Chapter 3 Plant Description

3.0 Introduction

This chapter describes the proposed construction and operation of two additional nuclear generating units at the Vogtle Electric Generating Plant (VEGP) site. The design proposed for construction at the VEGP site is the Westinghouse Electric Company, LLC (Westinghouse) AP1000. Chapter 3 presents detailed information about the proposed AP1000 units in the following sections:

- External Appearance and Plant Layout (Section 3.1)
- Reactor Power Conversion System (Section 3.2)
- Plant Water Use (Section 3.3)
- Cooling System (Section 3.4)
- Radioactive Waste Management System (Section 3.5)
- Nonradioactive Waste Systems (Section 3.6)
- Power Transmission System (Section 3.7)
- Transportation of Radioactive Materials (Section 3.8)
- Pre-Construction and Construction Activities (Section 3.9)
- Work Force Characterization (Section 3.10)

This environmental report identifies and evaluates the design parameters, site characteristics, and site interface values for the two proposed units that provide the basis for the NRC's issuance of an ESP. Plant-specific design parameters are based on the AP1000 Design Control Document **(Westinghouse 2005)** and AP1000 Siting Guide **(Westinghouse 2003)**. Site characteristics and site interface values were determined from site investigation, data collection, and analyses. Table 3.0-1 provides a consolidated list of site characteristics, design parameters, and site interface values used in assessing the environmental impacts of operating two additional nuclear plants at the VEGP site.

Table 3.0-1 is divided into three parts. Part I, Site Characteristics, includes the data that are specific to the VEGP site. Part II, Design Parameters, includes information supplied by Westinghouse for the AP1000 plant design. Part III, Site Interface Values, includes the values that have been determined based on the interrelationships between certain site characteristics and design parameters. The table includes a summary description of each item and a reference to the applicable ER section(s) providing more detailed information. Where a two-unit value differs from single-unit value, the two-unit value is included in brackets [ ] in the table.

Table 3.0-1 VEGP Site Characteristics, AP1000 Design Parameters and Site Interface Values

Part I Site Characteristic			
Item	**Value**		**Description and Reference**
Airborne Effluent Release Point			
Minimum Distance to EAB	½ mi (~800 m)		The lateral distance from the release point (power block area) to the modeled EAB for dose analysis. Refer to Section 2.7.6, Table 2.7-14
Atmospheric Dispersion (χ/Q) (Accident)	*The atmospheric dispersion coefficients used to estimate dose consequences of accident airborne releases.* *Values used in analyses presented in Section 7.1*		
	Time (hour)	Site χ/Q	Atmospheric dispersion coefficients used to estimate dose consequences of accident airborne releases.
EAB (χ/Q)	0 - 2	6.62E-5 sec/m^3	
LPZ (χ/Q)	0 - 8 8 - 24 24 - 96 96 - 720	1.25E-5 sec/m^3 1.10E-5 sec/m^3 8.40E-6 sec/m^3 5.75E-6 sec/m^3	Refer to Section 2.7.5, Tables 2.7-12 and 2.7-13, Section 7.1 and Table 7.1-2
Gaseous Effluents Dispersion, Deposition (Annual Average)			
Atmospheric Dispersion (χ/Q)	χ/Q values in Table 2.7-15		The atmospheric dispersion coefficients used to estimate dose consequences of normal airborne releases. Refer to Section 2.7.6, Table 2.7-15
Population Density			
Population density over the lifetime of the new units until 2090	Population density meets the guidance of RS-002, Attachment 3		Refer to Section 2.5.1, Figures 2.5.1-1 and 2.5.1-2, Table 2.5.1-1
Exclusion Area Boundary (EAB)	The EAB is as defined on Drawing No. AR01-0000-X2-2002 Refer to Figure 3.1-3		The exclusion area boundary generally follows the plant property line and is defined on Drawing No. AR01-0000-X2-2002. Refer to Section 2.7.5
Low Population Zone (LPZ)	A 2-mile-radius circle from the midpoint between the containment buildings of Units 1 and 2		The LPZ is a 2-mile-radius circle from the midpoint between Unit 1 and Unit 2 containment buildings. Refer to Section 2.7.5

Table 3.0-1 (cont.) VEGP Site Characteristics, AP1000 Design Parameters and Site Interface Values

