts on spawning areas are not greater than impacts at the alternative sites.
- The CCNPP site impact review does not postulate effluent discharge beyond the limits of existing National Pollutant Discharge Elimination System permits or regulations. Based on the information available for the alternative sites, the impacts from effluent discharge at the proposed site would be no greater than impacts at the alternative sites.
- The siting of the new unit at the CCNPP site would require the pre-emption of lands currently zoned farm and forest district, and light industrial for construction and operation. Therefore, land impacts at the proposed site would be greater than the impacts at the alternative sites.
- The potential impacts of a new nuclear facility on terrestrial and aquatic environments at the CCNPP site would be no greater than the impacts at the alternative sites.
- The CCNPP site is in a generally rural setting and has a population density that meets the population criteria of 10 CFR Part 100.
- The CCNPP site does not require decommissioning or dismantlement of an existing facility, aswould be required for the Crane Generating Station.

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As summarized in Table 9.3-5 no alternative sites are environmentally preferable, and therefore cannot be considered obviously superior, to the CCNPP site. Development of a greenfield or brownfield site would offer no advantages and would increase both the cost of the new facility and the severity of impacts. Collocation of the new reactor unit at an existing site would allow existing infrastructure and transmission lines to be used.

Alternative nuclear sites offer no environmental advantages over the preferred site. Although the CCNPP site offers no distinct environmental advantages over the NMP site, the CCNPP site is more centrally located to serve the southwest portion of the PJM region. The existing facility currently operates under an NRC license, and the proposed location has already been found acceptable under the requirements for that license. Further, operational experience at the CCNPP site has shown that the environmental impacts are SMALL, and operation of a new unit at the site should have essentially the same environmental impacts.

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Table 9.3-1—Profile of Demographic Characteristics – Baltimore County, Maryland

Geographic Area	RACE						
	One Race						Two or More Races
	White	Black or African American	American Indian and Alaska Native	Asian	Native Hawaiian and Other Pacific Islander	Other Race	
Baltimore County	534,409 69.6%	183,984 24.0%	918 0.1%	30,307 3.9%	415 0.1%	7,121 0.9%	10,443 1.4%
Maryland	3,356,489 61.5%	1,564,914 28.7%	16,711 0.3%	258,529 4.7%	2,554 0.0%	168,909 3.1%	93,212 1.7%
U.S.	215,333,394 74.4%	34,962,569 12.1%	2,357,544 0.8%	12,471,815 4.3%	397,030 0.1%	17,298,601 6.0%	5,557,184 1.9%

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Table 9.3-2—Profile of Demographic Characteristics – Calvert County, Maryland

Geographic Area	RACE						
	One Race						Two or More Races
	White	Black or African American	American Indian and Alaska Native	Asian	Native Hawaiian and Other Pacific Islander	Other Race	
Calvert County	72,898 83.6%	11,328 13.0%	129 0.1%	1,092 1.3%	0 0.0%	1,077 1.2%	691 0.8%
Maryland	3,356,489 61.5%	1,564,914 28.7%	16,711 0.3%	258,529 4.7%	2,554 0.0%	168,909 3.1%	93,212 1.7%
U.S.	215,333,394 74.4%	34,962,569 12.1%	2,357,544 0.8%	12,471,815 4.3%	397,030 0.1%	17,298,601 6.0%	5,557,184 1.9%

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Table 9.3-3—Profile of Demographic Characteristics – Oswego County, New York

Geographic Area	RACE						
	One Race						Two or More Races
	White	Black or African American	American Indian and Alaska Native	Asian	Native Hawaiian and Other Pacific Islander	Other Race	
Oswego County	115,102 97.1%	714 0.6%	46 0.0%	775 0.7%	0 0.0%	322 0.3%	1,601 1.4%
New York	12,508,643 67.1%	2,858,062 15.3%	67,460 0.4%	1,246,567 6.7%	6,123 0.0%	1,684,562 9.0%	283,858 1.5%
U.S.	215,333,394 74.4%	34,962,569 12.1%	2,357,544 0.8%	12,471,815 4.3%	397,030 0.1%	17,298,601 6.0%	5,557,184 1.9%

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Table 9.3-4—Profile of Demographic Characteristics – Wayne County, New York

Geographic Area	RACE						
	One Race						Two or More Races
	White	Black or African American	American Indian and Alaska Native	Asian	Native Hawaiian and Other Pacific Islander	Other Race	
Wayne County	85,795 93.3%	2,995 3.3%	212 0.2%	285 0.3%	0 0.0%	1,378 1.5%	1,289 1.4%
New York	12,508,643 67.1%	2,858,062 15.3%	67,460 0.4%	1,246,567 6.7%	6,123 0.0%	1,684,562 9.0%	283,858 1.5%
U.S.	215,333,394 74.4%	34,962,569 12.1%	2,357,544 0.8%	12,471,815 4.3%	397,030 0.1%	17,298,601 6.0%	5,557,184 1.9%

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Table 9.3-5—Summary Comparison of Candidate and Potential Sites

Location	CCNPP	NMP	Ginna	Greenfield	Crane Brownfield
Land use	Small	Small	Small	Moderate to Large	Moderate
Air Quality	Small	Small	Small	Small	Beneficial Small to Moderate
Water	Small	Small	Small to Moderate	Small to Large	Moderate to Large
Terrestrial Ecology	Moderate	Moderate	Moderate	Moderate to Large	Small
Aquatic Ecology	Small	Small	Small to Moderate	Small to Large	Small to Large
Socioeconomics	Small	Small	Small	Moderate to Large	Small to Moderate
Historic, Cultural, and Archeological Resources	Small	Small	Small	Not Evaluated	Small
Environmental Justice	Small	Small	Small	Not Evaluated	Small
Transmission Corridors	Small	Small	Moderate	Not Evaluated	Small
Transportation	Small to Moderate	Small to Moderate	Small to Moderate	Not Evaluated	Small to Moderate
Is this Site a Candidate Site (Yes or No)	Yes	Yes	Yes	Yes	Yes
Is this Candidate Site a good Alternative Site to the Proposed Site	Yes	Yes	Yes	No	Yes
Is the Site Obviously Superior?	Preferred alternative	No	No	No	No
Is the Site Environmentally Preferable?	Preferred alternative	No	No	No	No

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9.4 ALTERNATIVE PLANT AND TRANSMISSION SYSTEMS

The information presented in this section describes the evaluation of the alternative plant and transmission systems for heat dissipation, circulating water, and power transmission associated with the 1,562 MWe CCNPP Unit 3 facility. The information provided in this section is consistent with the items identified NUREG-1555 (NRC, 1999).

Throughout this chapter, environmental impacts of the alternatives will be assessed based on the significance of impacts, with the impacts characterized as being SMALL, MODERATE, or LARGE. This standard of significance was developed using the guidelines set forth in the footnotes to Table B-1 of 10 CFR 51, Appendix B to Subpart A (CFR, 2007a):

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

The impact categories evaluated in this chapter are the same as those used in the "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS), NUREG-1437, (NRC, 1996).

Section 9.4.1 discusses alternative heat dissipation systems. Section 9.4.2 discusses alternative circulating water systems. Section 9.4.3 discusses the transmission systems.

9.4.1 HEAT DISSIPATION SYSTEMS

This section discusses alternatives to the proposed heat dissipation system that was described in Section 3.4, and is presented using the format provided in NUREG-1555 (NRC, 1999), i.e., Environmental Standard Review Plan (ESRP) 9.4.1. The information provided in this section is based on two studies: a Cooling Tower and Circulating Water System study, and an Ultimate Heat Sink (UHS) and Intake/Discharge Structures Location study.

These alternatives are generally included in the broad categories of "once-through" and "closed-loop" systems. The once-through method involves the use of a large quantity of cooling water, withdrawn from a water source and returned to that source (receiving water body) following its circulation through the normal heat sink (i.e., main condenser). Closed-loop cooling systems use substantially less water because the water performing the cooling is continually recirculated through the normal heat sink (i.e., the main condenser), and only makeup water for evaporative losses and blowdown is required.

In closed-loop systems, two pumping stations are usually required—a makeup water system and a cooling water circulation system. Closed-loop systems include cooling towers, and a cooling pond or spray pond. As a result of the evaporation process, the concentration of chemicals in the water will increase. To maintain acceptable water chemistry, water must be discharged at a small rate (blowdown) and compensated by a makeup water source.

Heat dissipation systems are also categorized as wet or dry, and the use of either system depends on the site characteristics. Both wet and dry cooling systems use water as the heat exchange medium. Wet heat dissipation systems cool water by circulating it through a cooling

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tower. Heat from the water is dissipated by direct contact with air circulating through the tower. The heat transfer takes place primarily by evaporation of some of the water into the air stream (latent heat transfer).

Generally, a relatively minor amount of sensible heat transfer (heating of the air and cooling of the water) also occurs. During very cold weather, the amount of sensible heat transfer can be fairly substantial. On the other hand, during a warm, dry summer day, the amount of sensible heat transfer may be nil or even negative (when negative, the air discharged from the tower is cooler than the ambient dry bulb). This does not adversely affect the cold water performance of mechanical draft towers, but does affect evaporation rate. The wet cooling tower is used widely in the industry and is considered a mature technology.

