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UniStar
NUCLEAR ENERGY

November 11, 2008

UN#08-064

Mr. William P. Seib
Chief, Maryland Section South
U.S. Army Corps of Engineers – Baltimore District
10 S. Howard Street
Baltimore, MD 21201

Subject: Joint Federal/State Application of Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC, Calvert Cliffs Nuclear Power Plant Site, Lusby, Calvert County, Maryland, USACE Tracking No. NAB-2007-08123-M05

Reference: USACE Letter from William P. Seib (USACE) to Thomas E. Roberts (UNE), dated October 28, 2008

Dear Mr. Seib:

Enclosed is the response to Question 1 to your USACE letter dated October 28, 2008 (Reference).

Please do not hesitate to contact me at 410-470-5524, if you have any questions concerning the enclosed response.

Sincerely,

Dimitri Lutchenkov

Enclosure

Cc: Kathy Anderson – USACE
Susan Gray – PPRP
Robert Tabisz – MDE
Jeff Thompson – MDE

Application NAB-2007-08123-M05
Response to U.S. Army Corps of Engineers Information Request Dated 10/28/08
Calvert Cliffs 3 Project, LLC and UniStar Nuclear Operating Services, LLC
November 25, 2008

Question 1

A detailed analysis of all possible forms of energy that could meet the project purpose. The analysis should include, but not be limited to fossil fuel, fission, hydroelectric, biomass, solar, wind, geothermal, fusion and other potential near future energy options including a complete description of the criteria used to identify, evaluate, and screen project alternatives.

RESPONSE

A detailed analysis of possible forms of energy are described in Section 9.2 of the Calvert Cliffs (CCNPP) Unit 3 Environmental Report (ER). As stated in Section 9.2.2 of the CCNPP Unit 3 ER, "The CCNPP Unit 3 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."

The alternative energy sources considered in CCNPP Unit 3 COLA, Revision 3 application are: Wind, Geothermal, Hydropower, Solar Power, Wood Waste, Municipal Solid Waste, Energy Crops, Petroleum liquids (Oil), Fuel Cells, Coal, Natural Gas, Integrated Gasification Combined Cycle (IGCC).

Regarding wind energy (ER 9.2.2.1), this energy option 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.

Regarding geothermal energy (ER 9.2.2.2), geothermal plants are typically located in the western continental U.S., Alaska, and Hawaii, where hydrothermal reservoirs are prevalent. Maryland, located in the northeastern continental U.S., is not a candidate for large scale geothermal energy and could not produce the proposed baseload power.

Therefore, geothermal energy is non competitive with a new nuclear unit at the CCNPP site.

Regarding hydropower (ER 9.2.2.3), this energy source would require flooding more than 2,600 mi^2 (6,734 km^2) to produce the required baseload capacity, resulting in a large impact on land use. According to a study performed by the Idaho National Engineering and Environmental Laboratory, Maryland has 36 possible hydropower sites: 1 developed and with a power-generating capacity of 20 MWe, 32 developed and without power and a possible generating capacity of 10 MWe, and 3 undeveloped sites with a possible 0.10 MWe of generating capacity. Only one site had the potential generating capacity of 20 MWe or more. Therefore, hydropower is non-competitive with a new nuclear unit at the CCNPP site.

Regarding solar energy (ER 9.2.2.4), 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 were 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 4,000W-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-hr/m^2/day can be collected using flat-plate collectors. The footprint needed to produce a baseload capacity is much too large to construct at the proposed plant site. Additionally, concentrating solar power plants only perform efficiently in high-intensity sunlight locations, specifically the arid and semi-arid regions of the world. This does not include Maryland.

Regarding biomass energy (ER 9.2.2.5), 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 baseload capacity.

Regarding municipal solid waste (ER 9.2.2.6), the U.S. has about 89 operational municipal solid waste (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 baseload capacity. Additionally, 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. As such, MSW is not considered a viable energy option.

Other concepts for fueling electric generators (ER 9.2.2.7), include 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.

Regarding petroleum liquid power sources, (ER 9.2.2.8), 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.

Regarding fuel cell power source, (ER 9.2.2.9), 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. At the present time, fuel cells are not economically or technologically competitive with other alternatives for baseload electricity generation.

Regarding the coal energy option (ER 9.2.2.10), the environmental impacts of constructing a typical coal-fired steam 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. 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 Energy Information Administration shows that electricity generation is the single biggest source of carbon dioxide emissions in Maryland. In summary, a nuclear plant requires a much smaller construction footprint, whereas the coal-fired plant would require more area, and greenhouse gas emissions would be significantly greater.

Regarding natural gas as an energy option (ER 9.2.2.11 and ER 9.2.3.2), this energy alternative at the CCNPP site would require less land area than a coal-fired plant but more land area than a 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. This is significantly greater than the 0.35 mi^2 (0.92 km^2) required for construction of a new nuclear unit.

Regarding Integrated Gasification Combined Cycle (IGCC) energy technology (ER 9.2.2.12), 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. 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.

With regard to fusion as a viable energy source, an international thermonuclear experimental fusion reactor is being built jointly by the European Union, the United States, China, India, Japan, Russia and South Korea. It is located at Cadarache in southern France. The treaty authorizing the funding of the project was signed in November 2006 and the 500 MW machine is due to beginning running in 2016. (Reference: www.iter.org) Since fusion reactor technology is still in the experimental stage, it is highly unlikely that fusion reactor technology will be available in the near future to meet the expected baseload power requirements. As such, fusion reactor technology is not a viable energy option and not considered in the CCNPP Unit 3 COLA application.

ER Section 9.2 of CCNPP Unit 3 COLA, Revision 3 is attached and provides a detailed analysis of alternative energy sources for the proposed project.

9.0 ALTERNATIVES TO THE PROPOSED ACTION

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

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

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

9.1 NO ACTION ALTERNATIVE

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

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

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

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

9.2 ENERGY ALTERNATIVES

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

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

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

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

9.2.1 ALTERNATIVES NOT REQUIRING NEW GENERATING CAPACITY

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

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

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

9.2.1.1 {Initiating Conservation Measures

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

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

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

- Large load curtailment - This program provides a source of load that may be curtailed at the Company's request in order to meet system load requirements. Customers who participate in this program receive a credit on their bill.
- Voltage control - This procedure involves reducing distribution voltage by up to 5% during periods of capacity constraints. This level of reduction does not adversely affect customer equipment or operations.}

9.2.1.1.1 Conservation Programs

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

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

- Peak clipping programs - Include energy saver switches for air conditioners, heat pumps, and water heaters, allowing interruption of electrical service to reduce load during periods of peak demand; dispersed generation, giving dispatch control over customer backup generation resources; and curtailable service, allowing customers' load to be reduced during periods of peak demand.
- Load shifting programs - Use time-of-use rates and cool storage rebate programs to encourage shifting loads from peak to off-peak periods.
- Conservation programs - Promoting use of high-efficiency heating, ventilating, and air conditioning; encouraging construction of energy-efficient homes and commercial buildings; improving energy efficiency in existing homes; providing incentives for use of energy-efficient lighting, motors, and compressors.

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

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

9.2.1.2 Reactivating or Extending Service Life of Existing Plants

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

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

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

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

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

9.2.1.3 Purchasing Power from Other Utilities or Power Generators

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

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

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

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

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

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

9.2.2 ALTERNATIVES THAT REQUIRE NEW GENERATING CAPACITY

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

- Wind
- Geothermal

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

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

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

Combined heat and power systems that are geographically dispersed and located near customers were identified as a potential option for producing heat and electrical power. However, distributed energy generation was not seen as a competitive or viable alternative and was not given detailed consideration.

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

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

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

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

This section includes descriptions of power generating alternatives that CalvertCliffs 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, CalvertCliffs 3 Nuclear Project and UniStar Nuclear Operating Services have relied heavily upon the NRC Generic Environmental Impact Statement (GEIS) (NRC, 1996).}

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

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

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

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

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

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

9.2.2.1 Wind

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

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

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

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

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

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

If a 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 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.

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

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

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

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

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

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

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

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

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

9.2.2.2 Geothermal

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

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

9.2.2.3 Hydropower

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

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

9.2.2.4 Solar Power

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

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

9.2.2.4.1 Concentrating Solar Power Systems

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

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

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

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

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

9.2.2.4.2 "Flat Plate" Photovoltaic Cells

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

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

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

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

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

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

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

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

- Land use and aesthetics are the primary environmental impacts of solar power.

- Land requirements for each of the individual solar energy technologies are large, compared to the land used by a new nuclear plant. The land required for the solar power generating technologies ranges from 56,660 to 141,640 ft^2 (60,000 to 140,000 m^2) per MWe compared to 10,000 ft^2 (1,000 m^2) per MWe for nuclear technology.

- Depending on the solar technology used, there may be thermal discharge impacts. These impacts are anticipated to be small. During operation, PV and solar thermal technologies produce no air pollution, little or no noise, and require no transportable fuels.

- PV technology creates environmental impacts related to manufacture and disposal. The process to manufacture PV cells is similar to the production of a semiconductor chip. Chemicals used in the manufacture of PV cells include cadmium and lead. Potential human health risks also arise from the manufacture and deployment of PV systems because there is a risk of exposure to heavy metals such as selenium and cadmium during use and disposal (CEC, 2004). There is some concern that landfills could leach cadmium, mercury, and lead into the environment in the long term.

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

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

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

9.2.2.5 Wood Waste and Other Biomass

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

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

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

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

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

9.2.2.6 Municipal Solid Waste

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

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

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

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

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

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

9.2.2.7 Energy Crops

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

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

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

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

9.2.2.8 Petroleum Liquids (Oil)

From 2002 to 2005, petroleum costs almost doubled, increasing by 92.8%, and the period from 2004 to 2005 alone produced an average petroleum increase of 50.1% (EIA, 2006c). {As a result, from 2005 to 2006, net generation of electricity from petroleum liquids dropped by about 84%

in Maryland (EIA, 2007b). In the GEIS for License Renewal, the staff estimated that construction of a 1,000 MWe oil-fired plant would require about 0.19 mi^2 (0.49 km^2) (NRC, 1996).}

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

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

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

9.2.2.9 Fuel Cells

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

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

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

9.2.2.10 Coal

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

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

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

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

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

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

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

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

9.2.2.11 Natural Gas

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

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

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

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

9.2.2.12 Integrated Gasification Combined Cycle (IGCC)

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

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

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

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

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

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

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

9.2.3 ASSESSMENT OF REASONABLE ALTERNATIVE ENERGY SOURCES AND SYSTEMS

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

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

Table 9.2-1 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.

Air emissions were estimated for a coal-fired generation facility based on the emission factors contained 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 circulating fluidized bed combustor (FBC). The sulfur content of the coal was assumed to be 2% by weight. Emissions control 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.

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.

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

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

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

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

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

9.2.3.1.5 Summary

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

9.2.3.2 Natural Gas Generation

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

9.2.3.2.1 Air Quality

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

Human health effects are SMALL based on decreased air quality impacts. Natural gas technologies produce fewer pollutants than other fossil technologies, and SO_2, a contributor to acid rain, is not emitted at all (NRC, 1996). Air emissions were estimated for a natural gas-fired generation facility based on the emission factors contained 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). 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.

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.}

9.2.3.2.5 Summary

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

9.2.3.3 Combination of Alternatives

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

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

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

9.2.3.3.1 Determination of Alternatives

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

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

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

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

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

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

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

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

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

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

9.2.3.3.2 Environmental Impacts

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

Consequently, if the renewable portion of the combination alternative were enough to fully displace the output of the gas-fired facility, then, when the renewable resource is available, the output of fossil fueled facility could be eliminated, thereby eliminating its operational impacts.

Determination of the types of environmental impacts of these types of 'hybrid' plants or combination of facilities can be surmised from analysis of past projects.

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

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

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

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

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

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

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

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

9.2.3.3.3 Economic Comparison

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

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

9.2.3.3.4 Summary

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

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

9.2.4 CONCLUSION

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

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

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Table 9.2-1—{Impacts Comparison Table}

(Page 1 of 1)

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) NO_2 = 734 (809) CO = 4,402 (4,852)	Moderate SO_2 = 17 (19) NO_2 = 661 (729) 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.

Table 9.2-2—{Air Emissions from Alternative Power Generation Facilities}
(Page 1 of 1)

Fuel	Bituminous Coal	Natural Gas
Combustion Facility	Circulating FBC	Combined Cycle GTG
Generation Capacity	1,600 MWe	1,600 MWe
Air Pollutant Emissions – metric tons (tons) per year		
Sulfur Dioxide (SO_2)	415 (457)	17 (19)
Nitrogen Dioxide (NO_2)	734 (809)	661 (729)
Carbon Monoxide (CO)	4,402 (4,852)	152 (168)
Particulate Matter (PM)	21 (23)	34 (37)
PM less than 10μm (PM10)	15 (17)	24 (26)
Carbon Dioxide, equiv. (CO_2e)	1,731,000 (1,908,000)	565,000 (623,000)
CO_2e – CO_2 equivalent FBC – fluidized bed combustor GTG – gas turbine generator		

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UniStar
NUCLEAR ENERGY

November 21, 2008

UN#08-077

Ms. Kathy Anderson
Biologist and Project Manager
U.S. Army Corps of Engineers – Baltimore District
10 S. Howard Street
Baltimore, MD 21201

Subject: Joint Federal/State Application of Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC, Calvert Cliffs Nuclear Power Plant Site, Lusby, Calvert County, Maryland, USACE Tracking No. NAB-2007-08123-M05

Reference: USACE Letter from William P. Seib (USACE) to Thomas E. Roberts (UNE), dated October 28, 2008

Dear Ms. Anderson:

The purpose of this letter is to confirm that during our meeting on November 19, 2008 it was agreed that UniStar had complied with USACE's request to provide a response within 20 days of the letter dated October 28, 2008 with the issuance of our response, UniStar letter UN#08-064 dated November 14, 2008, to question 1. We respectfully request a reply confirming this issue.

Please do not hesitate to contact me at 410-470-5524, if you have any questions.

Sincerely,

Dimitri Lutchenkov

cc: Thomas Fredericks – NRC
Susan Gray – PPRP
Robert Tabisz – MDE
Jeff Thompson – MDE
William Seib – USACE

Dimitri Lutchenkov
Director, Environmental Affairs

100 Constellation Way, Suite 1400P
Baltimore, Maryland 21202-3106

UniStar
NUCLEAR ENERGY

November 21, 2008

UN#08-069

Mr. William P. Seib
Chief, Maryland Section Southern
U.S. Army Corps of Engineers – Baltimore District
10 S. Howard Street
Baltimore, MD 21201

Subject: Joint Federal/State Application of Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC, Calvert Cliffs Nuclear Power Plant Site, Lusby, Calvert County, Maryland, USACE Tracking No. NAB-2007-08123-M05

Reference: USACE Letter from William P. Seib (USACE) to Thomas E. Roberts (UNE), dated October 28, 2008

Dear Mr. Seib:

Enclosed are the responses to Questions 7, 8, 10, 11, 12, 13, 14, and 15 to your USACE letter dated October 28, 2008 (Reference).

Please do not hesitate to contact me at 410-470-5524, if you have any questions concerning the enclosed responses.

Sincerely,

Dimitri Lutchenkov

Enclosures

cc: Kathy Anderson – USACE
Thomas Frederichs – NRC
Susan Gray – PPRP
Robert Tabisz – MDE
Jeff Thompson – MDE

Application NAB-2007-08123-M05
Response to U.S. Army Corps of Engineers Information Request Dated 10/28/08
Calvert Cliffs 3 Project, LLC and UniStar Nuclear Operating Services, LLC
November 21, 2008

Question 7

Copies of all previously issued Federal, State and local permits and plans for the existing facilities at the project site as well as a description and plans for all mitigation completed for these previously authorized projects.

RESPONSE

Attached are lists of all Federal, State and local permits for the existing facility where copies of the approvals were available. Also included is a list of "Permits, Certificates, Registrations and Applications filed by the Baltimore Gas and Electric Company in connection with the Calvert Cliffs Nuclear Power Plant". This list includes approvals with application dates from December 1, 1967 to March 23, 1976 and captures additional permits we do not have copies of. In addition, a copy of the August 8, 2008 letter from the State of Maryland Critical Area Commission to Ms. Susan Gray at DNR's Power Plant Research Program outlining conditions of the their approval for the project is attached as is Maryland Department of Natural Resources Endangered Species Permit #45135 that addresses the eagle nest.

At the Corps request following a meeting on November 19, 2008, we are furnishing copies of all available Federal and State approvals/permits. The only local permits or plans being furnished are those known to have mitigation requirements associated with them. These include and are identified on the enclosed figure –

Calvert County Grading Permit 7316 issued 12/09/1993 for a wetland mitigation site associated with a transmission line upgrade.
(1.32 acre Wetland Mitigation Site labeled on the attached figure as a Protected Wetland)

Calvert County Grading Permit 52199 issued 02/25/2005 for grading associated with the construction of a building (PAF) to assemble reactor vessel heads.
(2 acre Forest Retention Area located on the western edge of the property boundary)

Calvert County Grading Permit 63810 issued 06/16/2006 for grading associated with geotechnical investigations.
(19,600 sq. ft. tree/shrub planting located south of units 1 & 2)

Calvert County Grading Permit 20657 issued 07/11/2008 for grading associated with geotechnical investigations.
(1,300 sq. ft. tree planting located north of units 1 & 2)

These mitigation areas as well as the oyster mitigation performed as a condition of the Board of Public Works approval for Wetlands License #71-45 are captured for illustration purposes on the attached figure.

Note: At the Corps request following a meeting on November 19, 2008, copies of the referenced drawings are only being provided to Ms. Kathy Anderson, PM USACE, Baltimore District.

Application NAB-2007-08123-M05
Response to U.S. Army Corps of Engineers Information Request Dated 10/28/08
Calvert Cliffs 3 Project, LLC and UniStar Nuclear Operating Services, LLC
November 21, 2008

Question 8

Vessel information including the ship/barge navigation needs to access the site; maximum draft when full; length and width of ships/barge; and the potential for the largest industry ships/barge necessary for project construction and future construction activities to access the site at the current proposed dredge depths.

RESPONSE

Typical barges to be used will have dimensions ranging from 35′ - 50′ wide, up to 200′ long with drafts of 2′ - 11′. Furthermore, it may be necessary to berth two or more barges side by side to optimize unloading. Based on preliminary construction schedule estimates, the barge dock may be in use for approximately 5 years. In addition, it is expected that the barge dock would be used in the future during major outages for delivery of large components as has been done for Units 1/2.

Enclosure

Response to RAIs

Enclosure
UN#08-037

ITEM NUMBER 7 SUPPLEMENTAL REQUEST REGARDING RAI #59

NRC Request:

What is the basis for the conclusion that prop wash impacts to the benthos will be small? What size vessels will use the barge dock? What is the time period during which the barge dock will be used?

UniStar Response:

Barges arriving at the CCNPP Unit 3 dock will normally be connected to the tug tow at its bow, with the props pointed out towards the center of the bay. The docking procedure is to bring the barge to a full stop, with minimal contact force. The tow will typically accomplish this by cutting the engines and coasting towards the dock, with the engines in low speed reverse as necessary to fine tune the final approach. Once the barges are docked, the barges will not be maneuvered within the barge facility until they are removed. Therefore, impacts associated with prop wash due to maneuvering vessels at the barge facility should not be factor (Ebbesmeyer et al., 1995). The removal of unloaded barges should require minimal engine force. Tows will again be typically connected to the barge at the bow, with props pointed out towards the center of the bay. Props will be engaged in low reverse during the initial movement away from the dock, with gradual acceleration as the barge and tow move over deeper water. Impacts from prop wash should only occur during arrival and departure. The lack of strong tidal currents and the lack of large waves should result in the rapid settling of sediment in 2 hours or less (Thouverez, 2000).

Typical barges to use the dock are 35 feet wide but can range up to 50 feet wide with heights ranging from 3 to 13 feet. Drafts can vary depending on the tonnage between 2 feet to 11 feet. Based on preliminary construction schedule estimates, the barge dock may be in use for approximately 5 years.

References:

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ER Impact:

No changes to the ER are required.

Item Number 9 Supplemental Request Regarding RAI #62

NRC Request:

This RAI requested a description of the possible impacts associated with pile driving. Only a list of three possible impacts was provided.

If pile driving will be used during the project, describe the potential impacts from sediment deposition (how much, to what extent?), noise (what levels and duration, any impacts to fish, birds, turtles?), and intense vibrations (how intense and for what duration, taxa most likely affected?). Also, if treated-wood pilings will be used, describe the potential impacts associated with that usage.

UniStar Response:

Section 4.3.2.2.4 notes impacts on aquatic life within the project area. The bay anchovy and Atlantic menhaden are the most common mid-water fish species in the immediate area of the project, based on monitoring of the baffle wall and intake screens for CCNPP Units 1 and 2. It was also noted that neither the shortnose sturgeon nor the loggerhead turtle has been found impinged on the CCNPP Unit 1 and 2 intake screens during the 21 years of monitoring data. Additionally, the National Marine Fisheries Service concluded that CCNPP license renewal would not adversely affect either the shortnose sturgeon or the loggerhead turtle because the CCNPP Units 1 and 2 discharge/intake do not lie within the areas normally used by either species.

This discussion expands upon the original submittal to address in greater detail the noise, vibration and sediment impacts associated with pile driving. The discussion relies heavily on research and interim guidance developed by the Fisheries Hydroacoustic Working Group (FHWG), which appears to constitute the most comprehensive and up to date efforts to avoid, minimize or mitigate the impacts of pile driving hydroacoustics. While the FHWG studies focus only on fish, the intent is to establish guidelines that are protective of marine mammals, sea turtles, diving birds and other aquatic organisms by addressing the most sensitive representative (fish) for all of these fauna.

Research and Guidelines

Until recently, very little data or guidance has been available that specifically addressed the noise impacts of pile driving. This deficiency was recognized when design of earthquake resistant structures such as replacement of the San Francisco Oakland Bay Bridge required the use of large diameter cast in steel shell (CISS) piles driven with impact hydraulic hammers. In response, the California Department of Transportation (Caltrans) in coordination with the Federal Highways Administration (FHWA) and the departments of transportation in Oregon and Washington established a Fisheries Hydroacoustic Working Group (FHWG) in order to improve and coordinate information on fishery impacts due to underwater sound pressure caused by in-water pile driving. In addition to the above transportation agencies, the FHWG is composed of representatives from NOAA Fisheries (Southwest), NOAA Fisheries (Northwest), U.S. Fish and Wildlife Service, California Department of Fish and Game, and the U.S. Army Corps of Engineers. The FHWG is supported by a panel of hydroacoustic and fisheries experts who have been recommended by the FHWG members. A Steering Committee oversees the FHWG and

is composed of managers with decision-making authority from each of the members' organizations (Caltrans, 2008).
The goal of the Working Group is to reach agreement on: 1) The nature and extent of knowledge about the current scientific basis for underwater noise effects on fish, 2) Interim guidelines for project assessment, mitigation, and monitoring for effects of pile-driving noise on fish species, and; 3) Future scientific research needed to satisfactorily resolve uncertainties regarding hydroacoustic impacts on fish species.

Metrics: From numerous options, the FHWG utilizes two standards for measurement of underwater pile driving sound and vibration impacts. The peak sound-pressure level (Peak Pressure or peak) is measured in decibels relative to a reference level of one micro Pascal (dB re 1 *u*Pa). The cumulative sound exposure level (SEL) is: dB re 1 $u\mathrm{Pa}^2$-s and is defined as the constant sound level of 1s duration that would contain the same acoustic energy as the original sound. Both measures are standardized at a distance of 10 m from the pile (Hawkins, A. 2006).

Background Studies-Pile Driving Sound: Support for development of the FHWG Interim Criteria included studies collecting and evaluating currently available information. This included compilation of available measurements of noise and vibration impacts associated with various forms of pile driving. Typical ranges of Peak Pressure and Cumulative SEL are illustrated in Table 1 (Hastings, M. 2005).

Pile Type	Distance from Pile (m)	Peak Pressure (dB re 1 μPa)	RMS(impulse) Pressure (dB re 1 μPa)	SEL (dB re 1 μPa2-s)
--Various Projects				
Timber (12-in) Drop	10	177	165	157
CISS (12-in) Drop	10	177	165	152
Concrete (24-in) Impact (diesel)	10	188	176	166
Steel H-Type Impact (diesel)	10	190	175	--
CISS (12-in) Impact (diesel)	10	190	180	165
CISS (24-in) Impact (diesel)	10	203	190	178
CISS (30-in) Impact (diesel)	10	208	192	180
--Richmond-San Rafael Bridge				
CISS (66-in) Impact (diesel)	4	219	202	--
CISS (66-in) Impact (diesel)	10	210	195	--
CISS (66-in) Impact (diesel)	20	204	189	--
--Benicia-Martinez Bridge				
CISS (96-in) Impact (Hydraulic)	5	227	215	201
CISS (96-in) Impact (Hydraulic)	10	220	205	194

CISS (96-in) Impact (Hydraulic)	20	214	203	190
--SFOBB East Span				
CISS (96-in) Impact (Hydraulic)	25	212	198	188
CISS (96-in) Impact (Hydraulic)	50	212	197	188
CISS (96-in) Impact (Hydraulic)	100	204	192	180

Table 1. Summary of Measured Underwater Sound Levels Near Marine Pile Driving

In addition to pile type and size, numerous other factors contribute to the noise impacts of pile driving. Tables 2 & 3 (Caltrans, 2007) illustrate differences between using an impact hammer vs. a vibratory driver; Table 2 also illustrates differences associated with relative water depth.

Pile Type and Approximate Size	Relative Water Depth	Average Sound Pressure Measured in dB		
		Peak	RMS	SEL
0.30 meter (12-inch) Steel H-type-Thin	<5 meters	190	175	160
0.30 meter (12-inch) Steel H-type-Thick	~5 meters	195	183	170
0.6 meter (24-inch) AZ Steel Sheet	~15 meters	205	190	180
0.61 meter (24-inch) Concrete Pile	~5 meters	185	170	160
0.61 meter (24-inch) Concrete Pile	~15 meters	188	176	166
0.30 meter (12-inch) Steel Pipe Pile	<15 meters	192	177	—
0.36 meter (14-inch) Steel Pipe Pile	~15 meters	200	184	174
0.61 meter (24-inch) Steel Pipe Pile	~15 meters	207	194	178
0.61 meter (24-inch) Steel Pipe Pile	~5 meters	203	190	177
1 meter (36-inch) Steel Pipe Pile	<5 meters	208	190	180
1 meter (36-inch) Steel Pipe Pile	~10 meters	210	193	183
1.5 meter (60-inch) Steel CISS	<5 meters	210	195	185
2.4 meter (96-inch) Steel CISS	~10 meters	220	205	195

Table 2. Summary of Near-Source (10-Meter) Unattenuated Sound Pressures for In-Water Pile Driving using an Impact Hammer

Pile Type and Approximate Size	Relative Water Depth	Average Sound Pressure Measured in dB		
		Peak	RMS	SEL
0.30 meter (12-inch) Steel H-type	<5 meters	165	150	150
0.30 meter (12-inch) Steel Pipe Pile	<5 meters	171	155	155
1meter (36-inch) Steel Pipe Pile-Typical	~5 meters	180	170	170
0.6 meter (24-inch) AZ Steel Sheet-Typical	~15 meters	175	160	160
0.6 meter (24-inch) AZ Steel Sheet-Loudest	~15 meters	182	165	165
1 meter (36-inch) Steel pipe Pile-Loudest	~5 meters	185	175	175
1.8 meter (72-inch) Steel Pipe Pile-Typical	~5 meters	183	170	170
1.8 meter (72-inch) Steel Pipe Pile-Loudest	~5 meters	195	180	180

Table 3. Summary of Near-Source (10-Meter) Unattenuated Sound Pressures for In-Water Pile Installation using a Vibratory Driver/Extractor

Background Studies-Impacts of Sound on Fish: The FHWG analyzed all available studies to address known impacts of sound on fish and to establish noise standards that would be protective of fishery resources. The objectives of this analysis are summarized as follows (Theiss, S. 2007):
"Ideally we want to define interim sound exposure criteria as representing the received signal level that defines the *onset* of effects, rather than using data representing effects at some point past their onset; however, data for the onset of effects in fishes are not available in the literature. Moreover, instead of proposing one set of criteria, peak sound pressure level (SPL) and cumulative sound exposure level (SEL), we propose criteria for each of *three different effects on fish*:
1) Hearing loss due to temporary threshold shift (TTS);
2) Damage to auditory tissues (generally sensory hair cells of the ear); and
3) Damage to non-auditory tissues.

At the same time, we also recognize that the biology of individual fish species as well as the physiological state of individual fish may alter the nature and sequence of effects. Based on the available scientific literature, vulnerability to non-auditory tissue damage increases as the mass of the fish decreases. Therefore, non-auditory tissue damage criteria are different depending on the mass of the fish. "

Interim Criteria: The FHWG met in June 2008 and agreed to new interim, dual criteria for injury to fish from pile driving noise. These new criteria are to be used as of August 2008 until further notice. This criteria (See Table 4) includes a peak level of 206 dB AND a cumulative SEL level of 187 dB for fish 2 grams and heavier OR a cumulative SEL of 183 dB for fish smaller than 2 grams.

Interim Criteria for Injury	Agreement in Principle
Peak	206 dB (for all size of fish)
Cumulative SEL	187 dB – for fish size of two grams or greater. 183 dB – for fish size of less than two grams.*

Table 4. FHWG Agreement in Principle Technical/Policy Meeting Vancouver, WA *June, 11 2008*

Signatories to the FHWG Interim Criteria include California Department of Transportation, Oregon Department of Transportation, Washington State Department of Transportation, California Department of Fish and Game, Federal Highways Administration (FHWA), NOAA Fisheries (Southwest), NOAA Fisheries (Northwest), U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers.
While the Interim Criteria are currently applicable to the three west coast states, ongoing research may contribute to expansion of these (or succeeding) criteria to other coastal jurisdictions. Towards this end, Caltrans is participating in the National Cooperative Highway Research Program (NCHRP) study #25-28 "Predicting and Mitigation Hydroacoustic Impacts on Fish from Pile Installation" and the Transportation Pooled Fund Program Study "Structural Acoustic Analysis of Piles."

Pile Driving proposed for CCNPP Unit 3

Project Overview: This information is preliminary and sizing of the sheet piles is based on the existing design.

Three pile driving tasks are proposed for construction. Of these, the project adjacent to the Intake Area would produce the most significant hydroacoustic impacts. The proposed sheet piling would be 180' W x 60' L, with an embedded length of approximately 15'. Soldier piles (30" dia. steel piles), would be installed on approximately 10' centers. These piles will be driven with conventional pile hammers.

PZ 27/22 or equivalent steel sheet piling is anticipated for construction of the CCNPP Unit 2 intake structure and barge unloading area. Sheet piling is anticipated to be driven with vibratory hammers. Construction duration for this project is estimated as two (2) months (see Figure Key and Figure 3).

The second project, to be constructed in the Barge Unloading Area, is a smaller project that will entail shallower depths. Any impacts from this activity would be reduced in comparison to impacts of sheet piling installation in the intake area. The project would be 90' W x 20'L, with

PZ 27/22 sheet piling and 30" soldier piles supporting the sheet piling. Construction duration for this project is estimated as two (2) weeks (see Figure Key, Figure 6 and 6A).

The third project, to be constructed in the Intake Cofferdam Area, will occur on uplands and is not expected to have any impact on aquatic resources. The project will be 1600' W x 60' L, PZ 27/22 sheet piling with an embedded length of approximately 45'. Construction duration is estimated as four (4) months (see Figure Key and Figure 4).

Project Sites: The intake area consists of several hundred feet of sheet pile that protect the sea-water intakes for CCNPP units 1 and 2. Shoreline adjacent to the existing sheet pile has been armored with riprap to protect against shore erosion. The sheet pile enclosure blocks the passage of most fish that might get close to the intake structures; a return system discharges any impinged fish back to the ocean. The proposed new sheet pile for unit 3 will entail only a minor modification to the existing sheet pile in this area.

The barge unloading area receives barges up to 200' long with a maximum load depth of 11'. The typical barge is 35' wide, but barges up to 50' wide can be accommodated. The proposed new unit 3 at CCNPP will necessitate expansion of docking capacities at the barge unloading area. However, the proposed sheet pile at this location will constitute only a minor portion of the unloading area expansion.

Pile Construction Noise and Vibration Impacts: The proposed project will employ 30" steel piles and conventional pile hammers to drive them. Vibratory hammers will be employed to drive the sheet piles. The shallow depth of the installation is associated with noise and vibration impacts that are less than pile driving activities in deeper water.

Among the Pile Driving examples illustrated in Tables 1 - 3, the entry in Row 7 of Table 1 represents the only entry for 30" steel pipe, with a peak sound impact of 208 db and a cumulative SEL of 180 dB. No water depth is indicated for this entry. Table 2, Row 9 lists an entry for 24" steel pipe in approximately 5 meters water depth. This impact is 203 db peak and 177 db SEL. Table 2, Row 10 lists 208 dB peak and 180 dB SEL for 36" steel pipe in less than 5 meters water depth.
These entries suggest that driving 30" steel pipe piles with conventional hammers at the project sites could produce sound impacts that approach or exceed the interim guidance criteria of 206 dB Peak. The project does not appear likely to exceed the minimum SEL criteria of 183 dB for fish size less than 2 grams. Driving the sheet piling does not appear to approach any of the interim criteria thresholds.
If warranted, additional measures for minimizing noise and vibration impacts are available for heavy duty pile driving, large projects or highly sensitive project environments. These include bubble curtains around large piles to muffle sound and vibration, alternative hammers/drivers that generate less sound, and timing to avoid sensitive periods (diurnal and/or seasonal). In some cases it may be possible to employ pre-drilled excavation and back-filling (auger cast pile) in lieu of driving piles or to construct cofferdams that isolate the pile driving from the water.
Appendix A provides a list of estuarine species in the Chesapeake Bay that could be exposed to noise and vibration impacts of the proposed project. The list indicates the relative sensitivity of each species and their probable response to noise and vibration impacts.

Sediment Impacts of Pile Driving: Minimal sediment disturbance will occur in conjunction with the pile driving operation. Pile driving compresses the surrounding soils, resulting in a stabilizing effect on the soils. Installation of rock armor along the toe of the sheet piling will protect against any transport of sediment away from this area that might result from wind, tides or currents.

Proposed sheet piling construction in the intake wedge area will result in minimal changes to the existing shoreline configuration and sediment transport/deposition patterns. The proposed construction will affect 180 feet of existing sheet piling and armored shoreline in an area where prior construction has occurred.

References

Caltrans, 2008. Fisheries – Bioacoustics, California Department of Transportation, Biological Resources Issues Links http://www.dot.ca.gov/hq/env/bio/fisheries_bioacoustics.htm accessed September 9, 2008

Caltrans, 2007. Caltrans unpublished "Guidance Manual of the Effects of Pile Driving Sound on Fish," Appendix-Compendium of Pile Driving sound Data [September 27, 2007].

Carlson, Thomas, Mardi Hastings, and Arthur N. Popper. Update on Recommendations for Revised Interim Sound Exposure Criteria for Fish during Pile Driving Activities. CALTRANS-Arlington Memo Update 12-21-07

Hastings, Mardi C. Ph.D. and Arthur N. popper, Ph.D. Effects of Sound on Fish. California Department of Transportation Contract No. 43A0139, Task Order 1. January 28, 2005 (Revised Appendix B – August 23, 2005).

Hawkins A. 2006. Assessing the impact of pile driving upon fish. IN: Proceedings of the 2005 International Conference on Ecology and Transportation, Eds. Irwin CL, Garrett P, McDermott KP. Center for Transportation and the Environment, North Carolina State University, Raleigh, NC: p. 22.

Appendix A – Pile Driving Impacts to Estuarine Species in Chesapeake Bay near the CCNPP Site

Figures Illustrating Project Site and Proposed Sheet Pile Construction

Figure Key – Figure Key plan, Calvert Cliffs Nuclear Power Plant

Figure 3 – Site Plan @ Unit 3 Intake Structure, Sheet 1

Figure 4 - Site Plan @ Unit 3 Intake Structure, Sheet 1

Figure 6 - Proposed Restoration of Barge Slip (With Existing Contours)

Figure 6A – Modifications @ Existing Barge Unloading Facility

ER Impact:

No changes to the ER are required.

Figures Supporting this RAI response are as follows:

Application NAB-2007-08123-M05
Response to U.S. Army Corps of Engineers Information Request Dated 10/28/08
Calvert Cliffs 3 Project, LLC and UniStar Nuclear Operating Services, LLC
November 21, 2008

Question 10

A narrative to describe and quantify cumulative and indirect impacts resulting from the project.

RESPONSE

As stated in Section 10.5 of the Calvert Cliffs (CCNPP) Unit 3 Environmental Report (ER), "Activities to be undertaken during construction and operation of CCNPP Unit 3 are consistent with those currently in place for CCNPP Units 1 and 2. Except for the construction footprint, available land use and the terrestrial environmental will remain unchanged." Section 10.5 further states, in part, "The environmental assessment demonstrates that cumulative adverse impacts to the vicinity and to the region will be small."

CCNPP Unit 3 ER Section 10.5.1 provides a detailed description of the cumulative impacts during construction and summarizes, "...the construction of CCNPP Unit 3 will not result in long-term cumulative impacts that are inconsistent with existing land use. Activities that occur during construction will be managed using best management practices and compliance with applicable regulations to limit both short-term and long-term adverse impacts. Furthermore, impacts will cease following completion of CCNPP Unit 3 and efforts made to reclaim those areas not required for operations."

CCNPP Unit 3 ER Section 10.5.2 provides a detailed description of the cumulative impacts of plant operation and summarizes, "Potential cumulative adverse impacts from operations include the withdrawal of water from the Chesapeake Bay, discharge of cooling tower blowdown, radiological dose consequences, waste generation, noise from the new hybrid cooling tower and socioeconomic changes." Section 10.5.2 also describes the impacts associated with several projects in the area of the CCNPP site that may contribute to cumulative socioeconomic and environmental impacts and concludes that the cumulative impacts of these projects should be small.

CCNPP Unit 3 ER Section 10.5.3 provides a summary of cumulative impacts and concludes that for both construction and operation of CCNPP Unit 3; "The environmental assessment demonstrates that cumulative adverse impacts to the vicinity and to the region will be small."

ER Section 10.5 of CCNPP Unit 3 COLA, Revision 3 is attached and provides additional details regarding cumulative and indirect impacts resulting from the project.

Application NAB-2007-08123-M05
Response to U.S. Army Corps of Engineers Information Request Dated 10/28/08
Calvert Cliffs 3 Project, LLC and UniStar Nuclear Operating Services, LLC
November 21, 2008

Question 11

A vicinity map and plan for the disposal options for any excess fill material resulting from construction.

RESPONSE

Two areas on the site within the proposed limits of disturbance (LOD) have been developed to accommodate excess soil and dredge materials (spoils): 1) adjacent to the construction access road the current design includes an area which will facilitate disposal of 750,000 cubic yards (See attached Sheets 2, 12 and 13) and 2) northwest of the Unit 3 Power Block, the design includes an area, in what is referred to as the Lake Davies area, for disposal of an additional 1,500,000 cubic yards (See attached Sheets 3, 4, 5 and 6).

It is anticipated that excess materials generated from initial clearing/grading the site which are suitable for use as fill material and excess materials from the cut and fill operations will be spoiled in the area adjacent to the access road whereas unsuitable excavated materials will be spoiled in the Lake Davies area.

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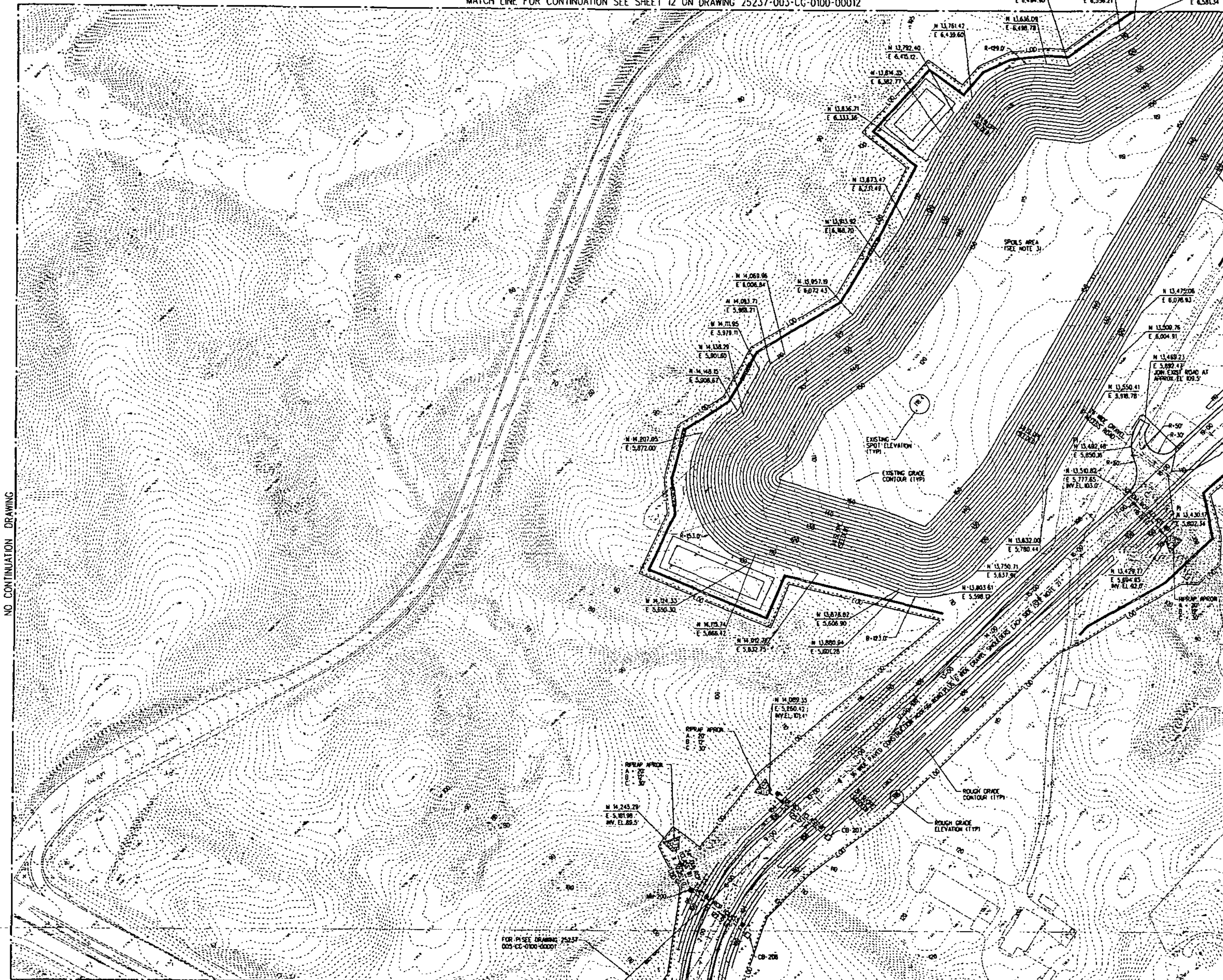

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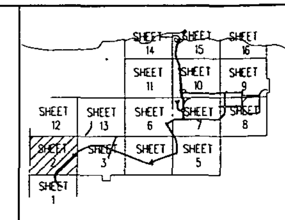
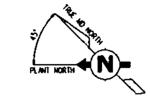


KEY PLAN



NOTES

1. FOR NOTES AND REFERENCE DRAWINGS SEE DRAWING 25237-003-CG-0000-00001.
2. FOR ROAD PROFILE SEE DRAWING 25237-003-0190-00002.
3. FIELD TO VERIFY REQUIRED CLEARANCES BENEATH AND ADJACENT TO OVERHEAD TRANSMISSION LINES.

LEGEND

----50----	1' EXISTING GRADE CONTOUR
	2' PROPOSED CONTOUR
----40----	10' PROPOSED CONTOUR
	STORM DRAIN PIPE OR CULVERT
	IDA LINE
	℄ DRAINAGE DITCH
----LOD----	LIMITS OF DISTURBANCE
	NEW SUPER SILT FENCE
	BERM ROUGH GRADE/CENTERLINE
	GABION
	RIP-RAP
□	SQUARE CATCH BASIN
○	CIRCULAR CATCH BASIN
●	GRATED MANHOLE
PI	POINT OF INTERSECTION
	PAVING GRID
	AGGREGATE

0 60 120 180 240FT

CONSTELLATION GENERATION GROUP, LLC
CONSTELLATION COL

BECHTEL
FREDERICK, MARYLAND

JOB NO. 25237

U.S. EVOLUTIONARY POWER REACTOR (EPR)

CALVERT CLIFFS UNIT 3
ROUGH GRADE PLAN SHEET 2

REV NO.	DATE	REVISIONS	BY	CHK	DES. SUPV	ENGR.	PROJ ENGR	APPR	ACCEPT
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	/ /								
	/ /								
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00B	09/24/08	ISSUED FOR REVIEW	RBD	PWH	MDB	JRD	LRR		
00A	07/30/08	ISSUED FOR REVIEW	RBD	RS	MDB	CJM	LRR		

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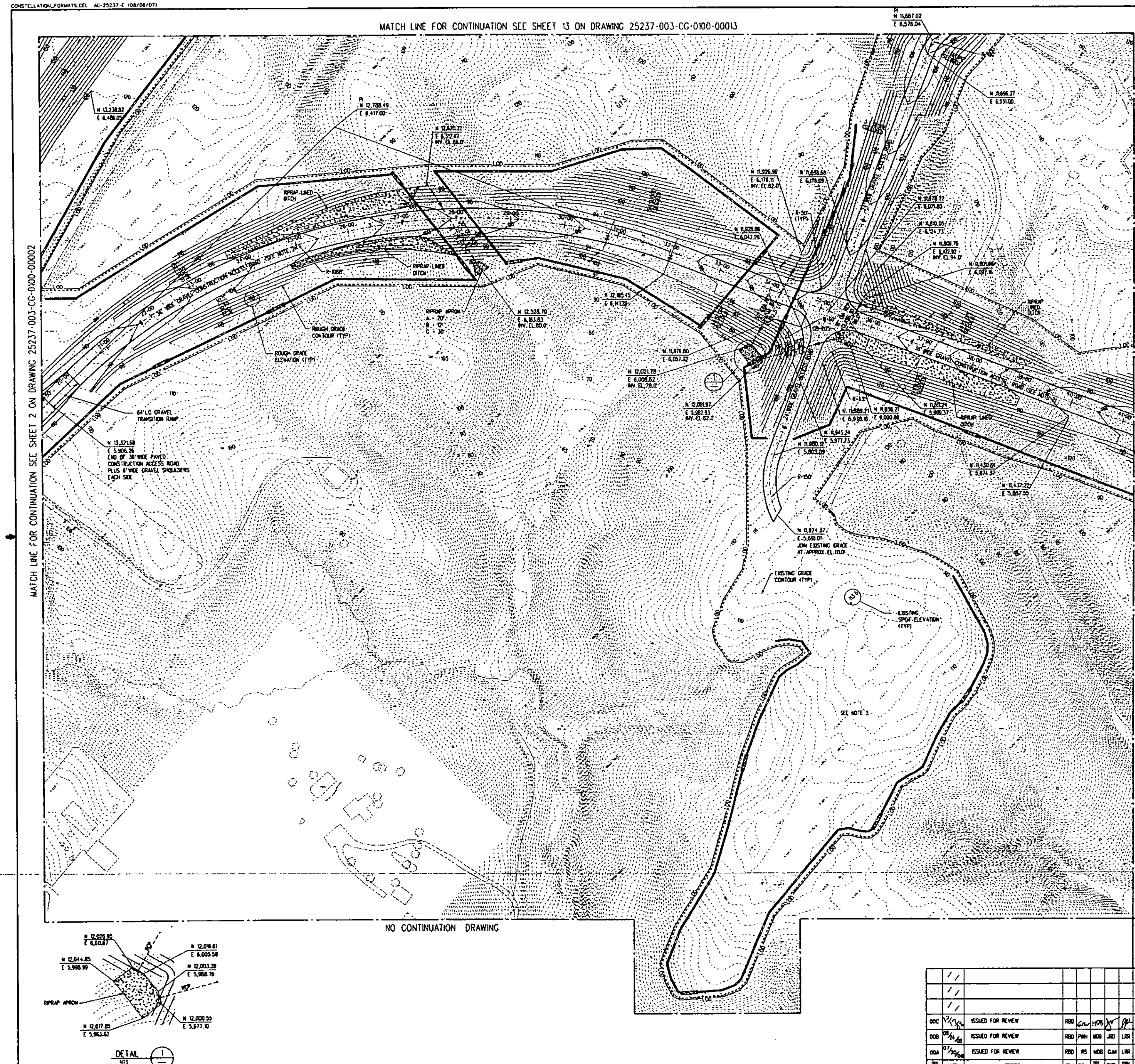

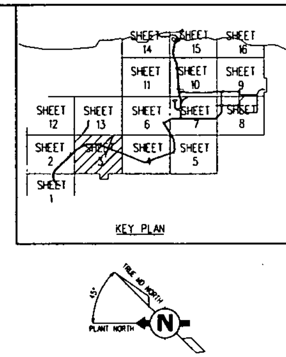

NOTES

1. FOR NOTES AND REFERENCE DRAWINGS SEE DRAWING 25237-003-CG-0000-00001.
2. FOR ROAD PROFILE SEE DRAWINGS 25237-003-CG-0190-00002 AND 25237-003-CG-0190-00003.
3. GRADING IN THIS AREA IS TO BE LIMITED TO THE INSTALLATION OF A 6" AGGREGATE BASE COARSE.

LEGEND

- 1' EXISTING GRADE CONTOUR
- 2' PROPOSED CONTOUR
- 10' PROPOSED CONTOUR
- STORM DRAIN PIPE OR CULVERT
- IDA LINE
- ℄ DRAINAGE DITCH
- LIMITS OF DISTURBANCE
- NEW SUPER SILT FENCE
- BERM ROUGH GRADE/CENTERLINE
- GABION
- RIP-RAP
- SQUARE CATCH BASIN
- CIRCULAR CATCH BASIN
- GRATED MANHOLE
- PI POINT OF INTERSECTION
- PAVING GRID
- AGGREGATE

0 60 120 180 240 FT

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CALVERT CLIFFS UNIT 3
ROUGH GRADE PLAN SHEET 3

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	/ /									
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00A	07/30/08	ISSUED FOR REVIEW	RBD	RS	MDB	GJM	LRR			

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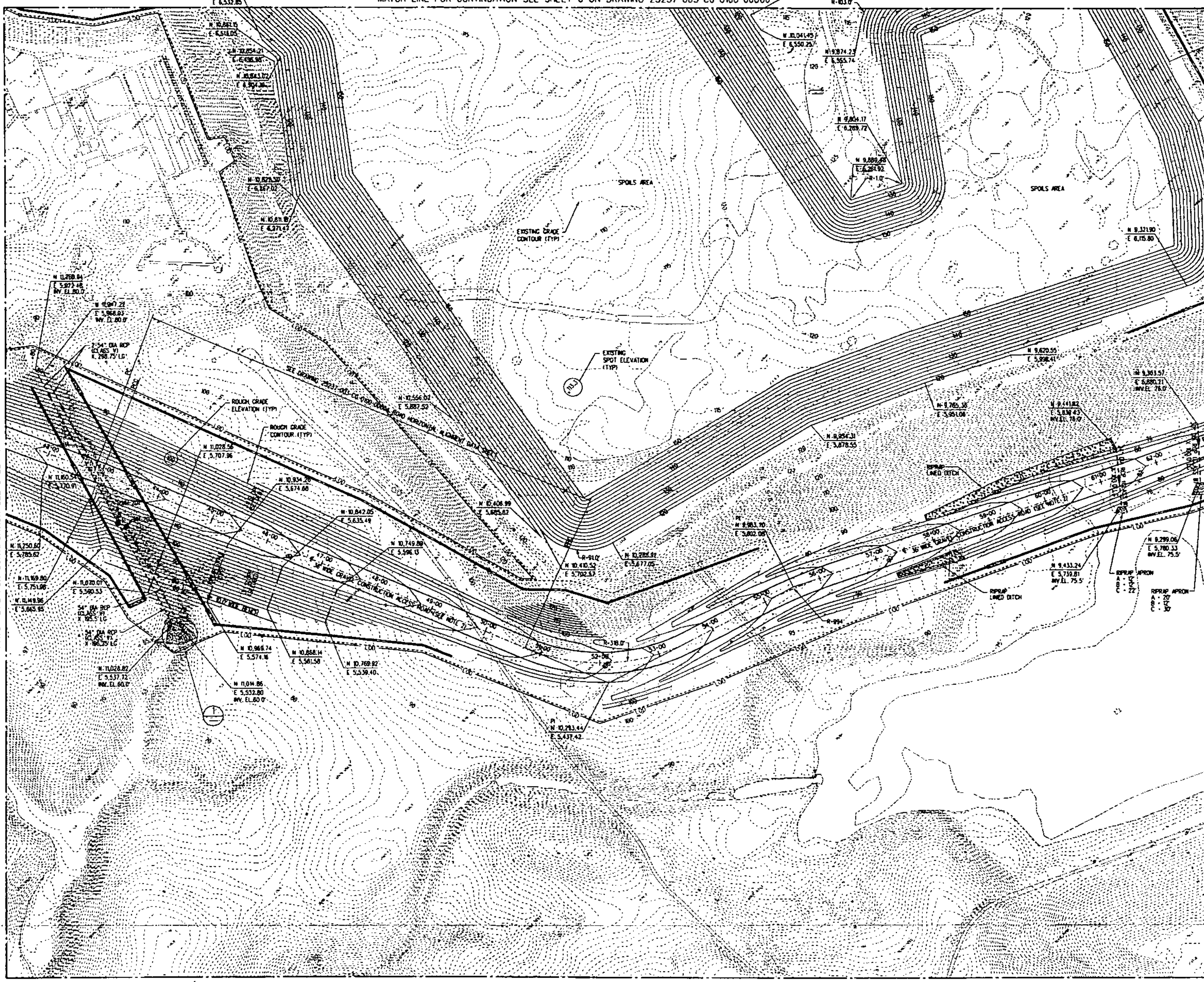

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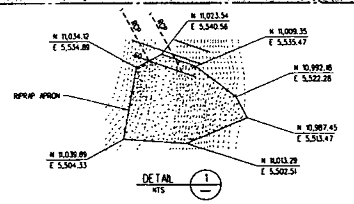

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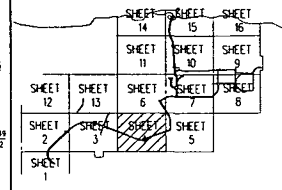

KEY PLAN

PLANT NORTH

NOTES

1. FOR NOTES AND REFERENCE DRAWINGS SEE DRAWING 25237-003-CG-0000-00001.
2. FOR ROAD PROFILE SEE DRAWINGS 25237-003-CG-0190-00003 AND 25237-003-CG-0190-00004.

LEGEND

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	2' PROPOSED CONTOUR
40	10' PROPOSED CONTOUR
	STORM DRAIN PIPE OR CULVERT
	10A LINE
	℄ DRAINAGE DITCH
LOD	LIMITS OF DISTURBANCE
	NEW SUPER SILT FENCE
	BERM ROUGH GRADE/CENTERLINE
	GABION
	RIP-RAP
□	SQUARE CATCH BASIN
○	CIRCULAR CATCH BASIN
●	GRATED MANHOLE
PI	POINT OF INTERSECTION
	PAVING GRID
	AGGREGATE

0 60 120 180 240FT

REV. NO.	DATE	REVISION	BY	CHK					
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00A	07/30/08	ISSUED FOR REVIEW	RBD	RS	MOB	GJM	LRR		

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U.S. EVOLUTIONARY POWER REACTOR (EPR)

CALVERT CLIFFS UNIT 3
ROUGH GRADE PLAN SHEET 4

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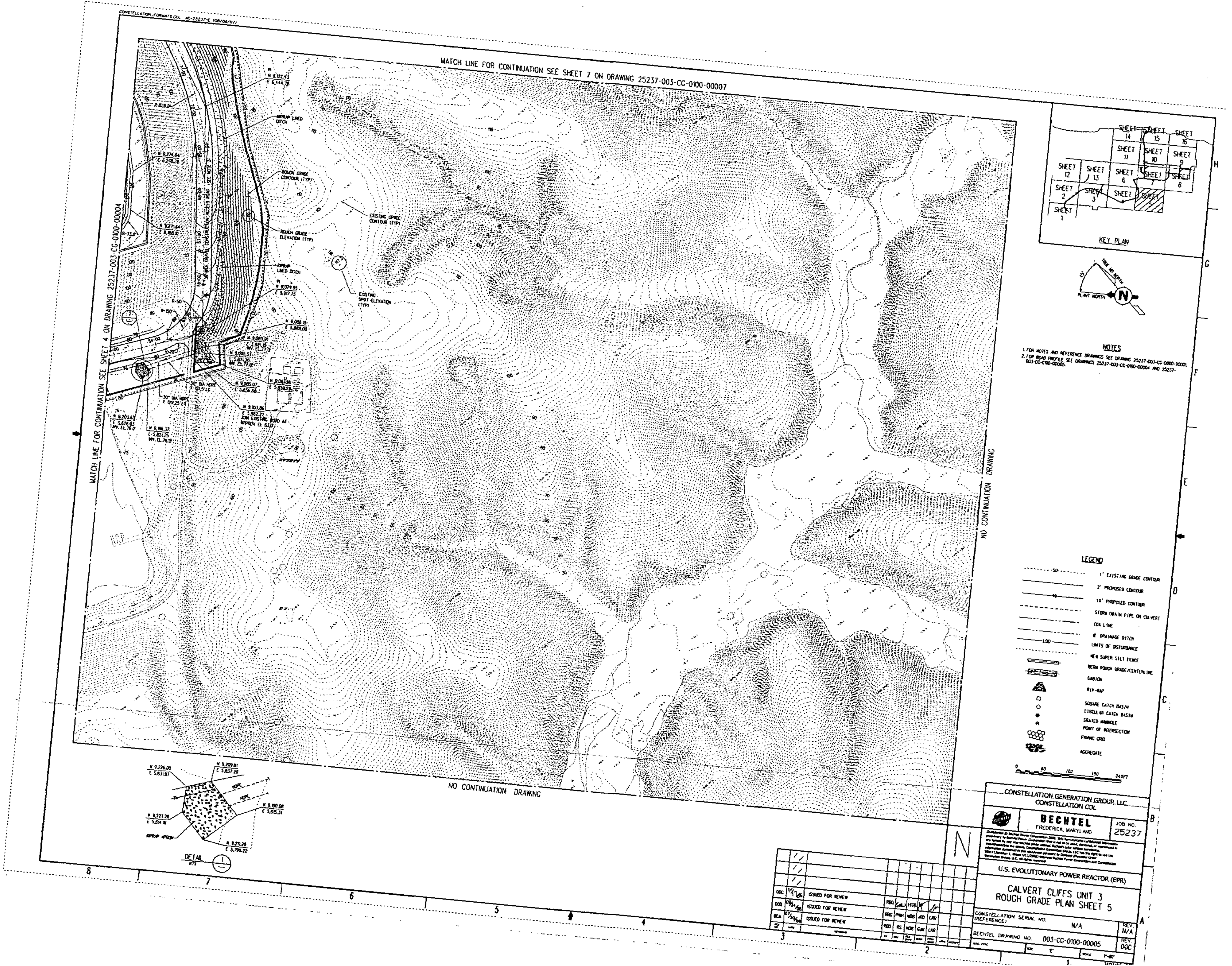

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RIPRAP LINED DITCH
ROUGH GRADE CONTOUR (TYP)
EXISTING GRADE CONTOUR (TYP)
ROUGH GRADE ELEVATION (TYP)
EXISTING SPOT ELEVATION (TYP)
KEY PLAN
SHEET 14
SHEET 15
SHEET 16
SHEET 11
SHEET 10
SHEET 9
SHEET 12
SHEET 13
SHEET 6
SHEET 7
SHEET 8
SHEET 2
SHEET 3
SHEET 4
SHEET 5
SHEET 1
TRUE NORTH
PLANT NORTH
NOTES
1. FOR NOTES AND REFERENCE DRAWINGS SEE DRAWING 25237-003-CG-0000-00001.
2. FOR ROAD PROFILE SEE DRAWINGS 25237-003-CG-0150-00004 AND 25237-003-CG-0150-00005.
LEGEND
1' EXISTING GRADE CONTOUR
2' PROPOSED CONTOUR
10' PROPOSED CONTOUR
STORM DRAIN PIPE OR CULVERT
IDA LINE
℄ DRAINAGE DITCH
LIMITS OF DISTURBANCE
NEW SUPER SILT FENCE
BERM ROUGH GRADE/CENTERLINE
GABION
RIP-RAP
SQUARE CATCH BASIN
CIRCULAR CATCH BASIN
GRATED MANHOLE
POINT OF INTERSECTION
PAVING GRID
AGGREGATE
0 60 120 180 240FT
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DETAIL 1
NTS
CONSTELLATION GENERATION GROUP, LLC
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BECHTEL
FREDERICK, MARYLAND
JOB NO. 25237
U.S. EVOLUTIONARY POWER REACTOR (EPR)
CALVERT CLIFFS UNIT 3
ROUGH GRADE PLAN SHEET 5
CONSTELLATION SERIAL NO. (REFERENCE) N/A
REV. N/A
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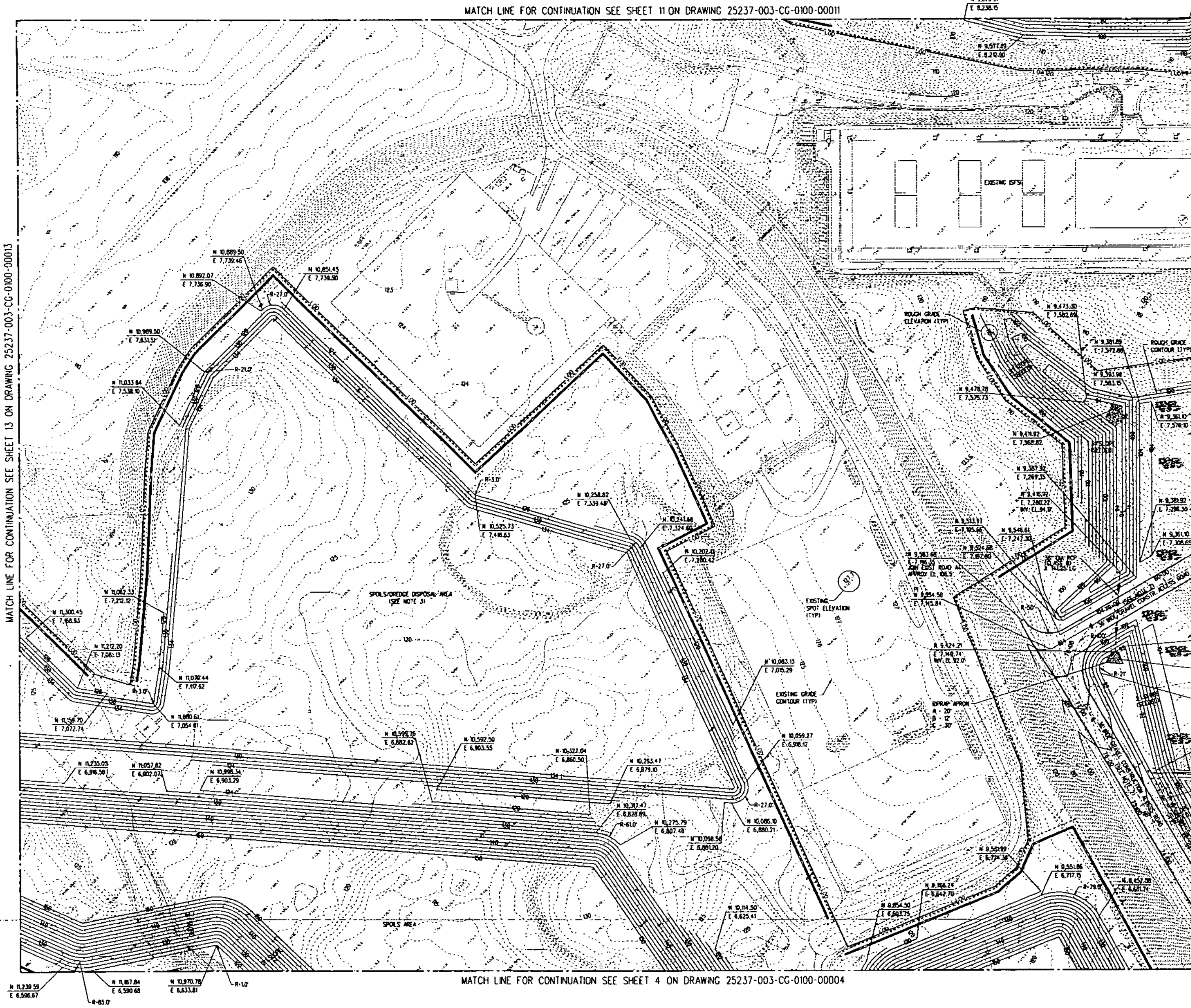

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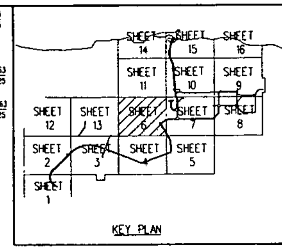
CONSTRUCTION LAYDOWN/EQUIPMENT STAGING/PARKING AREA (PAVING GRID)

CONSTRUCTION LAYDOWN/EQUIPMENT STAGING/PARKING AREA (GRAVEL)

RIPRAP LINED DITCH



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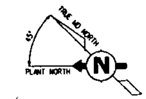

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1. FOR NOTES AND REFERENCE DRAWINGS SEE DRAWING 25237-003-CG-0000-00001.
2. FOR ROAD PROFILE SEE DRAWING 25237-003-CG-0100-00005.
3. FIELD TO VERIFY REQUIRED CLEARANCES BENEATH AND ADJACENT TO OVERHEAD TRANSMISSION LINES.

LEGEND

- 1' EXISTING GRADE CONTOUR
- 2' PROPOSED CONTOUR
- 10' PROPOSED CONTOUR
- STORM DRAIN PIPE OR CULVERT
- IDA LINE
- ℄ DRAINAGE DITCH
- LIMITS OF DISTURBANCE
- NEW SUPER SILT FENCE
- BERM ROUGH GRADE/CENTERLINE
- GABION
- RIP-RAP
- SQUARE CATCH BASIN
- CIRCULAR CATCH BASIN
- GRATED MANHOLE
- POINT OF INTERSECTION
- PAVING GRID
- AGGREGATE

0 60 120 180 240FT

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U.S. EVOLUTIONARY POWER REACTOR (EPR)

CALVERT CLIFFS UNIT 3
ROUGH GRADE PLAN SHEET 6

REV NO.	DATE	REVISIONS	BY	CHK					
	/ /								
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00A	07/30/08	ISSUED FOR REVIEW	RBD	RS	MOB	GJM	LRR		

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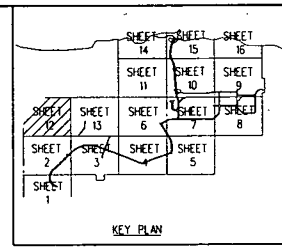

KEY PLAN

TRUE NO NORTH
PLANT NORTH

NOTES

1. FOR NOTES AND REFERENCE DRAWINGS SEE DRAWING 25237-003-CG-0000-00001.

LEGEND

- 1' EXISTING GRADE CONTOUR
- 2' PROPOSED CONTOUR
- 10' PROPOSED CONTOUR
- STORM DRAIN PIPE OR CULVERT
- 10A LINE
- ℄ DRAINAGE DITCH
- LIMITS OF DISTURBANCE
- NEW SUPER SILT FENCE
- BERM ROUGH GRADE/CENTERLINE
- GABION
- RIP-RAP
- SQUARE CATCH BASIN
- CIRCULAR CATCH BASIN
- GRATED MANHOLE
- POINT OF INTERSECTION
- PAVING GRID
- AGGREGATE

0 60 120 180 240FT

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FREDERICK, MARYLAND

JOB NO. 25237

U.S. EVOLUTIONARY POWER REACTOR (EPR)

CALVERT CLIFFS UNIT 3
ROUGH GRADE PLAN SHEET 12

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	/ /								
	/ /								
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00A	07/30/08	ISSUED FOR REVIEW	RBD	RS	MOB	GJM	LRR		
REV NO.	DATE	REVISIONS	BY	CHK					

CONSTELLATION SERIAL NO. (REFERENCE) N/A — REV. N/A

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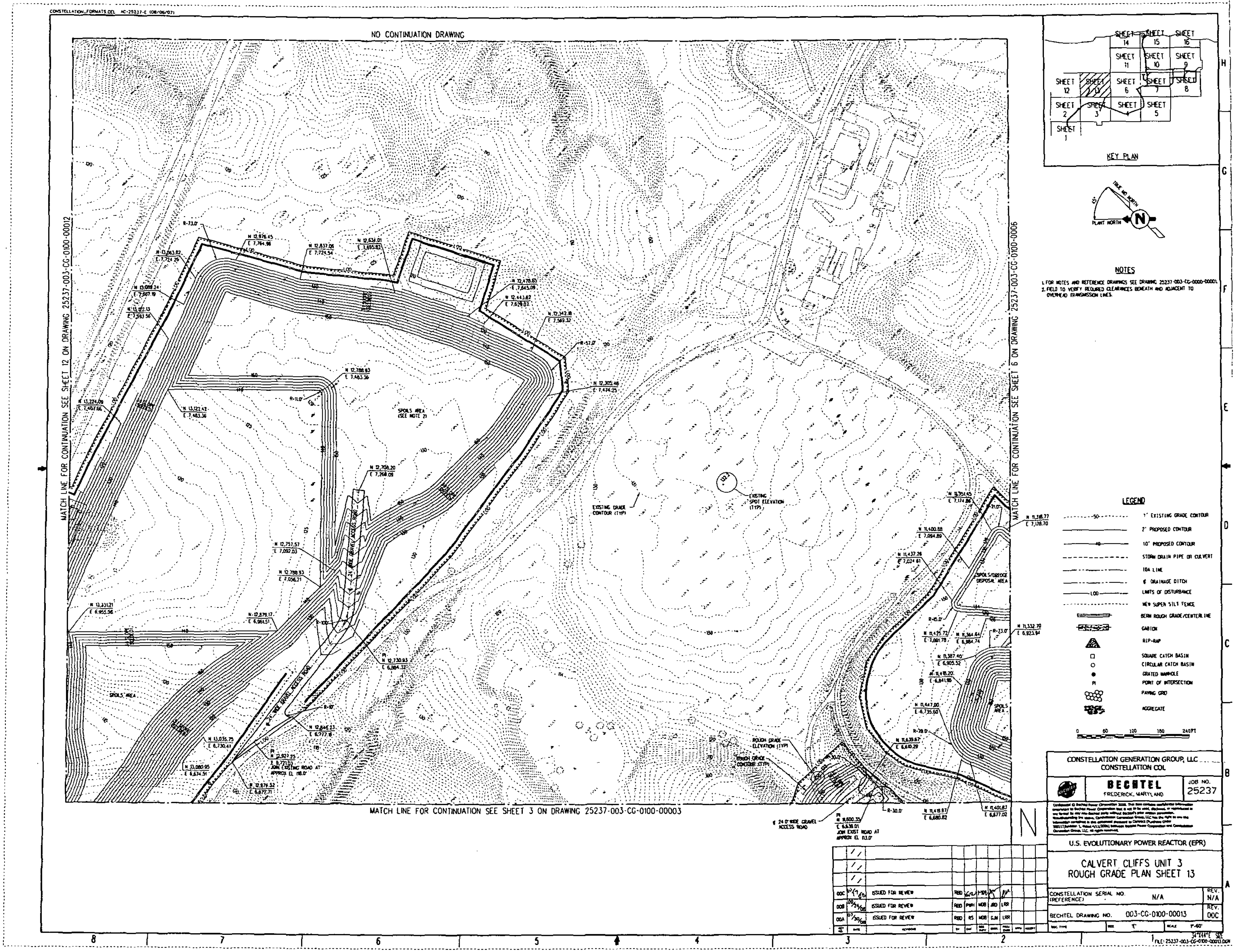

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MATCH LINE FOR CONTINUATION SEE SHEET 3 ON DRAWING 25237-003-CG-0100-00003
SPOILS AREA (SEE NOTE 2)
SPOILS AREA
SPOILS/DREDGE DISPOSAL AREA
EXISTING GRADE CONTOUR (TYP)
EXISTING SPOT ELEVATION (TYP)
ROUGH GRADE ELEVATION (TYP)
ROUGH GRADE CONTOUR (TYP)
24.0' WIDE GRAVEL ACCESS ROAD
JOIN EXIST ROAD AT APPROX EL 113.0'
JOIN EXISTING ROAD AT APPROX EL 118.0'
KEY PLAN
SHEET 14
SHEET 15
SHEET 16
SHEET 11
SHEET 10
SHEET 9
SHEET 12
SHEET 13
SHEET 6
SHEET 7
SHEET 8
SHEET 2
SHEET 3
SHEET 4
SHEET 5
SHEET 1
TRUE NORTH
PLANT NORTH
NOTES
1. FOR NOTES AND REFERENCE DRAWINGS SEE DRAWING 25237-003-CG-0000-00001.
2. FIELD TO VERIFY REQUIRED CLEARANCES BENEATH AND ADJACENT TO OVERHEAD TRANSMISSION LINES.
LEGEND
1' EXISTING GRADE CONTOUR
2' PROPOSED CONTOUR
10' PROPOSED CONTOUR
STORM DRAIN PIPE OR CULVERT
LIMITS OF DISTURBANCE
NEW SUPER SILT FENCE
BERM ROUGH GRADE/CENTERLINE
GABION
RIP-RAP
SQUARE CATCH BASIN
CIRCULAR CATCH BASIN
GRATED MANHOLE
POINT OF INTERSECTION
PAVING GRID
AGGREGATE
CONSTELLATION GENERATION GROUP, LLC
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FREDERICK, MARYLAND
JOB NO. 25237
U.S. EVOLUTIONARY POWER REACTOR (EPR)
CALVERT CLIFFS UNIT 3
ROUGH GRADE PLAN SHEET 13
CONSTELLATION SERIAL NO. (REFERENCE) N/A
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BECHTEL DRAWING NO. 003-CG-0100-00013
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00A ISSUED FOR REVIEW

Application NAB-2007-08123-M05
Response to U.S. Army Corps of Engineers Information Request Dated 10/28/08
Calvert Cliffs 3 Project, LLC and UniStar Nuclear Operating Services, LLC
November 21, 2008

Question 12

A narrative addressing public benefits of this project separate from the project's proponents' benefit.

RESPONSE

Locating the proposed new nuclear facility at the existing CCNPP property will afford benefits to the local economy. The CCNPP owners will pay property taxes on the proposed new unit for the duration of the operating licenses. Tax payments on the Calvert Cliffs Unit 3 will be very large. For instance, in 2006, Constellation Energy paid about $15.8 million in Calvert County property taxes for Units 1 and 2, and in 2007 it paid about $16.2 million in property taxes. The Calvert County Board of County Commissioners estimates that the new unit will provide the County with approximately $20 million in additional annual tax revenue, which can be used to fund education, school construction, roads, law enforcement, and fire and rescue services. Large tax payments are considered a benefit to the taxing entity because they support the development of infrastructure that supports further economic development and growth.

With respect to employment, approximately 833 people are employed at the existing CCNPP facility. It is anticipated that construction and operation of the new facility will require a skilled workforce of 363 people. New jobs within approximately a 50 mi (80 km) radius of the plant will be created by the construction and operation of the new facility. Many of these jobs will be in the service sector and could be filled by unemployed local residents, lessening demands on social service agencies in addition to strengthening the economy. It is anticipated that the new jobs will be maintained throughout the life of the plant.

Construction and operation of the new nuclear facility at CCNPP will also generate an economic multiplier effect in the area. The economic multiplier effect means that for every dollar spent an additional $0.69 of indirect economic revenue will be generated within the region of influence. The economic multiplier effect is one way of measuring direct and secondary effects. Direct effects reflect expenditures for goods, services, and labor, while secondary effects include subsequent spending in the community. The economic multiplier effect due to the increased spending by the direct and indirect labor force created as a result of the construction and operation of the new nuclear reactor unit will increase economic activity in the region, most noticeably in Calvert County.

Moreover, given concerns in the State of Maryland about climate change and carbon emissions, CCNPP Unit 3 serves an important environmental benefit need by reducing carbon emissions in the State. Upon operation, CCNPP Unit 3 will displace significant amounts of carbon compared to a coal-fired generating plant.

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Question 13

A description of the relative extent of the public and private need for the proposed project.

RESPONSE

Section 8.4 of the Calvert Cliffs (CCNPP) Unit 3 Environmental Report (ER) provides a description of the relative extent of the public and private need for the proposed project. As stated in Section 8.4, the Maryland Public Service Commission (PSC) has concluded that there is a need for new capacity and that the need for in-state generating capacity is increasing rapidly. A copy of Section II, Electricity Industry in Maryland, of the PSC's Electric Supply Adequacy Report of 2007 is attached. Additionally, given Maryland State concerns about climate change and carbon emissions, CCNPP Unit 3 serves another important need by reducing carbon emissions in Maryland. Also, the current national policy is to develop ways to reduce dependence on fossil fuels. New baseload nuclear generating capacity is required to enhance U.S. energy supply diversity and energy security, a key National Energy Policy objective.

ER Section 8.4 of CCNPP Unit 3 COLA, Revision 3 is attached.

PUBLIC SERVICE COMMISSION
OF MARYLAND

ELECTRIC SUPPLY ADEQUACY REPORT OF 2007

In compliance with Section 7-505(e) of
the Public Utility Companies Article

January 2007

II. ELECTRICITY INDUSTRY IN MARYLAND

On July 1, 1999, Maryland's Electric Customer Choice and Competition Act of 1999 (Act) went into effect. The Act established the legal framework for the restructuring and provided alterations to the regulation of the electric utility industry in Maryland. The Act restructures "the generation, supply, and pricing of electricity", such that competitive market forces are to be relied upon to encourage the construction of needed facilities.

A. Overview of Electricity Generation and Consumption in Maryland

Electricity generation in Maryland comes primarily from solid fuels (coal and nuclear), a condition that has changed little over the last six years. In 1999, coal supplied 57.4% of the electricity in the State while nuclear provided 25.8%. In 2005, the most recent year that complete information is available, coal generated 55.7% of the electricity in the State while nuclear provided 27.9%. Natural gas, petroleum, hydroelectricity, other gases, and other renewable sources combine for 16.4% of all in-State generation during 2005. Table II.A.1 below summarizes Maryland's in-State fuel mix in gigawatt-hours (GWh) by generating sources for the years 1999, 2004 and 2005:

Table II.A.1: Maryland Electric Power Generation Profile[6]

	1999		2004		2005	
Source	**GWh**	**% Share**	**GWh**	**% Share**	**GWh**	**% Share**
Coal	29,688	57.4%	29,216	56.1%	29,314	55.7%
Petroleum	4,290	8.3%	3,296	6.3%	3,818	7.3%
Natural Gas	2,125	4.1%	1,183	2.3%	1,874	3.6%
Other Gases	60	0.1%	413	0.8%	343	0.6%
Nuclear	13,312	25.8%	14,580	28.0%	14,703	27.9%
Hydroelectric	1,424	2.8%	2,508	4.8%	1,704	3.2%
Other Renewables	786	1.5%	857	1.7%	906	1.7%
Other	0	0.0%	1	0.0%	0	0.0%
Total Generation	**51,685**	**100.0%**	**52,054**	**100.0%**	**52,662**	**100.0%**

Table II.A.2 on the next page shows Maryland's in-State generating capacity profile as of year-end 1999 and 2004. The total of nearly 12,500 megawatts (MW) of installed capacity in Maryland, as of year-end 2004, was an increase of only 6% over the preceding five years. The relative mix of generating capacity has also not significantly changed in the last few years. Coal accounted for nearly 40% of in-State capacity for the years 1999 and 2004. Maryland's nuclear capacity is just below 14% of all of Maryland's generating capacity, a condition that also has not significantly changed. Dual-fired capacity increased its percentage share by almost 10% from 1999 to 2004. This amount is a reflection of the addition of generating units that are capable of burning either petroleum or natural gas. Also, several existing petroleum and natural gas fired units were modified so they are now able to use either fuel.

6 The Energy Information Administration (EIA) is the data source for Tables II.A.1, II.A.2, II.A.3, and II.B.1.

Table II.A.2: Maryland Generating Capacity Profile

	December 31, 1999		December 31, 2004	
Source	**MW**	**% Share**	**MW**	**% Share**
Coal	4,895	41.6%	4,958	39.7%
Petroleum	1,293	11.0%	885	7.1%
Natural Gas	1,398	11.9%	969	7.7%
Other Gases	0	0.0%	152	1.2%
Dual-Fired	1,854	15.7%	3,107	24.9%
Nuclear	1,675	14.2%	1,735	13.9%
Hydroelectric	531	4.5%	566	4.5%
Other Renewables	128	1.1%	127	1.0%
Total Generation	**11,774**	**100.0%**	**12,499**	**100.0%**

Table II.A.3 below summarizes Maryland electricity consumption by customer class for the years 1999, 2004 and 2005 and further compares it to the generation data from Table II.A.1 to show the increase in net imports over a five-year period. Electricity consumption increased by 15.7% between 1999 and 2005. This increase translates into a Maryland annualized compound growth rate of 2.5%, compared to a 1.1% national average for electricity growth. The increases in consumption between 2004 and 2005 occurred even though caps on standard offer service rates were beginning to expire and significant customer classes were starting to experience higher, market-based prices. The table shows that energy use among some customer classifications changed to a significant degree over that period. These changes were due to reclassifications of some customers in 2000, and were not the result of significant changes in actual energy usage rates. Due to the reclassification, commercial use decreased its share of the electricity market from 43.4% in 1999 to 26.2% in 2005, with industrial use increasing by a like amount, 16.8% in 1999 to 31.5% in 2005. Residential share had a slight increase of just over 2%.

Table II.A.3: Maryland Electricity Consumption and Energy Imports

	1999		2004		2005	
Retail Sales	**GWh**	**% Share**	**GWh**	**% Share**	**GWh**	**% Share**
Residential	23,342	39.5%	27,952	41.8%	28,440	41.6%
Commercial	25,662	43.4%	17,264	25.8%	17,932	26.2%
Industrial	9,936	16.8%	21,195	31.7%	21,517	31.5%
Other[7]	146	0.3%	481*	0.7%	477*	0.7%
Total (Actual)	**59,086**	**100.0%**	**66,892**	**100.0%**	**68,366**	**100.0%**
Loss Factor[8]	3,693	6.25%	4,181	6.25%	4,273	6.25%
Total (with Loss)	**62,779**		**71,073**		**72,639**	
Net Generation	51,685	82.3%	52,054	73.2%	52,662	72.5%
Net Imports	**11,094**	**17.7%**	**19,019**	**26.8%**	**19,977**	**27.5%**

7 In 2003, the "Other" section was removed; a new category called "Transportation" was used in 2004 and 2005.
8 The 6.25% loss factor is the 1999-2005 national average for transmission and distribution loss.

Of perhaps greater significance, 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 PJM region. (See section III-E for the import profiles for the other PJM member states.) This growing dependence on imports means that Maryland has an enormous stake in the reliability of the regional transmission grid and the existence of a robust wholesale power market.

B. Electric Generation Capacity and Output Profile; Potential Changes for Maryland

There has been very little change to the amount and the mix of generation in Maryland this decade. No significant generation has been added in the past three years and no units have retired since the Gould Street plant (101 MW) in the BGE zone ceased operations in November 2003. Table II.B.1 lists the current profile of Maryland-based generating units:

Table II.B.1: Maryland Generating Capacity Profile (as of January 1, 2005)

	Capacity		Vintage of Plants, by % of Fuel Type			
Primary Fuel Type	**Summer (MW)**	**Pct. of Total**	**1-10 years**	**11-20 years**	**21-30 years**	**31+ years**
Coal	4,958.0	39.7%	3.6%	13.0%	13.5%	69.9%
Dual-fired[9]	3,107.2	24.9%	13.8%	24.7%	39.4%	22.1%
Nuclear	1,735.0	13.9%	0.0%	0.0%	100.0%	0.0%
Natural/Other Gases	1,121.1	9.0%	57.2%	0.0%	0.0%	42.8%
Petroleum	885.0	7.0%	1.3%	1.9%	1.4%	95.4%
Hydroelectric	566.0	4.5%	0.0%	0.0%	0.0%	100.0%
Other Renewables	127.0	1.0%	49.4%	5.3%	45.3%	0.0%
TOTAL	**12,499.3**	**100.0%**	**10.6%**	**11.5%**	**29.6%**	**48.3%**

Coal plants[10] represent about 40% of summer peak capacity, but the only units built during the last thirty years were Constellation's two Brandon Shores plants (643 MW each, 1984 and 1991) and the AES Warrior Run plant (180 MW, 1999). The other major coal facilities in Maryland include Morgantown (1,244 MW), Chalk Point (683 MW), Dickerson (546 MW), H.A. Wagner (459 MW) and C.P. Crane (385 MW). Additionally, about 27% of all in-State capacity burns oil either as the primary or the sole fuel source and many of these facilities are aging as well. Overall, only about 22% of the State's generating capacity has been constructed in the past twenty years.

It is possible that some older units that cannot meet stricter environmental standards at the federal or State level may eventually retire. CPCN filings have been made by six of Maryland's coal facilities for various environmental upgrades for compliance with the Maryland

9 The primary fuel type of dual-fired plants: 81.7% petroleum and 18.3% natural gas.

10 Ownership breakdown of coal plants is as follows: Mirant Corp. 2,473 MW, Constellation Energy Group, Inc. 2,130 MW, AES Corp. 180 MW, Allegheny Energy Supply Co. LLC 115 MW, and New Page Corp. 60 MW.

Healthy Air Act (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.

Retirement of older generating units is occurring elsewhere within PJM. In New Jersey, PJM has granted the request of four older facilities to retire in the next two years: 285 MW at Martins Creek in September 2007, 447 MW at B.L. England in December 2007, 453 MW at Sewaren in September 2008, and 383 MW at Hudson in September 2008.

The Maryland generating output profile differs considerably from its capacity profile. In 2005, Maryland plants produced 52,662 gigawatt-hours (GWh) of electricity,[11] generated 55.7% by coal and 27.9% by nuclear plants. Thus, Maryland coal and nuclear facilities generate 83.6% of all electricity, although they represent only 53.6% of capacity. In contrast, oil and gas facilities generated but 10.6% of all electricity in 2005, despite representing 40.9% of in-State capacity.

During the past four years, the Commission has granted several CPCNs for generating projects in Maryland. Below, Table II.B.2 identifies all proposed generating projects for which the Commission has granted a CPCN. No other CPCN applications for new construction are pending. While granting a CPCN is a prerequisite for construction, granting a CPCN does not in and of itself guarantee that construction of new generation will actually take place. None of the facilities listed in Table II.B.2 (with the exception of a tiny amount of landfill gas) is under construction and no firm date to begin construction has been announced. If constructed, the electricity generated by these projects would be available to Maryland and the PJM region.

Table II.B.2: New Generating Resources Planned for Construction in Maryland

Resource Developer And Location	Capacity & Fuel	Requested In-Service Date	Interconnect w/Regional Market?	CPCN Status
Eastern Landfill Gas, LLC, Baltimore Co.	4.2 MW L.F. Gas	In-service Sept. 2006	Yes	Granted 7/19/2005
Clipper Windpower, Inc., Garrett Co.	101 MW Wind	4th Qtr. 2006	Yes	Granted 3/26/2003
Savage Mountain US Wind Force LLC, Allegany and Garrett Cos.	40 MW Wind	4th Qtr. 2007	Yes	Granted 3/20/2003
Sempra Energy, Catoctin Power LLC / Eastalco, Frederick Co.	640 MW Gas	2009	Yes	Granted 4/25/2005
Synergics Wind Energy, Roth Rock Windpower Project, Garrett Co.	40 MW Wind	2008	Yes	H.E. Proposed Order, 10/31/06
INGENCO Wholesale Power, New-land Park Landfill, Wicomico Co.	6.0 MW L.F. Gas	1st Qtr. 2007	Yes	Granted 4/8/2006

11 Source: EIA. The 52,662 GWh of electricity generated in 2005 consists of the following: coal 55.7%, nuclear 27.9%, petroleum 7.3%, natural gas 3.6%, hydroelectric 3.2%, other renewables 1.7%, and other gases 0.7%.

Growth in power plant development has been modest and has lagged electric load growth in Maryland. The total capacity for the new generating resources planned from the table above is only 831.2 MW, and as stated above no plants of significant size are under construction. Since 2000, only about 700 MW of new generation have been constructed. Natural gas (97%) has been the fuel of choice for these new peaking and mid-merit units. Renewal of federal tax credits has encouraged the planned development of wind farms in Western Maryland. Maryland's Renewable Energy Portfolio Standard and the Energy Policy Act of 2005 may also promote the development of similar facilities. In March 2003, the Commission approved CPCNs for Clipper Windpower, Inc.[12] and Savage Mountain US Windforce LLC[13]. The in-service dates for both of these facilities have been delayed due to ongoing court challenges. On October 31, 2006, a Commission Hearing Examiner (H.E.) issued a proposed order for the Synergics Wind Energy, LLC[14] project. This proposed order has been appealed by several parties and the Commission has not issued a final order. There have been no applications for large baseload power plants.

On October 27, 2005, Constellation Energy announced[15] its intention to apply to the Nuclear Regulatory Commission (NRC) for a combined nuclear construction and operating license. The company mentioned that two of the sites under consideration include its existing Calvert Cliffs Nuclear Power Plant in Southern Maryland and the Nine Mile Point Nuclear Station in upstate New York. In summer 2006, Constellation submitted into a PJM generation queue two potential nuclear power facilities that would be located at Calvert Cliffs. The two proposed units would each have a generating capacity of 1,640 MW (3,280 MW in total) and have projected in-service dates of 2015 and 2016, respectively. Given the lack of nuclear generation built in the United States in recent decades, a firm prediction that new nuclear plants will be built at Calvert Cliffs cannot be made.

C. Historic Electricity Consumption and Demand Forecast in Maryland

The 1999 Act went into effect on July of that year. Using 1999 as the base year and comparing it to 2005 data, total consumption has increased at an annual growth rate of 2.5% while generation has only increased by 1.0% per year. This moderate consumption growth rate combined with little change in generation output has resulted in Maryland electricity imports growing at an annualized rate of 10.3% over this time period. Table II.C.1 on the next page summarizes Maryland's electricity profile.

Current forecasts from PJM and the utilities estimate that electricity retail sales within Maryland will continue to increase, as they have consistently over the past fifteen years.[16]

[12] See Case No. 8938, *In the Matter of the Application of Clipper Windpower, Inc. for a Certificate of Public Convenience and Necessity to construct a 101 MW Generating Facility in Garrett County, Maryland.*

[13] See Case No. 8939, *In the Matter of the Application of Savage Mountain Windforce, LLC. for a Certificate of Public Convenience and Necessity to construct a 40 MW Generating Facility in Allegheny and Garrett Counties, Maryland.*

[14] See Case No. 9008, *In the Matter of the Application of Synergics Wind Energy, LLC. for a Certificate of Public Convenience and Necessity to construct a 40 MW Wind Power Facility in Garrett County, Maryland.*

[15] Source: Constellation Energy press release dated October 27, 2005.

[16] Other forecasts have been made that predict declining or unchanging electricity demand in Maryland for the next 10 to 15 years. If these forecasts are realized, it is likely that electric reliability problems in Maryland

However, planned generation additions within Maryland will not produce enough supply to satisfy the growth in consumption. The Table II.B.2: *New Generating Resources Planned for Construction in Maryland* lists only 831.2 MW of additional electric capacity in the next few years, but as stated previously, only 1% of the total (10 MW) is under construction or in-service.

Table II.C.1: Maryland Electricity Consumption by Class and Net Generation (GWh)

	Retail Electricity Sales (Consumption)					Pct.	Sales+Loss	Net
Year	**Res.**	**Com.**	**Ind.**	**Trans[18]**	**Total**	**Change**	**Factor[17]**	**Generation**
1990	19,102	11,021	19,308	102	49,533	N/A	52,629	33,162
1995	22,234	23,730	10,057	137	56,158	N/A	59,668	46,366
1999	23,342	25,662	9,936	146	59,086	N/A	62,779	51,686
2000	23,949	26,506	10,066	156	60,677	2.7%	64,469	51,145
2001	24,294	26,995	10,177	174	61,640	1.6%	65,493	49,062
2002	25,489	21,845	20,875	171	68,380	10.9%	72,654	48,279
2003	26,671	16,950	27,176	461	71,258	4.2%	75,712	52,244
2004	27,952	17,264	21,195	481	66,892	-6.1%	71,073	52,053
2005	28,440	17,932	21,517	477	68,366	2.2%	72,639	52,662

Table II.C.2 on the next page includes projected Maryland electricity consumption for the next ten years. Based on forecasts submitted by Maryland's electric utilities, electric energy sales will increase by nearly 17 percent between 2005 and 2016, an average annual growth rate of approximately 1.5 percent (see Table II.C.2, column one). Energy sales, exclusive of losses, are forecast to increase from 68.4 million MWh in 2005 to 79.8 million MWh in 2016. PJM is forecasting similar annual rates of growth in summer peak demand for the entire Mid-Atlantic region, including the LDA zones that cover Maryland, for the 2006 to 2017 time-period.[19]

- PJM Mid-Atlantic Region; 1.5%
- BGE zone (Central Maryland); 1.2%
- DPL zone (Delmarva including Eastern Shore); 1.9%
- PEPCO zone (Central and Southern Maryland); 1.4%
- APS zone (includes Western Maryland); 0.9%

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would be reduced, but not eliminated. Reasons for this conclusion are that consumption would be reduced by only modest amounts, and the risk of generating unit de-rates and retirements still exist. Additionally, even during previous periods of rapid electricity price increases in the 1970's and 1980's or large investments in energy efficiency programs in the 1990's, the demand for electricity in the State actually decreased only on rare occasions. During those periods, the sustainable results from the price increases and energy efficiency investments were a lowering of the rate of increase in demand.

17 "Sales + Loss Factor" is the estimated total including the 6.25% loss factor.

18 Beginning in 2003, the "Other" sector has been eliminated. Data previously assigned to the "Other" sector has been reclassified as follows: Lighting for public buildings, streets, and highways, interdepartmental sales, and other sales to public authorities are now included in the Commercial sector; agricultural and irrigation sales where separately identified are now included in the Industrial sector; and a new sector, Transportation, now includes electrified rail and various urban transit systems (such as automated guideway, trolley, and cable) where the principal propulsive energy source is electricity. Comparisons of data across years should include consideration of these reclassification changes.