Part II Design Parameters		
Item	**Single Unit [Two Unit] Value**	**Description and Reference**
Facility Characteristics		
Height	234 ft 0 in	The height from finished grade to the top of the tallest power block structure, excluding cooling towers Section 5.3.3.2.5 discusses potential for avian collisions, and Section 5.8.1.3 discusses visual impacts.
Foundation Embedment	39 ft 6 in *to bottom* of basemat from plant grade	The depth from finished grade to the bottom of the basemat for the most deeply embedded power block structure. Sections 4.2.2 and 5.2.2 discuss impacts to groundwater from installing the foundation
Max Inlet Temp Condenser / Heat Exchanger	91°F	The maximum acceptable design circulating water temperature at the inlet to the condenser or cooling water system heat exchangers. Refer to Section 3.4.2.3
Condenser / Heat Exchanger Duty	7.54E9 BTU/hr [1.51E10 BTU/hr]	Design value for the waste heat rejected to the circulating water system across the condensers. Selected value includes part of the service water system heat duty (from turbine equipment heat exchanger). Refer to Sections 3.4.1 and 3.4.2, and Table 3.4-2
Cooling Tower Temperature Range	25.2°F	The temperature difference between the hot water entering the tower and the cold water leaving the tower. Refer to Table 3.4-2
Cooling Tower Cooling Water Flow Rate	600,000 gpm [1,200,000 gpm]	The total nominal cooling water flow rate through the condenser/heat exchangers. Refer to Sections 3.3.1 and 3.4.1, and Table 3.4-2

Table 3.0-1 (cont.) VEGP Site Characteristics, AP1000 Design Parameters and Site Interface Values

Part II Design Parameters		
Item	**Single Unit [Two Unit] Value**	**Description and Reference**
Auxiliary Heat Sink		
CCW Heat Exchanger Duty	8.3E7 BTU/hr normal 2.96E8 BTU/hr shutdown [1.66E8 BTU/hr normal 5.92E8 BTU/hr shutdown]	The heat transferred from the CCW heat exchangers to the service water system for rejection to the environment. Refer to Section 3.3.1 and Table 3.4-1
SWS Cooling Tower Cooling Water Flow Rate	9,000 gpm normal 18,000 gpm shutdown [18,000 gpm normal 36,000 gpm shutdown]	The total nominal cooling water flow rate through the SWS. Refer to Section 3.3.1 and Table 3.4-1
Plant Characteristics		
Rated Thermal Power (RTP)	3,400 MWt	The thermal power generated by the core. Refer to Section 3.2
Rated NSSS Thermal Output	3,415 MWt [6,830 MWt]	The thermal power generated by the core plus heat from the reactor coolant pumps. Refer to Section 3.2
Average Fuel Enrichment	2.35 wt % to 4.45 wt % 4.51 wt %	Concentration of U-235 in fuel - Initial load. Refer to Section 3.2.1. Average concentration, in weight percent, of U-235 in reloads; see Section 5.11.1; used in analysis presented in Section 5.11.2
Fuel Burn-up	60,000 MWd/MTU (design max) 48,700 MWd/MTU (expected)	Value derived by multiplying the reactor thermal power by time of irradiation divided by fuel mass (expressed in megawatt - days per metric ton of uranium fuel). Refer to Section 3.2 and 5.11.1; average discharge burnup used in analysis presented in Section 5.11.2
Normal Releases		
Liquid Source Term	See Table 3.5-1 0.26 curies total nuclides except tritium [0.52 curies]	The annual activity, by isotope, contained in routine liquid effluent streams. Used in analyses presented in Section 5.4

Table 3.0-1 (cont.) VEGP Site Characteristics, AP1000 Design Parameters and Site Interface Values

Part II Design Parameters		
Item	**Single Unit [Two Unit] Value**	**Description and Reference**
Tritium (liquid)	1,010 curies [2,020 curies]	The annual activity of tritium contained in routine liquid effluent streams. Section 5.4 analyses account for tritium releases
Gaseous Source Term	See Table 3.5-2 11,000 curies total nuclides except tritium [22,000] [Double values in Table 3.5-2]	The annual activity, by isotope, contained in routine plant airborne effluent streams. Used in analysis presented in Section 5.4
Tritium (gaseous)	See Table 3.5-2 350 curies [700 curies]	The annual activity of tritium contained in routine plant airborne effluent streams. Section 5.4 analyses account for tritium releases
Solid Waste Activity	See Tables 3.5-4 and 3.5-5 1,764 curies [3,528 curies]	The annual activity contained in solid radioactive wastes generated during routine plant operations. Refer to Sections 3.5.3 and 5.5.4
Dry Active ("Solid") Waste Volume	5,759 ft^3 [11,518 ft^3]	The expected volume of solid radioactive wastes generated during routine plant operations. Refer to Section 3.5.3
Accident Releases		
Elevation (Post Accident)	Ground level	The elevation above finished grade of the release point for accident sequence releases. Used to calculate impacts of accidents in Sections 2.7.5, 7.1 and 7.2
Gaseous Source Term (Post-Accident)	See Tables 7.1-4 to 7.1-12	The activity, by isotope, contained in post-accident airborne effluents. Refer to Section 7.1 and Tables 7.1-4 to 7.1-12.