Because wet cooling towers provide direct contact between the cooling water and the air passing through the tower some of the liquid water may be entrained in the air stream and be carried out of the tower as “drift” droplets. The magnitude of drift loss is influenced by the number and size of the droplets produced within the cooling tower, which in turn are influenced by the fill design, the air and water patterns, and other interrelated factors. Tower maintenance and operation levels can influence the formation of drift droplets. For example, excessive water flow, excessive air flow, and water bypassing the tower drift eliminators can promote and/or increase drift emission.

To reduce the drift from cooling towers, drift eliminators are usually incorporated into the tower design to remove as many droplets as practical from the air stream before exiting the tower. The drift eliminators rely on inertial separation of the droplets, caused by direction changes, while passing through the eliminators. Types of drift eliminator configurations include herringbone, wave form, and cellular (or honeycomb) designs. The cellular units are generally the most efficient. Drift eliminators may include various materials, such as ceramics, fiber-reinforced cement, fiberglass, metal, plastic, and wood installed or formed into closely spaced slats, sheets, honeycomb assemblies, or tiles. The materials may include other features, such as corrugations and water removal channels, to enhance the drift removal further (USEPA, 1995).

Dry cooling systems transfer heat to the atmosphere without the evaporative loss of water. There are two types of dry cooling systems: direct dry cooling and indirect dry cooling. Direct dry cooling systems use air to directly condense steam, while indirect dry cooling systems use a closed-loop water cooling system to condense steam and air to cool the heated water.

The most common type of direct dry cooling system is a recirculated cooling system with mechanical draft towers. For dry cooling towers, the turbine exhaust steam exits directly to an air-cooled, finned-tube condenser. Because dry cooling systems do not evaporate water for heat transfer, dry cooling towers are quite large in comparison to similarly sized wet cooling towers. Also, because dry cooling towers rely on sensible heat transfer, a large quantity of air must be forced across the finned tubes by fans to improve heat rejection. This results in a larger number of fans being required for a mechanical draft dry cooling tower than would be needed for a mechanical draft wet cooling tower.

The key feature of dry cooling systems is that no evaporative cooling or release of heat to the surface water occurs. As a result, water consumption rates are very low compared to wet cooling. Because the unit does not rely in principle on evaporative cooling like the wet cooling tower, large volumes of air must be passed through the system compared to the volume of air used in wet cooling towers. As a result, dry cooling towers need larger heat transfer surfaces and therefore tend to be larger than comparable wet cooling towers.

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Dry cooling towers require high capital and operating and maintenance costs that are sufficient to pose a barrier to entry to the marketplace for some facilities (USEPA, 2001b). Dry cooling technology has a detrimental effect on electricity production by reducing the energy efficiency of steam turbines. Dry cooling requires the facility to use more energy than would be required with wet cooling towers to produce the same electricity. This energy penalty is most significant in warmer southern regions during summer months, when the demand for electricity is at its peak. The energy penalty would result in an increase in environmental impacts because replacement generating capacity would be needed to offset the loss in efficiency from dry cooling.

9.4.1.1 Evaluation of Alternative Heat Dissipation Systems

Heat dissipation system alternatives were identified and evaluated. The alternatives considered were those generally included in the broad categories of "once- through" and "closed-loop" systems. The evaluation includes the following types of heat dissipation systems:

- Other heat dissipation systems
  - Cooling Ponds
  - Spray Ponds
- Once-through cooling
- Natural draft cooling tower
- Mechanical draft cooling tower
- Hybrid (plume abated) cooling towers
- Dry cooling systems (closed-loop cooling system)

An initial evaluation of the once-through cooling alternative and the closed-loop alternative designs was performed to eliminate systems that are unsuitable for use at CCNPP Unit 3. The evaluation criteria included aesthetics, public perception, space requirements, environmental effects, noise impacts, fog and drift, water requirements, capital and operating costs, and legislative restrictions that might preclude the use of any of the alternatives.

~~The screening process identified the hybrid, cooling tower, without plume abatement, as the preferred closed-loop heat dissipation system for CCNPP Unit 3. The analysis of this alternative is discussed in Section 9.4.1.2. The discussion of non-preferred alternatives that were considered is provided below. Selection of the preferred heat dissipation alternative was supported by detailed net present value (NPV) analysis.~~

The evaluation identified the mechanical forced draft cooling tower, with plume abatement, as the preferred closed-loop heat dissipation system for CCNPP Unit 3. Under the restrictions imposed by Section 316 of the Federal Clean Water Act, closed-cycle cooling is the only practical alternative for CCNPP Unit 3 that would meet both the Section 316(b) intake requirements at new facilities, as well as the Section 316(c) thermal requirements at this multi-facility site. The analysis of this alternative is discussed in Section 9.4.1.2. The discussion of non-preferred alternatives that were considered is provided below. Selection of the preferred heat dissipation alternative was supported by detailed net present value (NPV) analysis.

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Table 9.2-1 provides a summary of the screening of Circulating Water Supply (CWS) System heat dissipation system alternatives, and Table 9.2-2 provides a summary of the environmental impacts of the heat dissipation system alternatives. Cooling ponds and spray ponds were not included in the alternatives study since neither alternative is reasonable given the plant location and existing infrastructure at the CCNPP site. However, a discussion of cooling ponds and spray ponds as a non-preferred alternative is provided below.

Cooling Ponds and Spray Ponds

Cooling ponds are usually man-made water bodies that are used by power plants and large industrial facilities for heat dissipation. In a conventional static-type cooling pond, warmed cooling water exiting the main condenser and other plant heat loads would be routed to the cooling pond where some of the water would evaporate, and the remaining water would be cooled and recirculated to the plant. The primary heat transfer mechanism in a cooling pond is evaporation. If there is no vertical mixing in the pond, layers (or thermoclines) of warm and cold water can form causing horizontal flows which in turn, can restrict the movement of warmer water to the surface for evaporation and cooling. This can result in only portions of the pond cooling capacity being used.

Although the conventional static-type cooling pond is probably the oldest form of water cooling it is not preferred for several reasons. The modern spray pond offers the following advantages over a conventional cooling pond: (1) a spray pond requires less than 10% of the land area required for a conventional pond, and (2) they provide over 30 times the cooling capacity of a conventional pond on a BTU/ft^2 basis.

A spray pond is typically a bentonite-lined structure in the ground, and is typically long and narrow to improve efficiency. The spray pond structure contains a volume of water and consists of an intake structure that houses pumps to transfer the water from the pond through their respective loops and back to the pond through a network of sprays located in the pond. The spray pond size depends on the number of nozzles required. It is important that the long, narrow spray pond have its long side perpendicular to the prevailing summer wind direction in order to benefit from a better spray droplet surface area and air contact interface. Generally, a spray pond long side dimension would be in the range of two to four times that of the narrow side dimension.

The area of the pond is determined by the quantity of water which it can treat per hour per unit area of the pond. Accepted industry practice for sizing spray ponds is based on values that are typically between 120 $lb/ft^2/hr$ (585 $kg/m^2/hr$) and 150 $lb/ft^2/hr$ (732 $kg/m^2/hr$). In actual practice, a spray pond will only cool the water to a point approximately midway between the hot water and wet bulb temperatures. Because of the various factors in spray pond applications, it is virtually impossible to accurately calculate the expected cooled water temperature. The 50% design efficiency factor (cooling to halfway point between hot water and wet bulb temperature) is considered to be a reasonable value for a well designed and located, long and narrow, spray pond.

Due to loss of water from the pond, a fresh water make up system operating on pond level is required. The water levels in cooling and spray ponds are usually maintained by rainfall or augmented by a makeup water system using fresh, salt, or reclaimed water.

Given the relatively large amount of land that would be required for a cooling pond or spray pond option, and expected thermal performance, neither the spray pond, nor the cooling pond

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alternative is reasonable for CCNPP Unit 3. Cooling ponds and spray ponds were not considered in the alternatives study.

Once-through Cooling System Using Chesapeake Bay Water

In a once-through cooling system, water is withdrawn from a water body, passes through the heat exchanger, and is discharged back to the same water body. The discharged water temperature is higher than the intake by the temperature gained when passing through the heat exchanger. A once-through cooling water system for a single unit plant would require either an onshore intake design or an offshore design.

If an onshore intake is proposed, the onshore structure would need to accommodate upwards of 2.5 million gpm (9.5 million Lpm) considering a 10°F (5.6°C) temperature rise across the condenser.

For CCNPP Unit 3, it is estimated that an onshore intake structure/pump house would need to be approximately 1,200 ft (365.8 m) long, by 170 ft (51.8 m) wide, and 66 ft (20.1 m) deep below the site grade. The pump house would need to have 6, 417,000 gpm (1.6 million Lpm) volute type pumps. The intake screens would include 24 to 60 ft (7.3 to 18.3 m) diameter drum screens (two per pump) with the width of the screen panel would need to be about 15 ft (4.6 m). Additionally, 72 bar screens (trash racks) that are 12 ft (3.7 m) wide would be required, with four rakes to clean the screens.

An offshore structure would require twelve, 12 ft (3.7m) diameter concrete pipes routed at least 3,000 ft (914.4 m) into the Chesapeake Bay, at a depth 35 ft (10.7 m). At the offshore end of each pipe there would need to be one bank of wedge wire screens arranged with interconnecting manifolds to supply about 420,000 gpm (1.6 million Lpm). It is expected that twelve, 8 ft (2.4 m) diameter T-type wedge wire screens would be needed for each bank because the wire mesh slot would be very small (1.75 mm or smaller). Wire mesh material would need to be copper-nickel for bio-fouling protection.