19 PJM Load Forecast Report; January 2007; Prepared by PJM Capacity Adequacy Planning Department.

Table II.C.2: Maryland Electricity Consumption Forecast (GWh)

Year	Estimated Total Sales[20]	Sales + Loss Factor[21]	Net Generation[22]	Net Imports[23]	Import Percentage[24]
2006	67,429	71,644	50,908	20,736	28.9%
2007	69,152	73,474	50,908	22,566	30.7%
2008	70,213	74,601	50,908	23,693	31.8%
2009	71,410	75,873	50,908	24,965	32.9%
2010	72,525	77,058	50,908	26,150	33.9%
2011	73,657	78,261	50,908	27,353	35.0%
2012	74,854	79,532	50,908	28,624	36.0%
2013	76,022	80,773	50,908	29,865	37.0%
2014	77,244	82,071	50,908	31,163	38.0%
2015	78,487	83,393	50,908	32,485	39.0%
2016	79,789	84,776	50,908	33,868	40.0%

It should be stated that there is a great deal of uncertainty in forecasting electricity consumption on a long-term basis and that actual demand could vary significantly, particularly in the later years. There are a number of Maryland-specific factors that add to this unpredictability. One factor is the long-term status of the Eastalco smelter outside Frederick, formerly the largest electricity consumer in the State before its closure in 2005. Another is how significant of an impact the Base Realignment and Closure (BRAC) program will have on Maryland's economy and, specifically, the demand for electricity. Finally, the elasticity of consumer response to sharply higher electricity prices, on both a short-term and long-term basis, is very difficult to forecast. As noted in footnote 16, previous history suggests that customers might not reduce demand for electricity as much as one might otherwise expect in the face of higher prices and widespread availability of demand-reduction programs. However, it certainly is possible that these price signals could help trigger a new wave of demand response and energy efficiency programs and cause consumer demand to fall short of levels projected by PJM and the utilities. Given the long lead times required to plan and construct generation and transmission facilities, and Maryland's current shortages of both forms of infrastructure, the State needs to assess the extent to which it can rely on the most optimistic of the load forecasts.

For a longer-term perspective, Chart II.C.1 on the next page combines the historical data from Table II.C.1 and the projected data from Table II.C.2 into a single graphic that shows the trend lines of electricity consumption and net generation for Maryland for the 1999 to 2016 period. The Chart displays an ever widening gap between estimated net consumption and net generation that would need to be filled by net electricity imports from neighboring states. Due to

[20] "Estimated Total Sales" is the total that the Commission estimated based upon sales forecast data received from Maryland energy suppliers. Delmarva Power and Light, Potomac Edison, and Somerset did not submit a Maryland specific forecast. Therefore the Commission had to estimate those companies' forecasted demand.

[21] "Sales + Loss Factor" is the estimated total including the 6.25% loss factor.

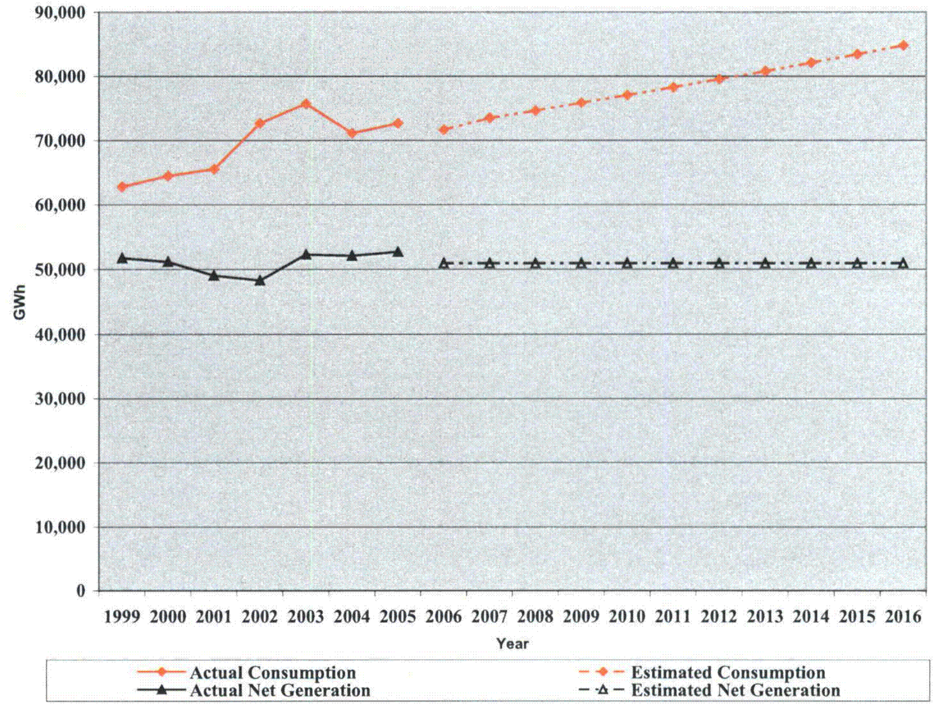
[22] "Net Generation" is the average of Maryland's net generation for the years 2000-2005.

[23] "Net Imports" is (Sales + Loss Factor) – Net Generation.

[24] "Import Percentage" is Net Imports as a percent of "Sales + Loss Factor".

the lack of scheduled construction of any in-State power plants of significant size, generation output was held constant at recent levels until 2016. However, because of the potential limitations on generation output for Maryland coal facilities due to a combination of the impacts of the Healthy Air Act and federal emissions regulations, it is not unreasonable to assume that the MWh of in-State generation may actually decline over the next ten years. In this event, the projected gap that must be filled by imports from other states would grow ever larger.

Chart II.C.1: Maryland Electricity Consumption and Net Generation, 1999 - 2016

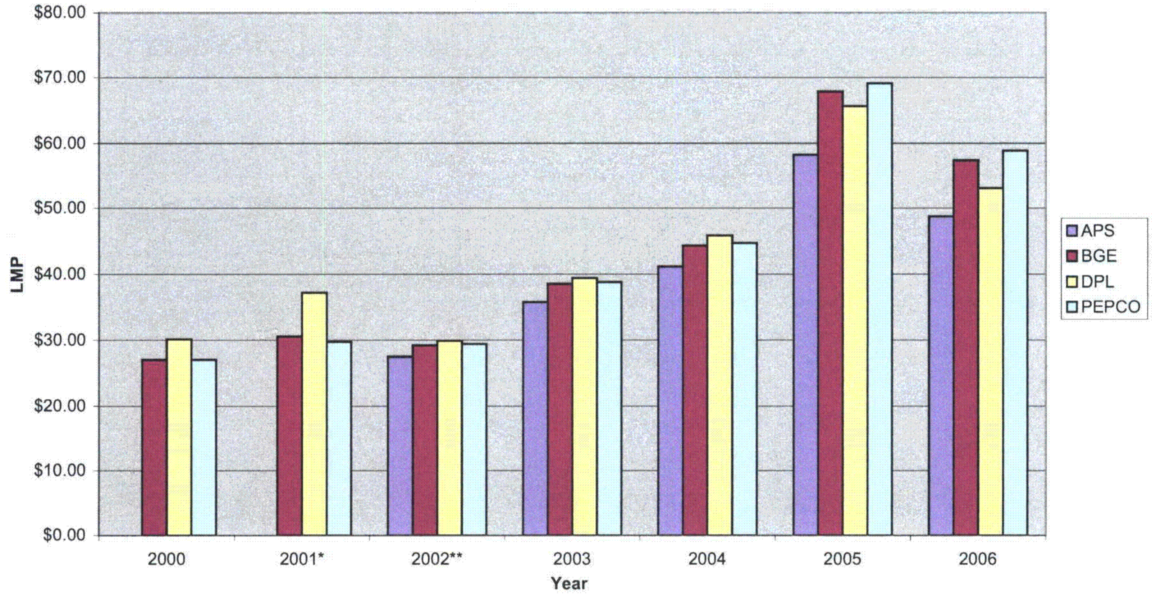


D. Transmission Congestion and High LMPs in Central and Southern Maryland

Transmission congestion occurs when constraints on the transmission system require generation to be dispatched out of merit (price) order. In effect, lower cost power cannot be delivered to where it is needed because of the congestion, so local higher cost power must be used instead. A direct consequence is that higher cost power must be dispatched to meet load requirements, and the consumers will pay higher prices.

Maryland is directly affected by transmission congestion, particularly since it and neighboring states (including the District of Columbia) have to import a large proportion of their energy needs. Evidence of electricity transmission congestion exists in the form of locational marginal prices (LMP). LMP is a pricing approach that shows the impact of congestion by calculating the real time marginal cost of out-of-merit generation, and delivering energy to the location where it is needed. LMPs in Maryland are among the very highest in PJM. While some progress has been made in the last year in reducing both the absolute LMPs and the LMP differential with other states and regions in PJM, Maryland continues to experience significant transmission congestion and high LMPs.

Chart II.D.1: Average Locational Marginal Price



* February 2001 not included in the average, data not available
** APS joined PJM in April 2002, average does not include period prior

Chart II.D.2: Average LMPs for Year 2006

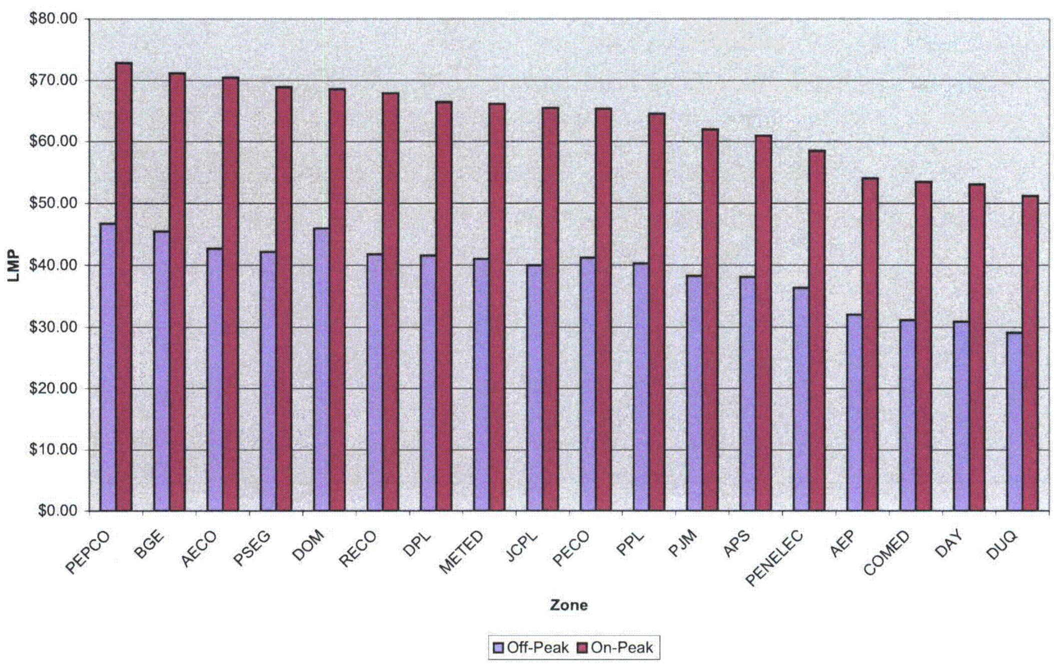
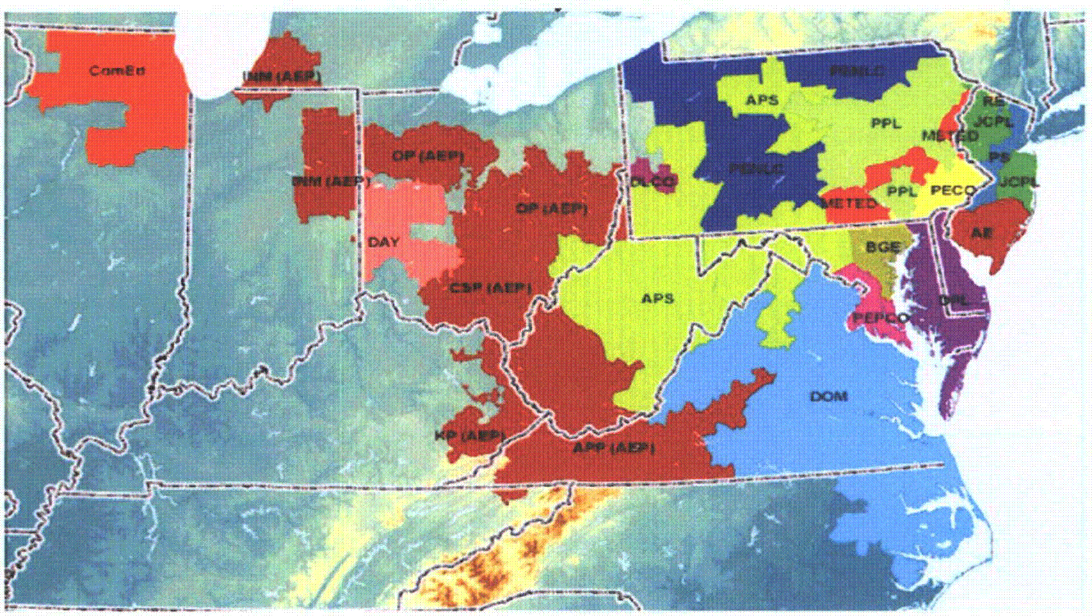


Chart II.D.1 shows the average LMP figures for the PJM zones that provide electricity to the State of Maryland. Western Maryland is covered by the Allegheny Power (APS) zone. Central Maryland includes the Baltimore Gas and Electric (BGE) and Pepco zones. The Delmarva Power and Light (DPL) zone covers the Eastern Shore. When viewing the above chart, one can see that annual average for LMPs found in Maryland had been rising steadily from 2002 to 2005. The data show a decrease for calendar year 2006. Transmission upgrades in PJM coupled with the moderation of fuel prices are the cause for the LMP decline in 2006. From 2005 to 2006, the LMP figures for BGE and Pepco have decreased by 12.86% and 11.84%, respectively. DPL and APS have experienced greater decreases with declines of 16.87% and 13.85%. This is another way of stating the earlier observation that the discrepancy between LMPs in the western part of the State and those in Central and Southern Maryland is growing.

While LMP developments in 2006 are encouraging, Maryland's problem of relatively high LMPs is not solved. Evidence of this can be found in Chart II.D.2. This chart displays the average on peak and off-peak LMP levels for the PJM energy grid. The PJM grid (PJM's footprint by zone can be seen in Map II.D.1 below[25]) is partitioned by the various zones or local deliverability areas (LDAs). The time period for which LMPs were calculated is calendar year 2006.

Map II.D.1: PJM Zones



According to data published on its website,[26] the PJM zones that serve the central Maryland areas have the highest LMPs during both on and off peak periods. On-Peak periods

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25 Source: http://www.pjm.com/documents/maps/pjm-zones.pdf

26 Monthly LMP data for PJM can be found at: ftp://www.pjm.com/pub/account/lmpmonthly/index.html.

are periods of increased usage and are defined by PJM to be weekdays, except NERC holidays[27] from the hour ending at 8:00 a.m. until the hour ending at 11:00 p.m. Off-peak periods are the periods during which overall demand is decreased. PJM deems these periods to be "all NERC holidays and weekend hours plus weekdays from the hour ending at midnight until the hour ending at 7:00 a.m."

Though the central Maryland zones have the highest LMPs in PJM, it should be noted that the zones associated with states that import large amounts of energy also have high LMPs. The AECO, DOM, PSEG, RECO, DPL, METED, JCPL, and PPL zones are in New Jersey, Virginia, Delaware and eastern Pennsylvania, all of which import large amounts of electricity from western PJM, and are, like Maryland, vulnerable to the price effects of transmission congestion.

E. Natural Gas Pipeline and LNG Terminal Infrastructure in Maryland

Maryland's natural gas pipeline infrastructure is composed of three types of systems: interstate transmission, intrastate transmission, and intrastate distribution. The Commission has jurisdiction over the intrastate facilities while the federal government has jurisdiction over the interstate facilities. Currently there are six interstate transmission companies that operate pipelines and related facilities in Maryland:

- Williams Gas Pipeline
- Eastern Shore Natural Gas
- Colonial Pipeline Company
- Columbia Gas Transmission Company
- Dominion Transmission & Dominion Cove Point LNG, LP
- Duke Energy Gas Transmission

The natural gas distribution infrastructure within Maryland is comprised of eight local distribution companies and one municipality. Table II.E.1 shows the miles of mains and the number of services that each local distribution company has.

Table II.E.1: Miles of Main and Number of Services

Local Distribution Company	Miles of Main	Number of Services
Baltimore Gas & Electric (BGE)	6,746	240,792
Chesapeake Utilities	262	11,912
Columbia Gas of Maryland	622	36,275
Easton Utilities	82	3,583
Elkton Gas	87	4,747
Frederick Gas	477	23,783
PPL Gas Inc.	19	439
Washington Gas	5,114	354,104

[27] NERC Holidays are New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, and Christmas Day.

While local distribution companies within Maryland have for the most part been able to expand their systems to meet the growing demand for natural gas, where natural gas is not readily available, piped propane systems have become an alternative. Currently, the State of Maryland has nine jurisdictional operators of piped propane systems, ranging in size between 10 customers, such as a shopping center, to more sizable systems, the largest having 10,265 customers. Eastern Shore Gas has the largest system encompassing the towns of Ocean City, Berlin, Snow Hill, Pocomoke City and their surrounding areas. State regulatory jurisdiction over piped propane covers safety only.

Within Maryland, two companies operate liquefied natural gas facilities: Dominion Transmission (Dominion Cove Point LNG, LP) and BGE. Dominion Transmission's Cove Point facility is located in Calvert County, Maryland. Cove Point is an import terminal used for the storage and dispatch of imported liquefied natural gas (LNG) into major interstate transmission pipelines. Dominion's Cove Point LNG import terminal is under the jurisdiction of the federal government, FERC being the exclusive licensing authority. BGE has two LNG facilities under the jurisdiction of the State. Its Spring Garden facility is a liquefaction/peaking plant located in Baltimore City. The plant takes natural gas off of its system during the warmer months, liquefies it and stores it until it is needed during the winter where it is re-gasified and sent out into its system. BGE's other facility is a satellite plant located in Westminster, Maryland. The satellite plant stores liquefied natural gas from Spring Gardens, delivered by truck, and stores it until it is needed during the winter for peak shaving purposes.

The Cove Point facility is being expanded and upon completion will be the largest LNG terminal in the United States. Dominion Resources received authorization from the FERC to begin construction of the addition on August 18, 2006. Construction began with official ground breaking ceremonies on October 5, 2006. The expansion will increase Cove Point's send-out capacity from 1 billion cubic feet per day to 1.8 BCF and storage capacity will increase from 7.8 BCF to 14.6 BCF. The existing and increased output from the Cove Point facility is destined to service natural gas markets in the Mid-Atlantic and Northeast United States, including Maryland. The project is being built in part because of the lack of firm pipeline capacity to transport natural gas from traditional natural gas producing regions in the Gulf of Mexico, the Gulf Coast, Texas, Oklahoma, and elsewhere in the southwestern United States.

In addition, AES Corporation filed an application with the FERC in January 2007 to build a second LNG facility at the Sparrows Point Industrial Complex. The facility, if built, would have a send-out capacity of 1.5 BCF, with provision for future expansion to increase send-out capacity to 2.25 BCF. As is the case with Cove Point, the need for the project is asserted to be the inability to acquire firm natural gas commitments from traditional domestic supply sources in the southeast and southwestern United States. The Sparrows Point facility would supply natural gas to homes, businesses, utilities, and natural gas fired power plants in the Mid-Atlantic region. The facility would be interconnected with existing natural gas pipelines via a new 85-mile pipeline, to be named Mid-Atlantic Express, LLC. Recently, the Sparrows Point developer announced an intention to construct a 300 MW gas-fired electric generating plant using LNG that has been gasified as the fuel.

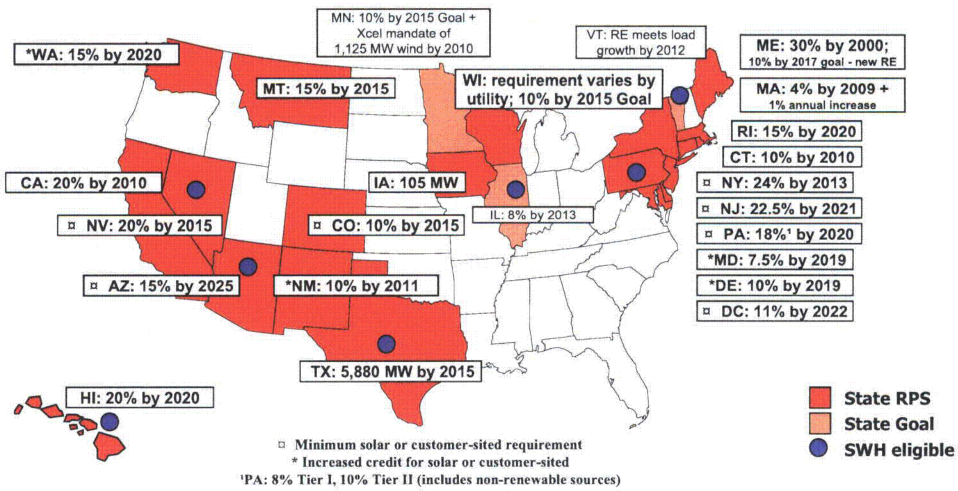
In order to comply with State and federal air emission statutes, increased output from natural gas power plants may be necessary. If so, expansion of existing LNG facilities as is occurring at Cove Point, and construction of new LNG facilities as proposed at Sparrows Point, may be required if natural gas deliveries for all purposes are to be assured.

F. Impacts of the Renewable Energy Portfolio Standard (RPS)

Maryland is one of twenty-four states and the District of Columbia that have implemented a Renewable Portfolio Standard Program. RPS programs typically require either the electricity suppliers in a state or the companies that deliver power to customers in the state to obtain a portion of their electricity from renewable resources. Each state has tailored its version of the RPS to meet specific policy goals, including development of special categories of renewable resources. Map II.F.1[28] displays the various state RPS programs.

PUC Article § 7-701 et seq. (RPS Legislation) describes the RPS for Maryland and how electricity suppliers can satisfy it. The legislation requires that the Commission implement the RPS. Implementation of the RPS is accomplished via a system that facilitates the trading of Renewable Energy Credits[29] (RECs), representing the generation of electricity from qualifying renewable resources. Maryland RECs are defined as coming from Tier 1[30] or Tier 2[31] sources. The RPS began on January 1, 2006, with 2006 being the first compliance year.

Map II.F.1: States with Renewable Portfolio Standards



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28 Source: http://www.dsireusa.org/

29 A REC is equal to the renewable attributes associated with one megawatt-hour of energy generated using specified renewable resources. Each supplier must present, on an annual basis, RECs equal to the percentage specified by the RPS Legislation. Generators and suppliers are allowed to trade RECs using a Commission sanctioned or established REC registry and trading system. A REC has a three-year life during which it may be transferred, sold, or otherwise redeemed.

30 Tier 1 RECs are RECs awarded for electricity generation from the following fuel sources: solar, wind, qualifying biomass, landfill or waste water treatment plant gas, geothermal, ocean, fuel cell that produces electricity from a Tier 1 renewable source, and small hydroelectric (less than 30 MW in rated capacity).

31 Tier 2 RECs are RECs awarded for electricity generation from the following fuel sources: hydroelectric power (rated capacity greater than 30 MW) other than pump storage generation, incineration of poultry litter, and waste-to-energy.

Suppliers that do not meet the annual RPS are required to pay a compliance fee as prescribed in the RPS Legislation. Compliance fees[32] will be a source of funding for the Maryland Renewable Energy Fund. The Maryland Renewable Energy Fund is designed to promote the development of renewable energy resources in Maryland. The Commission is responsible for creating and administering the overall RPS program. Responsibility for developing renewable energy resources, including administering the fund, has been vested with the Maryland Energy Administration (MEA).

Chart II.F.1: MD RPS Certified Rated Capacity by State (as of 12/31/2006)

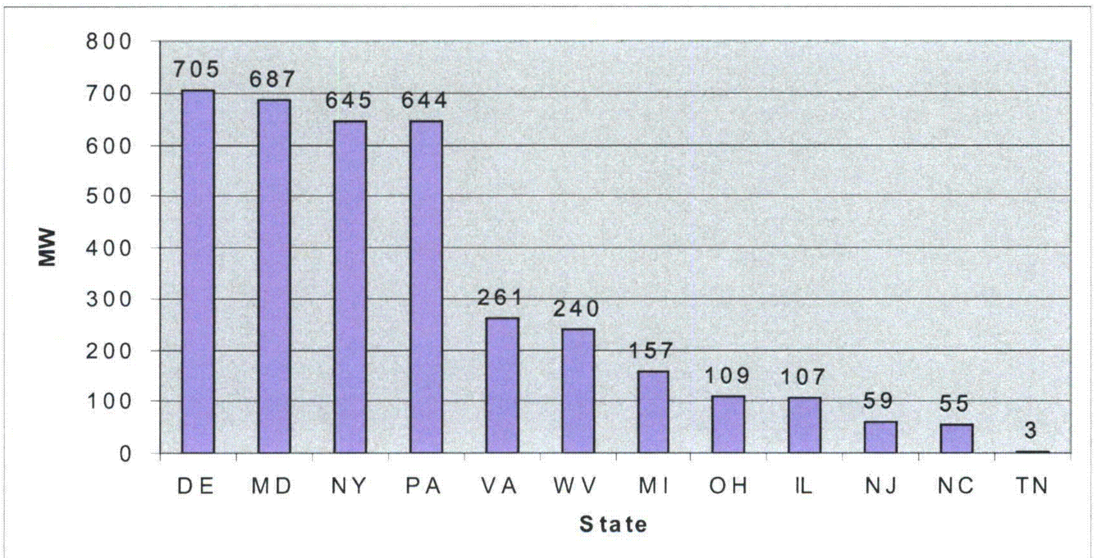


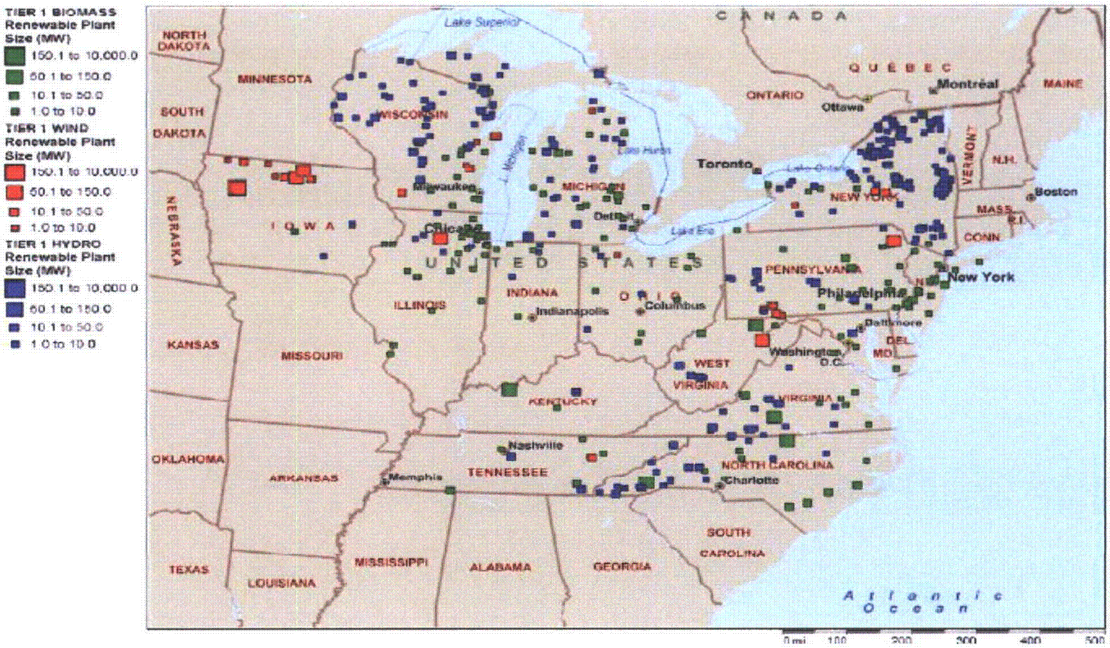
Chart II.F.1 presents the capacity that is currently registered for the RPS program and their geographic locations. While a significant amount of RPS eligible generation is in Maryland, the chart clearly shows that several other states have approximately equal amounts of eligible capacity including Delaware, New York and Pennsylvania. West Virginia, Virginia, Michigan, Ohio, and Illinois also have significant amounts of generation eligible to participate in the Maryland RPS.

Maps II.F.2 and II.F.3 show the approximate location and size of Tier 1 and Tier 2 facilities that may be eligible to participate in the Maryland RPS Program. This information is from a study[33] conducted by the Maryland Power Plant Research Program (PPRP) on the behalf of the Maryland Department of Natural Resources (DNR). The Maryland statute states that to qualify to sell RECs, a facility may be located in states that are both in the PJM RTO or in states adjacent to the states that lie within the PJM RTO. Based upon findings by the Maryland PPRP, for the foreseeable future it appears that the resulting geographic footprint allows for a significant number of existing resources to participate in the Maryland RPS.

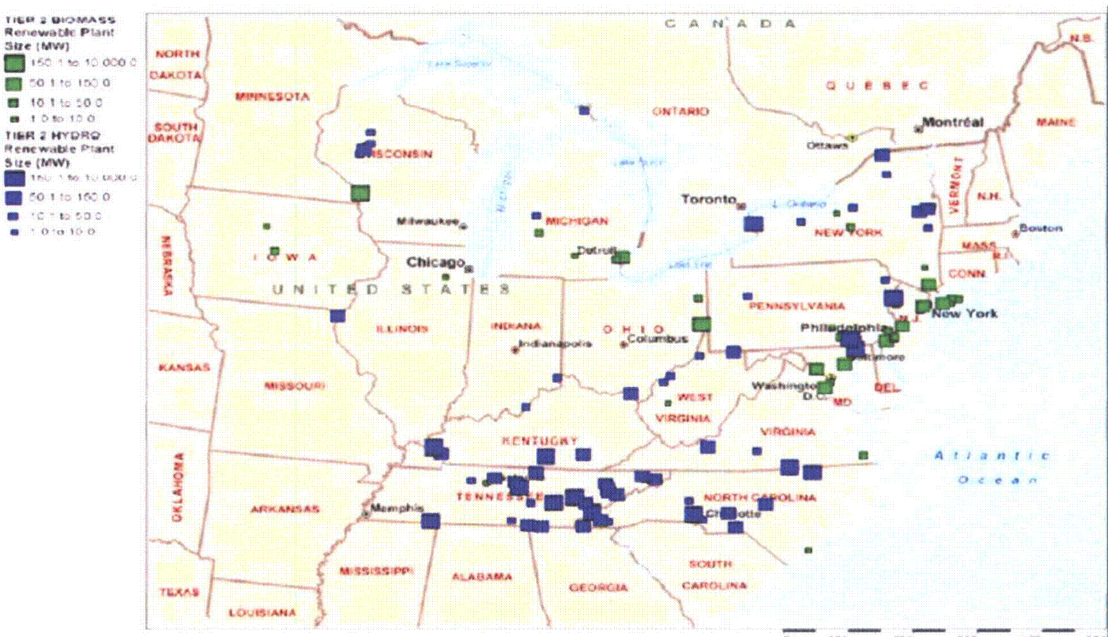
[32] Under § 7-707 of the RPS Statute the compliance fee is 2 cents for each kWh of Tier 1 shortfall and 1.5 cents for each kWh of Tier 2 Shortfall. For a designated industrial process load the compliance fee is 0.8 cents for each kWh of Tier 1 shortfall and no compliance fee for a Tier 2 shortfall.

[33] Source: http://esm.versar.com/pprp/bibliography/PPES_06_01/PPES_06_01.pdf.

Map II.F.2: Potential Tier 1 Renewable Energy Facilities by Technology Type and Size[34]



Map II.F.3: Potential Tier 2 Renewable Energy Facilities by Technology Type and Size[35]



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[34] Source: Maryland Power Plant Research Program – Inventory of Renewable Energy Resources Eligible for the Maryland Renewable Energy Portfolio Standard.

[35] Source: Maryland Power Plant Research Program – Inventory of Renewable Energy Resources Eligible for the Maryland Renewable Energy Portfolio Standard.

G. Demand Side Management, Demand Response and Distributed Generation

In 1991, the Maryland General Assembly enacted an energy conservation measure that is codified as §7-211 of the PUC Article. This provision required 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 Commission directed each affected utility to develop a comprehensive conservation plan. The Commission 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.

As noted earlier in this Report, another development in this area was the enactment of the 1999 Act. The 1999 Act established the legal framework for the restructuring of the electric utility industry in Maryland. The 1999 Act also modified PUC Article §7-211 to require that the Commission ensure that electric choice does not adversely impact the continuation of cost-effective energy conservation and efficiency programs. The amended section enumerates various factors the Commission should consider when determining whether a program or service encourages and promotes the efficient use and conservation of energy. Finally, the General Assembly required the Commission to evaluate current and potential Demand-Side Management (DSM) programs to suggest whether these programs are necessary or desirable, and to identify programs that are cost-effective. The Commission also was instructed to recommend the appropriate method of funding for any DSM programs found to be useful and cost-effective.

In 2001, the Commission issued a report on these matters to the General Assembly in consultation with the MEA. The report found generally that DSM programs could be useful tools, providing they met appropriate cost-effectiveness tests. Prior to the 1999 Act, such programs provided benefits including enhanced consumer education and awareness of ways to conserve energy, reduced environmental pollution, improved reliability, and positive effects on individual consumer's economic well-being as well as the State's overall economy. However, the report noted that, going forward, it would be increasingly difficult for DSM programs to be cost-effective given that generation, which has been deregulated, could no longer be considered in part of a traditional avoided cost analysis. The Commission suggested that the most beneficial way to determine whether a DSM program is cost-effective is to determine the overall demand reduction goal and decide whether the goal justifies the effort and attendant costs. The Commission supported the MEA as the appropriate agency to oversee DSM programs and recommended that programs be funded through the general fund or general obligation bonds rather than using public service company rates to recover these costs.

In the Phase II settlement agreement accepted by the Commission in Case No. 8908[36] on September 30, 2003, the parties to the settlement agreement agreed to the establishment of a working group:

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[36] Re *Competitive Selection of Electricity Supplier/Standard Offer Service (SOS)*, 94 Md. PSC, 113, 286 (2003). The PSC established Case No. 8908 for the purpose of investigating options for the competitive provision of SOS to electric customers once the obligation imposed on electric companies expired. The Commission issued orders approving a settlement in two phases on April 29, 2003 (Phase I), and October 1, 2003 (Phase II).

8.4 ASSESSMENT OF NEED FOR POWER

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

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

8.4.1 ASSESSMENT OF THE NEED FOR NEW CAPACITY

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

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

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

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

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

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

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

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

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

Energy Efficiency, Wholesale, and Retail Opportunities

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

8.4.2 OTHER BENEFITS OF NEW NUCLEAR CAPACITY

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

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

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

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

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

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

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

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

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

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

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

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

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

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

- U.S. economic reviews of the British study support it with "high confidence" (Yohe, 2007)."

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

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

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

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

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

8.4.3 SUMMARY OF NEED FOR POWER

In summary:

- The State of Maryland has a well-defined, systematic, and comprehensive resource monitoring, assessment, and reporting process that reviews the State's resources and growing demand for additional baseload capacity, eliminating the need for additional NRC review.

- The Maryland PSC has concluded that there is a need for new baseload capacity, and this conclusion has been given "great weight," herein as allowed for by the guidance in NUREG-1555 (NRC, 1999).

- The Maryland PSC/PPRP/CPCN process gives NRC assurance that construction would not proceed without the State's due consideration of the project's impact on supply adequacy and on the stability and reliability of the electric system in the state.

- The growing demand for new capacity shows benefits to be derived from CCNPP Unit 3.
- Given State concerns about climate change and carbon emissions, CCNPP Unit 3 serves another important need by reducing carbon emissions in Maryland. The new plant will offset significant amounts of carbon, as compared to a coal-fired generating plant.
- Decreased reliance on fossil fuels.
- The potential to reduce the average cost of electricity to consumers by increasing availability of low cost power generation to in-state consumers through the competitive marketplace.
- Improved diversity of the sources of energy relied upon for baseload generation.

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

8.4.4 REFERENCES

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Application NAB-2007-08123-M05
Response to U.S. Army Corps of Engineers Information Request Dated 10/28/08
Calvert Cliffs 3 Project, LLC and UniStar Nuclear Operating Services, LLC
November 21, 2008

Question 14

Are there any brownfields at the proposed project site?

RESPONSE

The following areas on the CCNPP South Parcel might be considered brownfield sites, under the EPA definition[1], until environmental investigation efforts verify otherwise:

- Vehicle Fueling/Repair Facility (Heavy Duty Shop)
- Hazardous Substances Storage Facility
- Pre-Assembly Facility

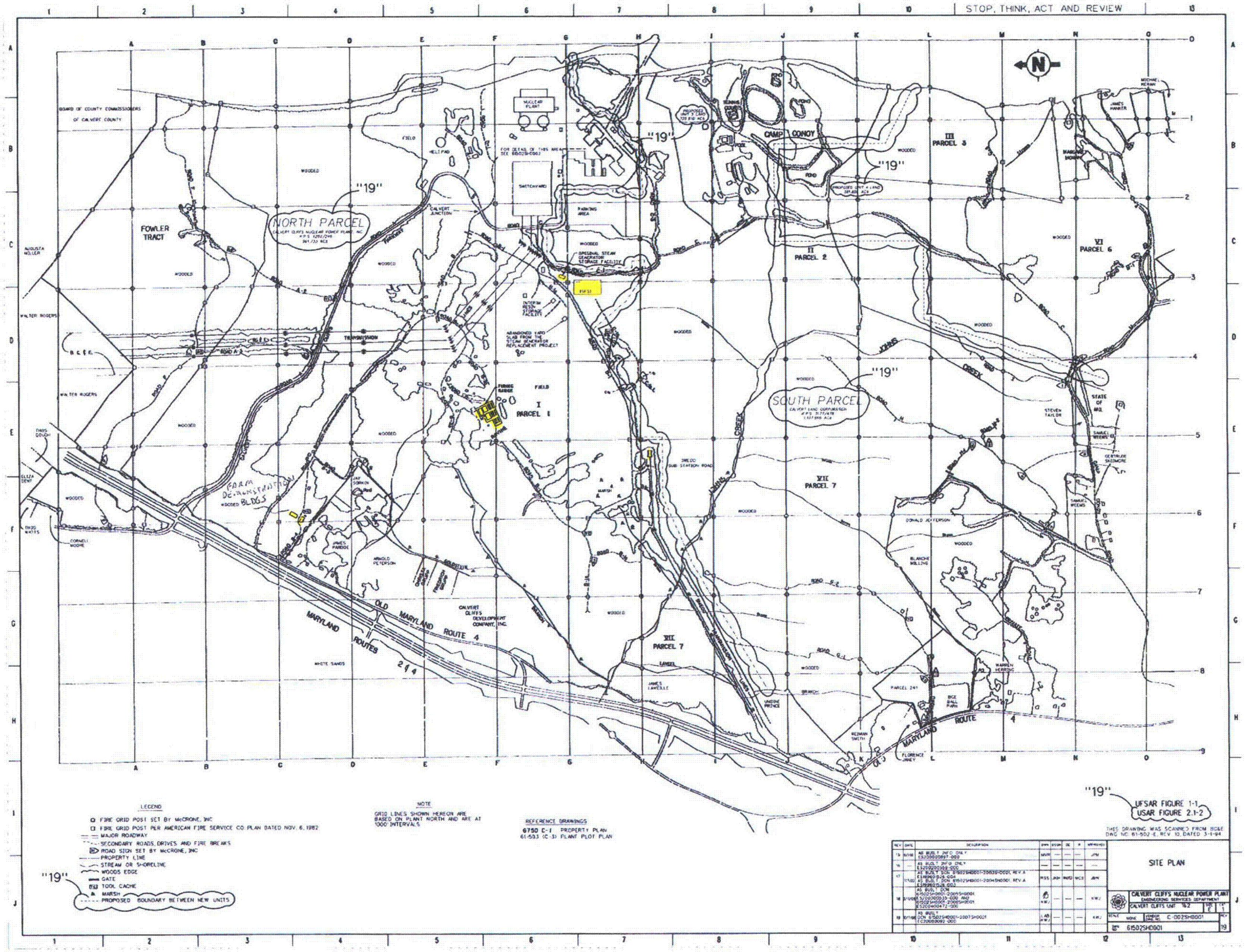
The following areas on the CCNPP North Parcel might be considered brownfield sites, under the EPA definition, until environmental investigation efforts verify otherwise:

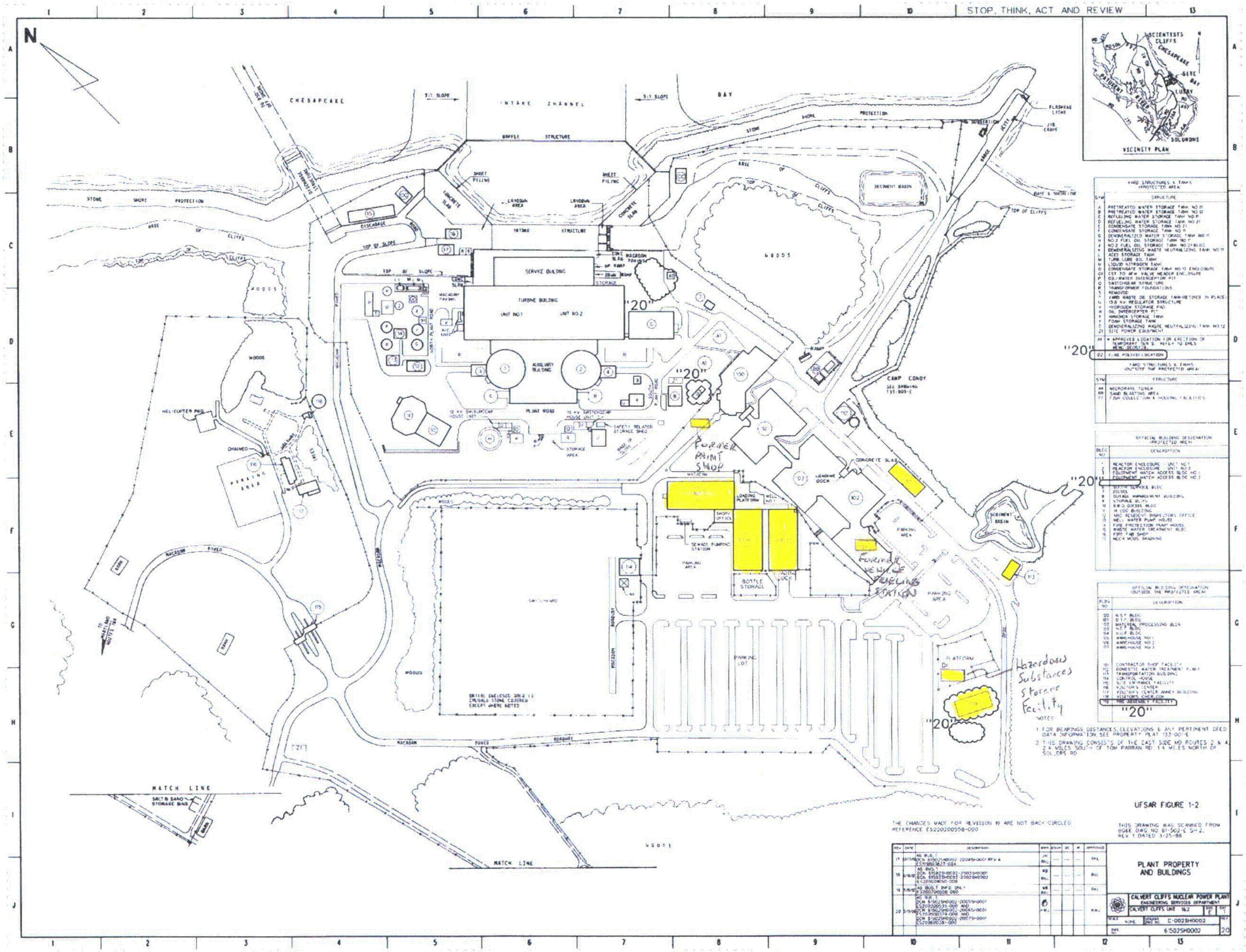
- CCNPP Firing Range
- Dredge Spoils Area (Lake Davies)
- SMECO 69 kV Substation
- Former Paint Shop Location
- Former Vehicle Fueling/Repair Facility (Heavy Duty Shop)
- CCNPP Warehouse areas where long term hazardous material storage occurred
- Current Vendor Shop Buildings (across from Materials Processing Facility)
- Old Steam Generator Storage Facility
- Farm Demonstration Storage Building

To the extent any such facility is removed prior to the construction of Calvert Cliffs Unit 3, the Co-Applicants will conduct an appropriate environmental review, investigation, and remediation as necessary.

The location of these areas is identified on the figure below.

1 The US EPA defines "Brownfield" as the following: "With certain legal exclusions and additions, the term `brownfield site' means real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. "


STOP, THINK, ACT AND REVIEW
NORTH PARCEL
SOUTH PARCEL
FOWLER TRACT
CAMP CONOY
PARCEL 1
PARCEL 2
PARCEL 3
PARCEL 6
PARCEL 7
NUCLEAR PLANT
SWITCHYARD
PARKING AREA
TRANSMISSION
JOHNS CREEK
OLD MARYLAND ROUTE 4
MARYLAND ROUTES 2 & 4
MARYLAND ROUTE 4
FARM DEMONSTRATION BLDGS
"19"
UFSAR FIGURE 1-1
USAR FIGURE 2.1-2
THIS DRAWING WAS SCANNED FROM BG&E DWG NO 61-502-E, REV 10, DATED 3-1-94
LEGEND
FIRE GRID POST SET BY McCRONE, INC
FIRE GRID POST PER AMERICAN FIRE SERVICE CO PLAN DATED NOV. 6, 1982
MAJOR ROADWAY
SECONDARY ROADS, DRIVES AND FIRE BREAKS
ROAD SIGN SET BY McCRONE, INC
PROPERTY LINE
STREAM OR SHORELINE
WOODS EDGE
GATE
TOOL CACHE
MARSH
PROPOSED BOUNDARY BETWEEN NEW UNITS
NOTE
GRID LINES SHOWN HEREON ARE BASED ON PLANT NORTH AND ARE AT 1000' INTERVALS
REFERENCE DRAWINGS
6750 C-1 PROPERTY PLAN
61-503 (C-3) PLANT PLOT PLAN
SITE PLAN
CALVERT CLIFFS NUCLEAR POWER PLANT
ENGINEERING SERVICES DEPARTMENT
CALVERT CLIFFS UNIT 1&2
C-002SH0001
61502SH0001


STOP, THINK, ACT AND REVIEW
N
CHESAPEAKE
INTAKE CHANNEL
BAY
BAFFLE STRUCTURE
SHEET PILING
INTAKE STRUCTURE
SERVICE BUILDING
TURBINE BUILDING
UNIT NO 1
UNIT NO 2
AUXILIARY BUILDING
PLANT ROAD
WOODS
HELICOPTER PAD
PARKING AREA
PARKING LOT
SWITCHYARD
LOADING PLATFORM
BOTTLE STORAGE
CONCRETE SLAB
SEDIMENT BASIN
CAMP CONOY
PLATFORM
MATCH LINE
SALT & SAND STORAGE BINS
FLASHING LIGHT
JIB CRANE
TOP OF CLIFFS
"20"
Former Paint Shop
Former vehicle fueling station
Hazardous Substances Storage Facility
SCIENTISTS CLIFFS
CHESAPEAKE
SITE
LUSBY
SOLOMONS
VICINITY PLAN
YARD STRUCTURES & TANKS (PROTECTED AREA)
SYM
STRUCTURE
A PRETREATED WATER STORAGE TANK NO 11
B PRETREATED WATER STORAGE TANK NO 12
C REFUELING WATER STORAGE TANK NO 11
D REFUELING WATER STORAGE TANK NO 21
E CONDENSATE STORAGE TANK NO 21
F CONDENSATE STORAGE TANK NO 11
G DEMINERALIZED WATER STORAGE TANK NO 11
L ACID STORAGE TANK
M TURB. LUBE OIL TANK
N LIQUID NITROGEN TANK
P OIL/WATER INTERCEPTOR PIT
Q SWITCHGEAR STRUCTURE
R TRANSFORMER FOUNDATIONS
S REMOVED
U 13.8 KV REGULATOR STRUCTURE
V HYDROGEN STORAGE PAD
W OIL INTERCEPTER PIT
Y FOAM STORAGE TANK
Z1 SITE POWER EQUIPMENT
YARD STRUCTURES & TANKS (OUTSIDE THE PROTECTED AREA)
AA MICROWAVE TOWER
BB SAND BLASTING AREA
CC FISH COLLECTION & HOLDING FACILITIES
OFFICIAL BUILDING DESIGNATION (PROTECTED AREA)
BLDG NO
DESCRIPTION
REACTOR ENCLOSURE - UNIT NO 1
REACTOR ENCLOSURE - UNIT NO 2
OFFICIAL BUILDING DESIGNATION (OUTSIDE THE PROTECTED AREA)
101 CONTRACTOR SHOP FACILITY
112 DOMESTIC WATER TREATMENT PLANT
113 TRANSPORTATION BUILDING
114 CONTROL HOUSE
115 SITE ENTRANCE FACILITY
116 VISITOR'S CENTER
117 VISITOR'S CENTER ANNEX BUILDING
118 VISITOR'S OVERLOOK
119 PRE-ASSEMBLY FACILITY
NOTES
1. FOR BEARINGS, DISTANCES, ELEVATIONS & ANY PERTINENT DEED DATA INFORMATION SEE PROPERTY PLAT 133-001-E
2. THIS DRAWING CONSISTS OF THE EAST SIDE MD ROUTES 2 & 4, 2.4 MILES SOUTH OF TOM PARRAN RD, 1.4 MILES NORTH OF SOLLERS RD
UFSAR FIGURE 1-2
THE CHANGES MADE FOR REVISION 19 ARE NOT BACK-CIRCLED
REFERENCE ES200200558-000
THIS DRAWING WAS SCANNED FROM BG&E DWG NO 61-502-E SH 2, REV 1 DATED 3-25-88
PLANT PROPERTY AND BUILDINGS
CALVERT CLIFFS NUCLEAR POWER PLANT
ENGINEERING SERVICES DEPARTMENT
CALVERT CLIFFS UNIT 1&2
C-002SH0002
61502SH0002
20
Rev 20 2008

Application NAB-2007-08123-M05
Response to U.S. Army Corps of Engineers Information Request Dated 10/28/08
Calvert Cliffs 3 Project, LLC and UniStar Nuclear Operating Services, LLC
November 21, 2008

Question 15

Will the construction and heavy haul roads be permanent use roads?

RESPONSE

The construction and heavy haul roads will remain in place for permanent use after construction. The construction road will normally be blocked during normal operation of Units 1, 2, and 3, but may be opened as needed to support maintenance and refueling outages. The heavy haul road will be used as needed to transport heavy loads to/from the barge pier and for transporting dry shielded canisters containing spent fuel from the Auxiliary Building to the Independent Spent Fuel Storage Installation (ISFSI). Portions of the current ISFSI heavy haul route will also be utilized for normal vehicular entrance into Unit1/2 and Unit 3 Protected Area.

Dimitri Lutchenkov
Director, Environmental Affairs

100 Constellation Way, Suite 1400P
Baltimore, Maryland 21202-3106

UniStar
NUCLEAR ENERGY

November 25, 2008

UN#08-081

Mr. William P. Seib
Chief, Maryland Section Southern
U.S. Army Corps of Engineers – Baltimore District
10 S. Howard Street
Baltimore, MD 21201

Subject: Joint Federal/State Application of Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC, Calvert Cliffs Nuclear Power Plant Site, Lusby, Calvert County, Maryland, USACE Tracking No. NAB-2007-08123-M05

Reference: USACE Letter from William P. Seib (USACE) to Thomas E. Roberts (UNE), dated October 28, 2008

Dear Mr. Seib:

Enclosed are the responses to Questions 4, 5, and 9 to your USACE letter dated October 28, 2008 (Reference). In addition, we have enclosed an updated response to Question 1.

Please do not hesitate to contact me at 410-470-5524, if you have any questions concerning the enclosed responses.

Sincerely,

Dimitri Lutchenkov

Enclosures

cc: Kathy Anderson – USACE
Thomas Fredericks – NRC
Susan Gray – PPRP
Robert Tabisz – MDE
Jeff Thompson – MDE

Application NAB-2007-08123-M05
Response to U.S. Army Corps of Engineers Information Request Dated 10/28/08
Calvert Cliffs 3 Project, LLC and UniStar Nuclear Operating Services, LLC
November 25, 2008

Question 4

A revised proposal to reduce wetland and stream impacts to the minimum necessary to meet access and safety requirements.

a. **Relocate or redesign the proposed construction laydown areas to uplands.**

b. **Modify the construction schedule so that the areas proposed for permanent impacts could be utilized as construction laydown areas.**

c. **Construct a retaining wall for the switchyard in lieu of the proposed grading.**

RESPONSE

4a. An upland laydown area containing approximately 60 acres is located northwest of the power block and adjacent to the existing Units 1 and 2 laydown yards (located within the Lake Davies area). The remaining laydown areas are required for staging areas for major components and critical materials that will be incorporated into the new plant. Due to the large size of some components and volume of materials that must be moved into the nuclear island, turbine island, and cooling tower coupled with the limited access into those areas, the designated laydown areas are critical to support essential material control and safe material handling activities.

4b. The switchyard and cooling tower areas are to be utilized as staging and fabrication areas for the first few years of construction for the larger modules that will be fabricated near the nuclear island. The area to the south of the power block will be utilized for erection of two concrete batch plants and their required aggregate and cement storage. The placement of the batch plant near the nuclear island, the turbine island, and the cooling tower is necessary to minimize concrete transport times and improve the ability to place quality concrete in these critical structures.

4c. A retaining wall could be added along the west of the construction access road which runs along the western side of the switchyard. However, this retaining wall would only reduce the impacts directly associated with the embankments and would not decrease impacts associated with the switchyard itself nor the stormwater management features west of the construction access road (e.g., stormwater pond, filtration trench).

Therefore, it is not practicable to further reduce the wetland and stream impacts within the construction areas.

Application NAB-2007-08123-M05
Response to U.S. Army Corps of Engineers Information Request Dated 10/28/08
Calvert Cliffs 3 Project, LLC and UniStar Nuclear Operating Services, LLC
November 25, 2008

Question 5

A revised proposal to reduce impacts to tidal waters to the minimum necessary for ingress and egress and erosion control.

a. **Reduce the width of the proposed dredge channel to the minimum necessary for barge ingress and egress and to ensure dredge barge access for the proposed method of dredging**

b. **Reduce the stone revetment footprint channelward of the intake area.**

c. **Reduce the length and width of the impact area for the discharge pipe and fish return to the minimum necessary to meet the purpose of these projects aspects.**

RESPONSE

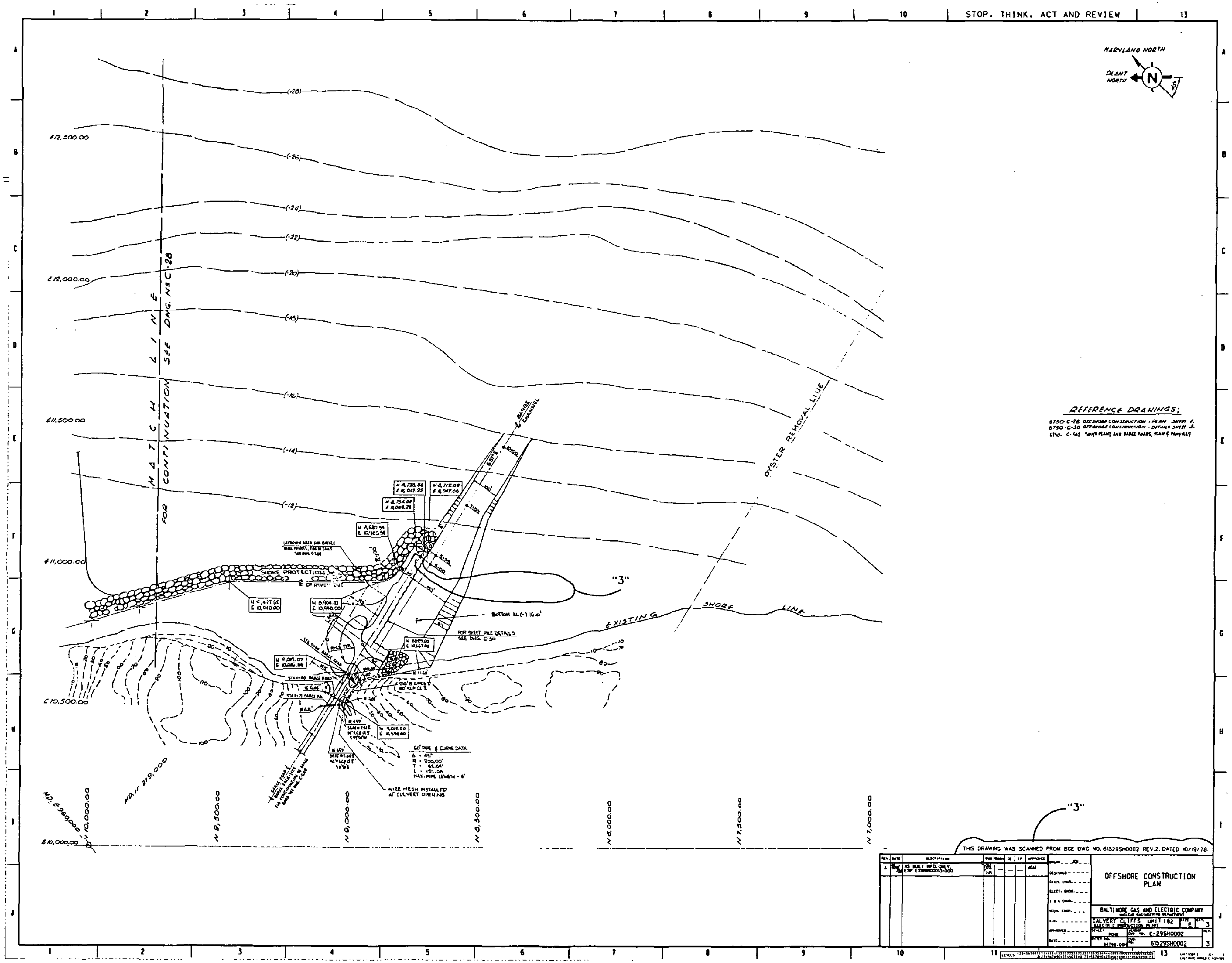
5a. The barge area width duplicates the original design for Units 1 and 2 (i.e., maintenance dredging) and is based on allowing for up to 4 barges to be moored at given time to accommodate deliveries during the peak construction period. For reference, see original plant drawing C-29, titled "Offshore Construction Plan – Sheet 2.

5b. The width at base of the riprap protection of 115-ft can be reduced based on the contour and 3:1 slope, to 95-ft. with toe included. This goes to a bottom elevation of El. -22 ft. (shown on Figure 3A). Separately, the top width of armor protection will be changed to 10-ft. instead of 6-ft., as shown.

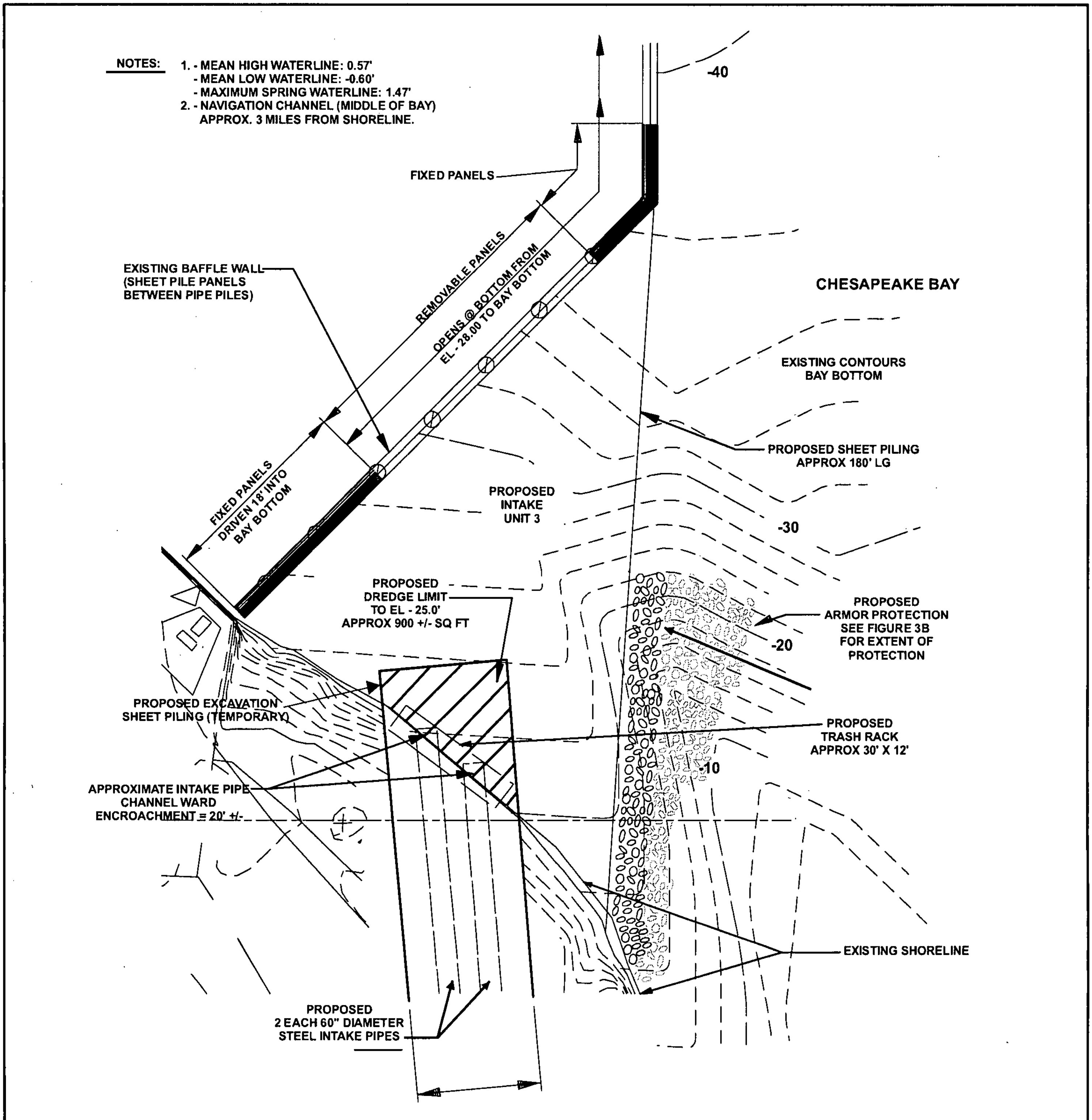
5c The length of the fish return pipe (Ref. Figure 4A) is based on having the outlet pipe discharge below the mean low low water (MLLW) to ensure survivability of the fish being returned to the bay through the fist return system. The width of impact area is based on dredging a 5-foot wide pipe channel with 5:1 side slopes. The width and side slopes selected are based on practical dredging limitations and to provide adequate width to ensure that the pipe channel does not fill in prior to installing the pipe, which could potentially require re-dredging of the area prior to placing the outfall. The upper soils that will be dredged are recent sediments and are soft. Smaller and/or steeper slopes will likely encounter constructability issues.

The length of the discharge pipe (Ref. Figure 5B) is based on requiring the outfall to be set at Elevation -10 ft. for system design requirements. As with the fish return line, the width is based on dredging a 3′ – 6′ wide trench with 5:1 side slopes. The width and side slopes selected are based on practical dredging limitations and provide adequate width to ensure that the pipe channel does not fill in prior to installing the pipe, which could potentially require re-dredging of the area prior to placing the outfall. The upper soils that will be dredged are recent sediments and are soft. Smaller and/or steeper slopes will likely encounter constructability issues.

Therefore, it is not practicable to further reduce the length and width of the impacted areas.


STOP. THINK. ACT AND REVIEW
MARYLAND NORTH
PLANT NORTH
MATCH LINE
FOR CONTINUATION SEE DWG. No. C-28
E12,500.00
E12,000.00
E11,500.00
E11,000.00
E10,500.00
E10,000.00
(-28)
(-26)
(-24)
(-22)
(-20)
(-18)
(-16)
(-14)
(-12)
BARGE CHANNEL
OYSTER REMOVAL LINE
SHORE PROTECTION
EXISTING SHORE LINE
"3"
BOTTOM EL.(-)11.60'
FOR SHEET PILE DETAILS SEE DWG. C-30
WIRE MESH INSTALLED AT CULVERT OPENING
60" PIPE & CURVE DATA
Δ = 45°
R = 200.00'
T = 82.84'
L = 157.08'
MAX. PIPE LENGTH = 4'
N 9,500.00
N 9,000.00
N 8,500.00
N 8,000.00
N 7,500.00
N 7,000.00
MD. E 960000
N 10,000.00
MD.N 219,000
REFERENCE DRAWINGS;
6750-C-28 OFFSHORE CONSTRUCTION - PLAN SHEET 1.
6750-C-30 OFFSHORE CONSTRUCTION - DETAILS SHEET 3.
6750- C-542 SOUTH PLANT AND BARGE ROADS, PLAN & PROFILES
THIS DRAWING WAS SCANNED FROM BGE DWG. NO. 61529SH0002 REV.2. DATED 10/19/78.
REV | DATE | DESCRIPTION | DWN | CHKD | DE | IP | APPROVED
3 | AS BUILT INFO. ONLY. ESP ES800013-000
DRAWN
DESIGNED
CIVIL ENGR.
ELECT. ENGR.
I & C ENGR.
MECH. ENGR.
APPROVED
DATE
OFFSHORE CONSTRUCTION PLAN
BALTIMORE GAS AND ELECTRIC COMPANY
NUCLEAR ENGINEERING DEPARTMENT
CALVERT CLIFFS UNIT 1&2
ELECTRIC PRODUCTION PLANT
SIZE E
CAT. 3
SCALE: NONE
VENDOR DWG. NO. C-29SH0002
34796.004
DWG. NO. 61529SH0002
REV. 3

TIDAL



PURPOSE: PLANT EXPANSION
DATA SOURCE: BECHTEL CORPORATION
DATUM: (NGVD 29)
PROJECT LATITUDE/LONGITUDE: 38.424133 -76.441598

N

FIGURE 3A
SITE PLAN @ UNIT 3 INTAKE STRUCTURE - SHT 2

SCALE IN FEET
0 25 50 Feet

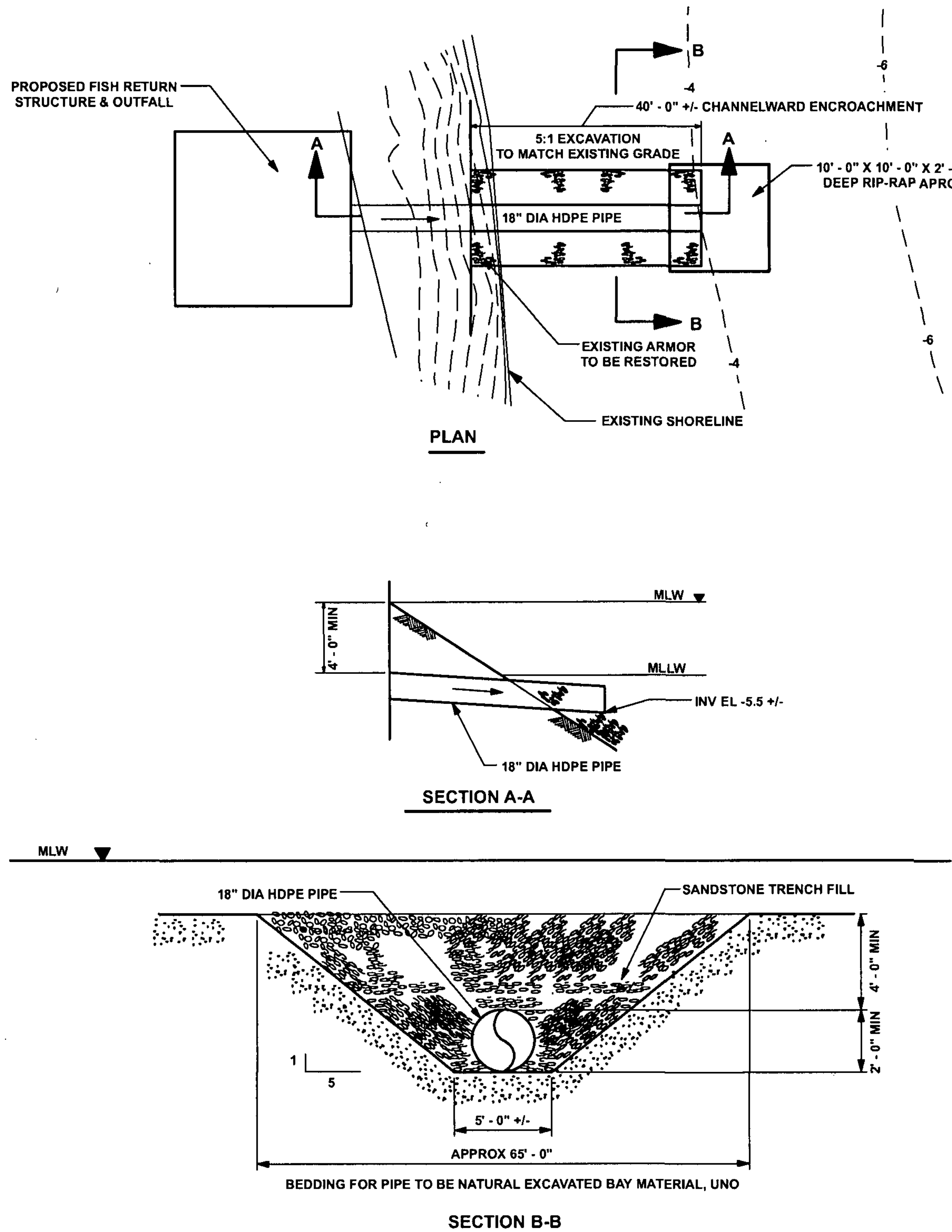
CALVERT CLIFFS NUCLEAR POWER PLANT

IN: PATUXENT / WEST CHESAPEAKE BAY
COUNTY OF: CALVERT STATE: MD
APPLICATION BY: CALVERT CLIFFS 3 NUCLEAR PROJECT, LLC AND UNISTAR NUCLEAR OPERATING SERVICES,LLC

DATE: 5/09/08 REV1 7/14/08

Map Document: (G:\Calvert Cliffs\frozen_5_1_08\404\Final Figures\figure4_key.mxd)
6/19/2008 -- 8:41:18 AM

TIDAL



PURPOSE: PLANT EXPANSION
DATA SOURCE:
BECHTEL CORPORATION
DATUM: (NGVD 29)
PROJECT LATITUDE/LONGITUDE:
38.424133
-76.441598

FIGURE 4A
FISH RETURN

SCALE IN FEET

NOT TO SCALE

CALVERT CLIFFS NUCLEAR POWER PLANT

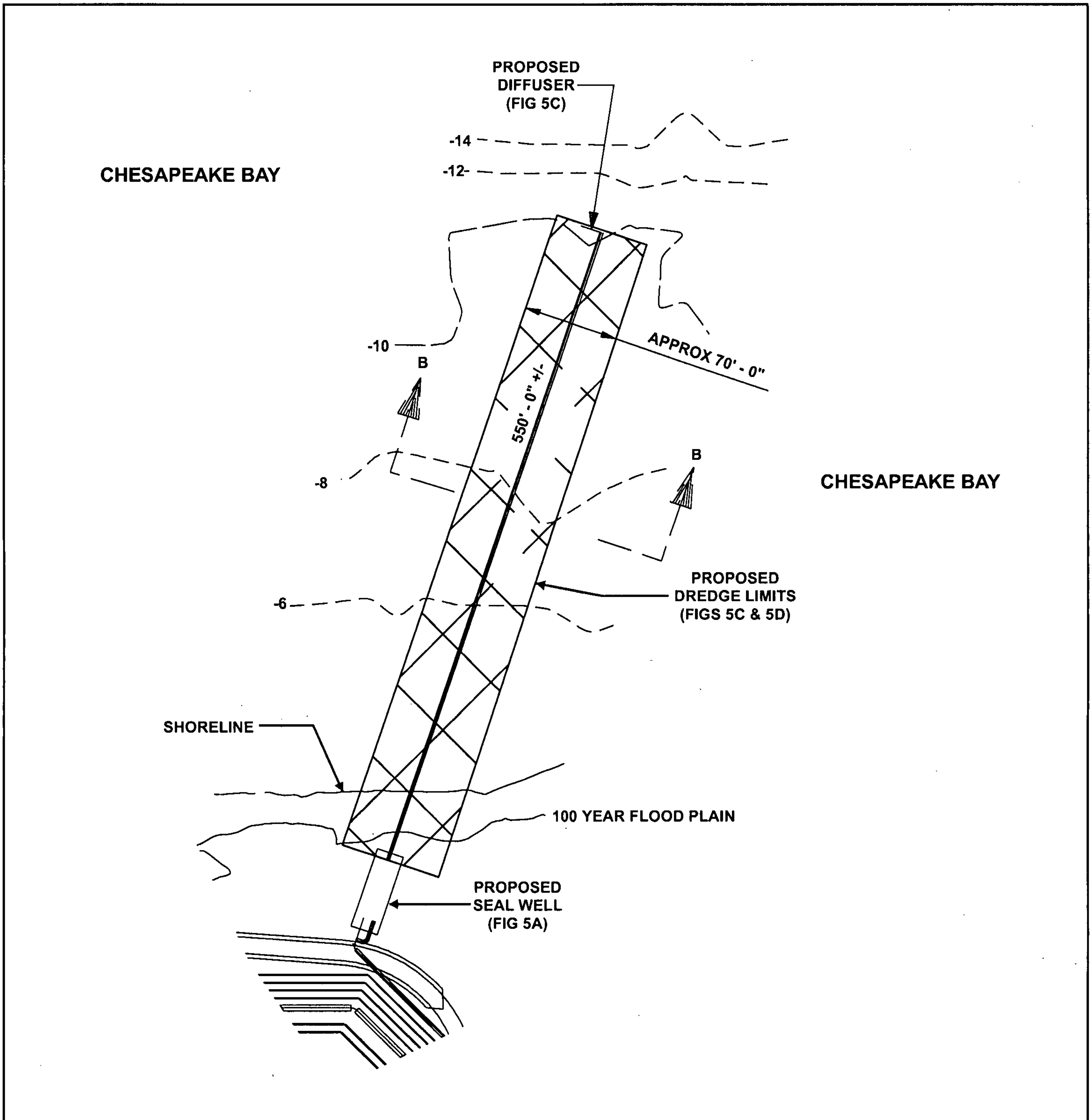
IN:
PATUXENT / WEST CHESAPEAKE BAY
COUNTY OF: CALVERT STATE: MD

APPLICATION BY:
CALVERT CLIFFS 3 NUCLEAR PROJECT, LLC
AND UNISTAR NUCLEAR OPERATING SERVICES,LLC

DATE: 5/09/08 REV1 7/14/08

Map Document: (G:\Calvert Cliffs\frozen_5_1_08\404\Final Figures\figure4__key.mxd)
6/19/2008 -- 8:41:18 AM

TIDAL



PURPOSE: PLANT EXPANSION DATA SOURCE: BECHTEL CORPORATION DATUM: (NGVD 29) PROJECT LATITUDE/LONGITUDE: 38.424133 -76.441598	**FIGURE 5B SEAL WELL & DISCHARGE PIPING** SCALE IN FEET 0 100 200 Feet	**CALVERT CLIFFS NUCLEAR POWER PLANT** IN: PATUXENT / WEST CHESAPEAKE BAY COUNTY OF: CALVERT STATE: MD APPLICATION BY: CALVERT CLIFFS 3 NUCLEAR PROJECT, LLC AND UNISTAR NUCLEAR OPERATING SERVICES,LLC DATE: 5/09/08 REV1 7/14/08

Map Document: (G:\Calvert Cliffs\frozen_5_1_081404\Final Figures\figure4__key.mxd)
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Application NAB-2007-08123-M05
Response to U.S. Army Corps of Engineers Information Request Dated 10/28/08
Calvert Cliffs 3 Project, LLC and UniStar Nuclear Operating Services, LLC
November 25, 2008

Question 9

A plan to manage potential impacts to aquatic species during pile driving work at the barge unloading facility site, including the use of curtains or containment structures.

a. **Describe any pre-cast concrete elements that may be installed into the water for pier facility construction or rehabilitation work.**

b. **Explain the potential aquatic species turbidity impacts and shock wave impacts due to driving large diameter steel piles for dock facility construction and provide a construction plan that would minimize these impacts, as well as quantify the difference due to implementation of these potential methods such as, but not limited to, silt or bubble curtains and netting.**

RESPONSE

9a Pre-cast Concrete Elements

The Calvert Cliffs 3 project does not plan on using any pre-cast concrete elements to be installed into the water.

9b Turbidity impacts and shock wave impacts (pile driving)

The Calvert Cliffs Unit 3 project will implement Best Management Practice (BMP) and Best Available Technologies (BATs) to ensure environmental compliance with applicable state and/or federal requirements to minimize turbidity during dredging and pile driving operations. BMP will be based on utilization of technical guide documents such as; 1) Maryland Standards and Specifications for Soil Erosion and Sediment Control, Maryland Department of the Environment, Water Management Administration, 1994, 2) Maryland Stormwater Design Manual, Volumes I and II, Maryland Department of the Environment, Water Management Administration, 2000, and 3) USACE Dredging Operations and Environmental Research (DOER) Program document ERDC TN-DOER-E21, "Silt Curtains as a Dredging Project Management Practice", September 2005 (Attachment 1). Typical topics covered in these guides include planning considerations (site-specific project conditions), design criteria, construction specifications (curtains and other materials), installation or deployment, removal, and maintenance. Consultation with qualified vendors (see examples Attachment 2) will also be utilized to ensure BMP and BAT.

Pile Driving Tasks Proposed for CCNPP Unit 3

Three pile driving tasks are proposed for construction of CCNPP Unit 3. The first task, adjacent to the existing Intake Area, would produce the most significant hydroacoustic impacts. The sheet piling area would be 180' W x 60' L, with an embedded length of approximately 15'. Soldier piles (30" dia. steel piles), would be installed on approximately 10' centers. These piles will be driven with conventional pile hammers. PZ 27/22 or equivalent steel sheet piling is anticipated for construction of the CCNPP Unit 3 intake structure. Sheet piling is anticipated to be driven with vibratory hammers. Construction duration for this task is estimated as two (2) months.

The existing Intake Area consists of several hundred feet of sheet pile that protect the sea water intakes for CCNPP Units 1 and 2. Shoreline adjacent to the existing sheet pile has been armored with riprap to protect against shore erosion. The sheet pile enclosure blocks the passage of most fish that might get close to the Units 1 and 2 intake structures and a return system discharges any impinged fish back to the ocean. The proposed new sheet pile for Unit 3 will entail only a minor modification to the existing sheet pile in this area.

The second task, to be constructed in the existing Barge Unloading Area, will entail shallower depths than the Intake Area. Any impacts from this activity would be smaller in comparison to impacts of sheet piling installation in the Intake Area. The area would be 90' W x 20'L with an embedded length of approximately 15', using PZ 27/22 sheet piling and 30" soldier piles supporting the sheet piling. Construction duration for this task is estimated as two (2) weeks.

The third task, to be constructed from the Intake Area to the Intake Structure Area, will occur on shore and is not expected to have any impact on aquatic resources. The task area will be 1600' L x 60' W. PZ 27/22 sheet piling with an embedded length of approximately 45'. Construction duration is estimated as four (4) months.

Sediment Impacts of Pile Driving: Minimal sediment disturbance will occur in conjunction with the pile driving operation. Pile driving compresses the surrounding soils, resulting in a stabilizing effect on the soils. Installation of rock armor along the toe of the sheet piling will protect against any transport of sediment away from this area that might result from wind, tides or currents.

Proposed sheet piling construction in the intake wedge area will result in minimal changes to the existing shoreline configuration and sediment transport/deposition patterns. The proposed construction will affect 180 feet of existing sheet piling and armored shoreline in an area where prior construction has occurred.

Mitigation measures for barge slip dredging and construction activities in the area of the new intake structure and discharge outfall include installing a silt curtain around each dredge or active dredge area to minimize sediment release, as far as practicable, at the seabed/silt curtain interface and at the surface water level/silt curtain interface. Construction activities include pile driving in the Intake Area and the Barge Unloading Area.

Pile Construction Noise and Vibration Impacts: This discussion relies heavily on research and interim guidance developed by the Fisheries Hydroacoustic Working Group (FHWG), which appears to constitute the most comprehensive and up to date efforts to avoid, minimize or mitigate the impacts of pile driving hydroacoustics. While the FHWG studies focus only on fish, the intent is to establish guidelines that are protective of marine mammals, sea turtles, diving birds and other aquatic organisms by addressing the most sensitive representative (fish) for all of these fauna.

Research and Guidelines: Until recently, very little data or guidance has been available that specifically addressed the noise impacts of pile driving. This deficiency was recognized when design of earthquake resistant structures such as replacement of the San Francisco Oakland Bay Bridge required the use of large diameter cast in steel shell (CISS) piles driven with impact hydraulic hammers. In response, the California Department of Transportation (Caltrans) in coordination with the Federal Highways Administration (FHWA) and the departments of transportation in Oregon and Washington established a Fisheries Hydroacoustic Working Group (FHWG) in order to improve and coordinate information on fishery impacts due to underwater sound pressure caused by in-water pile driving. In addition to the above transportation agencies, the FHWG is composed of representatives from NOAA Fisheries (Southwest), NOAA Fisheries (Northwest), U.S. Fish and Wildlife Service, California Department of Fish and Game, and the U.S. Army Corps of Engineers. The FHWG is supported by a panel of hydroacoustic and fisheries experts who have been recommended by the FHWG members. A Steering Committee oversees the FHWG and is composed of managers with decision-making authority from each of the members' organizations (Caltrans, 2008).

The goal of the Working Group is to reach agreement on: 1) The nature and extent of knowledge about the current scientific basis for underwater noise effects on fish, 2) Interim guidelines for project assessment, mitigation, and monitoring for effects of pile-driving noise on fish species, and; 3) Future scientific research needed to satisfactorily resolve uncertainties regarding hydroacoustic impacts on fish species.

Metrics: From numerous options, the FHWG utilizes two standards for measurement of underwater pile driving sound and vibration impacts. The peak sound-pressure level (Peak Pressure or peak) is measured in decibels relative to a reference level of one micro Pascal (dB re 1 *u*Pa). The cumulative sound exposure level (SEL) is: dB re 1 $u\text{Pa}^2$-s and is defined as the constant sound level of 1s duration that would contain the same acoustic energy as the original sound. Both measures are standardized at a distance of 10 m from the pile (Hawkins, A. 2006).

Background Studies-Pile Driving Sound: Support for development of the FHWG Interim Criteria included studies collecting and evaluating currently available information. This included compilation of available measurements of noise and vibration impacts associated with various forms of pile driving. Typical ranges of Peak Pressure and Cumulative SEL are illustrated in Table 1 (Hastings, M. 2005).

Table 1
Summary of Measured Underwater Sound Levels Near Marine Pile Driving

Pile Type	Distance from Pile (m)	Peak Pressure (dB re 1 μPa)	RMS (impulse) Pressure (dB re 1 μPa)	SEL (dB re 1 μPa2-s)
--Various Projects				
Timber (12-in) Drop	10	177	165	157
CISS (12-in) Drop	10	177	165	152
Concrete (24-in) Impact (diesel)	10	188	176	166
Steel H-Type Impact (diesel)	10	190	175	--
CISS (12-in) Impact (diesel)	10	190	180	165
CISS (24-in) Impact (diesel)	10	203	190	178
CISS (30-in) Impact (diesel)	10	208	192	180
--Richmond-San Rafael Bridge				
CISS (66-in) Impact (diesel)	4	219	202	--
CISS (66-in) Impact (diesel)	10	210	195	--
CISS (66-in) Impact (diesel)	20	204	189	--
--Benicia-Martinez Bridge				
CISS (96-in) Impact (Hydraulic)	5	227	215	201
CISS (96-in) Impact (Hydraulic)	10	220	205	194
CISS (96-in) Impact (Hydraulic)	20	214	203	190
--SFOBB East Span				
CISS (96-in) Impact (Hydraulic)	25	212	198	188
CISS (96-in) Impact (Hydraulic)	50	212	197	188
CISS (96-in) Impact (Hydraulic)	100	204	192	180

In addition to pile type and size, numerous other factors contribute to the noise impacts of pile driving. Tables 2 & 3 (Caltrans, 2007) illustrate differences between using an impact hammer vs. a vibratory driver; Table 2 also illustrates differences associated with relative water depth.

Table 2
Summary of Near-Source (10-Meter) Unattenuated Sound Pressures for In-Water Pile Driving using an Impact Hammer

Pile Type and Approximate Size	Relative Water Depth	Average Sound Pressure Measured in dB		
		Peak	RMS	SEL
0.30 m (12-inch) Steel H-type-Thin	<5 meters	190	175	160
0.30 m (12-inch) Steel H-type-Thick	~5 meters	195	183	170
0.6 meter (24-inch) AZ Steel Sheet	~15 meters	205	190	180
0.61 meter (24-inch) Concrete Pile	~5 meters	185	170	160
0.61 meter (24-inch) Concrete Pile	~15 meters	188	176	166
0.30 meter (12-inch) Steel Pipe Pile	<15 meters	192	177	—
Pile Type and Approximate Size	**Relative Water Depth**	**Average Sound Pressure Measured in dB**		
		Peak	**RMS**	**SEL**
0.36 meter (14-inch) Steel Pipe Pile	~15 meters	200	184	174
0.61 meter (24-inch) Steel Pipe Pile	~15 meters	207	194	178
0.61 meter (24-inch) Steel Pipe Pile	~5 meters	203	190	177
1 meter (36-inch) Steel Pipe Pile	<5 meters	208	190	180
1 meter (36-inch) Steel Pipe Pile	~10 meters	210	193	183
1.5 meter (60-inch) Steel CISS	<5 meters	210	195	185
2.4 meter (96-inch) Steel CISS	~10 meters	220	205	195

Table 3
Summary of Near-Source (10-Meter) Unattenuated Sound Pressures for In-Water Pile Installation using a Vibratory Driver/Extractor

Pile Type and Approximate Size	Relative Water Depth	Average Sound Pressure Measured in dB		
		Peak	RMS	SEL
0.30 meter (12-inch) Steel H-type	<5 meters	165	150	150
0.30 meter (12-inch) Steel Pipe Pile	<5 meters	171	155	155
1 m (36-inch) Steel Pipe Pile-Typical	~5 meters	180	170	170
0.6 m (24-inch) AZ Steel Sheet-Typical	~15 meters	175	160	160
0.6 m (24-inch) AZ Steel Sheet-Loudest	~15 meters	182	165	165
1 m (36-inch) Steel pipe Pile-Loudest	~5 meters	185	175	175
1.8 m (72-inch) Steel Pipe Pile-Typical	~5 meters	183	170	170
1.8 m (72-inch) Steel Pipe Pile-Loudest	~5 meters	195	180	180

Background Studies-Impacts of Sound on Fish: The FHWG analyzed all available studies to address known impacts of sound on fish and to establish noise standards that would be protective of fishery resources. The objectives of this analysis are summarized as follows (Theiss, S. 2007): "Ideally we want to define interim sound exposure criteria as representing the received signal level that defines the *onset* of effects, rather than using data representing effects at some point past their onset; however, data for the onset of effects in fishes are not available in the literature. Moreover, instead of proposing one set of criteria, peak sound pressure level (SPL) and cumulative sound exposure level (SEL), we propose criteria for each of *three different effects on fish*:

1) Hearing loss due to temporary threshold shift (TTS);
2) Damage to auditory tissues (generally sensory hair cells of the ear); and
3) Damage to non-auditory tissues.

At the same time, we also recognize that the biology of individual fish species as well as the physiological state of individual fish may alter the nature and sequence of effects. Based on the available scientific literature, vulnerability to non-auditory tissue damage increases as the mass of the fish decreases. Therefore, non-auditory tissue damage criteria are different depending on the mass of the fish.

Interim Criteria: The FHWG met in June 2008 and agreed to new interim, dual criteriafor injury to fish from pile driving noise. These new criteria are to be used as of August 2008 until further notice. This criteria (See Table 4) includes a peak level of 206 dB AND a cumulative

SEL level of 187 dB for fish 2 grams and heavier OR a cumulative SEL of 183 dB for fish smaller than 2 grams.

Table 4
FHWG Agreement in Principle Technical/Policy Meeting Vancouver, WA *June, 11 2008*

Interim Criteria for Injury	Agreement in Principle
Peak	206 dB (for all size of fish)
Cumulative SEL	187 dB – for fish size of two grams or greater. 183 dB – for fish size of less than two grams.*

Signatories to the FHWG Interim Criteria include California Department of Transportation, Oregon Department of Transportation, Washington State Department of Transportation, California Department of Fish and Game, Federal Highways Administration (FHWA), NOAA Fisheries (Southwest), NOAA Fisheries (Northwest), U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers.

While the Interim Criteria are currently applicable to the three west coast states, ongoing research may contribute to expansion of these (or succeeding) criteria to other coastal jurisdictions. Towards this end, Caltrans is participating in the National Cooperative Highway Research Program (NCHRP) study #25-28 "Predicting and Mitigation Hydroacoustic Impacts on Fish from Pile Installation" and the Transportation Pooled Fund Program Study "Structural Acoustic Analysis of Piles."

Among the Pile Driving examples illustrated in Tables 1 - 3, the entry in Row 7 of Table 1 represents the only entry for 30" steel pipe, with a peak sound impact of 208 db and a cumulative SEL of 180 dB. No water depth is indicated for this entry. Table 2, Row 9 lists an entry for 24" steel pipe in approximately 5 meters water depth. This impact is 203 db peak and 177 db SEL. Table 2, Row 10 lists 208 dB peak and 180 dB SEL for 36" steel pipe in less than 5 meters water depth.

These entries suggest that driving 30" steel pipe piles with conventional hammers at the project sites could produce sound impacts that approach or exceed the interim guidance criteria of 206 dB Peak. The project does not appear likely to exceed the minimum SEL criteria of 183 dB for fish size less than 2 grams. Driving the sheet piling does not appear to approach any of the interim criteria thresholds.

Minimizing Noise and Vibration Impacts: If warranted, additional measures for minimizing noise and vibration impacts are available for heavy duty pile driving, large projects or highly sensitive project environments. These include bubble curtains around large piles to muffle sound and vibration, and alternative hammers/drivers that generate less sound. Silt curtains are planned to be used around the pile driving area to minimize sediment impacts. To some extent, the curtains will muffle the noise and vibration impacts.

The following table provides a list of estuarine species in the Chesapeake Bay that could be exposed to noise and vibration impacts of the proposed project. The list indicates the relative sensitivity of each species and their probable response to noise and vibration impacts.