Table 3.0-1 (cont.) VEGP Site Characteristics, AP1000 Design Parameters and Site Interface Values

Part III Site Interface Values		
Item	**Single Unit [Two Unit] Value**	**Description and Reference**
Normal Plant Heat Sink (condenser and turbine auxiliary cooling)		
CWS Cooling Tower Acreage	38 acres [69.3 acres]	The land required for CWS natural draft cooling towers, including support facilities such as equipment sheds, basins, or canals, Refer to Sections 3.1.2 and 3.4.2
CWS Cooling Tower Approach Temperature	11°F	The difference between the cold water temperature leaving the tower and the ambient wet bulb temperature. Refer to Section 3.4.2
CWS Cooling Tower Blowdown Temperature	91°F	The design maximum expected blowdown temperature at the point of discharge to the receiving water body. Refer to Section 5.3
CWS Cooling Tower Evaporation Rate	13,950 gpm (14,440 gpm) [27,900 gpm (28,880 gpm)]	The expected (and maximum) rate at which water is lost by evaporation from the cooling water systems. Refer to Section 3.3.1 and Table 3.3-1; used as basis for analyses in Section 5.3.3.1
CWS Cooling Tower Drift Rate	12 gpm [24 gpm]	The maximum rate at which water is lost by drift from the cooling water systems. Refer to Section 3.3.1, and Table 3.3-1; used as basis for analyses in Section 5.3.3.1
CWS Cooling Tower Height	600 ft	The vertical height above finished grade of the natural draft cooling tower. Refer to Table 3.4-2; used as basis for analysis in Section 5.3.3.1
CWS Cooling Tower Make-up Flow Rate	18,612 gpm (28,892 gpm) [37,224 gpm (57,784 gpm)]	The expected (and maximum) design rate of removal of water from the Savannah River to replace water losses from circulating water systems. The make-up flow rate is a calculated value based on the sum of the evaporation rate plus the blowdown flow rate plus drift. Refer to Sections 3.3.1, 3.4.1 and 3.4.2 and Table 3.3-1 Used as basis for analysis in Section 5.3.1 and 5.3.2

Table 3.0-1 (cont.) VEGP Site Characteristics, AP1000 Design Parameters and Site Interface Values

Part III Site Interface Values		
Item	**Single Unit [Two Unit] Value**	**Description and Reference**
CWS Cooling Tower Offsite Noise Levels	< 20 dB above background	The maximum expected sound level at the site boundary. Refer to Section 5.8.1.1
CWS Cooling Tower Heat Rejection Rate (Blowdown)	4,650 gpm (expected), 14,440 gpm (max) @91°F [9,300 gpm (expected) 28,880 gpm (max)] @ 91°F	The expected heat rejection rate to a receiving water body, expressed as flow rate in gallons per minute at a temperature in degrees Fahrenheit. Refer to Sections 2.3.2, 3.4.2; used as basis for analyses in Sections 5.3.1 and 5.3.2
CWS Cooling Tower Maximum Consumption of Raw Water	14,452 gpm [28,904 gpm]	The expected maximum short-term consumptive use of water by the circulating water systems (evaporation and drift losses). Refer to Sections 3.3.1 and 3.4.1, and Table 3.3-1
CWS Cooling Tower Expected Consumption of Raw Water	13,962 gpm [27,924 gpm]	The expected normal operating consumption of water by the circulating water system (evaporation and drift losses). Refer to Sections 3.3 and 3.4, and Table 3.3-1
Auxiliary Heat Sink (nuclear island cooling)		
SWS Cooling Tower Acreage	0.5 acre [1 acre]	The land required for SWS mechanical draft cooling towers, including support facilities such as equipment sheds and basins. Refer to Section 3.1.2
SWS Cooling Tower Makeup Rate	269 gpm (1,177 gpm) [537 gpm (2,353 gpm)]	The expected (maximum) rate of removal of water from wells to replace water losses from auxiliary heat sink. Refer to Sections 3.3 and 3.4.1
Airborne Effluent Release Point		
Normal Dose Consequences to the Maximally Exposed Individual	Total body: 0.05 mrem [0.1 mrem]	The estimated annual design radiological dose consequences due to gaseous releases from normal operation of the plant. Refer to Section 5.4
Post-Accident Dose Consequences	See Tables 7.1-13 to 7.1-22	The estimated design radiological dose consequences due to gaseous releases from postulated accidents. Refer to Section 7.1