At the outlet for each screen, biocide agent supply piping would be necessary to protect intake pipes from bio-fouling. It is expected that a total of 144, 8 ft (2.4 m) diameter T-screens could be required. The onshore pump house structure for this would be approximately 800 ft (243.8 m) long, 120 ft (36.6 m) wide, and 66 ft (20.1 m) deep. The total offshore intake area covered by the wedge wire screens would be approximately 10 acres (4.0 hectares). The long trench to place the intake pipes would cover approximately 20 acres (8.1 hectares) of the bottom of the Chesapeake Bay.

The discharge structure would consist of a common onshore seal well structure. This structure would need to be approximately 250 ft (76.2 m) long, 80 ft (24.4 m) wide, and 50 ft (15.2 m) deep. The discharge piping would consist of 12 ft (3.7 m) diameter concrete pipes. It is expected that the discharge pipe length would be about 2,000 ft (610 m). The pipes could be placed in a large trench in a cut-and-fill operation, backfilled, and covered with riprap. At the end of each discharge pipe would be a multiple port diffuser. The diffuser main body would also be 12 ft (3.7 m) diameter pipe.

On top of the diffuser pipe would be six, 54 in (1.4 m) risers that discharge heated effluent to the ambient water. The large discharge flow would necessitate large separation distance between offshore intakes and offshore distances to prevent thermal recirculation from reaching an unacceptable level. The estimated separation distance would be 4,000 ft (1,219 m). The offshore diffuser area would be approximately 10 acres (4.0 hectares) at the bottom of

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Chesapeake Bay, approximately 2,000 ft (609.6 m) offshore. The long trench to place the discharge pipes would cover approximately 12 acres (4.9 hectares) of the bottom of the Chesapeake Bay.

Once-through cooling systems are required to comply with Federal and State regulations for thermal discharges into the Chesapeake Bay. Additionally, U.S. Environmental Protection Agency (EPA) regulations governing cooling water intake structures under Section 316(b) of the (USC, 2007) make it difficult for steam electric generating plants to use once-through cooling systems (FR, 2004).

Based on the large size of the intake and discharge structures and offshore pipes and potential permitting issues under U.S. EPA Section 316(b) Phase I or Phase II Rules, the once-through cooling system would be cost-prohibitive, and is therefore is not considered feasible for the use at CCNPP Unit 3. Additional discussion of Federal and State regulations under Section 316(b) governing cooling water intake structures for existing power plants is found in Section 9.4.2.1.

Natural Draft Cooling Tower

Wet cooling towers predominantly rely on the latent heat of water evaporation to exchange heat between the water and the air passing through the tower. In a natural draft cooling tower, warm water is brought into direct contact with cooler air. When the air enters the cooling tower, its moisture content is generally less than saturation. When the air exits, it emerges at a higher temperature and with moisture content at or near saturation.

Even at saturation, cooling can take place because a temperature increase results in an increase in heat capacity, which allows more sensible heat to be absorbed. A natural draft cooling tower receives its air supply from natural wind currents that result in a convective flow up the tower. This air convection cools the water on contact.

Because of the significant size of natural draft cooling towers (typically 500 ft (152.4 m) high, 400 ft (121.9 m) in diameter at the base), their use is generally reserved for use at flow rates above 200,000 gpm (757,000 Lpm) (Young, 2000). They are typically sized to be loaded at about 2 to 4 gpm/ft^2 (1.4 to 2.7 Lps/m^2). The size of and cost of the natural draft towers preclude them from further consideration for the CCNPP site.

Mechanical Draft Cooling Tower

A wet mechanical draft cooling tower system, operated completely as a wet-type cooling tower, would consist of multi-cell cooling tower banks, and associated intake/discharge, pumping, and piping systems. This closed-loop system would receive makeup water from the Chesapeake Bay and transfer heat to the environment via evaporation and conduction. These towers would have a relatively low profile of approximately 80 ft (24.4 m). Mechanical draft towers use fans to produce air movement.

A mechanical draft cooling tower would typically consist of a continuous row of rectangular cells in a side-by-side arrangement sharing a common cold water basin. Water to be cooled is pumped to a hot water distribution system above the fill, and then falls over the fill to the cold water basin. Air is drawn through the falling water by fans, which results in the transfer of heat from the water to the air, and the evaporation of some of the water. The fill serves to increase the air-water contact surface and contact time, thereby promoting heat transfer.

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A mechanical draft cooling tower employs large fans to either force or induce a draft that increases the contact time between the water and the air maximizing the heat transfer. A forced draft tower has the fan mounted at the base, forcing air in at the bottom and discharging air at low velocity through the top. An induced draft tower uses fans to create a draft that pulls air through the cooling tower fill.

Hybrid Plume Abatement Cooling Tower

A cooling tower plume occurs when the heated and saturated air leaving a wet cooling tower mixes with the relatively cooler ambient air under atmospheric conditions, and a supersaturated condition occurs during the process of mixing and dispersion. The excess vapor condenses (the amount in excess of saturation vapor) and becomes a visible plume.

A cooling tower plume may be visually objectionable or may result in problems of fogging or icing. A plume abatement hybrid cooling tower (i.e., combination wet-dry tower) combines dry cooling and wet cooling to reduce the cooling tower plume. The dry cooling section adds heat to the discharge air without adding moisture (sensible heat transfer). This results in a subsaturated air stream leaving the tower (less than 100% relative humidity) and therefore reduced plume potential.

Although the hybrid plume abatement cooling tower results in reduced water consumption and no visible plume, construction costs, operating and maintenance costs, and land use requirements are significantly higher. Nevertheless, the hybrid plume abatement cooling tower was the preferred alternative for CCNPP Unit 3 in order to have the least impact on the environment.

Dry Cooling System

A dry-type helper tower system could be utilized to assist a once-through cooling system by reducing circulating water discharge temperature before it re-enters the Chesapeake Bay. Use of a helper tower would be most beneficial when ambient air temperatures are low enough for a dry tower system to be functional.

A dry tower helper system would have the benefit of reduced environmental impact due to the fact that it would not experience cooling tower drift or evaporative losses. The water savings, however, are outweighed by the additional cost to construct and operate the air cooled condenser. Additionally, during periods of high ambient air temperature, the only way to reduce water temperature to within 7°F (13.9°C) of ambient dry bulb temperature would be to use evaporative cooling. The thermal performance limitations under high ambient air temperature conditions would result in either a very large dry tower array, or plant efficiency would have to be significantly reduced during high ambient air conditions due to high condenser water temperature and the consequential increase in steam turbine backpressure.

Use of a dry system would require a significant increase in dry tower land use. It is estimated that a dry (fin-fan) tower array would consist of 550 bays with a moderate profile (150 ft (45.7 m) high). Total land use for a dry cooling tower system is approximately 39.1 acres (15.8 hectares). An air-cooled condenser, where steam turbine exhaust is transported directly to a steam-to-air heat exchanger, was not considered because of the limitations of its use. The distances from the main steam turbine condensers to the air-cooled condensers and the size of the steam ducting required for this application (at approximately 26 ft (7.9 m) in diameter) would render the design not feasible. The steam duct would need to be uncommonly large and would far exceed the largest steam duct ever attempted.

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There are, however, specific environmental advantages that would be realized with an air-cooled condenser (dry tower) scenario. These advantages include:

- ♦ Makeup water use limited to that necessary to compensate for system leakage,
- ♦ No environmental impacts to terrestrial or estuarine habitat due to presence of intake and discharge structure and flows, and
- ♦ No environmental impacts to terrestrial or estuarine habitat due to cooling tower drift.
- ♦ Specifically, there would be no impact to the Chesapeake Bay due to effluent discharges from CCNPP Unit 3 in a 100% dry cooling tower option.

For a completely dry tower system, the material cost ($269.9 million) and the operation and maintenance costs ($5.4 million) are significantly greater than a wet type or wet/dry type of cooling tower, land use would be significant, and the system would require periods of significant unit power output reduction during periods of high ambient air temperatures.

Therefore, for the reasons stated above, the use of a dry tower is not a feasible alternative for CCNPP Unit 3.

9.4.1.2 Analysis of the Hybrid Cooling Tower With Plume Abatement Alternative

A hybrid cooling tower system with plume abatement was identified as the preferred option for use at CCNPP Unit 3 to transfer heat loads from the CWS to the environment. The cooling tower design will consist of a hybrid cooling tower shelland installed plume abatement equipment. The cooling tower will operate as a combination wet-dry type mechanical draft cooling tower, and will have drift eliminators installed.

The hybrid cooling tower system for CCNPP Unit 3 would be wholly situated on the CCNPP site. The cooling tower will be constructed of concrete. It will have a round hybrid shell, and drift eliminators will be installed. The base of the concrete hybrid cooling tower structure will have an overall diameter of 528 ft (161 m) and the tower will have an approximate height of 164 ft (50 m). Internal construction materials will include fiberglass-reinforced plastic (FRP) or polyvinyl chloride (PVC) for piping laterals, polypropylene for spray nozzles, and PVC for fill material.

The hybrid tower with plume abatement is the preferred alternative to transfer heat loads from the circulating water system to the environment. This type of cooling tower provides the greatest degree of operational flexibility while reducing or eliminating the visible plume.