Pile Driving Impacts to Estuarine Species in Chesapeake Bay near the CCNP Site

Species (*Scientific Name*)	Major Impacts	Moderate Impacts	Minor Impacts	Seasonal Impacts	No Impacts
Threatened and Endangered Species					
Shortnose sturgeon (*Acipenser brevirostrum*)					X
Atlantic sturgeon (*Acipenser oxyrhynchus oxyrhynchus*)			X		
Atlantic loggerhead turtle (*Caretta caretta*)			X	X	
Kemps ridley turtle (*Lepidochelys kempii*)			X	X	
Harvested Fish					
American shad (*Alosa sapidissima*)			X	X	
Bay anchovy (*Anchoa mitchilli*)					X
Atlantic menhaden (*Brevoortia tyrannus*)			X		
Atlantic croaker (*Micropogonias undulatus*)			X		
Striped bass (*Morone saxatilis*)		X			
Spot (*Leiostomus xanthurus*)		X			
White perch (*Morone americana*)		X			
Bluefish (*Pomatomus saltatrix*)					X
American eel (*Anguilla rostrata*)					X
Harvested Invertebrates					
Blue crab *Callinectes sapidus*		X			
American oyster *Crassostrea virginica*		X			
Additional Species					
Summer flounder (*Paralichthys dentatus*)		X			
Red drum (*Sciaenops ocellatus*)					X
Weakfish (*Cynoscion regalis*)					X

Species (*Scientific Name*)	Major Impacts	Moderate Impacts	Minor Impacts	Seasonal Impacts	No Impacts
Spotfin killifish (*Fundulus luciae*)					X
Alewife (*Alosa pseudoharengus*)					X
Blueback herring (*Alosa aestivalis*)					X
Green sea turtle (*Chelonia mydas*)					X
Leatherback sea turtle (*Dermochelys coriacea*)					X
Three Spine Stickleback (*Gasterosteus aculeatus*)		X		X	
Four Spine Stickleback (*Apeltes quadracus*)		X			
Black Drum (*Pogonias cromis*)			X	X	
Black sea bass (*Centropristis striata*)			X		
Bluegill (*Lepomis macrochirus*)					X
Striped blenny (*Chasmodes bosquianus*)			X	X	
Feathered blenny (*Hypsoblennius hentz*)			X	X	
Blue catfish (*Ictalurus furcatus*)			X	X	
White catfish (*Ameiurus catus*)			X	X	
Channel catfish (*Ictalurus punctatus*)			X	X	
Brown bullhead (*Ameiurus nebulosus*)			X	X	
Yellow bullhead (*Ameiurus natalis*)			X	X	
Cobia (*Rachycentron canadum*)					X
Cownose ray (*Rhinoptera bonasus*)			X	X	
Naked goby (*Gobiosoma bosc*)		X		X	
Seaboard goby (*Gobiosoma ginsburgi*)				X	
Green goby (*Microgobius thalassinus*)				X	
Hickory shad (*Alosa mediocris*)					X
Hogchoker (*Trinectes maculatus*)		X			

Species (*Scientific Name*)	Major Impacts	Moderate Impacts	Minor Impacts	Seasonal Impacts	No Impacts
Lined seahorse (*Hippocampus erectus*)			X		
Longnose gar (*Lepisosteus osseus*)			X	X	
Lookdown (*Selene vomer*)			X		
Spanish mackerel (*Scomberomorus maculatus*)					X
King mackerel (*Scomberomorus cavalla*)					X
Northern puffer (*Sphoeroides maculatus*)			X	X	
Oyster toadfish (*Opsanus tau*)			X		
Northern pipefish (*Syngnathus fuscus*)					X
Dusky pipefish (*Syngnathus floridae*)					X
Pumpkinseed (*Lepomis gibbosus*)			X	X	
Sandbar shark (*Carcharhinus plumbeus*)		X		X	
Northern searobin (*Prionotus carolinus*)			X		
Skilletfish (*Gobiesox strumosus*)			X		
Tautog (*Tautoga onitis*)			X	X	

Explanatory Notes:

Shortnose Sturgeon - Likelihood of encounter not high, are migratory and will presumably move away from area of impact (Natureserve)

Atlantic Sturgeon - Current distribution area includes Calvert County, are migratory and will presumably move away from area of impact (Natureserve) (Jenkins, 1994)

Atlantic Loggerhead Turtle - Chesapeake Bay important in summer months for subadults only. Current nesting distribution in VA and MD are in Accomack, Virginia Beach (city) and Worchester, all coastal counties/city (Natureserve)

Kemps Ridley Turtle - Rarely found in MD. Summer range of juveniles in Chesapeake Bay (Conant, 1998) (Natureserve)

American Shad - Prefer habitats near creek mouths. Move into Chesapeake during March-April and return to sea by the end of November, early December (Jenkins, 1994), are migratory and will presumably move away from area of impact

Bay Anchovy - Prefer lower freshwater and estuarine reaches of coastal rivers, bays, sounds, high salinity nearshore marine waters, and near mouth/tidal river, zooplankton feeder

Atlantic Menhaden - Continuous spawning, continuous migration

Atlantic Croaker - Mostly marine but are known to enter freshwater and be locally migrant, prefer mud and sand bottoms, mainly benthic feeder (Natureserve)
Striped Bass - Atlantic States Marine Fisheries Commission states that hydropower facilities and hydroelectric projects are a threat to the striped bass, more likely to stay in area of impact based on long-term residency of area, usually found further upstream from bay area (Jenkins, 1994)

Spot - Prefer mud and sand bottom habitats, spawn offshore, juveniles are non migrant, adults are migrant, benthic grazers (Natureserve)

White Perch - Occurs predominately in brackish water and close to shore in saltwater, common in quiet water, usually over mud, far up medium to large rivers in fresh water and in lakes and ponds with no ocean connection, move offshore during day, onshore at night, spawning occurs in shallow water. Eggs sink to bottom and stick (Thomson et al. 1978)

Bluefish -Mostly marine migrants rear continental shelf, some movement inshore to Bays and estuaries throughout July and August (Smithsonian marine station online)

American Eel - Extensive migratory pattern, found in upstream reaches for long periods of time but no distinct habitat preference. Feeds on smaller fish and periodically benthic crustaceans

Blue Crab - Main benthic feeders in the bay area, utilize all habitats within the bay area-varies with age, sex and season, breeding season occurs between May and October in the bay grass beds (Chesapeake Bay Program online)

American Oyster - Can be found in subtidal areas of the Chesapeake Bay and its tributaries. Concentrated in areas with shell, hard sand or firm mud bottoms at depths of 8 to 35 feet. Attach to one another, forming dense reefs (Chesapeake Bay Program online)

Summer Flounder - Bottom dwellers in muddy and sandy sediments, adults found in deep channels or sand bars and juveniles in eelgrass beds, must have sufficient sediment coverage for feeding (Chesapeake Bay Program online) found in the bay area between spring and fall and migrate offshore during winter months (Murdy et al, 1997)

Red Drum - Benthic feeder, seasonal migrations, most fish are identified near seaside beaches in the bay area, prefer 15 percent or more salinity (Murdy et al, 1997)

Weakfish - Found throughout bay in spring and summer and migrate during winter months, prefer shallow sandy bottoms, spawn near the mouth of the bay and feed on small schooling fish and other (Murdy et al, 1997)

Spotfin Killifish - Permanent resident of the rivulets and puddles of the upper reaches of the intertidal marshes (Chesapeake Bay area program online)

Alewife - Feed on mainly zooplankton, spend majority of time in open lake waters or marine waters except to spawn in the spring (Murdy et al, 1997)

Blueback Herring - Mostly the same as the Alewife, except spawning occurs later in the year (Murdy et al, 1997)

Green Sea Turtle - Most commonly feeds in shallow, low-energy waters with abundant submerged vegetation, migrates across open seas (NatureServe)

Leatherback Sea Turtle - Mainly pelagic expect to nest, nests on sloping sandy beaches backed by vegetation

Three Spine Stickleback - Migratory, builds a ball shaped nest from the soft muddy bottoms during winter and spring in shallow, vegetated areas of the bay (Chesapeake Bay program online)

Four Spine Stickleback - Year round resident, builds a cup shaped nest out of grasses and weeds between April and May in bay grass beds along the bay's shoreline (Murdy et al, 1977)

Black Drum - Migrant benthic feeder, spawn near Cape Charles Virginia from April to June and move throughout the bay until late fall

Black Sea Bass - Lower bay inhabitants prefer wrecks, jetties, pilings and rocky bottoms, spawn in bay and leave offshore in winter

Bluegill - Permanent inhabitant, commonly abundant in tributaries, prefers quiet slower-moving waters for spawning, sand and mud or gravel bottoms, spawning occurs April-September, nesting consists of fanning away detrital material and constructing a small depression on bottom (Murdy et al, 1997)

Striped and Feathered Blenny - Common to abundant residents, prefer oyster beds, mud flats and grass bed bottoms in summer and channels in winter, prefer to spawn in empty oyster shells, feed on crustaceans and mollusks (Murdy et al, 1997)

Blue Catfish - Prefer moderate to swift currents in main channels and backwaters of large and medium sized rivers, bottom feeders, spawn in bay from April to June in nests protected by parents until young hatch (Murdy et al, 1997)

White and Channel Catfish - Common in all tributaries, spawn early spring to summer, eggs laid in nests, feed on bottom-dwelling arthropods and some fish (Murdy et al, 1997)

Brown Bullhead - Found in all tributaries of the Chesapeake Bay, including ponds, lakes, and slow-flowing streams. Can tolerate salinities as high as 20 parts per thousand. Spawning occurs from April to June, with the eggs deposited under an overhang, log, or rock. Eggs and young are guarded by both male and female. (Murdy et al, 1997)

Yellow Bullhead - Common in shallow slow water, lots of vegetation, spawn in open areas or in vegetation, usually not found in waters with salinities great than 5 percent, bottom feeder, protects eggs and young, spawning occurs May-June (Murdy et al,1997)

Cobia - Summer visitor to bay area, found in open waters around wrecks, buoys and pilings, migrants, opportunistic hunter (Murdy et al, 1997)

Cownose Ray - Flap wings to uncover covered shellfish in the sediments on the bottom, seasonal migrant

Naked Goby - Permanent resident, secretive, bury themselves in muddy bottoms in winter, found in shallower waters during summer months, lay eggs in empty oyster shells

Seaboard Goby - Permanent, secretive, range throughout bay, lay eggs in empty oyster shells

Green Goby - Permanent, secretive, most abundant around redbeard sponges lay eggs in empty oyster shells

Hickory Shad - Not normally an abundant member, at northern most limit, feeds on other small fishes

Hogchoker - Year round resident, bottom dwellers in shallow and deep water with sandy, silty or muddy bottoms, hunt by burying themselves in the sediment, very abundant in the bay area

Lined Seahorse - Year round inhabitant in middle to lower bay area, found in Calvert County, shallow flats in eelgrass in summer and deeper water in winter with restrictive home range with limits of only a few feet, typically found clinging onto vegetation, sponges, pilings, or ropes, feeds on crustaceans (Murdy et al, 1997)

Longnose Gar - Probably present in all major tributaries of Chesapeake Bay, spawning occurs mostly in quiet areas and common in shallow freshwaters in Summer, larvae adhesively attach to submerged objects just above bottom, feed on a variety of fish and crustaceans (Murdy et al, 1997)

Lookdown - Found in schools over soft sand bottoms near bridges and pilings, feed on smaller fish, worms and crustaceans

King and Spanish Mackerel - Visit the bay between spring and fall, found usually along coastal waters, south of the Chesapeake, migrate long distances (Murdy et al, 1997)

Northern Puffer - Seasonal migrant, bottom dweller in flats and channel margins, feed on invertebrates, eggs attach to sandy or muddy bottoms

Oyster Toadfish - Bottom dwellers found near wrecks, debris, oyster reefs and muddy bottoms, move to deep waters in winter, feed on crabs, mollusks and small fish

Northern and Dusky Pipefish - Year round residents, found throughout bay, feed on tiny crustaceans, shallow bay grass beds in summer and deeper channel water in winter (Murdy et al, 1997)

Pumpkinseed - Prefer slow moving quiet waters, usually found in shallower water with lots of vegetation; sand, mud or gravel bottoms for spawning, spawning similar to Bluegill (Murdy et al, 1997)

Sandbar Shark - Feeds on blue crab and other bottom fishes, commonly found in shallow grass beds and sand bars, Chesapeake Bay is one of most important nursery grounds in Eastern US (Murdy et al, 1997)

Northern Searobin - Bottom dwellers found in the deep flats and channels, usually found in lower reaches of the bay, dislodge prey from bottom with pectoral fins (Murdy et al, 1997)

Skilletfish - Found year round in tributaries and bay, live among oyster reefs, mud flats and eelgrass beds, deep channels, like to cling to rocks and oyster shells, feel on bristle worms and crustaceans (Murdy et al, 1997)

Tautog - Locally abundant in lower bay area, seasonal abundance, frequently found in rocks piles, bridge pilings, artificial reefs and wrecks, feeds on crabs, crustaceans and mollusks (Murdy et al, 1997)

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ATTACHMENT 1

Dredging Operations and Environmental Research (DOER) Program
ERDC TN-DOER-E21
"Silt Curtains as a Dredging Project Management Practice"
September 2005

ATTACHEMENT 2

SILT CURTAIN VENDOR INFORMATION

ERDC TN-DOER-E21
September 2005

Silt Curtains as a Dredging Project Management Practice

INTRODUCTION: Environmental windows are imposed on many U.S. Army Corps of Engineers (USACE) dredging projects in both coastal and inland waterways. Over 83 protected or sensitive species that have been identified fall into at least 20 general categories of concern for potentially negative impacts from dredging and disposal operations. One of the most frequently cited reasons for establishing an environmental window is impacts from turbidity and suspended sediments (Reine, Dickerson, and Clarke 1998). Over the past 15 to 20 years there have also been increased concerns regarding the potential impacts that dredging of contaminated sediments may have on nearby environmental resources.

In response to the need to protect sensitive environmental resources, silt or turbidity curtains have been designated a "best management practice (BMP)" by the Corps of Engineers, other Federal Agencies, and state regulatory authorities. Silt curtains are devices that control suspended solids and turbidity in the water column generated by dredging and disposal of dredged material. Consequently, silt curtains are considered an integral and necessary part of the regulatory strategy for many dredging projects. Unfortunately, factors contributing to the effectiveness of silt curtains under different circumstances are poorly understood by dredging project regulators and the public alike. Dredging contractors attest to the fact that, in their experience, silt curtains do not work under many of the site conditions encountered in navigation and environmental dredging projects. The published literature contains few comprehensive studies that demonstrate how effective silt curtains have been in meeting the intended project objectives (Johanson 1976, 1977; JBF Scientific Corporation 1978; Lawler, Matusky and Skelly Engineers 1983).

One goal of the Dredging Operations and Environmental Research (DOER) Program is to provide current, accurate technical guidance on environmental controls for dredging operations. Remaining challenges include rigorous examination of silt or turbidity curtains as a temporary control measure to better define performance criteria and identification of technical guidelines for their selection and use in navigation and environmental dredging projects.

PURPOSE: This technical note reviews the basic types of silt curtains used in navigation and environmental dredging projects. The emphasis is on the state of the practice and circumstances under which silt curtains function best. A checklist is provided to aid in consideration of silt curtain applications, including selection, design, specifications, deployment, and maintenance of silt curtains at dredging projects. This note also serves to update and supplement earlier guidance (e.g., Johanson 1977 and JBF Scientific Corporation (1978)) published on the application and performance of silt curtains.

DEFINITIONS: Silt curtains, turbidity screens, silt/turbidity barriers, gunderbooms, etc., are not to be confused with silt fences used in terrestrial control of soil erosion. Silt curtains are designed specifically to control suspended solids and turbidity generated in the water column as a result of navigation and environmental dredging operations. Silt and turbidity control devices have many names that have been used interchangeably by the Corps of Engineers, the U.S. Environmental Protection Agency (USEPA), various State regulatory agencies, dredging contractors, consultants, and manufacturers and suppliers. The following terminology represents common usage:

- *Silt* is defined as fine-grained suspended material that can be readily resuspended or stripped from sediment that is either being hydraulically or mechanically dredged from or placed in the water. Resuspended matter is generally measured gravimetrically and expressed as Total Suspended Solids (TSS) in milligrams per liter.
- *Turbidity* is a measure of the *optical properties* (amount of scattering and absorption of light rays) of the water in which dredging and dredged material disposal occur. Turbidity is frequently expressed in Nephelometric Turbidity Units (NTU).
- A *Silt/Turbidity Curtain* has traditionally been defined as an *impermeable* device for control of suspended solids and turbidity in the water column generated by dredging and dredged material disposal operations. Recently, the term "silt curtain" has been used to describe floating vertical barriers fabricated from either solid or permeable materials.
- A *Silt/Turbidity Screen* is a *flow-through filtering* device for control of suspended material and turbidity in the water column generated by dredging and dredged material disposal operations. All screens are composites of solid material (usually to facilitate flotation and mooring purposes) and permeable geosynthetic fabrics to filter water and reduce water pressure on the device.
- A *Gunderboom* is a device similar to a silt or turbidity screen that has been modified to control oil spills by adding adsorbent geotextile material.

For the purposes of this technical note, the term "*silt curtain*" will be used generically to describe devices deployed in water to control suspended solids or turbidity resulting from dredging operations.

TYPICAL QUESTIONS ON SELECTION AND USE OF SILT CURTAINS

What Are the Components of Silt Curtains? Silt curtains are vertical, flexible structures that extend downward from the water surface to a specified water depth. Typically fabricated of flexible, polyester-reinforced thermoplastic (vinyl) fabric, the curtain is maintained in a vertical position by flotation material at the top and a ballast chain along the bottom (Figure 1).

A tension cable is often built into the curtain immediately above or just below the flotation segments (top tension) to absorb stresses imposed by currents and hydrodynamic turbulence. The curtains are usually manufactured in standard sections (e.g., up to 50 ft) that can be joined together at a particular site to provide a curtain of specified length. Curtains are generally deployed to extend to 1-2 ft above the bottom to allow mudflow to pass beneath them. Anchored

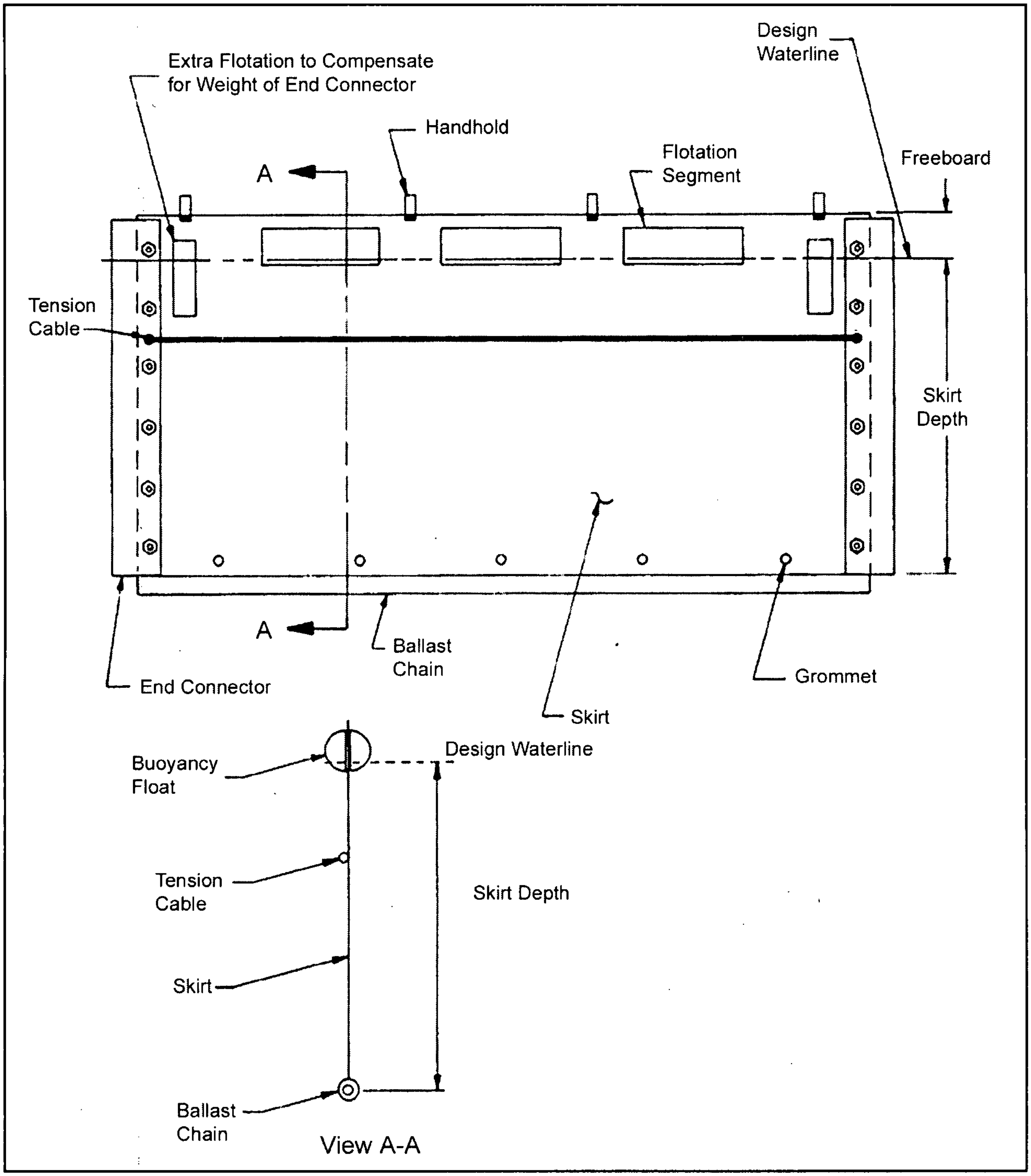

Figure 1. Construction of a typical silt curtain section (JBF Scientific Corporation (1978))

lines hold the curtain in a deployed configuration that can be U- or V-shaped, or circular or elliptical, depending upon the application.

What Are the Functions of Silt Curtains? Silt curtains are designed to contain or deflect suspended sediments or turbidity in the water column. Sediment containment within a limited area is intended to provide residence time to allow soil particles to settle out of suspension and reduce flow to other areas where negative impacts could occur. Suspended solids can also conceivably be diverted from areas where environmental damages could occur from the settlement of these suspended particles. Silt curtains may also be used to protect specific areas (e.g., sensitive habitats, water intakes, or recreational areas) from suspended sediment and particle-associated contamination.

What Processes Affect Silt Curtains? In many cases where silt curtains are used, the concentration of fine-grained suspended solids inside the curtain enclosure may be relatively high (i.e., in excess of 1 g/L). The suspended material may be composed of relatively large, rapidly settling particles or flocs. In the case of a typical pipeline disposal operation surrounded by a silt curtain (Figure 2), where suspended solid concentrations are high and material usually flocculated, the vast majority (95 percent) of the fine-grained material descends rapidly to the bottom where it forms a fluid mud layer that slopes away from the source at an approximate gradient of 1:200. The other 5 percent of the material remains suspended in the water column above the fluid mud layer and is responsible for the turbid appearance of the water inside the curtain. While the curtain provides an enclosure where some of the fine-grained material may flocculate and/or settle, most of this fine-grained suspended material in the water column escapes with the flow of water and fluid mud under the curtain. The silt curtain does not indefinitely contain turbid water but instead controls the dispersion of turbid water by diverting the flow under the curtain, thereby minimizing the turbidity in the water column outside the silt curtain.

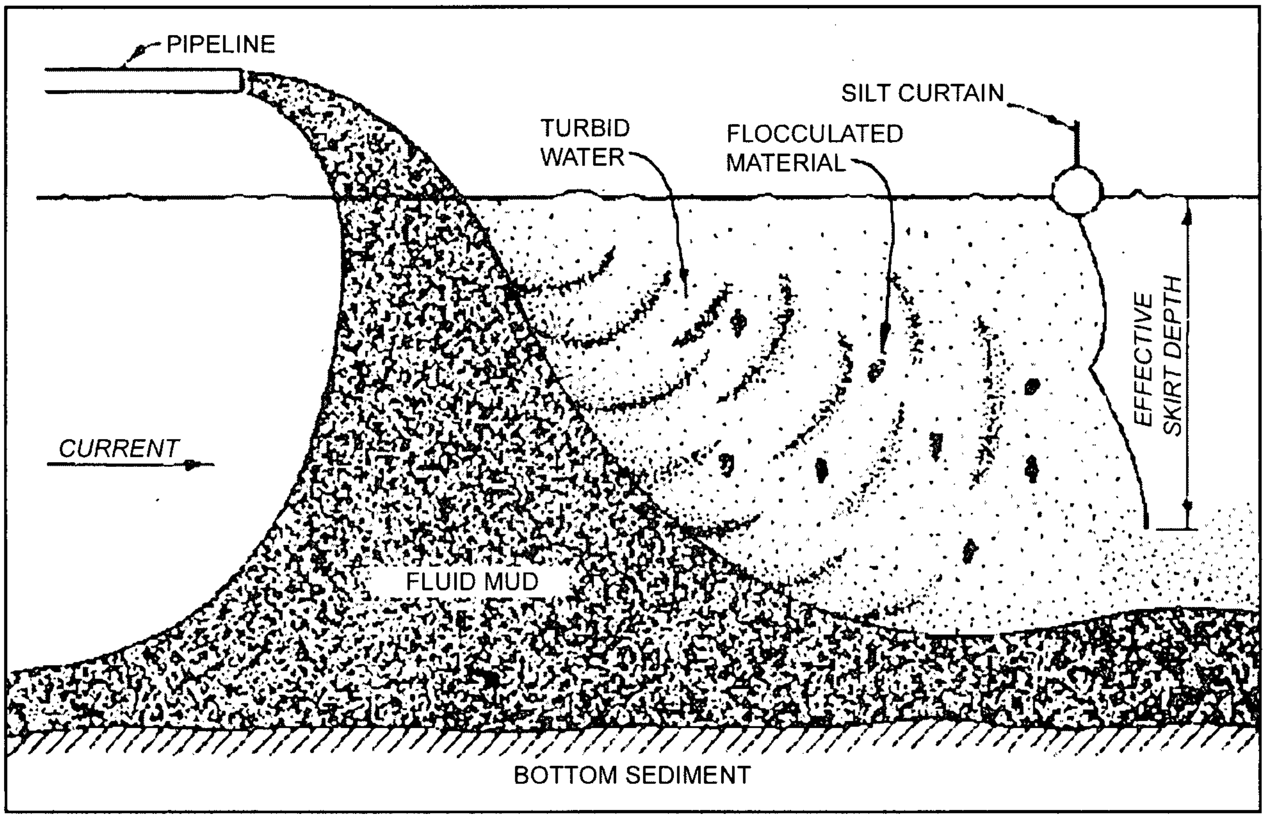

Figure 2. Processes affecting silt curtain performance (JBF Scientific Corporation (1978))

Whereas properly deployed and maintained silt curtains can effectively control the distribution of turbid water, they are not designed to contain or control fluid mud. In fact, when the accumulation of fluid mud reaches the depth of the ballast chain along the lower edge of the skirt, the curtain must be moved away from the discharge; otherwise sediment accumulation on the lower edge of the skirt can pull the curtain underwater and eventually bury it. Consequently, the rate of fluid mud accumulation relative to changes in water depth due to tides must be considered during a silt curtain operation.

How Are Silt Curtains Deployed? After the deployment site has been surveyed, the geometry of the deployed curtain should be determined based on the objectives of silt curtain application, the hydrodynamic regime at the project site, and factors such as boat traffic. Typical deployment configurations for silt curtains are shown in Figure 3. In some cases, the curtain may be deployed in an open-water environment in the form of a "maze," a semicircle or U, or a circle or ellipse.

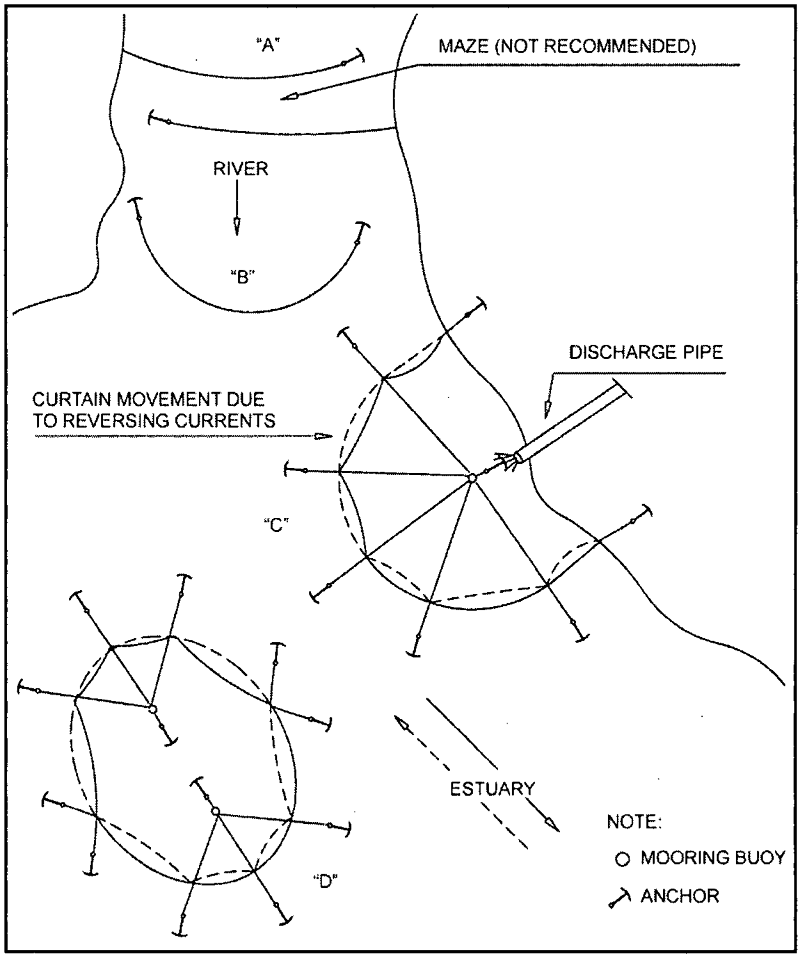

Figure 3. Typical silt curtain deployment configurations (JBF Scientific Corporation (1978))

The maze configuration ("A," Figure 3) has been used on rivers where boat traffic is present, but appears to be relatively ineffective due to direct flow through the aperture between the curtain sections. On a river where the current does not reverse, a U configuration ("B," Figure 3) is acceptable, but the distance between the anchored ends of the curtain (i.e., across the gap) should be large enough to prevent leakage of turbid water around the ends of the U. In situations where the turbid water is being generated by effluent from a containment area or a pipeline disposal operation close to the shoreline, the curtain can be anchored in a semicircular or U configuration ("C," Figure 3) with the ends of the curtain anchored onshore approximately equidistant from the discharge point. In a tidal situation with reversing currents a circular or elliptical configuration ("D," Figure 3) is necessary. This latter case requires a more extensive mooring system. A typical curtain might be 500 to 1500 ft for the U or semicircular configurations and 1000 to 3000 ft for the circular/elliptical case. Figure 4 shows a single floating silt curtain being deployed from a pier.

What Types of Silt Curtains Are Commercially Available for Silt Curtains? Many types of commercially available silt curtains are manufactured to perform specific functions. Names given by the manufacturers to describe the silt curtains include "floating," "floating diversion baffle," "fixed hanging," "permeable," "standing," "frame," "sinkable hanging," and "combination." Other names refer to the type of water or current where the curtain will be used (e.g., slack, slow, medium, fast, rough, tidal, etc.).

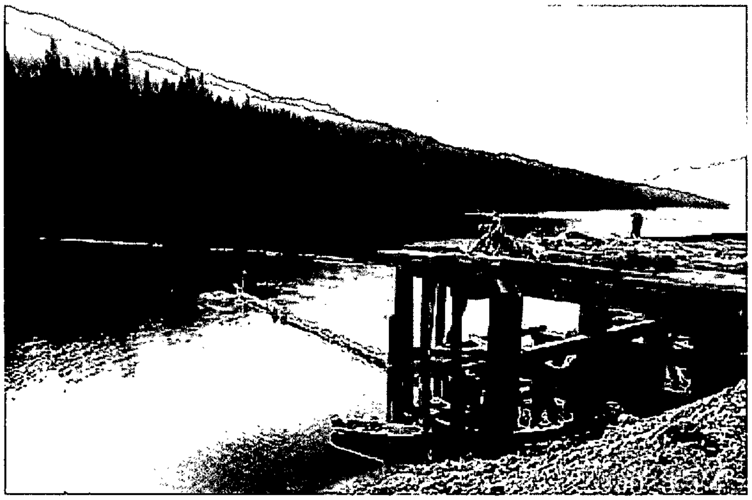

Figure 4. Single flotation silt curtain being deployed from shoreline (Courtesy of Marke Wilkie, Elastec/ American Marine, Inc., 401 Shearer Blvd., Cocoa, FL 32922)

Typical silt curtain types are shown in Figures 5 and 6. Most silt curtains incorporate the following common specification components:

- Flotation or buoyancy (e.g., solid or compressed air).
- Skirt depth (height between the top boom and the curtain bottom).
- Fabric (e.g., tensile strength, tear strength, abrasion resistance, material, coating, weight, seams/seals, drains, and color—bright yellow or international orange are recommended).
- Connectors (e.g., lace, bolt through, ASTM universal, PVC slotted tube, hook and O-ring).
- Ballast (e.g., type and weight).
- Tension member or load line (i.e., upper, mid, or bottom).

What Is Known about the Effectiveness of Silt Curtains? Silt curtains have been evaluated since the early 1970's. One of the most definitive early studies on the functional capabilities and performance of silt curtains in the United States was completed by JBF Scientific Corporation (1978) during the Corps of Engineers' Dredged Material Research Program. The study consisted of evaluating past and present uses, effectiveness of various applications, deployment guidelines and specifications, deployment methods, and environmental conditions that might limit the use of silt curtains. Much of the technical guidance presented in the study report is still valid and represents a fundamental source of information currently used by silt curtain design practitioners. Summarizing the JBF Scientific Corporation study, silt curtain effectiveness depends on many factors such as:

- Nature of the operation (i.e., navigation or environmental dredging).
- Quantity and type of material in suspension within or upstream of the curtain (including debris, oils, and chemicals).
- Characteristics, construction, and condition of the curtain as well as the area and configuration of the barrier enclosure (e.g., partial or full depth containment, either solid or permeable).

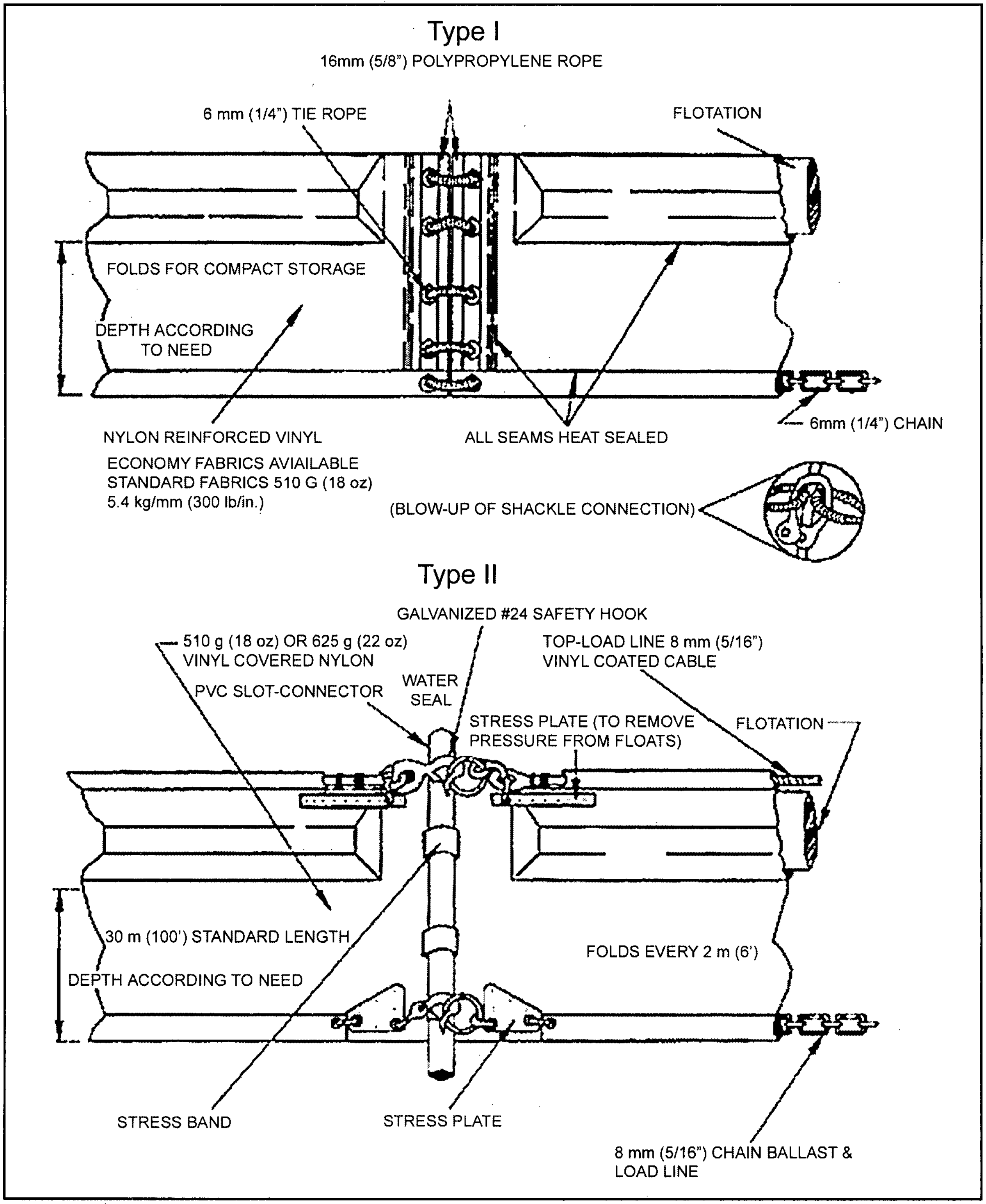

Figure 5. Types I and II silt curtains (USACE EP 1110-1-16, Appendix C, BMP-27, page C-167)

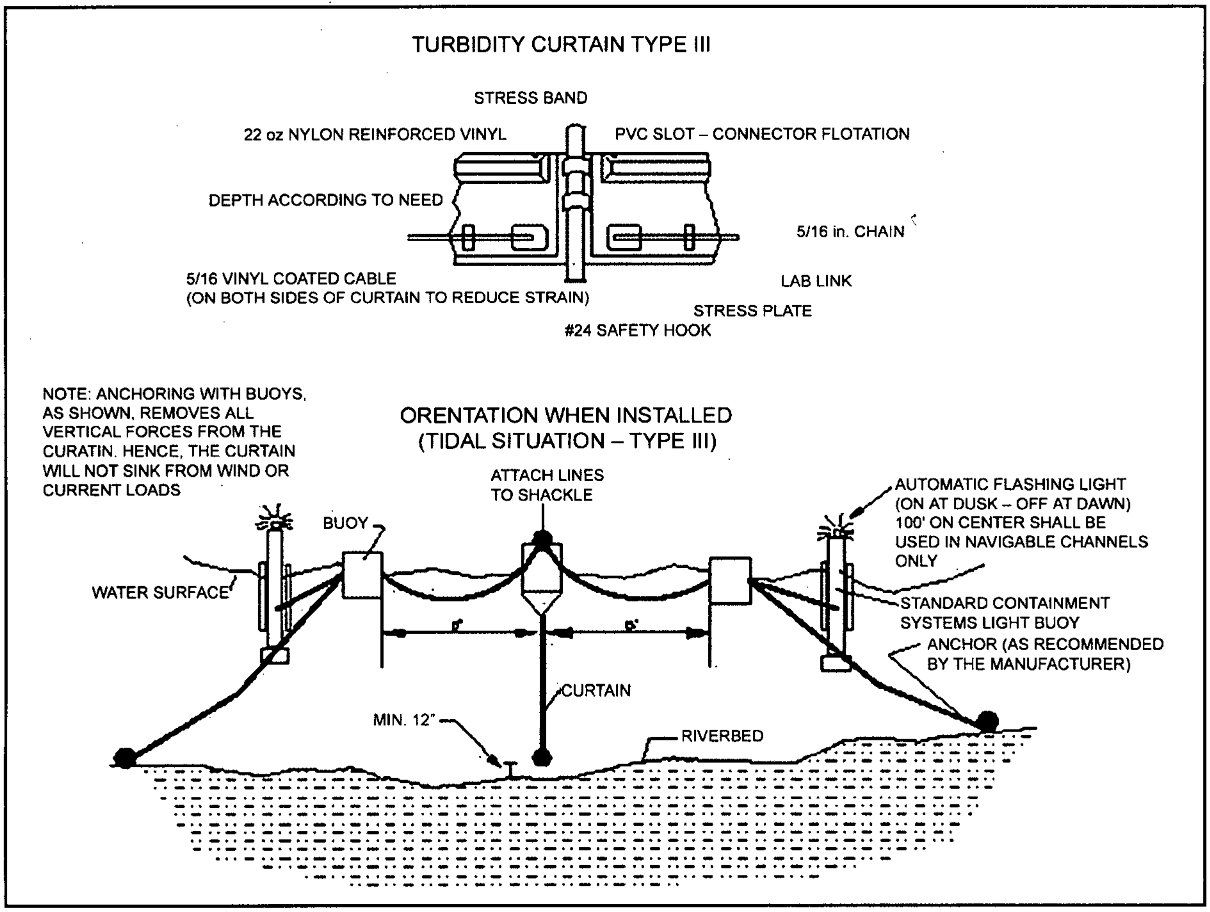

Figure 6. Type III silt curtain (USACE EP 1110-1-16, Appendix C, BMP-27, page C-167)

- Method of deployment.
- Hydrodynamic conditions (e.g., strong currents [>1 knot or 1.5 fps], high winds [especially with long fetch areas], fluctuating water levels [i.e., tides], excessive wave height including ship wakes, and drifting debris and ice).

Figure 7 shows a silt curtain installation in San Francisco Bay during a moderate squall.

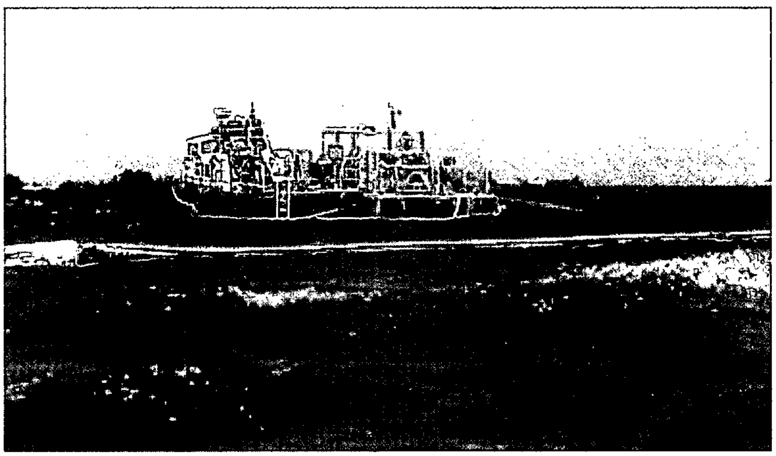

Figure 7. Floating curtain deployed in San Francisco Bay (courtesy of Julie Kistle, KFM-Joint Venture, San Francisco-Oakland Bay Bridge East Span Skyway Project Turbidity Monitoring Project)

JBF Scientific Corporation (1978) defined effectiveness as "the degree of turbidity reduction outside the curtain relative to the turbidity levels inside the curtain enclosure." They also concluded that:

> In some cases, turbidity levels in the water column outside the curtain can be 80-90 percent lower than levels inside or up-current of the curtain enclosure. High currents and energy environments cause silt curtains to flare, thus reducing the curtain's effective depth. At a current of 1 knot, the effective skirt depth of a 1.5-m curtain is approximately 0.9 m. Increased turbulence around the curtain also tends to cause resuspension of the fluid mud layer and may cause increased turbidity levels in the upper water column beyond the curtain. Tidal currents that dominate the hydrodynamic regime may cause the fluid mud to be resuspended, especially if the curtain is not properly deployed. Frequently, changes in the direction of the current will dominate the direction and movement (flapping) of an improperly anchored curtain. Where anchoring is inadequate and particularly at sites where tidal currents dominate the hydrodynamic regime and probably cause resuspension of the fluid mud as the curtain sweeps back and forth over the fluid mud with changes in the direction of the tidal currents, the turbidity levels outside the curtain can be higher (as much as 10 times) than the levels inside the curtain.

Finally, JBF Scientific Corporation (1978) stated, "With respect to overall effectiveness and deployment considerations a current velocity of approximately 1 knot appears to be a practical limiting condition for silt curtain use."

In preparation for the construction of the Westway interstate highway in New York, a test program was established to determine the effectiveness and deployment configurations needed for the dredging activities associated with the highway construction project. Lawler, Matusky, and Skelly Engineers (1983) reported the results of the water quality tests performed on the prototype silt curtains used in the test program. They concluded, "Visual observations and field measurements showed the silt curtain to be an effective barrier to currents, dye, suspended solids, and turbidity. The curtain did not function as a permeable fabric as predicted; water appeared to flow around it rather than through it." The silt curtain contained most contaminants with the exception of ammonia. Mixing outside the curtain in the water column brought the levels down to background levels. Lawler, Matusky, and Skelly Engineers also concluded, "The low currents measured behind the curtain indicated that the curtain blocks flow patterns and creates a quiescent zone. The lack of flow through the curtain is probably attributable to the water taking the path of least resistance (i.e., under the piers or around the ends). Clogging of the curtain with suspended solids (either background or caused by dredging) would only aggravate this situation." At the time, the concept of enclosing a dredge was new and untested. Notably, a concern arose that enclosing the dredge with a silt curtain would create a settling basin for solids that could promote the concentration and release of oxygen-consuming suspended contaminants in violation of water quality standards. The exchange of water inside the curtain became a design topic and relief panels (flaps) were considered to allow a 25-percent exchange of basin volume over a 12-hr period.

In 1994, the USEPA published a remediation guidance document as part of the Assessment and Remediation of Contaminated Sediments (ARCS) Program (USEPA 1994). They concluded, "As a generalization, silt curtains and screens are most effective in relatively shallow quiescent water. As the water depth increases and turbulence caused by currents and waves increases, it becomes increasingly difficult to effectively isolate the dredging operation from the ambient water. The St. Lawrence Centre (1993) advises against the use of silt curtains in water deeper than 6.5 m or in currents greater than 50 cm/sec (USEPA 1994)."

The USEPA also suggested that to be effective, curtains deployed around the remediation dredging operation must remain in place until the operation is completed at that site. For large projects, frequent relocation of the curtains may be necessary as the dredge moves to new areas. The USEPA also highlighted the fact that curtains should not impede navigation traffic, an important consideration during their deployment.

What Information Is Available on Selection, Design, Specification, and Deployment of Silt Curtains? Several types of guidelines are used to select, design, and deploy silt curtains for dredging projects. Guidelines available for silt curtains are contained in several technical and regulatory resource documents. Table 1 is a listing of technical guidelines and best management practices. Typically, topics covered include planning considerations (site-specific project conditions), design criteria, construction specifications (curtains and other materials), installation or deployment, removal, and maintenance. A notable exception is monitoring of curtain performance.

Selecting which guide or best management practice to follow depends on particular project requirements, site locations, and the type of silt curtain specification needed (i.e., performance of product). Table 2 is an example of the minimum recommended specification for a silt curtain (originally developed by JBF Scientific Corporation (1978)) that has been updated by a silt curtain manufacturer to reflect 2002 conditions.

What Should Be Done to Properly Select and Use a Silt Curtain? Table 3 is a checklist for selecting and applying silt curtains. The purpose of the checklist is to prompt the designer or reviewer to consider various critical aspects of selection, designation, and installation of silt curtains for typical dredging projects. However, the checklist should be considered as an aid and not be used as a specification requirement. The selection and use of silt curtains is extremely site-specific and requires both knowledge and practical experience for successful applications.

What Are Some "Lessons learned" Regarding Selection, Design, and Deployments of Silt Curtains? Silt curtains should be selected, designed, and installed to meet permit and water quality certification requirements where applicable.

- Very few silt curtain applications are alike. Each is unique and requires site-specific application and adaptation.
- Silt curtains should be designed to pass water either under or through their walls. Curtains are designed to confine suspended sediment and to allow it to settle or be filtered, not to impede the movement of water.

Table 1
Sources of Technical Guidelines on Silt Curtains

Source	Reference
Technical Reports	
US Army Corps of Engineers Exchange Bulletin Article	JBF Scientific Corporation. 1977. "Application and Performance of Silt Curtains," DMRP Work Unit 6C06, Dredged Material Research Exchange Bulletin Article - Vol. D-77-10, pp. 2-8.
Technical Report D-78-39	JBF Scientific Corporation. 1978. "An Analysis of the Functional Capabilities and Performance of Silt Curtains," Prepared for U.S. Army Engineer Waterways Experiment Station. Technical Report D-78-39. NTIS No. AD-A060 382
Manuals	
EM 1110-2-5025	USACE, "Dredging and Dredged Material Disposal," March 1983. p. 3-34
EM 1110-2-1614, 30 Jun 95	USACE, "Design of Coastal Revetments, Seawalls and Bulkheads," Chapter 6, Environmental Impacts, 6-3. Water Quality Impacts
EPA 905-B94-003	USEPA, "Great Lakes Contaminated Sediments: ARCS Remediation Guidance Document- Chapter 4 [EPA-905-B94-003]
Army TM 5-818-8/Air Force AFJMAN 32-1030- July 20, 1995	CEMP, "Engineering Use of Geotextiles," 20 Jul 95
Best Management Practices	
Section 404 (b)(1) Guidelines	Part 230.73: Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material, Subpart H, Actions to Minimize Adverse Effects –Actions affecting the method of dispersion.
BMP – Turbidity Curtains	King County Courthouse, 516 Third Avenue, Seattle, WA 98104
EMP No. 0-16	AAPA, "Environmental Management Practices Activity: Dredging and Dredge Material Disposal (EMP No. 0-16)
Manufacturer's Guide	
Turbidity Curtain Selection Guide	Elastec/American Marine, Inc., 401 Shearer Blvd., Cocoa, Florida 32922
Turbidity Barrier Guide	ABBCO/American Boom & Barrier Corp., 7077 N. Atlantic Avenue Cape Canaveral, Florida 32920
Turbidity Screens	Section IV-6 - Final Construction and Contract Specifications, New Cut Dune/Marsh Restoration Project, Federal Project No. TE-37, Terrebonne Parish, Louisiana, June 2001

Table 2
Recommended Silt Curtain Specifications[1,2]

Parameter	Recommended Value
Skirt Depth	Up to 100 ft maximum allowing 1-2 ft clearance between skirt and bottom
	Fabric
Tensile strength grab	500 lb/in.
Tear strength strip 18 oz 22 oz	 320 lb – quiescent conditions 400 lb – medium to high current
Abrasion resistance	200 lb/in. tensile strength after abrasion
Material	Polyester
Coating	PVC
Weight	18-22 oz (depending on type of curtain design)
Seams	Heat sealed
	Buoyancy
Ratio	>5
Type	Solid, closed cell, and enclosed in a fabric pocket
Connector	Load transfer type – aluminum extrusion
	Ballast
Type	Noncorrosive galvanized chain
Weight	See Figures 16 and 17
	Tension Member
No current	Fabric only
Current (0.1-1.0 knots	Top or center tension; center tension provides slightly greater effective skirt depth

[1] In 2002, a 100-ft section of silt curtain with top tension member to the above specifications and a skirt depth of 5 ft could be purchased at an approximate cost of $1,100.00.

[2] Source: Elastic/American Marine, 401 Shearer Blvd., Cocoa, FL 32922 USA, Tel: 321-636-5783, Fax: 321-636-5787, E-mail: jpearce@wlastec.com, www.elastec.com.

Table 3
Checklist for Selection and Application of Silt Curtains

1) **Pre-dredging Site Survey –**
   a) Have background conditions at the site been established? Y__N__N/A__
   b) Has the site been adequately characterized with respect to Y__N__N/A__
      i) Current velocity, water depth (relative to tidal range)? Y__N__N/A__
      ii) Bottom sediment types? Y__N__N/A__
      iii) Background levels of turbidity? Y__N__N/A__

(Sheet 1 of 4)

Table 3 (Continued)

2) Deployment –

a)	Have maximum surface currents over a tidal cycle (12 or 24 hr) been established first to determine types of deployment configurations that may be needed?	Y__N__N/A__
b)	Have direction of current and water turbulence been defined?	Y__N__N/A__
c)	Have the minimum water depths been established at the lowest low tide?	Y__N__N/A__
d)	Has a minimum 0.5-m skirt depth been established between the lower edge of the skirt and the existing bottom of the disposal area at the lowest low tide during the operations?	Y__N__N/A__
e)	Have the effects of fluid mud accumulation on water depth as well as the proposed schedule for moving the silt curtain to prevent burial been considered when selecting the curtain skirt depth?	Y__N__N/A__
f)	Is the character of the bottom sediment/vegetation known?	Y__N__N/A__
g)	Have traffic- and boat-generated waves been determined?	Y__N__N/A__
h)	Are locations of launching ramps, crane services, etc. known?	Y__N__N/A__
i)	Have deployment geometry and configurations been determined for the site?	Y__N__N/A__
j)	Have curtain deployment lengths been established?	Y__N__N/A__
k)	Have different anchor types been considered?	Y__N__N/A__
l)	Have different curtain configurations been considered (e.g., U, V, circular, elliptical)?	Y__N__N/A__

3) Silt Curtain Specifications –

a)	Does the lower edge of the silt curtain extend a minimum of 0.5 m from the bottom at lower tide?	Y__N__N/A_
b)	Is skirt depth less than the recommended 3 m?	Y__N__N/A__
c)	Has fabric material been selected (PVC or equivalent) with a minimum tensile strength of 525 N/m?	Y__N__N/A__
d)	Has the fabric weight (minimum of 610 g/m^2 for low current conditions, and 746-g/m^2 for high current conditions) been designated?	Y__N__N/A__
e)	Has a tear strength (min of 445 for 610-g fabric or 890 N for 746-g fabric been designated?	Y__N__N/A__
f)	Has a tensile strength after abrasion (greater than 350 N/m) been designated?	Y__N__N/A__
g)	Has a material been selected that is easily cleaned and resistant to marine growth, ultraviolet light, and mildew?	Y__N__N/A__
h)	Are all fabric seams heat-sealed or equivalent?	Y__N__N/A__
i)	Has flotation been designated as sections of solid, closed-cell, plastic foam flotation material sealed into a fabric pocket that provide a buoyancy ratio (buoyant force/curtain weight) greater than 5?	Y__N__N/A__
j)	Is each flotation segment a minimum of 3 m in length so the curtain may be easily folded for storage or transport?	Y__N__N/A__
k)	Do connectors in low currents (<0.1 knot) maintain adequate physical contact along the entire skirt joint?	Y__N__N/A__

(Sheet 2 of 4)

Table 3 (Continued)

3) Silt Curtain Specifications – (continued)

l) Have aluminum extrusion (or equivalent) load-transfer connectors been designated for current velocities exceeding 0.1 knot?	Y__N__N/A__
m) Have non-corrosive ballast chains with a weight ranging from approximately 1.5 kg/m for a 1.5-m skirt depth up to 3.0 kg/m for a 3-m skirt depth been selected?	Y__N__N/A__
n) Are tension members used as follows:	
i) Negligible current: no tension member?	Y__N__N/A__
ii) Current velocities between 0.1 and 1.0 knot?	Y__N__N/A__
iii) Galvanized or stainless steel wire rope as top or center tension member?	Y__N__N/A__
o) Have handholds been designated along the top of the curtain between the flotation segments for ease in handling?	Y__N__N/A__
p) Have repair kits been designated to patch minor tears in the fabric?	Y__N__N/A__

4) Transportation –

a) Have furls (lightweight straps or rope) been specified every 1 to 1.5 m from storage to unloading site?	Y__N__N/A__
b) Has curtain been specified to be compactly folded accordion style, packaged into large bundles, and carefully lifted into transportation vehicle?	Y__N__N/A__
c) Will curtains be unloaded like a string of sausages and connected in appropriate sections (up to 30 m) as they are played out of the vehicle?	Y__N__N/A__
d) Will curtains be towed by boat (traveling at 2 to 3 knots) to the deployment site?	Y__N__N/A__
e) Will the curtain be kept furled except near the end of the connectors until it has been deployed at the site?	Y__N__N/A__

5) Mooring –

a) Has the recommended mooring system consisting of an anchor, chain, an anchor rode (line or cable), and mooring and crown buoys been designated?	Y__N__N/A__
b) Has the anchor pattern been designated based on the curtain deployment geometry site conditions (e.g., from section joints every 30 m in a radial pattern and on both sides if the curtain is exposed to reversing tidal currents)?	Y__N__N/A__
c) Have sizes (e.g., ½ -inch etc.) of anchor lines and anchor weights (e.g., 4.5 kg for sandy bottoms and up to 34 kg for firm mud) been selected based on bottom conditions.?	Y__N__N/A__

(Sheet 3 of 4)

Table 3 (Concluded)	
6) Deployment Model –	
a) Has the length of time for deployment before reconfiguration or movement been determined based on accumulation of fluid mud inside the curtain relative to the deployment geometry, the discharge (filling) rate, and the initial bottom gap (i.e., the distance between the lower skirt edge and the bottom sediment at the beginning of the operation)?	Y__N__N/A__
b) Is the total length of the curtain available for the project adequate for the size of the enclosure?	Y__N__N/A__
7) Maintenance –	
Has adequate attention been given to	
a) Moving the curtain away from the turbidity sources just before the fluid mud layer reaches the lower edge of the skirt?	Y__N__N/A__
b) Replacing worn or broken anchor lines?	Y__N__N/A__
c) Maintaining the integrity of the curtain by repairing leaking connectors and / or tears in the curtain fabric?	Y__N__N/A__
d) Repairing tears in the flotation pocket with hand-type pop rivet gun and rivets?	Y__N__N/A__
e) Repairing moderate tears in skirts on land with vinyl/nylon repair kit and VINYLFIX or PVC glue?	Y__N__N/A__
f) Keeping one or two spare sections of curtain for immediate replacement of unrepairable sections onsite?	Y__N__N/A__
8) Recovery –	
a) Will silt curtains be refurled after operations are completed?	Y__N__N/A__
b) Will anchor/mooring systems be recovered?	Y__N__N/A__
c) Will the curtains be returned to the launching site for repacking and subsequent storage?	Y__N__N/A__
9) **Monitoring –**	
a) Have plans been made for monitoring during dredging operations?	Y__N__N/A__
b) Will measurements of turbidity (NTU) and samples for TSS (mg/L) be taken on both sides of the silt curtain near the dredging operations and near any sensitive habitat?	Y__N__N/A__
c) Will tide, wind, wave, and current measurements be made?	Y__N__N/A__
d) Are there plans to monitor post-dredging operations with respect to limited measurements of current, tidal range, winds, turbidity (NTU), and samples for TSS (mg/L) for comparison with background conditions?	Y__N__N/A__
	(Sheet 4 of 4)

- In applications where the curtain will be extended to the bottom of the waterway in tidal or moving water conditions, a heavy woven permeable filter fabric or tide flaps should be designed into the curtain to relieve pressure on the curtain wall.
- In general, silt curtains should be used on slow to moderate currents, stable water levels, and relatively shallow water depths.

- Currents greater than 1 to 1-1/2 knots are problematic, leading to difficult and often expensive curtain designs. Silt curtains should not be used in current velocities greater than 3-5 knots unless there are unusual circumstances and special designs are considered. Curtain deployments for deep, fast-flowing water and windy conditions require customized designs. However, for all practical purposes, the 1 to 1-1/2 knot value appears to be an industry standard.
- In slow currents, resuspension and turbidity are localized, so a fundamental question is whether or not a silt curtain is even necessary.
- In high currents where sediment plumes disperse rapidly, silt curtains are very difficult to maintain properly and can easily become dysfunctional.
- In all but the slowest current flows, curtains will "billow out" in the downstream direction, allowing water to pass beneath the curtain, thereby reducing the effective skirt depth.
- Extra length (up to 10-20 percent) and depth (slack) of curtains should be included in designs to allow for tidal fluctuations and exchanges of water within the curtain.
- Special designs may be required for applications of curtains at depths greater than 10-15 ft or with currents exceeding 1-1/2 knots, particularly in tidal waters. At greater depths, loads or pressures on curtains and mooring systems become excessive and could result in failure of standard construction materials.
- High winds can lift large curtains out of the water like a sail.
- Curtains can sink due to excessive biological fouling on the fabric.
- An attempt should be made to minimize the number of joints in the curtain; a minimum continuous span of 15 m (50 ft) between joints is a "good rule of thumb."
- Curtains should be a bright color (yellow or "international" orange are recommended) to enhance visibility for boaters.
- In tidal situations, where currents move in both directions, it is important to attach anchors on both sides of the curtain to hold the curtain in place and to not allow it to overrun the anchors and pull them out when the tide reverses.
- Anchor lines should be attached to the flotation device, not to the bottom of the curtain.
- Care should be taken during removal of silt curtains to avoid or minimize resuspension of settled solids.
- Removal of settled solids trapped by the silt curtain is optional and should only be considered if the resulting bottom contour elevation is significantly altered.
- When dredging contaminated sediment, installing silt curtains within continuous or intermittent sheetpile walls to provide anchoring points has proven to be more effective than using silt curtains alone.
- Silt curtains can be effective in containing floating debris, but not always in containing contamination. Soluble contaminants, particularly heavy metals, can flow through, around, or under the curtain.
- Aquatic habitat can be successfully protected with deflection curtains provided they are properly designed and deployed, taking into consideration site-specific conditions.
- Designs should conform to relevant contract specifications and manufacturer recommendations and guidelines for installation and safety measures.

- Silt curtains should not be considered a "one solution fits all" type of best management practice. They are highly specialized, temporary-use devices that should be selected only after careful evaluation of the intended function and designed based upon a detailed knowledge of the site where they will be used.

SUMMARY: The term "*silt curtain*" is used to describe devices deployed in water to control suspended solids or turbidity resulting from dredging operations. Almost every silt curtain application has unique features that require site-specific adaptations. Several sources of published technical guidelines and best management practices are identified and referenced in this note. Typical topics covered in these guides include planning considerations (site-specific project conditions), design criteria, construction specifications (curtains and other materials), installation or deployment, removal, and maintenance. A notable exception is monitoring of silt curtain performance.

For cost considerations, logistical constraints, and performance expectations, prevailing current velocities of 1 to 1-1/2 knots effectively limit deployments, with exceptions on a case-by-case basis. Unfortunately, few comprehensive studies are published on the actual performance of silt curtains under varying project conditions. Additional monitoring studies will be required to properly document the functional characteristics and incremental costs of silt curtains under demanding project conditions of moderate to high currents, winds, and waves.

Silt curtains should not be considered a "one solution fits all" type of best management practice. They are highly specialized, temporary-use devices that should be selected only after careful evaluation of the intended function and designed based on a detailed knowledge of the site where they will be used.

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> Francingues, N. R., and Palermo, M. R. (2005). "Silt curtains as a dredging project management practice," *DOER Technical Notes Collection* (ERDC TN-DOER-E21). U.S. Army Engineer Research and Development Center, Vicksburg, MS. http://el.erdc.usace.army.mil/dots/doer/doer.html.

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- Double sewn seams with grommets
- Depths per requirements ' 50' sections

1'-12'deep	12'-24' deep
24'-36' deep	36'-48 deep

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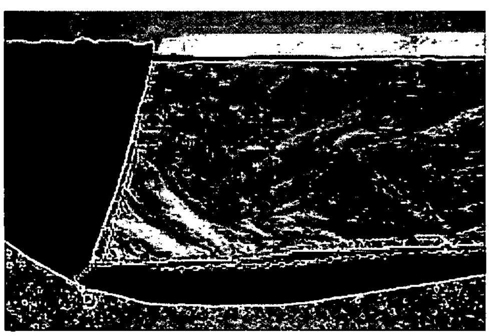


Click Here For Specifications

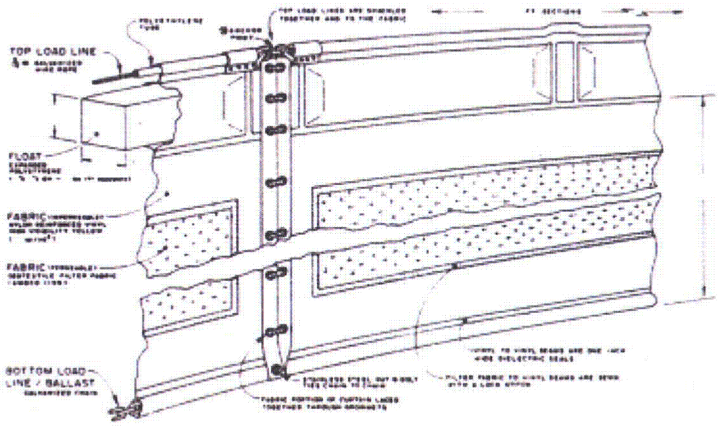
Curtain Floating Barriers for Turbidity Control

Floating Turbidity Control Curtains are impermeable barriers* constructed of a flexible reinforced thermoplastic material dielectrically welded to provide an upper hem for enclosing flotation material and a lower hem for enclosing ballast material. The skirt depth of the silt curtain is the material vertically below the upper hem. The length of the turbidity curtain is the horizontal distance between ends. Additional construction features are dependent on silt curtain design.

Curtain Floating Barriers are designed to control the settling of solids (silt) suspended in water by providing a controlled area of containment. This condition of suspension (turbidity) is usually created by disrupting natural conditions through construction or dredging in the marine environment. The containment of settleable solids is desirable to reduce the impact area of these solids.

Although the Silt Curtains listed are standard, Boom Environmental can custom design specific floating booms to solve unique problems. What this means is that the standard designs are available with a variety of fabric options, flotation sizes, load-bearing and ballast members, connectors and lengths. When a variation on a standard design won't work, Boom Environmental engineers can design to meet the requirements.

Custom Design Silt Curtain

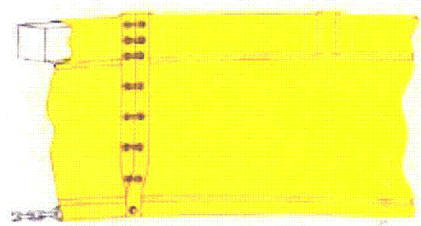


Lightweight Turbidity Curtain

Application: Calm waters with little current, such as lakes, ponds, canals and shoreline areas.

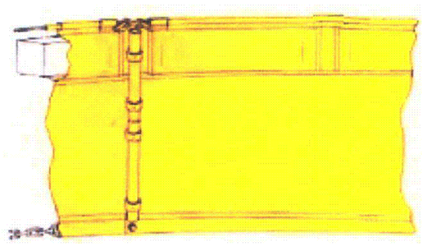
Specifications

- Fabric - Polyester reinforced vinyl high visibility yellow
- Connector - Sections are laced together through grommets and load lines are bolted together.
- Flotation - 6" expanded polystyrene over 9 lbs./ft. buoyancy.
- Ballast - 1/4" galvanized chain (.7 lbs/ft).



Middleweight Turbidity Curtain

Application: Rivers, streams, open lakes and exposed shorelines with moderate current moving in one direction.



Specifications

- Fabric - Polyester reinforced vinyl high visibility yellow 18 oz/yd2 weight.
- Connector - Shackled and bolted load lines.
- Flotation - 8" expanded polystyrene over 19 lbs/ft buoyancy.
- Ballast Line/Ballast - 5/16" galvanized chain (1.1 lbs/ft).
- Top Load Line - 5/16" galvanized wire rope enclosed in heavy tubing.

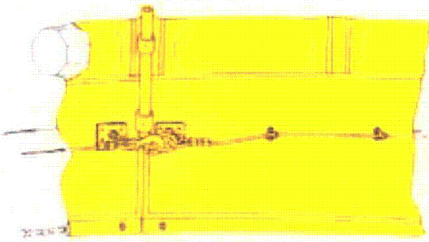
Heavyweight Turbidity Curtain

Application: Exposed areas subject to current, wind and tides.

Specifications

- Fabric - High strength nylon reinforced vinyl high visibility yellow 22 oz/yd2 weight.
- Connector - Snap hooks and rings

connect load lines with slotted reinforced PVC pipe for fabric closure. *Optional extruded aluminum connectors.
• Flotation - 12" expanded polystyrene over 29 lbs./Ft buoyancy.
• Ballast - 5/16" galvanized chain (1.1 lbs/ft).
• Load Lines - Dual 5/16" galvanized wire ropes with heavy vinyl coating.



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Type I:
Floatation consists of a series of expanded polyethylene logs, 6" in diameter and 55" long. The logs are enclosed in 22 oz./sq. yd. PVC coated nylon or polyester having 400 lbs. minimum tensile strength. Curtain is permanently attached to the bottom of the floatation unit and weighed down with 1/4" galvanized chain. The curtain material is slit film woven polypropylene having 200 lb. or 300 lb. tensile strength.

Type II:
Floatation and construction are identical to Type I. Curtain material is monofilament woven polypropylene.

Woven Curtain Material Specifications:

Property	Test Method	Results	Results	Results
Fabric Code		AEF 200W	AEF 300W	AEF 650W
Fabric Structure		Woven	Woven	Woven
Polymer		Polypropylene	Polypropylene	Polypropylene
Composition	ASTM D-4632	4.2 oz/sq. yd.	5.8 oz/sq. yd.	6.3 oz/sq. yd.
Weight	ASTM D-4632	200 lbs.	300 lbs.	390 x 250 lbs.
Grab Strength	ASTM D-4533	90 lbs.	120 lbs.	115 x 65 lbs.
Trap Tear Strength	ASTM D-3786	400 psi	600 psi	495 psi
Burst Strength	ASTM D-3787 (mod)	90 lbs.	150 lbs.	130 lbs.
Puncture	ASTM D-4632	20%	20%	30%
Elongation	ASTM D-4335	70% (500 hrs)	70% (500 hrs)	70% (500 hrs)
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Dimitri Lutchenkov
Director, Environmental Affairs

100 Constellation Way, Suite 1400P
Baltimore, Maryland 21202-3106

UniStar
NUCLEAR ENERGY

December 2, 2008

UN#08-085

Mr. William P. Seib
Chief, Maryland Section Southern
U.S. Army Corps of Engineers – Baltimore District
10 S. Howard Street
Baltimore, MD 21201

Subject: Joint Federal/State Application of Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC, Calvert Cliffs Nuclear Power Plant Site, Lusby, Calvert County, Maryland, USACE Tracking No. NAB-2007-08123-M05

Reference: USACE Letter from William P. Seib (USACE) to Thomas E. Roberts (UNE), dated October 28, 2008

Dear Mr. Seib:

Enclosed are the responses to Questions 2, 3 and 6 of your USACE letter dated October 28, 2008 (Reference). These are the remaining responses to the 15 questions in the referenced letter. We are also forwarding 10 CDs with all of the pertinent files to Ms. Kathy Anderson.

Please do not hesitate to contact me at 410-470-5524, if you have any questions concerning the enclosed responses.

Sincerely,

Dimitri Lutchenkov

Enclosures

cc: Kathy Anderson – USACE
Thomas Fredericks – NRC
Susan Gray – PPRP
Robert Tabisz – MDE
Jeff Thompson – MDE

Application NAB-2007-08123-M05
Response to U.S. Army Corps of Engineers Information Request Dated 10/28/08
Calvert Cliffs 3 Project, LLC and UniStar Nuclear Operating Services, LLC
December 2, 2008

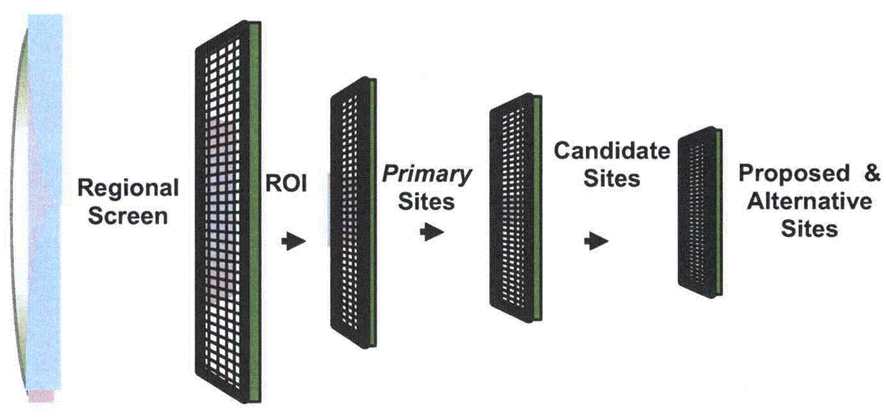
Question 2

A detailed analysis of alternative locations for the proposed project or any of the alternate energy sources that would have less impact to wetlands and waterways. Data collected using resource mapping is acceptable and should be noted as appropriate in all evaluations.

RESPONSE

Alternate energy sources (Wind, Geothermal, Hydropower, Solar Power, Wood Waste, Municipal Solid Waste, Energy Crops, Petroleum liquids (Oil), Fuel Cells, Coal, Natural Gas, Integrated Gasification Combined Cycle (IGCC)) were evaluated and determined to be non-viable energy sources for various reasons as described in Section 9.2 of the Calvert Cliffs (CCNPP) Unit 3 Environmental Report (ER) and in response to Question 1 of USACE letter dated 10/28/08. As such, a detailed analysis of how these alternate energy sources would have less impact to wetlands and waterways is unnecessary since these alternate energy sources are not considered to be viable energy options.

The alternatives analysis implements a multi-phase process in which initial Regions of Interest (ROIs) are identified and screened for "Potential" sites based on a high level set of criteria, further screening identifies "Candidate" sites based on a finer, more detailed, set of criteria and, finally, "Final" sites are selected and analyzed in detail.



The initial ROI is selected based on regulatory and strategic objectives. These include but are not limited to the following:

- Proximity to major population centers (that is, not located in an area with greater than or equal to 300 persons per square mile [ppsm]).
- Proximity of adequate transmission lines (that is, within approximately 30 miles (mi) [48.3 kilometer {km}) of 345- or 500-kV transmission lines). Per the EPR standard grid connection design, 345- or 500-kV transmission lines are needed.
- Lack of a suitable source for cooling water (that is, within 15 mi [24.10 km] of an adequate source for cooling water).
- Dedicated land (that is, not located within areas such as national and state parks, historic sites, and tribal lands).

Further screening is based on NRC site suitability and technical requirements as well as NEPA requirements for the consideration of alternative sites (e.g., reasonable range of alternatives and explicit consideration of environmental issues) and leads to the determination of potential sites. This screening includes but is not limited to the following:

- Consumptive use of water should not cause significant adverse effects on other users.
- The proposed action should not jeopardize Federal, State, and affected Native American tribal listed threatened, endangered, or candidates species or result in the destruction or adverse modification of critical habitat.
- There should not be any potential significant impacts to spawning grounds or nursery areas of populations of important aquatic species on Federal, State, 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 affect efforts to meet water-quality objectives.
- There should 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.
- There are no other significant issues that preclude the use of the site.

Next, screening of the potential sites involves the scoring and ranking based on a discrete set of criteria of each site. This resulted in selection of the following four candidate sites:

- Calvert Cliffs Nuclear Power Plant Unit 3
- Nine Mile Point Nuclear Power Plant Unit 3
- R.E. Ginna Nuclear Power Plant Unit 2
- Former Thiokol Site (brownfield site in Maryland)

Section 9.3 of the CCNPP Unit 3 COLA, Revision 4a, which addresses the site alternatives analysis is currently being updated and will be provided once the update is complete.

Application NAB-2007-08123-M05
Response to U.S. Army Corps of Engineers Information Request Dated 10/28/08
Calvert Cliffs 3 Project, LLC and UniStar Nuclear Operating Services, LLC
December 2, 2008

Question 3

A detailed analysis of the steps taken to minimize the proposed on-site impacts and the reasons for amending the project as changes developed from the initial proposal through to the current proposal and ultimately to a project that would further minimize the currently proposed impacts, including a complete description of the criteria used to identify, evaluate, and screen project alternatives. This on-site analysis does not preclude the necessity to review of the off-site alternatives or various forms of energy. This information must include the following:

a. Methods to avoid and minimize impacts to waters of the U.S.
   i. Methods to minimize dredging and construction related turbidity
   ii. Methods to minimize adverse effects to water quality
   iii. Methods to minimize adverse effects to natural and cultural resources

b. Quantify impacts to waters of the U.S. (both temporary and permanent) to all waters of the U.S., including jurisdictional wetlands, for each on-site project alternative. For waterways, include both the linear feet of waterway impacts (measured along the centerline of the waterway) and square fee of impact; for wetlands, include both square foot and acreage impacts; and for temporary wetland impacts, quantify any change in wetland classification (e.g., palustrine forested to palustrine emergent, etc.) and method of work to accomplish these changes.

RESPONSE

Question 3
The placement of the proposed CCNPP Unit 3 was designed to minimize environmental impacts, while maintaining the integrity of the existing CCNPP campus. A site layout study was conducted to select an appropriate location on the CCNPP campus for Unit 3 (Attachments 1a and 1b). The site selection criteria used to evaluate potential sites (north, south and west parcels) included: environmental impacts; security; land use and zoning; feasibility of construction; switchyard and transmission lines; impact to existing facilities, and process studies. As part of the environmental impact study, aesthetics, wetlands, threatened and endangered species, environmentally sensitive habitats, sound, air, and areas of historic and archaeological significance were evaluated. Choice of cooling water systems, water sources, and plant design specifications, were all made so as to minimize adverse effects to groundwater, the Chesapeake Bay, and the flora and fauna of the site and its environs. Specifically, the hybrid cooling tower design is a low profile design capability intended to minimize

if not totally avoid visual impact from both land and water sides. The plant itself will be situated such that it will be inland of the Chesapeake Bay Critical Area (CBCA) again minimizing visual impact. (The current planned mitigation in the CBCA increases the FIDS habitat by reforesting resulting in extending contiguous forest area within the CBCA and removes impervious area as well.) Placement of CCNPP Unit 3 2,500 ft away from and further inland than Units 1 and 2 allows for minimal impacts to the existing infrastructure of the CCNPP campus. Efforts were made to avoid impacts to wetlands by selecting a configuration that optimized use of uplands to the largest extent possible.

Based on the aforementioned criteria, it was determined that the south parcel would be the most ecologically sound location for the construction of CCNPP Unit 3.

3a. The Calvert Cliffs Unit 3 project will implement Best Management Practice (BMP) and Best Available Technologies (BATs) to ensure environmental compliance with applicable state and/or federal requirements to minimize turbidity during dredging and pile driving operations. BMP will be based on utilization of technical guide documents such as:

1) Maryland Standards and Specifications for Soil Erosion and Sediment Control, Maryland Department of the Environment, Water Management Administration, 1994;
2) Maryland Stormwater Design Manual, Volumes I and II, Maryland Department of the Environment, Water Management Administration, 2000; and
3) USACE Dredging Operations and Environmental Research (DOER) Program document ERDC TN-DOER-E21, "Silt Curtains as a Dredging Project Management Practice", September 2005 (Attachment 2).

Typical topics covered in these guides include planning considerations (site-specific project conditions), design criteria, construction specifications (curtains and other materials), installation or deployment, removal, and maintenance. Consultation with qualified vendors (see examples, Attachment 3) will also be utilized to ensure BMP and BAT.

Efforts were made to avoid and minimize impacts to cultural resources to the extent possible considering the required contiguous area required to facilitate the major components (power block, cooling towers and switchyard) of an electric power nuclear facility. All cultural resource impacts were identified, are being evaluated by the Maryland Historical Trust (MHT), and a Memorandum of Agreement (MOA) will be entered into as required by CPCN condition 57 to ensure necessary protections are in place.

3b. Provided below is an upper level summary of the stages of avoidance and/or minimization of on-site wetlands impacts. It should be noted that due to the magnitude/size of contiguous area required for the project, complete avoidance of some impacts to environmental categories, such as wetlands and cultural resources, associated with the CCNPP Unit 3, was not feasible. Attachment 4 contains a detailed response to 3b including four figures showing layout of the four configurations evaluated.

PROJECT WETLANDS AVOIDANCE/MINIMIZATION SUMMARY

Description	Wetlands Impacts (Acres)	Streams Impacts (LF)	Other Impacts
- Total delineated on Calvert Cliffs campus	133	94,200	344.2 acres CBCA*
- Option A layout in northern parcel	29.27	9,753	59.0 acres CBCA
- Option B layout in northern parcel	29.27	9,753	59.0 acres CBCA
- Option C layout in northern parcel	26.67	11,474	39.5 acres CBCA
- **Preferred Alternative** in southern parcel - Initial layout	23.3	10,409	26.9 acres CBCA
- Preferred alternative optimization - Multipurpose use of the lay down areas.	18.6	---	---
- Preferred alternative continued optimization o Construction road moved to avoid impact of Johns Creek watershed o Reduction of acreage of impact associated with storm water drainage basins o Batch plant relocation o Manmade wetland features were determined to be non-jurisdictional by USACE	14.3	10,199	---
- Preferred alternative continued optimization o Eliminated storm water basins adjacent to the access road o Optimized switchyard o Relocated other site LOD storm water basins	11.7	8,350	26.9 acres CBCA

* Chesapeake Bay Critical Area

ATTACHMENT 1a

UniStar
Calvert Cliffs Nuclear Power Plant Units 3 and 4
Cooling System Selection
and
Site Layout Study
Prepared for UniStar Nuclear and Constellation Generation Group
By
UniStar CCNPP Site Layout Team/Cooling System Expert Working Group
Team Lead:
David W. Murphy, P.E.
Bechtel Power Corporation
March 2006

ATTACHMENT 1b

Addendum
Cooling System Selection /Site Layout Study
August 16, 2007

ATTACHMENT 2

Dredging Operations and Environmental Research (DOER) Program
ERDC TN-DOER-E21
"Silt Curtains as a Dredging Project Management Practice"
September 2005

ATTACHEMENT 3

SILT CURTAIN VENDOR INFORMATION

ATTACHEMENT 4

DETAILED RESPONSE TO 3B

UniStar
Calvert Cliffs Nuclear Power Plant Units 3 and 4
Cooling System Selection
and
Site Layout Study

Prepared for UniStar Nuclear and Constellation Generation Group

By

UniStar CCNPP Site Layout Team/Cooling System Expert Working Group

Team Lead:

David W. Murphy, P.E.

Bechtel Power Corporation

March 2006

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Appendix H	Environmental Evaluation
Appendix I	Cultural Sites
Appendix J	Site Selection Team Biographies
Appendix K	Bibliography

List of Abbreviations and Acronyms

ALTA-ACSM	American Land Title Association – American Congress of Surveying and Mapping
ANS	American Nuclear Society
BG&E	Baltimore Gas & Electric
BTA	best technology available
CCNPP	Calvert Cliffs Nuclear Power Plant
CDS	Comprehensive Demonstration Study
CGG	Constellation Generation Group
COLA	Combined Construction Permit and Operating License application
COMAR	Code of Maryland Regulations
CPCN	Certificate of Public Convenience and Necessity
CW	circulating water
CWA	Clean Water Act
CWIS	cooling water intake structure
CZMP	Coastal Zone Management Program
DC	design criteria
EFH	essential fish habitat
EPR	Evolutionary Power Reactors
EPRI	Electric Power Research Institute
ER	Environmental Report
ERGS	Elm Road Generating Station
FF	Farm and Forestry (District)
gpm	gallons per minute
GPS	global positioning satellite
HAPs	habitats of particular concern
IDA	intensively developed area
ISFSI	independent spent fuel system installation
LNG	liquefied natural gas
LWA	limited work authorization
MDE	Maryland Department of Environment
MDNR	Maryland Department of Natural Resources
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Council
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
OCPP	Oak Creek Power Plant
PPRP	Power Plant Research Program
PWR	pressurized water reactor
RCA	Resource Conservation Area
RFMC	Regional Fishery Management Councils
RIS	representative imported species; resident important species
RS	representative species
SAV	submerged aquatic vegetation
SFA	Sustainable Fisheries Act
SNAC	spawning and nursery area of consequence
SSC	system, structure, and component
TDD	Technical Development Document
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Services
USGS	U.S. Geological Survey
WDNR	Wisconsin Department of Natural Resources

Executive Summary

The purpose of this study was to evaluate the Calvert Cliffs Nuclear Power Plant (CCNPP) site for locating two 1600 MWe U.S. Evolutionary Power Reactors (U.S. EPR) units and to determine the corresponding type of circulating water system for use with the new plant. The evaluations were performed by a team comprised of highly qualified industry experts.

Initial evaluations focused on the choice of open cycle (once-through) and closed cycle circulating water system options for use at the CCNPP site. The analysis of the circulating water system intake and discharge considered the applicable federal and state regulatory requirements, the feasibility of implementing various compliance alternatives, and the risks and impacts to Project economics and schedule based on either closed-cycle cooling or open-cycle cooling. Based upon the analysis conducted, the use of a closed-cycle cooling system is the recommended technology as the once-through (open) cooling option was determined to be not feasible. Selecting this technology minimizes the risks associated with environmental permitting and project schedule.

An evaluation process with an extensive listing of criteria and considerations was developed and used to evaluate layout locations on the Calvert Cliffs site. Criteria were grouped in the following eight categories:

1. Environmental
2. Land Use and Zoning (State, Local)
3. Construction Considerations
4. Construction Facilities
5. Switchyard/Transmission Lines
6. Security
7. Permanent Facility Considerations
8. Impact to Existing Facilities or Structures

Two layout options, located immediately north and south of the existing CCNPP units, presented the more favorable results.

- Northern location - units oriented side by side, south to north, reactor building towards the east, switchyard west, and cooling towers north.

- Southern location - units oriented side by side, north to south, reactor building to the east, switchyard west, and cooling towers south.

The northern location would make better use of land zoned industrial I-1 and would allow for a single site protected area. But this location presents greater construction challenges due to the distance from the existing barge facility and primary laydown, long heavy haul road route, activities crossing under the transmission lines, and impacts that would cause redesign and relocation of the current entrance and security facilities. The northern location impacts a greater area of wetlands than the southern location.

The southern location is located entirely within the area zoned Rural/Resource Preservation District, where power plants are not permitted as a principal use. Therefore, this location would require exemption from the County Zoning Ordinance or the land must be rezoned (an exemption is preferable). However, the southern location would be more advantageous for construction activities due to the location of the existing barge facility, heavy haul road, batch plant, laydown, and parking facilities. The southern location segregates the construction activities from the operating units and would not disrupt the current traffic flow and maintains the security access facilities. However, the southern location does not allow for a single site protected area that is connected with the existing CCNPP Units 1 and 2 protected area. This would result in a higher life cycle cost for security.

Based on the analysis by the team, it is recommended that the southern location with a closed circulating water system be established as the base case for Calvert Cliffs Units 3 and 4 Combined Construction Permit and Operating License application (COLA). Selection of the southern location is based on locating the entire power block and cooling tower arrangement outside the 1000' wide critical area, which is established under state law to protect the Chesapeake Bay shoreline and associated cliffs. This study assumes that appropriate approvals can be obtained to allow water-critical structures/pipelines to be located within the critical area.

Acknowledgements
The UniStar CCNPP Site Layout Team/Cooling System Expert Working Group

This report presents the results of efforts by the CCNPP Units 3 and 4 Site Layout Team/Cooling Water Systems Working Group, a multidisciplinary team of industry experts led by David W. Murphy, P.E., Bechtel Power Corporation (Bechtel). Members of the team, their affiliations, and contributed expertise are listed below. Biographies of key team members are presented in Appendix J.

Bechtel Power Corporation

David W. Murphy, P.E. – Team Lead, Engineering Lead
Charles Dicey, Plant Design Engineering Supervisor – Design / Layout Development
Clinton P. Lamerson, Construction Manager – Constructability Evaluation
Brian Morrow, Plant Design Engineering – Layout Design
Shankar S. Rao, P.E., Mechanical Engineering Supervisor – Statistical Analysis
Yifan Zheng, P.E., Sr. Eng. Specialist, Hydraulics & Hydrology – Cooling Water System

Constellation Generation Group (CGG)

Jim F. Burkman, Environmental Scientist – Cultural Resources, Land Use/Zoning
Gregory C. DeCamp, CHMM, Sr. Env. Scientist – Environment Lead, Ecol. Resources
Mark T. Hunter, Consultant Operations/Maintenance – Site Interface Lead
Carla M. Logan, Environmental Specialist – Clean Water Act (CWA) 316(a, b), Ecology
Brenda D. Nuse, Environmental Scientist – Site Environmental Coordinator
Thomas E. Roberts, Engineering Manager – CGG Engineering Lead

AKRF, Inc.

Douglas G. Heimbuch, Ph.D., Technical Director – CWA 316(a, b) and related issues
Maureen Vaskis Heimbuch, J.D., V.P. – CWA 316(a, b) and related issues
Fred Jacobs, Ph.D., Sr. V.P. – CWA(a, b), Magnuson-Stevens Act, and related issues

Alden Research Laboratory

Edward P. Taft, President – Cooling Water Intake/Discharge Technology, Hydrology

EPRI Solutions, Inc.
David E. Bailey, Assoc. Dir. – CWA 316(b), Cooling Water Intake Technology

Morgan State University

J. Howard Hixson, III, Program Mgr. – Chesapeake Bay Ecology, CCNPP Monitoring

Randolph-Macon College

C. Barry Knisley, Ph.D., Wornom Professor of Biology – Tiger Beetle Ecology

1.0 Introduction

1.1 Background

Constellation Generation Group (Constellation) is embarking on a study with the intent to develop a two-unit nuclear power plant. Constellation is considering the Calvert Cliffs site, along with other candidate sites, for the new plant. As such, Constellation may develop and submit a license application for the addition of two nuclear units at the Calvert Cliffs site in Calvert County, Maryland. The plant would be developed as a project of UniStar Nuclear, a collaboration of Constellation and AREVA with Bechtel as the Architect/Engineer. Development of the new plant would require approval by the U.S. Nuclear Regulatory Commission (NRC) of a construction and operating license application (COLA), including an environmental report (ER), which documents the safety and environmental analyses bases for the facility. With this plan, Constellation is taking an aggressive approach with the following milestones as the driver for the business plan and the decision process for layout and cooling water type selection and recommendation.

Environmental Report (ER) submittal
Design Certification (DC) submittal
COLA submittal
Limited Work Authorization (LWA)

For this study, the proposed units will be referred to as Calvert Cliffs Nuclear Power Plant Units 3 and 4 (CCNPP 3 and 4). References to north, south, and west in the report are based on the existing units as the reference point.

1.2 Purpose

In preparation of the COL, one of the first activities is to develop a layout study to evaluate various layout options and circulating cooling water alternatives, and select those best suited for a site. The purpose of this report is to document Constellation's evaluation of various facility layout options and circulating cooling water alternatives for a two-unit U.S. EPR plant located at the CCNPP site. To accomplish this task, an expert working group was developed. This team includes Constellation, Bechtel, and industry technical specialists. See Appendix J for team members and qualifications.

The team was charged with conducting the necessary analyses and recommending to senior management the circulating water system and layout of major plant facilities that represented the best choice in consideration of all relevant factors, including environmental, constructability, operability, cost, and schedule. Decisions based on the team's recommendations are intended as bases for subsequent engineering, environmental, and geological studies and analyses (e.g., subsurface investigations) necessary to confirm feasibility, basic design parameters, and other information essential for development of a COLA.

2.0 Scope/Basis

The scope of this study is to locate two 1600 MWe net (4592 MWt) U.S. EPR units on the Calvert Cliffs site with the associated circulating cooling water system. The size of the EPR site footprint is based on Framatome drawing NPGM2-102118 for OL-3. Spacing between the reactor building centerlines is 1000' which accommodates the construction activities.

Evaluation of closed-cycle cooling water system options (e.g., cooling tower types) and cooling water intake and discharge conceptual design options beyond that needed for recommendation of circulating water system type is not within the scope of this study.

2.1 Description of Calvert Cliffs Site

The Calvert Cliffs site is approximately 2100 acres on the western shore of the Chesapeake Bay in Calvert County. The Calvert Cliffs property is predominantly occupied by forests with some cleared land. Maryland's Critical Area law and the County Zoning Ordinance require a 100' critical area buffer and a 1000' critical area zone along the Chesapeake Bay shoreline. The CCNPP site includes approximately 2 miles of Chesapeake Bay frontage. This shoreline is mostly extremely steep cliffs with little beach area. South of the Calvert Cliffs units is a recreational area known as Camp Conoy. Camp Conoy contains various cabins, outbuildings, swimming pool, softball field, tennis courts, and fishing pond used by Constellation employees and their families.

The two existing units at Calvert Cliffs are located on a tract containing 976.2 acres, which was acquired from Belle Goldstein (in 1967) and is zoned I-1 (light industrial). An adjacent 29.4 acre tract acquired from Pardoe in 1985 is also zoned I-1. The I-1 district includes the Lake Davies area that was used for approximately 3 million cubic yards of dredging spoil from the construction of the intake canal for the existing units. The remaining land at Calvert Cliffs (1,051.3 acres) is zoned Rural/Resource Preservation District. When the pending comprehensive rewrite of the Zoning Ordinance becomes effective on May 1, 2006, this district will become the Farm & Forestry (FF) district. The FF tracts were acquired from the YMCA in 1968, and from Briscoe, Louis Goldstein, Gibson, Fowler and Raysinger in the 1980s. A chart listing all of the tracts included within the Calvert Cliffs site is attached as Appendix C. A table showing relevant land uses by zoning district is also included in Appendix C.

Calvert County's Flag Ponds Nature Park and Calvert Cliffs State Park border the site on the north and south, respectively. The northerly portion of the site is adjoined on its western border by Maryland Highway 2-4, a designated state-scenic highway. The southern portion of the site adjoins rural residential property to the west, between the site and Highway 2-4, and several residential parcels located on the bayshore.

Site topography, streams, existing CCNPP facilities, and other general site features relevant to this study are shown in figures included in Appendix A.

2.1.1 Site Environmental Characteristics

Environmental characteristics of the CCNPP site and adjacent areas of the Chesapeake Bay that contribute to the bases of this study are highlighted below. Detailed accounts of these characteristics are provided in Appendix H.

- Endangered or Threatened Species – Three species designated as threatened or endangered on the federal or state level are known to occur on the CCNPP site: the Northeastern Beach Tiger Beetle and Puritan Tiger Beetle, which occupy cliff and/or shoreline areas of the site, and the Bald Eagle, which is known to nest in the far southern part of the site.

- Wetlands and Floodplains – Wetlands on the CCNPP site of primary concern consist of small headwater streams in the Patuxent River drainage and associated riparian forest, and minor Chesapeake Bay tributary streams and associated small impoundments. No designated floodplains occur on the site except along the Chesapeake Bay shoreline.

- Cultural Resources – Known historic resources on the CCNPP site consist of a relocated tobacco barn that served as the CCNPP Visitor Center (closed in 2001 due to heightened security measures) and a historical house foundation and chimney, all located immediately north of existing plant facilities; log cabins associated with Camp Conoy, a former Boy Scout camp, located south of existing plant facilities; and tobacco barns located elsewhere on the site. No known archaeological sites are present on the CCNPP site.

- Chesapeake Bay Ecological Resources – Known Chesapeake Bay ecological resources in the immediate vicinity of the CCNPP site include oyster beds south of existing CCNPP plant facilities.

2.2 Description of U.S. EPR

The U.S. EPR is an evolutionary power reactor designed by Framatome ANP, a jointly-owned subsidiary of AREVA and Siemens. This plant is a four-loop design. The primary system design, loop configuration, and main components are similar to those of current operating U.S. PWRs. Construction of the EPR is currently proceeding at the Olkiluoto 3 site in Finland.

Cooling water requirements used for this study were estimated from CCNPP Units 1 and 2 and from the initial U.S. EPR heat balance. On this basis, a once-through cooling water system for a two-unit plant would require an onshore or offshore intake design to accommodate upwards of 5 million gallons per minute (gpm) considering a 10°F temperature rise across the condenser. Cooling water makeup and blowdown requirements for a closed-cycle circulating water system are estimated to be 40,000 gpm and 20,000 gpm per unit, respectively.

2.3 Site Layout Alternatives

This study will consider both an open and closed cooling water system for removal of heat from the turbine cycle. Layout alternatives will include locations north, south, and west of the existing CCNPP Units 1 and 2.

The new U.S. EPR units for the Calvert Cliffs site are located using the Maryland State Plane coordinate system based on USGS reference year 1927 (NAD). This coordinate system was used for the original construction of Units 1 and 2. The location is based on information obtained from Bechtel drawing 6750-C-1 (BG&E No. 61-501E) depicting plant coordinates MD N 219,000.00 and E 960,000 and plant grid coordinates N 10,000.00 and E 10,000.00.

2.4 Methodology

The methodology for the study was developed and implemented by the study team during the course of two working sessions held at Bechtel offices in Frederick, MD on January 5-6 and February 8, 2006; teleconferences; independent analyses, report preparation, and review by team members; and a site walkdown by selected team members on January 26, 2006. See Appendices D and E for documentation of walkdown results and meetings.

The team used an adaptive approach in which detailed methodology for subsequent steps were developed on the basis of investigation results. Following is a summary of key steps used in the methodology. Details of the process are described in Section 4.0.

2.4.1 Evaluation of Cooling System Options

Based on initial discussions by the team, selection of cooling system (once-through versus closed-cycle) was the appropriate starting point for the analysis. Detailed evaluation included consideration of applicable regulations, technological factors, cost, and associated regulatory and schedule risk. Results of the analysis, discussed in Section 3.0, indicated that a closed-cycle system was the appropriate choice for the new plant, a decision which drove the remainder of the evaluations.

2.4.2 Facility Layout Alternatives Evaluation and Selection

Based on the initial conclusions reached by the team, the facility layout evaluations were based on a close-cycle cooling system. Steps in the layout evaluation process are summarized below and described in more detail in Section 4.0 and Appendix B.

1. Identification of Exclusion Criteria – areas of the site that were deemed "off-limits" to development, were identified.

2. Identification of candidate facility layout options based on a closed cooling water system and the exclusion criteria.

3. Initial layout screening to eliminate configurations with obvious construction problems.

4. Evaluation of Remaining Layout Options (2 (north) and 4 (south))

    a. Development and Weighting of Evaluation Criteria
    b. Evaluation and Scoring Process

3.0 Evaluation of Cooling Water System Alternatives

Based on the analysis of the information discussed below, the use of a closed-cycle cooling system is the recommended cooling water system alternative for CCNPP Units 3 and 4. Selecting this technology is likely to minimize the risks associated with environmental permitting, which also would minimize the risk to the Project schedule. Furthermore, open-cycle cooling for CCNPP Units 3 and 4 is not a feasible alternative from an engineering and cost-effectiveness perspective.

In Section 3.1.1, below, applicable federal and state regulatory requirements, the feasibility of implementing various compliance alternatives, and the risks and possible impacts to Project economics and schedule based on the two major compliance alternatives, i.e., open and closed-cycle cooling, are identified and discussed. Also considered are possible impacts and benefits to CCNPP Units 1 and 2 of compliance alternatives for CCNPP Units 3 and 4 under USEPA's §316(b) Phase II Rule (discussed below in Section 3.1.1.2.c).

Engineering considerations regarding the installation and operation of open-cycle cooling for CCNPP Units 3 and 4 are discussed in Section 3.1.1.6, below. Also discussed in that section is the feasibility of satisfying regulatory requirements for reducing impacts to fish and shellfish through the use of cooling water intake structure (CWIS) technologies.

3.1 Federal and State Cooling Water Intake Structure and Thermal Discharge Regulations

CWIS' are regulated under §316(b) of the Federal Clean Water Act (CWA) and its implementing regulations, and under Title 26 of the Code of Maryland Regulations (COMAR) 26.08.03.05. The associated thermal discharges are regulated under COMAR 26.08.03.03, which implements CWA §316(a) in the State of Maryland. These regulations, and their applicability to CCNPP, are summarized in Appendix K. Discussed below are implications of these regulations to the choice of cooling water system alternatives for CCNPP Units 3 and 4.

The regulatory analyses presented in this section reflect reasonable interpretations of the federal and state regulations, as those regulations exist today. However, these regulations are not cast in stone. USEPA's regulations that implement §316(b) are under appeal and the Maryland §316(b) regulations predate USEPA's regulations which were promulgated in 2001, 2003, and 2004. Therefore, it is possible that the outcome of the appeal of the federal regulations or future regulatory action by Maryland could affect the validity of these analyses and, therefore, the conclusions and recommendations that were derived from them.

In addition, Maryland is authorized to implement its own regulatory program so long as the state regulations are as stringent as or more stringent than USEPA's regulations. Maryland could implement regulations that would require units such as the proposed CCNPP Units 3 and 4 to operate with closed cooling. Maryland could, although unlikely given past permitting history and its comments during the §316(b) rulemaking, adopt regulations that would prohibit some regulatory options available under USEPA's Rules. Maryland could also impose mandatory studies and assessments beyond those required by USEPA's Rules. Such regulations could adversely impact the Project's economics, and if additional studies were required, the Project's schedule.

3.1.1 §316(b) -- Federal CWIS Regulations

Section 316(b) of the CWA regulates CWISs associated with point source discharges (i.e., discharges regulated under §301 or §306 of the CWA):

> "Any standard pursuant to section 301 or section 306 of this Act and applicable to a point source shall require that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact."

USEPA promulgated regulations governing CWISs at new facilities, which include new steam electric generating stations ("Phase I Rule"), and existing steam electric generating stations ("Phase II Rule") pursuant to §316(b) of the CWA. The Phase I Rule was issued in December 2001 and was amended in June 2003. The Phase II Rule was issued in July 2004.

Given USEPA's definition of "existing facility" (see Appendix G) CCNPP Units 3 and 4 should be considered an existing facility and be regulated under the Phase II Rule. However, as discussed below in the Regulatory Uncertainties section, the definition of existing facility is being challenged in a pending appeal of USEPA's Phase II rule. Therefore, regulation of CCNPP Units 3 and 4 under Phase I as well as Phase II is considered.

USEPA's CWIS regulations are implemented in the context of the Agency's overall National Pollutant Discharge Elimination System (NPDES) regulations. These regulations require that the owner(s) and operator of a point source apply for and operate in conformance with an NPDES permit. The regulations also require that the owner(s) and the operator apply for a modification to an existing permit in advance of the discharge of any pollutants from any additional sources at the site. The NPDES regulations do not require that all sources regulated under a single permit be owned by the same entity. Therefore, CCNPP could apply for a modification of the existing NPDES Permit for Units 1 and 2 to accommodate the discharge of pollutants expected from Units 3 and 4.

If the units are regulated under a single permit, there may be substantial advantages associated with achieving compliance for Units 1 and 2 under USEPA's current §316(b) Phase II Rule[1]. This potential strategy is discussed in Section 3.1.1.2.c, below.

3.1.1.1 Phase I Compliance Alternatives

The Phase I Rule provides for two compliance alternatives: Track I (Fast Track) and Track II (Site-Specific Track). Under Track I, a facility with an estuarine cooling water source must:

- Reduce intake flow, at a minimum, to a level commensurate with that which can be attained by a once-through recirculating cooling water system.
- Design and construct each cooling water intake structure to a maximum design intake velocity of 0.5 ft/sec.
- Design and construct the cooling water intake structures such that the total design intake flow over one tidal cycle of ebb and flow is no greater than 1% of the volume of the water column within the area centered about the opening of the intake with a diameter defined by the distance of one tidal excursion at the mean low water level of the estuary.
- Implement technologies and operational measures to minimize impingement mortality and entrainment of threatened or endangered species and other species of fish and shellfish of concern.

As a practical matter, the intake flow reduction requirement of Track I make Track I a closed-cycle CWIS option.

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[1] *Wisconsin's Department of Natural Resources (WDNR) issued a renewed/modified NPDES permit for a facility on Lake Michigan, Oak Creek Power Plant (OCPP), that included the discharges associated with two additional units, referred to as the Elm Road Generating Station (ERGS), to be built on the same site. OCPP/ERGS will use a common intake structure, a modification of OCPP's existing CWIS. WDNR determined that the modification of the existing CWIS to accommodate the new units was regulated under USEPA's Phase II Rule. USEPA Region 5 did not object to the final permit for Oak Creek/Elm Road.*

Under Track II, a facility may install a CWIS that is not closed-cycle; however, it must comply with the following requirements:

- Reduce the level of adverse environmental impact to a level commensurate with that achieved in Track I.
- Design and construct the CWISs such that the total design intake flow over one tidal cycle of ebb and flood is no greater than 1% of the volume of the water column within the area centered about the opening of the intake with a diameter defined by the distance of one tidal excursion at the mean low water level of the estuary.
- Conduct a Comprehensive Demonstration Study (CDS) including a source water biological study, an evaluation of potential CWIS effects, an evaluation of proposed mitigation measures, and a verification monitoring plan.

3.1.1.1a Implications of Phase I Compliance Alternatives for CCNPP Units 3 and 4

There are no known major impediments for compliance under Track I of the Phase I Rule with a closed-cycle cooling system for CCNPP Units 3 and 4.

However, compliance under Track II of the Phase I Rule with a once-through cooling system would be problematic for a number of reasons:

- There are no demonstrated technologies for achieving reductions in entrainment commensurate with closed-cycle cooling (see Section 3.2.2, below).
- The 1% proportional intake flow requirement may be difficult to satisfy with once-through cooling for CCNPP Units 3 and 4. As one point of reference, CCNPP Units 1 and 2, with 2.4 million gpm of intake flow, withdraw 0.7% of the tidal flow in the area of the plant (BG&E, 1970). The ebb tide excursion distance in the vicinity of CCNPP is 5.3 km (Constellation, 2004). Assuming an equal distance (5.3 km) for the flood tide excursion and an average water depth of 15 m, the referenced water column volume, for the extreme case of an offshore intake 5.3 km from shore, would be 1,324 million m^3. Over one tidal cycle of ebb and flood (approximately 12 hours), 1% of that volume would be withdrawn by an intake flow rate of 4.8 million gpm, roughly the once-through cooling water requirement for CCNPP Units 3 and 4.
- There are requirements to develop a plan of study and submit this plan to Maryland for review, to implement the study plan and to present the results of the study in a comprehensive demonstration study. The time necessary to address these requirements would likely be three years, at a minimum. This would have a substantial impact on the Project's schedule.

3.1.1.2 Phase II Compliance Alternatives

The Phase II Rule establishes national numeric performance standards for reducing impingement mortality and entrainment and a series of compliance alternatives, including meeting the numeric performance standards through design and construction technologies or operational measures. The Phase II Rule requires most existing facilities to develop information to demonstrate that the facility meets or will meet the applicable performance standards. The information is referred to as a Comprehensive Demonstration Study.

The first compliance alternative (§125.94(a)(1)) applies to existing facilities that (1) operate with or will operate with a closed-cycle cooling system (§125.94(a)(1)(i)), in which case they are deemed to be in full compliance with the Phase II Rule and do not need to submit a CDS or (2) have an intake with a through screen velocity of 0.5 feet per second or less (§125.94(a)(1)(ii)), in which case the facility is deemed to have met the performance standard for reductions in impingement mortality and only needs to submit a CDS addressing compliance with the standard for reductions in entrainment.

The second compliance alternative (§125.94(a)(2)) addresses those facilities that meet the performance standards with the existing technological, operational, or restoration measures. The third alternative (§125.94(a)(3)) allows a facility to combine the benefits from newly installed technologies, operational measures, and restoration with existing technologies and measures to comply with the requirements:

> "You may demonstrate to the Director that you have selected, and will install and properly operate and maintain, design and construction technologies, operational measures, and/or restoration measures that will, in combination with any existing design and construction technologies, operational measures, and/or restoration measures, meet the performance standards specified in paragraph (b) of this section and/or the restoration requirements in paragraph (c) of this section."

The fourth compliance alternative (§125.94(a)(4)) applies when a facility installs a technology preapproved by USEPA or the state as meeting the national performance standards for a given water body type. The fifth alternative (§125.94(a)(5)) allows a facility to obtain a site-specific determination of best technology available (BTA) based upon a cost-cost test or a cost-benefit test.

The national performance standards are provided in 40 CFR §125.94(b). The standards applicable to facilities with an estuarine source water are as follows.

- Impingement mortality performance standards:

  > "If you choose compliance alternatives in paragraphs (a)(2), (a)(3), or (a)(4) of this section, you must reduce impingement mortality for all life

> stages of fish and shellfish by 80 to 95 percent from the calculation baseline."

- Entrainment performance standards:

> "If you choose compliance alternatives in paragraphs (a)(1)(ii), (a)(2), (a)(3), or (a)(4) of this section, you must also reduce entrainment of all life stages of fish and shellfish by 60 to 90 percent from the calculation baseline if: (i) Your facility has a capacity utilization rate of 15 percent or greater, and (ii)(A) Your facility uses cooling water withdrawn from a tidal river, estuary, ocean, or one of the Great Lakes."

Compliance with these performance standards is determined by comparing the impingement mortality and entrainment that would occur at the existing facility assuming a calculation baseline for the facility, and the impingement mortality and entrainment that would occur once the proposed technological and operational measures proposed under compliance alternative were implemented. USEPA defined the calculation baseline as:

> "...an estimate of impingement mortality and entrainment that would occur at your site assuming that: the cooling water system has been designed as a once- through system; the opening of the cooling water intake structure is located at, and the face of the standard 3/8-inch mesh traveling screen is oriented parallel to, the shoreline near the surface of the source water body; and the baseline practices, procedures, and structural configuration are those that your facility would maintain in the absence of any structural or operational controls, including flow or velocity reductions, implemented in whole or in part for the purposes of reducing impingement mortality and entrainment."

3.1.1.2.a Implications of Phase II Compliance Alternatives for CCNPP Units 3 and 4

If CCNPP Units 3 and 4 were to be regulated under Phase II, all four units at CCNPP would be treated as a single facility. In that case, Phase II compliance alternative 1 (closed-cycle for the facility) would no longer be an available alternative for all four units because CCNPP Units 1 and 2 use open-cycle cooling. However, this would not prevent CCNPP Units 3 and 4 from having a closed-cycle cooling system (see the discussion of compliance alternative 3, below).

Phase II compliance alternative 2 (existing facility already meets performance standards) would not be available either. This is because at the time the CDS would be filed (in accordance with the permitting schedule for CCNPP Units 1 and 2), technologies, operational measures, or restoration measures to meet the performance standards for the combined facility would not be in place.

Phase II compliance alternative 4 (preapproved technologies) is not available to CCNPP because neither USEPA nor Maryland, to date, has preapproved any technologies for reducing entrainment in estuarine environments.

Phase II compliance alternatives 3 and 5 would remain available to CCNPP. Under either of these compliance options, CCNPP Units 3 and 4 could use either closed-cycle or once-through cooling systems. However, there would be no clear benefits from requesting a site-specific BTA determination (compliance alternative 5) if CCNPP Units 3 and 4 used closed-cycle cooling, and there would be additional costs involved in obtaining the site-specific BTA determination.

Therefore, under Phase II, three options would be available for the combined facility of CCNPP Units 1-4:

- Closed-cycle cooling for CCNPP Units 3 and 4 and Phase II compliance alternative 3, or
- Once-through cooling for CCNPP Units 3 and 4 and Phase II compliance alternative 3, or
- Once-through cooling for CCNPP Units 3 and 4 and Phase II compliance alternative 5.

For options that use Phase II compliance alternative 3, the facility would have to demonstrate that the national performance standards were met with some combination of technologies, operational measures, and restoration measures. For the option that uses Phase II compliance alternative 5, a cost/benefit (or cost/cost) study would have to be conducted to determine whether CCNPP was entitled to site-specific determination of BTA (that would be less stringent than required by the national performance standards).

If Units 3 and 4 had a separate CWIS, CCNPP could opt to use compliance alternative 1 for Units 3 and 4. This would eliminate the need to submit a CDS for these units. CCNPP would be required to develop a separate compliance strategy for Units 1 and 2 and to submit a CDS for those units. However, as noted in Section 3.1.1.6.1, below, a separate CWIS for CCNPP Units 3 and 4 likely would be cost-prohibitive.

3.1.1.2.b Phase II Compliance Considerations with Once-through Cooling

Based on historical data, it appears that the national performance standard of an 80% reduction in impingement mortality might be satisfied (but only minimally so) with a fish return system like the one in use at CCNPP Units 1 and 2. The historical (1975–1995) average number of finfish and blue crab impinged by CCNPP Units 1 and 2 is 1,931,462 per year (Ringger, 2000). Of those, 351,688 per year were estimated to have been killed by impingement, the rest survived being returned to the Bay via the screen wash discharge trough. Therefore, on average, impingement mortality of fish and shellfish was reduced 82% compared to a calculation baseline condition, i.e., no return of impinged fish and shellfish to the Bay, and therefore no impingement survival. Under the Phase II Rule, Maryland has considerable discretion in establishing how compliance with the numeric performance standards will be measured and determined. For example, Maryland can set a specific reduction standard for a water body within the 80%–95% range established under the Phase II Rule; it does not have to accept only an 80% reduction. Likewise, Maryland can establish that the percent reduction must be achieved for each species as opposed to its being achieved based upon an average of all species or on the average reduction for representative species (RS).

Representative important species (RIS) (which would now be referred to as RS under the Phase II rule) entrained at CCNPP, based on historical data from CCNPP Units 1 and 2 include bay anchovy, naked goby, and spot (ANSP, 1981). The presence of bay anchovy as a key species subject to entrainment imposes additional challenges to reducing entrainment losses because bay anchovy larvae are extremely frail and exhibit low survival rates when impinged (e.g., on fine mesh screens intended to reduce entrainment).

It is very unlikely that any technology that would satisfy the national performance standard for entrainment could be successfully installed and operated for CCNPP Units 3 and 4. A summary of an evaluation of the feasibility of technology alternatives is presented in Section 3.1.1.6.2.b, below. The conclusion of that evaluation (particularly because bay anchovy were present as a key species subject to entrainment) was that no proven technologies currently exist that would reduce entrainment by at least 60% and could be successfully installed and operated at a facility like CCNPP.

Therefore, it is very unlikely that CCNPP, with once-through cooling for CCNPP Units 3 and 4, would be able to comply with §316(b) under Phase II compliance alternative 3 using CWIS technologies only. Another approach would be to schedule extensive outages or flow reductions during summer months to reduce entrainment, but it is assumed that approach would be economically prohibitive and therefore it is not considered a viable option. However, under Phase II compliance alternative 3, CCNPP could use restoration measures to mitigate entrainment losses, and by doing so comply with the Phase II Rule.

Restoration measures have been used successfully at Chalk Point on the Patuxent River to achieve compliance with §316(b) under USEPA's prior best professional judgment regulatory scheme and Maryland's existing regulations. Maryland was generally supportive of USEPA's including restoration as part of the compliance alternatives in the Phase II Rule. However, use of restoration is one of the issues under appeal and a decision is not expected to until August 2006. If restoration measures were to survive the appeal, and CCNPP could demonstrate that it satisfied the prerequisites, use of restoration measures to achieve compliance would be expected to be a low-cost measure, pending review of the results of new entrainment studies.

The other option for complying with the Phase II Rule with once-through cooling for CCNPP Units 3 and 4 is the site-specific determination of BTA after demonstrating that the costs for meeting the performance standards with technologies are significantly greater than the benefits from meeting the performance standards. Based on historical data from CCNPP Units 1 and 2 and cost-benefit analyses for other facilities such as PSEG's Salem Generating Station, it appears almost certain that such a demonstration would be feasible.

If CCNPP could demonstrate that it is entitled to site-specific (i.e., lower) performance standards based on demonstrations that the costs of achieving compliance are significantly greater than (1) the costs USEPA used for a facility like CCNPP or (2) the value of the benefits, then it is possible to substantially reduce compliance costs for CCNPP Units 3 and 4. Using this compliance alternative could result in a determination that there is no technological or operational measure that could be installed without incurring costs significantly greater than the value of the benefits. However, USEPA's Phase II Rule does not define "significantly greater" and the Rule grants considerable discretion to Maryland in making this determination. In addition, the Phase II Rule specifies the types of benefits that must be included and, depending upon the species entrained and impinged (e.g., species designated as threatened or endangered, species that are at risk of being driven to extinction), it is possible that non-use values would have to be included. Such a requirement could result in a very significant increase in the benefit valuation compared to a benefit based solely on impacts to commercial and recreational fisheries and ecological benefits.

Based upon the Maryland regulations, the estimated economic loss due to historical entrainment at CCNPP Units 1 and 2 was only $200 per year (McLean, et.al. 2002). Assuming that CCNPP Units 3 and 4, with a once-through cooling system, would withdraw twice as much cooling water as CCNPP Units 1 and 2 and therefore entrain twice as many organisms, the total economic loss due to entrainment at the facility (Units 1-4) would be less than $1,000 under the existing Maryland regulations. However, USEPA's Phase II Rule provides specific direction on how to conduct the cost-benefit analyses. The Rule specifically identifies the benefits categories to be considered, requires a consideration of the uncertainties associated with the benefits estimates and also requires that non-use benefits be considered, if appropriate, in the estimation. If non-use benefits were determined to be applicable, the results of the cost-benefit analysis may not be favorable to CCNPP.

3.1.1.2.c Phase II Compliance Considerations with Closed-cycle Cooling

Closed-cycle cooling for CCNPP Units 3 and 4 provides a means for satisfying the performance standards for all four units of the CCNPP facility. Since USEPA has defined an existing facility to include additional units that result in an increase in the design capacity of the CWIS (see Appendix G), the calculation baseline (for determining compliance with Phase II performance standards) would include CCNPP Units 3 and 4 and CCNPP Units 1 and 2. The flow for use in estimating the calculation baseline would be the design flow for CCNPP Units 1 and 2 plus the once-through design flow for CCNPP Units 3 and 4.

Reductions in flow and the resulting reductions in entrainment due to the use of a closed-cycle cooling system on CCNPP Units 3 and 4 could be used to determine compliance with the applicable performance standards of a 60% to 90% reduction in entrainment for CCNPP Units 1-4. For example, if the intake flow for CCNPP Units 3 and 4 is twice the intake flow of CCNPP Units 1 and 2, the intake flow of the facility as a whole (with closed-cycle cooling for CCNPP Units 3 and 4) would be one-third the calculation baseline intake flow (once-through cooling for all four units). Assuming entrainment is proportional to intake flow (as USEPA assumes), the facility would demonstrate a 66% reduction in entrainment compared to the calculation baseline, and would satisfy the national performance standards for entrainment. As noted above with respect to the impingement reduction standard, Maryland has the discretion under the Phase II Rule to establish a water body-specific standard within the 60% to 90% range and can also determine how the reduction is determined, e.g., species by species, average of all species, or average of RS.

3.1.2 §316(a) - Federal Thermal Discharge Regulations

Section 316(a) of the CWA is a variance provision for situations where an existing thermal effluent limitation imposed under §301 or §306 is more stringent than necessary to "assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water into which the discharge is to be made." In these situations, the regulator may impose a less stringent effluent limitation with respect to the thermal component of the discharge that still will assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on that body of water. USEPA has not established technology-based effluent limitations for the discharge of heat from steam electric power plants (40 CFR Part 423); therefore, only the state's thermal water quality standards apply.

3.1.3 COMAR 26.08.03.05 – Maryland CWIS Regulations

3.1.3.1 Regulation Summary

The Maryland CWIS regulation implements §316(b) at the state level and defines acceptable levels of entrainment and impingement:

> "The location, design, construction and capacity of cooling water intake structures shall reflect the best technology available (BTA) for minimizing adverse environmental impact." (COMAR 26.08.03.05(A))
>
> "The determination of BTA for minimizing adverse environmental impact shall consider the effect of:
>
> (1) Impingement loss as determined in §D of this regulation; and

> (2) Entrainment loss as determined in §E of this regulation." (COMAR 26.08.03.05(A))

With respect to impingement, 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:

> "Dischargers shall install and operate functional modifications to mitigate impingement loss, provided that the additional cost of installation of modifications to intake structures and of operational modifications over a 5-year period does not exceed 5 times the estimated annual value of the impingement loss." (COMAR 26.08.03.05(D)(2))

For entrainment, 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:

> "The discharger shall determine the extent of cooling water entrainment loss on a spawning or nursery area of consequence for RIS..." (COMAR 26.08.03.05(E)(2))

> "If entrainment loss results in significant adverse environmental impact, the discharger shall install and operate functional modifications to mitigate entrainment loss." (COMAR 26.08.03.05(E)(3))

3.1.3.2 Implications of Maryland CWIS Regulations for CCNPP Units 3 and 4

An economic analysis of impingement loss at CCNPP Units 1 and 2 was conducted using impingement data from 1977–1979 (ANSP, 1981). For those years of study, the average annual impingement loss of finfish and blue crab was 260,252 organisms per year with an average annual economic value of $24,289. Under the assumption that CCNPP Units 3 and 4, with a once-through cooling system, would withdraw twice as much cooling water as CCNPP Units 1 and 2 and therefore impinge twice as many organisms, and adjusting to the average annual impingement loss for the period 1975–1995 of 351,688 organisms (see Section 3.1.1.1.d(1)), the projected economic value of impingement loss for CCNPP Units 1-4 would be roughly $99,000 per year. Therefore, the maximum required 5-year cost for mitigating impingement loss at CCNPP Units 1-4 (under Maryland's existing regulations) would be roughly $500,000 (based on historical impingement estimates and dollar values from 1981).

To assess environmental impacts of entrainment at CCNPP Units 1 and 2, a spawning and nursery area of consequence (SNAC) study was conducted in 1980 (Martin Marietta Corporation, Environmental Center, 1980). That study reported reductions, due to entrainment, in the abundance of Atlantic croaker, bay anchovy, winter flounder, and naked goby in the study area of 4.1% to 6.4%. The study area was defined as a 38-mile stretch of Chesapeake Bay adjacent to CCNPP. That level of effect on the local fish populations was not considered large enough to constitute an adverse environmental impact (McLean, et. al., 2002). Assuming closed-cycle cooling for CCNPP Units 3 and 4, the makeup water for which might add less than 5% to the existing intake flow, it is likely that a conclusion of no adverse environmental impact would be reached. Furthermore, in that case, a new SNAC study may not be required.

However, assuming that CCNPP Units 3 and 4 with a once-through cooling system would withdraw twice as much cooling water as CCNPP Units 1 and 2, and therefore entrain twice as many organisms, the projected reduction in abundance of those species in the study area would be 12.3% to 19.2% for CCNPP Units 1-4. This level of reduction in local fish populations likely would be considered an adverse environmental impact. For example, Versar, Inc. (the biological integrator contractor for the Maryland Power Plant Research Program (PPRP) which performs technical reviews of §316(a) and §316(b) permit applications for the State of Maryland) concluded (under contract to the State of New Jersey) that entrainment at Salem Generating Station on the Delaware Bay was causing an adverse environmental impact because it reduced local finfish population abundance by more than 10%. Also, SNAC modeling results for Chalk Point Power Plant of 20% to 30% reductions in bay anchovy population abundance caused PPRP to conclude Chalk Point was causing an adverse environmental impact (McLean, et.al., 2002). Therefore, it seems likely that mitigation for entrainment loss may be required if CCNPP Units 3 and 4 use a once-through cooling system.

3.1.4 COMAR 26.08.03.03 – Maryland Thermal Discharge Regulations

3.1.4.1 Regulation Summary

Maryland state regulations specify three thermal mixing zone criteria for thermal discharges into tidal waters (COMAR 26.08.03.03). Thermal discharges must be controlled so that:

- The 24-hour average of the maximum radial dimension measured from the point of discharge to the boundary of the full capacity 2°C above ambient isotherm (measured during the critical periods) may not exceed ½ of the average ebb tidal excursion.

- The 24-hour average full capacity 2°C above ambient thermal barrier (measured during the critical periods) may not exceed 50% of the accessible cross-section of the receiving water body.

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

If a discharger is unable to meet these requirements, the discharger may request alternate thermal effluent limitations under the CWA §316(a). Alternate effluent limitations will be established only if the discharger demonstrates to the satisfaction of Maryland Department of the Environment (MDE) that the existing thermal effluent limitations are more stringent than necessary to assure the protection and propagation of a balanced, indigenous community of shellfish, fish, and wildlife in and on the body of water into which the discharge is made. The demonstration must consider the cumulative impact of the thermal discharge together with all other significant impacts on the species affected, including entrainment and impingement impacts.

In determining whether the protection and propagation of the affected species will be assured, the MDE may consider any information considered relevant and including evidence of the absence of the following factors:

- A significant increase in abundance or distribution of nuisance species
- A significant change in biological productivity
- A significant elimination or impairment of economic and recreational resources
- A significant reduction in the successful completion of the life cycle of representative important species

3.1.4.2 Implications of Maryland Thermal Discharge Regulations for CCNPP Units 3 and 4

The existing 2 units at CCNPP are in compliance with the Maryland thermal mixing zone criteria. For CCNPP Units 1 and 2, the full load 2°C isotherm is 1.81 km (less than ½ the ebb tide excursion distance of 5.3 km), the plume length occupies less than half of the estuary cross-section, and the area of affected bottom is 0.5% of the area swept by the average ebb tide (Constellation 2004). A thermal plume study would be needed to determine whether the combined thermal discharge of CCNPP Units 1 through 4 would meet the Maryland thermal mixing zone criteria.

However, at this stage of planning, it should be noted that under the scenario of once-through cooling for CCNPP Units 3 and 4, the combined heat load entering the Bay from CCNPP would be roughly three times the existing heat load from Units 1 and 2. That level of heat load is likely to be a concern to MDE and the Maryland Department of Natural Resources (MDNR) whether or not the thermal plume modeling indicates compliance with the thermal mixing zone criteria. Furthermore, if CCNPP is forced to apply for Alternate Effluent Limitations, CCNPP may not be able to demonstrate the protection and propagation of a balanced, indigenous community. Large portions of the Chesapeake Bay currently exhibit anoxic conditions during summer months. The addition of such a large heat load would be expected to exacerbate those degraded conditions and could jeopardize the protection and propagation of a balanced, indigenous community.

If CCNPP were to attempt to license Units 3 and 4 with a once-through cooling water system, it would be necessary to conduct additional studies to determine if a variance were required and, assuming the mixing zone standards were exceeded, then to support the request for a §316(a) variance. The studies would include: (1) a hydrothermal monitoring program in the Bay to obtain data needed for calibration and verification of a hydrothermal model; (2) a hydrothermal modeling study to depict the location and dimension of the various thermal isopleths over the varying tidal cycles; and (3) a biothermal assessment to determine the effects, if any, of the thermal discharge on the fish, shellfish, and wildlife in and on the Bay. These studies to demonstrate open cycle cooling meets §316(a) would add significant delays to the Project schedule.

3.1.5 Regulatory Uncertainties

The §316(b) Phase II Rule is currently being challenged by the Riverkeeper Network and others; a decision is not expected until August 2006, at the earliest. Among the issues being litigated are (1) the definition of existing facilities, i.e., whether the addition of new generating units at an existing site (such as the CCNPP Units 3 and 4) should be regulated under Phase I or Phase II; (2) if Phase II facilities will be allowed to use restoration measures, either alone or together with technological or operational measures, to meet the Phase II Rule requirements, (3) if the results of a cost-cost analysis can be used as the basis for a site-specific performance standards; and (4) if the results of a cost-benefit analysis can be used as the basis for a site-specific performance standard.

As a result of the litigation, it is possible that the CCNPP Units 3 and 4 will be regulated under the §316(b) Phase I (new facility) Rule. Likewise, if the Riverkeeper Network were to prevail in its challenge to restoration measures in the Phase II Rule as they did in a similar challenge that they successfully brought in the Phase I appeal, CCNPP's ability to use restoration measures to achieve compliance for either Units 1 and 2 or Units 3 and 4 (if regulated under Phase II) would be eliminated. Likewise, if the Riverkeeper Network were to prevail in their challenges to the inclusion of a site-specific compliance alternative based upon the cost-cost test or the cost-benefit test, the ability to petition for a site-specific performance standard may be disallowed as a result of the current appeal of the §316(b) Phase II Rule.

In addition to changes to the federal regulations as a result of the pending appeal, USEPA may issue guidance that could call into question the regulatory interpretations presented above. In August 2004, USEPA issued an outline for a guidance manual it intends to publish on implementing the §316(b) Phase II Rule. At that time, USEPA included the first section of the guidance manual that related to the timing of the compliance with the requirements to submit comprehensive demonstration studies. No other sections have been issued to date. As USEPA issues additional sections of this guidance manual, the Agency's advice may require modifications to some of the regulatory interpretations that formed the basis for the recommendations in this section.

Maryland's current regulations implementing §316(b) were promulgated well before USEPA adopted its §316(b) Phase I or Phase II Rules. In light of the new federal regulatory program, Maryland may decide to revise its existing regulations or reissue entirely new rules. Maryland can decide to incorporate the federal regulations in their entirety in lieu of having a separate state regulatory program. Under the CWA, however, Maryland can develop its own regulatory program so long as the regulations it adopts are as, or more, stringent than the regulations USEPA adopted.

For example, Maryland could determine that new units like CCNPP 3 and 4 should be required to operate with a closed-cycle cooling system, regardless of the outcome of the appeal of the federal Phase II rule. Maryland could also adopt regulations that would preclude the use of restoration measures or that would disallow any site-specific relief from uniform standards based upon a cost-benefit approach. The latter two changes, however, would mark a major departure from the approach contained in Maryland's current regulations and that Maryland has implemented in permits for facilities like Chalk Point. Maryland could also impose additional requirements that would impose other requirements on CCNPP Units 1-4.

At this point, it is not possible to predict the outcome of the appeal of the federal regulations or whether Maryland will issue new or modified regulations and what any such regulations would require. Therefore, it is not possible to predict whether any of these changes would adversely impact either the economics or schedule for this Project. However, during meetings with MDE and DNR, Constellation staff was told that Maryland would most likely adopt the federal regulation as is, rather than developing its own regulations. DNR and MDE also expressed continued support for restoration, should that option survive the legal challenge.

3.2 Engineering and Technology Considerations for Open-Cycle Cooling for CCNPP Units 3 and 4

3.2.1 CWIS Engineering Considerations

The new units are based on two 1600 MWe (4592 MWt) U.S. EPR. The circulating water (CW) system flow rate would be approximately 2.5 million gallons per minute (gpm) for each unit, considering 10°F temperature rise across the condenser. If an onshore intake structure/pumphouse is used, it would be approximately 1200 feet long (to accommodate 24 drum screens and 12 CW pumps), 170 feet wide and 66 feet deep below the site grade for the two-unit structure. The pump house would have 6- 417,000 gpm concrete volute type pumps per Unit (12 total). The intake screen would include 24-60 feet diameter drum screens (two per pump) with the width of the screen panel about 15 feet. Additionally, 72 bar screens (trash racks), 12 feet wide would be required with 4 rakes to clean these screens.

If an offshore structure is used, twelve-12 foot diameter concrete pipes routed at least 3,000 feet into the Chesapeake Bay to reach 35 feet depth would be required. At the offshore end of each pipe there would be one bank of wedge wire screens arranged with interconnecting manifolds to supply about 420,000 gpm. It is expected that twelve 8-foot diameter T-type wedge wire screens would be needed for each bank, as the wire mesh slot will be very small (1.75 mm or smaller). Wire mesh material would need to be copper-nickel for bio-fouling protection. At each screen's outlet, biocide agent supply piping would be necessary to protect intake pipes from bio-fouling. It is expected that a total of 144-8-foot diameter T-screens could be required. The onshore pumphouse structure for this would be approximately 800 feet long, 120 feet wide, and 66 feet deep. The pumphouse is smaller since the drum screens and bar screens are not needed due to the use of the wedge wire screens offshore. The total offshore intake area covered by the wedge wire screens would be approximately 10 acres. The long trench to place the intake pipes would cover approximately 20 acres of the bottom of the Bay.

The discharge structure would consist of:

- A common onshore seal well structure. This structure would be approximately 250 feet long, 80 feet wide, and 50 feet deep.

- Twelve, 12-foot diameter offshore discharge concrete pipes from the seal well. It is expected that the discharge pipe length would be about 2000 feet. All 12 pipes could be placed in a large trench in a cut-and-fill operation and backfilled, and covered with riprap. At the end of each discharge pipe there would be a multiple port diffuser. The diffuser main body would also be 12-foot pipe. On top of the diffuser pipe would be six, 54-in risers that discharge heated effluent to the ambient water. Therefore, there would be 72-54-in riser pipes discharging all 5 million gpm of heated cooling water flow.

- Due to large discharge flow, large separation distance between offshore intakes and offshore distances would be necessary to prevent thermal recirculation from reaching an unacceptable level. The estimated separation distance would be 4,000 feet.

- The offshore diffuser area would be approximately 10 acres at the bottom of the Bay approximately 2,000 feet offshore. The long trench to place the discharge pipes would cover approximately 12 acres of the bottom of the Bay.

Based on the enormous size of the intake and discharge structures and offshore pipes, the once-through cooling system would be cost-prohibitive and therefore, is not considered feasible for the new units at the Calvert Cliffs site.

3.2.2 CWIS Technologies for Reducing Impacts to Fish and Shellfish Due to Open-Cycle Cooling Systems

3.2.2.1 Technology Alternatives

As noted above, the Impingement Mortality performance standard of the Phase II Rule likely can be satisfied at CCNPP with a fish return system associated with the screen wash water discharge system. However, other technologies would have to be considered for reducing entrainment to meet the entrainment performance standard of the Phase II Rule.

In its Technical Development Document (TDD) for the Phase II Rule, USEPA reviewed 12 general types of CWIS technologies for once-through cooling systems that it believed could be used toward meeting the national performance standards (USEPA §316(b) Phase II TDD, Attachment A to Chapter 3):

- Conventional traveling screens (Impingement Mortality and Entrainment)
- Modified vertical traveling screens (Impingement Mortality and Entrainment)
- Inclined single-entry, single-exit traveling screens (Impingement Mortality and Entrainment)
- Fine mesh screens mounted on traveling screens (Impingement Mortality and Entrainment)
- Wedgewire screens (Impingement Mortality and Entrainment)
- Perforated pipes (Impingement only)
- Porous dikes/leaky dams (Impingement only)
- Louver systems (Impingement only)
- Velocity caps (Impingement only)
- Fish barrier nets (Impingement only)
- Aquatic filter barrier systems (Impingement Mortality and Entrainment)
- Sound barriers (Impingement only)

The feasibility of installation and operation of any of these technology types is site-specific. The size and location of CCNPP Units 3 and 4 pose severe challenges to the application of any of these technologies and the ability of entrainment reducing technologies to meet the performance standard under the conditions that exist at this site is questionable. To address the feasibility of these technologies for CCNPP Units 3 and 4, and in the absence of a site-specific evaluation of these technologies for CCNPP Units 3 and 4, the results from a recent site-specific evaluation for Salem Generating Station (Salem), a nuclear power plant located on a mid-Atlantic estuary, were reviewed.

Salem is a two-unit nuclear generating station located on the Delaware Bay with a cooling water withdrawal rate of 2.2 million gpm. Salem has the highest cooling water withdrawal rate of any generating station located on a mid-Atlantic coast estuary that has recently completed a thorough review of fish protection alternatives. Although the cooling water withdrawal rate at Salem is lower than the once-through requirement for CCNPP

Units 3 and 4, results from the Salem review provide important insights into the practicability of CWIS options for CCNPP Units 3 and 4.

3.2.2.2 Feasibility Evaluation of Technology Alternatives

As part of the 1999 NPDES permit renewal application for Salem, PSEG conducted an exhaustive review of the feasibility of fish protection alternatives for the CWIS at Salem (PSEG, 1999). Salem's review of fish protection alternatives was conducted in two steps: the first step was a screening-level evaluation of all available fish protection systems, the second step was a detailed evaluation of candidate systems. The screening-level evaluation considered 1) known biological effectiveness, 2) engineering feasibility, and 3) engineering and/or biological advantages of one alternative over another. Four categories of alternatives were considered in the screening-level evaluation: behavioral barriers (e.g., air bubble curtains), physical barriers (e.g., barrier nets), collection systems (e.g., modified traveling screens), and diversion systems (e.g., modular inclined screens). A total of 34 types of fish protection systems (including all technologies listed above from USEPA's §316(b) TDD) were considered in the screening-level evaluation. On the basis of the screening-level evaluations, 2 types of fish protection systems that address entrainment were selected for detailed evaluation: wedge-wire screens and fine mesh screens.

For wedge-wire screens, a 2 mm slot size was considered to be the smallest practical size for Salem due to heavy detritus and sediment loads in the estuary and the high water withdrawal volumes. EPRI reported a 62% reduction in entrainment with 2 mm wedge-wire screens (EPRI, 1999). To achieve the desired through-slot velocity of 0.5 ft/sec at Salem, 240 wedge-wire screen modules would have been required. Bio-fouling in the estuarine environment would have caused ongoing problems of keeping the screens clean. In an offshore location, the wedge-wire screen modules would have required a complex series of air backflush piping. Furthermore, the high velocity cross-flows needed for screen flushing and biological efficacy would not be assured during slack tide conditions when velocities approach zero. Under any tidal condition it was uncertain whether the necessary high velocity ambient cross-flows would exist given the 2.2 million gpm withdrawal rate. For these reasons, wedge-wire screens were not considered a proven feasible alternative for Salem, and cannot be considered a proven feasible alternative for CCNPP Units 3 and 4.

For fine mesh screens, a 0.5 mm slot size with a 0.5 ft/sec through-screen velocity was considered at Salem. The mortality rate of bay anchovy eggs collected on fine mesh screens was estimated to be 73%, and the mortality rate for bay anchovy larvae was estimated to be between 63% and 100%. Therefore, assuming 100% mortality of entrained bay anchovy, the fine mesh screens would be expected to reduce entrainment losses of bay anchovy eggs by 27%, and to reduce entrainment losses of bay anchovy larvae by between 0% and 37%.

As noted above, bay anchovy are a key species subject to entrainment at CCNPP. Therefore, fine mesh screens likely would not reduce entrainment losses by at least 60% as required by the Phase II national performance standards for entrainment.

The team reviewed preliminary studies by EPRI in 2005 on the potential effectiveness of wedge wire screens and their application at CCNPP. After review of the preliminary study, the ability to balance flow to ensure a maximum slot velocity of 0.5 ft/s and control bio fouling and blockage for an extremely large screen array is highly questionable. The final detailed report is to be issued later by EPRI.

3.3 Summary of Cooling Water System Considerations and Recommendation

USEPA's Phase I and Phase II regulations implementing §316(b) of the CWA, which regulates CWIS, provides for seven compliance options: Track I and Track II under the Phase I Rule (new facilities), and compliance alternatives 1-5 under the Phase II Rule (existing facilities). Given the definitions and guidance provided by USEPA regarding the Phase I and Phase II Rules, CCNPP Units 3 and 4 will be regulated under the Phase II Rule with all four units of CCNPP being considered a single facility.

Of the five compliance alternatives under the Phase II Rule, only two would be applicable to the combined CCNPP facility (Units 1-4). The first is compliance alternative 3, which would require CCNPP to satisfy the national performance standards for impingement mortality and entrainment through the implementation of additional technologies, operational measures, and restoration measures. The second is compliance alternative 5, which would allow CCNPP to obtain a site-specific determination of BTA.

Under compliance alternative 3, CCNPP Units 3 and 4 could use a once-through cooling system or a closed-cycle cooling system. However, no proven technologies exist for use with a once-through cooling system that would satisfy the national performance standard for entrainment and that could be successfully installed and maintained at CCNPP. Furthermore, it is assumed that extensive outages or flow reductions to reduce entrainment during summer months, the most biologically productive season, would be economically prohibitive, and hence would not be viable alternatives. Therefore, in order for CCNPP Units 3 and 4 to use once-through cooling under compliance alternative 3, restoration measures would have to be implemented to mitigate entrainment losses to satisfy the requirements of the Phase II Rule.

Closed-cycle cooling could also be used under Phase II compliance alternative 3. Under this CWIS compliance option, all four units would be considered a single facility, and the reduction in intake flow from the calculation baseline condition (all four units with once-through cooling) to the proposed condition (Units 1 and 2 with once-through cooling and Units 3 and 4 with closed-cycle cooling) would satisfy the performance standard requirements for Units 1 and 2 as well as for Units 3 and 4.

Because the Phase II Rule is currently in litigation, the definitions of "existing facility" and "new facility" may change. Due to the court's ruling in that litigation (expected August 2006), CCNPP Units 3 and 4 may be regulated under Phase I. In that case, CCNPP Units 3 and 4 could comply with §316(b) through Track I (Fast Track) by installing closed-cycle cooling. In that case, CCNPP Units 1 and 2 might choose to rely on Phase II compliance alternative 5 (site specific BTA) or compliance alternative 3 with restoration.

Therefore, under §316(b) of the CWA, CCNPP Units 3 and 4 have four practical CWIS compliance options, each with somewhat different permitting and scheduling risks:

- Closed –cycle cooling under Phase I, Track I
- Closed-cycle cooling under Phase II compliance alternative 3
- Once-through cooling and restoration under Phase II compliance alternative 3
- Once-through cooling and site-specific BTA under Phase II compliance alternative 5.

All options are likely to require CCNPP to conduct a thermal plume study for submittal to the State of Maryland to demonstrate compliance with the state's thermal mixing zone criteria. For the two once-through cooling options, the thermal plume study may trigger the requirement for alternative thermal effluent limitations. In that case, CCNPP would be at some risk of not being able to demonstrate that the additional heat load (from once-through cooling of CCNPP Units 3 and 4) to the Chesapeake Bay assures the protection and propagation of a balanced, indigenous community (as required by Maryland law). Furthermore, the state may require CCNPP to conduct an impact assessment for entrainment losses (under COMAR 26.08.03.05). The results of that assessment may demonstrate that the combined entrainment losses for Units 1-4 with once-through cooling cause an adverse environmental impact to local fish populations. In that case, CCNPP would be required to mitigate the entrainment losses. Furthermore for the open-cycle cooling system alternative, the environmental studies required for regulatory compliance could detrimentally affect Project schedule. A minimum of three years likely would be required to develop study plans, review the plans with Maryland, implement the studies, and submit the required reports.

For the two closed-cycle cooling options, it is unlikely that concerns over the thermal mixing zone or environmental impacts due to entrainment will be raised (based on historic determinations regarding CCNPP Units 1 and 2 by the State of Maryland). Using a closed cooling design for the Project would provide the highest degree of certainty (but would not guarantee) that regulatory approvals would be received in a time frame that would support the proposed schedule for the Project.

In addition to federal and state regulatory considerations regarding open-cycle cooling, engineering considerations suggest it would not be a viable alternative. The enormous size of the intake and discharge structures and offshore pipes for an open-cycle cooling system for CCNPP Units 3 and 4 likely would be cost-prohibitive for the Calvert Cliffs site.

For the foregoing reasons, the recommended CWIS compliance option for CCNPP Units 3 and 4 is once-through cooling with makeup water withdrawn from the existing intake structure. This option would allow CCNPP Units 1-4 to apply for a §316(b) permit as a single combined facility under Phase II Compliance Option 3. To address the risk that Maryland may require CCNPP Units 3 and 4 to be regulated under Phase I (as the result of the court ruling in the Phase II litigation or for other reasons), it is further recommended that the CWIS for Units 3 and 4 be designed with a maximum intake velocity of 0.5 fps and include additional fish protection (e.g., fine mesh screens or wedgewire screens). This CWIS configuration would satisfy the requirements of Phase I or Phase II. Therefore, if CCNPP Units 3 and 4 are forced to comply with the Phase I Rule, the Project would not be significantly impacted in terms of costs or schedule.

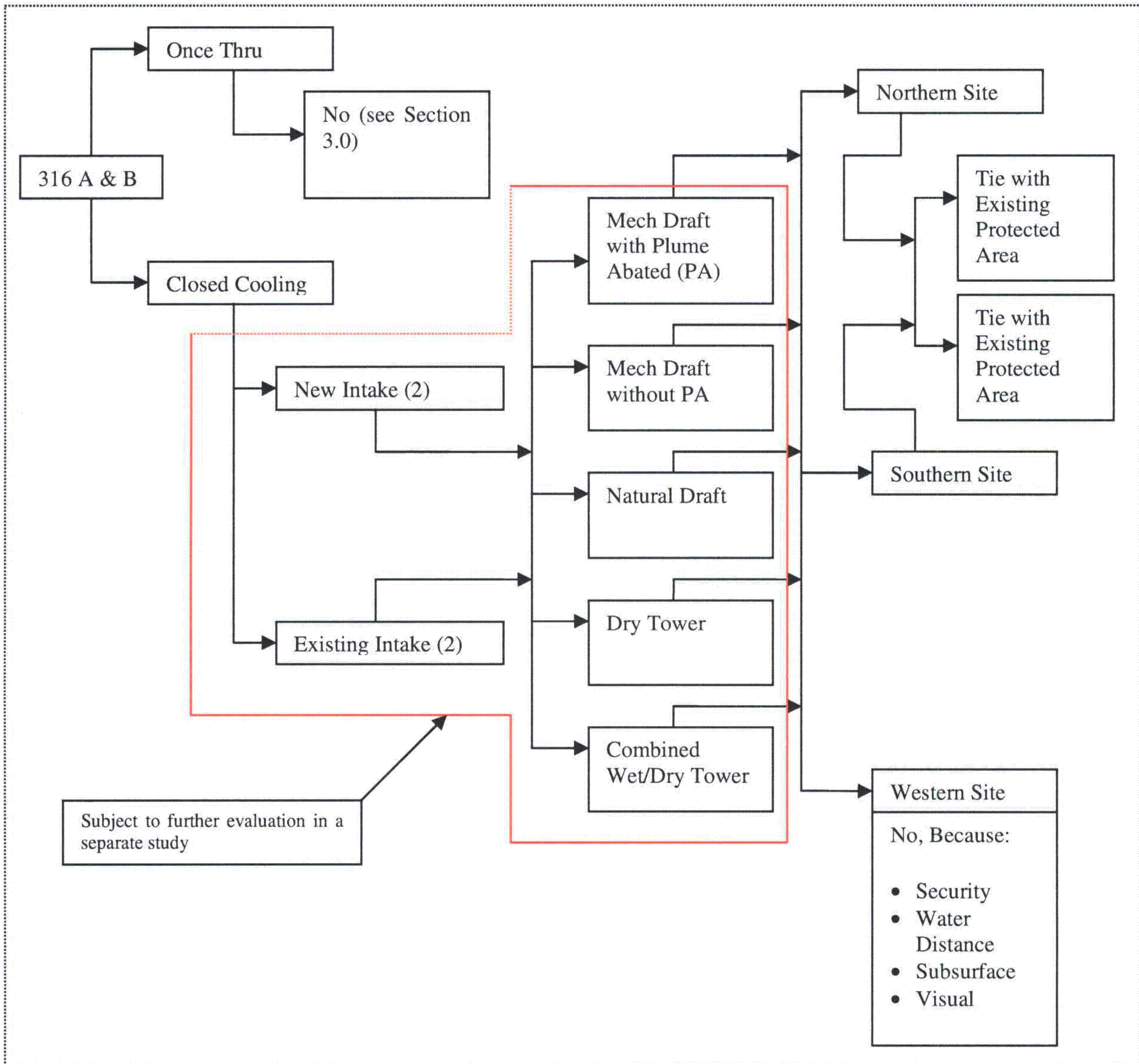
Other environmental issues associated with once-through cooling that were not addressed in this evaluation of cooling water system alternatives include:

- aesthetics (i.e., the visual impacts of the cooling towers [which is more exacerbated if natural draft cooling towers were used], themselves, and/or the cooling tower plume)
- noise (which is more exacerbated if mechanical draft cooling towers are used)
- air emissions from the cooling towers (e.g., salt drift).

These issues will be addressed in a separate report that evaluates cooling tower alternatives.

4.0 Site Layout Selection Process and Evaluation

During the layout evaluation process, the first decision point was based on the regulation associated with 316(a,b). Collectively it was determined by the industry experts that pursuing the once-through cooling water system was technically not feasible and of a high risk. Therefore, this study is pursuing the closed cooling water system for the layout location. The following process flow map was prepared by the study team for guidance in conducting the site layout study.



Using the evaluation process and the collective experience of the team members (Appendix E, January 5, 6, 2006), the following layout configurations and cooling water system resulted for more detailed evaluation.

1. Northern site with closed cooling water system.
2. Southern site with closed cooling water system.

A third option, location west of CCNPP Units 1 and 2, was eliminated at this stage because of uncertain foundation conditions associated with Lake Davies. The evaluation process at this stage also accounted for a potential regulatory benefit of using the existing

Units 1 and 2 intake as source for the Units 3 and 4 makeup (see Section 3.0 and Appendix G).

4.1 Exclusion Criteria

For the layout evaluation, the team established that neither the power block nor the cooling towers would be located within the following areas:

Exclusion Criteria

1. Lake Davies
2. 1500' radius from bald eagle nest
3. Cemetery located near southern property line
4. Reserved transmission corridors and within 300' of existing transmission lines
5. Nearby offsite/onsite pipelines or other hazards

Lake Davies

Located west of the existing units is Lake Davies. Lake Davies served as the landfill for the dredging spoils from the original intake/discharge canal construction. An estimated 3 million cubic yards of material were disposed of in this area. This area represents unknown subsurface conditions and would require excavation and backfill with suitable fill material. Further evaluation is deemed a high risk due to inadequate soil conditions. It is unknown whether sufficient quality backfill is available. This area would also require significant piping lengths to and from the bay for the closed cooling water makeup and discharge.

Therefore, locating two EPR units west of the existing Calvert Cliffs units is being discounted in this layout study.

Bald Eagle

An area of 1500 feet from the bald eagle nest is reserved as an exclusion zone for construction activity and location of the nuclear plant facilities. The bald eagle nest is located in the southern most corner of the Calvert Cliffs property (see figures in Appendix A) and is not impacted by the proposed southern layout location. See Appendix H for further detailed discussion of the bald eagle.

Cemetery

A small cemetery of 3 graves was found located at the end of Road M-1 in the southern portion of the property. This location is not impacted by the proposed southern layout location. See Appendix I for further discussion of cultural sites.

Reserved Transmission Corridors

The CCNPP site has 500 kv transmission lines going north across the property from the existing switchyard. For locating the cooling towers, a 300' setback distance was applied for the northern options due to the influence of drift on the transmission lines. This setback is outside of the 550' transmission line easement.

Nearby Offsite or Onsite Pipelines or Other Hazards

Although this criterion was established as a generic exclusion criterion potentially applicable for other facility layout evaluations, the team determined there are no nearby offsite or onsite hazardous pipelines that impact layout selection for this study. A modified American Land Title Association – American Congress of Surveying and Mapping (ALTA-ACSM) survey will be performed to verify the absence of onsite hazardous pipelines. See discussion of the Cove Point LNG facility as it relates to Option 4 in section 4.3.2.2(a).

4.2 Proposed Layouts

Based on a closed cooling water system and the exclusion criteria listed above, the following 4 proposed plant layout options were developed for further evaluation.

1. Option 1 – North, units oriented side by side, east to west, reactor building north, switchyard south, and cooling towers north.

2. Option 2 – North, units oriented side by side, south to north, reactor building towards the east, switchyard west, and cooling towers north.

3. Option 3 – North, units oriented side by side, east to west, reactor building towards the south, switchyard north, and cooling towers north.

4. Option 4 – South, units oriented side by side, north to south, reactor building towards the east, switchyard west, and cooling towers south.

See Appendix A for figures of Options 1 through 4 and mechanical draft, natural draft, and hybrid type cooling towers configurations for Options 2 and 4.

4.2.1 Initial Layout Screening

Prior to a detailed layout evaluation process, an initial screening was performed of the 4 site layouts. Based on this initial screening, Options 1 and 3 were eliminated from further evaluation as described below:

Option 1

This option consists of locating the new units on the north side of the existing units. The reactor buildings and turbine buildings of the two units would be side by side, east to west, along with the switchyard to the south and the cooling towers to the north. This arrangement of reactor buildings and turbine buildings of Units 3 and 4 in an east-to-west configuration presents significant construction challenges. With this arrangement, the eastern-most unit would be constructed first with an approximate 1-year lag for the next unit. This arrangement would cause all construction to pass over the western-most unit to get to the eastern unit on the bay side. This arrangement would result in a more complex circulating water piping or box culvert layout with routing between the unit and the bay, between the units, and west of Unit 4. Connection with the existing protected area would create a very large protected area that would contain the switchyard for the new units.

Significant amount of grubbing, clearing, and cut and fill would be required for this option. Most of the property north of the main access road is heavily forested outside of the cleared land around the visitors center and security access point. A significant amount of cut and fill would be required to create a plant grade at approximate Elevation 75 feet (considered to approximate the existing switchyard grade) and fill in the ravines and valleys on each side of fire road A-2 and the large valley at the north end of the property in the Fowler Tract. A large wetland is identified in the northern section of the property and is also detrimental to this option (See Appendix H).

Construction on the north would require separating the construction activities and site from the operating plant. This would require relocation of the main access road and security access point. The following facilities would also require demolition and/or relocation:

1. Security access facility
2. Cell phone tower
3. Visitor center
4. Educational center
5. Chimneys
6. Transformers
7. PUP facility
8. Dog training facility
9. Historical tobacco barns

This option would require extending the existing switchyard south and reconfiguring the transmission lines south to the new bay to allow for space on the north end to connect with the new switchyard.

Option 3

Option 3 is a similar configuration as Option 1 except that the reactor buildings are south and the switchyard is located on the north side of the turbine buildings resulting in a longer transition to the existing switchyard. The constructability issues are the same as described in Option 1 above due to the reactor buildings and turbine buildings of the two units being located side by side, east to west. This configuration would facilitate a better transition to the existing protected area due to the reactor buildings and safeguards buildings being located south next to the existing protected area.

Based on the above discussion, Options 1 and 3 were screened from further detailed evaluation. Options 2 and 4 was further evaluated in detail using a rigorous process.

4.3 Evaluation of Options 2 and 4

4.3.1 Evaluation Methodology and Process

The layout for a new U.S. EPR power block and permanent facilities involved consideration and integration of various issues. The following considerations are generic in nature and each was reviewed by the team for applicability to the Calvert Cliffs site. Each siting decision generally has both positive and negative effects on multiple issues and was considered in the total context of plant siting. Evaluation criteria were developed based on the following eight categories:

1. Environmental
2. Land Use and Zoning (State, Local)
3. Construction Considerations
4. Construction Facilities
5. Switchyard/Transmission Lines
6. Security
7. Permanent Facility Considerations
8. Impact to Existing Facilities or Structures

Detailed criteria evaluated for each category included:

1. Environmental

- Visual/aesthetic impact of power block
- Wetlands/marshes
- Endangered or threatened species (animal or plants)
- Flood plains
- Environmentally sensitive areas
- Historic/cultural sites
- Impacts on source receiving water body and associated ecological resources

See Appendix H for detail discussion of environmental issues and Appendix I for cultural sites.

2. Land Use and Zoning (State, Local)

- Critical Areas
- Subdivision
- Certificate of Public Convenience and Necessity (CPCN) considerations
- Coastal Zone Management Act Consistency
- Impact on Easements

3. Construction Considerations

- Standoff distance from the existing unit security fence, supervision of crane operations, exclusion areas
- Evacuation of construction forces and existing unit personnel
- Foundation integrity - undercutting
- Dewatering effects; impacts on groundwater levels
- Slope stability
- Rock blasting
- Dredging, erosion, turbidity effects
- Construction dust and equipment exhaust
- Construction noise, vibrations, electromagnetic disturbance
- Construction accident hazards
- Crane failures; heavy load drops, boom swings
- New unit SSCs installed in proximity to existing unit SSCs
- Impacts on the site meteorological tower(s)
- Hazardous construction materials; potential missiles greater than existing plant design basis
- Hazardous onsite material storage and lines
- Construction flooding events (ruptured lines, site drainage interruptions, flooding of excavations, etc.)

- Normal operation, maintenance, and outage activities for the existing unit; delivery, receiving traffic patterns; sally ports
- Plumes from the existing and new units, diesel generators, offgas, etc.
- New and spent fuel handling and transport for the new and existing units
- Missile impacts from existing unit on new unit
- Impacts of existing unit normal operations and accidents on the new unit
- Restrictions on decommissioning activities for the existing unit while the new unit is in operation
- Excavation
- Timeline for construction
- Steep slope areas
- Areas subject to liquefaction
- Permanent drainage corridors and ponds
- Construction drainage corridors and ponds
- Construction laydown and parking areas for the existing unit (or alternate areas identified)
- Reserved transmission corridors
- Nearby offsite or onsite pipelines or other hazardous items (Included as exclusion criteria earlier in section)
- Spacing between the 2 unit EPRs is based on the construction crane orientation and lift paths. See Appendix F for the crane plan provided by Framatome.

4. Construction Facilities

- Safety
- Batch plant
- Laydown areas
- Construction office locations

- Construction parking areas and access roads
- Barge facility (existing)
- Heavy haul roads (slow grades, no transmission lines to cross under, short as possible, large turn radius for crawlers, direct access power block areas)
- Warehousing/staging/fuel location

5. Switchyard

Locate the switchyard considering:

- Location in front of the main startup transformers
- Location adjacent to the existing switchyard to allow for expansion and interconnection
- Location convenient to the transmission line corridor for existing and new transmission lines
- Sizing depends on the transmission voltage and phase spacing, the bus arrangement, the number of outgoing and incoming transmission lines, the number of interconnections with the existing switchyard, and the number of bays required for future expansion.

6. Security

Identify applicable security restrictions:

- Separate the existing and new units to allow for security during construction
- Defend the design basis threat
- Use of common security force and area
- Protection of the existing unit's security barrier during construction of the new unit
- Relocation of security boundary after the new unit is completed
- Impacts on existing security monitoring and detection systems, lighting, lines of sight
- Minimum standoffs from existing unit security fence, exclusion areas

In developing a layout for both the north and south locations, consideration was given to connecting with the existing protected area. This configuration would make for a single protected area and activities and maintenance personnel would be able to flow between the existing units and the new units.

7. Permanent Facility Considerations

- Review the EPR low trajectory turbine missile ejection zone for impacts on the existing unit.
- Confirm acceptable minimum distance to onsite and near site hazardous facilities (pipelines, barge accidents, etc.)
- Locate accident release points within the ½ mile exclusion radius of the EPR
- Identify access routes, sally ports, openings for normal operations, maintenance, and outage activities
- Identify access routes for future replacement of major components
- Offgas tower dispersion
- Tie-ins to existing unit SSCs
- If necessary, consider rotating individual power block structures (would require coordination with Framatome)
- Cooling tower fog and drift (HVAC opening, transmission line icing, tank vent freezing, stair and grating icing, onsite road icing)
- Need for blowdown cooling and holdup prior to discharge
- Pipe/canal routing to/from the condenser
- Installation schedule based on construction access requirements.
- Consider need for new water intake and discharge structures to minimize existing unit impacts
- Use of common plant resources
- Impacts of new unit normal operations and accidents on the existing unit

8. Impact to Existing Facilities or Structures

- Cultural structures
- Existing structures
- Areas reserved for future facilities to support existing unit operations

4.3.2 Discussion of Options 2 and 4

The following sections describe the main advantages and disadvantages of Layout Options 2 and 4 with respect to criteria identified in the previous section.

4.3.2.1 Northern Location - Option 2

This option consists of locating the two units on the north side of the existing units. The reactor buildings and turbine buildings of the two units are oriented side by side, south to north, reactor building towards the east, switchyard west, and cooling towers north. The power blocks are entirely within the I-1 zoning district. Depending on the cooling tower scheme, a portion of the cooling towers and circulating water system may extend over the Rural/Resource Preservation District into the Fowler tract.

With the arrangement of reactor buildings and turbine buildings of Units 3 and 4 south to north, better construction access, circulating water system layout, and security separation between the units is provided. With this arrangement, construction materials and activities can flow from the west for both units without crossing over each other. Routing of the circulating water system piping or box culverts between the switchyard and the turbine buildings provides a simpler layout for construction.

North options would require extending the existing switchyard south and reconfiguring the transmission lines south to the new bay to allow for space on the north end to connect with the new switchyard. Even though the cooling towers are located greater than 300 feet from the transmission lines under this option, there is the potential for plume and drift effects on the main transmission lines running north from Units 1 and 2.

Due to the north location being adjacent to the existing protected area, special compensatory actions may be necessary during construction. Also, since the height of the site for the new plant is greater than the existing plant, the possibility exists that a blast wall may be necessary along the construction road as it passes the diesel generator buildings. These considerations may also cause the power blocks to be located further north, thus creating more separation between the existing protected area and the construction zone.

Significant amount of grubbing, clearing, and cut and fill is anticipated for this option. Most of the property north of the main access road is heavily forested outside of the cleared land around the visitor center and security access point. A significant amount of cut and fill would be required to create a plant grade at approximate Elevation 75 feet and fill in the ravines and valleys on each side of fire road A-2 and the large valley at the north end of the property in the Fowler Tract. A large wetland is identified in the northern section of the property.

Construction on the north would require separating the construction activities and site from the operating plant. This would require demolition and/or relocation of the main access road and security access point. The following facilities would also require demolition and/or relocation:

1. Cell phone tower
2. Visitor center
3. Educational center
4. Chimneys
5. Transformers
6. PUP facility
7. Dog training facility
8. Historical tobacco barns

4.3.2.2 Southern Location - Option 4

This option consists of locating the new units on the south side of the existing units in the Camp Conoy area outside of the 1000' critical zone. The reactor buildings and turbine buildings of the two units are oriented side by side, north to south, reactor building towards the east, switchyard west, and cooling towers south. This option provides better construction access, circulating water system layout, and security separation. With this arrangement, construction materials and activities can flow from the west for both units without crossing over each other. Based on the site topography, site preparation would involve lower amount of excavation for this location. Natural valleys exist on the southern side for location of the power block.

For the southern option the existing switchyard would be expanded south and the transition made from the Unit 3/4 switchyard to the existing switchyard. No reconfiguring of the outgoing transmission lines would be required. With the southern option, the cooling towers are significantly further from the transmission lines and, therefore, would not be affected by the drift and plume.

Less grubbing, clearing, and cut and fill are anticipated for Option 4. Proposed locations for the batch plant, laydown, and parking areas are either clear fields or lightly forested areas. The Lake Davies area is proposed for the laydown yard. Areas around Camp Conoy are also clear fields. Wetlands in the southern location consist primarily of the Camp Conoy fishing pond and 3 water retention ponds that lead from the fishing pond to the Chesapeake Bay.

Construction to the south provides for a natural separation of the construction activities and site from the operating plant. No demolition and/or relocation of the main access road and security access point would be required. The facilities that would require demolition and/or relocation include Camp Conoy and its associated cabins, outbuildings, and recreational facilities.

4.3.2.2(a) Cove Point Liquefied Natural Gas Facility

A preliminary evaluation of effects from the Cove Point Liquefied Natural Gas (LNG) Facility on the southern layout location was conducted. The Cove Point terminal resumed importation of liquefied natural gas in 2003. This facility is relatively close to the Calvert Cliffs Units 1 and 2 and would be slightly closer to additional units located south of the existing units. Due to the location of Cove Point, any accidental release of LNG will have some impact on the safety of the proposed EPR plant.

The previous evaluation was based on a maximum hazard distance that would have a 3 psi overpressure criterion. The maximum hazard distance with the 850,000 barrel LNG tank will be 0.22 miles. Since the tank will be located approximately 3 miles from the proposed site for expansion at Calvert Cliffs, the hazard distance will not stretch closer than approximately 2.75 miles from the plant.

Regarding shipping vessels, the Coast Guard has committed to establish approach and docking procedures that keep vessels outside the 3.4 mile exclusionary range from CCNPP. The proposed southern location is located farther inland than Calvert Cliffs Units 1 and 2 to stay outside the 1000' critical area from the shore. Since the southern location is farther inland, the 3.4 mile exclusionary zone from CCNPP would be maintained.

4.3.3 Scoring Process

A weighted scoring process was developed to evaluate the criteria in the eight categories above. Fifteen (15) team members from the February 8, 2006 (see Appendix E) meeting anonymously scored the weighting factors, the responses were averaged, and presented to the team for consensus. The weighted results were,

Category	Weight
1. Environmental	20%
2. Land Use & Zoning	20%
3. Construction Considerations	20%
4. Construction Facilities	10%
5. Switchyard	5%
6. Security	10%
7. Permanent Facility Considerations	10%
8. Impact to Existing Facilities	5%

The eight categories and corresponding criteria were reviewed by the team members in detail for Options 2 and 4 by the subject matter expert. Thirteen team members then scored the categories for which they felt sufficiently knowledgeable. These values were averaged and then multiplied by the weighted value and summed to determine an overall score for Options 2 and 4. The results are as follows:

Table 4.3.3-1
Scoring Summary - CCNPP Units 3 and 4 Site Layout Study

Criteria	Weight %	Options			
		2		4	
		Score	Subtotal	Score	Subtotal
Environmental	20	4.08	0.82	5.77	1.15
Land Use & Zoning (State, Local)	20	3.85	0.77	5.62	1.12
Construction Considerations	20	4.00	0.80	6.64	1.33
Construction Facilities	10	3.55	0.35	7.18	0.72
Switch Yard/Transmission Line	5	4.60	0.23	6.10	0.31
Security	10	4.08	0.41	4.31	0.43
Permanent Facility Considerations	10	4.15	0.42	5.45	0.55
Impact to Existing Facility Structures	5	3.69	0.18	5.45	0.27
Totals	**100**		**3.98**		**5.88**

Methodology, results, and sensitivity analysis details can be found in Appendix B. Sensitivity analysis conducted for the weighting and scoring to determine impact to overall score and the relationship to each other indicates that the overall score varies only slightly.

5.0 Conclusion

From the analysis of CWA Section 316(a,b) and related cooling water system issues, the use of once-through cooling for the circulating water system is not a feasible option for a proposed nuclear power plant at the CCNPP site. Therefore, a closed cooling water system is determined to be the best option considering the business model associated with the licensing, construction, and commissioning of a new nuclear plant at the CCNPP site.

Layout Options 2 (northern location) and 4 (southern location) were down-selected as the most desirable options to evaluate in detail.

Based on detailed evaluation and scoring, Option 4 scores significantly higher than Option 2. Sensitivity analysis conducted for the weighting and scoring to determine impact to overall score and the relationship to each other indicates that the overall score varies only slightly and in no cases did the overall conclusion change.

Option 2 would make better use of land currently zoned I-1, but would present a greater impact to land within the 1000' critical area. Option 2 would present greater construction challenges, including a longer distance from the barge area and construction facilities. Option 2 would require all construction activities to cross under the transmission lines. This option would also cause for greater redesign of the current entrance and security facilities for the existing plant. Option 2 would allow for a single site protected area connected with the existing protected area for CCNPP Units 1 and 2.

Option 4 is located entirely within the Rural/Resource Preservation District which would result in the need for an exemption from the current zoning. However, the power block and cooling towers for Option 4 could be located entirely outside the 1000' critical area. Option 4 would result in better flow for construction activities and makes better use of the barge location, heavy haul road, batch plant, laydown, and parking facilities. Option 4 would not disrupt the current traffic entrance and flow for the operating plant and would maintain the existing security facilities. Option 4 would better segregate the construction traffic and activities from the operating plant traffic and activities. However, Option 4 would require a separate protected area due the distance and location from the protected area for CCNPP Units 1 and 2.

Therefore, Option 4 is the recommended layout option for the base case to conduct further site investigations and studies.

6.0 Risk and Contingency for Option 4 – Southern Location

The team identified the following risks associated with the recommended southern location:

1. Unfavorable litigation 316(b)
2. Unfavorable zoning
3. Construction within the critical area
4. Residences south of the site
5. Use of existing intake
6. Limited cooling tower options
7. Salt drift impact on vegetation in the critical area
8. NRC construction security requirements
9. ISFSI proximity
10. Storm water management
11. Additional barge dredging
12. Inadequate subsurface conditions

Rating the probability from 1 (highly unlikely) to 5 (high) and the consequences from 1 (low) to 5 (high) and taking the product yields the following exposure. This evaluation shows the focus where a contingency plan should be developed.

Table 6-1
Risk Evaluation for South Option

Risk	Probability	Consequence	Exposure (PxC)
1. Unfavorable litigation 316(b)	2	2	4
2. Unfavorable zoning	2	4	8
3. Construction within the critical area	2	3	6
4. Residences to south	3	2	6
5. Use of existing intake	3	2	6
6. Limited cooling tower options	3	1	3
7. Salt drift impact on vegetation within the critical area	5	2	10
8. NRC constr. Security req.	4	1	4
9. ISFSI proximity	5	2	10
10. Storm water management	5	1	5
11. Additional barge dredging	5	2	10
12. Inadequate subsurface cond.	1	2	2

Probability: 1(highly unlikely) - 5 (high)
Consequence: 1 (low) - 5 (high)

A contingency plan was developed for the items that had an exposure rating of 6 or higher.

Table 6-2
Contingency Plan

Issue	Indications	Methods of Detection	Actions Required	Parts/Services Needed	Impact to Schedule
Additional barge dredging required	Area is shallow and requires dredging for steam generator and reactor head delivery	TBD	Obtain permitting process information on dredging being performed in 2006. Verify quantity and schedule for work in 2006 for applying to later dredging activities.	Dredging contractor	Obtain permits and schedule work to meet delivery schedule of large components
Salt drift affect vegetation within the critical area	Similar condition and cooling tower arrangement at Brandon Shores plant	TBD	Review conditions at Brandon Shores. Establish mitigation plan.	Evaluate as part of detailed site engineering.	TBD
ISFSI proximity	Southern location and construction area near ISFSI	TBD	Review ISFSI security plan and take mitigating measures as necessary	Evaluate as part of detailed site engineering.	Conduct review and put mitigating measures in place prior to construction
Unfavorable zoning	Southern location is in the rural resource preservation district	TBD	Obtain zoning text amendment	County zoning amendment submitted by Constellation legal.	Amendment approved by County. Unfavorable zoning could re-emerge in CPCN process.
Construction within the critical area	Power block and cooling towers will be outside the critical area. Intake/discharge or piping to the existing intake may be in the RCA	TBD	Verify that water critical systems and structures will be in the intensely developed area rather than the RCA (completed). Develop feasibility study for the intake and discharge systems and structures. Prepare recommendation for review with internal stakeholders.	Evaluate as part of detailed site engineering.	TBD
Location of residences south of southern location.	Power blocks are located 3000' – 4000' feet from the nearest residence.	TBD	Communication with community. Review / evaluate noise and plume abatement options.	N/A	TBD

Issue	Indications	Methods of Detection	Actions Required	Parts/Services Needed	Impact to Schedule
Use of existing intake for supply and/or discharge.	Option exists to use the existing Units 1 and 2 intake.	TBD	Develop feasibility study and recommendation to internal stakeholders.	Evaluate as part of detailed site engineering.	TBD

7.0 Recommendation

Based on the analysis of the siting team, it is recommended to establish the south location, Option 4 with a closed circulating water system as the base case for the CCNPP Units 3 and 4 COLA. Selection of the south option is based on locating the entire power block and cooling tower arrangement outside the 1000' critical area. The study assumes that appropriate approvals can be obtained to allow water-critical structures/pipelines to be located within the critical area. Water-critical structures/pipelines may be located within the intensely developed area, which has previously been designated for impact within the 1000' critical area.

See figures 3a, 3b, and 3c (Appendix A) for the recommended location dimensions and reactor building centerline coordinates. Figure 8 of Appendix A includes a rendering drawing showing two U.S. EPR Units with a hybrid cooling tower arrangement (as an example) located at the recommended southern location.

UniStar

Calvert Cliffs Nuclear Power Plant Units 3 and 4

Cooling System Selection

and

Site Layout Study

Appendix A

Figures

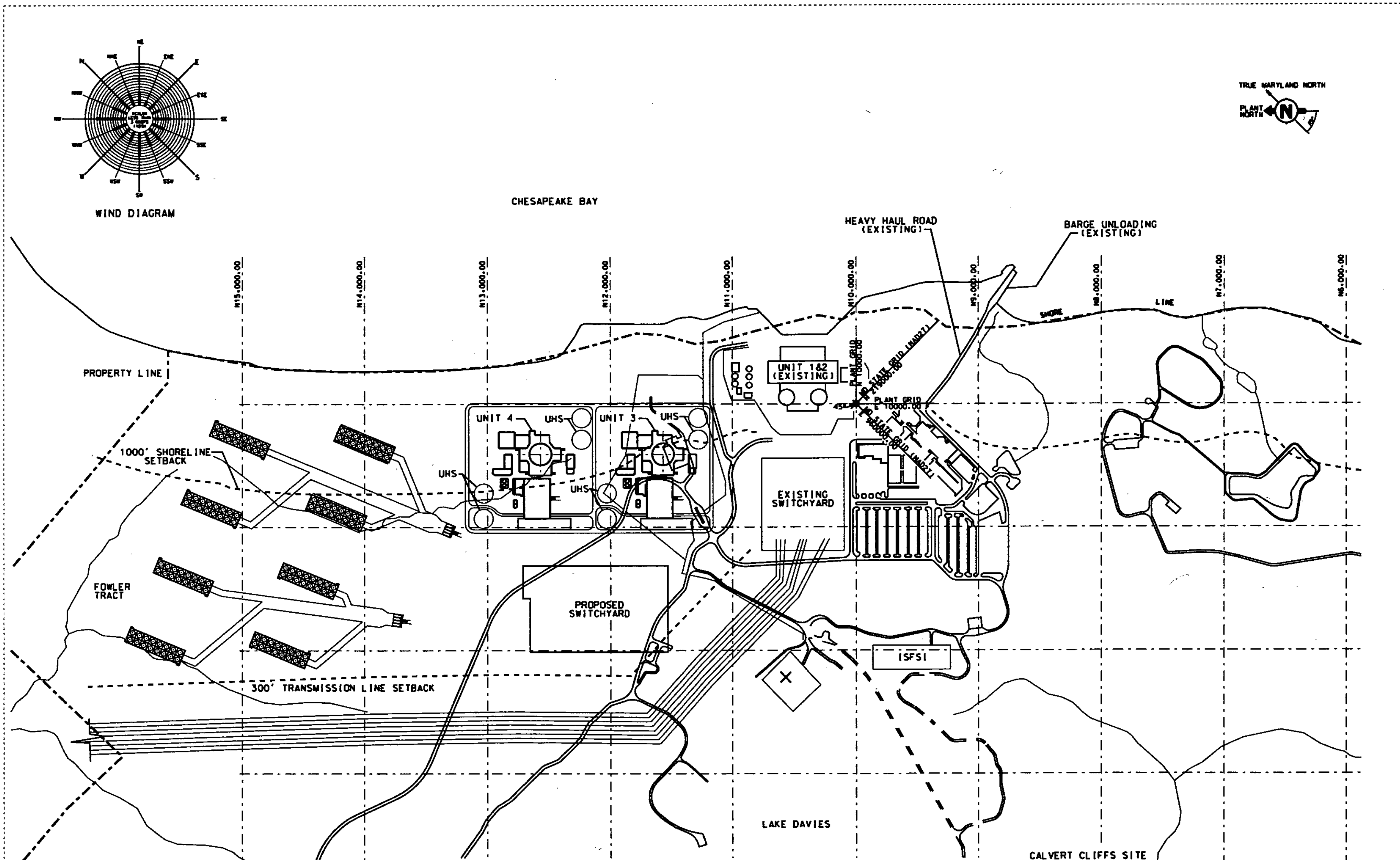


Figure 2a - Units 3 and 4 Siting Plan, Option 2a

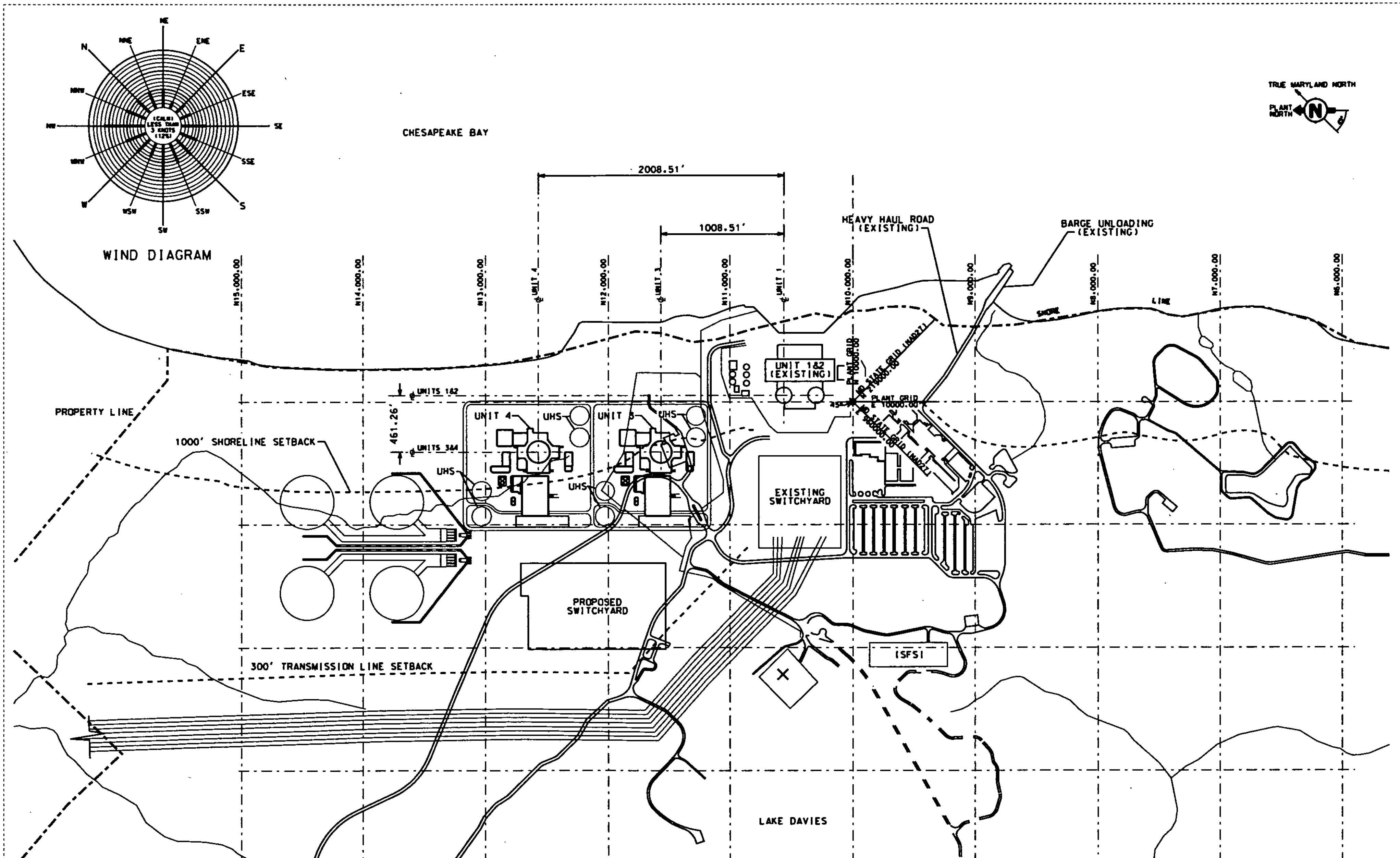


Figure 2b - Units 3 and 4 Siting Plan, Option 2b

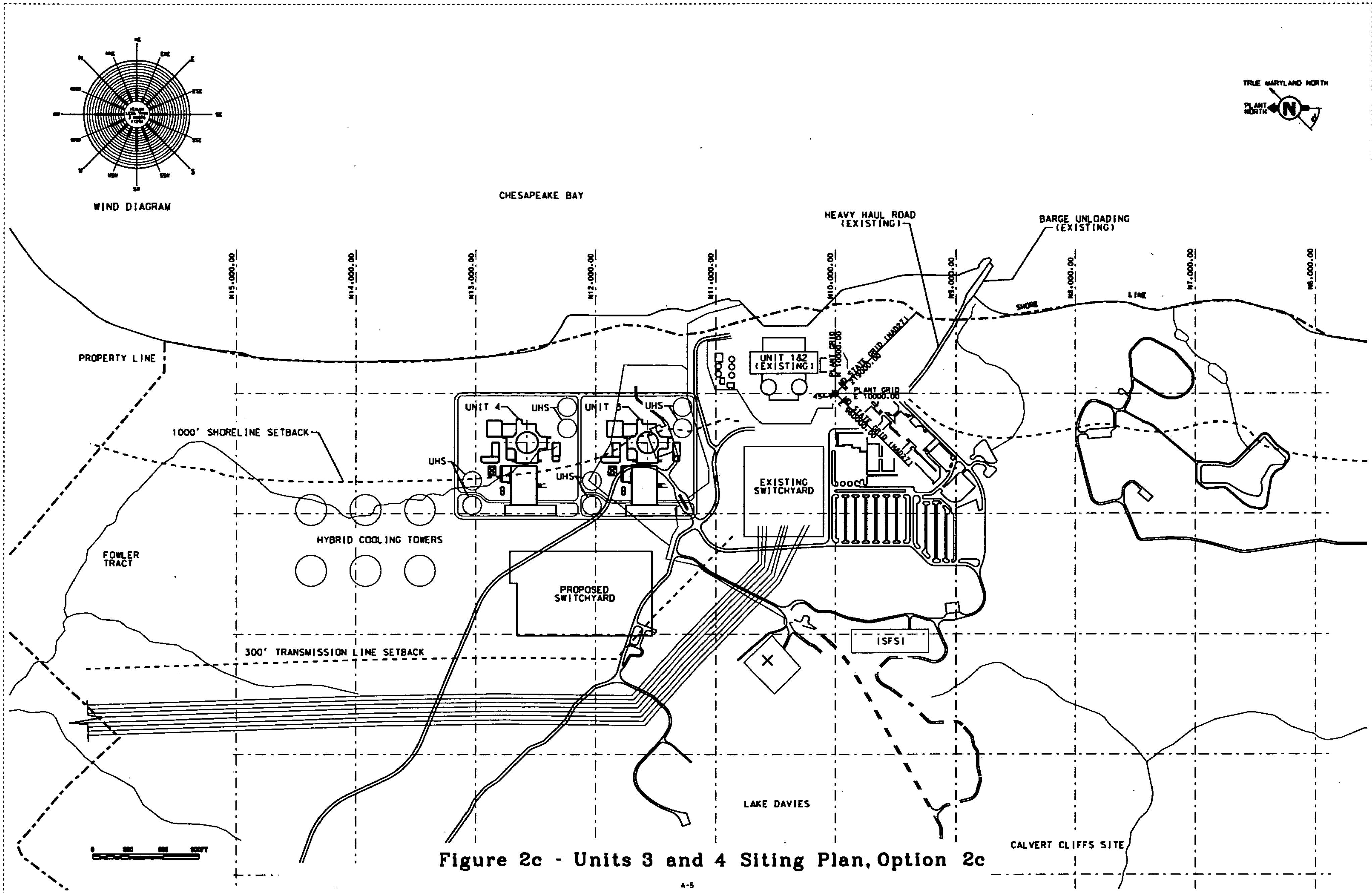


Figure 2c - Units 3 and 4 Siting Plan, Option 2c

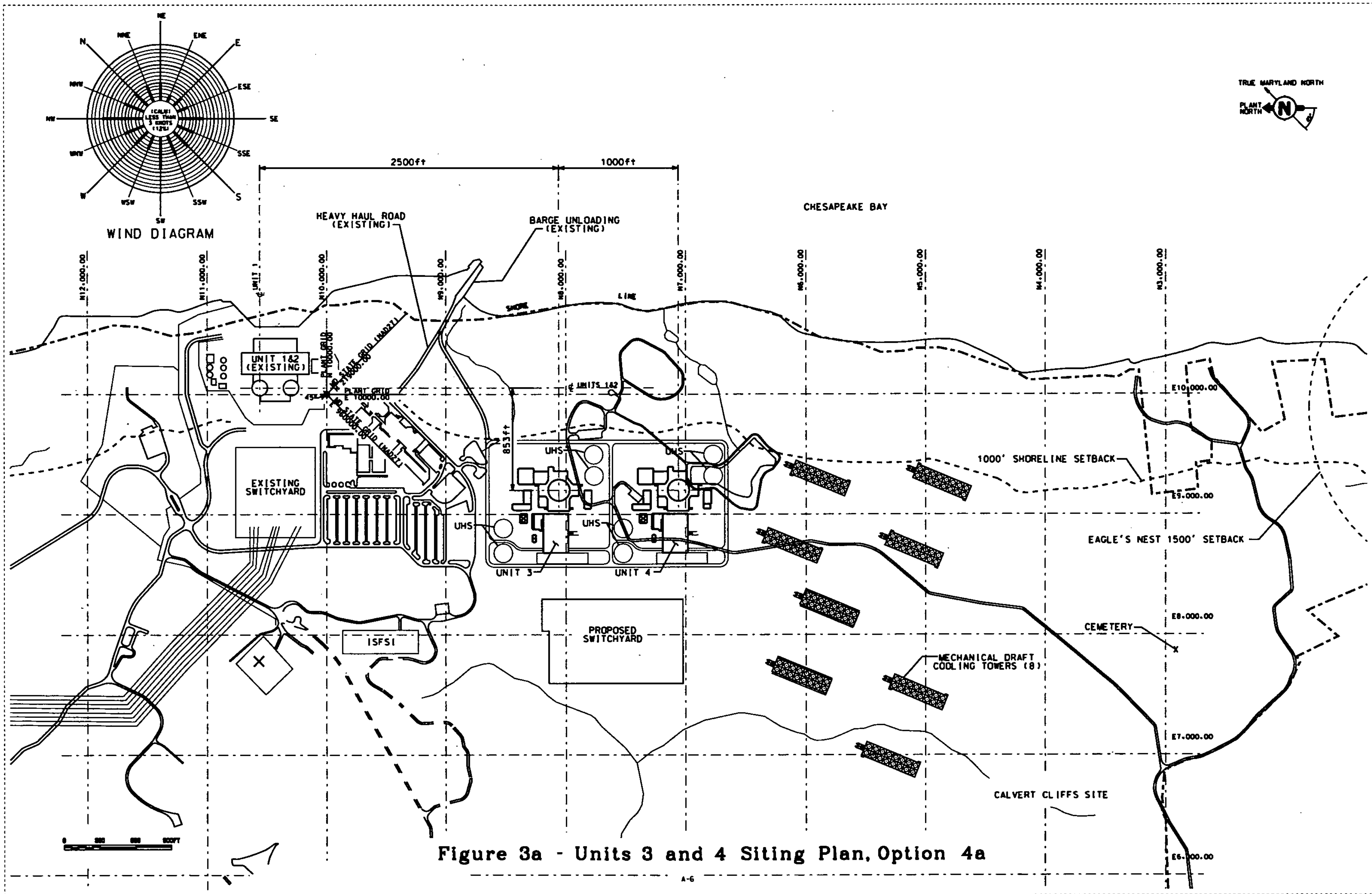


Figure 3a - Units 3 and 4 Siting Plan, Option 4a

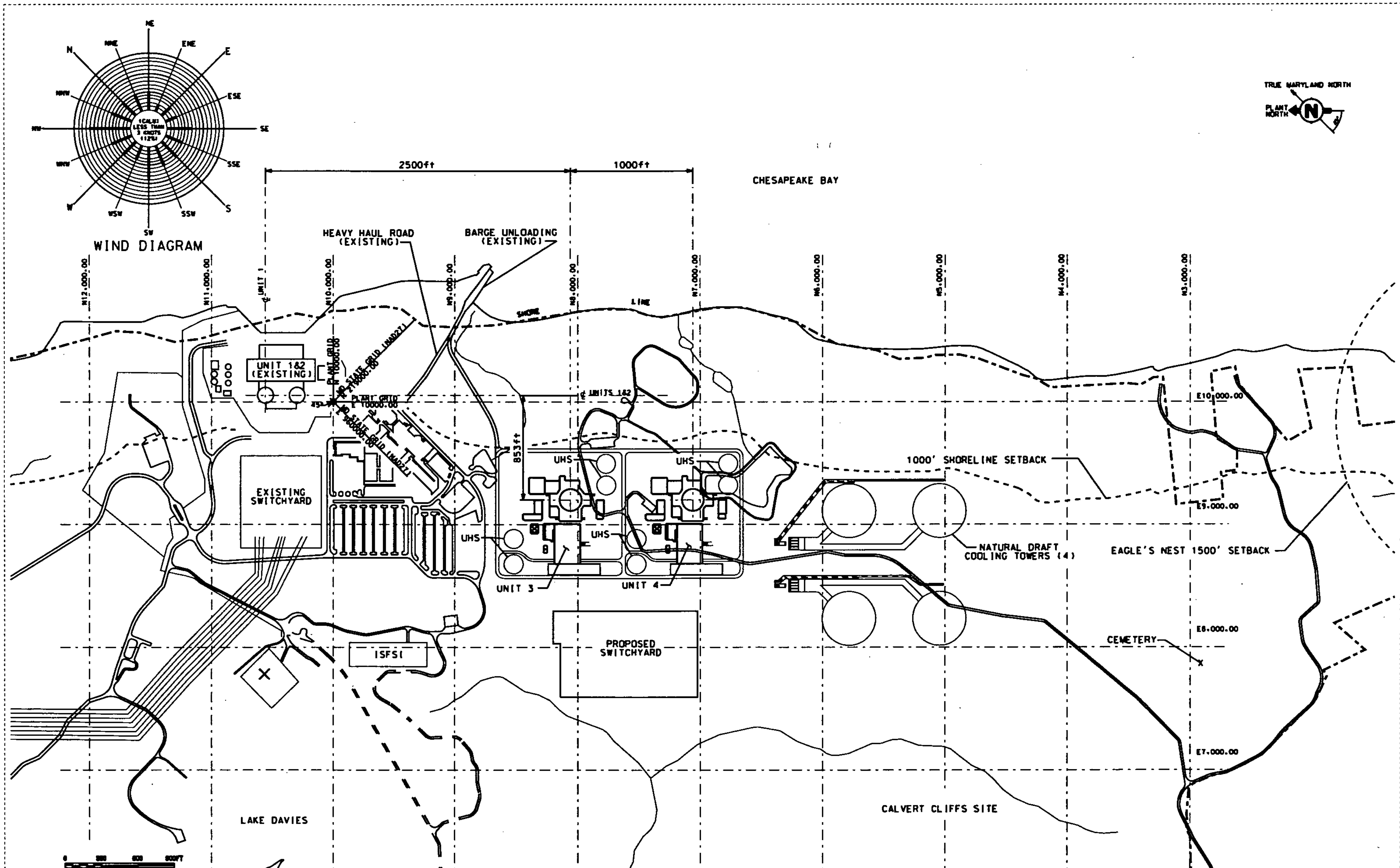


Figure 3b - Units 3 and 4 Siting Plan, Option 4b

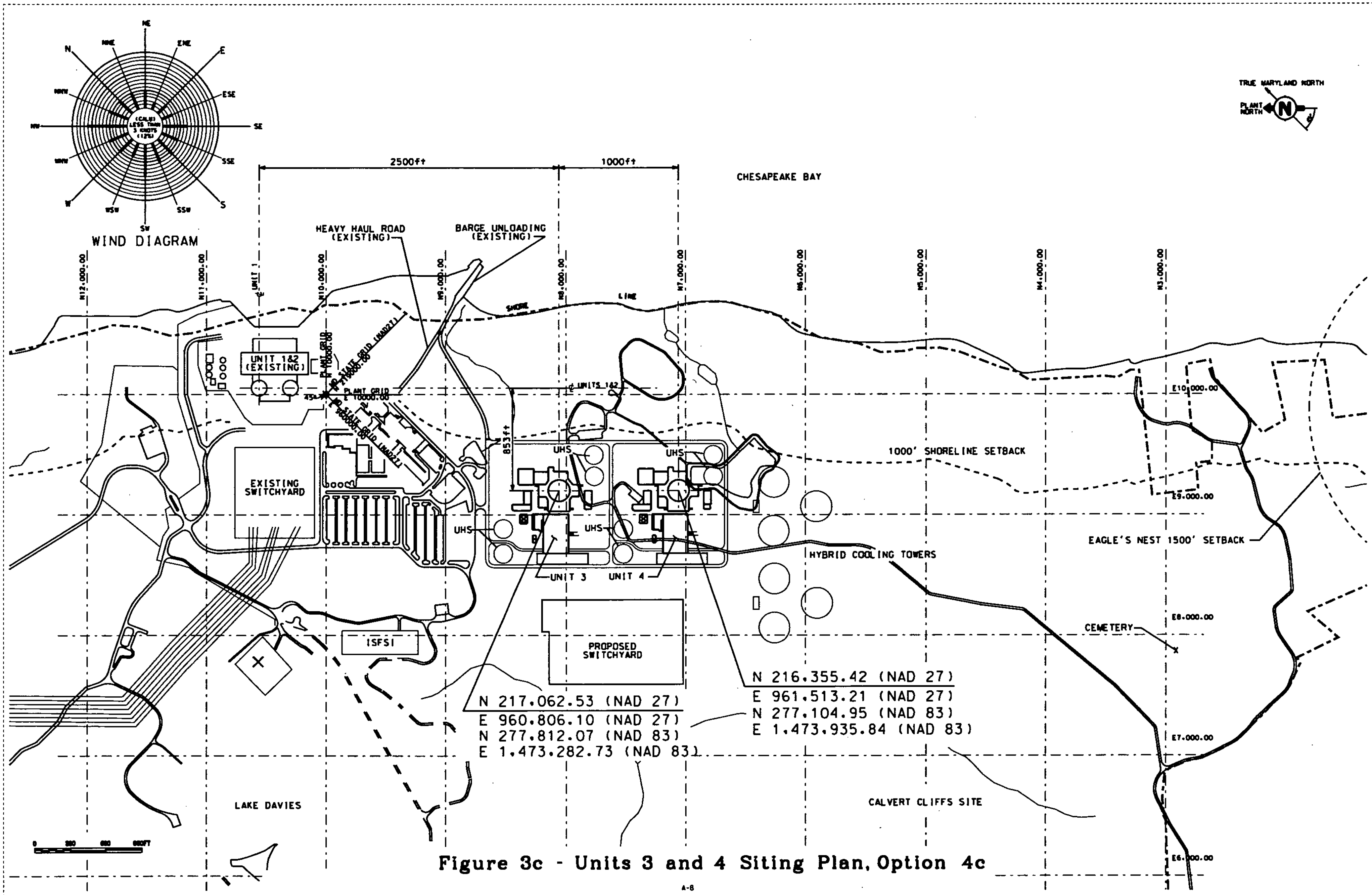


Figure 3c - Units 3 and 4 Siting Plan, Option 4c

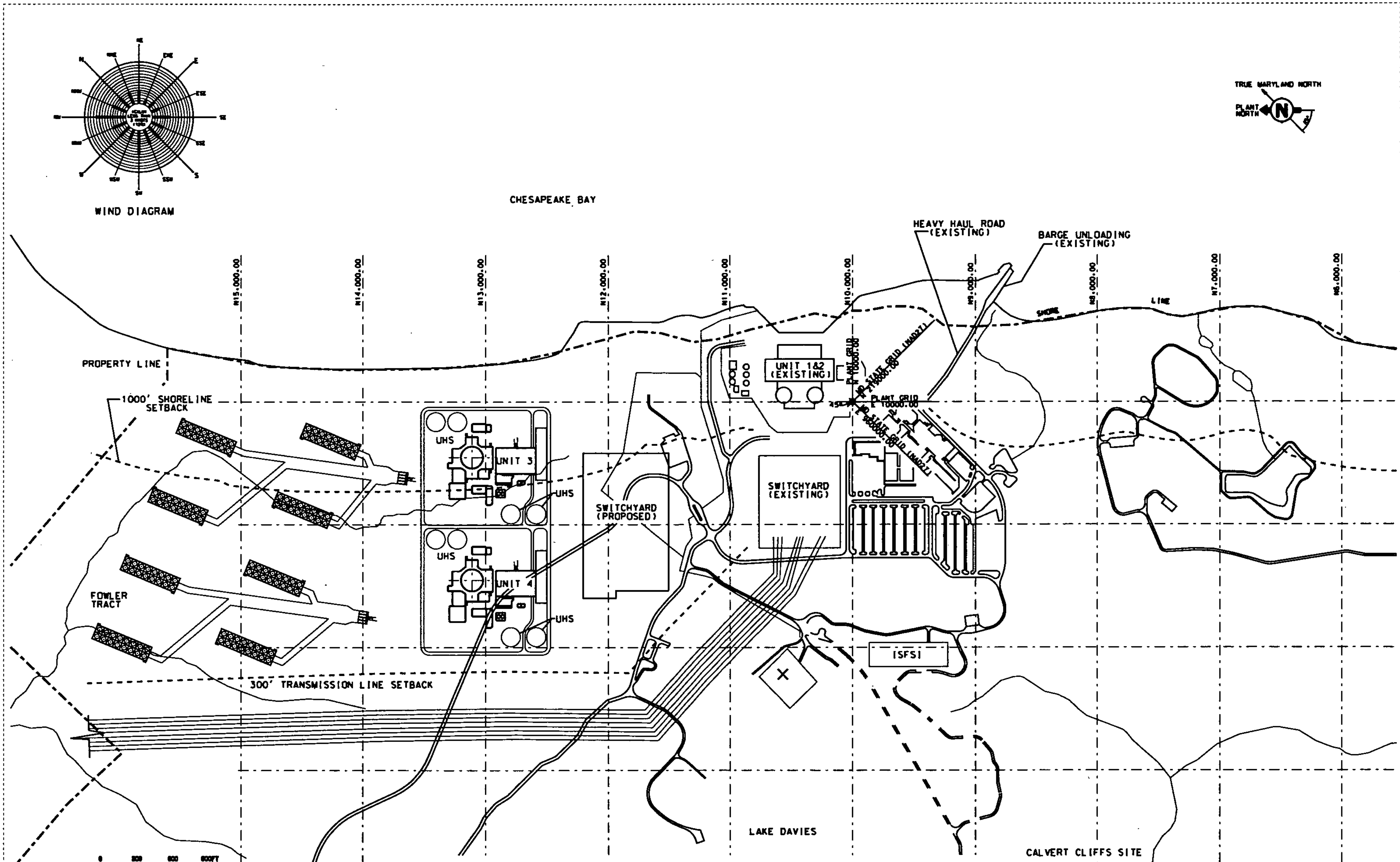


Figure 4 - Units 3 and 4 Siting Plan, Option 1

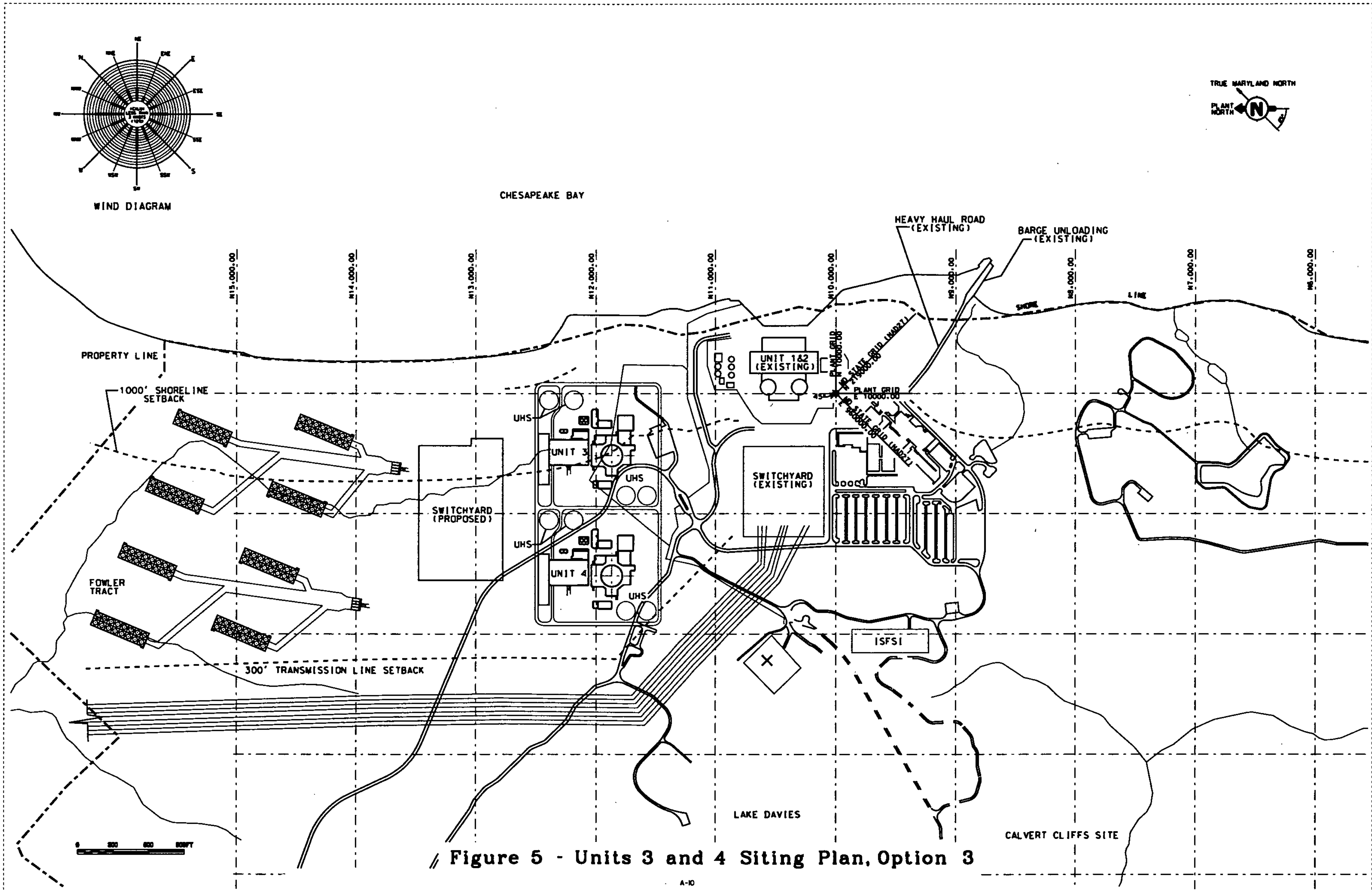


Figure 5 - Units 3 and 4 Siting Plan, Option 3

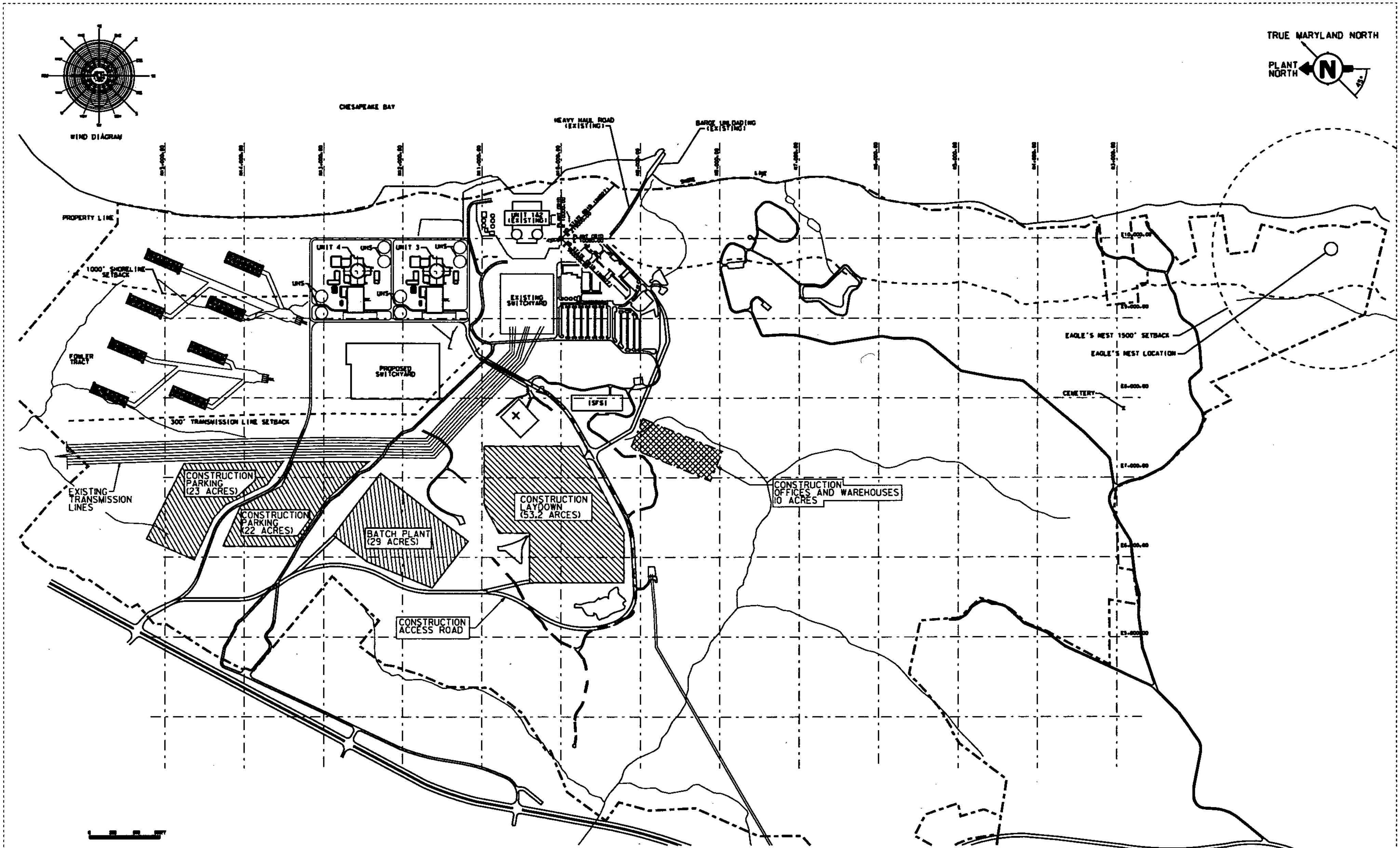


Figure 6 - Units 3 and 4 Siting Plan
Option 2a with Plan for Batch Plant, Laydown Area, and Parking