9.4.1.3 Summary of Alternative Heat Dissipation Evaluation

As discussed earlier in this section, a hybrid cooling tower system with plume abatement provides the greatest degree of operational flexibility, quiet performance under a wide range of environmental conditions, and little or no plume. It is therefore the preferred alternative to transfer heat loads from the CWS to the environment.

Although the dry cooling tower system and the hybrid plume abated cooling tower system may be considered an environmentally equivalent alternative as stated earlier, the construction costs and operation and maintenance costs for these options are significantly greater than for the hybrid cooling tower system with plume abatement. Additionally, the dry cooling system

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would require periods of significant unit power output reduction during periods of high ambient air temperatures.

9.4.2 CIRCULATING WATER SYSTEMS

In accordance with NUREG-1555 (NRC, 1999), ESRP 9.4.2, this section discusses alternatives to the following components of the CWS for CCNPP Unit 3. These components include the intake systems, discharge systems, water supply, and water treatment processes. The information provided in this section is based on two studies: a Cooling Tower and Circulating Water System study, and an Ultimate Heat Sink (UHS) and Intake/Discharge structures location study. A summary of the environmental impacts of the circulating water intake and discharge system alternatives for CCNPP Unit 3 are provided in Table 9.2-1 and Table 9.2-2.

The CWS is an integral part of the heat dissipation system. It provides the interface between (1) the normal heat sink (i.e., main steam turbine condenser) where waste heat is discharged from the steam cycle and is removed by the circulating water, and (2) the heat dissipation system where the heat energy is then dissipated or transferred to the environment.

Essentially, two types of CWSs are available for removing this waste heat: once-through (open-loop) and recycle (closed-loop) systems. In once-through cooling systems, water is withdrawn from a cooling source, passed through the condenser, and then returned to the source (receiving water body). In the recycle (closed-loop) cooling system, heat picked up from the condenser by the circulating water is dissipated through auxiliary cooling facilities, after which the cooled water is recirculated to the condenser.

As discussed in Section 9.4.1, the CWS for CCNPP Unit 3 will be a closed-loop system, with volute pumps and piping, a water retention basin, and a round mechanical draft hybrid cooling tower with drift eliminators that will be operated as a wet cooling tower (i.e., without plume abatement) year-round.

The cooling water withdrawal rate for the CWS will normally be approximately 34,800 gpm (131,500 lpm), and maximum makeup will be approximately ~~40,440~~47,383 gpm (~~153,000~~179,365 lpm). These numbers include the desalination plant. These withdrawals include consideration of losses due to evaporation, drift and blowdown. A fraction of the intake water will be used to clean debris from the traveling screens.

Blowdown from the CWS cooling tower will be routed to a retention basin prior to being returned to the Chesapeake Bay. The blowdown water will enter the retention basin at the cold water temperature for the cooling tower basin (approximately 90°F (32.2°C)). The water will then give up additional heat to the atmosphere before entering the discharge pipe, and will transfer additional heat to the discharge piping during its passage to the outfall. The normal circulating water system blowdown discharge is estimated to be 17,400 gpm (65,700 lpm). The discharge is not likely to produce tangible aesthetic or recreational impacts. No effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected.

CCNPP Unit 3 will utilize methods similar to those employed at CCNPP Units 1 and 2 to minimize fish impingement and entrainment at the intake structure (e.g., low-velocity approach and screens). It is expected that addition of a new nuclear unit using closed-loop cooling systems will increase fish impingement and entrainment by less than 3.5% over the existing condition. The flow velocity into the intake channel from the Chesapeake Bay will be less than 0.5 fps (0.2 m/s). Therefore, it is anticipated that use of closed-loop cooling systems at CCNPP Unit 3 will have minimal impact on fish impingement and entrainment.

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9.4.2.1 Intake and Discharge Systems

For both once-through and closed-loop cooling systems, the water intake and discharge structures can be of various configurations to accommodate the source water body and to minimize impact to the aquatic ecosystem. The intake structures are generally located along the shoreline of the body of water and are equipped with fish protection devices. The discharge structures are generally of the jet or diffuser outfall type and are designed to promote rapid mixing of the effluent stream with the receiving body of water. Biocides and other chemicals used for corrosion control and for other water treatment purposes may be mixed with the condenser cooling water and discharged from the system.

Cooling water intake structures (CWIS) are typically regulated under Section 316(b) of the Federal CWA and its implementing regulations (FR, 2004), and under the Code of Maryland Regulation 26.08.03.05 (COMAR, 2007). A federal court decision in January 2007 changed that regulatory process. The regulations that implement Section 316(b) were effectively suspended, and U.S. EPA recommended that all permits for Phase II facilities should include conditions under Section 316(b) developed on a best professional judgment basis (USEPA, 2007).

The Maryland CWIS regulation implements Section 316(b) at the state level and defines acceptable levels of impingement and entrainment (COMAR, 2007). The Maryland regulation requires the facility to mitigate impingement loss to the extent that the costs for the mitigation are not greater than the benefits. Specifically, the location, design, construction and capacity of cooling water intake structures must reflect the best technology available for minimizing adverse environmental impact. For entrainment, Maryland requires that the facility must determine whether the entrainment loss causes an adverse environmental impact and must mitigate the entrainment loss if the facility does cause an adverse environmental impact.

Intake and discharge structures will be required for operation of CCNPP Unit 3. Three alternative locations for the intake and discharge structures were considered:

- Alternative 1a and 1b - New intake and discharge structures near CCNPP Units 1 and 2. The intake structure would be located between the existing CCNPP Units 1 and 2 intake ~~curtain wall and screens~~structure and the barge slip, near the existing intake structures for CCNPP Units 1 and 2. This location would provide not only physical protection but also facilitate the intake of cooler water afforded by the existing curtain wall. This location would also be likely to incur lower construction costs because dredging a new or expanded approach channel may not be required.

  For Alternative 1a, a new discharge structure would be built near the existing CCNPP Unit 1 and 2 intake structure to provide a flow path for discharge from the CCNPP Unit 3 retention basin, into the Chesapeake Bay.

  Alternative 1b would be very similar to 1a, with the exception of the intake piping. The Alternative 1b intake piping would extend approximately 3,500 ft (1,067 m) offshore. The suction end of the offshore intake piping would be fitted with velocity caps.

- Alternative 2 - New intake structure near CCNPP Units 1 and 2 intake structure and new discharge structure north of existing barge slip. The intake structure would be located close to CCNPP Units 1 and 2 intake structure (same as Option 1).

- Alternative 3 - New intake and discharge structures at Camp Conoy (south of the existing intake and discharge structures). The new intake and discharge structures

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would be located at Camp Conroy to provide a flow path for the intake and discharge loads.

For additional details, see Table 9.4-3.

Alternative 2 is the environmentally preferable alternative for locating the new intake and discharge systems. As stated above, the new outfall structure would be just north of the existing barge slip. In addition, the discharge concept will be a shoreline type discharge (unless there is restriction for a shoreline structure). This concept is based on the assumption that the blowdown discharge will meet the Water Quality Standard of the State of Maryland for discharge to Chesapeake Bay at end of pipe.

Discharge into the Chesapeake Bay at this location would have no/insignificant impact on plant operation caused by recirculation back to the existing intake channel. It also requires the fewest additional environmental permits because the intake and the discharge structures would be located in the existing IDA and would require shorter runs of piping. In addition, access and security constraints during construction would be avoided because construction would occur on the site of operating CCNPP Units 1 and 2.

Intake System

The Chesapeake Bay intake system would consists of the CCNPP Units 1 and 2 intake channel; the CCNPP Unit 3 intake piping, the CCNPP Unit 3 non-safety-related CWS makeup water intake structure and associated equipment, including the non-safety-related CWS makeup pump; the safety-related UHS makeup water intake structure and associated equipment, including the safety-related UHS makeup water pumps; and the makeup water chemical treatment system.

~~The intake channel will be an approximately 100 ft (30.4 m) long, by 123 ft (37.5 m) wide structure, with an earthen bottom at elevation –20 ft, 6 in (-6.2 m) msl, and vertical sheet pile sides extending to elevation 10 ft (3.0 m) msl. The general site location of the new intake system is shown in Figure 3.1-3, while Figure 3.4-2 and Figure 3.4-3 show the intake structure and channel in more details.~~

The CCNPP Unit 3 intake piping consists of two runs of 60-inch diameter safety related concrete pipes approximately 490 ft (149.4 m) long. These pipes convey water from the CCNPP Units 1 and 2 intake channel to a common forebay approximately 100 ft (30.48 m) long, 80 ft (24.38 m) wide structure with an earthen bottom at Elevation -22 ft 6 in (-6.86m) NGVD 29 and vertical sheet pile sides extending to Elevation 10 ft (3.05 m) NGVD 29. The nonsafety-related CWS intake structure and the safety-related UHS makeup water intake structure are situated at opposite ends of the common forebay.

The new CCNPP Unit 3 intake piping draws water from the existing intake channel for CCNPP Units 1 and 2. The piping is oriented perpendicular to the tidal flow of the bay. This orientation minimizes the component of the tidal flow parallel to the channel flow and reduces the potential of fish entering the piping and common forebay as shown on Figure 3.4-3. The flow velocities at the circulating water makeup structure and the UHS makeup structure would be less than 0.3 feet per second (fps) (0.15 mps) and less than 0.1 fps (0.003 mps), respectively.