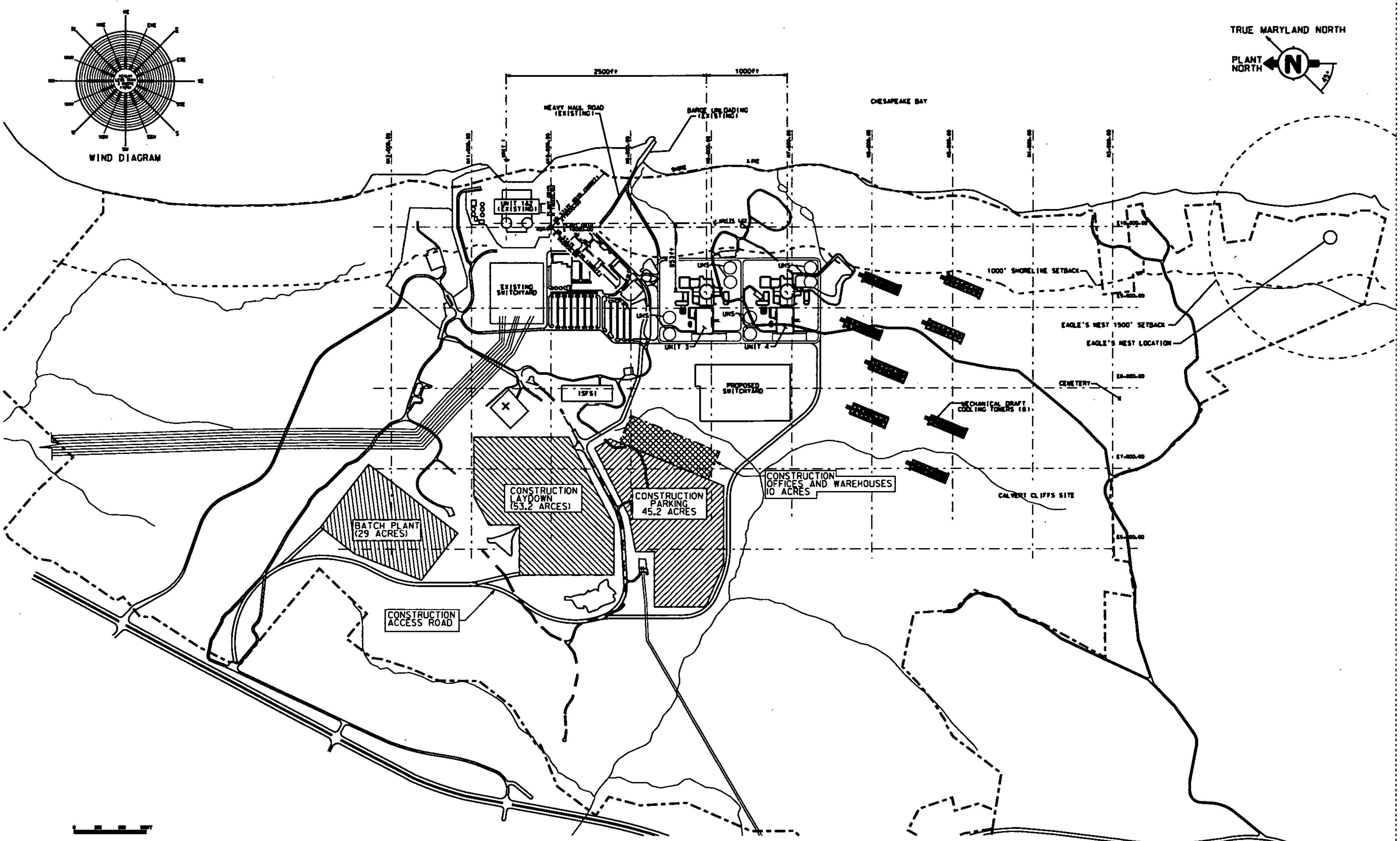


Figure 7 - Units 3 and 4 Siting Plan Option 4a with Plan for Batch Plant, Laydown Area, and Parking

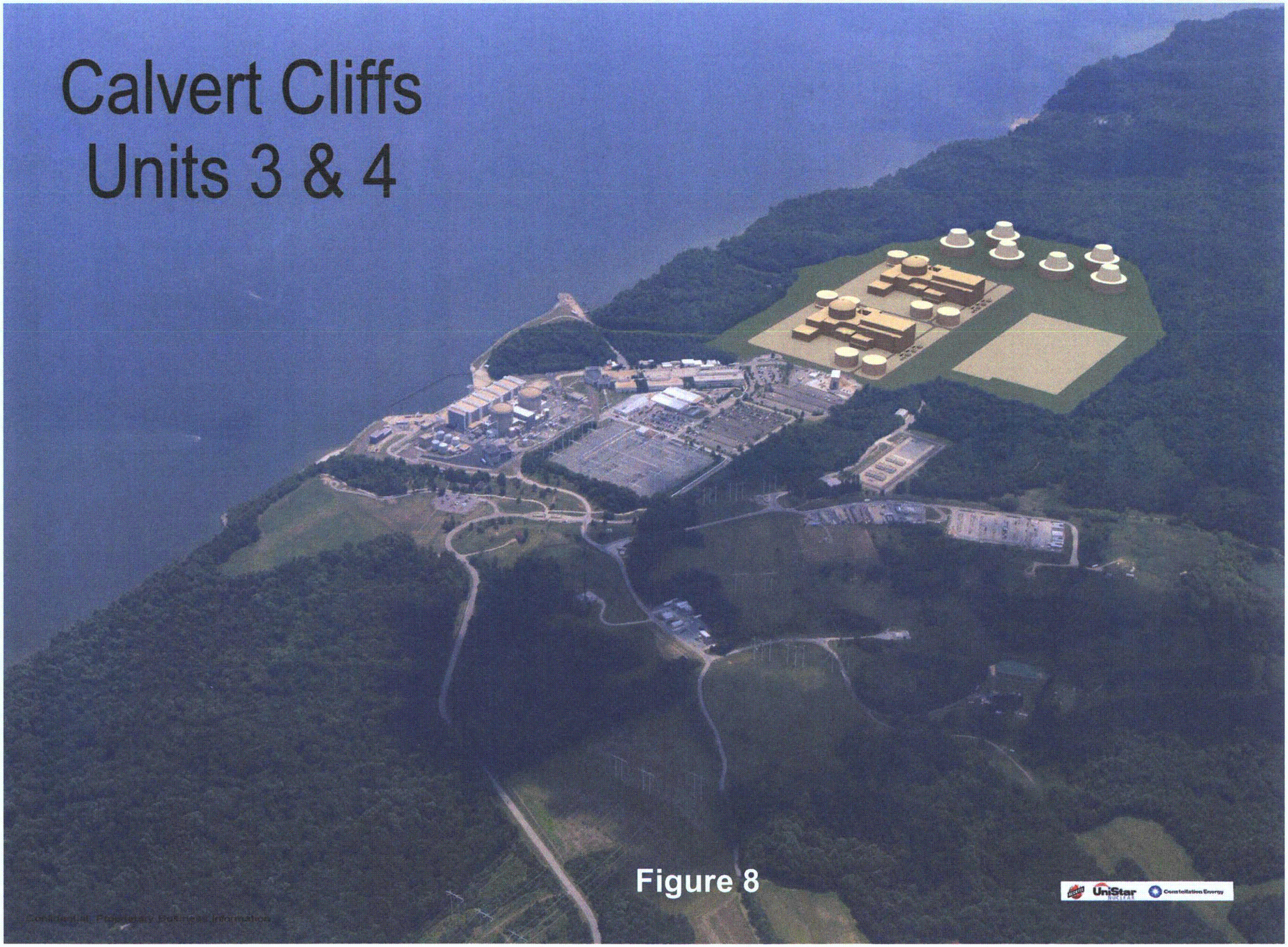


Figure 8

UniStar
Calvert Cliffs Nuclear Power Plant Units 3 and 4
Cooling System Selection
and
Site Layout Study

Appendix B

CCNPP Units 3 and 4 Site Evaluation Process/ Sensitivity Analysis

Methodology

The two Options (2 and 4) selected for further evaluation were evaluated for suitability based on the following Categories:

1. Environmental
2. Land Use and State/Local Zoning
3. Construction Considerations
4. Construction Facilities
5. Switchyard/Transmission Line
6. Security
7. Permanent Facility Considerations
8. Impact to Existing Facility Structures

Each of the above criteria was expanded to additional considerations as indicated in the checklist (Table B-1). In the meeting on February 8, 2006 among the engineers from Bechtel, Constellation, and industry experts (see Appendix E for list of attendees), this checklist was evaluated by assigning weighting to each of the criteria. First, each individual in the meeting assigned a weight to each criterion based on the description and discussion of each criterion and sub-criterion associated with it. Then, an average weight was calculated based on input from everyone. This average weight for each criterion was discussed to reach a consensus (see Table B-2 for this information).

After assigning the weight to each of the criteria, the two Options were evaluated based on suitability considering each of the sub-criterion. Each sub-criterion was considered by the team members for its applicability to the two Options selected for further evaluation. Then each criterion was ranked based on the impact of sub-criteria within the criterion. The criterion was ranked for each Option from 1 to 9 (absolute scale) based on least desirable (1) to most desirable (9). Individuals not knowledgeable in certain category had the option to skip that category. The average for such category accounted for this consideration. Similar to the weighting, the input from everyone in the meeting was averaged and a consensus was obtained for the Average Value of each category.

Result

Based on the weight and ranking of each category, a total score for each of the two Options was determined (see Table B-2). The result of this evaluation indicates that Option 4 (South Location) is more suitable for consideration.

Sensitivity Evaluation

In order to validate that assigning the weighting to the categories and scoring the Options for each of the categories is not significantly affected by variation in the weights and scoring, a sensitivity evaluation is performed of the data colleted from individual team members.

Weighting Sensitivity Evaluation

In this evaluation, the maximum and the minimum weighting assigned by the team members to the following four top weighted categories were assigned to the associated category and the total score for Options 2 and 4 were calculated:

1. Environmental
2. Land Use and Zoning
3. Construction Considerations
4. Construction Facilities

The scores assigned to each of the categories were kept unchanged from the normal case.

The evaluation and results are tabulated in Table B-3. From the summary charts of the evaluation it is evident that the resulting scores for the two Options are not significantly affected by the variation in the assigned weighting for the top four categories.

Scoring Sensitivity Evaluation

In this evaluation, the maximum scoring assigned by team members for the top four categories described above was applied to Option 2 and minimum scoring applied to Option 4. The weights for each criterion remained unchanged from normal case.

The evaluation and results are tabulated in Table B-4. From the summary charts of the evaluation it is evident that the resulting scores for the two Options considered are not significantly affected by the variation in the assigned scoring for the four categories.

Table B-1
CCNPP Units 3 and 4 Site Layout Checklist

No.	Criteria	Option 2 – N Plus	Option 2 – N Neutral	Option 2 – N Minus	Option 4 – S Plus	Option 4 – S Neutral	Option 4 – S Minus	Comment/Value
1.00	Environmental							
1.01	Visual / Aesthetic impact of Power Block							
1.02	Wetlands / Marshes							
1.03	Endangered or Threatened species (Animals & Plants)							
1.04	Flood plains							
1.05	Environmentally sensitive areas							
1.06	Historic sites / Cultural Sites							
1.07	Receiving water body impacts							
	Section 1 Score							
2.00	Land Use and Zoning (State, Local)							
2.01	Critical Areas							
2.02	Sub-Division							
2.03	CPCN (Certificate of Public Convenience and Necessity) Considerations							
2.04	Coastal Zone Management Act Consistency							
2.05	Impact on Easements							
2.06	Other areas							
	Section 2 Score							
3.00	Construction Considerations							
3.01	Standoff distance from the existing unit security fence, supervision of crane operations, exclusion areas							
3.02	Evacuation of construction forces and existing unit personnel							
3.03	Foundation integrity - undercutting							
3.04	Dewatering effects; impacts on groundwater levels							
3.05	Slope stability							
3.06	Rock blasting							
3.07	Dredging, erosion, turbidity effects							
3.08	Construction dust and equipment exhaust							
3.09	Construction noise, vibrations, electromagnetic disturbance							
3.10	Construction accident hazards							
3.11	Crane failures; heavy load drops, boom swings							
3.12	New unit SSCs installed in proximity to existing unit SSCs							

No.	Criteria	Option 2 – N Plus	Option 2 – N Neutral	Option 2 – N Minus	Option 4 – S Plus	Option 4 – S Neutral	Option 4 – S Minus	Comment/Value
3.13	Impacts on the site meteorological tower(s)							
3.14	Hazardous construction materials; potential missiles greater than existing plant design basis							
3.15	Hazardous onsite material storage and lines							
3.16	Construction flooding events (ruptured lines, site drainage interruptions, flooding of excavations, etc.)							
3.17	Normal operation, maintenance, and outage activities for the existing unit; delivery, receiving traffic patterns; sallie-ports							
3.18	Plumes from the existing and new units, diesel generators, offgas, etc.							
3.19	New and spent fuel handling and transport for the new and existing units							
3.20	Missile impacts from existing unit on new unit							
3.21	Impacts of existing unit normal operations and accidents on the new unit							
3.22	Impacts of new unit normal operations and accidents on the existing unit							
3.23	Restrictions on decommissioning activities for the existing unit while the new unit is in operation							
3.24	Excavation							
3.25	Timeline for Construction							
3.26	Steep slope areas							
3.27	Areas subject to liquefaction							
3.28	Permanent drainage corridors and ponds							
3.29	Construction drainage corridors and ponds							
3.30	Construction laydown and parking areas for the existing unit (or alternate areas identified)							
3.31	Reserved transmission corridors							
3.32	Nearby offsite or onsite pipelines, other hazardous items							
	Section 3 Score							
4.00	Construction Facilities							
4.01	Safety							
4.02	Batch plant							
4.03	Laydown areas							
4.04	Construction office locations							
4.05	Construction parking areas and access roads							
4.06	Barge facility (existing)							

No.	Criteria	Option 2 – N Plus	Option 2 – N Neutral	Option 2 – N Minus	Option 4 – S Plus	Option 4 – S Neutral	Option 4 – S Minus	Comment/Value
4.07	Heavy haul roads (slow grades, no transmission lines to cross under, short as possible, large turn radius for crawlers, direct access power block areas)							
4.08	Warehousing /Staging/Fuel							
	Section 4 Score							
5.00	Switchyard/Transmission Lines							
5.01	Location in front of the main startup transformers							
5.02	Location adjacent to the existing switchyard to allow for expansion and interconnection.							
5.03	Location convenient to the transmission line corridor for existing and new transmission lines							
5.04	Sizing depends on the transmission voltage and phase spacing, the bus arrangement, the number of outgoing and incoming transmission lines, the number of interconnections with the existing switchyard, and the number of bays required for future expansion.							
	Section 5 Score							
6.00	Security							
6.01	Separate the existing and new units to allow for security during construction							
6.02	Defend the design basis threat							
6.03	Use of common security force and area							
6.04	Protection of the existing unit's security barrier during construction of the new unit							
6.05	Relocation of security boundary after the new unit is completed							
6.06	Impacts on existing security monitoring and detection systems, lighting, lines of sight							
6.07	Minimum standoffs from existing unit security fence, exclusion areas							
	Section 6 Score							
7.00	Permanent facility considerations							
7.01	Review the EPR low trajectory turbine missile ejection zone for impacts on the existing unit.							
7.02	Confirm acceptable minimum distance to onsite and near site hazardous facilities (pipelines, barge accidents, etc.)							
7.03	Locate accident release points within the ½ mile exclusion radius of the EPR.							

No.	Criteria	Option 2 – N			Option 4 – S			Comment/Value
		Plus	Neutral	Minus	Plus	Neutral	Minus	
7.04	Identify access routes, sallie-ports, openings for normal operations, maintenance, and outage activities							
7.05	Identify access routes for future replacement of major components							
7.06	Offgas tower dispersion							
7.07	Tie-ins to existing unit SSCs							
7.08	If necessary, consider rotating individual power block structures (would require coordination with Framatome)							
7.09	Cooling tower fog and drift (HVAC opening, transmission line icing, tank vent freezing, stair and grating icing, onsite road icing)							
7.10	Need for blowdown cooling and holdup prior to discharge							
7.11	Installation schedule based on construction access requirements							
7.12	Consider need for new water intake and discharge structures to minimize existing unit impacts							
7.13	Use of Common Plant resources							
	Section 7 Score							
8.00	Impact to existing facilities or structures							
8.01	Cultural structures							
8.02	Existing structures							
8.03	Areas reserved for future facilities to support existing unit operations							
	Section 8 Score							

Table B-2
Scoring Summary – CCNPP Units 3 and 4 Site Layout Study

North Option - Units oriented side by side south to north, reactor building towards the east, switchyard west, and cooling tower north
South Option - Units oriented side by side north to south, reactor building to the east, switchyard west, and cooling tower South

Criteria	Weight % (total is 100%)	Options			
		North		South	
		Score	Sub Total	Score	Sub Total
1. Environmental	20	4.08	0.82	5.77	1.15
2. Land Use & Zoning (State, Local)	20	3.85	0.77	5.62	1.12
3. Construction Considerations	20	4.00	0.80	6.64	1.33
4. Construction Facilities	10	3.55	0.35	7.18	0.72
5. Switch Yard / Transmission Line	5	4.60	0.23	6.10	0.31
6. Security	10	4.08	0.41	4.31	0.43
7. Permanent Facility Considerations	10	4.15	0.42	5.45	0.55
8. Impact to Existing Facility Structures	5	3.69	0.18	5.45	0.27
Totals	**100**		**3.98**		**5.88**

Individual Weighting Input and Evaluation

Criteria	Weight (total is 100%)	1	2	3	4	5	6	7	8	9
1. Environmental		25	15	20	30	25	20	15	20	25
2. Land Use & Zoning (State, Local)		25	15	25	20	25	20	15	20	25
3. Construction Considerations		20	25	20	30	25	20	20	15	15
4. Construction Facilities		5	25	15	5	10	5	15	10	10
5. Switch Yard / Transmission Line		5	5	8	5	5	5	10	5	5
6. Security		10	10	7	10	5	15	15	10	5
7. Permanent Facility Considerations		5	3	3	0	3	10	5	15	10
8. Impact to Existing Facility Structures		5	2	2	0	2	5	5	5	5
Totals		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Criteria	Weight (total is 100%)	10	11	12	13	14	15	Subtotals	Average	High	Low
1. Environmental		20	20	20	20	10	20	305	20.33	30	10
2. Land Use & Zoning (State, Local)		15	20	20	20	30	20	315	21.00	30	15
3. Construction Considerations		25	15	20	15	30	15	310	20.67	30	15
4. Construction Facilities		5	10	10	10	10	10	155	10.33	25	5
5. Switch Yard / Transmission Line		5	5	10	5	5	10	93	6.20	10	5
6. Security		5	10	10	5	5	5	127	8.47	15	5
7. Permanent Facility Considerations		20	15	5	20	10	15	139	9.27	20	0
8. Impact to Existing Facility Structures		5	5	5	5	0	5	56	3.73	5	0
Totals		**100**	**100**	**100**	**100**	**100**	**100**	**1500**	**100**		

Individual Scoring of Option 2

Option 2 – North Criteria	Weight (total is 100%)	1	2	3	4	5	6	7	8	9
1. Environmental		5	5	4	4	4	4	3	4	4
2. Land Use & Zoning (State, Local)		3	5	3	2	4	6	4	3	3
3. Construction Considerations		4	5		3	4	4	4	5	
4. Construction Facilities		4	5		4	2	4	4	4	
5. Switch Yard / Transmission Line		5	5			4	5	5	6	
6. Security		5	5		6	4	5	6	5	
7. Permanent Facility Considerations		5	5		6	4	6	5	4	
8. Impact to Existing Facility Structures		5	5		4	4	4	5	5	
Totals		**36**	**40**	**7**	**29**	**30**	**38**	**36**	**36**	**7**

Criteria	Weight (total is 100%)	10	11	12	13	14	15	Subtotals	Average	High	Low
1. Environmental		3	4	4	5			53	4.08	5	3
2. Land Use & Zoning (State, Local)		5	4	4	4			50	3.85	6	2
3. Construction Considerations		4	3	4	4			44	4.00	5	3
4. Construction Facilities		1	4	4	3			39	3.55	5	1
5. Switch Yard / Transmission Line		5	4	3	4			46	4.60	6	3
6. Security		3	7	3	4			53	4.08	7	3
7. Permanent Facility Considerations		5	4	4	6			54	4.15	6	4
8. Impact to Existing Facility Structures		4	4	4	4			48	3.69	5	4
Totals		**30**	**34**	**30**	**34**	**0**	**0**	**387**	**31.99**		

Individual Scoring of Option 4

Option 4 – South Criteria	Weight (total is 100%)	1	2	3	4	5	6	7	8	9
1. Environmental		5	7	7	3	6	6	4	6	8
2. Land Use & Zoning (State, Local)		7	7	5	4	6	4	6	7	6
3. Construction Considerations		7	7		2	7	7	6	5	
4. Construction Facilities		6	7		6	8	7	7	5	
5. Switch Yard / Transmission Line		8	7			6	6	6	4	
6. Security		5	5		4	7	5	4	5	
7. Permanent Facility Considerations		5	7		4	7	4	5	6	
8. Impact to Existing Facility Structures		5	5		6	6	6	5	6	
Totals		**48**	**52**	**12**	**29**	**53**	**45**	**43**	**44**	**14**

Criteria	Weight (total is 100%)	10	11	12	13	14	15	Subtotals	Average	High	Low
1. Environmental		6	6	6	5			75	5.77	8	3
2. Land Use & Zoning (State, Local)		4	6	5	6			73	5.62	7	4
3. Construction Considerations		6	9	8	9			73	6.64	9	5
4. Construction Facilities		8	9	7	9			79	7.18	9	5
5. Switch Yard / Transmission Line		5	6	7	6			61	6.10	8	4
6. Security		6	4	5	6			56	4.31	7	4
7. Permanent Facility Considerations		6	6	6	4			60	5.45	7	4
8. Impact to Existing Facility Structures		4	6	5	6			60	5.45	6	4
Totals		**45**	**52**	**49**	**51**	**0**	**0**	**537**	**46.52**		

Table B-3
Sensitivity Evaluation – Weighting
Maximum Weight Applied to Environmental

Criteria	Weight % (total is 100%)	Options			
		2		4	
		Score	Sub Total	Score	Sub Total
Environmental	30	4.08	1.22	5.77	1.73
Land Use & Zoning (State, Local)	17	3.85	0.65	5.62	0.95
Construction Considerations	17	4.00	0.68	6.64	1.13
Construction Facilities	9	3.55	0.32	7.18	0.65
Switch Yard / Transmission Line	5	4.60	0.23	6.10	0.31
Security	9	4.08	0.37	4.31	0.39
Permanent Facility Considerations	9	4.15	0.37	5.45	0.49
Impact to Existing Facility Structures	4	3.69	0.15	5.45	0.22
Totals	**100**		**3.99**		**5.86**

Maximum Weight applied to Land Use and Zoning

Criteria	Weight % (total is 100%)	Options			
		2		4	
		Score	Sub Total	Score	Sub Total
Environmental	17	4.08	0.69	5.77	0.98
Land Use & Zoning (State, Local)	30	3.85	1.15	5.62	1.68
Construction Considerations	17	4.00	0.68	6.64	1.13
Construction Facilities	9	3.55	0.32	7.18	0.65
Switch Yard / Transmission Line	5	4.60	0.23	6.10	0.31
Security	9	4.08	0.37	4.31	0.39
Permanent Facility Considerations	9	4.15	0.37	5.45	0.49
Impact to Existing Facility Structures	4	3.69	0.15	5.45	0.22
Totals	**100**		**3.96**		**5.84**

Maximum Weight applied to Construction Considerations

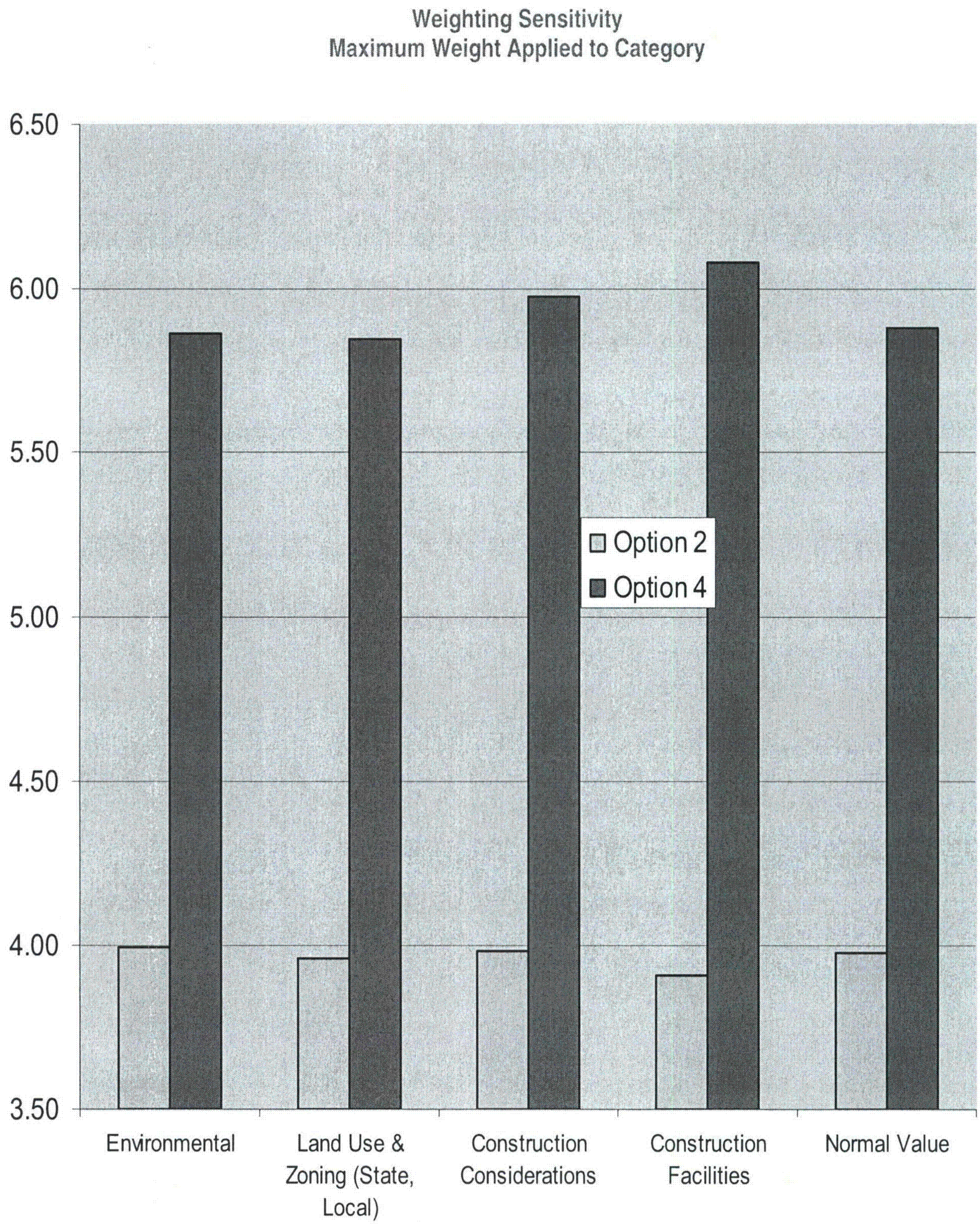
Criteria	Weight % (total is 100%)	Options 2 Score	Options 2 Sub Total	Options 4 Score	Options 4 Sub Total
Environmental	17	4.08	0.69	5.77	0.98
Land Use & Zoning (State, Local)	17	3.85	0.65	5.62	0.95
Construction Considerations	30	4.00	1.20	6.64	1.99
Construction Facilities	9	3.55	0.32	7.18	0.65
Switch Yard / Transmission Line	5	4.60	0.23	6.10	0.31
Security	9	4.08	0.37	4.31	0.39
Permanent Facility Considerations	9	4.15	0.37	5.45	0.49
Impact to Existing Facility Structures	4	3.69	0.15	5.45	0.22
Totals	**100**		**3.98**		**5.97**

Maximum Weight applied to Construction Facility

Criteria	Weight % (total is 100%)	Options 2 Score	Options 2 Sub Total	Options 4 Score	Options 4 Sub Total
Environmental	16	4.08	0.65	5.77	0.92
Land Use & Zoning (State, Local)	16	3.85	0.62	5.62	0.90
Construction Considerations	16	4.00	0.64	6.64	1.06
Construction Facilities	25	3.55	0.89	7.18	1.80
Switch Yard / Transmission Line	5	4.60	0.23	6.10	0.31
Security	9	4.08	0.37	4.31	0.39
Permanent Facility Considerations	9	4.15	0.37	5.45	0.49
Impact to Existing Facility Structures	4	3.69	0.15	5.45	0.22
Totals	**100**		**3.91**		**6.08**

Summary Sensitivity Evaluation for Maximum Weight

Case	Option 2	Option 4
Environmental	3.99	5.86
Land Use & Zoning (State, Local)	3.96	5.84
Construction Considerations	3.98	5.97
Construction Facilities	3.91	6.08
Normal Value	3.98	5.88


Weighting Sensitivity
Maximum Weight Applied to Category
6.50
6.00
5.50
5.00
4.50
4.00
3.50
Option 2
Option 4
Environmental
Land Use & Zoning (State, Local)
Construction Considerations
Construction Facilities
Normal Value

Scoring Summary
CCNPP Units 3 and 4 Site Layout Study

Sensitivity Evaluation – Weighting
Minimum Weight Applied to Environmental

Criteria	Weight % (total is 100%)	Options			
		2		4	
		Score	Sub Total	Score	Sub Total
Environmental	10	4.08	0.41	5.77	0.58
Land Use & Zoning (State, Local)	23	3.85	0.88	5.62	1.29
Construction Considerations	23	4.00	0.92	6.64	1.53
Construction Facilities	11	3.55	0.39	7.18	0.79
Switch Yard / Transmission Line	6	4.60	0.28	6.10	0.37
Security	11	4.08	0.45	4.31	0.47
Permanent Facility Considerations	11	4.15	0.46	5.45	0.60
Impact to Existing Facility Structures	5	3.69	0.18	5.45	0.27
Totals	**100**		**3.97**		**5.90**

Minimum Weight applied to Land Use and Zoning

Criteria	Weight % (total is 100%)	Options			
		2		4	
		Score	Sub Total	Score	Sub Total
Environmental	22	4.08	0.90	5.77	1.27
Land Use & Zoning (State, Local)	15	3.85	0.58	5.62	0.84
Construction Considerations	22	4.00	0.88	6.64	1.46
Construction Facilities	11	3.55	0.39	7.18	0.79
Switch Yard / Transmission Line	6	4.60	0.28	6.10	0.37
Security	10	4.08	0.41	4.31	0.43
Permanent Facility Considerations	10	4.15	0.42	5.45	0.55
Impact to Existing Facility Structures	4	3.69	0.15	5.45	0.22
Totals	**100**		**3.99**		**5.92**

Minimum Weight applied to Construction Considerations

Criteria	Weight % (total is 100%)	Options 2 Score	Options 2 Sub Total	Options 4 Score	Options 4 Sub Total
Environmental	22	4.08	0.90	5.77	1.27
Land Use & Zoning (State, Local)	22	3.85	0.85	5.62	1.24
Construction Considerations	15	4.00	0.60	6.64	1.00
Construction Facilities	10	3.55	0.35	7.18	0.72
Switch Yard / Transmission Line	5	4.60	0.23	6.10	0.31
Security	10	4.08	0.41	4.31	0.43
Permanent Facility Considerations	11	4.15	0.46	5.45	0.60
Impact to Existing Facility Structures	5	3.69	0.18	5.45	0.27
Totals	**100**		**3.98**		**5.83**

Minimum Weight applied to Construction Facility

Criteria	Weight % (total is 100%)	Options 2 Score	Options 2 Sub Total	Options 4 Score	Options 4 Sub Total
Environmental	21	4.08	0.86	5.77	1.21
Land Use & Zoning (State, Local)	21	3.85	0.81	5.62	1.18
Construction Considerations	21	4.00	0.84	6.64	1.39
Construction Facilities	5	3.55	0.18	7.18	0.36
Switch Yard / Transmission Line	5	4.60	0.23	6.10	0.31
Security	11	4.08	0.45	4.31	0.47
Permanent Facility Considerations	11	4.15	0.46	5.45	0.60
Impact to Existing Facility Structures	5	3.69	0.18	5.45	0.27
Totals	**100**		**4.00**		**5.80**

Summary Sensitivity Evaluation for Maximum Weight

Case	Option 2	Option 4
Environmental	3.97	5.90
Land Use & Zoning	3.99	5.92
Construction Considerations	3.98	5.83
Construction Facilities	4.00	5.80
Normal Value	3.98	5.88

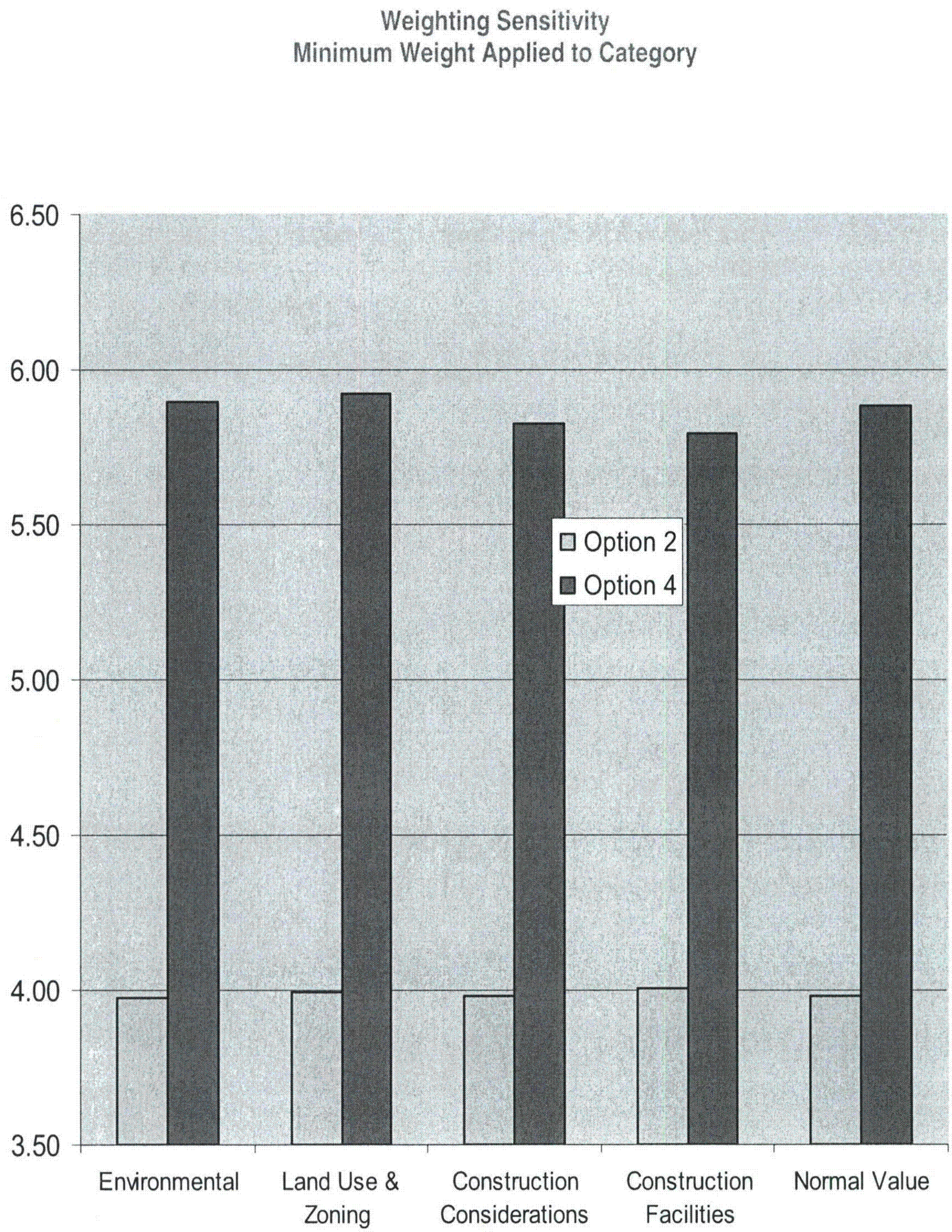

Weighting Sensitivity
Minimum Weight Applied to Category
6.50
6.00
5.50
5.00
4.50
4.00
3.50
Option 2
Option 4
Environmental
Land Use & Zoning
Construction Considerations
Construction Facilities
Normal Value

Table B-4
Sensitivity Evaluation – Scoring
Maximum Score Applied to Option 2 and Minimum Score Applied to Option 4 for Environmental

Criteria	Weight % (total is 100%)	Options 2 Score	Options 2 Sub Total	Options 4 Score	Options 4 Sub Total
Environmental	20	5.00	1.00	3.00	0.60
Land Use & Zoning (State, Local)	20	3.85	0.77	5.62	1.12
Construction Considerations	20	4.00	0.80	6.64	1.33
Construction Facilities	10	3.55	0.35	7.18	0.72
Switch Yard / Transmission Line	5	4.60	0.23	6.10	0.31
Security	10	4.08	0.41	4.31	0.43
Permanent Facility Considerations	10	4.15	0.42	5.45	0.55
Impact to Existing Facility Structures	5	3.69	0.18	5.45	0.27
Totals	**100**		**4.16**		**5.32**

Sensitivity Evaluation – Scoring
Maximum Score applied to Option 2 and Minimum Score Applied to Option 4 for Land Use and Zoning

Criteria	Weight % (total is 100%)	Options 2 Score	Options 2 Sub Total	Options 4 Score	Options 4 Sub Total
Environmental	20	4.08	0.82	5.77	1.15
Land Use & Zoning (State, Local)	20	6.00	1.20	3.00	0.60
Construction Considerations	20	4.00	0.80	6.64	1.33
Construction Facilities	10	3.55	0.35	7.18	0.72
Switch Yard / Transmission Line	5	4.60	0.23	6.10	0.31
Security	10	4.08	0.41	4.31	0.43
Permanent Facility Considerations	10	4.15	0.42	5.45	0.55
Impact to Existing Facility Structures	5	3.69	0.18	5.45	0.27
Totals	**100**		**4.41**		**5.35**

Sensitivity Evaluation – Scoring
Maximum Score applied to Option 2 and Minimum Score Applied to Option 4 for Construction Considerations

Criteria	Weight % (total is 100%)	Options			
		2		4	
		Score	Sub Total	Score	Sub Total
Environmental	20	4.08	0.82	5.77	1.15
Land Use & Zoning (State, Local)	20	3.85	0.77	5.62	1.12
Construction Considerations	20	5.00	1.00	5.00	1.00
Construction Facilities	10	3.55	0.36	7.18	0.72
Switch Yard / Transmission Line	5	4.60	0.23	6.10	0.31
Security	10	4.08	0.41	4.31	0.43
Permanent Facility Considerations	10	4.15	0.42	5.45	0.55
Impact to Existing Facility Structures	5	3.69	0.18	5.45	0.27
Totals	**100**		**4.18**		**5.55**

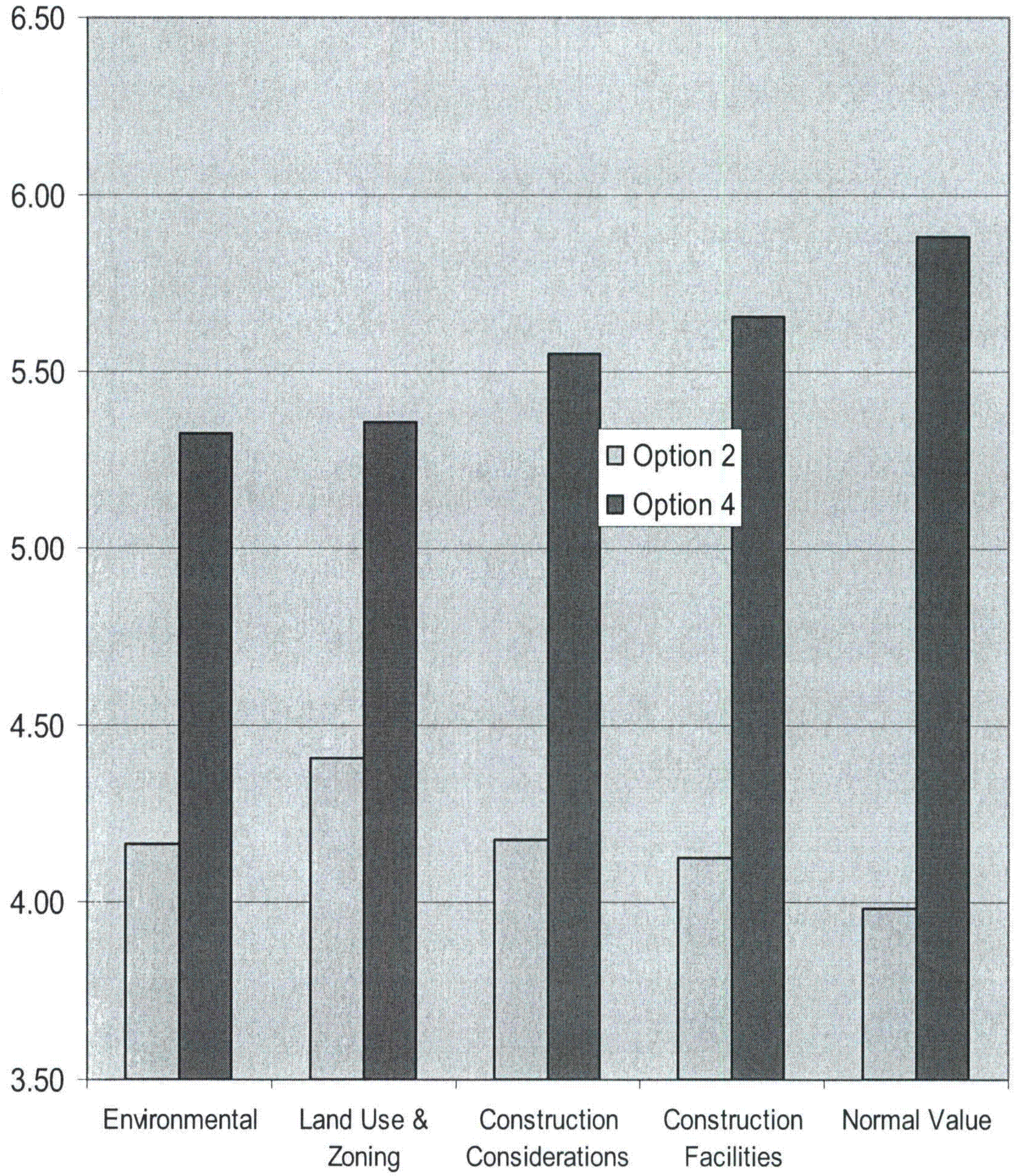
Sensitivity Evaluation – Scoring
Maximum Score applied to Option 2 and Minimum Score Applied to Option 4 for Construction Facilities

Criteria	Weight % (total is 100%)	Options			
		2		4	
		Score	Sub Total	Score	Sub Total
Environmental	20	4.08	0.82	5.77	1.15
Land Use & Zoning	20	3.85	0.77	5.62	1.12
Construction Considerations	20	4.00	0.80	6.64	1.33
Construction Facilities	10	5.00	0.50	5.00	0.50
Switch Yard / Transmission Line	5	4.60	0.23	6.10	0.31
Security	10	4.08	0.41	4.31	0.43
Permanent Facility Considerations	10	4.15	0.42	5.45	0.55
Impact to Existing Facility Structures	5	3.69	0.18	5.45	0.27
Totals	**100**		**4.12**		**5.66**

Summary Sensitivity Evaluation for Score

Case	Option 2	Option 4
Environmental	4.16	5.32
Land Use & Zoning	4.41	5.35
Construction Considerations	4.18	5.55
Construction Facilities	4.12	5.66
Normal Value	3.98	5.88

Scoring Sensitivity
Maximum Score Applied to Option 2 and Minimum Score Applied to Option 4



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Appendix C

Property and Zoning Information

CCNPP Related Land Uses by Zoning District

	I-1 District	I-1 District	Rural/ Resource Preservation District	Farm and Forestry District
	Current	Rewrite	Current	Rewrite
Commercial Power Generating Facility	P	P*	X	X*
Accessory Building or Use	P	P	P	P
Target Range	SC	SC	SC	SC
Public Utility Lines & Accessory Structures	P	P	P	P
Heliport	S	S	S	S
Temporary Structure Incidental to Construction (non-residential)	C	C	C	C
Tower, Commercial on Private Property (no height restriction)	SC	SC	SC	SC
Tower, Commercial on Private Property, less than 75 feet	C	C	SC	SC
Antenna, Commercial on Private Property	C	C	C	C
Satellite Dish Antenna; Ground Mounted, greater than 3' in diameter	C	C	C	C
Satellite Dish Antenna; Roof Mounted, greater than 3' in diameter	C	C	SC	SC
Satellite Dish Antenna; Ground or Roof Mounted, less than 3' in diameter	P	P	P	P

P Permitted Use
C Permitted Use if it meets certain conditions
S Permitted Use subject to special exception from the Board of Appeals
SC Permitted Use subject to special exception if it meets certain conditions
X Use is not permitted
* Status of this use in the Comprehensive Rewrite requires verification

Parcel	Grantor	Year Acq'd	Acres Acq'd	Grantee	Year Sold	Acres Sold	Net Acreage Left	Tax ID	SDAT Acreage
1	Belle Goldstein	1967	986.2	Maryland/Wayson Land Holdings*	1984/ 2002	8.8/1.2	976.2	01-000578	962.0
3	YMCA	1968	150.4				150.4	01-000586	150.4
5	Briscoe	1982	68.6				68.6	01-002562	68.6
6	Louis Goldstein	1984	289.3				289.3	01-001116	291.8
2	Gibson	1984	414.4	Calvert County Commis.	1999	25.6	388.8	01-008625	388.8
7	Pardoe	1985	29.4				29.4	01-239996	29.4
4	Fowler	1986	167.1	Wayson Land Holdings*	2002	15.4	151.7	01-007769	166.0
6	Raysinger	1988	2.5				2.5	01-001116	**
	Total		**2,107.9**			**41.0**	**2,056.9**		**2,057.0**

* BGE sold 8.8 acres of the Belle Goldstein tract to the State of Maryland in 1984. CCNPP sold 1.2 acres of the Belle Goldstein tract and 15.4 acres of the Fowler tract to Wayson Land Holdings in 2002. SDAT got the latter transaction backwards. It deducted 15.4 acres from the Belle Goldstein tract and 1.1 acres from the Fowler tract.

** SDAT has combined the Louis Goldstein tract and the Raysinger tract into a single tax parcel.

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Appendix D

Walkdown Results

Walkdown Report

Location: Calvert Cliffs Nuclear Plant Site

Date: January 26, 2006

Participants: David Murphy, Bechtel
Chuck Dicey, Bechtel
Mark Hunter, Constellation
Tom Roberts, Constellation

Purpose: Walkdown Calvert Cliffs site to gather information for evaluating potential locations for Units 3 and 4.

Observations:

Southern side of property

1. Ponds downstream of Camp Conoy Lake are man-made water impoundment structures. Berms were formed on the bay side to create pooling and slow run-off to the bay.

2. Bald eagle nest is at the southern most location on the Calvert Cliffs property past current residential construction. Mark Hunter has provided GPS coordinates for the location.

3. The cemetery of 3 graves is located near the southern property line at the end of fire road M-1 (near node point N-3 on drawing 61502, sht 001).

4. The land just west of the Camp Conoy provides for moderately deep natural valleys for locating the power block.

5. Areas around Camp Conoy would require grading for locating the cooling towers.

6. Southern area works well with the nearby location of the barge ramp and heavy haul road. The existing heavy haul road is adjacent with the proposed site location.

7. The natural valley between the steep cliffs where the Camp Conoy tennis courts are located provides for an excellent area for locating an intake and discharge structure with the makeup and discharge lines routed through this valley to the circulating water system.

Northern side of property

1. Large ravines exist on both sides of fire road A-2 with a large deep valley at the northern most location on the property. This valley is located mostly within the Fowler tract. Most of the areas requiring significant fill would be used for the cooling tower locations and construction facilities.

2. Significant grubbing, clearing, and grading are required for the northern location.

3. At the proposed power block location, the land is mostly cleared, but would require significant grading to get to a grade elevation of approx. 75' as the natural elevation is 90'–100'.

4. A northern location would require demolition or relocation of the visitor center, educational center, tobacco barns, restored chimneys, security checkpoint and associated transformers, some of the main access road, cell phone tower, Procedure Upgrade Project trailers, and dog training facility.

Heavy Haul Road

The heavy haul road has 3 potential routes for a northern location. The first being through the existing Unit 1 and 2 protected area. This route contains a constricting Sallie-port, various 90° turns, runs just west of the Units 1 and 2 reactor buildings and would have a significant grade to traverse to get to the north location.

The second route would use the road just west of the existing switchyard and the third would use the road by the ISFSI. Both the second and third routes would be in excess of a mile in length. All routes require crossing under the transmission lines to get to a northern location.

For a southern site, the haul route is approximately a half mile with limited impact to the operating plant, and would not cross under any transmission lines.

Existing Intake and Discharge Structure

The existing intake and discharge structures were reviewed. There is the potential to connect to the existing intake for supplying makeup to both the northern and southern locations. The challenge is to locate the intake building either inside the protected area or outside and transition intake lines into the intake channel. Blowdown from the circulating water system could be returned to the intake channel from the southern location (would require additional feasibility studies) or tied into the existing discharge structure from a northern location. The difficulty would be integrating the change with the operating units.

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Appendix E

Documentation of Meetings

January 5 and 6, 2006 Attendance

Attendees:

Name	Company	January 5	January 6
David Murphy	Bechtel	✓	✓
Ed Sherow	Bechtel	✓	*
Frank Lopez	Bechtel	✓	✓
Steve Routh	Bechtel	✓	✓
Hector Cruz	Bechtel	✓	Did not attend
Yifan Zheng	Bechtel	✓	Did not attend
Chuck Dicey	Bechtel	Did not attend	✓
Mark Hunter	Constellation	✓	✓
Tom Roberts	Constellation	✓	✓
Greg DeCamp	Constellation	✓	✓
Mike Milbrandt	Constellation	✓	✓
Jim Burkman	Constellation	✓	✓
Carla Logan	Constellation	✓	✓
Fred Jacobs	AKRF	✓	✓
Doug Heimbuch	AKRF	✓	✓
Maureen Heimbuch	AKRF	Via teleconference	Did not attend
David Bailey	EPRI	✓	Did not attend
Jay Hixson	Morgan State	✓	Did not attend
Barry Knisley	Randolph - Macon	✓	Did not attend
Brenda Nuse	Constellation	✓	Did not attend
Ken Johnson	Constellation	✓	Did not attend
Dick Ransom	Constellation	Did not attend	Did not attend
Dave Tomlinson	Constellation	✓	Did not attend
Karen Patterson	TT/NUS	✓	✓
Ned Taft	Alden	Via teleconference	Did not attend
Bruce Bradford	TT/NUS	✓	✓

Calvert Cliffs Siting Study Meeting Notes
January 5 and 6, 2006

January 5, 2006

Scope Items for Consideration

1. Schedule

2. Impact to existing site

3. Zoning Issues

4. Beetles – Tiger

    - Two species (Northeastern Beach and Puritan), both have active adults from June 15 to August, both have minimal impacts due to salt deposition.

    - Northeastern Beach: (a) located at Flag Ponds & Western Shores, also used to be at Cove Point, (b) eggs/larvae are in beach sand

    - Puritan (a) located at Scientist Cliffs, Calvert Cliffs State Park, Cove Point, etc and south of Barge Dock, (beetles are able to use a narrow beach area with High Cliffs), (b) Eggs/larvae are laid in a sand/soft material layer in the cliffs. The beetles need a "bare" or exposed cliff face for access soil to lay their eggs.

5. Environmental Approvals (know order/precedence/pre-requisites)

6. Eagle Nest (s) Location

7. Noise

8. Life Cycle Costs and NOT Initial Capital Cost will govern decisions

9. Cultural Resources (old tobacco barn, foundation and chimney, camp conoy)

10. Use of Fresh water and source (water to run the plant plus possible Ultimate Heat Sink)

11. Develop a plan to allow investigation of plants and vegetation to be implemented in the spring.

Other Discussion Topics and Considerations

1. Offshore screens for *Once Through* would require many modules with small screens that would provide fouling problems.

2. *Once Through* cooling would have thermal impacts that are seen as high risk

3. Need to define and/or minimize interaction with future U1/U2 changes (i.e. know relationship to future U1/U2 changes such as power upgrade).

4. Cooling Option and impacts of 316A & B. Phase I (New Facility) with Track 1 (closed cycle) and track 2 (Once through). Phase II (Existing Facilities).

5. Intake Options: Use existing U1/U2 intake to feed the new units so total site would be 50% cooling tower. This would help U1/U2 also. Need to have velocity of feed to new units to be < 0.5 ft/sec.

6. Initiate a Flight Study for impacts and restraints

7. Perform Study to locate Oyster bed south of the plant

8. Develop Matrix of options for Cooling System. Matrix to included various options, +/- items. Must consider type of system, type of towers, plumes and deposition of material, impact on T-Lines, etc.

9. Obtain or perform a study for existing site background noise data.

10. Site with 2 units to be arranged to have a common switchyard that would then tie into the existing U1/U2 switchyard for interface with the grid.

11. Efforts and process developed for the Calvert Site selection will become the standard for other plants.

12. Site selection will address both 1 unit and 2 unit options.

13. The 1000 foot zone critical area is a Maryland State requirement enforced by Calvert County. There is also a sensitive zone that is the first 100 feet. Potential to encroach the 1000 foot, but leave at least 300 feet.

14. Site has sections zoned as industrial and buffer. Goal is to use industrial area first and then buffer area if needed. Working to get state to approve a Certificate of Public Convenience and Necessity (CPCN) that will give flexibility for changing zoning, height and other restrictions.

15. Constructability and crane access and usage will be addressed.

Location Considerations

North Side

Plus Items	Negative Items
Area is designated as industrial	Water intake and discharge could impact cliffs and will have to go past sand bar (1.0 miles in length). High Cliffs
No oyster bed area	Flag Pond Nature Park is in relative close proximity to immediate north
Good access to tie into existing intake area and discharge area	Shore intake not possible without dredging and high maintenance. Concern on impact to U1/2 discharge pipe
Minimal impact due to Tiger Beetles to be addressed	Will need to be within 1000 ft exclusion area and will need to use part of "Fowler" property
Open fields for soil borings	Higher elevation and much earthwork to be done

South Side

Plus Items	Negative Items
Shoreline intake and discharge can use "valley area" and not impact cliffs	Old Oyster bar (may not be active) will need survey and may need to be re-seeded
Offshore area is OK with respect to recirc of discharge.	
Minimal impact due to Tiger Beetles to be addressed	

West Side

Plus Items	Negative Items

January 6, 2006

Site Critical Items

1. Have space for 2 Units and ability to tie the 2 new units together

2. Stay 300 feet from the Bay (100 foot sensitive zone plus 200 feet of the critical zone)

3. Do not place the nuclear island on Lake Davies

4. Maintain 1500 feet separation from Bald Eagle Nest, also address any nest in the Flag Pond Area

Site Objectives/Desires Wants

1. Low Regulatory risk
2. Minimal environmental impact
3. Positive public viewpoint
4. Acceptable Capital/Life cycle cost
5. Streamlined schedule
6. DOE Funding
7. Licensing benefit to Units 1 and 2
8. Common security

Cooling Tower Options and Considerations

1. Once through cooling is not viable due to 316 A & B regulations and impacts. These impacts include:

    a. No known or pre-approved technology to meet 95% entrainment requirements

    b. Large thermal plume to be added to existing plume

    c. Flow greater than 1% of Tidal flow

    d. Use of existing intake for once through would have fouling of wedge wire screens and high maintenance

    e. Long schedule to perform multiple studies with uncertain results

2. Mechanical towers using wet technology with salt drift of 80% within 300 feet to be considered

3. Natural Draft towers with salt drift of 80% within 1 mile to be considered

4. Visual impact of cooling towers to be considered.

5. Intake for make-up to consider both new and existing intake structure.

6. Particulate emissions to be considered

7. Tower size impact on selected site to be considered

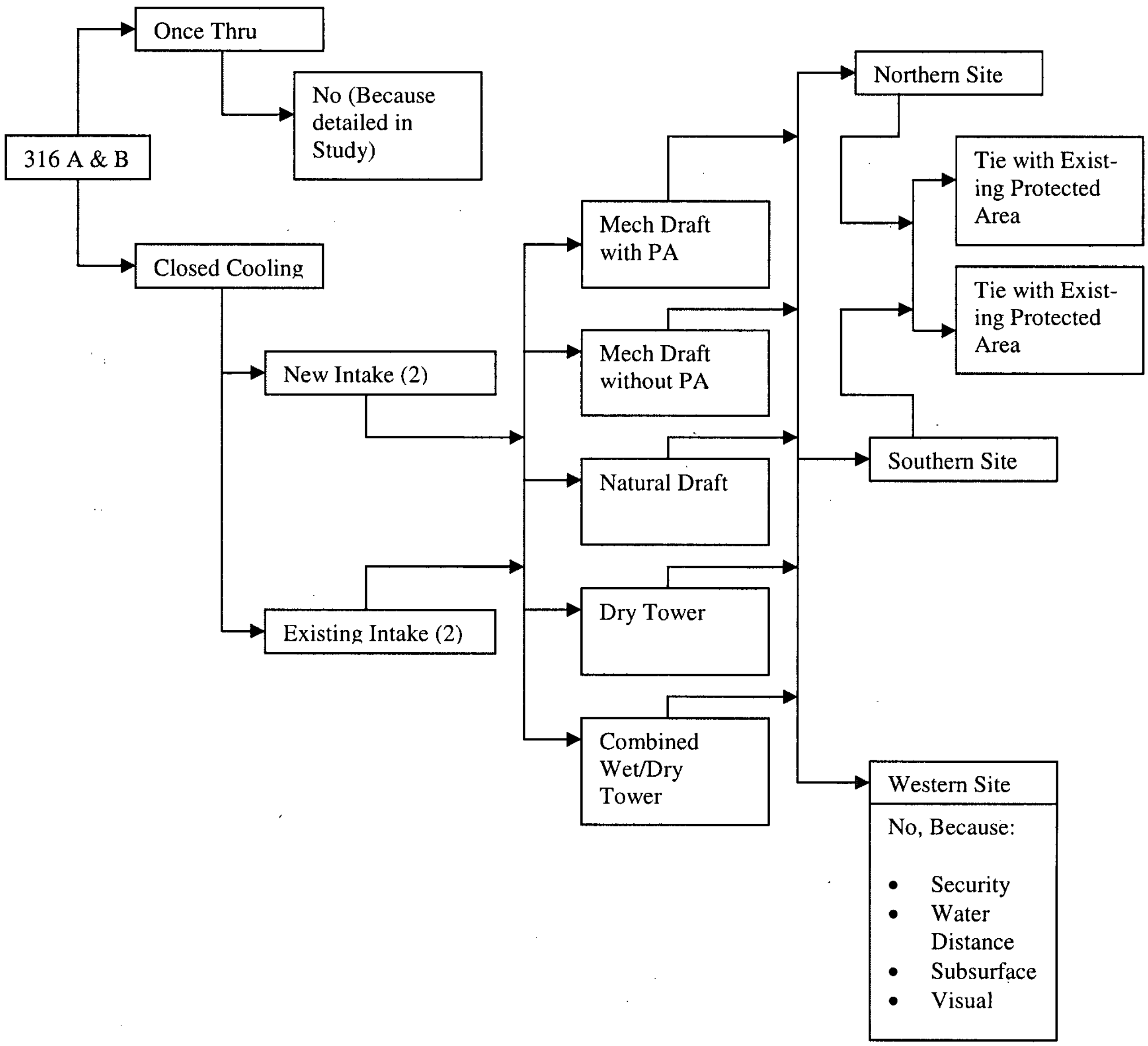
Site Location Options

The following site options are to be included and addressed in the Site Layout Study Report:

1. North of existing units with mechanical towers and use of a new intake structure
2. North of existing units with mechanical towers and use of existing intake structure
3. North of existing units with natural draft towers and use of a new intake structure
4. North of existing units with natural draft towers and use of existing intake structure
5. South of existing units with mechanical towers and use of a new intake structure
6. South of existing units with mechanical towers and use of existing intake structure
7. South of existing units with natural draft towers and use of a new intake structure
8. South of existing units with natural draft towers and use of existing intake structure

Site Selection Logic Tree

The following logic tree was discussed and will be used in the site selection



Notes/Basis for Logic Tree:

1. New Plant will be for 2 each EPR Units
2. Phase I/II decision to affect compliance regulations

Calvert Cliffs Unit 3 & 4 Site Layout Study Report Outline

The study will include the following sections: (Note, study outline issued to all parties on 1/10/06)

Executive Summary

Acknowledgements

Introduction

Purpose

Scope/Basis

Known information

Site Layout Evaluation (group by type of consideration reviewed)

Key Layout Drivers

- 316A&B
  - Technical
  - Regulatory
  - Integration (D Heimbuck (AKRF) Carla Logan D Bailey (EPRI), N Taft (Alden))
  - Bay Ecology (J Hixson)
    - Oyster Beds
- Environmental Items
  - Endangered Species (G DeCamp)
    - Tiger Beetles (B. Kinsley)
    - Bald Eagle (G DeCamp)
- Security items
- Land Use/Zoning
  - Zoning (J Burkman)
  - Chesapeake Bay Buffer Zone (100 foot and 1000 foot zones) (J Burkman)
- Cooling Tower Considerations (D Murphy, H Cruz)

- Constructability Items
  - Crane Use Plans
  - Barge Access
- North/South/West Sites (D Murphy, B Nuse

Matrix of Sites/Cooling Options

Discussion of Options

Conclusion

Recommendation

Appendices

- Drawings
- Walkdown Results
- Pictures
- Meeting Notes
- Individuals Contacted and Discussion Summary
- List of Recommended Field Studies
- Bibliography/References

Schedule

Issue Outline: 1/10

Input: 1/20

First Draft: 2/1

Review First Draft: 2/2 to 2/8

Review Meeting to finalize: 2/8

Issue Final 2/10

Senior Management Presentation: 2/13 to 2/17

Available for use with external stack holders starting 2/20

Start Field Activities: 3/27

Action Items – Calvert Cliff Siting Study

Date: January 5 and 6, 2005

Meeting with Constellation-UniStar, and Bechtel (BPC) to review Calvert Cliffs Siting Study

Action Items

	Action Item Description Actions Performed	Responsible Party - Company	Due Date/ Status
1.	Perform a Bathometric Study to determine water levels and bottom of bay	Carla Logan	1/17/06 Open
2.	Obtain MDNR report for location of Eagle(s) nest. Southern nest coordinates provided and will be part of study	Mark Hunter	1/17/06 Complete
3.	Obtain or create a map/drawing of site wetlands and restricted areas. Greg DeCamp has ordered the drawing	Jim Burkman	1/17/06 Ongoing
4.	Obtain location of proposed gas line There is no gas line	Mark Hunter/ Jim Burkman	1/12/06 Complete
5.	Define items/data needed from Framatome (OL3) for site Layout. Include any Plant Data Requirements Data requested has been received, ongoing as new needs arise (using Dave Marcelli per item 6)	David Murphy	1/12/06 Ongoing
6.	Establish FANP contact for requests for information (Joe Savage or Dave Marcelli ?) Dave Marcelli is contact.	Mike Milbrantd	1/12/06 Complete
7.	Check into ability/technology to provide picture overlays and identify costs	David Murphy	1/27/06 Open
8.	Identify and provide information for visual permits, guides and zoning information Information provided and will be part of study	Mark Hunter	1/20/06 Complete
9.	Define number and potential locations for monitoring wells. Coordinate with Unit 1&2 for location of and potential use of Unit 1&2 monitoring wells.	David Murphy/ Mark Hunter	1/27/06 Open
10.	Obtain copy or confirm existence of paperwork to allow "minor disturbances" on the overall site from a permit aspect.	Jim Burkman	1/27/06 Open
11.	Establish Automation Plan for interface between Constellation, Bechtel and Others Being worked with IMS integration with Areva	Dave Murphy/ Ed Sherow	2/24/06 Open

Conference Call Attendance

Attendees:

Name	Company	January 17 Conference Call	January 24 Conference call
David Murphy	Bechtel	✓	✓
Ed Sherow	Bechtel	Not on call	Not on call
Frank Lopez	Bechtel	✓	Not on call
Mark Hunter	Constellation	✓	✓
Tom Roberts	Constellation	✓	✓
Greg DeCamp	Constellation	✓	✓
Mike Milbrandt	Constellation	✓	✓
Jim Burkman	Constellation	✓	✓
Carla Logan	Constellation	✓	✓
Fred Jacobs	AKRF	✓	✓
Doug Heimbuch	AKRF	✓	✓
David Bailey	EPRI	Not on call	Not on call
Jay Hixson	Morgan State	Not on call	✓
Barry Knisley	Randolph - Macon	Not on call	Not on call
Brenda Nuse	Constellation	✓	✓
Ken Johnson	Constellation	✓	✓
Dick Ransom	Constellation	✓	✓
Karen Patterson	TT/NUS	Not on call	Not on call
Ned Taft	Alden	Not on call	✓
Bruce Bradford	TT/NUS	✓	Not on call

February 8, 2006 Attendance

Attendees:

Name	Company	February 8
Shawn Hughes	Constellation	Attended
Mike Milbrandt	Constellation	Attended
Tom Roberts	Constellation	Attended
Mark Hunter	Constellation	Attended
Greg DeCamp	Constellation	Attended
Ken Johnson	Constellation	Attended
Dick Ransom	Constellation	Attended
Jim Burkman	Constellation	Attended
Carla Logan	Constellation	Did not attend
Brenda Nuse	Constellation	Attended
Fred Jacobs	AKRF	Did not attend
Doug Heimbuch	AKRF	Attended
David Bailey	EPRI	Did not attend
Jay Hixson	Morgan State	Attended
Barry Knisley	Randolph - Macon	Attended
Ned Taft	Alden	Did not attend
Frank Lopez	Bechtel	Attended P/T
David Murphy	Bechtel	Attended
Ed Sherow	Bechtel	Attended
Chuck Dicey	Bechtel	Attended P/T
Shankar Rao	Bechtel	Attended

Action Items – Calvert Cliff Siting Study

Date: February 8, 2006

Meeting with Constellation-UniStar, and Bechtel (BPC) to review Calvert Cliffs Siting Study

Action Items

	Action Item Description Actions Performed	Responsible Party - Company	Due Date/ Status
1.	Develop generic checklist template for other sites	D. Murphy	3/31/06
2.	Revise wording of items on checklists to be a "criteria" on the generic checklist	D. Murphy	3/31/06
3.	Validate there is no impact or define any impacts for transmission line and/or "remote" grid substations impacted by project (Needed to support CPCN and ER)	T Roberts	2/17/06
4.	Intensively developed area (IDA) coordinates to be provided	J Burkman	2/14/06
5.	Show IDA and Zoning boundaries on Layout drawings	D Murphy	2/15/06
6.	Add resume/CV of each team member supporting the Study Report	ALL	2/14/06
7.	Provide Template for Resume/CV input	D Murphy	2/9/06
8.	Rework Option 4 to get towers out of critical area	D. Murphy	2/14/06
9.	Review and revise wording in sections that you authored to reflect items from meeting. Use appendix for details and put more summary level in body of report with reference to appendix. a. Include critical review of references and bibliography. b. Highlight what items we control and what items are outside of our control c. Remove Appendix G on Recommended Field Studies, unless study is required specifically for South location and not just part of COL/ER	ALL Doug Heimbuch	2/10/06 2/14/06
10.	Develop summary of construction impacts as part of report	D. Murphy	2/24/06
11.	Complete Artistic rendering	D. Murphy	2/14/06
12.	Develop Cost Summary List for Options	T Roberts D Murphy	2/15/06

Schedule of Near Term Activities

2/10 – Input from team on report
2/14 – Input from Doug on report
2/15 – Dry Run for Constellation Meeting Presentation (1:00 pm in Annapolis)
2/17 – Constellation Management Meeting
2/20 – Input to NRC on Core Bore locations based on Study
2/24 – Issue final study report
2/28 – Meeting with GEA on Cooling Towers
3/?? – NRC Meeting to review Core Boring Data
??/?? – Meeting with External Stakeholders
3/27 – Commence Core Borings at site.

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and
Site Layout Study

Appendix F

Crane Plan for OL-3 and Framatome

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and
Site Layout Study

Appendix G

Overview of Federal and State Cooling Water Intake Structure and Thermal Discharge Regulations

G.1 Regulatory Overview

Cooling water intake structures ("CWIS") are regulated under §316(b) of the Federal Clean Water Act ("CWA") and its implementing regulations, and under Title 26 of the Code of Maryland Regulations ("COMAR") 26.08.03.05. The associated thermal discharges are regulated under COMAR 26.08.03.03, which implements CWA §316(a) in the State of Maryland.

G.2 §316(b) -- Federal CWIS Regulation

Section 316(b) regulates CWISs associated with point source discharges (i.e., discharges regulated under §301 or §306 of the CWA):

> "Any standard pursuant to section 301 or section 306 of this Act and applicable to a point source shall require that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact."

USEPA promulgated regulations governing CWISs at new facilities, which include new steam electric generating stations ("Phase I Rule"), and existing ("Phase II Rule") steam electric generating stations pursuant to §316(b) of the CWA. The Phase I Rule was issued in December 2001 and was amended in June 2003. The Phase II Rule was issued in July 2004.

G.2.1 New Facility: Phase I Rule

G.2.1.1 Definition of *New Source*

USEPA at 40 CFR §125.83 defines a new facility that would be regulated under the Phase I Rule as:

> "any building, structure, facility, or installation that meets the definition of a "new source" or "new discharger" in 40 CFR 122.2 *and* 122.29(b)(1), (2), and (4) *and* is a greenfield or stand-alone facility; commences construction after January 17, 2002; and uses either a newly constructed cooling water intake structure, or an existing cooling water intake structure whose design capacity is increased to accommodate the intake of additional cooling water. *New facilities include only "greenfield" and "stand-alone facilities."* A greenfield facility is a facility that is constructed at a site at which no other source is located, or that totally replaces the process or production equipment at an existing facility (See 40 CFR 122.29(b)(1)(i) and (ii)). A stand-alone facility is a new, separate facility

> that is constructed on property where an existing facility is located and whose processes are substantially independent of the existing facility at the same site. New facility does not include new units that are added to a facility for purposes of the same general industrial operation." [emphasis added]

Therefore, in order for a facility to meet the definition of "new facility," it must meet *all* of the requirements of the first sentence of the definition from the Phase I Rule:

> (1) it must be a "new source" or "new discharger[1]" within the meaning of both 40 CFR §122.2 and §122.29(b)(1), (2) and (4);
>
> (2) it must be a "greenfield" or a "stand-alone" facility, as defined in 40 CFR §125.83;
>
> (3) construction must have commenced after January 17, 2002; and
>
> (4) it must use a new CWIS or an existing CWIS whose design capacity is increased to accommodate the intake of additional cooling water.

USEPA's regulations at 40 CFR §122.2 define "new source" as:

> "any building, structure, facility, or installation from which there is or may be a "discharge of pollutants," the construction of which commenced: (a) [a]fter the promulgation of standards of performance under section 306 of CWA which are applicable to such source..."

and 40 CFR §122.29(b)(1) provides criteria for determining what constitutes a "new source":

> "(1) a source is a "new source" if it meets the definition in §122.2, *and* (i) [i]t is constructed at a site at which no other source is located; *or* (ii) [i]t totally replaces the process or production equipment that causes the discharge of pollutants at an existing source; *or* (iii)[i]ts processes are substantially independent of an existing source at the same site. In determining whether these processes are substantially independent, the Director shall consider such factors as the extent to which the new facility is inte-

---

[1] *"New discharger" definition applies to buildings, facilities, etc. which are in existence but which had not been discharging as of August 1979 and which had not never received a final NPDES permit for discharges from the site.*

> grated with the existing plant; and the extent to which the new facility is engaged in the same general type of activity as the existing source." [emphasis added]

USEPA defined "greenfield" facility (40 CFR §125.83) as

> "...a facility that is constructed at a site at which no other source is located, or that totally replaces the process or production equipment at an existing facility (see 40 CFR 122.29(b)(1)(i)(ii))."

USEPA defined "stand-alone" facility (40 CFR §125.83) as

> "...a new separate facility that is constructed on property where an existing source is located and whose processes are substantially independent of the existing facility at the same site (see 40 CFR 122.29(b)(1)(iii))."

G.2.1.2 Applicability of Phase I to CCNPP Units 3&4

CCNPP Units 3&4 do not meet any of the criteria in 40 CFR §122.29(b)(1) for determining when a facility is a "new source." Subsection (b)(1)(i) does not apply because CCNPP Units 3&4 would be built at the site of the existing CCNPP Units 1&2, an existing source. Subsection (b)(1)(ii) does not apply because the CCNPP Units 3&4 would not replace the processes or production equipment that causes the discharge of pollutants at CCNPP Units 1&2; CCNPP Units 1&2 will continue to operate after Units 3&4 are built. In addition, CCNPP Units 3&4 will be engaged in the same specific type of activity as the existing CCNPP units. Also, 40 CFR §122.29(b)(1)(iii) does not apply because the operations of Units 3&4 and Units 1&2 will not be substantially independent; they will share switching and transmission facilities; and they likely will share some discharge pipes. CCNPP Units 3&4 are not "new sources" within the meaning of that term in 40 CFR §122.2 based upon the criteria in 40 CFR §122.29(b)(1), (2) or (4)[2].

Furthermore, CCNPP Units 3&4 are not "greenfield" or "stand-alone" facilities. Finally, USEPA's definition of new facility specifically excludes new units used for the same general industrial operation.

---

[2] *Subsection (b)(2) is a further clarification on facilities that are deemed to be "new sources" under subsection (b)(1). Subsection (b)(4) provides clarification on how to determine whether construction has commenced for purposes of the "new source" definition in 40 CFR §122.2. Neither is relevant for purposes of CCNPP Units 3&4.*

In summary, CCNPP Units 3&4 do not fit within the definition of "new source" when it is considered in light of the criteria in 40 CFR §122.29(b)(1), (2) and (4). CCNPP Units 3&4 are neither "greenfield" nor "stand-alone" facilities. The units are being constructed at the existing CCNPP site; CCNPP Units 1&2 are an operating steam electric generating plant that will continue to operate after Units 3&4 are built and in operation. Not meeting either of these requirements is sufficient for CCNPP Units 3&4 to be excluded from the definition of "new facility" and therefore from regulation under the Phase I Rule.

However, the criteria for determining existing facilities and new facilities are being challenged in court (as discussed in the report). Although the current regulatory language clearly indicates that CCNPP Units 3&4 would not be deemed a new facility, the decision of the court may change that.

G.2.2 Existing Facility: Phase II Rule

G.2.2.1 Definition of *Existing Facility*

The Phase II regulations applicable to existing steam electric generating stations defines existing facility as:

> "...any facility that commenced construction as described in 40 CFR 122.29(b)(4) on or before January 17, 2002; and any modification of, or any addition of a unit at such a facility that does not meet the definition of a new facility at §125.83."

The preamble to the Phase II Rule (69 Fed. Reg. 41579) clarifies the key focus for determining what constitutes an existing facility. USEPA states:

> "...modifications or additions to the cooling water intake structure (or even the total replacement of an existing cooling water intake structure with a new one) does not convert an otherwise unchanged existing facility into a new facility, regardless of the purpose of such changes (e.g., to comply with today's rule or to increase capacity). *Rather, the determination as to whether a facility is new or existing focuses on the power-generating point source itself, i.e., whether it is a greenfield facility or a stand-alone facility.* This focus on the point source discharger is consistent with section 316(b), which by its express terms applies only to point sources." (emphasis added)

USEPA goes on to provide examples of existing facilities for purposes of the Phase II Rule. The Preamble continues at 69 Fed. Reg. 41579 (col. 2) and states:

> "For example, the following facility modifications or additions would result in a facility being characterized as an existing facility under today's rule:
>
> – An existing power generating facility undergoes a modification of its process short of total replacement of the process and concurrently increases the design capacity of its existing cooling water intake structures;
>
> – *An existing power generating facility builds a new process at its site for purposes of the same industrial operation and concurrently increases the design capacity of its existing cooling water intake structures;..."* [emphasis added]

USEPA went on to explain the approach taken in the Phase I Rule and how it relates to the Phase II Rule [emphasis added]:

> "In the preamble to the Phase I rule, ...[US]EPA noted that it had generally deferred regulation of new sources constructed on a site at which an existing source is located until the Agency had completed analysis of its survey data on existing facilities. 66 FR 65286. Accordingly, the Phase I rule treated almost all changes to existing facilities for purposes of the same industrial operation as existing facilities. *These included the addition of new generating units at the same site, even where they required an increase in cooling water intake structure design capacity or the construction of a new cooling water intake structure,* as well as the complete demolition of an existing facility and its replacement with a new facility, so long as it did not increase the design capacity of the cooling water intake structure... As the preamble explained: "The definition of a new facility in the final rule applies to a facility that is repowered only if the existing facility has been demolished and another facility is constructed in its place, and modifies the existing cooling water intake structure to increase the design intake capacity." " 69 Fed Reg. 41579 (cols. 2 and 3)

In a footnote to the last sentence above, USEPA clarified its position by stating:

> "Because they are part of the same ''industrial operation,'' such units are not ''stand-alone'' facilities for purposes of the ''new facility'' definition. As the fifth sentence of the definition of ''new facility'' explains, they are categorically treated as ''existing facilities'' regardless of any other considerations unless they completely replace an existing facility and its cooling water design intake capacity is increased. Accordingly, there is thus no

> need to make a determination whether they are ''substantially independent'' of the existing facility at the same site under the fourth sentence of the definition in order to determine whether they are ''existing'' or ''new facilities.'' The fifth sentence alone controls this question."

The addition of this footnote, which was numbered as "2a" is being cited in the challenges to USEPA's definition of "existing facility" in appeal of the Phase II Rule pending before the Second Circuit Court of Appeals. Environmental groups are challenging USEPA's application of the "substantial independence" test under 40 CFR §122.29(b) in the Phase II Rule. A decision is not expected until August 2006.

USEPA also provided:

> "In particular, new units that are added to a facility for purposes of the same general industrial operation should be treated as existing facilities because limitations associated with an existing site make it inappropriate to subject such units to new facility requirements. These limitations include space, existing location on a waterbody, location in already congested areas which could affect (if Phase 1 requirements were applied) visibility impairment, highway and airport safety issues, noise abatement issues, salt drift and corrosion problems and additional energy requirements. Moreover, power generation facilities should not be discouraged from making any upgrade, modification, or repowering that would increase energy efficiency or supply out of concern that they would be considered a new facility for purposes of section 316(b). Additional benefits will be realized in terms of reducing industrial sprawl if incremental power generation is not discouraged at existing power generation sites. These considerations counsel in favor of treating new units locating at existing sites as existing rather than new facilities. [US]EPA also noted when it promulgated the Phase I rule (*see* 66 FR 65286) that it is not feasible for the permit authority to judge whether the facility could have been located elsewhere for the purpose of determining whether the facility is subject to the new facility rules."

G.2.2.2 Applicability of Phase II to CCNPP Units 3&4

Given the definition of "existing facility" and USEPA's clarifications, CCNPP Units 3&4 should be considered an existing facility and be regulated under the Phase II Rule. CCNPP Units 1&2 clearly commenced construction prior to January 17, 2002, (under any definition of commencement of construction), CCNPP Units 3&4 are additional units at the facility and CCNPP Units 3&4 do not satisfy the definition of a "new facility".

G.2.3 COMAR 26.08.03.05 -- Maryland CWIS Regulation

The Maryland CWIS regulation implements §316(b) at the state level and defines acceptable levels of entrainment and impingement:

> "The location, design, construction and capacity of cooling water intake structures shall reflect the best technology available (BTA) for minimizing adverse environmental impact." (COMAR 26.08.03.05(A))
>
> "The determination of BTA for minimizing adverse environmental impact shall consider the effect of:
>
> (1) Impingement loss as determined in §D of this regulation; and
>
> (2) Entrainment loss as determined in §E of this regulation." (COMAR 26.08.03.05(A))

With respect to impingement, 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:

> "Dischargers shall install and operate functional modifications to mitigate impingement loss, provided that the additional cost of installation of modifications to intake structures and of operation modifications over a 5-year period does not exceed 5 times the estimated annual value of the impingement loss." (COMAR 26.08.03.05(D)(2))

For entrainment, 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:

> "The discharger shall determine the extent of cooling water entrainment loss on a spawning or nursery area of consequence for RIS..." (COMAR 26.08.03.05(E)(2))
>
> "If entrainment loss results in significant adverse environmental impact, the discharger shall install and operate functional modifications to mitigate entrainment loss." (COMAR 26.08.03.05(E)(3))

G.2.4 COMAR 26.08.03.03 -- Maryland Thermal Discharge Regulation

Maryland state regulations specify three thermal mixing zone criteria for thermal discharges into tidal waters (COMAR 26.08.03.03). Thermal discharges must be controlled so that:

- The 24-hour average of the maximum radial dimension measured from the point of discharge to the boundary of the full capacity 2°C above ambient isotherm (measured during the critical periods) may not exceed ½ of the average ebb tidal excursion.
- The 24-hour average full capacity 2°C above ambient thermal barrier (measured during the critical periods) may not exceed 50% of the accessible cross section of the receiving water body.
- The 24-hour average area of the bottom touched by waters heated 2°C or more above ambient at full capacity (measured during the critical periods) may not exceed 5% of the bottom beneath the average ebb tidal excursion multiplied by the width of the receiving water body.

If a discharger is unable to meet these requirements, the discharger may request alternate thermal effluent limitations under the CWA §316(a). Alternate effluent limitations will be established only if the discharger demonstrates to the satisfaction of Maryland Department of the Environment (MDE) that the existing thermal effluent limitations are more stringent than necessary to assure the protection and propagation of a balanced, indigenous community of shellfish, fish and wildlife in and on the body of water into which the discharge is made. The demonstration must consider the cumulative impact of the thermal discharge together with all other significant impacts on the species affected, including entrainment and impingement impacts.

In determining whether the protection and propagation of the affected species will be assured, MDE may consider any relevant information including evidence of the absence of the following factors:

- A significant increase in abundance or distribution of nuisance species;
- A significant change in biological productivity;
- A significant elimination or impairment of economic and recreational resources; and

- A significant reduction in the successful completion of the life cycle of representative important species.

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Site Layout Study

Appendix H

Environmental Evaluation

H Environmental Evaluation

H.1 Threatened or Endangered Species

H.1.1 Tiger Beetles

The two tiger beetle species of concern inhabit only the beach and cliff areas of the CCNPP site, which are recognized as valued resources and subject to specific land use protections (e.g., Critical Area and Critical Area Buffer Zones) in part because of the potential presence of these protected species. In addition, the beach and cliff areas along most of the undeveloped shoreline on the site are designated "Habitat Protection Areas" for the beetles under terms established by the Critical Area provisions in Section 8-1 of the Zoning Ordinance. Construction disturbance or preemption of these habitat areas is therefore a particular concern for the Site Layout Study Team.

Terms of the Wildlife Protection Agreement between CCNPP and The Nature Conservancy (CCNPP and Nature Conservancy 2003) include continuance of CCNPP's practice of restricting public vehicular access to the protected areas and granting of limited access to the areas to the Nature Conservancy and its agents for studies and monitoring of the Northeastern Beach Tiger Beetle and Puritan Tiger Beetle populations. Occurrence information included in the following summary is based primarily on annual surveys conducted under terms of the USFWS recovery plans for these two species (USFWS 1993, 1994).

The Northeastern Beach Tiger Beetle occurs on the CCNPP site only along a 100–150 meter section of the beach at the northern site boundary adjacent to Calvert County's Flag Ponds Nature Park, where they are found in small numbers (<50 individuals). Larger numbers occur northward on the Flag Ponds Nature Park property. Larvae of this species would be potentially impacted by beach disturbances, such at heavy equipment, etc. The larvae live in permanent burrows on the beach itself where they develop over a 1–2 year period. They are inactive from mid-November until April, spending this time in their burrows in the ground (8–12 inches deep). However, larvae have not been surveyed at CCNPP and, if present, probably occur only in small numbers. Adults are active, foraging on the beach, from June through September, after which they die off, and would thus be affected by beach disturbances only during their summer activity period.

The Puritan Tiger Beetle occurs on the CCNPP site in a scattered distribution along much of the shoreline from the Barge Slip southward to the southern site boundary. Greatest numbers of adults (and presumably larvae) occur east of the tennis courts at Camp Conoy (northernmost ravine south of the Barge Slip) being considered as a potential location for cooling water structures, but some adults are also present on the beach in this area. Adults have a shorter activity period than the Northeastern Beach Tiger Beetle, and are found along the beach, where they forage, during summer (June–August). Unlike the Northeastern Beach Tiger Beetle, Puritan Tiger Beetle adults move high onto the cliff face to oviposit, and it is in these upper cliff strata where the larvae spend their 2-year life cycle in burrows. Bare cliffs are necessary for adult oviposition and larval development of this species, even though erosion and cliff breakdown periodically eliminate some individuals. Adults of this species would be impacted by the same kind of disturbance on the beach as the Northeastern Beach Tiger Beetle (summer only). Larvae of the Puritan tiger beetle would be adversely affected by disturbances to the cliff sections where they occur.

Two potential impacts to Puritan tiger beetle from alteration of larval habitat have been identified for the South Option. However, both impacts could be avoided by appropriate planning and construction techniques. The first involves direct construction disturbance to cliff habitat, which could be avoided by confining cooling water intake and discharge facilities to already developed areas north of the Barge Slip or to the area of the northern most ravine south of the Barge Slip. Cliff habitat is absent in the former area and field reconnaissance of the latter area by the author (B. Knisley) on February 2, 2006 indicates there is no habitat in the immediate area of the channel because the cliffs are too low and vegetated. The closest Puritan tiger beetle habitat in that area is approximately 25–30 meters north and 30–35 meters south of the current channel. The second potential impact from development of the South Option is increased flow of surface or subsurface water onto or into the cliff face. This could occur as a result from construction work, resulting footprint of the facility (e.g.., cooling tower layout), and stormwater management provisions. Recent studies of the Puritan Tiger Beetle in Calvert County and at the Sassafras River sites indicate that episodes of rapid cliff erosion at some sites is due to cliff top water drainage rather than tidal activity (Knisley, unpublished work; David Miller, pers. comm.). While moderate levels of erosion are necessary to keep the cliff face unvegetated and suitable as habitat, excessive erosion can eliminate (at least temporarily) or reduce beetle numbers.

USFWS and MDNR would be concerned about direct habitat impacts that might jeopardize the populations of either of these species, but particularly the Puritan Tiger Beetle, populations of which have been declining significantly in Calvert County in recent years. Minimizing or, to the extent practicable, avoiding adverse impact to these species is therefore an appropriate general criterion for locating new plant facilities on the CCNPP site. In practical terms, it is expected that this general criterion could be met in a manner that would ensure an acceptable level of protection by the following provisions:

- Minimizing or avoiding physical disturbance of beach areas at the extreme northern end of the site (e.g., northernmost 200 meters) to protect larvae of the Northeastern Beach Tiger Beetle, and cliff areas south of the Barge Slip to protect larvae of the Puritan Tiger Beetle.
- Ensuring that construction work and completed facility do not cause increased flow of surface or subsurface water into or onto the cliff face.

- Avoiding construction disturbance of beach habitat during the period June-September to avoid impact to adults of both species.
- Restoring disturbed beach habitat, possibly including some beach nourishment, following construction.
- Effecting other mitigation if necessary.

Impact consideration associated with North, West, and South location options include:

North – This option poses potential moderate adverse impact to the Northeastern Beach Tiger Beetle if beach habitat within approximately 200 meters of northern property line is disturbed by construction or preempted for permanent facilities due to presence of adults in summer and larvae (if present) year-round. Although previous surveys suggest that few or no larvae are likely to occur in that area, distribution does change somewhat from year to year. The north location option poses potential for adverse impact to adults of the Puritan Tiger Beetle if Barge Slip upgrade activities occur in July-September.

South – The south location option poses potential for adverse impact to the Puritan Tiger Beetle if cliff habitat occupied by larvae is disturbed by construction, preempted by permanent facilities, or is subject to accelerated erosion from increased surface or subsurface water flows onto or into the cliff face, or if beach habitat (e.g., for cooling water structures or Barge Slip upgrade) is disturbed during July-September or preempted for permanent facilities due to use by adults. Restricting construction disturbance and permanent cooling water facilities locations to areas already developed (e.g., the existing intake structure area) would be optimal for protection. It is also expected that restriction of such disturbances and facilities to the area east of the tennis courts at Camp Conoy (northernmost ravine south of the Barge Slip), considered a potentially attractive location from an engineering standpoint, would also be effective in minimizing or avoiding impact to larvae because of the absence of substantial cliff habitat there. There is little or no potential for adverse impact to Northeastern Beach Tiger Beetle for the South option.

West – Potential for impact is dependent on location of cooling water intake and discharge structures. See above.

Additional reconnaissance or survey of beach habitat at the north end of the CCNPP property is recommended in the event the North Option is selected and the cooling water intake and or discharge are routed northward rather than into the existing developed area. This activity would be appropriately conducted when larvae become active, in the late April to May timeframe to confirm presence and approximate abundance of larvae in this location. Continued surveys and monitoring beginning in summer 2006 are advisable to enable appropriate assessment of impact for the preferred and alternative facility location(s). These surveys would enable better accounting for annual variability in distribution and abundance, and enable more thorough location and characterization of habitat and beetle populations in potentially impacted areas.

H.1.2 Bald Eagle

Information from CCNPP environmental staff report indicates that bald eagles regularly utilize Chesapeake Bay shoreline areas of the site, and that active nesting has occurred for many years at an onsite forest location near the bay near the south end of the CCNPP site. The approximate location of this nest, reported by Benassi (1995), was confirmed by a January 2006 reconnaissance of the area by team members (Nuse 2006a, 2006b). The NRC (1999) reported that seven offspring were fledged at this site since 1987, providing an indication of nesting success. The only other bald eagle nest known to occur near the CCNPP site is located at the far north end of Flag Ponds County Park, well over 0.25 miles north of the northern CCNPP site boundary.

The USFWS recommends that CCNPP allow no nonroutine human activities with ¼ mile from active bald eagle nests during the nesting season (December 15 through June 15) unless these activities have first been coordinated with and received the approval of the MDNR. USFWS has further indicated that consultation with the federal agency should be initiated for activities such as major construction and clear-cutting of timber within ¼ mile of the nest, regardless of the time of year the activity takes place (NRC 1999, Appendix E).

In consideration of the above information, it is appropriate to establish the area within 1,500 feet of the bald eagle nest as an exclusion zone for construction activity and location of construction and operation-phase facilities for a new plant. Preliminary layout activities indicate that the new plant could be readily located at any of the candidate locations (North, West, South) in conformance with this exclusion criterion.

H.2 Wetlands

No formal wetland delineations are known to have been performed on the CCNPP site. However, probable wetlands on the site and surrounding areas have been mapped on the basis of aerial photographic interpretation as part of the U.S. Fish and Wildlife Service's (USFWS) National Wetland Inventory (NWI; WetLand Maps.com. 2006, USFWS 1990). Selected wetlands on the site were also summarily described and mapped as part of a reconnaissance-level biological survey of the site sponsored by Baltimore Gas and Electric Company (BG&E) in 1994, the primary purpose of which was to identify known rare, threatened and endangered species and map and describe plant community types on the site (Benassi 1995, BG&E 1997). The only onsite wetland known to exist on the site but not acknowledged in the above sources is a 1-acre mitigation wetland (BG&E 1995). Figure H.2-1 and Table H.2-1, respectively provide location and summary characteristics of onsite wetlands from these sources, which serve as a basis for the following description.

Aside from estuarine subtidal and intertidal zones of Chesapeake Bay that constitutes the eastern border of the site, "natural" wetlands on areas of the CCNPP site potentially affected by new plant development consist primarily, and perhaps exclusively, of small headwater drainage courses and riparian deciduous forest that borders them. These forested wetlands occur as narrow strips bordering the extreme upper reaches of Perin Branch, which drains the portion of the site north of the existing plant facilities, and the upper reaches of Johns Creek and its tributaries, which drain most of the central and southern portions of the site (only the Camp Conoy areas and land immediately southeast of Camp Conoy drain directly to the bay). Both of these streams are tributaries of St. Leonard Creek, which outfalls to the Patuxent River. Portions of the upper Perin Branch riparian wetlands lie within the designated Chesapeake Bay Critical Area.

The NWI classifies the riparian forest in the extreme upper reaches of these small tributaries, including all Perin Branch drainage courses and the most upstream segments of Johns Creek and its tributaries onsite, as "temporarily flooded" (classified PFO1A; see Figure H.2-1 and Table H.2-1), denoting that water is present only for brief periods in the growing season and water table usually lies well below the surface. The NWI classification assigned to the lower, more westward portions of Johns Creek drainage courses onsite is similar but with a different modifier ("seasonally flooded," PFO1C), denoting surface water presence for extended periods in spring and probably persistent near-surface water table. The subtlety of this difference as reflected in plant species composition is suggested by the fact that only the latter "seasonally flooded" riparian communities were recognized and mapped by Benassi (1995) as wetlands on the basis of field reconnaissance.

At this level of analysis, the only other potentially natural or near-natural wetlands in site areas of concern for new plant construction consist of three small (≤ approximately 1 acre) areas located within the Chesapeake Bay Critical Area downgradient from, and on the same small incised Chesapeake Bay tributary stream as, the Camp Conoy "fishing pond" impoundment (Figure H.2-1, Table H.2-1,). The one nearest to the fishing pond is categorized as seasonally flooded deciduous scrub-shrub (PSS1E); the remaining two are categorized as permanently flooded impoundments (PUBHH). The Camp Conoy fishing pond (estimated surface area approximately 3 acres) is a man-made impoundment, reportedly associated with Camp Conoy at the time of acquisition for original CCNPP plant development (Nuse 2006).

Remaining wetlands on or near CCNPP site areas of potential interest to new plant facilities arrangement are clearly man-made or a direct result of site development. These include a 1-acre wetland adjacent to and west of the 500-kV transmission corridor created as a mitigation project (not acknowledged by NWI), and several areas that provide control benefits for stormwater from developed areas of the site or from "Lake Davies" (now dry), an area west of the existing plant facilities where dredged spoils from original CCNPP plant construction were disposed. The nonnative and invasive common reed *Phragmites* predominates in these latter wetlands (Benassi 1995, MDNR 2006b).

Resource values provided by interior wetlands on the site include attenuation of stormwater flows and associated erosion and sedimentation potential, and groundwater recharge. The natural wetlands at CCNPP, including the Chesapeake Bay intertidal zone and riparian communities bordering onsite streams, and wetlands in the Camp Conoy area (i.e., fishing pond and wetlands downstream from it) also contribute to the diversity of native flora and faunal species on the site. However, on the basis of existing information as discussed above, there is no reason to conclude that wetlands on the CCNPP site are particularly unique. Benassi (1995) concluded that plant communities on the site, which included wetlands, are common for the Coastal Plain of Maryland. Activities associated with new plant development that occur in or affect wetlands would nonetheless be regulated, and adverse impacts may require mitigation.

In view of information presented above, location of wetlands on the site, and the relatively large land area that would be required for new plant development, establishing wetlands as exclusion zones for purposes of plant site arrangement is neither practical nor likely feasible. It is nonetheless desirable to minimize associated direct and indirect adverse impact on wetlands to the extent practicable.

Wetland impact considerations associated with North, West, and South location options include:

<u>North</u> – Rerouting of approximately 1 mile of upper reaches of Perin Branch and elimination of associated natural riparian forest wetland totaling in excess of 25 acres (estimated) for power island area and cooling towers. Possible construction disturbance of natural intertidal and subtidal zones for cooling water intake and/or discharge facilities. Possible elimination or disturbance of elimination of 1-acre mitigation wetland near transmission line and man-made wetlands in or near Lake Davies for construction-phase facilities.

<u>West</u> – Potential elimination or disturbance of some natural riparian forest wetland associated with Johns Creek and natural intertidal and subtidal zones for cooling water intake and/or discharge facilities. Possible elimination or disturbance of elimination of man-made wetlands in or near Lake Davies.

<u>South</u> – Rerouting of several hundred feet of small Chesapeake Bay tributary(s) and elimination of 3-acre impoundment (fishing pond) and small (1-acre) scrub-shrub wetland in Camp Conoy area. Possible rerouting of a few hundred feet of stream (upper reach of Johns Creek) and elimination or disturbance of a few acres of associated natural riparian forest wetland. Possible construction disturbance of natural intertidal and subtidal zones for cooling water intake and/or discharge facilities. Possible elimination or disturbance of elimination of man-made wetlands in or near Lake Davies for construction-phase facilities.

It is expected that adverse impact on wetlands associated with any of these options could be acceptably mitigated. However, the North option would result in substantially greater impact to wetlands that either the West or South options.

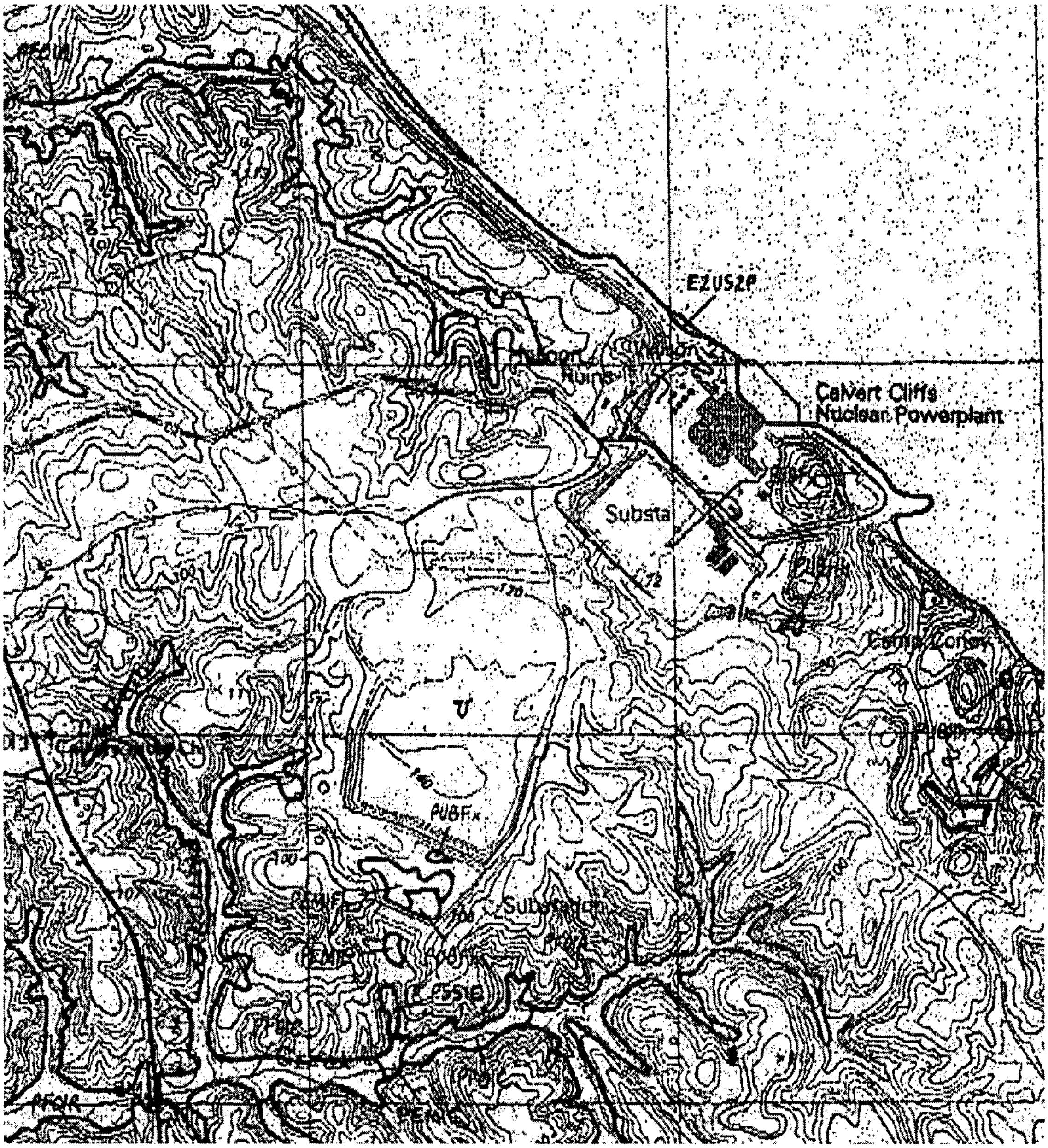
Table H.2-1
CCNPP Site Wetland Summary Data

Class Code[a]	Classification Description[a]	Location and Remarks[b]
E1UB1	Estuarine - Subtidal - Unconsolidated Bottom - Cobble-Gravel	Subtidal zone along Chesapeake Bay shoreline
E2US2P	Estuarine - Intertidal - Unconsolidated Shore - Sand - Irregularly Flooded	Intertidal zone along Chesapeake Bay shoreline; essentially entire beach.
PFO1A	Palustrine - Forested - Broad-Leaved Deciduous – Temporarily Flooded	Riparian zone of onsite Patuxent River tributary (St. Leonard Cr.) headwater streams i.e., Perin Br. tributary on north portion of site; Johns Cr. & its tributary on west and south part of site. Exclusive type along Perin Br and predominant in uppermost segments of Johns Cr and its tributaries onsite. Not reported or mapped as wetland in field reconnaissance report by Benassi (1995). [See also BG&E (1997)].
PFO1C	Palustrine - Forested - Broad-Leaved Deciduous - Seasonally Flooded	Riparian zone of lower portions on Johns Cr and its tributaries onsite. Recognized from onsite reconnaissance as wetlands characterized by red maple (*Acer rubrum*) – sweet gum (*Liquidambar styraciflua*) dominants in overstory and such herbaceous species as rice cut grass (*Leersia oryzoides*), false nettle (*Boehmeria cylindrical*) and sensitive fern (*Onoclea sensibilis*) in the ground layer (Benassi 1995; BG&E 1997).
PSS1E	Palustrine - Scrub-Shrub - Broad-Leaved Deciduous - Seasonally Flooded/Saturated	Two very small (< 1 acre) areas, one along Johns Cr tributary leading from south end of Lake Davies fill area, one along the same ravine and immediately downgradient of the 3-acre Camp Conoy "fishing pond" impoundment.
PEM1E	Palustrine - Emergent - Broad-Leaved Deciduous - Seasonally Flooded/Saturated	Two very small (approx. 1 acre) areas, one along Johns Cr mainstem, one along Johns Cr tributary leading from south end of Lake Davies fill area.
PEM1FH	Palustrine - Emergent - Broad-Leaved Deciduous - Semipermanently/ Permanently Flooded	Small area (2-3 acres) at south end of Lake Davies fill area. Recognized from field reconnaissance as onsite wetland type (emergent wetland associated with spoil areas, typically dominated by common reed grass; i.e., *Phragmites australis*), but not mapped, by Benassi (1995).

Class Code[a]	Classification Description[a]	Location and Remarks[b]
PUBFX	Palustrine - Unconsolidated Bottom - Semipermanently Flooded – Excavated	One very small (approx. 1 acre) area at south end of Lake Davies fill area.
PUBHH	Palustrine - Unconsolidated Bottom - Permanently Flooded – Impoundment	Four small impoundments in swales/ravines of small Chesapeake Bay tributaries in and near Camp Conoy. The largest (approx. 3 acres) is part of the Camp Conoy recreational facility (fishing pond). Two additional ones, both ≤ approx. 1 acre and located on the same ravine as the above fishing pond The fishing pond and upstream-most water impoundment pond were mapped by Benassi (1995) and characterized as supporting some floating and emergent vegetation along the banks. A seep associated with one of the ponds in the Camp Conoy area was noted by Benassi (1995) as dominated by rushes (*Juncus sp.*), sedges (*Carex sp.*), and sphagnum moss (*Sphagnum sp.*), and supported the bladderwort *Utricularia gibba*, formerly considered rare (but not threatened or endangered) in MD. The fourth impoundment, located in another ravine from the previous three, between Camp Conoy and existing plant facilities, is a CCNPP stormwater control facility.
PUBFX	Palustrine – Unconsolidated Bottom – Semipermanently Flooded – Excavated	One small stormwater basin adjacent to switchyard.
Not mapped	Not mapped	Small (1 acre) wetland mitigation area located adjacent to and southwest of 500-kV transmission corridor between Main Access Road and Site Road B on previously cultivated land.

[a] Source: Cowardin et al. 1979
[b] Sources: USFWS (1990), Benassi (1995), BG&E (1995, 1997)

Figure H.2-1
National Wetland Inventory Map for CCNPP Site (USFWS 1990)



H.3 Chesapeake Bay Ecological Resources

As a result of extensive environmental review associated with operating license renewal, the NRC (1999) concluded that potential adverse impacts of continued operation of CCNPP Units 1 and 2 on the Chesapeake Bay and associated ecological resources, including fish and shellfish impingement, entrainment, and thermal shock would be small. The existing plant employs a once-through cooling system that withdraws approximately 2.4 million gallons per minute (gpm) of cooling water from the bay through a shoreline intake structure and discharges it back to the bay at a temperature of up to approximately 12°F above ambient temperature via conduits that terminate approximately 850 feet offshore at about the 10 foot depth contour (BG&E 1997, NRC 1999). A determination of corresponding adverse impacts that may result from use of a once-through cooling water system for a 2-unit plant addition at the CCNPP site is beyond the scope or need of this study. As indicated elsewhere in this report, extensive study, including detailed and lengthy field studies, would be required to acceptably demonstrate the level of impact and compliance with applicable regulatory standards. Therefore, the following discussion with respect to cooling water system impacts is limited to potential construction and operational impacts on ecological resources of the bay associated with use of a closed-cycle cooling system for the new units, particularly as related to location of the intake and discharge structures. Potential impacts on Chesapeake Bay ecological resources from dredging associated with Barge Slip and approach channel upgrade, presumed to be necessary regardless of site layout and cooling water options, are also noted.

As discussed elsewhere in this report, use of a closed-cycle cooling water system for a 2-unit EPR plant addition at the CCNPP site would result in a cooling water intake of approximately 80,000 gpm and discharge of approximately 40,000 gpm. Although the discharge temperature would be higher for the new units, these cooling water flows are less than 5 percent of cooling water flows for the existing plant. Given this information and assuming appropriate dispersion of the heated cooling water discharge, it is reasonable to assume at this level of analysis that adverse impact on Chesapeake Bay ecological resources from cooling system operation for the two additional postulated units would be small, absent the presence of an exceptionally high-value resource in the field of influence of the intake and discharge. At this level of analysis, it is also likely that potential impacts of cooling water intake and discharge construction would be small, absent the presence of an exceptionally high-value resource in areas disturbed by construction or preempted by location of permanent structures. A similar conclusion is assumed at this stage with respect to dredging and construction that may be required for upgrade of the Barge Slip and its approach channel, considering the nature and likely limited extent of these activities.

A review of ecological survey and monitoring reports (Heck, K.L, ed., 1985) and other assessments related to CCNPP construction and operation (e.g., AEC 1973; NRC 1999, Section 2.2.5) indicates that oyster beds are likely the only habitat or resource known to occur in the area that may be of interest in this regard. The potential presence in the

CCNPP area of "essential fish habitat" (EFH) and associated "habitats of particular concern" (HAPCs) designated under the Magnuson-Stevens Act is also of interest because these designations are recent and are particularly applicable to the siting of new facilities. The following subsections therefore focus on the potential presence of these resources in the vicinity of CCNPP.

H.3.1 Eastern Oyster (*Crassostrea virginica*) Beds

Dredging of the cooling water intake channel and navigation channel to the CCNPP Barge Slip as part of initial CCNPP plant construction affected 500 acres of the 680-acre Flag Pond oyster bar immediately offshore of the plant, mitigation for which involved transplantation of oysters to a site on the nearby Patuxent River (AEC 1973). Long-term preoperational and operational studies indicate that oyster bars existed and to some extent persist south of the intake and within the discharge area (Heck, K.L, ed. 1985). The area north of the plant consists of bay bottom that is shifting sand or soft mud and unsuitable for oysters (ANSP, 1968). Areas with beds south of the plant are rocky, making commercial harvest difficult.

Neither the current areal extent nor condition of the existing oyster beds are known, although their condition and productivity likely reflects declines observed bay-wide in recent years due to deleterious changes in habitat resulting from nutrient addition, disease, etc., evidenced further from the fact that little or no commercial harvesting occurs there now. Ongoing monitoring studies indicate that operation of CCNPP has had no adverse impact on oysters (ANSP 1985, Abbe 1988, 1992). These studies further indicate that, while oysters are a Resident Important Species (RIS), populations in and around CCNPP are seriously diminished because of the bay-wide disease problem. The soft Clam, *Mya arenaria* is also an RIS, but its abundance of legal sized clams has not been high enough to support a commercial fishery in this are since before 1971 (NRC 1999, Section 2.2.5).

Considering the information presented above, it is expected that modification and use of the existing CCNPP cooling water intake and/or discharge structures to accommodate the new units offers little or no potential for adverse impact on oyster beds.

A definitive assessment of potential for adverse impact on oyster beds from construction and operation of new cooling water facilities and upgrade of the Barge Slip would require field studies to identify, map, and assess the condition of any oyster beds that may exist in potentially affected areas. However, based on currently known information, there is no reason to expect that these impacts would be considered significant, considering also that mitigation could be applied if needed. Based on information presented above, an offshore cooling water intake and/or discharge located south of existing plant facilities offers greater potential for adverse impact than the north location option due to the known presence of oyster beds south of existing plant facilities.

H.3.2 Essential Fish Habitat

EFH is defined under the Magnuson-Stevens Fishery Conservation Management Act (16 USC §§ 1801 to 1883), as amended by the Sustainable Fisheries Act (SFA) of 1996, as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." "Waters" include aquatic areas and their physical, chemical and biological properties that are used by fish. "Substrate" includes sediment, hard bottom, structures, and associated biological communities that are under the water column. Waters and substrates necessary for fish spawning, breeding, feeding or growth to maturity—covering all stages within the life cycle of a particular species—refers to those habitats required to support a sustainable fishery and a particular species' contribution to a healthy ecosystem (50 Code of Federal Regulations (CFR) 600.10). [See also National Marine Fisheries Service (NMFS) 2006a.]

Section 303(a)(7) of the Magnuson-Stevens Act requires that the eight Regional Fishery Management Councils (RFMC) describe and identify EFH for each federally managed species, and minimize adverse impacts from fishing activities on EFH. Section 305(b)(2)-(4) of the Magnuson-Stevens Act outlines the process for providing the National Marine Fisheries Service (NMFS) within the National Oceanic and Atmospheric Administration (NOAA), and the RFMC with the opportunity to comment on activities proposed by federal agencies that have the potential to adversely impact EFH areas. Federal agencies are required to consult with NMFS (using existing consultation processes for NEPA, the Endangered Species Act, or the Fish and Wildlife Coordination Act) on any action that they authorize, fund, or undertake that may adversely impact EFH. This requirement is therefore applicable to the NRC in connection with issuing a COL for a new nuclear plant.

Adverse effects to EFH, as defined in 50 CFR 600.910(A), include any impact that reduces the quality and/or quantity of EFH. Adverse effects may include:

- Direct impacts such as physical disruption or the release of contaminants;
- Indirect impacts such as the loss of prey or reduction in the fecundity (number of offspring produced) of a managed species; and
- Site-specific or habitat-wide impacts that may include individual, cumulative or synergetic consequences of a federal action.

An EFH assessment of a federal action that may adversely affect EFH must contain:

- A description of the proposed project;

- An analysis of the effects, including cumulative, on EFH, the managed species and associated species such as major prey species, and the life history stages that may be affected;
- The agency's conclusions regarding the effects of the action on EFH; and
- Proposed mitigation if applicable (50 CFR 600.920(g)).

NOAA, National Marine Fisheries Service (NMFS 2006b) has compiled a summary of EFH Designations for the Chesapeake Bay mainstem for Maryland/Virginia. If those species designated as being restricted to seawater (>25 ppt) are eliminated from further consideration, the mainstem portion of the Bay which includes the Calvert Cliffs area may serve as EFH for a total of twelve species, listed in the following table:

Table H.3.2-1

Species	Eggs	Larvae	Juveniles	Adults	Spawning Adults
windowpane flounder (Scopthalmus aquosus)			X	X	
bluefish (Pomatomus saltatrix)			X	X	
Atlantic butterfish (Peprilus triacanthus)	X	X	X	X	
summer flounder (Paralicthys dentatus)		X	X	X	
black sea bass (Centropristus striata)			X	X	
king mackerel (Scomberomorus cavalla)	X	X	X	X	
Spanish mackerel (Scomberomorus maculatus)	X	X	X	X	
cobia (Rachycentron canadum)	X	X	X	X	
red drum (Sciaenops occelatus)	X	X	X	X	
clearnose skate (Raja eglanteria)			X	X	
little skate (Leucoraja erinacea)			X	X	
winter skate (Leucoraja ocellata)			X	X	

However, not all of the species and life stages identified in the table would be expected to occur in the vicinity of CCNP. For example, Spanish and king mackerel early life stages are generally found offshore and would not normally be found in the mesohaline (5 to 18 ppt) portion of the Chesapeake Bay.

HAPCs are discrete subsets of EFH that provide extremely important ecological functions or are especially vulnerable to degradation (NMFS 2006c). RFMCs may designate a specific habitat area as an HAPC based on one or more of the following reasons:

- Importance of the ecological function provided by the habitat
- Extent to which the habitat is sensitive to human-induced environmental degradation
- Whether, and to what extent, development activities are, or will be, stressing the habitat type
- Rarity of the habitat type

The HAPC designation does not confer additional protection or restrictions on an area, but can help prioritize conservation efforts. Healthy populations of fish require not only the relatively small habitats identified as HAPCs, but also other areas that provide suitable habitat functions. The only known HAPCs designated for the Chesapeake Bay determined from the present review are for the following two species (Dobrzynski and Johnson 2001):

- Summer Flounder (larvae and juveniles) – submerged aquatic vegetation (SAV) and macroalgae beds in nursery habitats.
- Sandbar Shark – lower Chesapeake Bay

It does not appear at this stage of analysis that HAPCs for these two species exist near CCNPP. CCNPP is located remote from the lower bay and field surveys suggest that there are no appreciable SAV beds known to occur in the CCNPP vicinity (Orth and Nowak 1990)

The distribution and life history characteristics, status of the fishery, and impacts of the proposed action on these species, life stages, and their habitats would be addressed in an EFH assessment report, which would be prepared as part of the federal permitting procedures associated with licensing of the new units, placement of in-water structures, or activities that involve dredge and fill. Efforts to avoid, minimize, and mitigate impacts would be presented in the assessment report, as needed. While it is not anticipated that the actions being contemplated under any of the closed-cycle cooling scenarios would result in a significant adverse impacts to EFH, this conclusion would need to be demonstrated through the EFH evaluation process.

H.4 Coastal Zone Consistency

Maryland's Coastal Zone Management Program (CZMP) was developed pursuant to the Federal Coastal Zone Management Act of 1972, as amended. The program was approved by the U.S. Department of Commerce, National Oceanic Atmospheric Administration, in August 1979. Section 307 of the Act requires that federal activities, including federal licenses and permits, be consistent with a state's federally approved CZMP. Applicants for federal licenses and permits are required to certify that the proposed activity is consistent with a state's CZMP. Calvert Cliffs is located within Maryland's Coastal Zone.

Most federal licenses/permits are issued without a separate coastal zone review process as they are deemed to have no impact (i.e., maintenance dredging, sheet pile replacement). However, projects like the Cove Point Expansion and the ongoing work at the Woodrow Wilson Bridge have required a consistency review. A new unit at Calvert Cliffs will require a review. With the current units being tucked into the cliffs and with the lack of cooling towers, the site is somewhat passive. Additional units, particularly those with cooling towers, will be somewhat controversial from a consistency standpoint.

UniStar
Calvert Cliffs Nuclear Power Plant Units 3 and 4
Cooling System Selection
and
Site Layout Study

Appendix I

Cultural Sites

I.1 Cultural Sites

While a systematic cultural resources field survey of the Calvert Cliffs Property has not been performed, several historic period sites have been identified. These historic properties include the following:

The Calvert Cliffs Plant itself which has been recorded as a historical property in the Maryland Historical Trust Survey, including a written statement covering its historical and architectural importance.

To the North

Preston's Cliffs; Wilson Place – Recorded in the State listings as a historic site in 1967 and later as an archaeological site in 1973. The remnants of this farm are visible today as the location of the Visitors Center and Nature Trail. The farm site consists of the foundation and fireplace chimneys of a house, dating to 1691, which was destroyed in 1972 because of its deteriorated condition, a standing log barn, noted as the oldest of its kind still standing in the state (built in 1820) and a modified frame tobacco barn, original construction 1820-1840, that now serves as the Visitors Center and museum. There is one other standing tobacco barn in this general area that has not been evaluated for its historical significance.

To the South

Camp Canoy – Dating to the early 1930's, this site, a former Boy Scout Camp, has two remaining log cabins and a larger log structure. These buildings have been used by the plant for meetings and storage. From a historic perspective, this site and that of a cemetery located at the end of Road M-1 are unrecorded and unevaluated. Upon site investigation of the cemetery, the three headstones have been removed. This area was identified and roped off by Constellation Energy.

To the West

Parran's Park – This site consisted of a historic farmstead that included a clapboard house, original construction about 1750, that burned in 1955 and other farm outbuildings. Part of an original tobacco barn dating to 1840-1860 still exists as part of a reconstructed building and used today as a farm and maintenance center. There are two other tobacco barns nearby that have not been evaluated for their historical significance.

There are no known or recorded prehistoric archeological sites at Calvert Cliffs, although, with the exception of a study in 1992 on a transmission right-of-way, records could not be located to indicate that any field surveys had been undertaken to identify such resources. With numerous important archaeological sites in close proximity to Calvert Cliffs, it is possible that undetected or buried archaeological sites exist within the property lines.

Although the Maryland Historical Trust evaluated two historic properties on the site in 1971, they were found to be in too great a deteriorated condition to be included on the National Register. At present, none of the historical sites mentioned above are listed on the National Register.

Under Section 106 of the National Historic Preservation Act of 1966, the licensing of a new unit will require that we initiate historical and cultural resource consultations with the appropriate agencies. Accordingly, phase I field studies should be anticipated as well as mitigation that could include avoidance or in some cases the relocation of items with historic significance. Both north and south locations have structures that will need further evaluation and we should recognize that structures like the visitors center, standing tobacco barns and cemetery will receive much scrutiny.

During 1992 and 1993, archeological surveys were conducted along a proposed new transmission line right-of-way, Calvert Cliffs to Chalk Point. As a result, two archeological sites were examined during preconstruction surveys. One site was found to retain sufficient subsurface integrity to be considered eligible for inclusion on the National Register of Historic Places; however, the historic and prehistoric artifacts found did not provide unique information and the sites were dropped from further consideration. . The impact areas of the right-of-way were evaluated extensively, and the transmission towers were located in areas that would not affect any intact subsurface artifacts.

UniStar
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Appendix J

Site Selection Team Biography

David W. Murphy, Bechtel
Siting Team Lead

Mr. Murphy has over 20 years of engineering experience with nuclear power generation facilities. His experience ranges from operating nuclear plant services to the recovery of shutdown nuclear plants and to the development of new nuclear generation. He has supervised projects of varying size including projects of in excess of 800,000 man-hours for mechanical / nuclear engineering. Mr. Murphy has a BS degree in nuclear engineering from University of Maryland and is a Registered Professional Engineer in Maryland. He is an ANS member and has previously served as committee chair for ANSI 51.10.

Thomas Roberts, UNISTAR Nuclear

Thomas Roberts has over 33 years of engineering, construction and operating experience with nuclear power generation facilities. His experience ranges from engineering and construction of new nuclear power plants to support of day to day operations and maintenance of operating nuclear plants. Mr. Roberts has hands on operating experience at various nuclear and fossil power plants. He has managed projects of varying size including projects requiring coordination with federal, state and multiple utility interfaces. Mr. Roberts has a Plant Manager Certification Mr. Roberts has a BS degree in Civil Structural engineering and a minor in Environmental engineering from University of Rhode Island. Mr. Roberts has been a registered Professional Engineer in Maryland and Florida.

Gregory C. DeCamp, CHMM
UniStar Environmental Lead
Constellation Energy

Mr. DeCamp has over 30 years as an environmental consultant to industry and government, particularly electric utilities (nuclear, fossil-fueled, hydroelectric generating stations and associated high-voltage transmission facilities) and U.S. Department of Energy (DOE) projects and operations. He has managed and conducted numerous environmental projects involving facility siting and routing, permitting, design and operations consultation; ecological baseline studies and monitoring; impact assessment; National Environmental Policy Act (NEPA) document preparation; compliance program development; auditing; and facility closure and remediation plan development. Recent professional activities include service as technical manager or section lead for development of environmental reports to the U.S. Nuclear Regulatory Commission (NRC) in support of operating license renewal for seven nuclear power stations. Mr. DeCamp's academic credentials include a B.S. in chemistry from Xavier University (Ohio) and a Masters degree in biology (concentration in ecology) from Bowling Green State University (Ohio).

Mark T. Hunter, UniStar Site Lead

Mr. Hunter has over 34 years of Operations and Maintenance experience with nuclear power generation facilities. His experience ranges from operating nuclear plant services to the recovery of shutdown nuclear plants and to the development of new nuclear generation. He has obtained a Senior Reactor Operating License at the proposed site and has worked in various organizations through out his 29 years at this site.

Kenneth S. Johnson, P.E., Q.E.P.
Manager - Environmental Services, Constellation Generation Group
Fleet Optimization

Kenneth S. Johnson is the Manager of Environmental Services for the Constellation Generation Group (CGG). In this role, Mr. Johnson has overall responsibility and accountable for the performance of leadership duties associated with environmentally sound operation of CGG's fleet of assets (Nuclear, Fossil, etc.). Consequently, he is responsible to maintain, manage and monitor the technical strategic focus and corporate responsibilities as related to environmental issues and risks across the complete energy generation mix, and directly responsible for overall development and implementation of strategic plans and actions in providing high quality and timely environmental technical support to individual and collective CGG merchant plant assets. In addition, as environmental Manager, Mr. Johnson is one of the company's primary interfaces with local, state, federal regulatory agencies and other non-governmental environmental stakeholders.

Mr. Johnson attended Clemson University where he received a Bachelor of Science degree in Civil Engineering and a Masters degree in Environmental Systems Engineering. He is a registered professional engineer (PE) and certified as a qualified environmental professional (QEP). In addition, Mr. Johnson has authored or co-authored numerous publications on environmental issues for the energy industry.

Carla M. Logan, Constellation Generation Group
Environmental Specialist

Ms. Logan has over 25 years of experience in a broad range of environmental issues associated with utilities including nuclear power generation facilities and other industries. Her experience includes managing aquatic toxicology studies, remedial investigations, Constellation's liability at Superfund and other contaminated sites, and conducting environmental due diligence for potential acquisition projects. She is currently the fleet-wide project manager for Constellation Energy's compliance with Clean Water Act Section 316(b) and serves on the Technical Committee for the Kane and Lombard Superfund Site in Baltimore. Ms. Logan has a BA degree in Biological Sciences from University of Delaware. She is a member of the Society of Environmental Toxicology and Chemistry, Johns Hopkins University Part-time Programs Science Advisory Board, and the Society of Risk Analysis.

James F. Burkman, Environmental Scientist, Constellation Generation Group

Mr. Burkman has over 13 years of environmental experience related to the electric utility industry. During that time, he has been directly involved in land use permitting for Constellation Energy's Fossil and Nuclear Fleet. In addition, he contributed to various sections of the Environmental Report for the Nine Mile Point license renewal.

Brenda D. Nuse, Calvert Cliffs Nuclear Power Plant

Ms. Nuse has over 25 years of experience at the Calvert Cliffs Nuclear Plant. During this time her work has included environmental sampling, analysis, data analysis, preparation of environmental reports and permitting. Ms Nuse participated as a site environmental expert in the license renewal project. Her areas of expertise include water, wastewater, wildlife and natural resources. She is the site project lead for 316(b) programs. Ms. Nuse has a BS degree in Biology from St. Mary's College of Maryland.

Douglas Heimbuch, Ph.D., Technical Director at AKRF

Mr. Heimbuch is an environmental scientist with two decades of experience in natural resources, and is an acknowledged expert in the fields of fishery science and biostatistics. He is also experienced in the study of population dynamics, statistical analysis of environmental data, development of environmental sampling designs, estimation of parameters of animal populations, and assessment of effects of power plant operations on fish populations. He has published numerous articles on fish, water quality, and related issues for academic peer review journals. Dr. Heimbuch has analyzed the effects of entrainment and impingement on fish populations for several power plant projects, including the 316(b) Demonstration for the PSEG Salem plant, the mid-Hudson River Power Plants, and studies sponsored by NYPA to assess fish abundance and distribution in waterbodies surrounding New York City. He has evaluated the effectiveness of mitigation measures implemented to address 316(b) issues and has worked with resource economists to link the results from his analyses of fisheries data to information on the recreational and commercial value of fish as part of cost-benefit analyses.

J Howard Hixson III, Biomonitoring Program Manager, Morgan State University-Estuarine Research Center

Mr. Hixson has over 33 years experience in the monitoring of power plant effects on the environment. He spent 24 years at the Calvert Cliffs Nuclear Power Plant monitoring effects on the surrounding waters. His experience ranges from designing studies to working with plant engineers and operators developing procedures to minimize effects and preventing situations adverse to plant operations. He has worked in a wide range of disciplines, from phytoplankton and fish egg and larvae identification to feeding habits and movements of finfish. Mr. Hixson has a BS in Biology from St. Mary's College of Maryland. He has authored or co-authored over 20 reports or publications relating to biomonitoring and environmental impacts.

Edward P. Taft, Alden Research Laboratory
Reviewer

E.P. Taft is President and CEO of Alden Research Laboratory, an international consulting engineering laboratory providing a wide variety of services for electric power utilities, architect-engineering firms, equipment manufacturers, and governmental agencies. Mr. Taft is also responsible for Alden's environmental services, primarily fisheries issues at water projects. He is a recognized expert in this area and has overall responsibility for all Alden services in fish protection and passage. Mr. Taft provides overall technical and managerial guidance to a team of fisheries biologists and engineers, and personally participates on projects. With his extensive experience, Mr. Taft is often called upon to participate in legal proceedings as an expert. He provided extensive comments to the Electric Power Research Institute and the Utility Water Act Group on technical aspects of EPA's new 316(b) Rule during the rulemaking process. He participated in the NPDES Permit Hearings on the design of intake structures for minimizing losses of aquatic organisms at three Hudson River power plants in the late 1970s. He is currently involved in upcoming NPDES hearings for a nuclear power plant in Connecticut and a large coal-fired plant in Wisconsin.

C. Barry Knisley,
Siting Team Member, Environmental Group

Dr. Knisley (B.S. Penn State, M.S, Ph.D. Rutgers) is Wornom Professor of Biology at Randolph-Macon College. He is an entomologist and ecologist with over 30 years of experience studying tiger beetle ecology and conservation, including research with the Northeastern Beach and Puritan Tiger Beetles since 1985. He has authored or co-authored two books and over 40 journal articles on tiger beetles. Dr. Knisley has been the lead researcher on most of the USFWS-listed U. S. tiger beetles and has collaborated with, advised, and conducted contract research for the USFWS, Bureau of Land Management, U.S. Army Corps of Engineers, National Park Service, various state agencies, and environmental firms.

David E. Bailey, Consultant on Cooling Water Use from an Environmental and Regulatory Perspective

Mr. Bailey has over 25 years of environmental experience related to electric utility industry surface and groundwater use and impacts. This includes over 23 years of experience working for Potomac Electric Power Company as their lead water expert. Mr. Bailey has been directly involved in licensing of new generation in Maryland as well as managing acquisition and renewal of water appropriation and discharge permits for generating stations and ash storage sites. Mr. Bailey served in a leadership role in negotiating the new 316(b) Rule with EPA on behalf of the industry. This Rule establishes new requirements for protection of fish and shellfish affected by cooling water intake structures. Mr. Bailey has been working for EPRI Solutions for over two years to provide 316(b) compliance support services for both existing and new electric generation facilities.

Shankar Rao, Bechtel
Engineering Group Supervisor

Mr. Rao is a Senior Mechanical Engineer with over 25 years of engineering experience associated with Power Plant Systems design, procurement, construction and commissioning support. He is currently providing support for early site permitting for a new nuclear power plant. His recent experience includes design, construction and commissioning of the balance of plant (BOP) for Qinshan Nuclear plant in China which is a CANDU reactor designed by AECL of Canada. Past experience includes Appendix R fire protection safe shutdown evaluation, Auxiliary Feedwater system design and analyses, HVAC and chilled water system design. Mr. Rao has a B.S. in Mechanical Engineering and is a Registered Professional Engineer in Maryland.

Clinton P. Lamerson, Construction Team Member

Mr. Lamerson has 40 years construction experience. As a Construction Manager, New Generation Nuclear his experience ranges from construction field engineering, supervision, and site management of PWR and BWR nuclear power stations, fossil power stations, nuclear operating plant services, and power project development. He is responsible for construction input to Early Site Permit applications and combined Construction and Operating License applications. He is also responsible for the development of construction execution plans, construction methods, schedules, and cost estimates.

Chuck Dicey, Plant Design Engineering Supervisor

Mr. Dicey has over 37 years in the design, engineering, construction support, operation of nuclear and fossil power plants. His experience includes new power plant designs (nuclear and fossil), plant upgrades and modifications, power uprate modifications, detailed designs for piping designs and modifications, pipe support details, equipment locations, space allocations, configuration control, and HVAC duct design and modifications. Mr. Dicey has a diploma in mechanical drafting from Fayette Institute of Commerce and Technology. He is also certified as a Six Sigma Yellow Belt (Six Sigma Qualtec/Bechtel).

Yifan Zheng, P.E. - Bechtel

Sr. Engineering Specialist – Hydraulics & Hydrology

Mr. Zheng has over 15 years of engineering experience with Bechtel providing engineering supports for both fossil and nuclear power generation facilities. His experiences are mostly related to the hydraulics and hydrology design, evaluation, and calculations. For nuclear power plant facilities, his experience includes performing engineering analysis for the plant cooling water system, design of hydraulic structures such as pump intake, outfall, and coastal structures, conduct site adequacy assessment, evaluate clean water act 316a and 316b compliance, and participate in the Early Site Permit study for new nuclear generation units. He has been a lead hydraulic engineering specialist for numerous Bechtel power projects in his field. Mr. Zheng has a MS degree in civil engineering from the University of Minnesota – Twin Cities, and is a Registered Professional Engineer in Maryland. He is a member of ASCE, ASME and AWWA, and he also holds the position of the Secretary of the Hydraulic Structure Technical Committee for ASCE.

UniStar
Calvert Cliffs Nuclear Power Plant Units 3 and 4
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Appendix K

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The bibliography of the CCNPP Units 3 and 4 siting study is presented here. The items in the bibliography correspond to the sections and Appendices of the study.

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August 16, 2007
25237-000-T7C-GAMC-00250

Mr. R. Krich
Senior V.P. Regulatory Affairs
UniStar Nuclear
750 East Pratt Street
14th Floor
Baltimore, MD 21202

Subject: **CCNPP Cooling System Selection and Site Layout Study Addendum**
Constellation COLA - Bechtel Job Number 25237
PO Number: 500117

Dear Mr. Krich:

Attached for your use is the addendum to the Calvert Cliffs Nuclear Power Plant Cooling System Selection and Site Layout Study. The original basis for the Cooling System Selection and Site Layout Study issued in March 2006 was for locating 2 U.S. EPR units on the Calvert Cliffs site near Lusby, MD. Since issuance of this study, UniStar Nuclear has changed the basis for licensing activities to a single Unit at the Calvert Cliffs site. As a result, this addendum was prepared to evaluate any resulting changes in cooling system and site selection due to a change in basis from two Units to one.

Previously, a multi-discipline team was assembled to provide consulting input for evaluation of the CCNPP site. A technical evaluation was made regarding the cooling system selection and a rigorous analysis was made of various site layouts. Since it is not feasible to reassemble the team that scored various site layout options, subjective arguments are developed from the evaluation criteria and results to evaluate the layout of a single unit versus two units.

The evaluation concludes that the selection of a close cooling water system and southern layout option from the previous study are valid given the decision for licensing a single unit at the CCNPP site.

If you have any questions regarding the foregoing, please contact me at 301-228-8655 or David Murphy at 301-228-6587

Sincerely,
BECHTEL POWER CORPORATION

for Nar Goel
Project Manager

SSR:gcs

Enclosure: Addendum to CCNPP Cooling System Selection / Site Layout Study (3 pages)

Action Summary
Response Required: No
Due Date: N/A
Bechtel AIL/Schedule: N/A

cc:

Bechtel	CGG
S. Close	D. Green
DWM D. Murphy	M. Milbradt
S. Rao	J. Price
E. Sherow	T. Roberts

Addendum

Cooling System Selection /Site Layout Study

Purpose

The original basis for the Cooling System Selection and Site Layout Study issued in March 2006 was for locating 2 U.S. EPR units on the Calvert Cliffs site near Lusby, MD. Since issuance of this study, UniStar Nuclear has changed the basis for licensing activities to a single Unit at the Calvert Cliffs site. As a result, this addendum is prepared to evaluate any changes to the cooling system or site selection required by a change of the basis from two Units to one.

Background / Methodology

Previously, a multi-discipline team was assembled to provide consulting input for evaluation of the CCNPP site. A technical evaluation was made regarding the cooling system selection and a rigorous analysis was made of various site layouts.

Since it is not feasible to reassemble the team that scored various site layout options, subjective arguments will be developed from the evaluation criteria and results to evaluate the layout of a single unit versus two units.

Evaluation of Cooling Water System

Based on the information compiled regarding applicable federal and state regulatory requirements, the feasibility of implementing various compliance alternatives, and the risks and impacts to Project economics and schedule, changing the basis from two units to one would not result in a change to the cooling water system selected. Due to the extremely large volume of water needed to supply a once through cooling system for a single unit – approximately 2.5 million gpm, an enormous intake and discharge structure with offshore pipes would be required. This configuration was determined to be cost-prohibitive for a two unit plant and the same reasoning would apply to a single unit.

Therefore, a closed cooling system (i.e, cooling towers) remains the most feasible selection for a single unit.

Site Layout Selection

Using the exclusion criteria developed in section 4.1, a single unit would not affect the decision to avoid these locations. A single unit could not be located west of the existing units in the Lake Davies area. This area represents unknown subsurface conditions especially considering the extreme loading from a single reactor building and would require excavation and backfill with suitable fill material.

In the original study, evaluation criteria were developed based on the following eight categories:

1. Environmental
2. Land use and zoning (State, Local)
3. Construction Considerations
4. Construction Facilities
5. Switchyard /Transmission Lines
6. Security
7. Permanent Facility Considerations
8. Impact to Existing Facilities or Structures

The following is a subjective evaluation of each category based on a single EPR unit.

Environmental

Changing the basis to one unit would not affect the results of the evaluation of the north and south locations. The north location remains not as desirable as compared to the southern location due to its impact to probable wetlands and historic and cultural sites since the single unit foot print continues to affect the wetlands and historic/cultural sites.

Land use and zoning (State, Local)

Due to space requirements for the power block, switchyard, and cooling tower, the northern location impacts the 1000' critical area more than the southern location. Changing the basis to a single unit would not change this negative impact.

Construction Considerations

Changing the basis to a single unit would not change the previous conclusion with regard to construction considerations since the southern location allows for better segregation of construction traffic and activities from the operating plant traffic and activities than a northern location.

Construction Facilities

Construction facilities were evaluated based on distance from the barge area and the need to cross under the existing transmission lines for all construction activities for a northern site. Changing the basis to a single unit does not change this negative impact.

Switchyard /Transmission Lines

The northern option required extending the existing switchyard south and reconfiguring the transmission lines south to the new bay to allow for space on the north end to connect with the new switchyard. Also the northern option presents the possibility for plume and drift effects from the cooling tower on the main transmission lines.

Security

Changing the basis to a single unit does not change the previous conclusion where a northern layout may facilitate a single site protected area connected with CCNPP Units 1 and 2 and a southern site would require a separate protected area due to distance and location from CCNPP Units 1 and 2.

Permanent Facility Considerations

Changing the basis to a single unit would not change the previous conclusion for the northern location where special compensatory measures may be necessary during construction due to the location of the new unit and construction roads near the existing diesel generator buildings.

Impact to Existing Facilities or Structures

Impacts to existing facilities remain the same for either locations whether a single unit is considered or two. Therefore, a change in basis to one unit does not change the previous conclusion.

Conclusion

Changing the basis of the cooling system selection / site layout study from two units to one does not affect the overall decision to recommend a closed cooling water system along with the southern layout option as the base case for which to conduct further site investigation studies.

Prepared: David H. Murphy 8/16/07

Verified: ____________ 8/16/07

ERDC TN-DOER-E21
September 2005

Silt Curtains as a Dredging Project Management Practice

INTRODUCTION: Environmental windows are imposed on many U.S. Army Corps of Engineers (USACE) dredging projects in both coastal and inland waterways. Over 83 protected or sensitive species that have been identified fall into at least 20 general categories of concern for potentially negative impacts from dredging and disposal operations. One of the most frequently cited reasons for establishing an environmental window is impacts from turbidity and suspended sediments (Reine, Dickerson, and Clarke 1998). Over the past 15 to 20 years there have also been increased concerns regarding the potential impacts that dredging of contaminated sediments may have on nearby environmental resources.

In response to the need to protect sensitive environmental resources, silt or turbidity curtains have been designated a "best management practice (BMP)" by the Corps of Engineers, other Federal Agencies, and state regulatory authorities. Silt curtains are devices that control suspended solids and turbidity in the water column generated by dredging and disposal of dredged material. Consequently, silt curtains are considered an integral and necessary part of the regulatory strategy for many dredging projects. Unfortunately, factors contributing to the effectiveness of silt curtains under different circumstances are poorly understood by dredging project regulators and the public alike. Dredging contractors attest to the fact that, in their experience, silt curtains do not work under many of the site conditions encountered in navigation and environmental dredging projects. The published literature contains few comprehensive studies that demonstrate how effective silt curtains have been in meeting the intended project objectives (Johanson 1976, 1977; JBF Scientific Corporation 1978; Lawler, Matusky and Skelly Engineers 1983).

One goal of the Dredging Operations and Environmental Research (DOER) Program is to provide current, accurate technical guidance on environmental controls for dredging operations. Remaining challenges include rigorous examination of silt or turbidity curtains as a temporary control measure to better define performance criteria and identification of technical guidelines for their selection and use in navigation and environmental dredging projects.

PURPOSE: This technical note reviews the basic types of silt curtains used in navigation and environmental dredging projects. The emphasis is on the state of the practice and circumstances under which silt curtains function best. A checklist is provided to aid in consideration of silt curtain applications, including selection, design, specifications, deployment, and maintenance of silt curtains at dredging projects. This note also serves to update and supplement earlier guidance (e.g., Johanson 1977 and JBF Scientific Corporation (1978)) published on the application and performance of silt curtains.

DEFINITIONS: Silt curtains, turbidity screens, silt/turbidity barriers, gunderbooms, etc., are not to be confused with silt fences used in terrestrial control of soil erosion. Silt curtains are designed specifically to control suspended solids and turbidity generated in the water column as a result of navigation and environmental dredging operations. Silt and turbidity control devices have many names that have been used interchangeably by the Corps of Engineers, the U.S. Environmental Protection Agency (USEPA), various State regulatory agencies, dredging contractors, consultants, and manufacturers and suppliers. The following terminology represents common usage:

- *Silt* is defined as fine-grained suspended material that can be readily resuspended or stripped from sediment that is either being hydraulically or mechanically dredged from or placed in the water. Resuspended matter is generally measured gravimetrically and expressed as Total Suspended Solids (TSS) in milligrams per liter.
- *Turbidity* is a measure of the *optical properties* (amount of scattering and absorption of light rays) of the water in which dredging and dredged material disposal occur. Turbidity is frequently expressed in Nephelometric Turbidity Units (NTU).
- A *Silt/Turbidity Curtain* has traditionally been defined as an *impermeable* device for control of suspended solids and turbidity in the water column generated by dredging and dredged material disposal operations. Recently, the term "silt curtain" has been used to describe floating vertical barriers fabricated from either solid or permeable materials.
- A *Silt/Turbidity Screen* is a *flow-through filtering* device for control of suspended material and turbidity in the water column generated by dredging and dredged material disposal operations. All screens are composites of solid material (usually to facilitate flotation and mooring purposes) and permeable geosynthetic fabrics to filter water and reduce water pressure on the device.
- A *Gunderboom* is a device similar to a silt or turbidity screen that has been modified to control oil spills by adding adsorbent geotextile material.

For the purposes of this technical note, the term "*silt curtain*" will be used generically to describe devices deployed in water to control suspended solids or turbidity resulting from dredging operations.

TYPICAL QUESTIONS ON SELECTION AND USE OF SILT CURTAINS

What Are the Components of Silt Curtains? Silt curtains are vertical, flexible structures that extend downward from the water surface to a specified water depth. Typically fabricated of flexible, polyester-reinforced thermoplastic (vinyl) fabric, the curtain is maintained in a vertical position by flotation material at the top and a ballast chain along the bottom (Figure 1).

A tension cable is often built into the curtain immediately above or just below the flotation segments (top tension) to absorb stresses imposed by currents and hydrodynamic turbulence. The curtains are usually manufactured in standard sections (e.g., up to 50 ft) that can be joined together at a particular site to provide a curtain of specified length. Curtains are generally deployed to extend to 1-2 ft above the bottom to allow mudflow to pass beneath them. Anchored

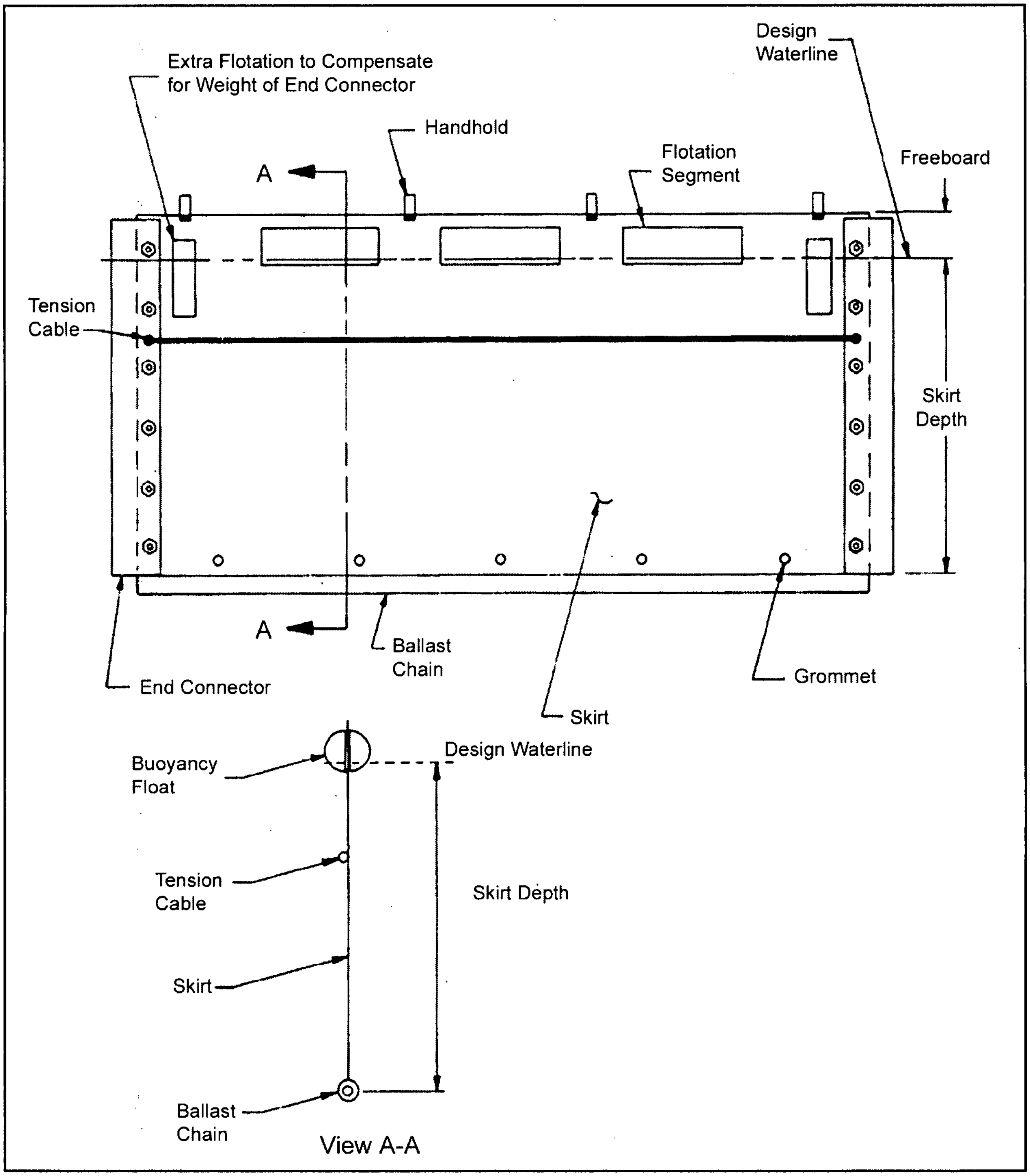

Figure 1. Construction of a typical silt curtain section (JBF Scientific Corporation (1978))

lines hold the curtain in a deployed configuration that can be U- or V-shaped, or circular or elliptical, depending upon the application.

What Are the Functions of Silt Curtains? Silt curtains are designed to contain or deflect suspended sediments or turbidity in the water column. Sediment containment within a limited area is intended to provide residence time to allow soil particles to settle out of suspension and reduce flow to other areas where negative impacts could occur. Suspended solids can also conceivably be diverted from areas where environmental damages could occur from the settlement of these suspended particles. Silt curtains may also be used to protect specific areas (e.g., sensitive habitats, water intakes, or recreational areas) from suspended sediment and particle-associated contamination.

What Processes Affect Silt Curtains? In many cases where silt curtains are used, the concentration of fine-grained suspended solids inside the curtain enclosure may be relatively high (i.e., in excess of 1 g/L). The suspended material may be composed of relatively large, rapidly settling particles or flocs. In the case of a typical pipeline disposal operation surrounded by a silt curtain (Figure 2), where suspended solid concentrations are high and material usually flocculated, the vast majority (95 percent) of the fine-grained material descends rapidly to the bottom where it forms a fluid mud layer that slopes away from the source at an approximate gradient of 1:200. The other 5 percent of the material remains suspended in the water column above the fluid mud layer and is responsible for the turbid appearance of the water inside the curtain. While the curtain provides an enclosure where some of the fine-grained material may flocculate and/or settle, most of this fine-grained suspended material in the water column escapes with the flow of water and fluid mud under the curtain. The silt curtain does not indefinitely contain turbid water but instead controls the dispersion of turbid water by diverting the flow under the curtain, thereby minimizing the turbidity in the water column outside the silt curtain.

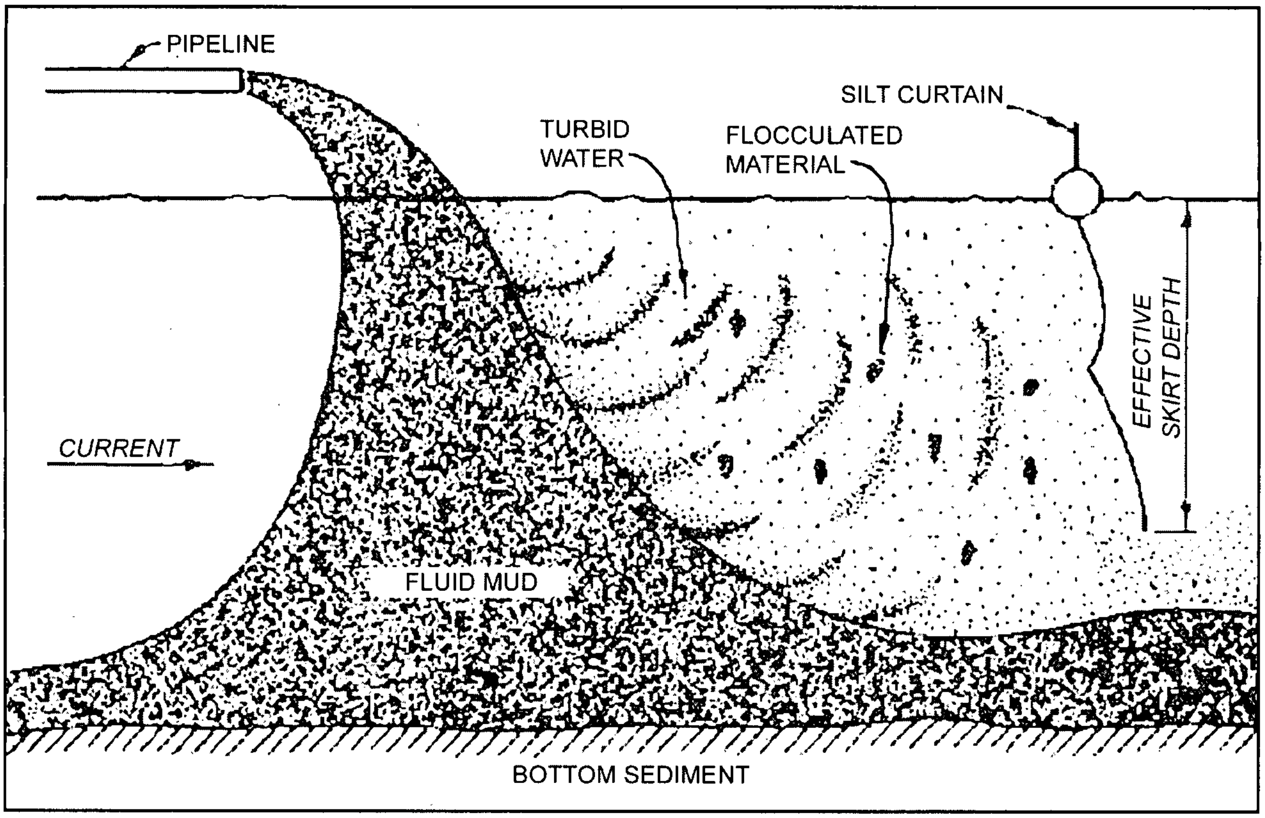

Figure 2. Processes affecting silt curtain performance (JBF Scientific Corporation (1978))

Whereas properly deployed and maintained silt curtains can effectively control the distribution of turbid water, they are not designed to contain or control fluid mud. In fact, when the accumulation of fluid mud reaches the depth of the ballast chain along the lower edge of the skirt, the curtain must be moved away from the discharge; otherwise sediment accumulation on the lower edge of the skirt can pull the curtain underwater and eventually bury it. Consequently, the rate of fluid mud accumulation relative to changes in water depth due to tides must be considered during a silt curtain operation.

How Are Silt Curtains Deployed? After the deployment site has been surveyed, the geometry of the deployed curtain should be determined based on the objectives of silt curtain application, the hydrodynamic regime at the project site, and factors such as boat traffic. Typical deployment configurations for silt curtains are shown in Figure 3. In some cases, the curtain may be deployed in an open-water environment in the form of a "maze," a semicircle or U, or a circle or ellipse.

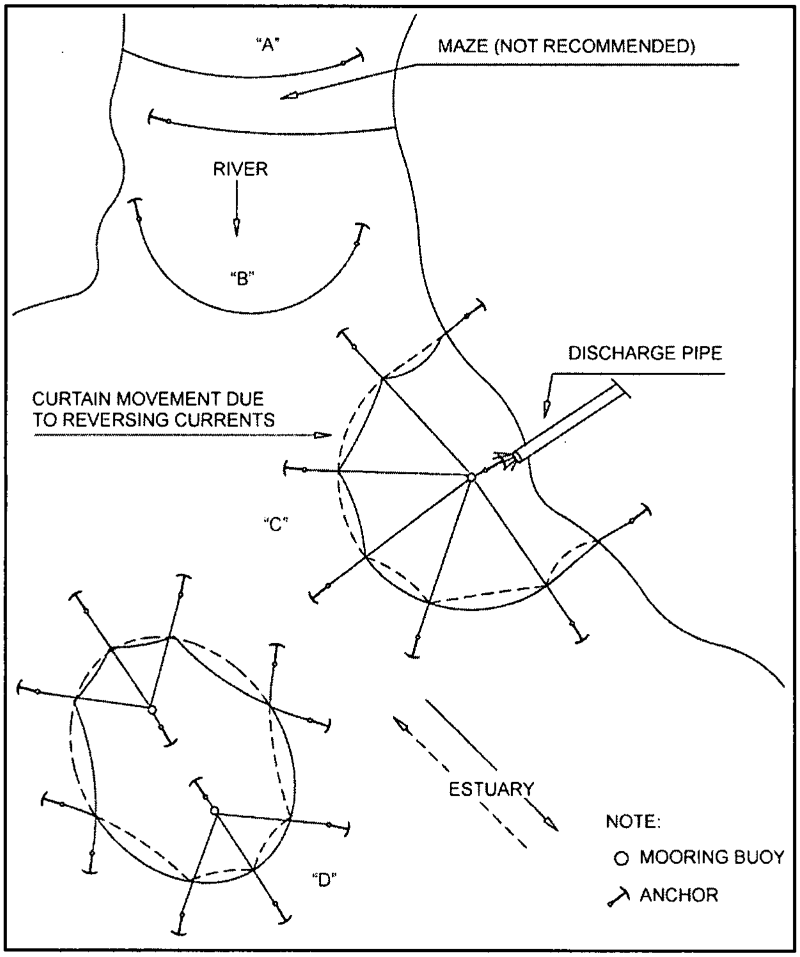

Figure 3. Typical silt curtain deployment configurations (JBF Scientific Corporation (1978))

The maze configuration ("A," Figure 3) has been used on rivers where boat traffic is present, but appears to be relatively ineffective due to direct flow through the aperture between the curtain sections. On a river where the current does not reverse, a U configuration ("B," Figure 3) is acceptable, but the distance between the anchored ends of the curtain (i.e., across the gap) should be large enough to prevent leakage of turbid water around the ends of the U. In situations where the turbid water is being generated by effluent from a containment area or a pipeline disposal operation close to the shoreline, the curtain can be anchored in a semicircular or U configuration ("C," Figure 3) with the ends of the curtain anchored onshore approximately equidistant from the discharge point. In a tidal situation with reversing currents a circular or elliptical configuration ("D," Figure 3) is necessary. This latter case requires a more extensive mooring system. A typical curtain might be 500 to 1500 ft for the U or semicircular configurations and 1000 to 3000 ft for the circular/elliptical case. Figure 4 shows a single floating silt curtain being deployed from a pier.

What Types of Silt Curtains Are Commercially Available for Silt Curtains? Many types of commercially available silt curtains are manufactured to perform specific functions. Names given by the manufacturers to describe the silt curtains include "floating," "floating diversion baffle," "fixed hanging," "permeable," "standing," "frame," "sinkable hanging," and "combination." Other names refer to the type of water or current where the curtain will be used (e.g., slack, slow, medium, fast, rough, tidal, etc.).

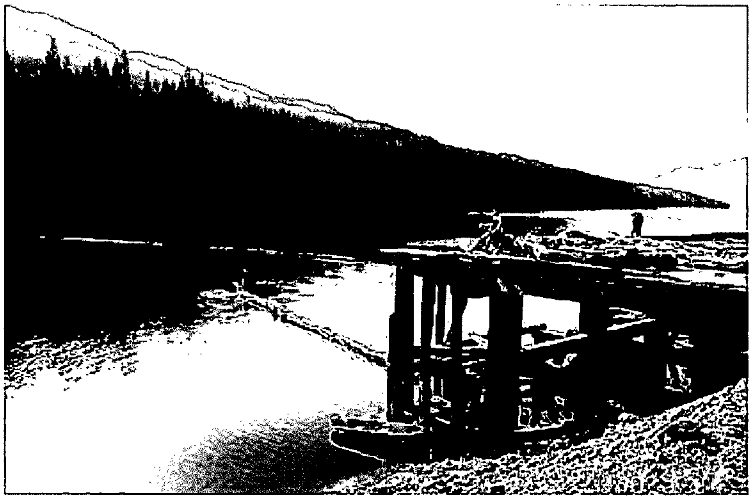

Figure 4. Single flotation silt curtain being deployed from shoreline (Courtesy of Marke Wilkie, Elastec/ American Marine, Inc., 401 Shearer Blvd., Cocoa, FL 32922)

Typical silt curtain types are shown in Figures 5 and 6. Most silt curtains incorporate the following common specification components:

- Flotation or buoyancy (e.g., solid or compressed air).
- Skirt depth (height between the top boom and the curtain bottom).
- Fabric (e.g., tensile strength, tear strength, abrasion resistance, material, coating, weight, seams/seals, drains, and color—bright yellow or international orange are recommended).
- Connectors (e.g., lace, bolt through, ASTM universal, PVC slotted tube, hook and O-ring).
- Ballast (e.g., type and weight).
- Tension member or load line (i.e., upper, mid, or bottom).

What Is Known about the Effectiveness of Silt Curtains? Silt curtains have been evaluated since the early 1970's. One of the most definitive early studies on the functional capabilities and performance of silt curtains in the United States was completed by JBF Scientific Corporation (1978) during the Corps of Engineers' Dredged Material Research Program. The study consisted of evaluating past and present uses, effectiveness of various applications, deployment guidelines and specifications, deployment methods, and environmental conditions that might limit the use of silt curtains. Much of the technical guidance presented in the study report is still valid and represents a fundamental source of information currently used by silt curtain design practitioners. Summarizing the JBF Scientific Corporation study, silt curtain effectiveness depends on many factors such as:

- Nature of the operation (i.e., navigation or environmental dredging).
- Quantity and type of material in suspension within or upstream of the curtain (including debris, oils, and chemicals).
- Characteristics, construction, and condition of the curtain as well as the area and configuration of the barrier enclosure (e.g., partial or full depth containment, either solid or permeable).

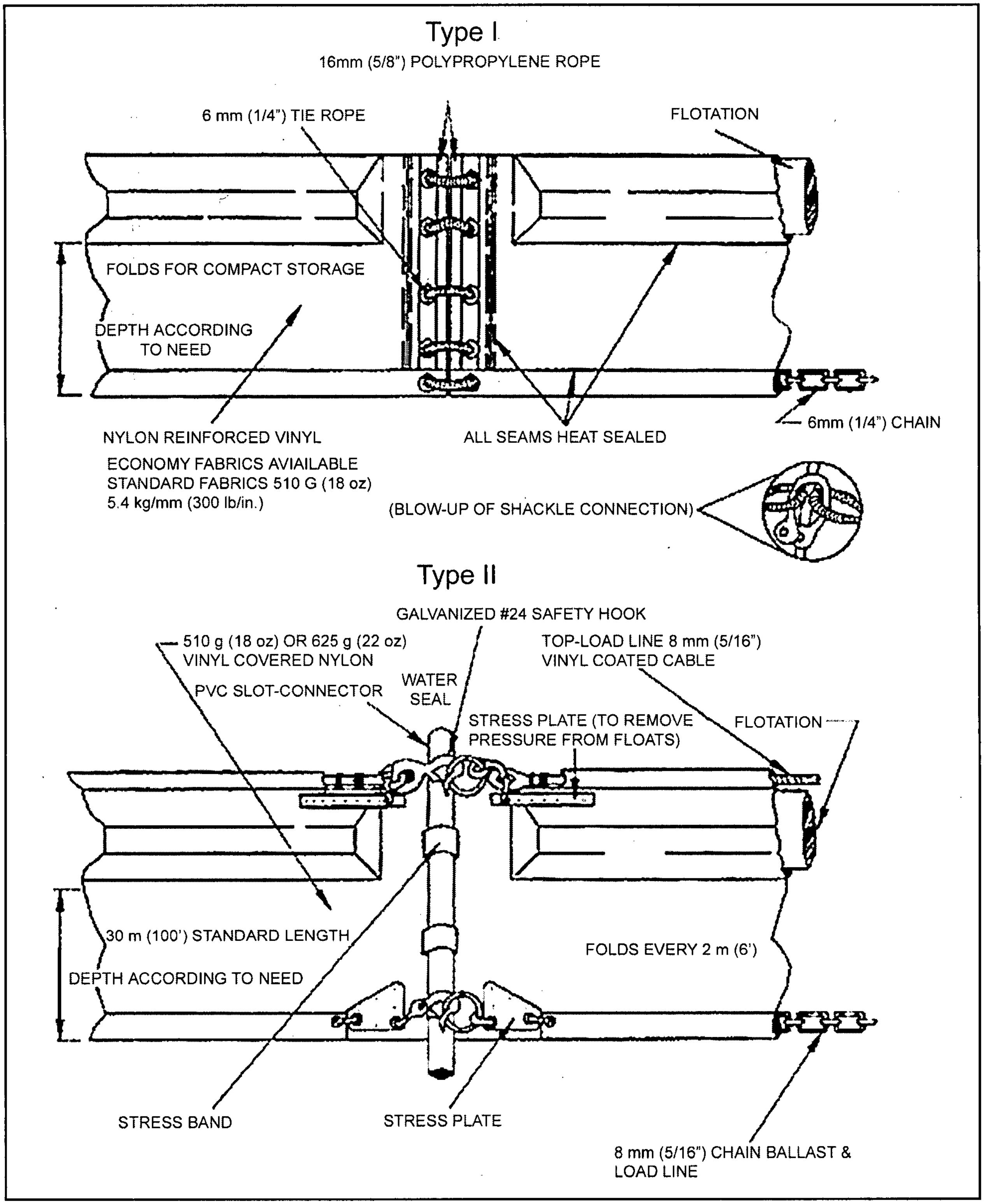

Figure 5. Types I and II silt curtains (USACE EP 1110-1-16, Appendix C, BMP-27, page C-167)

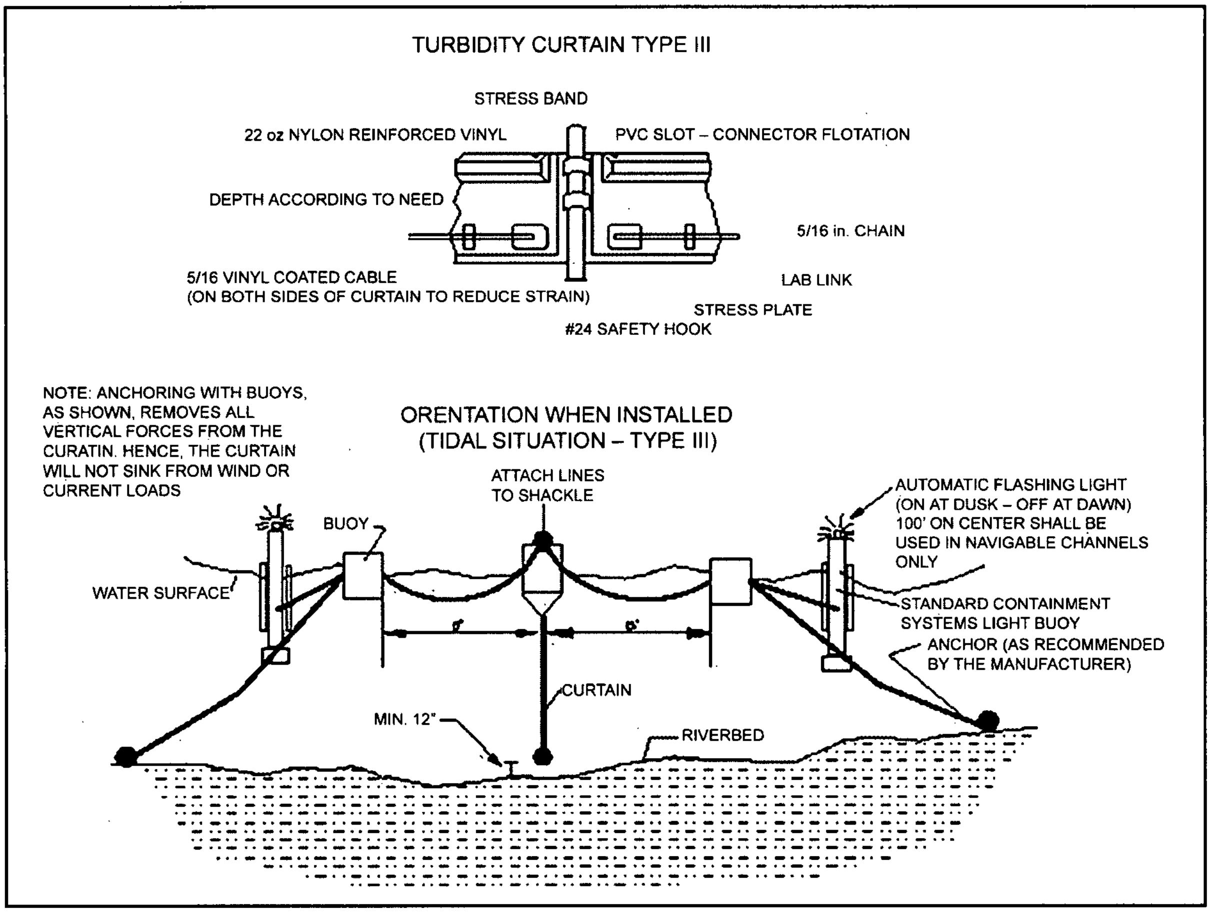

Figure 6. Type III silt curtain (USACE EP 1110-1-16, Appendix C, BMP-27, page C-167)

- Method of deployment.
- Hydrodynamic conditions (e.g., strong currents [>1 knot or 1.5 fps], high winds [especially with long fetch areas], fluctuating water levels [i.e., tides], excessive wave height including ship wakes, and drifting debris and ice).

Figure 7 shows a silt curtain installation in San Francisco Bay during a moderate squall.

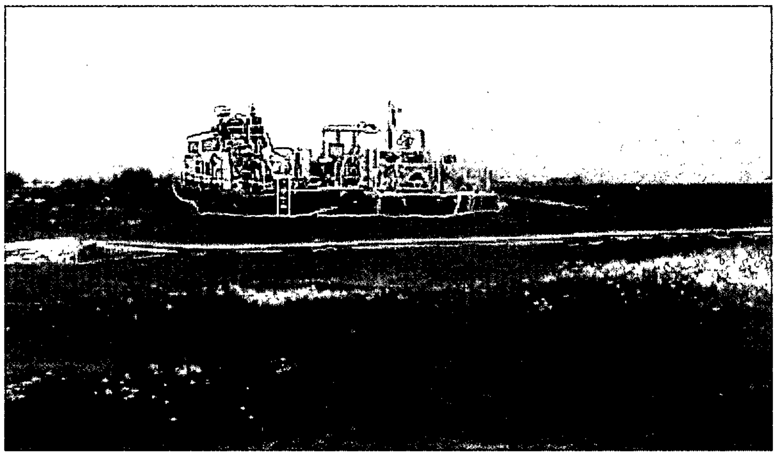

Figure 7. Floating curtain deployed in San Francisco Bay (courtesy of Julie Kistle, KFM-Joint Venture, San Francisco-Oakland Bay Bridge East Span Skyway Project Turbidity Monitoring Project)

JBF Scientific Corporation (1978) defined effectiveness as "the degree of turbidity reduction outside the curtain relative to the turbidity levels inside the curtain enclosure." They also concluded that:

> In some cases, turbidity levels in the water column outside the curtain can be 80-90 percent lower than levels inside or up-current of the curtain enclosure. High currents and energy environments cause silt curtains to flare, thus reducing the curtain's effective depth. At a current of 1 knot, the effective skirt depth of a 1.5-m curtain is approximately 0.9 m. Increased turbulence around the curtain also tends to cause resuspension of the fluid mud layer and may cause increased turbidity levels in the upper water column beyond the curtain. Tidal currents that dominate the hydrodynamic regime may cause the fluid mud to be resuspended, especially if the curtain is not properly deployed. Frequently, changes in the direction of the current will dominate the direction and movement (flapping) of an improperly anchored curtain. Where anchoring is inadequate and particularly at sites where tidal currents dominate the hydrodynamic regime and probably cause resuspension of the fluid mud as the curtain sweeps back and forth over the fluid mud with changes in the direction of the tidal currents, the turbidity levels outside the curtain can be higher (as much as 10 times) than the levels inside the curtain.

Finally, JBF Scientific Corporation (1978) stated, "With respect to overall effectiveness and deployment considerations a current velocity of approximately 1 knot appears to be a practical limiting condition for silt curtain use."

In preparation for the construction of the Westway interstate highway in New York, a test program was established to determine the effectiveness and deployment configurations needed for the dredging activities associated with the highway construction project. Lawler, Matusky, and Skelly Engineers (1983) reported the results of the water quality tests performed on the prototype silt curtains used in the test program. They concluded, "Visual observations and field measurements showed the silt curtain to be an effective barrier to currents, dye, suspended solids, and turbidity. The curtain did not function as a permeable fabric as predicted; water appeared to flow around it rather than through it." The silt curtain contained most contaminants with the exception of ammonia. Mixing outside the curtain in the water column brought the levels down to background levels. Lawler, Matusky, and Skelly Engineers also concluded, "The low currents measured behind the curtain indicated that the curtain blocks flow patterns and creates a quiescent zone. The lack of flow through the curtain is probably attributable to the water taking the path of least resistance (i.e., under the piers or around the ends). Clogging of the curtain with suspended solids (either background or caused by dredging) would only aggravate this situation." At the time, the concept of enclosing a dredge was new and untested. Notably, a concern arose that enclosing the dredge with a silt curtain would create a settling basin for solids that could promote the concentration and release of oxygen-consuming suspended contaminants in violation of water quality standards. The exchange of water inside the curtain became a design topic and relief panels (flaps) were considered to allow a 25-percent exchange of basin volume over a 12-hr period.

In 1994, the USEPA published a remediation guidance document as part of the Assessment and Remediation of Contaminated Sediments (ARCS) Program (USEPA 1994). They concluded, "As a generalization, silt curtains and screens are most effective in relatively shallow quiescent water. As the water depth increases and turbulence caused by currents and waves increases, it becomes increasingly difficult to effectively isolate the dredging operation from the ambient water. The St. Lawrence Centre (1993) advises against the use of silt curtains in water deeper than 6.5 m or in currents greater than 50 cm/sec (USEPA 1994)."

The USEPA also suggested that to be effective, curtains deployed around the remediation dredging operation must remain in place until the operation is completed at that site. For large projects, frequent relocation of the curtains may be necessary as the dredge moves to new areas. The USEPA also highlighted the fact that curtains should not impede navigation traffic, an important consideration during their deployment.

What Information Is Available on Selection, Design, Specification, and Deployment of Silt Curtains? Several types of guidelines are used to select, design, and deploy silt curtains for dredging projects. Guidelines available for silt curtains are contained in several technical and regulatory resource documents. Table 1 is a listing of technical guidelines and best management practices. Typically, topics covered include planning considerations (site-specific project conditions), design criteria, construction specifications (curtains and other materials), installation or deployment, removal, and maintenance. A notable exception is monitoring of curtain performance.

Selecting which guide or best management practice to follow depends on particular project requirements, site locations, and the type of silt curtain specification needed (i.e., performance of product). Table 2 is an example of the minimum recommended specification for a silt curtain (originally developed by JBF Scientific Corporation (1978)) that has been updated by a silt curtain manufacturer to reflect 2002 conditions.

What Should Be Done to Properly Select and Use a Silt Curtain? Table 3 is a checklist for selecting and applying silt curtains. The purpose of the checklist is to prompt the designer or reviewer to consider various critical aspects of selection, designation, and installation of silt curtains for typical dredging projects. However, the checklist should be considered as an aid and not be used as a specification requirement. The selection and use of silt curtains is extremely site-specific and requires both knowledge and practical experience for successful applications.

What Are Some "Lessons learned" Regarding Selection, Design, and Deployments of Silt Curtains? Silt curtains should be selected, designed, and installed to meet permit and water quality certification requirements where applicable.

- Very few silt curtain applications are alike. Each is unique and requires site-specific application and adaptation.
- Silt curtains should be designed to pass water either under or through their walls. Curtains are designed to confine suspended sediment and to allow it to settle or be filtered, not to impede the movement of water.

Table 1
Sources of Technical Guidelines on Silt Curtains

Source	**Reference**
	Technical Reports
US Army Corps of Engineers Exchange Bulletin Article	JBF Scientific Corporation. 1977. "Application and Performance of Silt Curtains," DMRP Work Unit 6C06, Dredged Material Research Exchange Bulletin Article - Vol. D-77-10, pp. 2-8.
Technical Report D-78-39	JBF Scientific Corporation. 1978. "An Analysis of the Functional Capabilities and Performance of Silt Curtains," Prepared for U.S. Army Engineer Waterways Experiment Station. Technical Report D-78-39. NTIS No. AD-A060 382
	Manuals
EM 1110-2-5025	USACE, "Dredging and Dredged Material Disposal," March 1983. p. 3-34
EM 1110-2-1614, 30 Jun 95	USACE, "Design of Coastal Revetments, Seawalls and Bulkheads," Chapter 6, Environmental Impacts, 6-3. Water Quality Impacts
EPA 905-B94-003	USEPA, "Great Lakes Contaminated Sediments: ARCS Remediation Guidance Document- Chapter 4 [EPA-905-B94-003]
Army TM 5-818-8/Air Force AFJMAN 32-1030-July 20, 1995	CEMP, "Engineering Use of Geotextiles," 20 Jul 95
	Best Management Practices
Section 404 (b)(1) Guidelines	Part 230.73: Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material, Subpart H, Actions to Minimize Adverse Effects –Actions affecting the method of dispersion.
BMP – Turbidity Curtains	King County Courthouse, 516 Third Avenue, Seattle, WA 98104
EMP No. 0-16	AAPA, "Environmental Management Practices Activity: Dredging and Dredge Material Disposal (EMP No. 0-16)
	Manufacturer's Guide
Turbidity Curtain Selection Guide	Elastec/American Marine, Inc., 401 Shearer Blvd., Cocoa, Florida 32922
Turbidity Barrier Guide	ABBCO/American Boom & Barrier Corp., 7077 N. Atlantic Avenue Cape Canaveral, Florida 32920
Turbidity Screens	Section IV-6 - Final Construction and Contract Specifications, New Cut Dune/Marsh Restoration Project, Federal Project No. TE-37, Terrebonne Parish, Louisiana, June 2001

Table 2
Recommended Silt Curtain Specifications[1,2]

Parameter	Recommended Value
Skirt Depth	Up to 100 ft maximum allowing 1-2 ft clearance between skirt and bottom
	Fabric
Tensile strength grab	500 lb/in.
Tear strength strip 18 oz 22 oz	 320 lb – quiescent conditions 400 lb – medium to high current
Abrasion resistance	200 lb/in. tensile strength after abrasion
Material	Polyester
Coating	PVC
Weight	18-22 oz (depending on type of curtain design)
Seams	Heat sealed
	Buoyancy
Ratio	>5
Type	Solid, closed cell, and enclosed in a fabric pocket
Connector	Load transfer type – aluminum extrusion
	Ballast
Type	Noncorrosive galvanized chain
Weight	See Figures 16 and 17
	Tension Member
No current	Fabric only
Current (0.1-1.0 knots	Top or center tension; center tension provides slightly greater effective skirt depth

[1] In 2002, a 100-ft section of silt curtain with top tension member to the above specifications and a skirt depth of 5 ft could be purchased at an approximate cost of $1,100.00.

[2] Source: Elastic/American Marine, 401 Shearer Blvd., Cocoa, FL 32922 USA, Tel: 321-636-5783, Fax: 321-636-5787, E-mail: jpearce@wlastec.com, www.elastec.com.

Table 3
Checklist for Selection and Application of Silt Curtains

1) **Pre-dredging Site Survey –**
   a) Have background conditions at the site been established? Y__N__N/A__
   b) Has the site been adequately characterized with respect to Y__N__N/A__
      i) Current velocity, water depth (relative to tidal range)? Y__N__N/A__
      ii) Bottom sediment types? Y__N__N/A__
      iii) Background levels of turbidity? Y__N__N/A__

(Sheet 1 of 4)

Table 3 (Continued)

2) Deployment –

a)	Have maximum surface currents over a tidal cycle (12 or 24 hr) been established first to determine types of deployment configurations that may be needed?	Y__N__N/A__
b)	Have direction of current and water turbulence been defined?	Y__N__N/A__
c)	Have the minimum water depths been established at the lowest low tide?	Y__N__N/A__
d)	Has a minimum 0.5-m skirt depth been established between the lower edge of the skirt and the existing bottom of the disposal area at the lowest low tide during the operations?	Y__N__N/A__
e)	Have the effects of fluid mud accumulation on water depth as well as the proposed schedule for moving the silt curtain to prevent burial been considered when selecting the curtain skirt depth?	Y__N__N/A__
f)	Is the character of the bottom sediment/vegetation known?	Y__N__N/A__
g)	Have traffic- and boat-generated waves been determined?	Y__N__N/A__
h)	Are locations of launching ramps, crane services, etc. known?	Y__N__N/A__
i)	Have deployment geometry and configurations been determined for the site?	Y__N__N/A__
j)	Have curtain deployment lengths been established?	Y__N__N/A__
k)	Have different anchor types been considered?	Y__N__N/A__
l)	Have different curtain configurations been considered (e.g., U, V, circular, elliptical)?	Y__N__N/A__

3) Silt Curtain Specifications –

a)	Does the lower edge of the silt curtain extend a minimum of 0.5 m from the bottom at lower tide?	Y__N__N/A_
b)	Is skirt depth less than the recommended 3 m?	Y__N__N/A__
c)	Has fabric material been selected (PVC or equivalent) with a minimum tensile strength of 525 N/m?	Y__N__N/A__
d)	Has the fabric weight (minimum of 610 g/m^2 for low current conditions, and 746-g/m^2 for high current conditions) been designated?	Y__N__N/A__
e)	Has a tear strength (min of 445 for 610-g fabric or 890 N for 746-g fabric been designated?	Y__N__N/A__
f)	Has a tensile strength after abrasion (greater than 350 N/m) been designated?	Y__N__N/A__
g)	Has a material been selected that is easily cleaned and resistant to marine growth, ultraviolet light, and mildew?	Y__N__N/A__
h)	Are all fabric seams heat-sealed or equivalent?	Y__N__N/A__
i)	Has flotation been designated as sections of solid, closed-cell, plastic foam flotation material sealed into a fabric pocket that provide a buoyancy ratio (buoyant force/curtain weight) greater than 5?	Y__N__N/A__
j)	Is each flotation segment a minimum of 3 m in length so the curtain may be easily folded for storage or transport?	Y__N__N/A__
k)	Do connectors in low currents (<0.1 knot) maintain adequate physical contact along the entire skirt joint?	Y__N__N/A__

(Sheet 2 of 4)

Table 3 (Continued)

3) Silt Curtain Specifications – (continued)	
l) Have aluminum extrusion (or equivalent) load-transfer connectors been designated for current velocities exceeding 0.1 knot?	Y__N__N/A__
m) Have non-corrosive ballast chains with a weight ranging from approximately 1.5 kg/m for a 1.5-m skirt depth up to 3.0 kg/m for a 3-m skirt depth been selected?	Y__N__N/A__
n) Are tension members used as follows:	
i) Negligible current: no tension member?	Y__N__N/A__
ii) Current velocities between 0.1 and 1.0 knot?	Y__N__N/A__
iii) Galvanized or stainless steel wire rope as top or center tension member?	Y__N__N/A__
o) Have handholds been designated along the top of the curtain between the flotation segments for ease in handling?	Y__N__N/A__
p) Have repair kits been designated to patch minor tears in the fabric?	Y__N__N/A__
4) Transportation –	
a) Have furls (lightweight straps or rope) been specified every 1 to 1.5 m from storage to unloading site?	Y__N__N/A__
b) Has curtain been specified to be compactly folded accordion style, packaged into large bundles, and carefully lifted into transportation vehicle?	Y__N__N/A__
c) Will curtains be unloaded like a string of sausages and connected in appropriate sections (up to 30 m) as they are played out of the vehicle?	Y__N__N/A__
d) Will curtains be towed by boat (traveling at 2 to 3 knots) to the deployment site?	Y__N__N/A__
e) Will the curtain be kept furled except near the end of the connectors until it has been deployed at the site?	Y__N__N/A__
5) Mooring –	
a) Has the recommended mooring system consisting of an anchor, chain, an anchor rode (line or cable), and mooring and crown buoys been designated?	Y__N__N/A__
b) Has the anchor pattern been designated based on the curtain deployment geometry site conditions (e.g., from section joints every 30 m in a radial pattern and on both sides if the curtain is exposed to reversing tidal currents)?	Y__N__N/A__
c) Have sizes (e.g., ½ -inch etc.) of anchor lines and anchor weights (e.g., 4.5 kg for sandy bottoms and up to 34 kg for firm mud) been selected based on bottom conditions.?	Y__N__N/A__

(Sheet 3 of 4)

Table 3 (Concluded)

6) Deployment Model –	
a) Has the length of time for deployment before reconfiguration or movement been determined based on accumulation of fluid mud inside the curtain relative to the deployment geometry, the discharge (filling) rate, and the initial bottom gap (i.e., the distance between the lower skirt edge and the bottom sediment at the beginning of the operation)?	Y__N__N/A__
b) Is the total length of the curtain available for the project adequate for the size of the enclosure?	Y__N__N/A__
7) Maintenance –	
Has adequate attention been given to	
a) Moving the curtain away from the turbidity sources just before the fluid mud layer reaches the lower edge of the skirt?	Y__N__N/A__
b) Replacing worn or broken anchor lines?	Y__N__N/A__
c) Maintaining the integrity of the curtain by repairing leaking connectors and / or tears in the curtain fabric?	Y__N__N/A__
d) Repairing tears in the flotation pocket with hand-type pop rivet gun and rivets?	Y__N__N/A__
e) Repairing moderate tears in skirts on land with vinyl/nylon repair kit and VINYLFIX or PVC glue?	Y__N__N/A__
f) Keeping one or two spare sections of curtain for immediate replacement of unrepairable sections onsite?	Y__N__N/A__
8) Recovery –	
a) Will silt curtains be refurled after operations are completed?	Y__N__N/A__
b) Will anchor/mooring systems be recovered?	Y__N__N/A__
c) Will the curtains be returned to the launching site for repacking and subsequent storage?	Y__N__N/A__
9) **Monitoring –**	
a) Have plans been made for monitoring during dredging operations?	Y__N__N/A__
b) Will measurements of turbidity (NTU) and samples for TSS (mg/L) be taken on both sides of the silt curtain near the dredging operations and near any sensitive habitat?	Y__N__N/A__
c) Will tide, wind, wave, and current measurements be made?	Y__N__N/A__
d) Are there plans to monitor post-dredging operations with respect to limited measurements of current, tidal range, winds, turbidity (NTU), and samples for TSS (mg/L) for comparison with background conditions?	Y__N__N/A__
	(Sheet 4 of 4)

- In applications where the curtain will be extended to the bottom of the waterway in tidal or moving water conditions, a heavy woven permeable filter fabric or tide flaps should be designed into the curtain to relieve pressure on the curtain wall.
- In general, silt curtains should be used on slow to moderate currents, stable water levels, and relatively shallow water depths.