The new CCNPP Unit 3 CWS makeup water intake structure will be an approximately 78 ft (24 m) long, 55 ft (17 m) wide concrete structure with individual pump bays. Three 50 percent capacity, vertical, wet pit CWS makeup pumps provide makeup water.

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The CCNPP Unit 3 CWS makeup water intake structure will be an approximately 70 ft (21.3 m) long, 68 ft (20.7 m) wide concrete structure with individual pump bays. Three 50% capacity pumps will provide saltwater makeup to the CWS. The new UHS makeup water intake will be an approximately 66 ft (20.1 m) long, 84 ft (25.6 m) wide concrete structure with individual pump bays. Four 100% capacity, makeup pumps will be available to provide makeup water. 75 ft (22.9 m) long, 60 ft (18.3 m) wide concrete structure with individual pump bays. Four 100 percent capacity vertical wet pit UHS makeup pumps will be available to provide saltwater makeup water.

In both the CWS and UHS makeup intake structures, one makeup pump is located in each pump bay, along with one dedicated traveling band screen and trash rack. Debris collected by the trash racks and the traveling water screens will be collected in a debris basin for cleanout and disposal as solid waste. The through-trash rack and through-screen mesh flow velocities will be less than 0.5 fps (0.15 m/s). Table 9.4-3 summarizes the environmental impacts of the circulating water intake alternatives for CCNPP Unit 3. In both intake structures, there is no need for a fish return system since the flow velocities through the screens are less than 0.5 fps (0.15 mps) in the worst case scenario (minimum bay level with highest makeup demand flow). Nevertheless, a fish return system will be provided as part of the combined makeup water intake structure design to reduce mortality of aquatic species.

The fish return system will be located on the east side (bay side) of the Unit 3 intake forebay. Screen wash water and fish collected from the traveling screens of Unit 3 makeup water structure will be diverted to the new fish return facility and returned to the Chesapeake Bay via a buried pipe to a new shoreline outfall. The outfall will be submerged below low tide to minimize impacts to fish into the Chesapeake Bay from any drop at the pipe exit.

Section 316(b) of the federal CWA requires the U.S. EPA to ensure that the location, design, construction, and capacity of CWIS reflect the best technology available (BTA) for minimizing adverse environmental impact. The objective of any CWIS design is to have adequate sweeping flow past the screens to meet entrainment and impingement reduction goals established under Section 316(b) requirements. In addition to the impingement and entrainment losses associated with CWIS, there are the cumulative effects of multiple intakes, re-siting or modification of CWIS contributing to environmental impacts at the ecosystem level. These impacts include disturbances to threatened and endangered species, keystone species, the thermal stratification of water bodies, and the overall structure of the aquatic system food web.

Consequently, in addition to evaluating alternative screen operations and screening technologies, such as fine mesh traveling water screens or wedge wire screens, additional means of reducing impingement, such as curtain walls, fish return systems, or other physical barriers, must also be assessed. There are a number of different alternatives for reducing impingement and entrainment impacts, including changes in intake structure operation, fish handling, external structure design; however no single operational or technological change will have the same effects or benefits at all facilities so therefore site specific studies and evaluations are critical to successful, cost-effective reductions of CWIS impacts.

The new intake channel piping will be located off the existing intake channel for CCNPP Units 1 and 2, which is perpendicular to the tidal flow of the Chesapeake Bay to minimize the component of the tidal flow parallel to the channel flow and the potential for fish to enter the channel and intake structure. Flow velocities at the intake structure will depend on the Chesapeake Bay water level. At the minimum Chesapeake Bay water level of -4.0 ft (-1.2 m) msl the flow velocity along the new intake channel will be less than 0.5 fps (0.15 m/s) based on the maximum makeup demand of 43,480 gpm (164,590 lpm).

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It is expected that addition of the CCNPP Unit 3 using closed cycle cooling will increase fish impingement and entrainment by less than 3.5% (based on preliminary cooling tower performance) over the existing condition. CCNPP Unit 3 will utilize methods similar to those employed at CCNPP Units 1 and 2 to minimize fish impingement and entrainment at the intake structure (e.g., low-velocity approach and screens). Therefore, it is anticipated that use of closed-loop cooling systems at CCNPP Unit 3 will have minimal impact on fish impingement and entrainment. However, to minimize the effects of entrainment a fish return system is used.

The fish return outfall, an 18-inch diameter HDPE pipe is located in a mechanically excavated trench. The pipe is installed 4 feet below the bay bottom and emerges from the bay bottom 40 feet channelward. The outfall location is protected with a 10-foot by 10 foot riprap apron extending approximately 48 feet channelward. To install the pipe, approximately 40 linear feet of the existing shoreline revetment was removed, and approximately 500 cubic yards of material will be dredged within the work area. The dredged material will be returned to the trench after the pipe is placed, and the existing shoreline revetment restored to its original design after pipe installation.

CCNPP Unit 3 relies on makeup water from the Chesapeake Bay for safe shutdown, and is designed for a minimum low water level of -4.0 ft (-1.2 m) msl and can continue to operate at an extreme low water elevation of -6.0 ft (-1.8 m) msl. The Essential Service Water System (ESWS) cooling towers will typically be supplied with fresh water makeup from storage tanks that are supplied from the desalinization plant.

Flow velocities at the CWS makeup water intake structure and the UHS makeup water intake structure will be sufficiently low that the intake channel may also act as a siltation basin. As a result, dredging may be required to maintain the channel depth. However, operating experience at CCNPP Units 1 and 2 has not indicated that siltation will be a problem, or that dredging will be required.

Discharge System

The final plant discharge consists of cooling tower blowdown from both the CWS and ESWS cooling towers and site wastewater streams, including the domestic water treatment and circulation water treatment systems. Only biocides or chemical additives approved by the U.S. EPA and the State of Maryland as safe for humans and the constituent discharged to the environment will meet requirements established in the NPDES permit.

An NPDES permit will be obtained for CCNPP Unit 3 prior to startup. This permit will specify threshold concentrations of "free available chlorine" (when chlorine is used) and "free available oxidants" (when bromine or a combination of bromine and chlorine is used) in cooling tower blowdown when the dechlorination system is not in use. Lower discharge limits will apply to effluent from the dechlorination system (which will be released into the Chesapeake Bay) when it is in use. The CCNPP Unit 3 NPDES permit will contain discharge limits for discharges from the cooling towers for two priority pollutants, chromium and zinc, which are widely used in the U.S. as corrosion inhibitors in cooling towers.

During operation, discharge flow to the Chesapeake Bay will be from the retention basin, which collects all site ~~non-radioactive~~ treated wastewater and tower blowdown. Discharge from the retention basin would be through an a 30 in (76.2 cm) diameter discharge pipe. Before the discharge point, the pipe will branch into three nozzles. The normal discharge flow will be up to ~~18,540~~21,019 gpm (~~70,180~~79,172 lpm) and the maximum discharge flow will be approximately ~~37,080~~24,363 gpm (~~140,360~~91,364 lpm).

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The proposed discharge structure will be designed to meet all applicable navigation and maintenance criteria and to provide an acceptable mixing zone for the thermal plume per state regulations for thermal discharges. Figure 3.4-4 shows details of the discharge system. The proposed discharge point will be near the southwest bank of Chesapeake Bay, approximately ~~1,200~~400 ft (~~365.8~~122 m) ~~south of the intake structure for CCNPP Unit 3~~north of the barge slip and extending about 550 ft (167.6 m) into the Chesapeake Bay.

The preliminary centerline elevation of the discharge pipe will be 3 ft (0.9 m) above the bottom of the Chesapeake Bay. Riprap will be placed around the discharge point to resist potential erosion as a result of the discharge jet from the pipe. A summary of the environmental impacts of the circulating water discharge system alternatives for CCNPP Unit 3 are provided in Table 9.4-4.

9.4.2.2 Water Supply (Makeup Water System Alternatives)

CCNPP Unit 3 will require makeup water to the CWS and ESWS cooling towers to replace water inventory lost to evaporation, drift, and blowdown. As described in Section 9.4.2, during normal operations fresh water makeup to the ESWS cooling towers and UHS will be provided either directly from the non-safety related desalination plant, or from storage tanks that are supplied from desalination plant. Makeup water for the desalination plant will be extracted from the CWS cooling tower makeup line, which draws water from the Chesapeake Bay. Brackish water from the Chesapeake Bay will provide an backup source of makeup water to the ESWS and UHS when the fresh water supply is unavailable.

The following makeup water system alternatives were analyzed:

- Potential Groundwater Sources
- Recycled plant water
- Desalination plant

As noted in Chapters 4 and 5, the preferred water supply alternative (desalination) would have SMALL construction and operational impacts. As a result, mitigation alternatives are not discussed in this section.

Groundwater Sources

There are five aquifers in the vicinity of the CCNPP site: Surficial, Chesapeake, Castle-Hayne – Aquia, Severn-Magothy, and Potomac (includes the Patapsco Aquifer and Potomac Confining Unit). The characteristics of these aquifers are described within Section 2.3.

Groundwater is the primary water supply in most areas of Maryland within the Atlantic Coastal Plain. The aquifers in this region are the primary water supply for southern Maryland (which includes Calvert County) and the Eastern Shore. Withdrawals from Coastal Plain aquifers have caused groundwater levels in confined aquifers to decline by tens to hundreds of feet from their original levels.