- Currents greater than 1 to 1-1/2 knots are problematic, leading to difficult and often expensive curtain designs. Silt curtains should not be used in current velocities greater than 3-5 knots unless there are unusual circumstances and special designs are considered. Curtain deployments for deep, fast-flowing water and windy conditions require customized designs. However, for all practical purposes, the 1 to 1-1/2 knot value appears to be an industry standard.
- In slow currents, resuspension and turbidity are localized, so a fundamental question is whether or not a silt curtain is even necessary.
- In high currents where sediment plumes disperse rapidly, silt curtains are very difficult to maintain properly and can easily become dysfunctional.
- In all but the slowest current flows, curtains will "billow out" in the downstream direction, allowing water to pass beneath the curtain, thereby reducing the effective skirt depth.
- Extra length (up to 10-20 percent) and depth (slack) of curtains should be included in designs to allow for tidal fluctuations and exchanges of water within the curtain.
- Special designs may be required for applications of curtains at depths greater than 10-15 ft or with currents exceeding 1-1/2 knots, particularly in tidal waters. At greater depths, loads or pressures on curtains and mooring systems become excessive and could result in failure of standard construction materials.
- High winds can lift large curtains out of the water like a sail.
- Curtains can sink due to excessive biological fouling on the fabric.
- An attempt should be made to minimize the number of joints in the curtain; a minimum continuous span of 15 m (50 ft) between joints is a "good rule of thumb."
- Curtains should be a bright color (yellow or "international" orange are recommended) to enhance visibility for boaters.
- In tidal situations, where currents move in both directions, it is important to attach anchors on both sides of the curtain to hold the curtain in place and to not allow it to overrun the anchors and pull them out when the tide reverses.
- Anchor lines should be attached to the flotation device, not to the bottom of the curtain.
- Care should be taken during removal of silt curtains to avoid or minimize resuspension of settled solids.
- Removal of settled solids trapped by the silt curtain is optional and should only be considered if the resulting bottom contour elevation is significantly altered.
- When dredging contaminated sediment, installing silt curtains within continuous or intermittent sheetpile walls to provide anchoring points has proven to be more effective than using silt curtains alone.
- Silt curtains can be effective in containing floating debris, but not always in containing contamination. Soluble contaminants, particularly heavy metals, can flow through, around, or under the curtain.
- Aquatic habitat can be successfully protected with deflection curtains provided they are properly designed and deployed, taking into consideration site-specific conditions.
- Designs should conform to relevant contract specifications and manufacturer recommendations and guidelines for installation and safety measures.

- Silt curtains should not be considered a "one solution fits all" type of best management practice. They are highly specialized, temporary-use devices that should be selected only after careful evaluation of the intended function and designed based upon a detailed knowledge of the site where they will be used.

SUMMARY: The term "*silt curtain*" is used to describe devices deployed in water to control suspended solids or turbidity resulting from dredging operations. Almost every silt curtain application has unique features that require site-specific adaptations. Several sources of published technical guidelines and best management practices are identified and referenced in this note. Typical topics covered in these guides include planning considerations (site-specific project conditions), design criteria, construction specifications (curtains and other materials), installation or deployment, removal, and maintenance. A notable exception is monitoring of silt curtain performance.

For cost considerations, logistical constraints, and performance expectations, prevailing current velocities of 1 to 1-1/2 knots effectively limit deployments, with exceptions on a case-by-case basis. Unfortunately, few comprehensive studies are published on the actual performance of silt curtains under varying project conditions. Additional monitoring studies will be required to properly document the functional characteristics and incremental costs of silt curtains under demanding project conditions of moderate to high currents, winds, and waves.

Silt curtains should not be considered a "one solution fits all" type of best management practice. They are highly specialized, temporary-use devices that should be selected only after careful evaluation of the intended function and designed based on a detailed knowledge of the site where they will be used.

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Francingues, N. R., and Palermo, M. R. (2005). "Silt curtains as a dredging project management practice," *DOER Technical Notes Collection* (ERDC TN-DOER-E21). U.S. Army Engineer Research and Development Center, Vicksburg, MS. http://el.erdc.usace.army.mil/dots/doer/doer.html.

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- Double sewn seams with grommets
- Depths per requirements ' 50' sections

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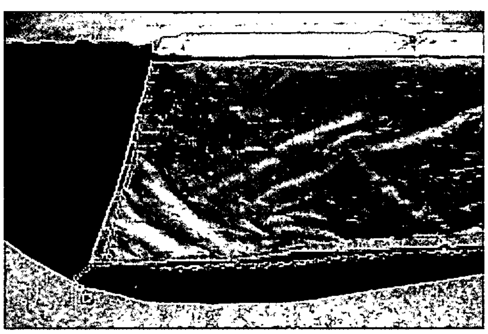
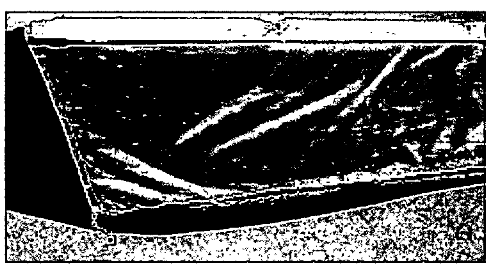
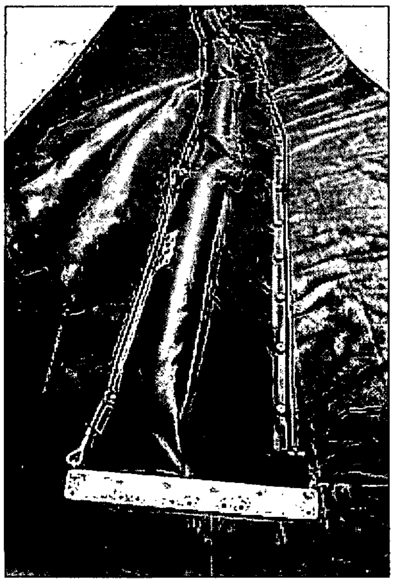




Click Here For Specifications

Curtain Floating Barriers for Turbidity Control

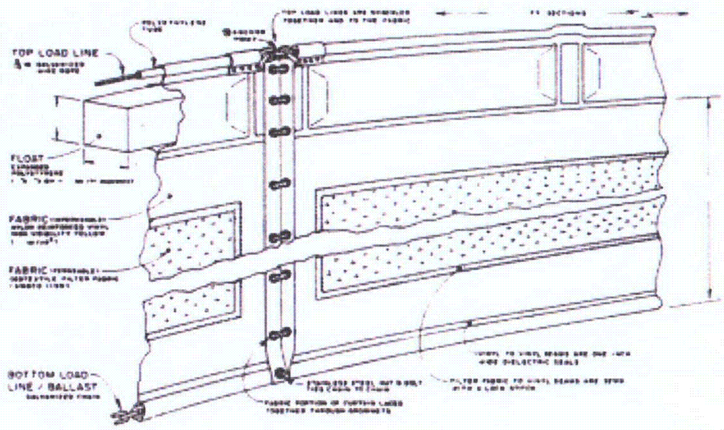


Floating Turbidity Control Curtains are impermeable barriers* constructed of a flexible reinforced thermoplastic material dielectrically welded to provide an upper hem for enclosing flotation material and a lower hem for enclosing ballast material. The skirt depth of the silt curtain is the material vertically below the upper hem. The length of the turbidity curtain is the horizontal distance between ends. Additional construction features are dependent on silt curtain design.

Curtain Floating Barriers are designed to control the settling of solids (silt) suspended in water by providing a controlled area of containment. This condition of suspension (turbidity) is usually created by disrupting natural conditions through construction or dredging in the marine environment. The containment of settleable solids is desirable to reduce the impact area of these solids.

Although the Silt Curtains listed are standard, Boom Environmental can custom design specific floating booms to solve unique problems. What this means is that the standard designs are available with a variety of fabric options, flotation sizes, load-bearing and ballast members, connectors and lengths. When a variation on a standard design won't work, Boom Environmental engineers can design to meet the requirements.

Custom Design Silt Curtain

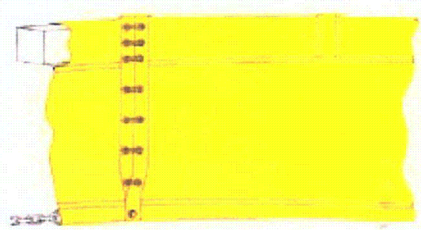


Lightweight Turbidity Curtain

Application: Calm waters with little current, such as lakes, ponds, canals and shoreline areas.

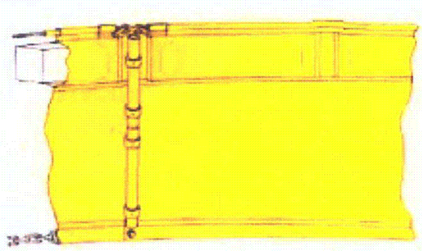
Specifications

- Fabric - Polyester reinforced vinyl high visibility yellow
- Connector - Sections are laced together through grommets and load lines are bolted together.
- Flotation - 6" expanded polystyrene over 9 lbs./ft. buoyancy.
- Ballast - 1/4" galvanized chain (.7 lbs/ft).



Middleweight Turbidity Curtain

Application: Rivers, streams, open lakes and exposed shorelines with moderate current moving in one direction.



Specifications

- Fabric - Polyester reinforced vinyl high visibility yellow 18 oz/yd2 weight.
- Connector - Shackled and bolted load lines.
- Flotation - 8" expanded polystyrene over 19 lbs/ft buoyancy.
- Ballast Line/Ballast - 5/16" galvanized chain (1.1 lbs/ft).
- Top Load Line - 5/16" galvanized wire rope enclosed in heavy tubing.

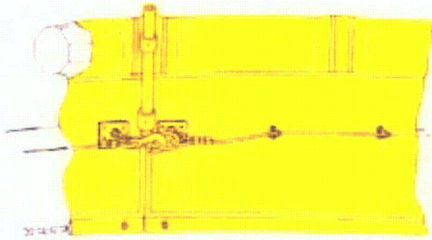
Heavyweight Turbidity Curtain

Application: Exposed areas subject to current, wind and tides.

Specifications

- Fabric - High strength nylon reinforced vinyl high visibility yellow 22 oz/yd2 weight.
- Connector - Snap hooks and rings

connect load lines with slotted reinforced PVC pipe for fabric closure. *Optional extruded aluminum connectors.
- Flotation - 12" expanded polystyrene over 29 lbs./Ft buoyancy.
- Ballast - 5/16" galvanized chain (1.1 lbs/ft).
- Load Lines - Dual 5/16" galvanized wire ropes with heavy vinyl coating.



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Type I:
Floatation consists of a series of expanded polyethylene logs, 6" in diameter and 55" long. The logs are enclosed in 22 oz./sq. yd. PVC coated nylon or polyester having 400 lbs. minimum tensile strength. Curtain is permanently attached to the bottom of the floatation unit and weighed down with 1/4" galvanized chain. The curtain material is slit film woven polypropylene having 200 lb. or 300 lb. tensile strength.

Type II:
Floatation and construction are identical to Type I. Curtain material is monofilament woven polypropylene.

Woven Curtain Material Specifications:

Property	Test Method	Results	Results	Results
Fabric Code		AEF 200W	AEF 300W	AEF 650W
Fabric Structure		Woven	Woven	Woven
Polymer		Polypropylene	Polypropylene	Polypropylene
Composition	ASTM D-4632	4.2 oz/sq. yd.	5.8 oz/sq. yd.	6.3 oz/sq. yd.
Weight	ASTM D-4632	200 lbs.	300 lbs.	390 x 250 lbs.
Grab Strength	ASTM D-4533	90 lbs.	120 lbs.	115 x 65 lbs.
Trap Tear Strength	ASTM D-3786	400 psi	600 psi	495 psi
Burst Strength	ASTM D-3787 (mod)	90 lbs.	150 lbs.	130 lbs.
Puncture	ASTM D-4632	20%	20%	30%
Elongation	ASTM D-4335	70% (500 hrs)	70% (500 hrs)	70% (500 hrs)
U.V. Resistance	CW-02215	40	40	70-100
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Contractor Screen
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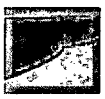
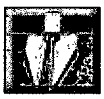
Light duty curtain.

Fastwater Screen
Medium duty curtain.

Ruffwater Screen
Heavy duty curtain.



Custom Curtain
Custom curtain.



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The Clean Water Act and enforcement of the NPDES (National Pollution Discharge Elimination System) has heightened the awareness of pollutants and the effect they have on water bodies and environment. State and Federal regulators have mandated that turbidity be controlled and localized; of the most cost effective ways to do this is through the use of Turbidity Screens.

There are many types of screens available, however we have developed four industry standards that are referred to as Contractor Screen (TYPE 0), Stillwater Screen (Type I), Fastwater Screen (TYPE II) and Ruffwater Screen (TYPE III). Elastec/American Marine manufactures a variety of other barriers for pollutant control, also providing custom solutions for applications where a standard approach is not feasible.

When selecting a screen for a specific project the main considerations are the hydrodynamic forces, project duration and ease of use by field personnel. Our technical staff works closely with engineers, contractors, and regulators from project inception to completion to ensure a comprehensive cost effective solution.

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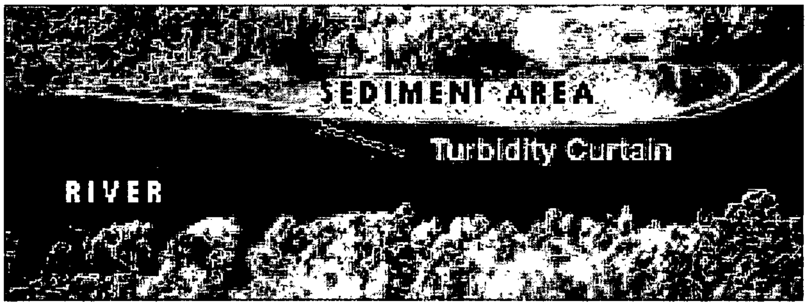

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1.0 ALTERNATIVES ANALYSIS

1.1 PROJECT DESCRIPTION

The co-applicants UniStar Nuclear Energy, LLC (UNE) and UniStar Nuclear Operating Services, LLC (UNO) are proposing to construct and operate a new nuclear power unit on the existing Calvert Cliffs Nuclear Power Plant (CCNPP) site. UNO will be the operator and co-licensee of the new unit. The new unit will be designated as CCNPP Unit 3 and will consist of one 1600 MWe U.S. Evolutionary Power Reactor (EPR) unit. The purpose of the proposed new nuclear power unit is to generate electricity for sale at wholesale. Development of the new nuclear power unit would require approval by the U.S. Nuclear Regulatory Commission (NRC) of a Construction and Operating License Application (COLA). In preparation for the COLA, the Site Layout Team/Cooling Water Systems Working Group (team), a multi-disciplinary team of industry experts, was selected to evaluate a suitable layout location for the proposed power unit. The purpose of their study was to evaluate the CCNPP site for locating two 1600 MWe U.S. EPR units and to determine the corresponding type of circulating water system for use with the new plant (Bechtel, 2006). At this time, however, the co-applicants plan to permit and construct one unit (Unit 3). Therefore, the alternative options presented in this section discuss Unit 3 only, and this section presents the results of Bechtel's study (2006) and MACTEC's analysis of impacts for each of the evaluated alternatives as requested by USACE in the request for additional information item 3b (letter received October 28, 2008).

1.2 FACILITY LAYOUT ALTERNATIVES

The selected site layout will include approximately 425 acres of power block, cooling towers, proposed switchyard, ancillary parking, four construction laydown areas, new transmission lines, construction access roads, a new cooling water intake structure (CWIS), discharge pipe, and barge terminal expansion. The co-applicants applied as much repositioning of core project components as possible within project practicability limits to avoid and minimize impacts to wetlands and other natural resources at the CCNPP site. The results of this effort are four project layout alternative scenarios. In this document, these alternative layouts are identified as Alternative A, Alternative B, Alternative C, and the Preferred Alternative (Figures 1.2-1, 1.2-2, 1.2-3, and 1.2-4, respectively).

For the layout evaluation, the team established that neither the power block nor the cooling towers would be located within the following excluded areas (Bechtel, 2006):

- Lake Davies
- 1500-ft radius from bald eagle nest
- Cemetery located near the southern property boundary.
- Reserved transmission corridors and within 300 feet of existing transmission lines
- Nearby offsite and onsite pipelines or other hazards

The on-site facility configuration (site layout) was then assessed for potential environmental impacts to the CCNPP site. This analysis focused on several environmental categories that are protected under special-purpose environmental laws and that contain specific provisions for the avoidance and minimization of impacts. These categories include wetlands, floodplains, Chesapeake Bay Critical Area (CBCA), historic and archaeological resources, and protected species. Complete avoidance of some impacts to environmental categories, such as wetlands, associated with the CCNPP Unit 3 may not be feasible due to the large area of land disturbance required. Efforts were made to avoid impacts to wetlands through consideration of several different project alternatives, including the No-Action Alternative (see Section 1.3).

Efforts to minimize impacts in the alternatives development process included:

- Avoiding and minimizing impacts to the most valuable/functional wetlands
- Moving the core development project component (power block) to the largest contiguous upland area

These minimization techniques resulted in the reduction of impacts on-site for the Preferred Alternative layout. These minimization efforts are described in the following paragraphs.

Efforts were made to avoid, to the extent practicable, the long-term and short-term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative. Impacts were only considered when there was no practicable alternative, and Unit 3 includes all practicable measures to reduce impacts to wetlands and jurisdictional waters. In keeping with the direction provided in the CWA [Section 404 (b)(1) Guidelines], the co-applicants evaluated each of the on-site alternative layouts based on the approximate acreage, type, and value of wetlands that would be impacted. Alternatives that would result in no impacts or minimal impacts to wetlands were preferred over alternatives that would result in a greater amount of impacts.

Efforts also were made to minimize the potential risks to human safety and property damage and the potential adverse impacts on natural and beneficial floodplain values. The co-applicants evaluated each alternative layout based on the approximate acreage of floodplains that would be impacted. Alternatives that would result in no impacts or minimal impacts to floodplains were preferred over alternatives that would result in a greater amount of impact to floodplains.

In addition, the co-applicants evaluated each of the alternative layouts with respect to the CBCA, an area that includes the Chesapeake Bay, its tributaries to the head of tide, tidal wetlands, and all land and water areas within 1,000 feet beyond the landward boundary of these waters and wetlands. The CBCA was established to help improve water quality and productivity in the Chesapeake Bay and to foster more environmentally sensitive development in areas near the shoreline. Alternatives that would result in no impacts or minimal impacts to the CBCA were preferred over alternatives that would result in a greater amount of impacts.

The co-applicants also evaluated each of the alternative layouts based on the potential to result in direct or indirect impacts to known historic and archaeological resources. Alternative layouts that were retained through the evaluation process were considered to be the most feasible, possible, prudent, and reasonable alternatives and were retained for further consideration. Alternatives that would result in no impacts or minimal impacts to these resources were preferred over alternatives that would result in a greater amount of impacts with respect to historic and archaeological resources.

1.2.1 Alternative A

Alternative A (Figure 1.2-1) consists of locating Unit 3 on the north side of the existing units. A significant amount of grubbing, clearing, and cut and fill would be required for this alternative. Most of the property north of the main access road is heavily forested outside of the cleared land around the visitors' center and security access point. A significant amount of cut and fill would be required to create a plant grade at approximate elevation 75 feet (considered to approximate the existing switchyard grade) and fill in the ravines and valleys on each side of fire road A-2 and the large valley at the north end of the property. A large wetland (approximately 48 acres) is identified in the northern section of the property, which would be impacted by the construction of the once-through cooling system.

Construction of Alternative A would result in a total of 29.27 acres of impact to jurisdictional wetlands (Figure 1.2-1). Of these total impacts, 26.36 acres would be permanent and 2.91 acres would be temporary. In addition, there would also be 59.0 acres of impacts to the CBCA. Based on construction activities, approximately 16.32 acres of jurisdictional wetlands would be impacted due to cooling tower construction, 5.90 acres of jurisdictional wetlands would be impacted due to power block construction, 2.13 acres of jurisdictional wetlands would be impacted due to heavy haul road and construction access road development, 0.81 acre of jurisdictional wetland would be impacted due to laydown area construction, and 4.14 acres of jurisdictional wetlands would be impacted due to switchyard construction The majority of the impacts (28.17 acres) would be to forested wetlands; however, 0.74 acre of the impacts would be to emergent wetlands and 0.36 acre of impacts would be to open water. Stream impacts associated with this alternative include 9,752.88 linear feet (20,877.13 square feet) to perennial and intermittent stream channels. Of these total impacts, 525.90 linear feet (1,235.80 square feet) would be temporary impacts, and 9,226.98 linear feet (19,641.33 square feet) would be permanent impacts. The following table summarizes the impacts that would result from the construction of Alternative A.

Table 1-1. Potential Impacts to Wetlands, Streams, and CBCA from Construction of Alternative A CCNPP Unit 3, Calvert County, Maryland

	Impacts to Jurisdictional Waters					
	Permanent Impacts		**Temporary Impacts**		**Total Impacts**	
	LF	**SF**	**LF**	**SF**	**LF**	**SF**
Stream Impacts	9,226.98	19,641.33	525.90	1,235.80	9,752.88	20,877.13
Wetland Impacts	**Acres**	**SF**	**Acres**	**SF**	**Acres**	**SF**
PEM	0.63	27,442.80	0.11	4,791.60	0.74	32,234.40
PFO	25.38	1,105,552.80	2.79	121,532.40	28.17	1,227,085.20
POW	0.36	15,681.60	0	0	0.36	15,681.60
Total Wetland Impacts	**26.37**	**1,148,677.20**	**2.9**	**126,324**	**29.27**	**1,275,001.20**
					Acres	**SF**
CBCA Impacts					59.0	2,570,040

Notes:
CBCA – Chesapeake Bay Critical Area
LF – Linear Feet
PEM – Palustrine Emergent
PFO – Palustrine Forested
SF – Square Feet

Prepared by: AES 11/14/2008
Checked by: RMR 11/14/2008

Conversion impacts to wetlands currently classified as forested and emergent wetlands would result after construction of Alternative A. The forested wetlands adjacent to the once-through cooling system (2.44

acres) in the northernmost right corner of the site; the forested wetlands adjacent to the switchyard (0.09 acre); the forested wetlands adjacent to the heavy haul road (0.02 acre); and the forested wetlands (0.25 acre) adjacent to the construction access road would become scrub shrub due to the potential for shading and human activities. The emergent and forested wetlands adjacent to the laydown area (0.11 acre) would remain emergent and forested unless excessive drainage and bulldozing occurred

1.2.2 Alternative B

Alternative B (Figure 1.2-2) is a similar configuration as Alternative A except that the reactor buildings are located on the south side of the turbine buildings and the switchyard is located on the north side of the turbine buildings resulting in a longer transition to the existing switchyard. Comparison of LODs for Alternative sites A and B can be found in Table 1-5.

Construction of Alternative B would result in a total of 29.27 acres of impact to jurisdictional wetlands (Figure 1.2-2). Of these total impacts, 26.36 acres would be permanent and 2.91 acres would be temporary. In addition, there would also be 59.0 acres of impacts to the CBCA. Based on construction activities, approximately 16.32 acres of jurisdictional wetlands would be impacted due to cooling tower construction, 5.90 acres of jurisdictional wetlands would be impacted due to switchyard construction, 2.13 acres of jurisdictional wetlands would be impacted due to heavy haul road and construction access road development, 0.81 acre of jurisdictional wetland would be impacted due to laydown area construction, and 4.14 acres of jurisdictional wetlands would be impacted due to power block construction. The majority of the impacts (28.17 acres) would be to forested wetlands; however, 0.74 acre of the impacts would be to emergent wetlands and 0.36 acre of impacts would be to open water. Stream impacts associated with this alternative include 9,752.88 linear feet (20,877.13 square feet) to perennial and intermittent stream channels. Of these total impacts, 525.90 linear feet (1,235.80 square feet) would be temporary impacts, and 9,226.98 linear feet (19,641.33 square feet) would be permanent impacts. The following table summarizes the impacts that would result from the construction of Alternative B.

Table 1-2. Potential Impacts to Wetlands, Streams, and CBCA from Construction of Alternative B
CCNPP Unit 3, Calvert County, Maryland

	Impacts to Jurisdictional Waters					
	Permanent Impacts		**Temporary Impacts**		**Total Impacts**	
	LF	**SF**	**LF**	**SF**	**LF**	**SF**
Stream Impacts	9,226.98	19,641.33	525.90	1,235.80	9,752.88	20,877.13
Wetland Impacts	**Acres**	**SF**	**Acres**	**SF**	**Acres**	**SF**
PEM	0.63	27,442.80	0.11	4,791.60	0.74	32,234.40
PFO	25.38	1,105,552.80	2.79	121,532.40	28.17	1,227,085.20
POW	0.36	15,681.60	0	0	0.36	15,681.60
Total Wetland Impacts	**26.37**	**1,148,677.20**	**2.9**	**126,324**	**29.27**	**1,275,001.20**
					Acres	**SF**
CBCA Impacts					59.0	2,570,040

Notes:
CBCA – Chesapeake Bay Critical Area
LF – Linear Feet
PEM – Palustrine Emergent
PFO – Palustrine Forested
SF – Square Feet

Prepared by: AES 11/14/2008
Checked by: RMR 11/14/2008

Conversion impacts to wetlands currently classified as forested and emergent wetlands would result after construction of Alternative B. The forested wetlands adjacent to the once-through cooling system (2.44 acres) in the northernmost right corner of the site; the forested wetlands adjacent to the switchyard (0.09 acre); the forested wetlands adjacent to the heavy haul road (0.02 acre); and the forested wetlands (0.25 acre) adjacent to the construction access road would become scrub shrub due to the potential for shading and human activities. The emergent and forested wetlands adjacent to the laydown area (0.11 acre) would remain emergent and forested unless excessive drainage and bulldozing occurred.

The impacts described for Alternative B are equal to the impacts described for Alternative A. Because neither alternative showed reduced impacts to jurisdictional waters or the CBCA, other alternatives were evaluated as described below.

1.2.3 Alternative C

Alternative C (Figure 1.2-3) would require extending the existing switchyard south and reconfiguring the transmission lines south to the new bay to allow for space on the north end to connect with the new switchyard. A significant amount of grubbing, clearing, and cut and fill is anticipated for this option. Most of the property north of the main access road is heavily forested outside of the cleared land around the visitor center and security access point. A significant amount of cut and fill would be required to create a plant grade at approximate elevation of 75 feet and fill in the ravines and valleys on each side of fire road A-2 and the large valley at the north end of the property. A large wetland (approximately 48 acres) is identified in the northern section of the property.

Construction of Alternative C would result in a total of 26.67 acres of impacts to jurisdictional wetlands. Of these total impacts, 22.63 acres would be permanent and 4.04 acres would be temporary. In addition, there would also be impacts totaling 39.51 acres to the CBCA. Based on construction activities, approximately 4.39 acres of jurisdictional wetlands would be impacted due to cooling tower construction, 5.18 acres of jurisdictional wetlands would be impacted due to powerblock construction, 13.89 acres of jurisdictional wetlands would be impacted due to retention basin construction, 1.69 acres of jurisdictional wetland would be impacted due to heavy haul road and construction access road development, 1.44 acres of jurisdictional wetland would be impacted due to laydown area construction, and 0.08 acre would be impacted due to transmission line construction. The majority of the impacts (25.80 acres) would be to jurisdictional forested wetlands; however, 0.61 acre of the impacts would be to emergent wetlands and 0.26 acre of the impacts would be to open water. Stream impacts associated with this alternative include 11,473.84 linear feet (26,914.17 square feet) to perennial and intermittent stream channels. Of these total impacts, 1,065.44 linear feet (2,681.82 square feet) are temporary impacts and 10,408.40 linear feet (24,232.35 square feet) are permanent impacts. The following table summarizes the impacts that would occur as a result of construction of Alternative C.

Table 1-3. Potential Impacts to Wetlands, Streams, and CBCA from Construction of Alternative C CCNPP Unit 3, Calvert County, Maryland

	Impacts to Jurisdictional Waters					
	Permanent Impacts		**Temporary Impacts**		**Total Impacts**	
	LF	**SF**	**LF**	**SF**	**LF**	**SF**
Stream Impacts	10,408.40	24,232.35	1,065.44	2,681.82	11,473.84	26,914.14
Wetland Impacts	**Acres**	**SF**	**Acres**	**SF**	**Acres**	**SF**
PEM	0.48	20,908.80	0.13	5,662.80	0.61	26,571.60
PFO	22.15	964,854	3.65	158,994	25.80	1,123,848
POW	0	0	0.26	11,325.60	0.26	11,325.60
Total Wetland Impacts	**22.63**	**985,762.80**	**4.04**	**175,982.40**	**26.67**	**1,161,745.20**
					Acres	**SF**
CBCA Impacts					39.51	1,721,055.60

Notes:
CBCA – Chesapeake Bay Critical Area
LF – Linear Feet
PEM – Palustrine Emergent
PFO – Palustrine Forested
POW – Palustrine Open Water
SF – Square Feet

Prepared by: AES 11/14/2008
Checked by: RMR 11/14/2008

Conversion impacts to wetlands currently classified as forested, scrub shrub and emergent wetlands would result in reclassification at the completion of construction of Alternative C. The forested wetlands adjacent to the cooling tower and the power block (0.31 acre) and the forested wetlands adjacent to the heavy haul road (0.05 acre) would become scrub shrub due to the potential for shading and maintenance activities.

Alternative C results in fewer impacts to jurisdictional wetlands as compared to Alternatives A and B. This alternative also has fewer impacts to the CBCA and results in fewer conversions of wetland cover types. Alternative C, however, has a greater impact to intermittent and perennial streams than Alternatives A and B.

1.2.4 Preferred Alternative

For the Preferred Alternative (Figure 1.2-4), the existing switchyard would be expanded south and the transition would be made from the Unit 3 switchyard to the existing switchyard. Less grubbing, clearing, and cut and fill are anticipated for the Preferred Alternative. Proposed locations for the batch plant, laydown, and parking areas are either clear fields or lightly forested areas. The Lake Davies area is proposed for the laydown yard. Areas around Camp Conoy are also clear fields. Wetlands in the southern location consist primarily of the Camp Conoy fishing pond and three water retention ponds that lead from the fishing pond to the Chesapeake Bay. The Preferred Alternative is located farther inland than Calvert Cliffs Units 1 and 2 to stay outside the CBCA.

The Preferred Alternative would result in a total of 11.72 acres of impact to jurisdictional wetlands. These impacts are permanent. Based on construction activities, approximately 0.75 acre of jurisdictional wetlands would be impacted due to cooling tower construction; 0.72 acre of jurisdictional wetland would be impacted due to construction access road development; 0.03 acre of isolated wetland would be impacted due to power block construction; 4.13 acres of jurisdictional wetland would be impacted due to switchyard construction; and 6.09 acres of jurisdictional wetland would be impacted due to laydown area construction. The majority of the impacts (7.88 acres) would be to jurisdictional forested wetlands; however, 1.21 acres of these impacts would be to emergent wetlands and 2.63 acres of impacts would be to open water. Other impacts associated with this alternative include impacts of 8,350.08 linear feet (22,983.51 square feet) to perennial and intermittent stream channels. These impacts are permanent. There would also be 26.89 acres of impact to the CBCA as a result of construction of the Preferred Alternative. The following table summarizes the impacts that would result from construction of the Preferred Alternative.

Table 1-4. Potential Impacts to Wetlands, Streams, and CBCA from Construction of the Preferred Alternative, CCNPP Unit 3, Calvert County, Maryland

	Impacts to Jurisdictional Waters					
	Permanent Impacts		**Temporary Impacts**		**Total Impacts**	
	LF	**SF**	**LF**	**SF**	**LF**	**SF**
Stream Impacts	8,350.08	22,983.51	0	0	8,350.08	22,983.51
Wetland Impacts	**Acres**	**SF**	**Acres**	**SF**	**Acres**	**SF**
PEM	1.21	52,707.60	0	0	1.21	52,707.60
PFO	7.88	343,252.80	0	0	7.88	343,252.80
POW	2.63	114,562.80	0	0	2.63	114,562.80
Total Wetland Impacts	**11.72**	**510,523.20**	**0**	**0**	**11.72**	**510,523.20**
					Acres	**SF**
CBCA Impacts					26.89	1,171,328.4

Notes:
CBCA – Chesapeake Bay Critical Area
LF – Linear Feet
PEM – Palustrine Emergent
PFO – Palustrine Forested
POW – Palustrine Open Water
SF – Square Feet

Prepared by: AES 11/14/2008
Checked by: RMR 11/14/2008

Under the Preferred Alternative, there are no conversion impacts to wetlands.

The following table compares the potential impacts to wetlands, streams, total area of limit of disturbance (LOD) and CBCA impacts on the CCNPP site for the four alternative site layouts discussed above.

Table 1-5. Impacts to Wetlands, Streams, LOD and CBCA for Alternative Site Layouts, CCNPP Unit 3, Calvert County, Maryland

Alternative Site Layouts	Impacts as a Result of Alternative Construction							
	Wetlands		Streams		LOD		CBCA	
	Acres	SF	LF	SF	Acres	SF	Acres	SF
Alternative A	29.27	1,275,001.2	9,752.88	20,877.13	428	18,643,680	59	2,570,040
Alternative B	29.27	1,275,001.2	9,752.88	20,877.13	428	18,643,680	59	2,570,040
Alternative C	26.67	1,161,745.2	11,473.84	26,914.14	510	22,215,600	39.51	1,721,056
Preferred Alternative	11.72	510,523.20	8,350.08	22983.51	405	17,641,800	26.89	1,171,328

Notes:
CBCA – Chesapeake Bay Critical Area
LF – Linear Feet
LOD – Limit of Disturbance
SF – Square Feet

Prepared by: AES 11/14/2008
Checked by: RMR 11/14/2008

Overall impacts to jurisdictional wetlands were reduced in the Preferred Alternative from Alternatives A, B, and C. There would be an approximately 17.55-acre decrease in jurisdictional wetland impacts from Alternatives A and B and an approximate 14.95-acre decrease in impacts from Alternative C. Impacts to streams were also reduced in the Preferred Alternative from Alternatives A, B, and C. There is an approximate 1,402.8-linear feet decrease in stream impacts from Alternatives A and B to the Preferred Alternative and an approximate 3,123.76-linear feet decrease from Alternative C to the Preferred Alternative. Along with wetland and stream impact decreases, the Preferred Alternative also has a 23-acre decrease in total LOD over Alternatives A and B and a 105-acre decrease in total LOD over Alternative C. Concerning the CBCA, there was an approximate 32.11 acre decrease in impacts from Alternative A and B to the Preferred Alternative and an approximate 12.62 acres decrease in impacts from Alternative C to the Preferred Alternative.

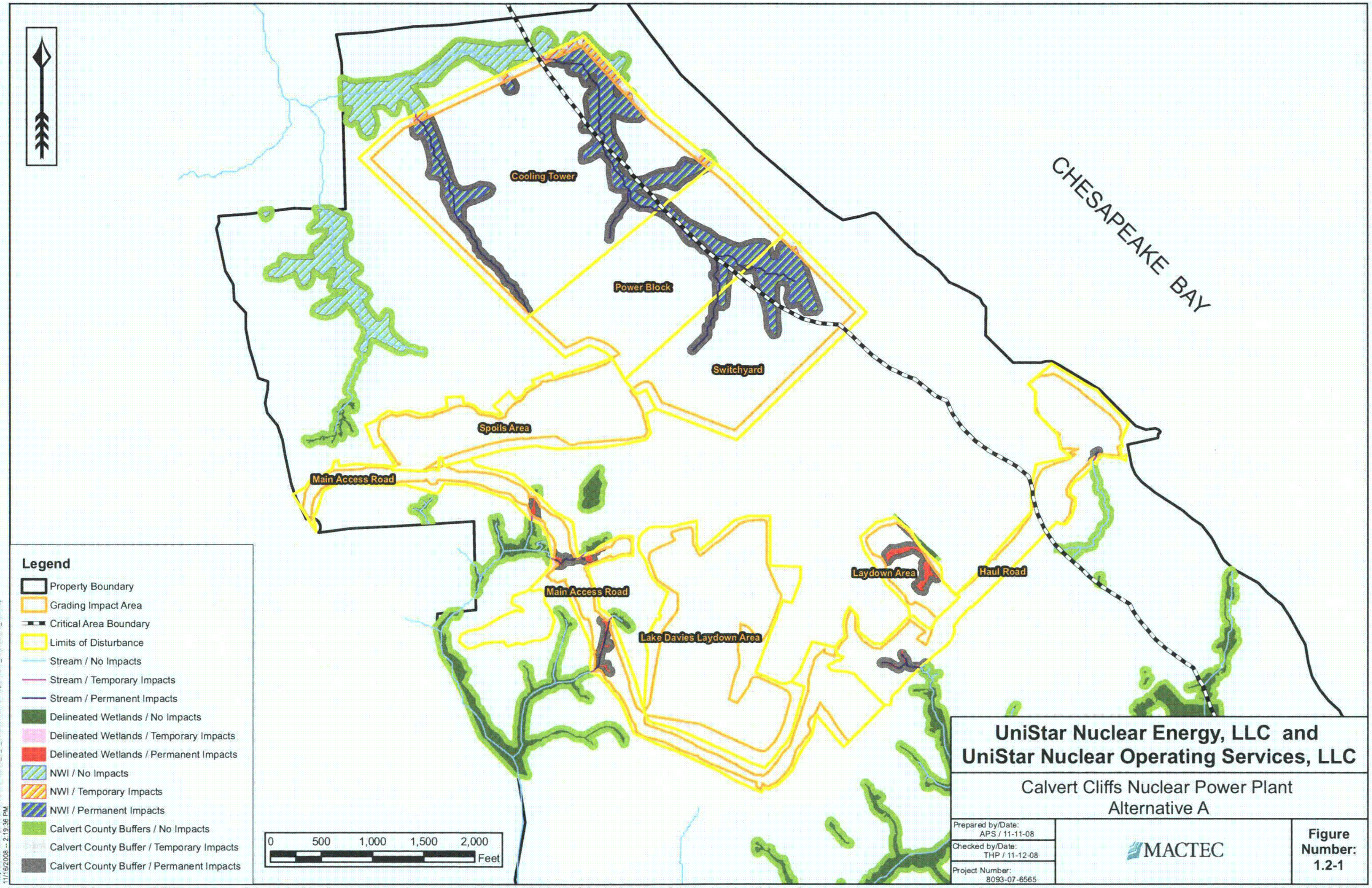
Based on the results of the alternative site layout analysis, the Preferred Alternative was selected as the proposed site layout that best addresses avoidance and minimization of wetland impacts.

1.3 NO ACTION ALTERNATIVE

Under this alternative, CCNPP would not develop an additional EPR unit at the site. The CCNPP site is an existing nuclear power facility and would likely continue in this capacity for quite some time. Considering the current condition of the on-site wetlands and current land use, wetland impacts could be expected to occur under the No Action Alternative. Due to the strict regulations promulgated by State and federal programs regarding jurisdictional waters impacts, it is unlikely that substantial unregulated impacts to jurisdictional waters, including wetlands, would occur. However, some impacts from this category would be expected. No impact to federal- or State-listed threatened or endangered animals or plants, or their habitats, would occur under this alternative. In addition, no impact to the existing on-site cultural resources would occur under this alternative.

1.4 REFERENCES

Bechtel Power Group, 2006. *UniStar Calvert Cliffs Nuclear Power Plant Units 3 and 4 Cooling System Selection and Site Layout Study*. March.



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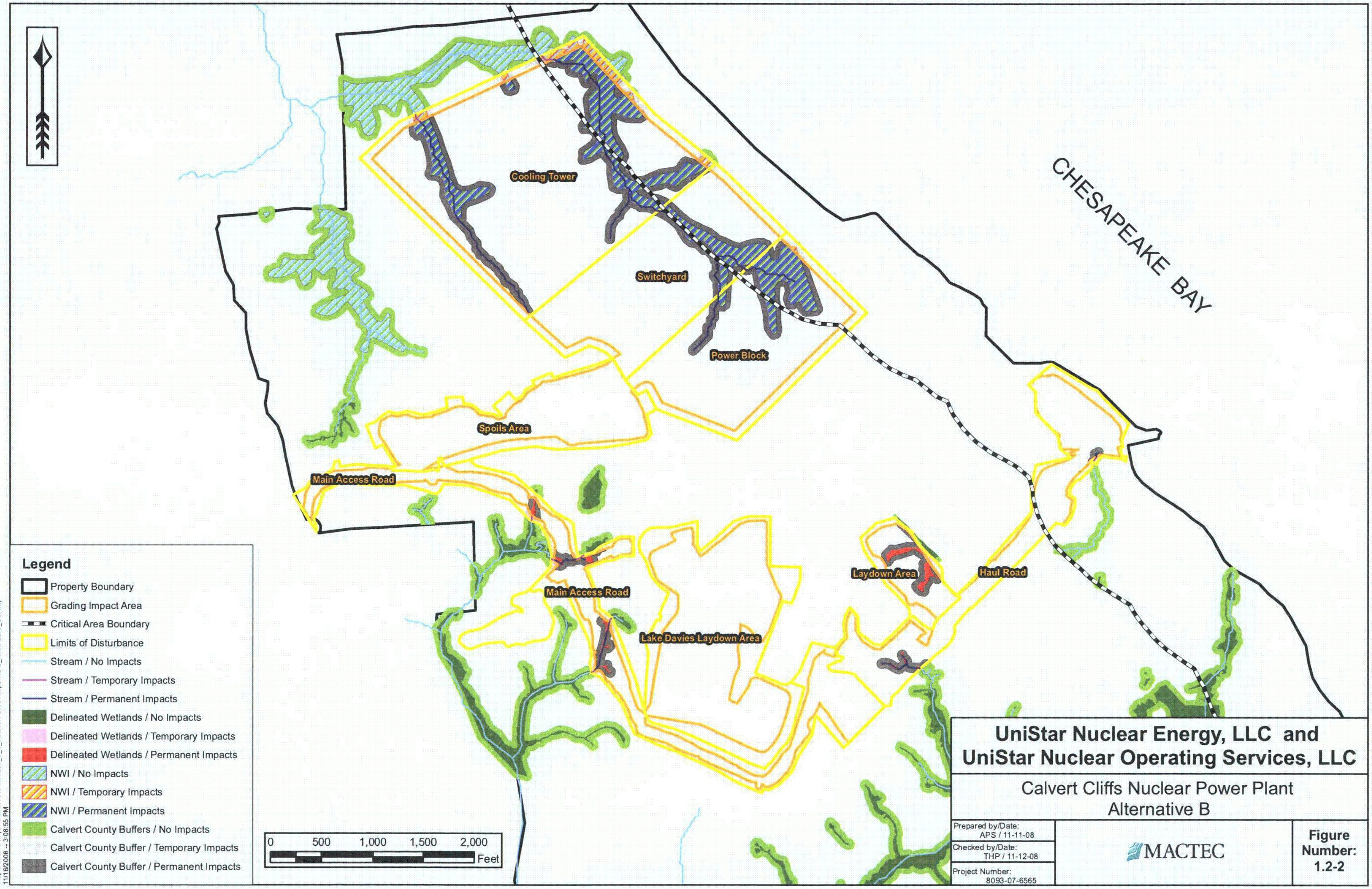

UniStar Nuclear Energy, LLC and UniStar Nuclear Operating Services, LLC

Calvert Cliffs Nuclear Power Plant
Alternative B

Prepared by/Date: APS / 11-11-08	MACTEC	**Figure Number: 1.2-2**
Checked by/Date: THP / 11-12-08		
Project Number: 8093-07-6565		

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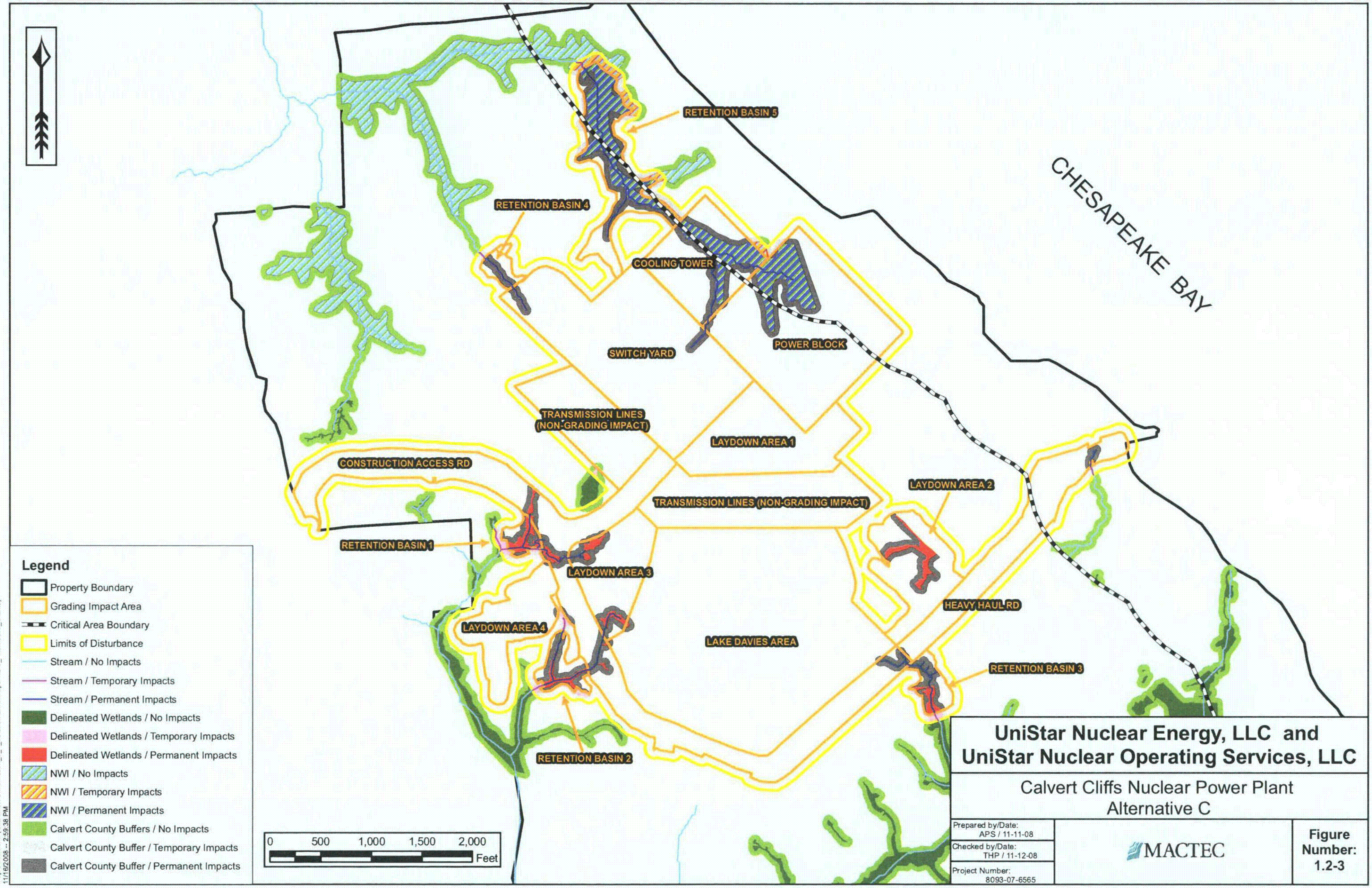

UniStar Nuclear Energy, LLC and UniStar Nuclear Operating Services, LLC

Calvert Cliffs Nuclear Power Plant
Alternative C

Prepared by/Date: APS / 11-11-08
Checked by/Date: THP / 11-12-08
Project Number: 8093-07-6565

MACTEC

Figure Number: 1.2-3

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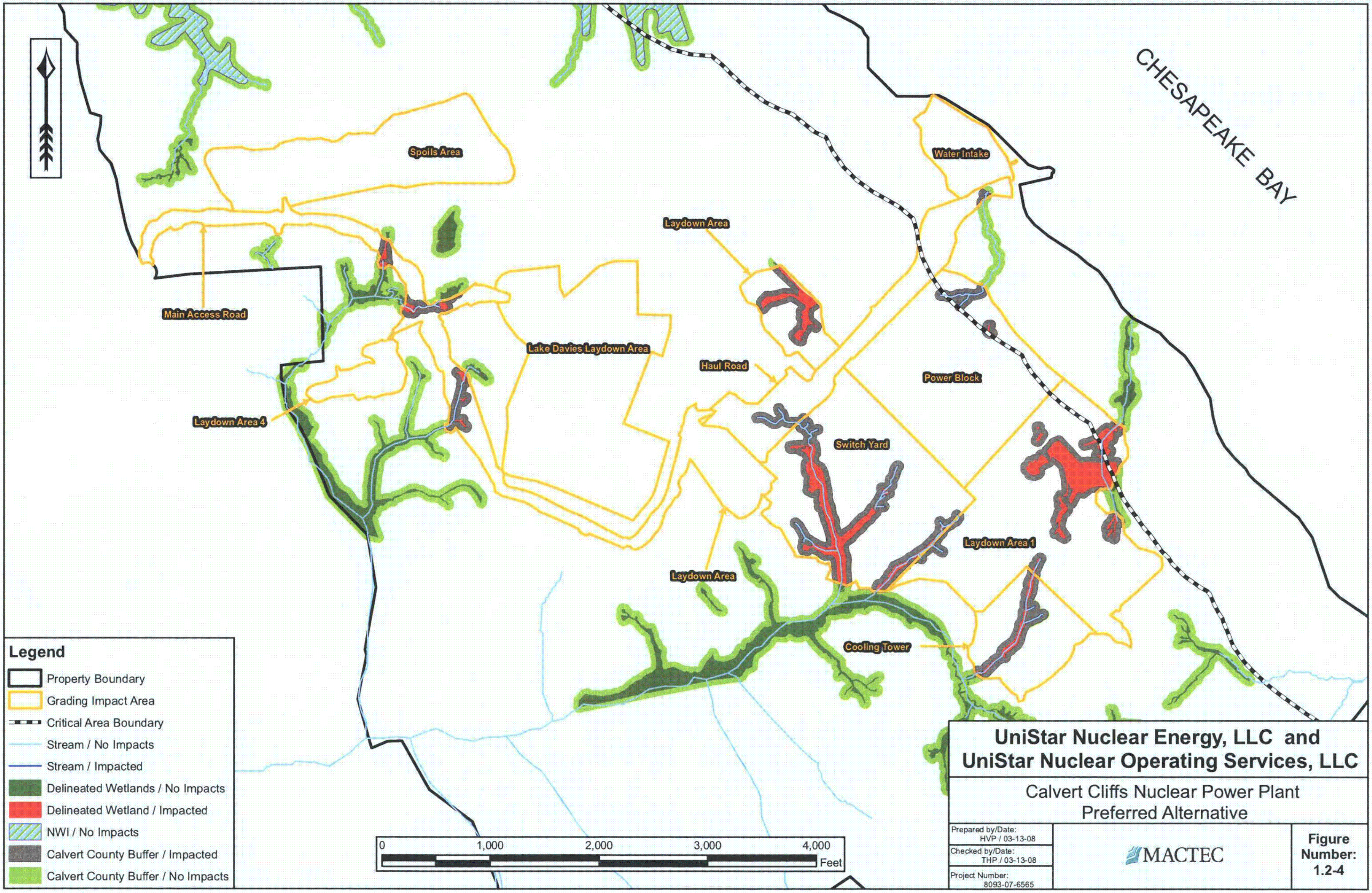
CHESAPEAKE BAY
Spoils Area
Water Intake
Laydown Area
Main Access Road
Lake Davies Laydown Area
Haul Road
Power Block
Laydown Area 4
Switch Yard
Laydown Area 1
Laydown Area
Cooling Tower
Legend
Property Boundary
Grading Impact Area
Critical Area Boundary
Stream / No Impacts
Stream / Impacted
Delineated Wetlands / No Impacts
Delineated Wetland / Impacted
NWI / No Impacts
Calvert County Buffer / Impacted
Calvert County Buffer / No Impacts
0
1,000
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Feet
UniStar Nuclear Energy, LLC and
UniStar Nuclear Operating Services, LLC
Calvert Cliffs Nuclear Power Plant
Preferred Alternative
Prepared by/Date: HVP / 03-13-08
Checked by/Date: THP / 03-13-08
Project Number: 8093-07-6565
MACTEC
Figure Number: 1.2-4

Application NAB-2007-08123-M05
Response to U.S. Army Corps of Engineers Information Request Dated 10/28/08
Calvert Cliffs 3 Project, LLC and UniStar Nuclear Operating Services, LLC
December 2, 2008

Question 6

A detailed mitigation plan

- a. **Proposed mitigation methods.**
- b. **Proposed mitigation site(s).**
- c. **Wetland creation and enhancement plans.**
  - i. **Planting and grading plans.**
  - ii. **Hydrologic inputs and maintenance of hydrology.**
  - iii. **Monitoring and restoration plan.**
- d. **Stream Mitigation**
  - i. **Baseline plan**
  - ii. **Existing site conditions plan including photographic documentation; channel cross section; pattern and profile; ordinary high water mark (OHWM); and channel and structure stability in relationship to permanent survey markers that shall be installed.**
  - iii. **Proposed project plans.**
  - iv. **Project plans related to the existing site conditions and the proposed conditions, including all structures or fill; dimensions of structures or fill; proposed water depths relative to the OHWM; channel cross section; pattern and profile; and channel and structure stability in relationship to permanent survey markers.**
- e. **Distinction between the wetland and stream mitigation plan, critical areas mitigation plan, forest mitigation plan and forest interior dwelling bird (FIDS) habitat mitigation plan.**

RESPONSE

6a-d Attached is a copy of the Concept Nontidal Wetland and Stream Mitigation Plan. A final mitigation plan will be submitted prior to issuance of the US Army Corps of Engineers non-tidal wetland permit. This final mitigation plan will incorporate appropriate changes based upon the collection of additional field data, input from various agencies, and public comment.

6e The Concept Nontidal Wetland and Stream Mitigation Plan for the CCNPP Unit 3 project proposes wetland creation and enhancement and stream restoration and enhancement as mitigation for the loss of jurisdictional waters of the United States and waters of the State of Maryland as a result of development of the Unit 3 facility. This compensatory mitigation plan does not include mitigation for impacts to the Chesapeake Bay Critical Area (CBCA), even though one of the proposed mitigation sites occurs in the CBCA. Selection of candidate sites for the CBCA mitigation plan, the forest mitigation plan, and the forest interior dwelling species (FIDS) habitat mitigation plan are being considered separately, and the proposed forested wetland creation site has been designed to have the added advantage of being consistent with the habitat goals for the CBCA-continuous forest canopy and FIDS habitat. Figure 1-6e, attached, presents the mitigation sites for the wetland and stream mitigation plan, the forest mitigation plan, and the FIDS habitat mitigation plan.

UNITED STATES ARMY CORPS OF ENGINEERS

REQUEST FOR ADDITIONAL INFORMATION
DATED OCTOBER 28, 2008

ITEM 6 RESPONSE

December 1, 2008

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1.0 EXECUTIVE SUMMARY

MACTEC Engineering and Consulting, Inc. (MACTEC) has reviewed the request for additional information (RAI) from the U.S. Department of the Army (USACE), Item Number 6, in USACE correspondence received on October 28, 2008, in context to the protocols in the Maryland Compensatory Mitigation Guidance [Interagency Management Task Force (IMTF), 1994]. MACTEC concurs with the USACE in regard to the intent to continue to develop a Phase II Final Mitigation Plan for the Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 facility. While there are many steps to accomplishing the Phase II Final Mitigation Plan per the IMTF guidance, the immediate effort requires that MACTEC refine the existing concept elements as provided in the draft mitigation plan presented in Section 7.0 of the "Supplemental Environmental Resource Report" (dated May 16, 2008), as included in the Joint Permit Application (JPA). This refinement is accomplished by incorporating a greater level of detail and technical quality onto that previously submitted. Please note that this document and the aforementioned Phase II Final Mitigation Plan present the compensatory mitigation plan for proposed impacts to nontidal wetlands on the CCNNP Unit 3 project. The compensatory mitigation plan for proposed impacts to tidal wetlands on the CCNPP Unit 3 project will be addressed by UniStar.

MACTEC is herein providing a concept level design to the degree of addressing RAI Item Number 6, with the intent to later develop intermediate and final Phase II permitting documents. This concept design consists of:

1. **Supplemental Qualitative/Quantitative Observations and Data** regarding the potential and need for ecological lift at each of the proposed wetland and stream mitigation sites. Existing Conditions Photos will depict the disturbed condition of each proposed mitigation site, based on 2007 LIDAR data and ground-level photography acquired during 2008 site visits. Accompanying narrative will describe the observed condition and the proposed treatment to restore ecological function and value.

2. **Concept Design Plans** (not for construction) that show in plan view the existing contours of the proposed mitigation sites at the location of the proposed treatment. Corresponding concept representative channel treatments, instream structures, wetland creation and enhancement activities, and planting plan and monitoring program will be provided as the design progresses toward a Phase II mitigation plan.

The compensatory mitigation plan (inclusive of the concept design) for the CCNPP Unit 3 project proposes wetland creation and enhancement and stream restoration and enhancement as mitigation for the loss of jurisdictional, nontidal waters of the United States and nontidal waters of the State of Maryland as a result of development of the Unit 3 facility. The compensatory mitigation plan does not include mitigation for impacts to the Chesapeake Bay Critical Area (CBCA), even though one of the proposed mitigation sites occurs in the CBCA. Selection of candidate sites for the CBCA mitigation plan, the forest mitigation plan, and the forest interior dwelling species (FIDS) habitat mitigation plan was conducted separately and exclusively from the selection of candidate sites for wetland and stream creation, enhancement, and restoration. The proposed forested wetland creation site (under the compensatory mitigation plan) within the CBCA is not required by the Critical Area Commission (CAC) as mitigation for impacts to jurisdictional streams or wetlands within the CBCA. Although the CAC will require mitigation for impacts within the CBCA, no CAC/CBCA rules exist which require this mitigation to be in the form of forested wetland creation. Finally, the CAC has had an opportunity to review the mitigation plan as presented in Section 5 of the Calvert Cliffs Unit 3 submission to the Critical Area Commission Chesapeake and Atlantic Coastal Bays, dated May 7 2008, and is in general agreement with the intent and proposed activities of this plan. In particular, the selection of the aforementioned wetland mitigation site in the CBCA will provide in-kind forested wetland creation, as mitigation for forested wetland impacts, and increase the amount of FIDS habitat within the Camp Conoy area. The wetland creation activities will also be accomplished through the planting of desirable, native, wetland plant species that are common to the CCNPP property, to the extent possible.

It should be noted that refining the concept design to an acceptable level of detail and quality sufficient for the Phase II Mitigation Plan submittal will include additional field data collection to establish more detailed understanding of the existing conditions and site potential and provide discrete evidence of the associated lift in ecological function and value.

The Environment Article Annotated Code of Maryland (ACM) 5-901—5-911, defines the Maryland Department of the Environment (MDE) as the authority over approving impacts and mitigation. According to the Code of Maryland (COMAR) regulations (COMAR 26.23.04.02), a "permittee shall take all necessary steps to first avoid adverse impacts and then minimize losses of nontidal wetlands. If the permittee demonstrates to the Department's satisfaction that losses of nontidal wetlands are unavoidable and necessary, the Department shall require the permittee to develop and implement mitigation practices." The State of Maryland identifies the requirements and considerations (COMAR 26.23.04.05) of the mitigation plan including information to be included with the permit application, elements of the Phase I mitigation plan to be reviewed by the MDE for ultimate rendering of approval or disapproval and in the case of approval, subsequent guidance toward a Phase II mitigation plan.

With these considerations, the Phase II Final Mitigation Plan for CCNPP Unit 3 cannot be initiated until the review agencies provide concurrence; i.e., the MDE accepts the Phase I Conceptual Mitigation Plan as the appropriate approach to provide compensatory mitigation for project related impacts to waters of the State of Maryland.

The draft mitigation plan presented in Section 7.0 of the "Supplemental Environmental Resource Report", as included in the JPA, addressed the above items which are relevant to the project. The concept design document presented herein provides refinement to the basic components of the Phase I Mitigation Plan, i.e., supplemental qualitative/quantitative observations and data and the concept design plan for the proposed wetland creation and enhancement and stream restoration and enhancement activities.

Finally, the Phase II Final Mitigation Plan will be prepared in accordance with the protocols presented in the *Maryland Compensatory Mitigation Guidance* (IMTF, 1994) and the USACE Regulatory Guidance Letter No. 08-03 (*Minimum Monitoring Requirements for Compensatory Mitigation Projects Involving the Restoration, Establishment, and/or Enhancement of Aquatic Resources*), dated October 10, 2008.

2.0 WETLAND MITIGATION PLAN BACKGROUND

Compensatory mitigation for unavoidable impacts to approximately 11.72 acres of jurisdictional, nontidal forested wetlands, emergent (herbaceous) wetlands, and surface waters (including Camp Conoy Fishing Pond) (USACE and/or MDE jurisdictional) will be required to complete the project. After field reconnaissance and site walk-through of the CCNPP property in 2007 and 2008, including the CCNPP Unit 3 project area, specific locations were identified as having ecological lift potential for wetland enhancement or being suitable for the creation of wetland communities from upland landscape. Data on vegetative, hydrologic, and soil conditions were collected at potential mitigations site locations to determine if enhancement or creation could be successfully achieved. Prior to intermediate design implementation, additional detail data will be collected as required to meet the requirements in the *Mitigation and Monitoring Guidelines* (Baltimore District Regulatory Program, U.S. Army Corps of Engineers, November 2004) and the protocols in the *Maryland Compensatory Mitigation Guidance* (IMTF) and to supplement the reconnaissance field data collected in 2007 and 2008.

Common functions of wetlands are groundwater recharge, groundwater discharge, floodflow alteration, sediment/shoreline stabilization, sediment/toxicant retention, nutrient removal/transformation, production export, aquatic diversity/abundance, and wildlife diversity/abundance. Common values of wetlands are recreation, uniqueness/heritage, education/scientific value, and visual quality/aesthetics. The Ohio Rapid Assessment Method (ORAM), as outlined in the *Ohio Rapid Assessment Method for Wetlands* (Version 5.0 updated February 2001) (Mack, 2001) was used to quantify the functions and values of wetland communities on the CCNPP Unit 3 project site in order to determine the appropriate level of mitigation. The areas assessed were the wetlands being impacted by the development and, in order to determine the viability of mitigation sites, the wetlands not being impacted. Section 5.0 of the "Supplemental Environmental Resource Report", as included in the JPA, presents the results of the 2008 field evaluation of the functions and values of the wetland areas proposed for impact and the wetland areas considered for selection as potential mitigation sites.

The wetlands proposed for impact, which were evaluated through ORAM, were located in the headwaters of Johns Creek, the headwaters of Goldstein Branch, the Camp Conoy area, and Branch 1 and Branch 2 located along Chesapeake Bay. A substantial portion of the impacts to wetland areas on the CCNPP Unit 3 site are wetland systems which are degraded. The forested wetland area which abuts the parking lot located to the south of the existing CCNPP plant warehouse and administration building had the fewest functions and values of wetland areas proposed for impact; i.e., with degraded wildlife habitat and visual quality/aesthetics.

Among the group of wetlands that are not being impacted by development of the CCNPP Unit 3 facility, specific sites were selected which would benefit from mitigation, through an increase in wetland values and functions. The wetland mitigation opportunities will include creation and enhancement within the Lake Davies Disposal Area (sediment basins) and the portion of Johns Creek located to the south of the sediment basins, as well as a upland grassed field located at the Camp Conoy area (wetland creation site).

Phragmites (*Phragmites communis*) is found throughout the entire site, especially within the wetland sites proposed for mitigation. By eradicating phragmites, the wetlands infested with this nuisance species will have uplift for wildlife habitat (wetland function). Increased diversification of native plant species will also be provided through the planting of these mitigation sites with native bottomland hardwood tree species and/or shrubs. Finally, by removing the phragmites from the degraded wetlands, a more normal hydropattern will be established.

As previously stated, field reconnaissance and site walk-through of the CCNPP property was conducted in 2007 and 2008, including the CCNPP Unit 3 project area, to identify suitable mitigation sites for wetland enhancement and wetland creation. Potential mitigation sites were eliminated from further consideration if it was determined that enhancement or creation could not be achieved without difficulty. In some cases, the footprint of the CCNPP Unit 3 facility precluded the selection of potentially suitable mitigation sites, where modifications to the site layout would be problematic. The most desirable mitigation site, which was subsequently eliminated from further consideration, was the open grass field which occurs northwest of the old Visitor Center parking lot (approximately 2 acres in size). This field drains into an unnamed tributary of Woodland Branch. This potential mitigation site was not selected because the watershed which encompasses this area would not provide a sufficient source of hydrology to provide an opportunity for wetland creation.

The wetland mitigation component of the compensatory mitigation plan includes the following proposed activities:

- The creation of forested wetland habitat within the Camp Conoy area which lies within the CBCA (Mitigation Site WC-1);

- The creation of forested and herbaceous wetland habitat within the middle manmade, abandoned, sediment basin of the Lake Davies Disposal Area (Mitigation Site WC-2);
- The enhancement of a smaller manmade, abandoned, sediment basin within the Lake Davies Disposal Area (Mitigation Site WE-1);
- The enhancement of a portion of Johns Creek and a linear drainageway extension occurring to the south of the Lake Davies Disposal Area (Mitigation Site WE-2);
- The eradication of phragmites through herbicide application (Mitigation Sites WC-2, WE-1, and WE-2); and
- Soil material from impacted on-site wetland areas which do not contain phragmites will be used in the creation mitigations sites as a supplemental growth medium (Mitigation Sites WC-1 and WC-2).

Following the completion of the on site wetland creation and wetland enhancement activities for the CCNPP Unit 3 project, a five-year annual monitoring program will be implemented in accordance with the requirements of the *Mitigation and Monitoring Guidelines* (USACE) and the protocols in the *Maryland Compensatory Mitigation Guidance* (IMTF, 1994). Furthermore, the monitoring program will be conducted pursuant to the Maryland Department of the Environment, Water Management Administration (MDEWMA) mitigation monitoring guidelines and protocols. The targets for the creation and enhancement efforts will be divided into two specific components:

1. The creation and enhancement of wetland communities, and
2. The creation of wetland hydrology within the created wetlands.

The success criteria for the monitoring program will include, at a minimum, the success of the planted vegetation, as measured through survivorship counts and observations of vitality and growth, and the existence of wetland hydrology for the created wetlands. If success criteria have been satisfied at the completion of the five-year monitoring program, a request for release from monitoring will be made to the USACE and/or MDEWMA.

With regard to protective mechanisms, the wetland mitigation area will be protected into perpetuity through establishment of a legally-binding deed restriction. The deed restrictions generally will follow the standard USACE Baltimore District model for such instruments. Ownership of the mitigation area will likely reside with CCNPP or its assigns, until such a time when CCNPP decides to sell the property or donate it to a public agency or private conservation organization. If the mitigation area should ever be sold, appropriate protective mechanisms (which will have been recorded) will remain in effect and will remain with the site into perpetuity. Section 7.0 of the "Supplemental Environmental Resource Report" presented in the JPA provides further elaboration of proposed protective mechanisms for the project, along with information on adaptive management plans for the mitigation area, if required.

For the CCNPP Unit 3 project, in-kind wetland mitigation is being proposed herein. The following mitigation ratios and credits have been utilized for the wetland component of the compensatory mitigation plan:

Table 1. Wetland Mitigation Ratios and Credit, CCNPP Unit 3 Site, Calvert County, Maryland

Type of Wetland	Mitigation Type	Mitigation Quantity (Acre)	Mitigation Ratio	Credit Amount
Emergent	Creation	1.3	1:1	1.3
Forested	Creation	11.8	2:1	5.9
Forested	Enhancement	18.1	3:1	6.03
			TOTAL	13.23

The use of a 3:1 mitigation credit ratio for enhancement is based on controlling phragmites coupled with the planting of native bottomland hardwood species.

3.0 EXISTING WETLAND DATA

After field reconnaissance and site walk-through of the CCNPP property, including the CCNPP Unit 3 project area, specific locations were identified as having ecological lift potential for wetland enhancement or being suitable for the creation of wetland communities from upland landscape. Data on vegetative, hydrologic, and soil conditions were collected at potential mitigation site locations to determine if enhancement or creation could be achieved successfully. Prior to intermediate design implementation, additional detailed data will be collected as required to meet the *Mitigation and Monitoring Guidelines* (Baltimore District Regulatory Program, USACE, November 2004) and to supplement the reconnaissance field data collected in 2007 and 2008.

3.1 Wetland Creation Mitigation Sites

Mitigation Site WC-1

Mitigation Site WC-1 is located adjacent to the northern boundary of the CCNPP Unit 3 project area within the Camp Conoy area, which lies within the CBCA (see Concept Plan Sheet 8, Appendix A). The WC-1 site is the only mitigation area among the total of four proposed wetland mitigation sites that occurs within the CBCA. The selection of the WC-1 site resulted from an opportunity to route stormwater from the Unit 3 facility to the proposed forested wetland creation site, thereby providing a source of hydrology for this mitigation site. The proposed forested wetland creation site within the CBCA is not required by the CAC as mitigation for impacts to jurisdictional streams or wetlands within the CBCA. Although the CAC will require mitigation for impacts within the CBCA, no CAC/CBCA rules exist which require this mitigation to be in the form of forested wetlands.

The WC-1 site is a ruderal area, which is primarily comprised of grasses and forbs (see Photo 1). A fenced tennis court occurs within the northern portion of the mitigation site. The existing vegetation and the soil profile within the WC-1 site were examined during field reconnaissance. Soil probing was conducted to describe profile horizons and determine the general hydrology of the area. Based on soil probes, it appears that fill material of varying depths and soil textures have been placed over the native soils. Drainage is generally to the east to forested uplands.

Photo 1: Photo depicts the current site conditions within the proposed WC-1 site. Photo taken from southern end of site, looking to the north.

Mitigation Site WC-2

Mitigation Site WC-2 is located within the Lake Davies Disposal Area, near the western boundary of the CCNPP Unit 3 project area (see Concept Plan Sheet 5, Appendix A). The Lake Davies Disposal Area was created during the construction of CCNPP Units 1 and 2 as a disposal area for dredged material from the project area. The WC-2 site occurs as the middle of three sediment basins (i.e., upper, middle, and lower basins) which are separated from each other by elevated berms. The middle and lower basins are man-made but support hydrophytes within areas of hydric soils and also exhibit wetland hydrology. The existing site conditions of the basins provide an opportunity for the implementation of nontidal wetland mitigation strategies.

The existing vegetation and the soil profile within the WC-2 site were examined during field reconnaissance (see Photos 2 and 3). The dredge materials are covered by a dense stand of phragmites. Its presence on the dredge material piles and within the two sediment basins is likely a result of propagules (seeds and rhizome fragments) contained in the dredge materials. The WC-2 site is presently dominated by phragmites. The perimeter of this mitigation site is comprised of red maple (*Acer rubrum*), tulip poplar (*Liriodendron tulipifera*), black willow (*Salix nigra*), and rattlebush (*Sesbania* sp.). The central portion of the WC-2 site is generally flooded and lacks emergent vegetation. Based on soil probes, it appears that sands and other soil material have migrated into the basin from the surrounding uplands and the berm area. In addition, field observations indicate the presence of hydric soils and wetland hydrology within this proposed wetland creation mitigation site. These sequentially connected basins carry water from the dredge materials area to Johns Creek and Goldstein Branch. A culvert hydrologically connects the middle basin to the lower sediment basin (WE-1).

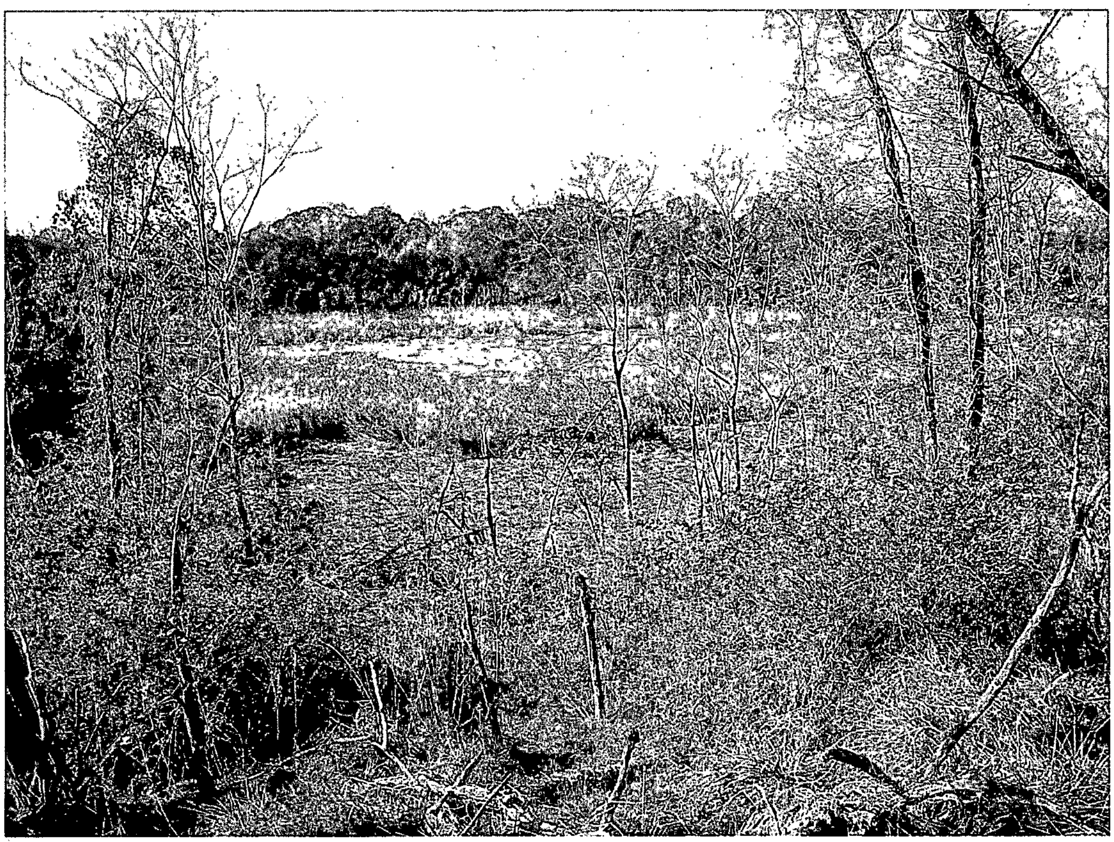

Photo 2: Photo depicts the current site conditions within the proposed WC-2 site. Photo taken from northeast corner of site (from top of berm), looking to the southwest.

Photo 3: Photo depicts the current site conditions within the proposed WC-2 site. Photo taken from northeast corner of site, looking to the west.

3.2 Wetland Enhancement Mitigation Sites

Mitigation Site WE-1

Mitigation Site WE-1 is located within the aforementioned Lake Davies Disposal Area (see Concept Plan Sheet 5, Appendix A). The WE-1 site is the lower sediment basin within the disposal area. Berms physically separate this basin from the middle sediment basin (WC-2) and a linear drainageway extension to the south (WE-2).

The existing vegetation and the soil profile within the WE-1 site were examined during field reconnaissance (see Photo 4). The mitigation site is presently dominated by phragmites. The plant associates include false nettle (*Boehmeria cylindrica*), giant cane (*Arundinaria gigantea*), and black willow. Based on soil probes, it appears that sands and other soil material have migrated into the basin from the surrounding uplands and the berm areas. In addition, field observations indicate the presence of hydric soils and wetland hydrology within this proposed wetland enhancement mitigation site. Culverts hydrologically connect this basin to the middle sediment basin (WC-2) and the linear drainageway extension to the south (WE-2).

Photo 4: Photo depicts the current site conditions within the proposed WE-1 site. Photo taken from north central end of site (from berm), looking to the south.

Mitigation Site WE-2

Mitigation Site WE-2 is located within Johns Creek (see Concept Plan Sheets 5 and 6, Appendix A). This mitigation site also includes a linear drainageway extension that is located to the south of WE-1, and is adjacent to the southern end of the Lake Davies Disposal Area. The downstream portion of Johns Creek proposed for enhancement includes the portion of the reach which extends from a point located approximately 1,000 feet upstream of the Maryland Highway 2/4 bridge to a point located near the western end of stream mitigation site SR-4. The WE-2 site occurs outside of the CCNPP Unit 3 boundary, but within the CCNPP property boundary. Therefore, as with the other three proposed wetland mitigation sites, mitigation activities will be implemented on site. The existing vegetation, hydroperiod, and soil profile within the WE-2 site were examined during field reconnaissance (see Photos 5, 6, and 7). The portions of the Johns Creek reach that are not infested with phragmites (downstream and upstream of the mitigation site) are not included within the WE-2 mitigation area. The bottomland hardwood forest community that encompasses Johns Creek is comprised of red maple, sweetgum (*Liquidambar styraciflua*), and black gum (*Nyssa sylvatica*). The groundcover is typically dominated by phragmites.

The plant associates include New York fern (*Thelypteris noveboracensis*), sensitive fern (*Onoclea sensibilis*), royal fern (*Osmunda regalis*), tussock sedge (*Carex stricta*), eastern bur-reed (*Sporangium americanum*), soft rush (*Juncus effusus*), lizard tail (*Saururus cernuus*), and skunk cabbage (*Symplocarpus foetida*). The linear drainageway extension is presently dominated by phragmites. No berm exists at the confluence of the linear drainageway extension and Johns Creek.

Photo 5: Photo depicts the current site conditions within the linear drainageway extension of the proposed WE-2 site. Photo taken from east side of drainageway extension, looking to the southwest.

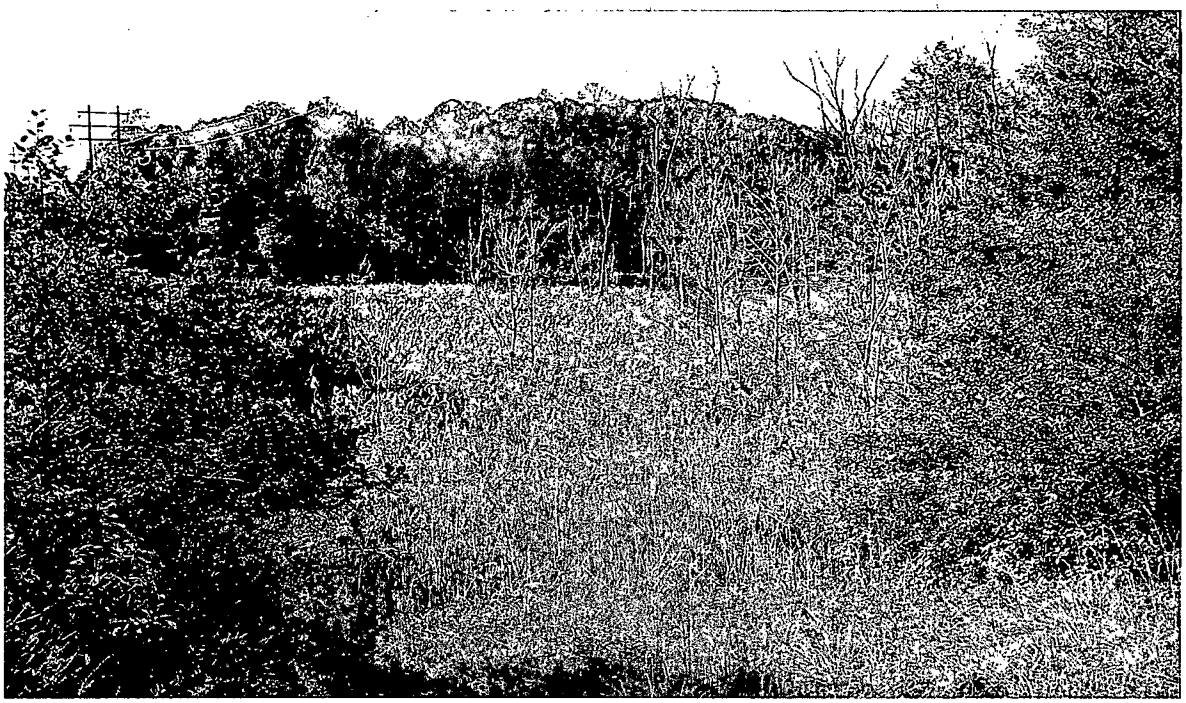

Photo 6: Photo depicts the current site conditions within the proposed WE-2 site. Photo taken from southeast corner of linear drainageway extension, looking to the southwest at the confluence of the drainageway extension and Johns Creek.

Photo 7: Photo depicts the current site conditions within the proposed WE-2 site. Photo taken within the Johns Creek reach, looking to the east (upstream).

4.0 WETLAND MITIGATION DESIGN METHODOLOGY

Compensatory mitigation for unavoidable impacts to approximately 11.72 acres of jurisdictional, nontidal forested wetlands, emergent (herbaceous) wetlands, and surface waters (including Camp Conoy Fishing Pond) (USACE and/or MDE jurisdictional) will include:

- The creation of forested wetland habitat within the Camp Conoy area which lies within the CBCA (Mitigation Site WC-1);
- The creation of forested and herbaceous wetland habitat within the middle manmade, abandoned, sediment basin of the Lake Davies Disposal Area (Mitigation Site WC-2);
- The enhancement of a smaller manmade, abandoned, sediment basin within the Lake Davies Disposal Area (Mitigation Site WE-1);
- The enhancement of a portion of Johns Creek and a linear drainageway extension occurring to the south of the Lake Davies Disposal Area (Mitigation Site WE-2);
- The eradication of phragmites through herbicide application (Mitigation Sites WC-2, WE-1, and WE-2); and
- Soil material from impacted on-site wetland areas which do not contain phragmites will be used in the creation mitigations sites as a supplemental growth medium (Mitigation Sites WC-1 and WC-2).

Phragmites is a large, coarse, perennial grass that usually forms large, dense stands, reducing the diversity of plant and wildlife species. These stands exist in various locations within the CCNPP property. Phragmites can grow to more than 10 ft in height. Flowering and seed set occur between July and September, and germination occurs in spring on exposed moist soils. Vegetative spread by below-ground rhizomes (roots) can result in dense patches with up to 20 stems per square foot. Phragmites is capable of vigorous vegetative reproduction and often forms dense, nearly monospecific stands, as has been observed in the sediment basins of the Lake Davies Disposal Area and within Johns Creek and other forested wetland areas on the CCNPP Unit 3 project site. Therefore, the benefits of eradicating phragmites would be the replacement of a somewhat sterile environment with a more diverse community through the planting of desirable plant species. Finally, the likelihood of the long-term success of the enhancement activity will be increased through the eradication of phragmites during the monitoring period. The eradication of phragmites within the mitigation sites (WC-2, WE-1, and WE-2) will include multiple treatment events, as the density/biomass of this nuisance species within the mitigation sites is very high.

During site reconnaissance, a beaver (*Castor canadensis*) dam and tree and shrub girdling/cuttings were observed within the downstream portion of the Johns Creek reach (see Photo 8). Beaver control methods area not proposed for the compensatory mitigation plan for the CCNPP Unit 3 project.

Photo 8: Photo depicts beaver dam and tree girdling in the downstream portion of the Johns Creek reach.

To summarize, the primary goal of the wetland component of the compensatory mitigation plan is to establish viable bottomland hardwood forest habitat and emergent wetland habitat within a altered wetland area (Lake Davies Disposal Area), along with enhancement of existing poorly drained bottomland hardwood forest habitat within Johns Creek and the creation of forested wetland habitat within the Camp Conoy area. The compensatory mitigation plan will also include the eradication of phragmites within mitigation sites WC-2, WE-1, and WE-2.

4.1 Wetland Creation Mitigation Sites

Mitigation Site WC-1

A critical component of wetland creation design is hydrology. If hydrologic conditions are inadequate, the vigor and survivorship of the planted hydrophytes within a created wetland will decrease and success criteria may not be met. For the WC-1 site, stormwater from the proposed power block and adjacent laydown area will be used to drive the hydrology of the created wetlands. Three wetland cells in series are proposed. Discharge from the site will enter into the cell at the highest elevation. A catch basin with an overflow elevation set approximately one foot above the ground elevation and equipped with a small outlet pipe will drain water from this cell through the berm into the middle cell in approximately 24 hours. Likewise, water from the middle cell will flow into the lower cell through a catch basin set approximately 1-foot above base elevation. Water in the lowest cell will discharge slowly into an existing channel leading down to the Chesapeake Bay. The uppermost wetland cell will also be equipped with an overflow spillway to handle discharges up to the 25-year storm. These peaks will be reduced through temporary storage in the wetland and then released into the channel below Camp Conoy. The 24-hour drawdown time in the wetland cells was determined to reduce inundation of tree roots for excessive periods of time. There may be some micropools and other microtopography features added to the wetland cells to diversify habitat for wetland flora and fauna. It is important to note that the WC-1 site will receive treated stormwater to drive the hydrology of the site. The WC-1 site has not been designed to provide attenuation (water quality treatment) for stormwater being routed from the constructed CCNPP Unit 3 facility to this location.

The bottom elevations within the aformentioned cells will not be uniform; i.e., an assemblage of hummocks will be created during site excavation to provide areas of shallow and deeper water and areas of saturated soil conditions. This manipulation of the hydropattern through design and construction will provide more diversity in habitat conditions for the proposed wetland creation than would be expected to occur in a created wetland with a "flatter" floor construction and uniform conditions of inundation. Based on the results of recent site evaluations, the soils within this proposed mitigation area are sandy; therefore, additional clay material will be incorporated into the existing soil material within the mitigation area during construction to increase soil water retention capability. Soil material from impacted on-site wetland areas will be used for the creation of the WC-1 mitigation site; however, only impacted wetlands which do not contain phragmites will be considered for a source of hydric soil material.

The WC-1 site will be planted with seedlings of native hydrophytic tree species to create a wetland hardwood forest community. Approximately 4.6 acres of forested wetlands will be created in this location. At a mitigation credit ratio of 2:1, this mitigation site will yield approximately 2.3 acres of credit. Finally, wetland function will be increased by creating wildlife habitat for wetland dependent and wetland independent species. These created wetlands will provide waterfowl habitat; i.e., winter flooded conditions for resident and migratory species, with drawdown in the spring to maintain the vitality of the planted tree species and provide a suitable substrate for plant regeneration.

Mitigation Site WC-2

Within the Lake Davies Disposal Area, wetland creation will be provided for the middle abandoned sediment basin through the establishment of the following vegetative zones:

- An interior open water (pond) area will be planted with floating aquatic species;
- A surrounding freshwater marsh fringe will be planted with herbaceous plant species; and
- An outer zone will be planted with woody bottomland hardwood species.

With regard to the opportunity to provide wetland creation, wetland fill material will be deposited within the sediment basin to raise the ground elevation across the central portion of the basin. Soil material from impacted on-site wetland areas will be used for the WC-2 mitigation site; however, only impacted wetlands which do not contain phragmites will be considered for a source of hydric soil material. The undesirable, exotic plant species phragmites, which is currently infesting the sediment basin, will be eradicated through the application of chemical herbicide prior to the filling and planting activities. The hydroperiod of this created wetland area will be manipulated through the establishment of a water control structure. Through these mitigation activities, approximately 0.9 acre of open water (pond) habitat and 1.3 acres of freshwater marsh habitat will be created. At a mitigation credit ratio of 1:1, this mitigation site will yield approximately 1.3 acres of credit for emergent marsh. The planting of approximately 7.2 acres of bottomland hardwood forest will provide forested wetland creation. At a mitigation credit ratio of 2:1, this mitigation site will yield approximately 3.6 acres of credit for forested wetlands. The creation of zones of open water, marsh, and bottomland hardwood forest will greatly increase wetland habitat diversity (wetland function) and wetland value within this basin and be an improvement over the existing habitat condition; i.e., a monoculture of phragmites. During the construction of the WC-2 site, the phragmites will be sprayed with herbicide.

Mitigation Site WE-1

The lower sediment basin within the Lake Davies Disposal Area will be enhanced through the eradication of phragmites by application of chemical herbicide, and the planting of woody bottomland hardwood species (trees and shrubs). These mitigation activities will provide approximately 2.4 acres of wetland enhancement. At a mitigation credit ratio of 3:1, this mitigation site will yield approximately 0.8 acre of credit for forested wetlands.

The planting of desirable woody species within the enhancement area, along with phragmites eradication, will provide suitable wildlife habitat (wetland function) and wetland values within this phragmites-infested basin. The benefits of eradicating phragmites would be the replacement of a somewhat sterile environment with a more diverse community through the planting of desirable plant species.

Mitigation Site WE-2

Wetland enhancement will also be provided within a significant portion of the Johns Creek system through the eradication of phragmites, by application of chemical herbicide, and the planting of woody bottomland hardwood species. The target areas encompass:

- The eastern (upstream) and western (downstream) portions of Johns Creek in the vicinity of the confluence of Johns Creek and the linear drainageway extension occurring to the south of the Lake Davies Disposal Area and

The portion of Johns Creek which is proposed for enhancement includes the portion of the reach which extends from a point located approximately 1,000 feet upstream of the Maryland Highway 2/4 bridge to a point located near the western end of stream mitigation site SR-4. The linear drainageway extension appears as a remnant stream system that is presumed to have historically extended northward into the area that is now known as the Lake Davies Disposal Area.

The planting of desirable woody species (trees and shrubs) within the enhancement areas of Johns Creek, along with phragmites control, will provide wildlife habitat within this poorly-drained bottomland hardwood forest community. The phragmites-infested portions of Johns Creek have been significantly degraded over time as a result of recruitment of this invasive species. Therefore, the proposed mitigation activities will replace the loss of one or more functions within the targeted wetland community. In addition, there should be no adverse impact on natural resources from the enhancement activity. For example, if phragmites has impeded the flow of water between the linear drainageway extension and Johns Creek, then the control of this invasive species will improve hydrology between these wetland areas. The mitigation activities associated with the WE-2 site will provide approximately 15.7 acres of wetland enhancement. At a mitigation credit ratio of 3:1, this mitigation site will yield approximately 5.23 acres of credit for forested wetlands.

5.0 WETLAND DESIGN CRITERIA

5.1 Wetland Mitigation Planting Plan

The compensatory mitigation plan for the CCNPP Unit 3 project will entail the eradication of phragmites as necessary, then the planting of native hydrophytic tree and/or shrub species within the proposed mitigation sites. These mitigation activities will be conducted in accordance with the requirements of the *Mitigation and Monitoring Guidelines*, Baltimore District Regulatory Program, USACE, November 2004. The components of the wetland mitigation planting plan for the proposed mitigation sites are discussed below.

Mitigation Site WC-1

After excavation and the establishment of bottom elevations and the installation of water control structures, the WC-1 site will be planted with native hydrophytic trees species. The tree species will be planted at a density of 680 stems per acre (eight-foot centers) to allow for anticipated mortality from wildlife depredation by white-tailed deer (*Odocoileus virginianus*) or other browsers and defoliation by insects during early seedling establishment. It is expected that recruited, desirable, woody species will add to the overstory stem density in the mitigation site. The plant material will be representative of the species composition of the adjacent bottomland hardwood forested wetlands within the CCNPP property and native to the region. In addition, the plant material will include species that have been identified as suitable for installation on wetland mitigation projects by the Calvert County Soil and Water Conservation District (CCSWCD) and the CAC. The final selection of plant stock may be determined to some extent by availability. The selected tree species will consist of containerized and/or bare root stock protected by tree shelters (i.e., TUBEX® or Miracle Tube tree shelters). The tree shelters will provide protection from wildlife depredation, wind, or other influences. The tree material for installation will include, but are not limited to, willow oak (*Quercus phellos*), water oak (*Quercus nigra*), black gum, red maple, tulip tree, river birch (*Betula nigra*), and/or American sycamore (*Platanus occidentalis*). The palette of tree species will be finalized before installation. Additional species may be added if they are determined to be highly suitable for installation in the WC-1 mitigation site.