The current rate of decline in many of the confined aquifers has been estimated at about 2 ft (0.6 m) per year. Declines have been especially large in southern Maryland and parts of the Eastern Shore, where groundwater pumping is projected to increase by more than 20% between 2000 and 2030. Some regions are expected to experience significantly greater increases. Continued water level declines at current rates could affect the long-term

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sustainability of the region's groundwater resources and introduce saltwater intrusion concerns.

Groundwater withdrawals will not be used to support CCNPP Unit 3 operations; however, construction water needs may be met through a combination of limited groundwater withdrawals and haulage. These limited groundwater withdrawals would be performed within the limits of the existing groundwater permit for CCNPP Units 1 and 2, and will require prior discussions with the MDE. Groundwater withdrawals made to support construction of CCNPP Unit 3 will use existing wells.

Recycled Plant Water

CCNPP Unit 3 waste water treatment plant effluent could be used to reduce groundwater demand or desalinization plant output to provide fresh water for the proposed CCNPP Unit 3. This source would only provide 20 gpm (75.7 lpm) and fresh water from the desalinization plant will still be required for the plant potable/sanitary water system and demineralized water system. As a result, recycled plant water cannot, on its own, provide the makeup water need to support construction and operation of the proposed unit.

Desalinization Plant

A desalinization plant is also a viable option for fresh water. The desalinization plant will use Chesapeake Bay water as its raw water input and will therefore not affect existing groundwater resources. Placing a desalinization plant at plant grade instead of near the intake structures at the shoreline significantly reduces the head requirement for the effluent transfer pump(s) used to send the desalination plant fresh water output to the proposed storage tank.

About half of all of the desalinated water produced is produced through thermal processes, in which salt water is heated to produce vapor that is then condensed into fresh water. The main objective of any thermal process is to minimize the amount of heat required to produce a gallon of fresh water. Two principal competitive types of thermal processes produce desalinated water, multi-stage flash evaporation (MSF) and multiple effect distillation (MED). An alternative, non-thermal process used to produce desalinated water is reverse osmosis (RO).

Although the MED and MSF desalination processes are more often employed on larger desalinization plants, and thus are more mature technologies, they were not considered to be viable options for the relatively small water output requirement at CCNPP. As a result of advancements in technology, seawater desalination using RO membranes has become more attractive for this type of application and will be used for CCNPP Unit 3. The desalinization plant considered will be required to provide ~~3,040~~3,063 gpm (~~11,508~~11,595 lpm) of product flow using stage media filtration, a one-pass sea water reverse osmosis (SWRO)~~ at 40% recovery~~.

The desalinization system will also provide the initial fill for the 72 hour inventory of the ESWS cooling tower basins system. The system will include seawater feed pumps, multimedia filters, chemical injection system, and an RO permeate tank. The RO reject stream will be diluted using a holding pond or by mixing with the CCNPP Units 1 and 2 cooling water discharge. A 500 gpm (31.6 l/s) desalinization plant will require a building with an approximate size of 65 ft (19.8 m) by 165 ft (50.3 m). This building will be located adjacent to the circulating water cooling towers, on the southwest end of the CCNPP site (approximate Elevation 100 ft (30.5 m)) as shown in Figure 3.1-1.

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Summary of Makeup Water Alternatives

The operation of CCNPP Unit 3 will require a consistent source of fresh makeup water for cooling purposes. It has been determined that CCNPP Unit 3 will not withdraw any groundwater for use at the site during operations, but will make limited groundwater withdrawals to support construction within the limitations of the existing groundwater permit for CCNPP Units 1 and 2. The SWRO desalinization plant will provide fresh water for the plant demineralized water system, potable and sanitary water systems, and normal makeup for the ESWS cooling towers. The Chesapeake Bay is the source of water for the desalination plant. The desalinization plant will withdraw an estimated ~~3,040~~3,063 gpm (~~11,508~~11,595 Lpm) from the Chesapeake Bay via a connection to the CWS makeup line.

9.4.2.3 Water Treatment

Evaporation of water from cooling towers leads to an increase in chemical and solids concentrations in the circulating water, which in turn increases scaling tendencies of the cooling water. A water treatment system is required at CCNPP Unit 3 to minimize bio-fouling, prevent or minimize growth of bacteria (especially *Legionella* in the case of cooling towers), and inhibit scale on system heat transfer surfaces. Water treatment will be required for both influent and effluent water streams. Considering that water sources for CCNPP Unit 3 are the same as those for CCNPP Units 1 and 2, treatment methodologies will be similar.

The circulating water treatment system provides treated water for the CWS and consists of three phases: makeup treatment, internal circulating water treatment, and blowdown treatment. Makeup treatment will consist of a biocide injected into Chesapeake Bay water influent during spring, summer, and fall months to minimize marine growth and control fouling on heat exchanger surfaces. Treatment also improves makeup water quality.

Similar to CCNPP Units 1 and 2, an environmental permit to operate this treatment system will be obtained from the State. For prevention of *Legionella*, treatment for internal circulating water components (i.e., piping between the new intake structure and condensers) will include existing power industry control techniques consisting of hyperchlorination (chlorine shock) in combination with intermittent chlorination at lower levels, biocide and scale inhibitor addition. Blowdown treatment will depend on water chemistry, but is anticipated to include application of biocide dechlorinator, and scale inhibitor to control biogrowth, reduce residual chlorine and protect against and scaling, respectively. Since seawater has a tendency to foam due to the presence of organics, a small amount of antifoam may also be added to blowdown.

ESWS cooling tower water chemistry will be maintained by the SW water treatment system, which is designed to treat desalinated water from the SWRO desalinization plant for normal operating and shutdown conditions. This treatment system will also be capable of treating Chesapeake Bay water for design basis accident conditions. Treatment of system blowdown will also control the concentration of various chemicals in the ESWS cooling towers.

Desalinated water from the SWRO desalinization plant will be treated by the demineralized water treatment system, which provides demineralized water to the demineralized water distribution system. During normal operation, demineralized water is delivered to power plant users. Treatment techniques will meet makeup water treatment requirements set by the Electric Power Research Institute and include the addition of a corrosion inhibitor, similar to the service water system for the existing plant that uses demineralized water.

The drinking water treatment system, which supplies water for the potable and sanitary distribution system, will treat desalinated water so that it meets the State of Maryland potable

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(drinking) water program and U.S. EPA standards for drinking water quality under the National Primary Drinking Water Regulation and National Secondary Drinking Water Regulation. The system will be designed to function during normal operation and outages (i.e., shutdown).

Liquid wastes generated by the plant during all modes of operation will be managed by the liquid waste storage and processing systems. The liquid waste storage system collects and segregates incoming waste streams, provides initial chemical treatment of those wastes, and delivers them to one or another of the processing systems. The liquid waste processing system separates waste waters from radioactive and chemical contaminants. The treated water is returned to the liquid waste storage system for monitoring and eventual release. Chemicals used to treat wastewater for both systems include sulfuric acid for reducing pH, sodium hydroxide for raising pH, and an anti-foaming agent for promoting settling of precipitates.

CCNPP Unit 3 will use a Waste Water Treatment System for the treatment of sewage similar to that of CCNPP Units 1 and 2. This treatment system removes and processes raw sewage so that discharged effluent conforms to applicable Local and State health and safety codes, and environmental regulations. Sodium hypochlorite (chlorination) is used to disinfect the effluent by destroying bacteria and viruses, and sodium thiosulfate (dechlorination) reduces chlorine concentration to a specified level before final discharge. Soda ash (sodium bicarbonate) is used for pH control. Alum and polymer are used to precipitate and settle phosphorus and suspended solids in the alum clarifier; polymer is also used to aid flocculation.

9.4.3 TRANSMISSION SYSTEMS

Section 9.4.3 of NUREG-1555 (NRC, 1999) provides guidelines for the preparation of summary discussion that identifies the feasible and legislatively compliant alternative transmission systems . As discussed in Section 3.7, the existing CCNPP Units 1 and 2 power transmission system consists of two circuits, which connects CCNPP to the Waugh Chapel Substation in Anne Arundel County and to the Potomac Electric Power Company Chalk Point generating station in Prince Georges County. The northern CCNPP to Waugh Chapel circuit is composed of two separate three-phase 500 kV transmission lines on a single right-of-way from CCNPP, while the southern CCNPP to Chalk Point circuit is a single 500, three-phase 500-kV line.

The north and south circuits of the CCNPP power transmission system are located in corridors totaling approximately 65 mi (105 km) of 350 to 400 ft (100 to 125 m) right-of-way that is owned by Baltimore Gas and Electric Company. Land use within these corridors is well established, stable, does not interfere with Federal, State, Regional, or Local land use plans, and is without Native American tribal communities. The lines cross mostly secondary-growth hardwood and pine forests, pasture, and farmland.

The transmission lines to support CCNPP Unit 3 will be constructed within the CCNPP site. Thus, environmental impacts are limited to CCNPP Unit 3 construction area on the CCNPP site.

No new corridors, widening of existing corridors, or crossings over main highways, primary and secondary roads, waterways, or railroad lines will be required. Therefore, there would be no impacts from land use changes. The impact to humans and animals resulting from increased transmission-line induced currents is minimized due to conformance with the consensus electrical code, and is SMALL. Access to the existing corridors would be through existing access roads in compliance with existing negotiated easement agreements.