Mitigation Site WC-2

Three planting zones are proposed for the WC-2 mitigation site; i.e., open water, freshwater marsh fringe, and bottomland hardwood forest. The open water (pond) habitat will be planted with pondweed (*Potamogeton* sp.), water lily (*Nymphaea* sp.), or other suitable floating aquatic species. The marsh fringe will be planted with native hydrophytic herbaceous species. The herbaceous species will be planted at a density of 4,800 stems per acre (three-foot centers). The plant material will be representative of the species composition of adjacent herbaceous wetlands within the CCNPP property and native to the region. In addition, the plant material will include species that have been identified as suitable for installation on wetland mitigation projects by the CCSWCD. The final selection of plant stock may be determined to some extent by availability. The herbaceous material for installation will include arrow arum (*Peltandra virginica*), duck potato (*Sagittaria latifolia*), water plantain (*Alisma subcordatum*), and/or pickerelweed (*Pontederia cordata*). The palette of herbaceous species will be finalized before installation. Additional species may be added if they are determined to be highly suitable for installation in the WC-2 mitigation site. The tree species for installation within the outer zone (bottomland hardwood forest) of the mitigation site will include, but are not limited to, willow oak, water oak, black gum, red maple, tulip tree, river birch, and/or American sycamore. The palette of tree species will be finalized before installation. Additional species may be added if they are determined to be highly suitable for installation in the WC-2 mitigation site. The tree species will be planted at a density of 680 stems per acre (eight-foot centers). The installation of plant material within the WC-2 mitigation site will be conducted following the deposition of fill material and contour shaping within the basin.

The eradication of the existing phragmites within the WC-2 mitigation site will be conducted through the application of approved herbicide. The eradication of phragmites will be completed before the installation of plant material, the deposition of fill material, and contour shaping within the basin.

Mitigation Site WE-1

The enhancement of the WE-1 mitigation site will entail the planting of native hydrophytic trees to establish a bottomland hardwood forest community within this basin. The tree species for installation will include, but are not limited to, willow oak, water oak, black gum, red maple, tulip tree, river birch, and/or American sycamore. The palette of tree species will be finalized before installation and may include the addition of other desirable tree species. The plant material will be representative of the species composition of the adjacent bottomland hardwood forested wetlands within the CCNPP property and native to the region. The tree species will be planted at a density of 680 stems per acre (eight-foot centers).

The eradication of phragmites within the WE-1 mitigation site will be conducted through the application of approved herbicide. The eradication of phragmites will be completed before the installation of plant material.

Mitigation Site WE-2

The enhancement of the WE-2 mitigation site will entail the planting of native hydrophytic trees and shrubs to establish a bottomland hardwood forest community within the mitigation site. The proposed mitigation site includes the bottomland hardwood forest component of the eastern (upstream) and western (downstream) portions of Johns Creek (in the vicinity of the confluence of Johns Creek and the linear drainageway extension) and the linear drainageway extension. The tree species for installation will include, but are not limited to, willow oak, water oak, black gum, red maple, tulip tree, river birch, and/or American sycamore. The shrub species for installation will include silky dogwood (*Cornus amomum*), inkberry (*Ilex glabra*), shadbush (*Amelanchier canadensis*), highbush blueberry (*Vaccinium corymbosum*), possum-haw (*Viburnum nudum*), elderberry (*Sambucus canadensis*), and Virginia willow (*Itea virginica*). The palette of tree and shrub species will be finalized before installation and may include the addition of other desirable tree or shrub species. The plant material will be representative of the species composition within Johns Creek and native to the region. The tree and shrub species will be planted at a density of 680 stems per acre (eight-foot centers).

The eradication of phragmites within the WE-2 mitigation site will be conducted through the application of approved herbicide. The eradication of phragmites will be completed before the installation of plant material.

6.0 WETLAND MONITORING

Following the completion of the on site wetland creation and wetland enhancement activities for the CCNPP Unit 3 project, a five-year annual monitoring program will be implemented in accordance with the requirements of the *Mitigation and Monitoring Guidelines* (USACE, 2004), the protocols presented in the *Maryland Compensatory Mitigation Guidance* (IMTF, 1994), and the guidance provided in Regulatory Guidance Letter No. 08-03 (USACE, October 2008). The monitoring program will be conducted pursuant to the MDEWMA mitigation monitoring guidelines and protocols.

The mitigation monitoring effort will entail the establishment of sample plots and/or belt transects within the mitigation sites to obtain data on vegetative conditions and the collection of hydrologic data, soil data, and other site specific information. The data and information to be collected and reported at the mitigation sites will include:

- The growth and vitality of the planted hydrophytic species;
- The species composition of recruited, desirable plant species;
- The species composition and areal cover of nuisance/non-native plant species;
- Measurements of surface inundation or groundwater;
- Wildlife utilization and depredation; and
- Current site conditions at fixed photographic points.

The monitoring program will include an initial baseline (time-zero) monitoring event, to be conducted immediately following the planting of the mitigation sites and the eradication of phragmites within WC-2, WE-1, and WE-2. After the baseline event is completed, a five-year monitoring schedule will be initiated, which will include annual sample events during September-October of each year. A baseline report and five annual monitoring reports will be prepared for review by regulatory staff. The reports will include the vegetative sampling results, current hydrologic conditions, photodocumentation, descriptions of problems encountered, and discussion of maintenance actions taken. Monitoring reports will be submitted within 90 days of each monitoring event. Monitoring reports will be submitted to the USACE and the MDEWMA. Following agency review and coordination, remedial/contingency measures will be implemented, if required.

The targets for the creation and enhancement efforts will be divided into two specific components:

1. The creation and enhancement of wetland communities, and
2. The creation of wetland hydrology within the created wetlands.

The success criteria for the monitoring program will include, at a minimum, the success of the planted vegetation, as measured through survivorship counts and observations of vitality and growth, and the existence of wetland hydrology for the created wetlands. If success criteria have been satisfied at the completion of the five-year monitoring program, a request for release from monitoring will be made to the USACE and/or MDEWMA.

The primary success criteria for the CCNPP Unit 3 wetland creation/enhancement mitigation sites will include:

- A minimum density of 600 stems per acre of woody tree and shrub species (planted and naturally regenerated/recruited stems) within Mitigation Sites WC-1, WC-2, WE-1, and WE-2;
- The appearance of positive growth indicators for planted species, such as height and/or ground level diameter, within Mitigation Sites WC-1, WC-2, WE-1, and WE-2;
- A value of no more than 10 percent areal cover of phragmites within the treated wetland mitigation sites, WC-2, WE-1, and WE-2; and
- The establishment of appropriate inundated conditions or saturated soil conditions during the growing season and under normal yearly climatological conditions for the wetland creation mitigation sites, WC-1 and WC-2.

Performance standards for the wetland mitigation monitoring program will be conducted in accordance with the MDE guidelines and with consideration of other permitting agencies as mandated by the state of Maryland.

7.0 STREAM MITIGATION PLAN BACKGROUND

The CCNPP Unit 3 site contains five potential stream restoration reaches and five potential stream enhancement reaches (perennial and intermittent) on site. Of these sites, three restoration reaches and two enhancement reaches are located within or just outside the 1,000-foot CBCA defined by the CAC (see Figures A and B). Of the ten proposed mitigation reaches, only Branch 1 (SR-3) and Branch 2 (SE-4) drain directly to the Chesapeake Bay (see Concept Plan Sheet 2, Appendix A). A brief summary of proposed mitigation is located below, followed by a more detailed description of each proposed mitigation reach.

Stream restoration and stream enhancement are intended to compensate for the unavoidable, direct loss of physical, biological and/or riparian function of impacted streams. In general, the physical stream functions are divided into hydrologic and hydraulic components. Hydrologic function compromised by development includes infiltration/ groundwater recharge, channel/floodplain storage and routing of precipitation and runoff. Hydrologic function also includes the resultant timing, duration and quantity of surface runoff delivered to the receiving streams as discharge. Similarly, hydraulic function often disrupted by watershed development includes efficient flow conveyance and effective sediment transport. Aquatic resources can be adversely affected by any temporary or permanent change to physical, biological, chemical, and /or riparian component in an otherwise natural environment.

American eels (*Anguilla rostrata*) occupy a unique and significant niche along the Atlantic coastal reaches including embayments, local tributaries, small freshwater streams, and ponds. (ASFC, 2006). Specifically, American eels are catadromous, spending the majority of their lives in smaller streams, under boulders, undercut banks, and soft bottoms with rooted submerged aquatic vegetation and migrating to the Sargasso Sea as adults to reproduce and die.

American eel were collected at CCNPP during fall 2006 and spring 2007 aquatic surveys at the following locations: Goldstein Branch, the most downstream location of Johns Creek, Lake Conoy, Pond #1, and Pond #2. The upper stream reaches of some of the collection locations are within or adjacent to stream segments identified as good potential candidates for restoration or enhancement. These reaches were identified as potential mitigation areas because they viewed as being unstable with stream habitat being impaired. A major factor in the low stream habitat is sediment. High sediment loads and debris can cause physical damage to streams and American eel habitats (Wiley et al, 2004). Sedimentation and siltation can severely alter aquatic communities and habitats. Sediment may also clog and damage fish gills, suffocate eggs and aquatic insect larvae on the substrate, and filled the spaces between bottom cobbles where fish lay eggs. Therefore, the stream restoration and enhancement portion of the proposed compensatory mitigation plan will be designed to maintain existing, and promote improved passage of migratory fish species and more specifically, the catadromous American eel. The stream mitigation activities (enhancement, restoration, and preservation) proposed for the unavoidable impacts to streams as a result of the construction of CCNPP Unit 3 will help mitigate for potential impacts to the American eel as a result of project construction. The stream enhancement and restoration activities will establish a diverse velocity-depth regime (i.e., slow-shallow, slow-deep, fast-shallow, and fast-deep), vegetation, and substrate characteristics within mitigation stream segments (GMCME, 2007).

Site reconnaissance revealed that natural, physical migration barriers, such as beaver dams and stream head-cuts, exist on-site. The proposed mitigation design for the stream restoration and enhancement areas will be specifically for the physiological needs of the American eel, other migratory fish species, as well as the remaining resident fish and benthic macroinvertebrate populations. These designs will incorporate hydrologic (watershed routing to determine timing, quantity and quality of discharge) and hydraulic (one-dimensional discharge modeling assuming steady, uniform flow) analyses. The design will also address migratory (resting, darting, bursting, and sustained swimming speeds) and residential habitat needs, including appropriate depth, velocity and substrate during a range of flows (normal low to normal high flow conditions).

An example of a tool that may be implemented to facilitate eel migration on the Branch 2 system may include a natural fish way using step pools or other systems. Another example of a tool that may be implemented to facilitate eel migration for John's Creek includes the shading of stream beds and stabilization of stream banks to discourage further siltation.

UniStar will use qualified professional fisheries biologists to collect existing populations (if present) prior to construction activities. Eels will be relocated to an appropriate location and various BMPs (such as silt fencing with smaller mesh) will be applied in an attempt to prevent eel re-entry during construction. During stream restoration and enhancement construction activity, efforts will be made to prevent harm to American eels.

A reconnaissance and inventory of streams on CCNPP property was conducted on February 21 and 22, 2008 by scientists and engineers to observe existing conditions and assess potential for ecological lift.

Since then, cursory level data (geomorphic and biologic) has been collected during various repeat visits. Sites demonstrating geomorphic stability and corresponding biological indicators were excluded as potential mitigation sites. Historically disturbed sites that exhibited a strong tendency to evolve toward stability were also discarded. However, some sites displayed persistent instability and the tendency to continue to degrade. Based on the reconnaissance and initial data collection efforts, these sites were identified and selected as part of the proposed Phase I mitigation plan. These mitigation sites were revisited on November 10, 2008 for further photographic documentation and refinement of mitigation concepts. Following this walkthrough, field notes and photographic logs were compiled and the opportunity for physical, biological and/or riparian lift and corresponding compensatory mitigation activity was identified at various locations throughout CCNPP. Table 2 summarizes the mitigation activity (enhancement/restoration) by site and provides location information:

Table 2. Stream Mitigation Summary, CCNPP Unit 3 Site, Calvert County, Maryland

Stream Segment	Segment Length (lf)	Width (ft) of Uplift	Area (ac)
SR-1 (Lower Woodland Branch)	2,114	varies*	6.78
SR-2 (Upper Woodland Branch)	1,534	varies*	2.90
SR-3 (Branch 1)	1,237	varies*	0.77
SR-4 (Johns Creek mainstem)	951	varies*	2.76
SR-5 (Unnamed tributary Johns Creek)	447	varies*	1.15
Stream Restoration Total	6,283		14.36
SE-1 (Unnamed tributary L.W. Branch)	1,160	30	0.80
SE-2 (Middle Woodland Branch)	655	30	0.45
SE-3 (Unnamed tributary U.W. Branch)	507	30	0.35
SE-4 (Branch 2)	920	30	0.63
SE-5 (Unnamed tributary Johns Creek)	904	30	0.62
Stream Enhancement Total	4,146		2.86

ac - acre
ft - feet
lf – linear feet
*Varies per measurement of valley width.

Stream restoration will take advantage of opportunities to reconnect channels to their historic flow paths and restore active access to wooded floodplains. Areas where degraded channels are abandoned will be designed to function as pockets of seasonal wetlands, ephemeral ponds and oxbow lakes in the riparian zone. Stream enhancement activities intended to improve existing stream physical and ecological functions within the channel's current flow path include bank grading operations and floodplain creation at lower elevations, bank treatments and native plantings.

Stream restoration and enhancement of proposed mitigation sites, combined with the proposed stormwater management plan, will offset losses to watershed functions by increasing the ability to provide flood storage, naturally recharge local aquifers, perform water quality improvement, and maintain stream and riparian functions that support corresponding ecology.

With regard to protective mechanisms, the stream mitigation area will be protected into perpetuity through establishment of a legally-binding deed restriction. The deed restrictions generally will follow the standard USACE Baltimore District model for such instruments. Ownership of the mitigation area will likely reside with CCNPP or its assigns, until such a time when CCNPP decides to sell the property or donate it to a public agency or private conservation organization. If the mitigation area should ever be sold, appropriate protective mechanisms (which will have been recorded) will remain in effect and will remain with the site into perpetuity. Section 7.0 of the "Supplemental Environmental Resource Report" presented in the JPA provides further elaboration of proposed protective mechanisms for the project, along with information on adaptive management plans for the mitigation area, if required.

The amount of stream mitigation proposed herein is based on a mitigation ratio of 1:1 for stream impacts.

8.0 EXISTING STREAM DATA

After field reconnaissance and site walk-through of the streams on CCNPP property, specific locations were identified as having strong potential for ecological lift in function and value. To understand the potential for ecological up-lift, cursory level data were collected at representative mitigation site locations, including biological and geomorphic assessments (Table 3). Before intermediate design is performed, additional detail data will be collected to supplement the data supplied in Table 3. This table provides a summary of representative data collected throughout mitigation segments. Note that bank pins were installed in restoration segments and in the reference reach so as to validate bank loss erosion rates at a later date, as needed. This data assisted in identifying the potential for ecological lift and allowed for qualitative comparisons within and among proposed mitigation sites. This process was conducted on potential restoration reaches only. Prior to completing the Phase II mitigation plan, additional data will be collected throughout the proposed mitigation sites to document as evidence of existing conditions and serve as the datum to evaluate ecological lift following completion of mitigation efforts.

Table 3. Summary of Existing Stream Data

Stream Segment	Representative Cross-Section	BEHI Rating	Phankuch Rating	MBSS Benthic IBI	RBP Score	Bankloss (tons/ yr.)	Bank Pin Installed
SR-1				4.7 (Good)	87		
SR-2	Yes	Extreme	Poor	3.6 (Fair)	71	32.7	Yes
SR-3	Yes	Extreme	Poor	1.9 (V.Poor)	130	663	Yes
SR-4				4.4 (Good)	89		
SR-5				3.3 (Fair)	149		
Reference Reach (John's Creek)	Yes	Moderate	Good			6.4	Yes

Table Created By: RLS 11/2008
Table Checked By: RGH 11/2008

9.0 STREAM MITIGATION DESIGN METHODOLOGY

Following a review of conceptual-level restoration alternatives the primary general design approach incorporates elements of natural channel design. It is assumed that potential future watershed development will occur under existing and new stormwater management regulations intended to comply with Maryland's "Stormwater Management Act of 2007" (Act), which became effective on October 1, 2007. The new regulations are intended to reduce watershed development-related impacts (http://www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/swm2007.asp) and will be enacted on or around December 31, 2008. For this reason, future impacts to the contributing watersheds of the mitigation reaches are expected to be minimized, and therefore a natural channel design approach is applied as the initial iteration of design.

Because the use of a reference reach and natural channel design provides limited application for unique systems, the proposed design method will later incorporate a combination of empirical, analog, and analytical approaches, capitalizing on their respective values. Initial analog design values (included herein) are a result of preliminary review of dimensionless ratios produced from regional reference reach data and a single reference reach.

Empirical relationships for determining design flows and channel geometry criteria will later be applied to our sites. Comparison of the analog with the empirical criteria will produce converging lines of evidence for use in determining the explicit range of values to be used as actual design criteria. Additional and ultimate final design criteria will be developed drawing from our past experiences to improve the overall sensibility (site constraints [tree-saves, property lines, utilities, and future development], constructability, cost, public perception, etc.) of the proposed design. Following development of final design criteria, the preliminary design will be refined to produce an Intermediate Design. The Intermediate Design will incorporate sediment transport and it will address stakeholder comments of the concept design.

Drawing from a multitude of analytical models, this next step in design attempts to identify and select those appropriate to the Calvert Cliffs mitigation project site and will incorporate more detailed sediment transport capacity considerations based on our first iteration concept design. Examining detailed sediment modeling parameters, design criteria are refined and this intermediate design provides a nearly final horizontal alignment, average slope, typical cross sections, and standard details for other proposed in-stream treatments. A final set of design documents will include construction plans and technical specifications incorporating all elements of work to be performed under the mitigation plan. For reference, some example details of the type and configuration of various structures and bank treatments have been provided (see Concept Plan Sheet 8, Appendix A).

9.1 Stream Design Criteria

A certain range of flows are responsible for the majority of sediment carried to and distributed throughout a riparian system. One such index flow of interest is the channel forming discharge (RDC/CHL CHETN-VIII-5) and can be estimated by determining: 1) the bankfull discharge (using field indicators), 2) the specified recurrence interval discharge (R.I. ~ between 1.25 and 1.50-YR), and 3) effective discharge (requiring sediment and flow discharge rating curves).

9.1.1 Maryland Regional Curves

Regression equations developed for the Maryland coastal plain regional curves relate bankfull area (sf), bankfull width (ft), bankfull mean depth (ft), and bankfull discharge (cubic feet per second [cfs]) to the contributing drainage area (square miles). Virginia and Maryland Coastal Plain regression equations are as follows:

Bankfull area:	$y = 11.9899x^{0.63803}$	***Equation 1***
Bankfull width:	$y = 10.4459x^{0.36543}$	***Equation 2***
Bankfull mean depth:	$y = 1.145x^{0.27345}$	***Equation 3***
Bankfull discharge:	$y = 28.3076x^{0.59834}$	***Equation 4***

where "x" represents the drainage area of interest in square miles, and "y" the predicted parameter.

Virginia and Maryland non-tidal coastal plain regional curves can be found online at http://www.deq.state.va.us/coastal/documents/task85-01-04.pdf (viewed 11-13-08). Regression equations listed above are from "Table 6" of Krstolic and Chaplin (2007).

9.1.2 Concept Design Criteria

For each of the proposed stream mitigation sites, the watershed areas were delineated and a bankfull discharge estimated based on the limited data, design criteria for each mitigation site have been established (Table 4). Table 4 depicts a summary of concept design criteria, per mitigation site. Note that these criteria are not final and merely depict an initial iteration based on the limited available data. Additional data collection shall include reference reach data for the Woodland Branch watershed as well as the western coastal systems.

Table 4. CCNPP Stream Mitigation - Regional Prediction for Bankfull Dimension

CCNPP Stream Mitigation - Regional Prediction for Bankfull Dimension (2008.11.17)

Watershed	Site	A_w (mi^2)	A_{bkf} (ft^2)	W_{bkf} (ft)	d_{bkf} (ft)	Q_{bkf} (ft^3/s)
Woodland Branch	SR-1	0.55	8.2	8.4	1.0	20
	SE-1	0.13	3.3	5.0	0.7	8
	SR-2	0.17	3.9	5.5	0.7	10
	SE-2	0.27	5.2	6.5	0.8	13
Coastal Tributaries	SR-3	0.19	4.2	5.7	0.7	10
	SE-4	0.10	2.8	4.5	0.6	7
Johns Creek	SR-4	0.58	8.5	8.6	1.0	20
	SR-5	0.31	5.7	6.8	0.8	14
	SE-5	0.25	5.0	6.3	0.8	12

Created By: JBG 11/2008
Checked By: RGH 11/2008

These criteria are not final and merely depict an initial iteration based on the limited available data. Additional data collection shall include reference reach data for the Woodland Branch watershed as well as the western bay tributary systems.

Additional detailed reference reach stream survey and subsequent data analysis will identify flood prone width and access to floodplain, changes in channel slope, width to depth ratios, entrenchment ratios, riffle and pool lengths, pool-to-pool spacing, sinuosity, radius of curvature, meander width, meander length, and sediment characterization (pebble counts and bulk samples). Field survey data may be supplemented with any or all of the following: sediment supply and transport capacity analysis, hydraulic modeling, and regional curve data. Without sufficient reference reach data, the application of natural channel design methodology suffers diminished credibility and possible failure with regard to restoration uplift.

9.1.3 Additional Design Concepts

Before proposing disturbance of the existing forested areas, wetlands and wetland buffers, a conscious effort to minimize disturbance and temporary impacts was applied. While some areas appeared as good candidates for enhancement, the consideration of staging, access and other construction activity was weighed against the expected benefit. Only areas adjacent to excellent restoration sites were considered for enhancement, thereby minimizing collateral damage to the existing natural areas.

Some bed and bank treatments that may be expected as part of the proposed stream mitigation plan are grading to reshape channel sections and floodplains, incorporation of large wood, log vanes, live staking, soil wrapping, branch packing, and a step-pool or x-weir where grade needs to be stepped down. Transplants may also be used where they are available and appropriate. Woody and herbaceous riparian species native to Maryland and the Chesapeake Bay will be specified in the plans and efforts will be made to control or eliminate invasive species in the mitigation corridors.

Functional lift that can be achieved using this approach includes reconnection to floodplain and flood dissipation, creation of complex bed features including riffles and pools to provide habitat for aquatic species, amphibian habitat in the ephemeral ponds, and woody planting to provide bank protection, shade, nutrient uptake, and food supply. Where channels can be modified in place, the hyporheic zone (where groundwater emerges through the bed of the channel) maintains its integrity, and the benthos living in this zone experience less disruption

9.2 Site Specific Design Strategies

9.2.1 Woodland Branch:

Five proposed mitigation reaches within Woodland Branch have been identified as stream restoration or enhancement sites: SR-1 (Lower Woodland Branch), SE-1 (unnamed tributary to Lower Woodland Branch), SR-2 (Upper Woodland Branch), SE-2 (Middle Woodland Branch), and SE-3 (unnamed tributary to Upper Woodland Branch). Although the Woodland Branch watershed drains to a tributary stream of the Patuxent River, stream restoration efforts will be completed in consideration with CBCA requirements.

<u>Woodland Branch SR-1</u>

Existing Conditions:

SR-1 (Lower Woodland Branch) – Located near the northern boundary on the CCNPP property, this site begins below a significant head-cut. Because of the extreme degree of entrenchment, practical improvements to the channel would include Priority 1 restoration (Photos 9, 10, 11).

Photo 9: Photo depicts a representative section of the proposed mitigation reach along Woodland Branch. Note the roots have been under-mined by down-cutting . Photo taken looking upstream;

Photo 10 and 11: Views of Woodland Branch showing degree if incision and a depositional feature below an exposed bank.

Proposed Restoration Approach:

Priority 1 restoration would include relocating the main channel alignment away from the existing "F" type channel, beginning at a severe headcut and continuing downstream to an area where floodplain access is more available (Figure 1). As is typical for proposed relocation, the abandoned reach of channel will be plugged throughout to prevent bypass, however it will still retain depressional qualities allowing it to serve as an ephemeral pond.

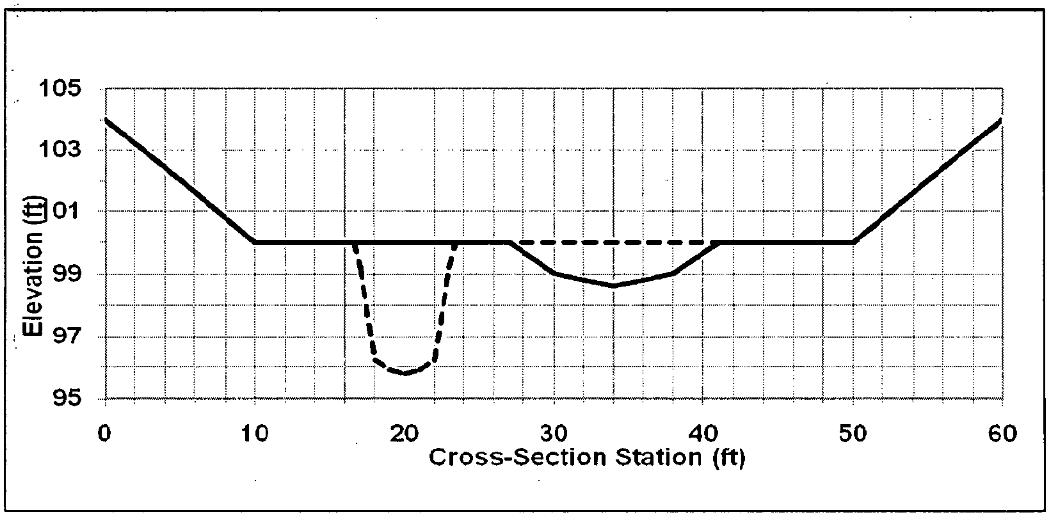

Figure 1: Example Cross-Section view showing an existing stream channel (dotted line) and a proposed new channel excavated to accommodate Priority 1 restoration (solid line). Example is not based on actual field measurement.

Woodland Branch SE-1

Existing Conditions:

SE-1 (unnamed tributary to Lower Woodland Branch) - This site begins below an existing stream crossing/culvert (12" CMP). The culvert has acted to protect the upstream from further degradation by: (1) arresting upstream migration of headcuts; (2) providing flood storage upstream of the roadway embankment, suppressing modified peak discharge and timing; and (3) capturing excess sediment from downstream transport.

Photo 12: Photo is representative section of the proposed mitigation reach along an unnamed tributary to lower Woodland Branch. See Concept Plan Sheet 3, Appendix A, SE 1.

Proposed Enhancement Approach:

The entrenchment of this stream reach has not escalated to unmanageable proportions, therefore allowing corrective measures to be addressed through minor changes to existing channel dimension. Maintaining the existing channel alignment, slight adjustments to the profile and channel cross section will allow the stream to transform from an existing "F" type channel toward a more stable "C" or "E" type channel (Figure 2) through bank sloping and/or creating inner berm features.

Functional lift that can be achieved using this approach includes creating a small floodplain at a lower elevation, creation of complex bed features including riffles and pools to provide habitat for aquatic species, and woody planting to provide bank protection, shade, nutrient uptake, and food supply. One advantage of modifying a channel in place is that the hyporheic zone maintains its integrity and the benthos living in this zone experience less disruption.

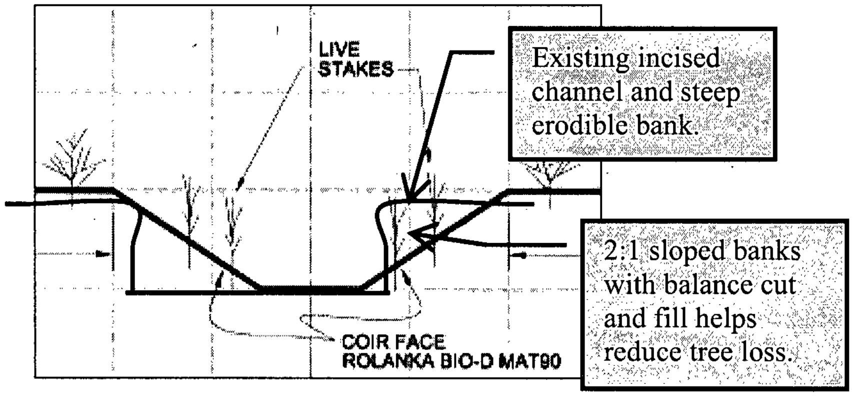

Figure 2: Example Cross-Section showing an existing over-widened stream channel and proposed slightly excavated enhanced stream banks. Example is not based on actual field measurement.

Woodland Branch SR-2

Existing Conditions:

SR-2 (Upper Woodland Branch) - Located in the northeast section of the CCNPP property, this site begins at an identified intermittent/perennial (I/P) transition of flow, and continues down valley until bank height ratios provide the opportunity to reconnect with the existing, semi-active floodplain (Photos 13, 14, 15).

Photo 13: Photo depicts a representative section of the proposed mitigation reach along Woodland Branch. Photo taken looking upstream; See Concept Plan Sheet 4, Appendix A, SR-4

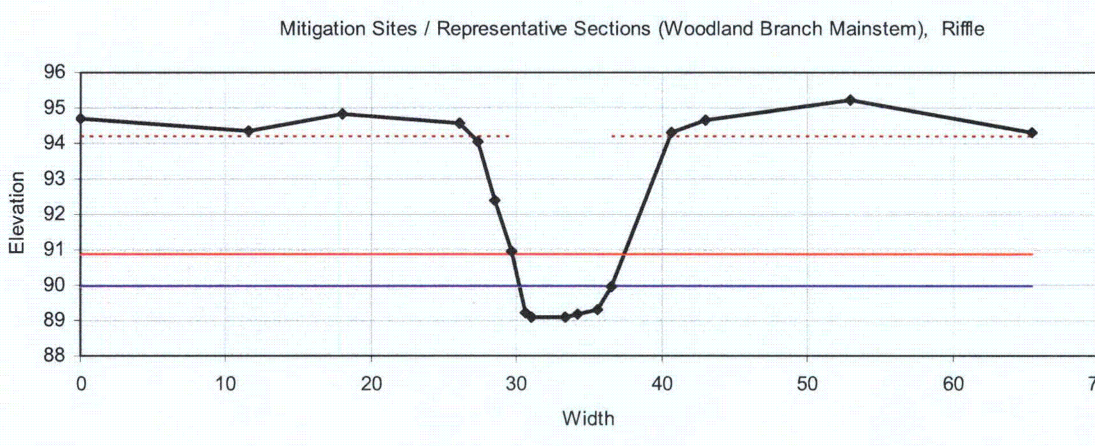

Figure 3: The Cross-Section above was measured on Woodland Branch. The blue line reflects bankfull elevation and the red line reflects the flood prone area, showing this channel is deeply incised.

Photo 14 and 15: The photos are of SR-2 showing an incised reach and sand deposits typical in the bed and flood deposit areas, particularly in the downstream locations.

<u>Proposed Restoration Approach:</u>

Similar to SR-1, practical improvements to Upper Woodland Branch would require Priority 1 restoration inclusive of relocating the main channel alignment away from the existing "G" type channel, or gully, beginning at a severe headcut upstream of the I/P point and continuing downstream to an area where floodplain access is more available (Figure 4).

Bed and streambank treatments may include an incorporation of large wood, live staking, soil wrapping, branch packing, and a step-pool or x-weir where stream gradient needs to be stepped down.

Functional lift can be achieved using this approach, similar to those described in the general description of channel improvements section of this document. Large quantities of sand deposited in the bed and overbanks areas downstream will be reduced by reducing the amount of bed and bank degradation.

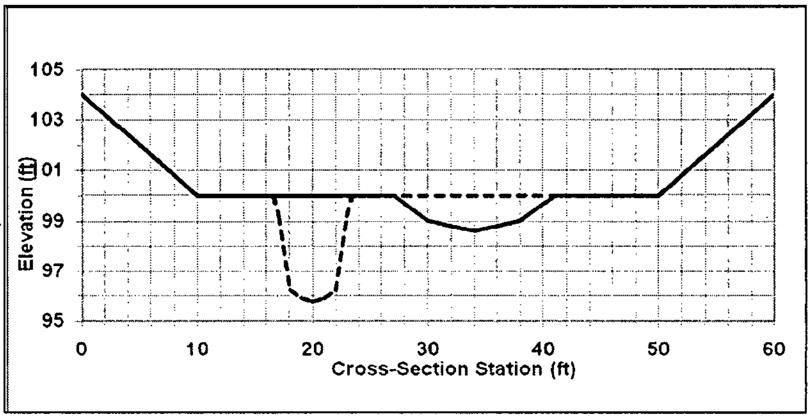

Figure 4: Example Cross-Section view showing an existing stream channel (dotted line) and a proposed new channel excavated to accommodate Priority 1 restoration (solid line). Example is not based on actual field measurement.

Woodland Branch SE-2

Existing Conditions:

SE-2 (Middle Woodland Branch) - This site begins below an existing stream crossing/culvert (12" CMP). The culvert has acted to protect the upstream from further degradation by: (1) arresting upstream migration of headcuts; (2) providing flood storage upstream of the roadway embankment, suppressing modified peak discharge and timing; and (3) capturing excess sediment from downstream transport. Photos 16 and 17 were taken downstream of the culvert.

Photo 16 and 17: Depict representative sections of the proposed mitigation reach along Woodland Branch. Note the roots have been under-mined by down-cutting activity. See Concept Plan Sheet 4, Appendix A, SE-2

<u>Proposed Enhancement Approach:</u>

The entrenchment of this stream reach has not escalated to unmanageable proportions, thereby allowing corrective measures to be addressed through minor changes to existing channel dimension. Maintaining the existing channel alignment, slight adjustments to the profile and channel cross section will allow the stream to transform from an existing "F" type channel toward a more stable "C" or "E" type channel (see Figure 5) through bank sloping and/or creating inner berm features.

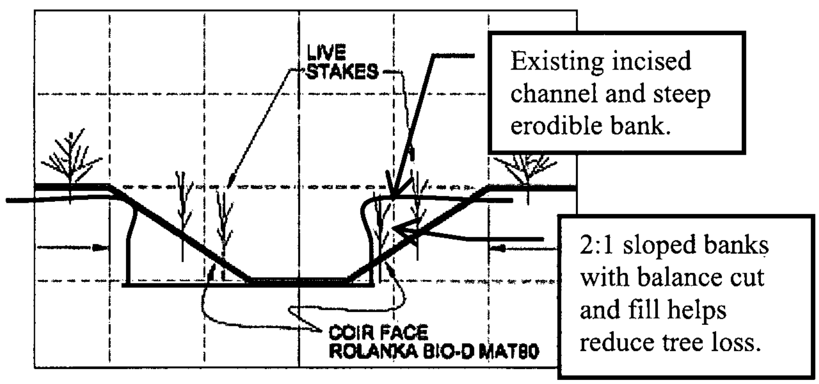

Figure 5: Example Cross-Section showing an existing over-widened stream channel and proposed slightly excavated enhanced stream banks. Example is not based on actual field measurement.

Woodland Branch SE-3

Existing Conditions:

SE-3 (Unnamed Tributary to Upper Woodland Branch) - This tributary is located in the northeastern portion of the CCNPP and forms part of the headwaters within Woodland Branch. A series of headcuts exist in this reach. While it appears that the existence of in stream woody debris has softened the impact of head cutting, active channel scour and down cutting, degradation persist.

Proposed Enhancement Approach:

The current condition exhibits vulnerability to repeat occurrences and combined with restoration of the main channel, enhancement in the form of adjustment of channel dimension and assertive revegetation would decrease the average channel shear stress and increase the resistance.

Photo 18: depicts representative sections of the proposed mitigation reach along Woodland Branch. Note the roots have been under-mined by down-cutting activity. See Concept Plan Sheet 4, Appendix A, SE-2

9.2.2 Western Bay Tributaries:

Two proposed mitigation reaches consist of low order streams that discharge directly into the western Chesapeake Bay; SR-3 (Branch 1), and SE-4 (Branch 2). These sites will be recognized independently form the others requiring unique reference reach design data.

Branch 1:
The Branch 1 proposed mitigation reach is almost entirely located within the 1,000-ft CBCA; this reach is identified as *SR-3 (Branch 1)* on Concept Plan Sheet 8, Appendix A.

Existing Conditions:

SR-3 (Branch 1) – This channel, adjacent to the proposed Unit 3 impact zone appears to have undergone severe stream bank erosion and deep scour; possibly due to prior land use. It is a highly entrenched, gully shaped, low gradient, Rosgen F (Rosgen, 1996). The gully is approximately fifty feet wide with the channel substrate comprised of small gravel, fragipan clay, and broken sea shells (Photo 19).

Photo 19: Photo depicts a representative section of the proposed mitigation reach along Branch 1. Photo taken looking downstream - note the seventeen foot high, nearly vertical stream bank (See Concept Plan Sheet 8, Appendix A, SR-3).

Proposed Restoration Approaches:

Because of the extreme nature of the over widening and incision, this stream allows for Priority 2 restoration in the form of establishing a "new" active floodplain within the existing "F" type channel (Figure 6). However, this can only be accomplished through bank (future valley wall) grading and substantial adjustment of the existing alignment and profile. This restoration activity will begin immediately below the proposed fill zone and continue downstream until reconnection with the adjacent floodplain becomes practical, near an existing culvert. CCNPP would create a new channel within this gully shape. This construction effort would minimize the loss of healthy trees by stabilizing steep valley slopes using bio-engineering applications.

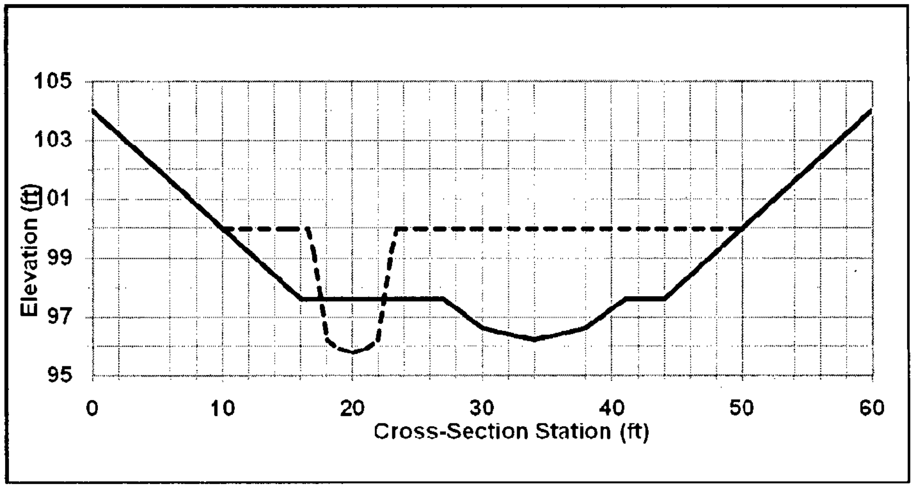

Figure 6: Example Cross-Section showing an existing stream channel (dotted line) and the proposed new channel excavated to accommodate priority 2 restoration (solid line). Example is not based on actual field measurement.

Branch 2:

The Branch 2 proposed mitigation reach is entirely located within the 1,000-ft CBCA; this reach is *SE-4 (Branch 2)*.

Existing Conditions:

SE-4 (Branch 2) – This stream originates in Camp Conoy flowing from Lake Conoy toward the Chesapeake Bay and does not suffer from excessive degradation (see Photos 20, 21 and Figure 7). This stream includes a sequence of impoundments built decades ago, which have since been naturalized and function as wetlands.

Photo 20: Photo of representative section of the proposed mitigation reach along Branch 2. Note the undermined tree roots and small impoundment about 100 feet up stream on this section; photo taken looking upstream. See Concept Plan Sheet 8, Appendix A, SE-4.

Photo 21: Photo depicts a representative section of the proposed mitigation reach along Branch 2. Note the large headcut with a measurement of approximately seven feet; photo taken looking upstream. The individual is standing in the stream bed looking down into the pool formed by the headcut or small, eroding waterfall. See Concept Plan Sheet 8, Appendix A, SE-4

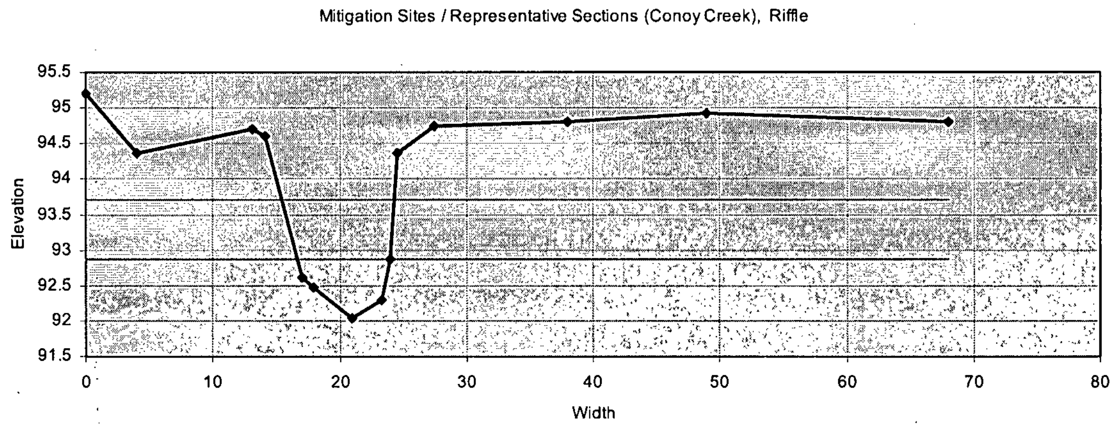

Figure 7: The Cross-Section shown above was measured on Branch 2 (SE-4). The blue line reflects bankfull and the red line above it reflects the flood prone area.

Proposed Enhancement Approach

The primary element of enhancement at this site involves providing a channel stabilization grade control feature at the confluence with the Bay. By preventing upstream migration of a single seven-foot headcut, this feature will preserve the upstream sequence of wetlands and stream channels. Additional enhancement throughout this reach includes riparian re-vegetation and minor bank grading where knickpoints have initiated. Minor bank grading plus other enhancements will be performed in preparation for bio-engineering application and native plant landscaping (see Figure 8).

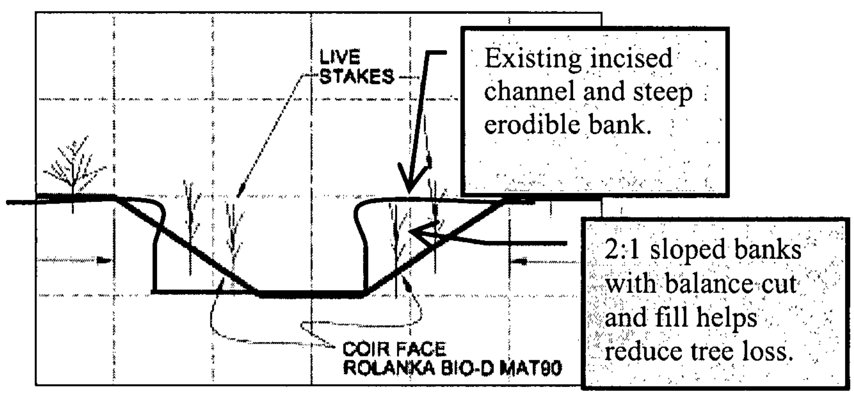

Figure 8: Example Cross-Section showing an existing degraded stream channel and proposed slightly excavated enhanced stream banks. Example is not based on actual field measurement.

9.2.3 Johns Creek

Three proposed mitigation reaches within Johns Creek have been identified as stream restoration or enhancement sites; SR-4 (Johns Creek mainstem ~951 lf), SR-5 (unnamed tributary to Johns Creek~ 447 lf), and SE-5 (unnamed tributary to Johns Creek~ 904 lf). These stream restoration and enhancement reaches are located outside the Critical Area limits.

<u>Johns Creek SR-4</u>

Existing Conditions:

SR-4 (Johns Creek mainstem) has been affected by a series of headcut activities resulting in this section of stream channel being over widened and incised. (Photo 22)

Photo 22: Photo is a representative section of the proposed mitigation reach along Johns Creek (main stem). Note the roots have been undermined by down-cutting. Photo taken looking downstream. See Concept Plan Sheet 6, Appendix A, SR-4.

<u>Proposed Restoration Approach</u>

To remediate this condition, Priority I restoration is proposed whereby the existing channel will be abandoned and relocated toward the center of the valley, allowing for restored stream function. This treatment will continue for 950 lf until acceptable access to the active floodplain is achieved (Figure 9).

Using Maryland Regional Curve regression Equations 1-3, the design channel can be expected to approximate the following dimensions:

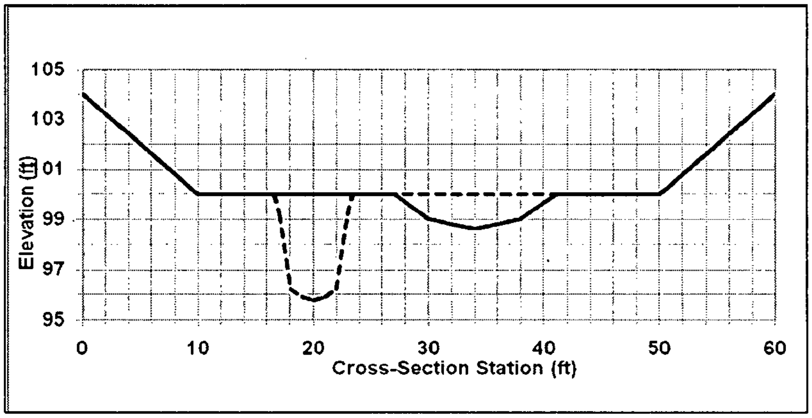

Figure 9: Example Cross-Section view showing an existing stream channel (dotted line) and a proposed new channel excavated to accommodate Priority 1 restoration (solid line). Example is not based on actual field measurement.

John's Creek SR-5

Existing Conditions:

SR-5 (Unnamed Tributary to Johns Creek) – Located southeast of John Creek in the southwest portion of the CCNPP property, this unnamed tributary to John's Creek is located upstream and adjacent to a proposed wetland enhancement zone. This channel exhibits a series of medium size headcuts and seems to have been relocated at some point in the past due to the presence of very small levee-like features on both banks in the upper section of this restoration reach that could be old excavated material (Photo 23).

Photo 23: Photo depicts a representative section of the proposed mitigation reach along an unnamed tributary to Johns Creek. Note the stream channel is incised in this section. Photo taken looking downstream.

<u>Proposed Restoration Approach</u>

Priority I restoration is proposed whereby the existing channel will be abandoned and relocated toward the center of the valley where a remnant channel is visible, allowing for restored stream function. This treatment will continue nearly 450 lf until acceptable access to the active floodplain is achieved.

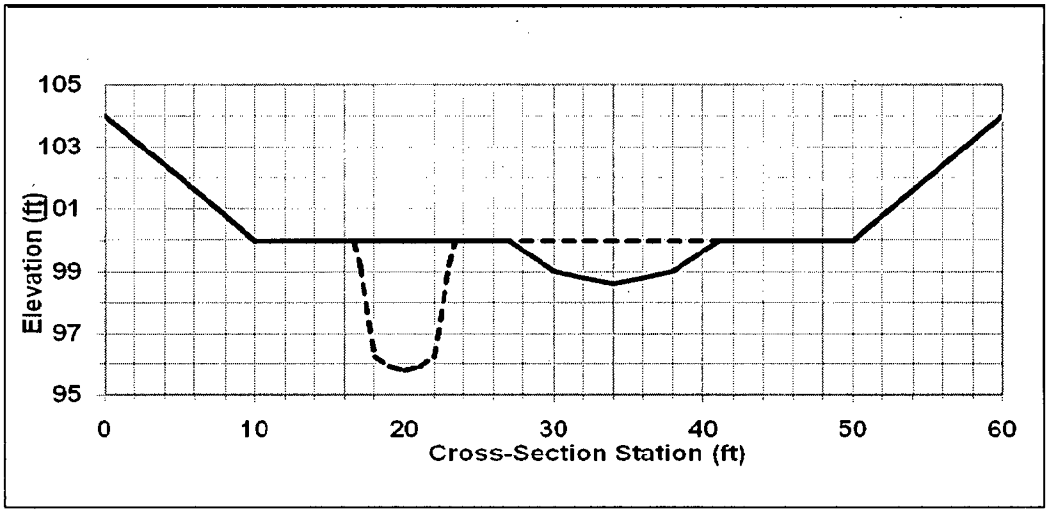

Figure 10: Example Cross-Section view showing an existing stream channel (dotted line) and a proposed new channel excavated to accommodate Priority 1 restoration (solid line). Example is not based on actual field measurement.

<u>John's Creek SE-5</u>

Existing Conditions:

SE-5 (Unnamed Tributary to Johns Creek) – This stream mitigation reach is located in the southwest portion of the CCNPP near the southern property boundary. This unnamed stream channel is a tributary to John's Creek and is located upstream of SR-5. The degradation in this stream segment is likely due to a combination of the downstream degraded SR-5 and that of historical land use in the valley. This segment appears to be in a state of transition from a slightly entrenched Bc to a highly entrenched G (Photo 24).

<u>Proposed Enhancement Approach</u>

Enhancement activity in the stream segment would include the grading of streambanks to an angle more representative of natural stream slopes. The reduced streambank slope angle would allow the stream to better access its floodplain and improve ecological connectivity. Success of this enhancement reach could be contingent, in part, to effective re-establishment of grade control in the downstream, SR-5. (Figure 11)

Photo 24: Photo depicts a representative section of the proposed mitigation reach along Woodland Branch. Note the roots have been under-mined by down-cutting activity that may be an affect from historical land use activity. Photo taken looking upstream.

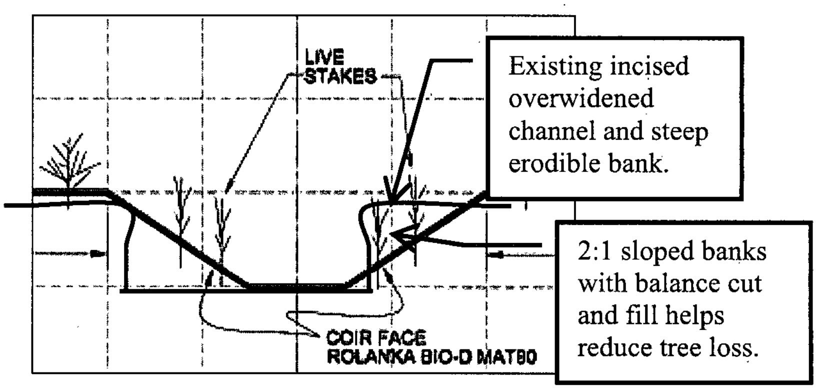

Figure 11: Example Cross-Section showing an existing over-widened stream channel and proposed slightly excavated enhanced stream banks. Example is not based on actual field measurement.

10.0 STREAM MONITORING

The purpose of monitoring is to determine the degree of success a mitigation project has achieved in meeting the objectives of providing proper channel function and increased habitat quality. Success criteria (specific to the selected mitigation objectives) such as physical channel measurements to demonstrate dynamic equilibrium, photographs, native riparian plant density and vigor, and evidence of aquatic species present in the stream systems will be gathered annually to show how well the proposed mitigation plan achieves its goals of no net loss of stream function. Depending on the preferences of the mitigation review team (federal and state agencies) various levels of monitoring may be required based on the complexity of the mitigation project being proposed. At a minimum, the monitoring plan shall include:

1. Party(ies) responsible for monitoring. If more than one, identify primary party,
2. Data to be collected and reported, how often and for what duration (identify proposed monitoring stations, including transect locations on map).
3. Assessment tools and/or methods to be used for data collection monitoring the progress towards attainment of performance standard targets.
4. Format for reporting monitoring data and assessing mitigation status.
5. Monitoring schedule - Monitoring will be conducted for a minimum period of five years.

Per the USACE Wilmington District Stream Mitigation Guidelines (2003) and Baltimore District Stream Mitigation Guidelines (2004), the explicit directives provide the framework for project monitoring. Following final construction, an as-built topographic survey (including identification and location of actual plantings) shall be conducted and corresponding plans with explanations of any deviations from the approved mitigation plan. As-built plans should be certified by a professional engineer and should document the dimension, pattern and profile of the restored channel. Permanent cross-sections should be established at an approximate frequency of one per 20 (bankfull-width) lengths. In general, the locations should be selected to represent approximately 50 percent pools and 50 percent riffle areas. The as-built survey should also include photo documentation at all cross-sections and structures, a plan view diagram, a longitudinal profile, vegetation information and a pebble count/bulk sampling data.

Depending on the level of treatment (creation and enhancement) different levels of ecological function and geomorphic stability success criteria identified and corresponding data may be required.
The following criteria may be used to evaluate success:

1. Photo documentation
2. Channel aggradation or degradation

3. Bank erosion
4. Success of riparian vegetation
5. Effectiveness of erosion control measures
6. Presence or absence of developing instream bars (should be absent)
7. Ecological function
8. Health and survival of vegetation (80 percent survival of planted species required after 5 years)
9. Restoration reach should mimic upstream conditions (or reference reach when applicable)
10. Channel stability
11. Should be insignificant change from the as-built dimension
12. Changes should be minor and represent an increase in stability (e.g. decreased width to depth ratio without a decrease in entrenchment ratio)
13. Pool/riffle spacing should remain fairly constant
14. Pools should not be aggradating nor should riffles be degrading
15. Pebble count should show a change in the size of bed material toward a desired composition.

Annual monitoring forms require as-built plans and current data. Monitoring reports should contain a discussion of any deviations from as-built and an evaluation of the significance of these deviations and whether they are indicative of a stabilizing or destabilizing situation.

Finally, the stream mitigation monitoring program will be implemented in accordance with the requirements of the *Mitigation and Monitoring Guidelines* (USACE, 2004), the protocols presented in the *Maryland Compensatory Mitigation Guidance* (IMTF, 1994), and the guidance provided in Regulatory Guidance Letter No. 08-03 (USACE, October 2008). The monitoring program will be conducted pursuant to the MDEWMA mitigation monitoring guidelines and protocols.

11.0 REFERENCES

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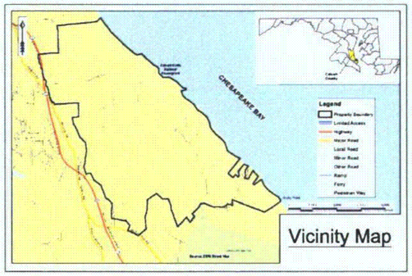
APPENDIX A

CONCEPT PLAN SHEETS (1 THROUGH 9)

Project Name:

Calvert Cliffs Nuclear Power Plant: Concept Non-Tidal Stream And Wetland Mitigation Overview.

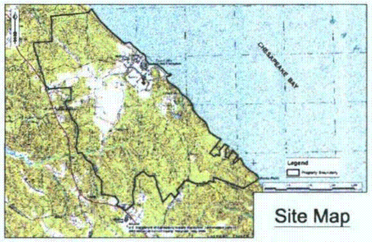
Lusby, Maryland



Vicinity Map

Project Owner:

Calvert Cliffs 3 Nuclear Project, LLC and
UniStar Nuclear Operating Services, LLC
1650 Calvert Cliffs Parkway
Lusby, MD 20657
Phone 410-495-2614



Site Map

Designer's Name:

MACTEC

MACTEC Engineering and Consulting
3301 Atlantic Avenue
Raleigh, NC 27604
Phone 919-876-0416
Fax 919-831-8136

Plan Sheet Index

1	Title Sheet
2	Sites and Quantities of Mitigation Areas
3	Plan Sheet 1
4	Plan Sheet 2
5	Plan Sheet 3
6	Plan Sheet 4
7	Plan Sheet 5
8	Plan Sheet 6
9	Example Details

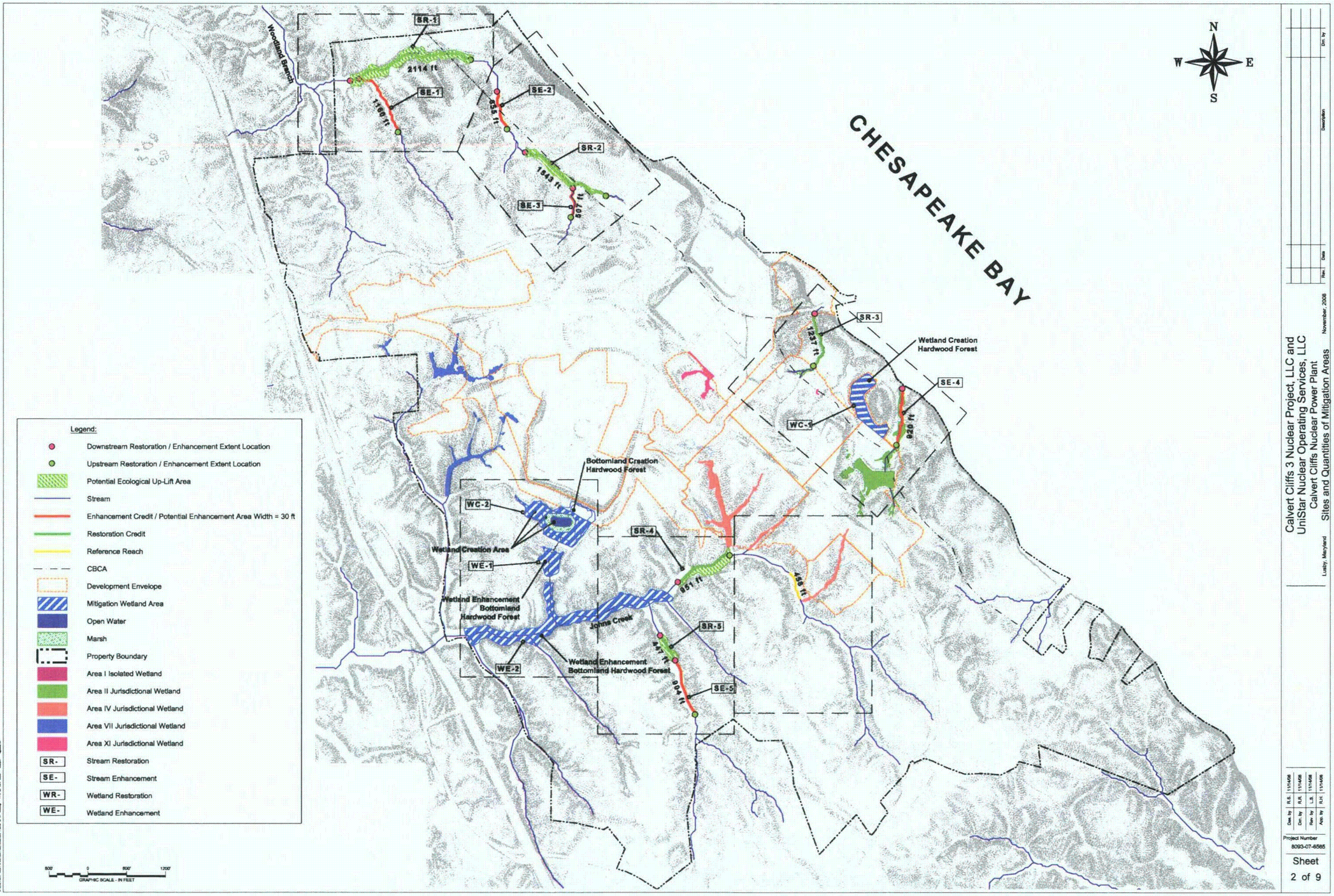
Calvert Cliffs 3 Nuclear Project, LLC and
UniStar Nuclear Operating Services, LLC
Calvert Cliffs Nuclear Power Plant
Title Sheet

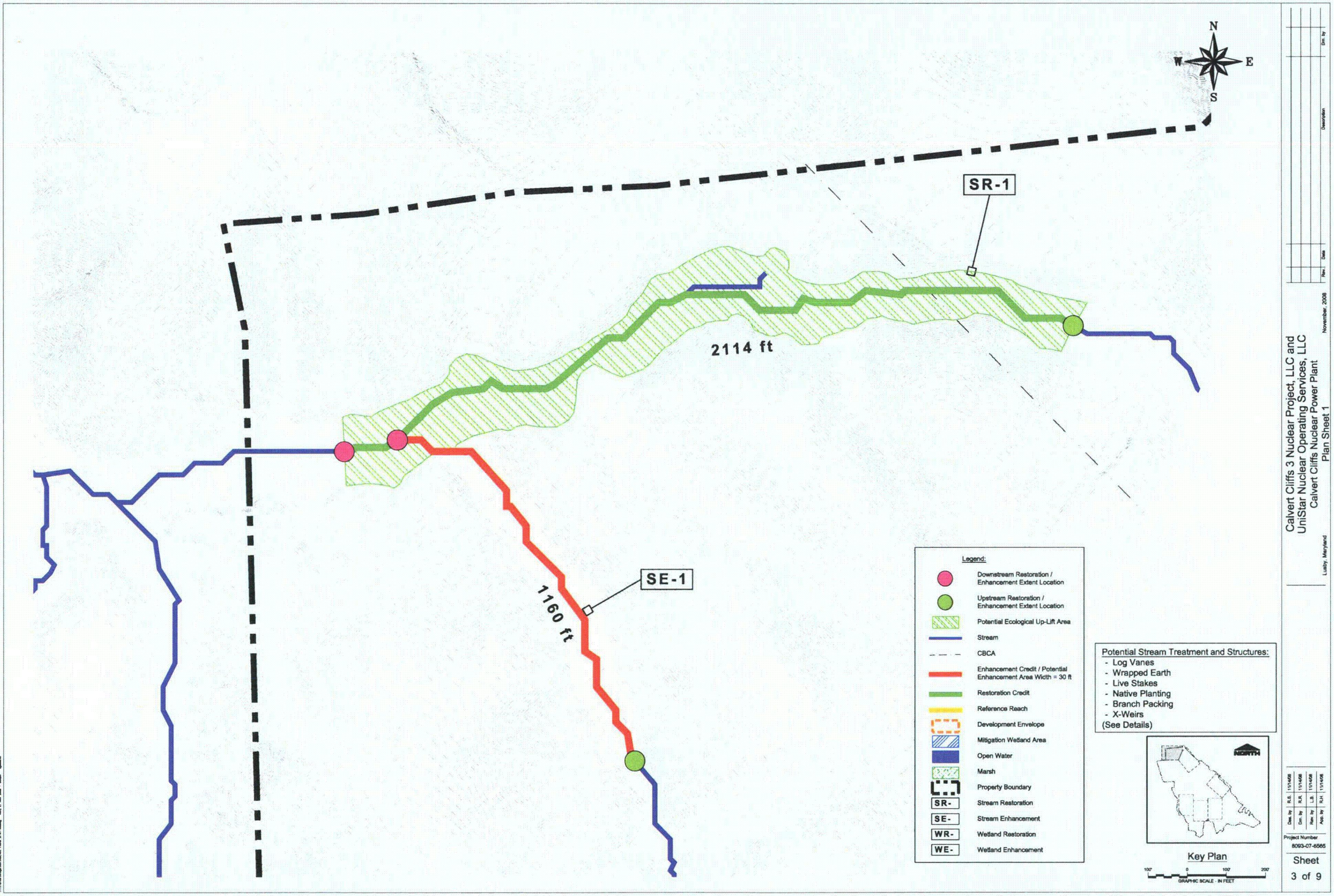
Lusby, Maryland

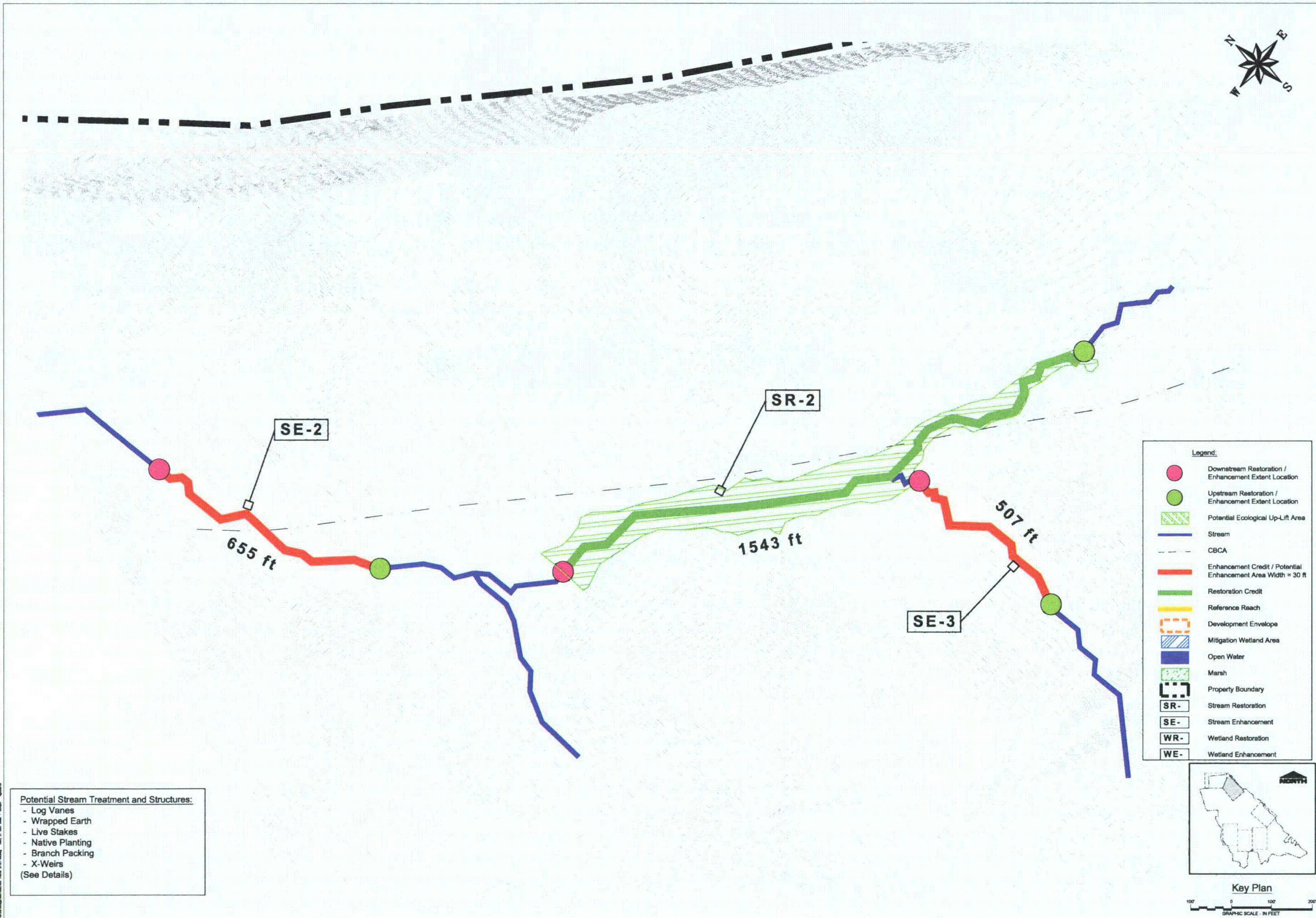
November, 2008

Project Number
6093-07-6565

Sheet
1 of 9


CHESAPEAKE BAY
N
S
E
W
Woodland Branch
SR-1
2114 ft
SE-1
1160 ft
SE-2
SR-2
1843 ft
SE-3
507 ft
SR-3
1237 ft
Wetland Creation
Hardwood Forest
SE-4
920 ft
WC-1
Bottomland Creation
Hardwood Forest
WC-2
Wetland Creation Area
WE-1
Wetland Enhancement
Bottomland
Hardwood Forest
Johns Creek
WE-2
Wetland Enhancement
Bottomland Hardwood Forest
SR-4
951 ft
SR-5
SE-5
904 ft
456 ft
Legend:
Downstream Restoration / Enhancement Extent Location
Upstream Restoration / Enhancement Extent Location
Potential Ecological Up-Lift Area
Stream
Enhancement Credit / Potential Enhancement Area Width = 30 ft
Restoration Credit
Reference Reach
CBCA
Development Envelope
Mitigation Wetland Area
Open Water
Marsh
Property Boundary
Area I Isolated Wetland
Area II Jurisdictional Wetland
Area IV Jurisdictional Wetland
Area VII Jurisdictional Wetland
Area XI Jurisdictional Wetland
SR- Stream Restoration
SE- Stream Enhancement
WR- Wetland Restoration
WE- Wetland Enhancement
GRAPHIC SCALE - IN FEET
Calvert Cliffs 3 Nuclear Project, LLC and
UniStar Nuclear Operating Services, LLC
Calvert Cliffs Nuclear Power Plant
Sites and Quantities of Mitigation Areas
Lusby, Maryland
November, 2008
Project Number
Sheet
2 of 9


N
W
E
S
SR-1
2114 ft
SE-1
1160 ft
Legend:
Downstream Restoration / Enhancement Extent Location
Upstream Restoration / Enhancement Extent Location
Potential Ecological Up-Lift Area
Stream
CBCA
Enhancement Credit / Potential Enhancement Area Width = 30 ft
Restoration Credit
Reference Reach
Development Envelope
Mitigation Wetland Area
Open Water
Marsh
Property Boundary
SR- Stream Restoration
SE- Stream Enhancement
WR- Wetland Restoration
WE- Wetland Enhancement
Potential Stream Treatment and Structures:
- Log Vanes
- Wrapped Earth
- Live Stakes
- Native Planting
- Branch Packing
- X-Weirs
(See Details)
Key Plan
100' 0 100' 200'
GRAPHIC SCALE - IN FEET
Calvert Cliffs 3 Nuclear Project, LLC and
UniStar Nuclear Operating Services, LLC
Calvert Cliffs Nuclear Power Plant
Plan Sheet 1
Lusby, Maryland
November, 2008
Rev. Date Description Drn. by
Des. by R.S. 11/14/08
Drn. by R.R. 11/14/08
Rev. by L.B. 11/14/08
App. by R.H. 11/14/08
Project Number
8093-07-6565
Sheet
3 of 9



Calvert Cliffs 3 Nuclear Project, LLC and
UniStar Nuclear Operating Services, LLC
Calvert Cliffs Nuclear Power Plant
Plan Sheet 2

Lusby, Maryland

November, 2008

Rev.	Date	Description	Drn. by

Des. by	R.S.	11/14/08
Drn. by	R.R.	11/14/08
Rev. by	L.B.	11/14/08
App. by	R.H.	11/14/08

Project Number
8093-07-6565

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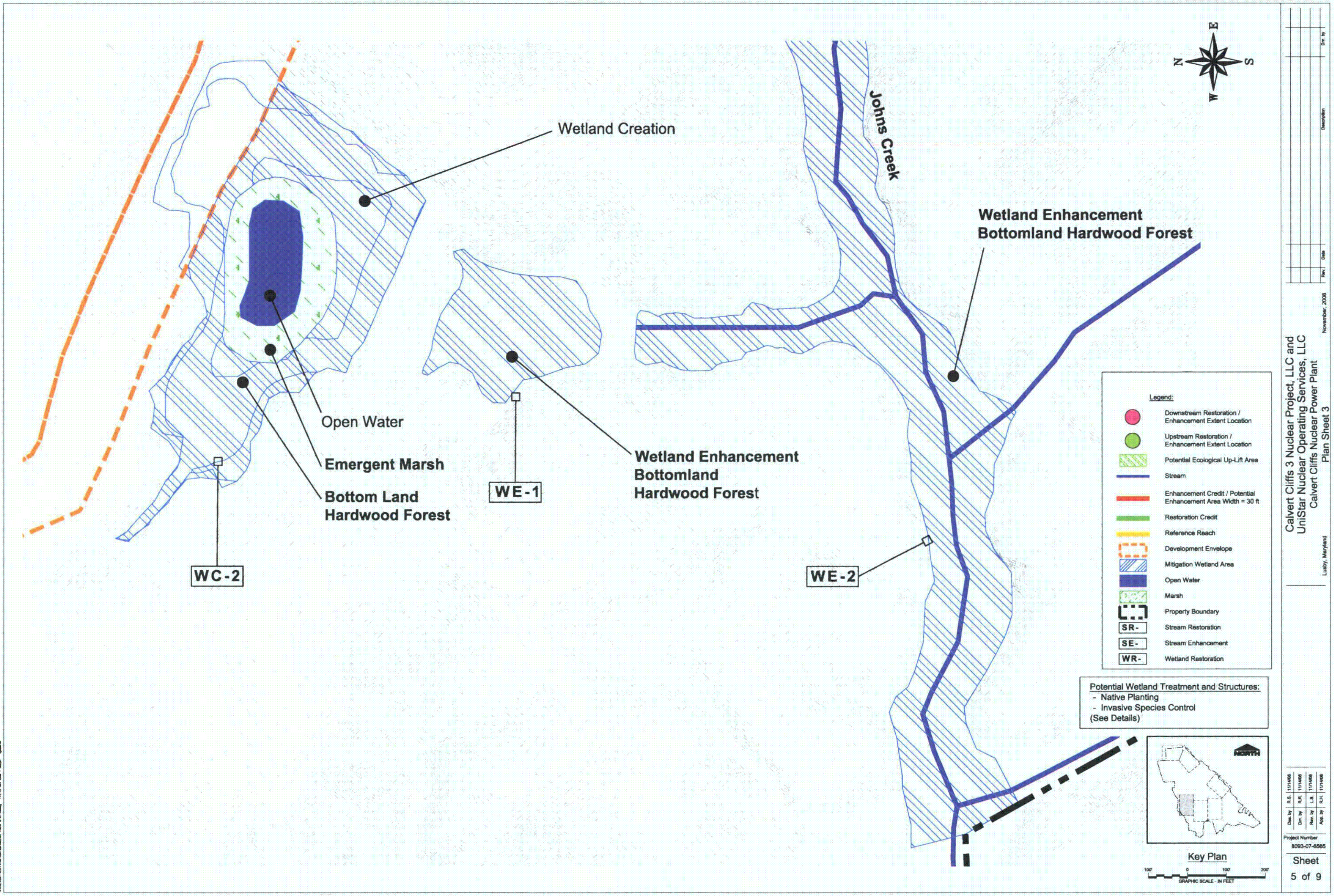
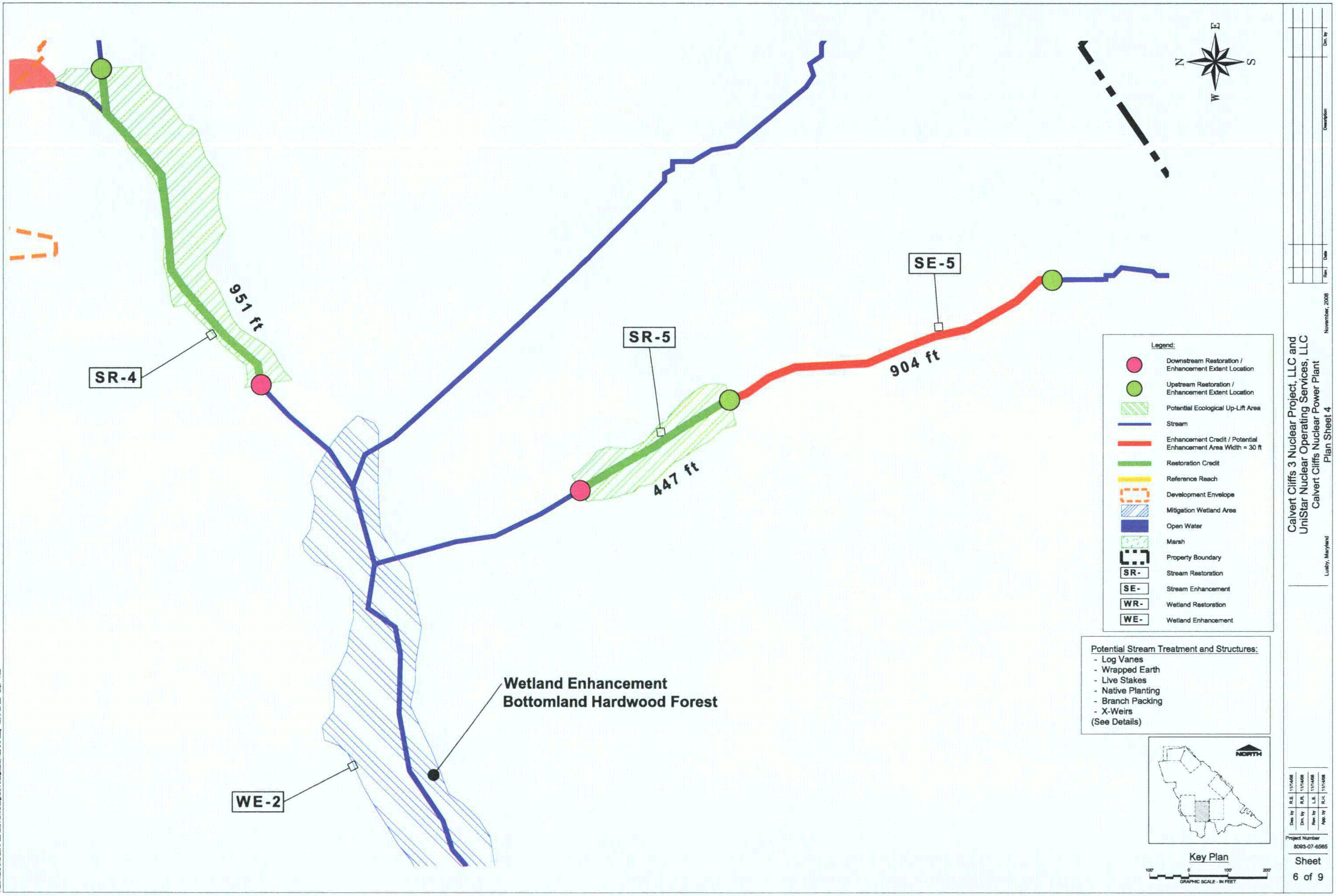
4 of 9



Wetland Creation
Johns Creek
Wetland Enhancement
Bottomland Hardwood Forest
Open Water
Emergent Marsh
Bottom Land
Hardwood Forest
WE-1
Wetland Enhancement
Bottomland
Hardwood Forest
WC-2
WE-2
Legend:
Downstream Restoration / Enhancement Extent Location
Upstream Restoration / Enhancement Extent Location
Potential Ecological Up-Lift Area
Stream
Enhancement Credit / Potential Enhancement Area Width = 30 ft
Restoration Credit
Reference Reach
Development Envelope
Mitigation Wetland Area
Open Water
Marsh
Property Boundary
SR- Stream Restoration
SE- Stream Enhancement
WR- Wetland Restoration
Potential Wetland Treatment and Structures:
- Native Planting
- Invasive Species Control
(See Details)
Key Plan
NORTH
GRAPHIC SCALE - IN FEET
Calvert Cliffs 3 Nuclear Project, LLC and
UniStar Nuclear Operating Services, LLC
Calvert Cliffs Nuclear Power Plant
Plan Sheet 3
Lusby, Maryland
November, 2008
Project Number
Sheet
5 of 9



SR-4
951 ft
SR-5
447 ft
SE-5
904 ft
WE-2
Wetland Enhancement
Bottomland Hardwood Forest
Legend:
Downstream Restoration / Enhancement Extent Location
Upstream Restoration / Enhancement Extent Location
Potential Ecological Up-Lift Area
Stream
Enhancement Credit / Potential Enhancement Area Width = 30 ft
Restoration Credit
Reference Reach
Development Envelope
Mitigation Wetland Area
Open Water
Marsh
Property Boundary
SR- Stream Restoration
SE- Stream Enhancement
WR- Wetland Restoration
WE- Wetland Enhancement
Potential Stream Treatment and Structures:
- Log Vanes
- Wrapped Earth
- Live Stakes
- Native Planting
- Branch Packing
- X-Weirs
(See Details)
Key Plan
NORTH
GRAPHIC SCALE - IN FEET
Calvert Cliffs 3 Nuclear Project, LLC and
UniStar Nuclear Operating Services, LLC
Calvert Cliffs Nuclear Power Plant
Plan Sheet 4
Lusby, Maryland
November, 2008
Sheet
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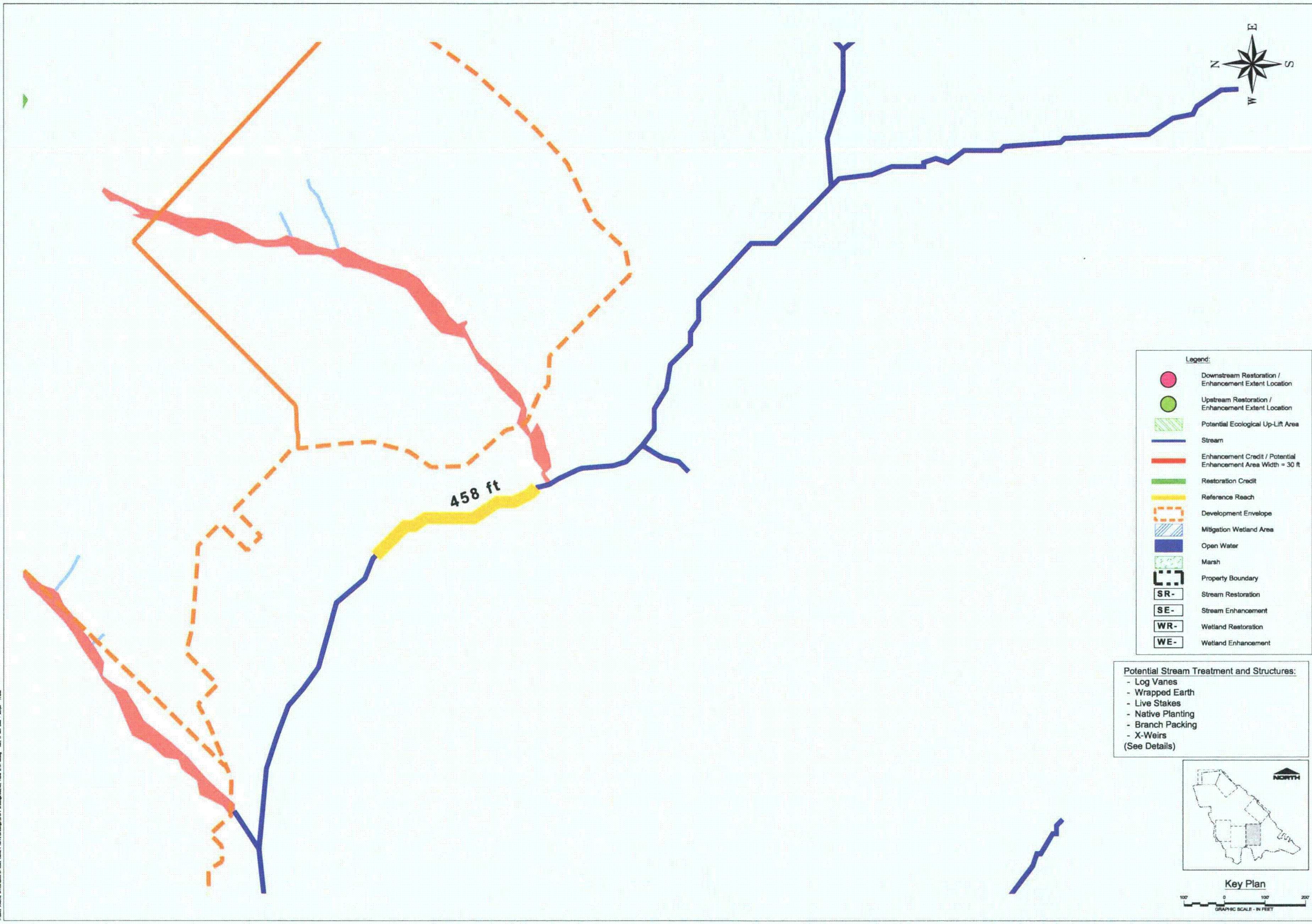

Calvert Cliffs 3 Nuclear Project, LLC and
UniStar Nuclear Operating Services, LLC
Calvert Cliffs Nuclear Power Plant
Plan Sheet 5

Lusby, Maryland

November, 2008

Rev.	Date	Description	Drn. by

Des. by	R.S.	11/14/08
Drn. by	R.R.	11/14/08
Rev. by	L.B.	11/14/08
App. by	R.H.	11/14/08

Project Number
8093-07-6565

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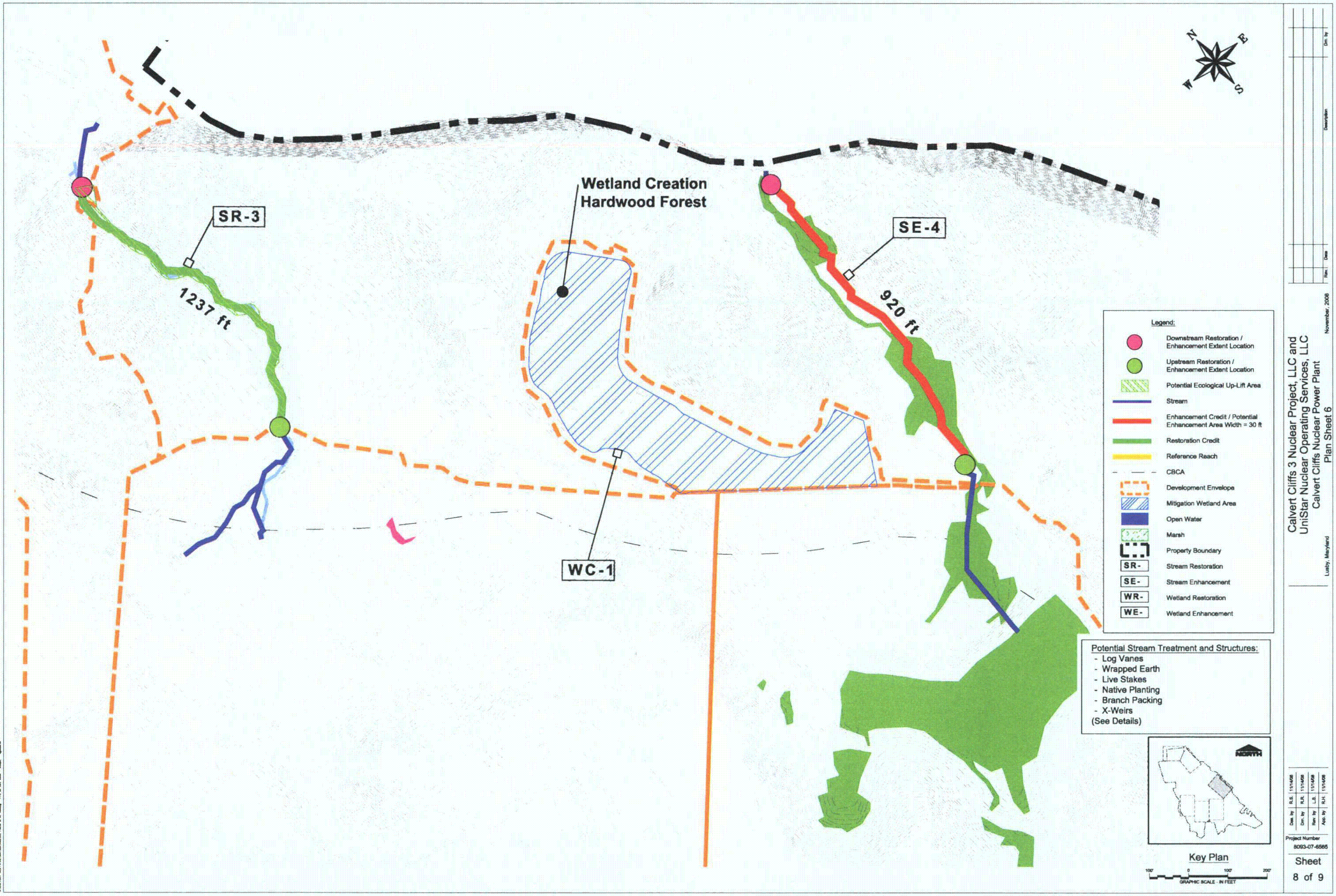

N
E
S
W
Wetland Creation
Hardwood Forest
SR-3
1237 ft
SE-4
920 ft
WC-1
Legend:
Downstream Restoration / Enhancement Extent Location
Upstream Restoration / Enhancement Extent Location
Potential Ecological Up-Lift Area
Stream
Enhancement Credit / Potential Enhancement Area Width = 30 ft
Restoration Credit
Reference Reach
CBCA
Development Envelope
Mitigation Wetland Area
Open Water
Marsh
Property Boundary
SR- Stream Restoration
SE- Stream Enhancement
WR- Wetland Restoration
WE- Wetland Enhancement
Potential Stream Treatment and Structures:
- Log Vanes
- Wrapped Earth
- Live Stakes
- Native Planting
- Branch Packing
- X-Weirs
(See Details)
NORTH
Key Plan
GRAPHIC SCALE - IN FEET
Calvert Cliffs 3 Nuclear Project, LLC and
UniStar Nuclear Operating Services, LLC
Calvert Cliffs Nuclear Power Plant
Plan Sheet 6
Lusby, Maryland
November, 2008
Project Number
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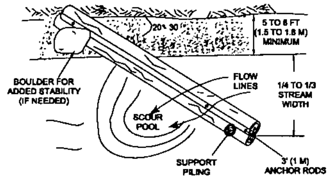
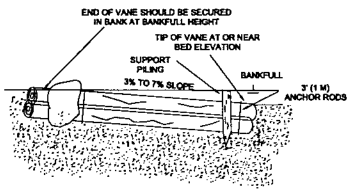


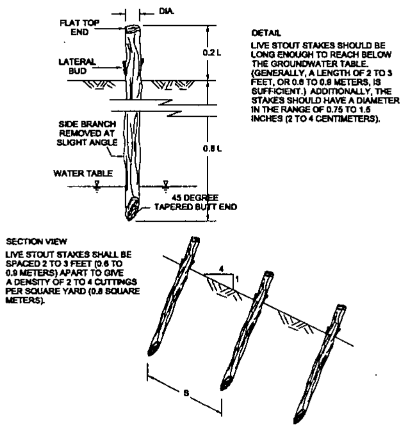
LOG VANES: PLAN VIEW

N.T.S.



LOG VANES: SECTION VIEW

NOT TO SCALE



GENERAL NOTES:

1. AFTER INSTALLATION OF WRAPPED EARTH MATTING, LIVE STAKES SHALL BE INSTALLED ON THE STREAMBANKS.

2. EACH LIVE STAKE SHALL BE 24"-36" TALL WITH A DIAMETER OF 1/2-1" MAXIMUM AND AT LEAST 4 NODES (BUDS). AT LEAST 2 NODES (6") OF THE LIVE STAKE SHALL BE ABOVE GROUND SURFACE AND AT LEAST 2 NODES (12"+) SHALL BE BURIED BENEATH THE GROUND SURFACE. INSTALL LIVE STAKE TO BELOW-GROUND DEPTH OF 12"-18", THEN PRUNE ABOVE-GROUND PORTION OF LIVE STAKE ABOVE SECOND NODE.

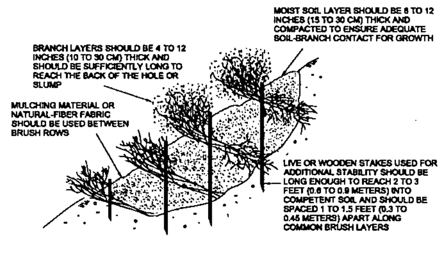
3. LIVE STAKES SHALL BE INSTALLED AT A SPACING OF 2' TO 3' ON CENTER (O.C.), FROM TOE OF STREAMBANK TO THE TOP OF BANK ALONG ALL DISTURBED BANKS.

4. LIVE STAKES SHALL BE INSTALLED IN SOIL AREAS OF WRAPPED EARTH AND THROUGH THE WRAPPED EARTH MATTING (TRM).

5. LIVE STAKE CUTTINGS SHALL BE COLLECTED WITHIN 30 MILES OF PROJECT SITE.

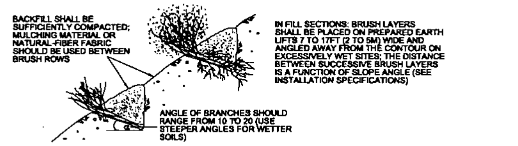
LIVE STAKING DETAIL

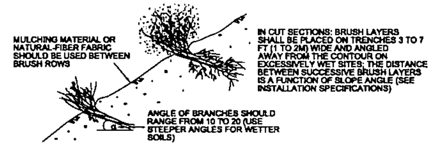
NOT TO SCALE



BRANCH PACKING SECTION VIEW

NOT TO SCALE





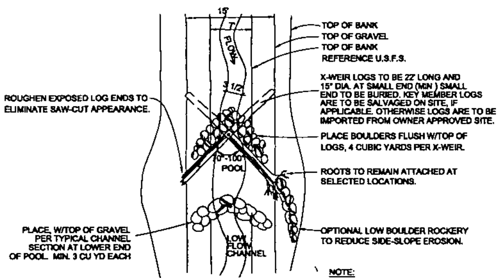
LIVE BRANCHES SHOULD HAVE DIAMETERS BETWEEN 0.5 TO 2.5 INCHES (1.5 TO 6.0CM); BRANCH CUTTINGS SHALL BE ARRANGED IN A CRISSCROSS FASHION IN 4 TO 12-INCH (10 TO 30-CM) THICK LAYERS WITH THE GROWING TIPS ORIENTED TOWARDS THE SLOPE FACE; A MAXIMUM OF 25% OF THE BRANCH LENGTH SHALL PROTRUDE FROM THE SLOPE SURFACE

CONSTRUCTION NOTES:

INSTALLATION SHOULD OCCUR DURING PERIODS OF LOW FLOW AND SHOULD PROCEED UP THE SLOPE; A STABLE ROCK TOE SHOULD BE CONSTRUCTED BELOW THE NORMAL BASEFLOW LEVEL (SEE RIPRAP GUIDELINES)

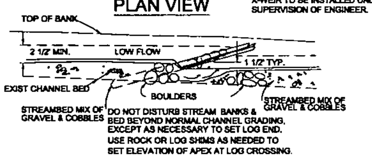
BRANCH PACKING PLAN VIEW

NOT TO SCALE



NOTE:
X-WEIR TO BE INSTALLED UNDER SUPERVISION OF ENGINEER.

PLAN VIEW

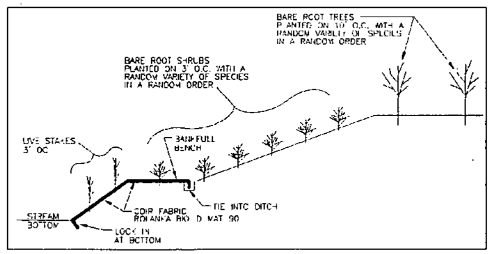


DO NOT DISTURB STREAM BANKS & BED BEYOND NORMAL CHANNEL GRADING, EXCEPT AS NECESSARY TO SET LOG END. USE ROCK OR LOG SHIMS AS NEEDED TO SET ELEVATION OF APEX AT LOG CROSSING.

PROFILE

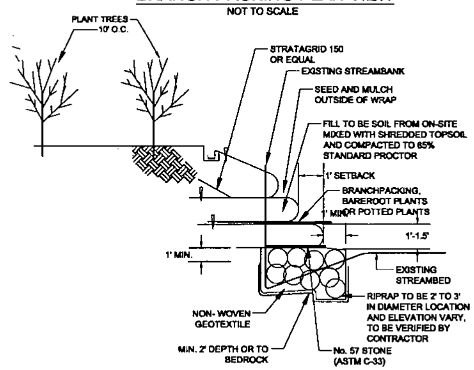
X-WEIR DETAIL

NOT TO SCALE



COIR FACE DETAIL

NOT TO SCALE



WRAPPED EARTH DETAIL

NOT TO SCALE

Rev.	Date	Description	Drn. by

Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC
Calvert Cliffs Nuclear Power Plant
Example Details

Lusby, Maryland — November, 2008

Des. by	R.B.	11/14/08
Drn. by	R.R.	11/14/08
Rev. by	L.B.	11/14/08
App. by	R.H.	11/14/08

Project Number 8093-07-6586

Sheet
9 of 9