The transmission line work to support CCNPP Unit 3 will, however, require new towers and transmission lines to connect the CCNPP Unit 3 switchyard to the CCNPP Units 1 and 2 switchyard. Line routing would be conducted to avoid or minimize impacts to the existing

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Independent Spent Fuel Storage Installation, wetlands, and ~~threatened and endangered~~ protected species (bald eagle nest) identified in the local area. Based on the results of a feasibility study, numerous breaker upgrades and associated modifications will also be required at Waugh Chapel, Chalk Point, and other substations, but all of these changes would be implemented within the existing substations.

The power transmission needs of CCNPP Unit 3 can be satisfied with relatively minimal changes to the existing transmission corridor and power transmission system for CCNPP Units 1 and 2. Based on this conclusion, and the small expected impact to the environment from utilizing the existing transmission corridor and equipment, no other alternatives were considered since all other alternatives were obviously less preferable.

9.4.4 REFERENCES

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Table 9.4-1—Comparison of Cooling Tower Evaluation Criteria

Type of Cooling	Footprint per Plant Unit (1,562 MWe) [(a)]	Maximum Height	Materials of Construction	Plant Efficiency Impact	Auxiliary Load	Water Makeup [(b)]	Drift Rate	Pump Head	Visible Plume	Noise	O&M Cost [(c)]	Capital Cost
	Acres	Ft (m)		%	MW	gpm (Lpm)	% of Full Flow	Feet H_2O (kg/cm^2)		dBA @ 1m	USD	USD
Natural Draft Wet Cooling Tower	10	439 (134)	Concrete	0.5	0	43,000 (162,800)	<0.005	38 (1.16)	Yes	82	1,320,000	66,000,000
Rectangular Mechanical Draft (Wet)	23	58 (17.7)	Fiberglass (FRP)	0.5	8.3	43,000 (162,800)	0.005	31 (0.94)	Yes	85	760,000	38,000,000
Round Mechanical Draft (Wet)	11	65 (19.8)	Concrete	0.5	7.2	43,000 (162,800)	0.005	32 (0.97)	Yes	85	1,080,000	54,000,000
Rectangular Plume Abated (Hybrid)	28	67 (20.4)	FRP Structure Titanium Coils	0.5	15.5	38,700 (146,500)	0.005	32 (0.97)	No	88	1,000,000	100,000,000
Round Plume Abated (Hybrid)	8.	164 (50)	Concrete Structure Titanium Coils	0.5	17.9	38,700 (146,500)	0.005	44 (1.34)	No	88	900,000	90,000,000
Round Plume Abated (Hybrid) Without Plume Abatement Option	5	164 (50)	Concrete Structure	0.5	11.6	38,700 (146,500)	0.005	44 (1.34)	Yes	85	200,000	60,000,000
Dry Tower (Air Cooled)	39	122 (37.2)	Hot Dipped Galvanized Steel, Titanium Tubes	25	78.7	None	None	0 (0)	No	88	5,398,000	269,900,000

Notes:
Footprint includes the required separation between towers, if applicable.
Water total makeup includes drift, evaporation, and blowdown (at 2 cycles of concentration).
O&M costs are calculated at 1% or 2% of the capital cost, based on vendor input.

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Table 9.4-2—Environmental Impacts of Alternative Cooling Tower Systems
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Factors Affecting System Selection	Once-Through Cooling System	Dry Tower (Air-Cooled Condenser)	Natural Draft Wet Cooling Tower (NDWCT)	Mechanical Draft Wet Cooling Tower (MDWCT)	Hybrid (plume-abated) Cooling Tower (HCT)	Hybrid Cooling Tower (HCT) without Plume Abatement Option
Land Use: Onsite Land Requirements	N/A Rejected from range of alternatives before land use evaluated Impacts would be small.	39.1 acres (15.8 hectares) Impacts would be small.	10.0 acres (4 hectares) Impacts would be small.	23 acres (10.1 hectares) for rectangular MDWCT and 11 acres for a round MDWCT. Impacts would be small.	8 acres (3.2 hectares) for a round HCT and 27.5 acres (11.1hectares) for a rectangular HCT. Impacts would be small.	5.0 acres (2.0 hectares) for a round HCT without plume abatement option. Impacts would be small.
Land Use: Terrain Considerations	N/A Rejected from range of alternatives before land use evaluated Impacts would be small.	Terrain features of the CCNPP site are suitable for a dry tower air-cooled system. Impacts would be small.	Terrain features of the CCNPP site are suitable for an NDWCT system. Impacts would be small.	Terrain features of the CCNPP site are suitable for a MDWCT system. Impacts would be small.	Terrain features of the CCNPP site are suitable for an HCT. Impacts would be small.	Terrain features of the CCNPP site are suitable for an HCT without plume abatement option. Impacts would be small.
Water Use	2,500,000 gpm (9.5 million Lpm) for an on-shore intake. 420,000 gpm (1.6 million Lpm) for an off-shore intake. Potential for large impacts to aquatic biota. Impacts would be large.	No makeup water needed for use of a dry tower air-cooled system. No significant impacts to aquatic biota. Impacts would be small.	43,000 gpm (163,000 Lpm) for water makeup. Total water makeup includes drift, evaporation, and blowdown (@ 2 cycles of concentration). Potential for small to moderate impacts to aquatic biota. Impacts would be small to moderate.	43,000 gpm (163,000 Lpm) for water makeup for both a rectangular and round MDWCT. Total water makeup includes drift, evaporation, and blowdown (@ 2 cycles of concentration). Potential for small to moderate impacts to aquatic biota. Impacts would be small to moderate.	38,700 gpm (146,500 Lpm) for water makeup for both a rectangular and round HCT. Total water makeup includes drift, evaporation, and blowdown (@ 2 cycles of concentration). Potential for small to moderate impacts to aquatic biota. Impacts would be small to moderate.	38,700 gpm (146,500 Lpm) for water makeup for a round concrete HCT without plume abatement option. Total water makeup includes drift, evaporation, and blowdown (@ 2 cycles of concentration). Potential for small to moderate impacts to aquatic biota. Impacts would be small to moderate.
Atmospheric Effects	Some plume associated with discharge canal. Impacts would be small.	No visible plume associated with a dry tower air-cooled system. Impacts would be small.	Visible plume. NDWCT presents greater potential for fogging and salt deposition. Impacts would be small	Short average and median visible plume. Drift eliminators minimize salt deposition. Impacts would be small.	Reduced plume potential with an HCT. Impacts would be small	Short average and median visible plume. Drift eliminators minimize salt deposition. Impacts would be small

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Table 9.4-2—Environmental Impacts of Alternative Cooling Tower Systems

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Factors Affecting System Selection	Once-Through Cooling System	Dry Tower (Air-Cooled Condenser)	Natural Draft Wet Cooling Tower (NDWCT)	Mechanical Draft Wet Cooling Tower (MDWCT)	Hybrid (plume-abated) Cooling Tower (HCT)	Hybrid Cooling Tower (HCT) without Plume Abatement Option
Thermal and Physical Effects	Enormous size of the intake and discharge structures and offshore pipes are needed. Thermal Discharges associated with the once-through cooling system would need to meet applicable	Discharges associated with a dry tower air-cooled system would need to meet applicable water quality standards and be in compliance with applicable thermal discharge regulations. The discharge is not likely to produce	Discharges associated with the NDWCT would need to meet applicable water quality standards and be in compliance with applicable thermal discharge regulations. The discharge is not likely to produce tangible	Discharges associated with the MDWCT would need to meet applicable water quality standards and be in compliance with applicable thermal discharge regulations. Cooling water will be sent to a retention basin,	Discharges associated with the HCT would need to meet applicable water quality standards and be in compliance with applicable thermal discharge regulations. Therefore, the discharge is not likely to produce	Discharges associated with the HCT without the plume abatement option would need to meet applicable water quality standards and be in compliance with applicable thermal discharge regulations. Therefore, the discharge is not likely to produce
Thermal and Physical Effects (cont.)	water quality standards and be in compliance with applicable thermal discharge regulations. Thermal discharge study needed to identify environmental impacts on Chesapeake Bay. Impacts would be large.	tangible aesthetic or recreational impacts. No effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.	aesthetic or recreational impacts. No effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small to moderate.	thus reducing thermal impacts to receiving waters. The discharge is not likely to produce tangible aesthetic or recreational impacts. No effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.	tangible aesthetic or recreational impacts. No effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.	tangible aesthetic or recreational impacts. No effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.
Noise Levels	N/A Rejected from range of alternatives before noise evaluated	A dry tower air-cooled system would emit broadband noise that is largely indistinguishable from background levels and would be considered unobtrusive Impacts would be small.	NDWCT would emit broadband noise that is largely indistinguishable from background levels and would be considered unobtrusive Impacts would be small.	MDWCT would emit broadband noise that is largely indistinguishable from background levels and would be considered unobtrusive Impacts would be small.	HCT would emit broadband noise that is largely indistinguishable from background levels and would be considered unobtrusive. Impacts would be small.	HCT without plume abatement would emit broadband noise that is largely indistinguishable from background levels and would be considered unobtrusive Impacts would be small.

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Table 9.4-2—Environmental Impacts of Alternative Cooling Tower Systems

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Factors Affecting System Selection	Once-Through Cooling System	Dry Tower (Air-Cooled Condenser)	Natural Draft Wet Cooling Tower (NDWCT)	Mechanical Draft Wet Cooling Tower (MDWCT)	Hybrid (plume-abated) Cooling Tower (HCT)	Hybrid Cooling Tower (HCT) without Plume Abatement Option
Aesthetic and Recreational Benefits	No likely tangible aesthetic or recreational impacts; no effect on navigation or recreational use of Chesapeake Bay is expected. Impacts would be small.	No visible plume with the use of a dry tower air-cooled system. The heavily forested onsite areas, onsite elevation changes and topographical features (i.e., hills and valleys), and the new plant's location approximately 3,000 to 4,000 ft (914.4 to 1,219.2 m) from the nearest residential properties will help to shield the new plant from view.	NDWCT plumes resemble clouds and would not disrupt the viewscape. The heavily forested onsite areas, onsite elevation changes and topographical features (i.e., hills and valleys), and the new plant's location approximately 3,000 to 4,000 ft (914.4 to 1,219.2 m) from the nearest residential properties will help to shield the new plant from view.	MDWCT plumes resemble clouds and would not disrupt the viewscape. The heavily forested onsite areas, onsite elevation changes and topographical features (i.e., hills and valleys), and the new plant's location approximately 3,000 to 4,000 ft (914.4 to 1,219.2 m) from the nearest residential properties will help to shield the new plant from view.	No visible plume with the use of an HCT. The heavily forested onsite areas, onsite elevation changes and topographical features (i.e., hills and valleys), and the new plant's location approximately 3,000 to 4,000 ft (914.4 to 1,219.2 m) from the nearest residential properties will help to shield the new plant from view.	Visible plume. The heavily forested onsite areas, onsite elevation changes and topographical features (i.e., hills and valleys), and the new plant's location approximately 3,000 to 4,000 ft (914.4 to 1,219.2 m) from the nearest residential properties will help to shield the new plant from view. The cooling tower discharge is not likely to produce tangible aesthetic or recreational impacts. Impacts would be small.
Aesthetic and Recreational Benefits (cont.)		The discharge is not likely to produce tangible aesthetic or recreational impacts No effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.	The cooling tower discharge is not likely to produce tangible aesthetic or recreational impacts; no effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.	The cooling tower discharge is not likely to produce tangible aesthetic or recreational impacts; no effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.	The cooling tower discharge is not likely to produce tangible aesthetic or recreational impacts; no effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.	No effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.

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Table 9.4-2—Environmental Impacts of Alternative Cooling Tower Systems
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Factors Affecting System Selection	Once-Through Cooling System	Dry Tower (Air-Cooled Condenser)	Natural Draft Wet Cooling Tower (NDWCT)	Mechanical Draft Wet Cooling Tower (MDWCT)	Hybrid (plume-abated) Cooling Tower (HCT)	Hybrid Cooling Tower (HCT) without Plume Abatement Option
Legislative Restrictions	Potential compliance issues with Section 316(b) of the CWA. Also, potential significant NPDES thermal discharge issues surrounding discharges back into Chesapeake Bay. Impacts would be large.	Potential compliance issues with the requirements for emissions under the federal Clean Air Act. These regulatory restrictions would not negatively affect implementation of this heat dissipation system, but they may impact overall operational cost.	Intake structure would meet Section 316(b) of the CWA and implementing regulations, as applicable. NPDES discharge permit thermal discharge limitation would address thermal load from blowdown to Chesapeake Bay. These restrictions would not negatively affect implementation of this heat dissipation system. Impacts would be small to moderate.	Intake structure would meet Section 316(b) of the CWA and implementing regulations, as applicable. NPDES discharge permit thermal discharge limitation would address thermal load from blowdown to Chesapeake Bay. These restrictions would not negatively affect implementation of this heat dissipation system. Impacts would be small.	Intake structure would meet Section 316(b) of the CWA and implementing regulations, as applicable. NPDES discharge permit thermal discharge limitation would address thermal load from blowdown to Chesapeake Bay. These restrictions would not negatively affect implementation of this heat dissipation system. Impacts would be small.	Intake structure would meet Section 316(b) of the CWA and the implementing regulations, as applicable. NPDES discharge permit thermal discharge limitation would address thermal load from HCT blowdown to Chesapeake Bay. These restrictions would not negatively affect implementation of this heat dissipation system. Impacts would be small.
Environmental impacts	Large	Small	Small to Moderate	Small to moderate	Small	Small
Is this an environmentally suitable alternative heat dissipation system?	No	No	No	No	Yes	Yes

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Table 9.4-3—Alternate Intake Systems

	Proposed System (closed loop)	Alternative Systems (open loop)	Intake location (Alternative 1a – Nearshore)	Intake location (Alternative 1b – Offshore)	Intake Location (Alternative 2)	Intake Location (Alternative 3)
Construction Impacts	Some adverse impacts as discussed in Section 4.1, but mitigated as noted in Section 4.6. Small	Adverse impacts due to large intake structure required. Large	Impacts minimal: use existing structures – avoid new channel dredging. But construction could interfere with operations at CCNPP Units 1 and 2. Small	Impacts moderate: use existing structures – new offshore channel dredging for pipeline needed. But construction could interfere with operations at CCNPP Units 1 and 2. Moderate	Impacts minimal; for minor dredging, similar to Alternative 1; Better flow for construction traffic, less impact on operations at CCNPP Units 1 and 2. Small	New intake structures would require new trenching for intake – higher costs due to longer pipe runs. Moderate
Aquatic Impacts	No expected long-term impacts; entrainment and impingement expected to be minimal. Small	Adverse impacts from entrainment of resident species. Large	Short term adverse impact from dredging and sediment. Mitigation plans (barriers and coffer dams) would limit impact. Small	Short to moderate term adverse impact from dredging and sediment. Mitigation plans (barriers and coffer dams) would limit impact. Moderate	Short term aquatic impacts associated with dredging and sediment. Mitigation plans (barriers and coffer dams) would limit impact. Small	Short term aquatic impacts from sedimentation; sedimentation would be greater with construction of new trench and structure. Small
Water Use Impacts	No expected long term impacts; water consumption minimal. Small	High water use would require large intake structure from Chesapeake Bay Large	Impact on surface and groundwater expected to be minimal. Small	Impact on surface and groundwater expected to be minimal. Small	Impact on surface and groundwater expected to be minimal. Small	Surface and groundwater impact. Moderate
Compliance with Regulations	Satisfies regulatory performance standards for CWA and Maryland regulations.	Does not meet current CWA and Maryland criteria for entrainment	Would comply with current CWA and Maryland regulations with additional permits.	Would comply with current CWA and Maryland regulations with additional permits.	Compliance with CWA and Maryland regulations. Similar permitting structure as Alternative 1, intake and discharge in intensely disturbed areas.	Compliance with CWA and Maryland regulations; extensive new permitting may be required.
Environmental Preferability	Environmentally preferable: limits entrainment and lower water use.	Cost prohibitive not compliant with regulations.	No; construction may interfere with operation at CCNPP Units 1 and 2.	No; construction may interfere with operations at CCNPP Units 1 and 2.	Yes; minimal impacts to current operation, better flow for construction traffic and laydown.	No, would require significant construction activities in previously undisturbed areas.

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Table 9.4-4—Alternate Discharge Systems

	Proposed System (closed loop)	Alternative Systems (open loop)	Discharge Location south of intake structure (nearshore – closed loop)	Deep Water Discharge Location (offshore - open loop)
Construction Impacts	Some sedimentation for construction of subsurface diffuser	Adverse impacts due to large discharge structure required.	Impacts minimal: use existing structures – dredging into the Chesapeake Bay would result in some sedimentation that would be mitigated per Section 4.6.	Offshore diffuser area would be approximately 10 acres at the bottom of Chesapeake Bay. Discharge pipe trench to disturb approximately 12 acres of Chesapeake Bay bottom. Large intake and discharge structures necessary for large volume of water.
Aquatic Impacts	No expected long-term impacts; thermal diffusion is expected to reduce impacts from thermal discharge and mixing zones.	Adverse impacts from entrainment – best fish return technology not feasible.	Short term disturbance to benthic organisms; short term effect on fin-fish from sediment and other construction – mitigation per Section 4.2 and Section 4.6.	Greater impact to fish and shellfish from potential impingement and entrainment. Potential for long-term thermal impacts to local ecology.
Water-Use Impacts	No expected long term impacts; water consumption minimal.	Large discharge flow – impact on water quality and aquatic biota from discharge.	Impact on surface and groundwater expected to be minimal.	Large intake/discharge flow from/into Chesapeake Bay for system cooling. Potential for greater impacts from large volume of heated thermal discharge.
Compliance with Regulations	Meets regulatory temperature limit standards for CWA and Maryland regulations – Discharge of chemicals or other constituents limited by Maryland NPDES permit.	Does not meet current CWA and Maryland criteria for thermal discharge or best technology.	Location would limit mixing and impact to intake system. Meets current CWA and Maryland criteria for thermal discharge or best technology.	Necessary location for compliance with mixing zone standards Potential issues with compliance under Section 316 (a) and (b) of Maryland NPDES permit.
Environmental Preferability	Environmentally preferable: limits thermal impacts.	Cost prohibitive not compliant with regulations.	Yes. Greater diffusion and less mixing issues.	No. Regulatory compliance issues, aquatic biota impacts, and potential for public perception controversy.

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