Table 3.0-1 (cont.) VEGP Site Characteristics, AP1000 Design Parameters and Site Interface Values

Part III Site Interface Values		
Item	**Single Unit [Two Unit] Value**	**Description and Reference**
Liquid Radwaste System		
Normal Dose Consequences	10 CFR 50, App I, 10 CFR 20 40 CFR 190	The estimated design radiological dose consequences due to liquid effluent releases from normal operation of the plant. Refer to Section 5.4.2.1
Plant Characteristics		
Total Acreage	310 acres for 2 units	The land area required to provide space for all plant facilities, including power block, switchyard, spent fuel storage, and administrative facilities. Refer to Section 4.1.1.1
Groundwater Consumptive Use	376 gpm (1,570 gpm) [762 gpm (3,140 gpm)]	The Rate of withdrawal of groundwater to serve the new units. Used in analysis in 5.2.2
Plant Population		
Operation	345 [660]	The number of people required to operate and maintain the plant. Refer to Section 3.10.3; used in analyses in Section 5.8
Refueling / Major Maintenance	1,000	The additional number of temporary staff required to conduct refueling and major maintenance activities. Refer to Section 5.8
Construction	1,576 people monthly average [3,152 people monthly average]	The monthly average estimated construction workforce staffing for two AP1000 units being constructed simultaneously. This assumes a site preparation schedule of 18 months, 48 months from first concrete to fuel load, with 6 months from fuel load to commercial operation and 12 months between commercial operation of each unit. This assumes 20.5 job hours per net kilowatt installed, giving credit for offsite modular construction. The peak number of construction workforce personnel could reach the 4,400 range. Refer to Section 3.10.1; used in analyses in Section 4.7

Section 3.0 References

(Westinghouse 2003) Westinghouse Electric Company, LLC, *AP1000 Siting Guide: Site Information for an Early Site Permit Application*, APP-0000-X1-001, Revision 3, April 24, 2003.

(Westinghouse 2005) Westinghouse Electric Company, LLC, *AP1000 Design Control Document*, Revision 15, AP1000 Document APP-GW-GL-700, November 11, 2005.

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3.1 External Appearance and Plant Layout

3.1.1 Existing Site

The 3,169 acre VEGP site is located on a coastal plain bluff on the southwest side of the Savannah River in eastern Burke County. The site exclusion area boundary (EAB) is bounded by River Road, Hancock Landing Road and 1.7 miles of the Savannah River (River Miles 150.0 to 151.7). The property boundary entirely encompasses the EAB and extends beyond River Road in some areas. The site is approximately 30 river miles above the U. S. 301 bridge and directly across the river from the Department of Energy's Savannah River Site (Barnwell County, South Carolina). The VEGP site is approximately 15 miles east north east of Waynesboro, Georgia and 26 miles southeast of Augusta, Georgia, the nearest population center (i.e. having more than 25,000 residents). It is also about 100 miles from Savannah, Georgia; and 150 river miles from the mouth of the Savannah River. The existing VEGP Units 1 and 2 are Westinghouse pressurized water reactor (PWR) plants licensed by the US Nuclear Regulatory Commission (NRC) in 1987 and 1989, respectively, that have been in commercial operation since that time. Each unit has a thermal power rating of 3,565 megawatts thermal (MWt). Plant Wilson, a six-unit oil-fueled combustion turbine facility constructed in 1974 and owned by Georgia Power Company (GPC), is also located on the VEGP site.

VEGP Units 1 and 2 each has a concrete containment building adjacent to a common steel and metal-sided turbine building with a reinforced concrete roof. The units share a concrete auxiliary building, control building, and fuel handling building. Supporting structures located on the site include two natural draft cooling towers (one per unit), associated intake and discharge structures, service water cooling towers, a water treatment building, a switchyard, and a training center. Figure 3.1-1 provides an aerial photograph of the existing VEGP site and Figure 3.1-3 is a site drawing illustrating the existing plant layout and the proposed AP1000 layout.

The existing VEGP site was originally a four-unit site. The construction permit granted by the NRC reflected four units, and the site grading work was done to support four units. However, only two units were actually constructed.

3.1.2 Proposed Site

SNC has selected the Westinghouse AP1000 certified plant design for the VEGP ESP application. The proposed AP1000 units, to be referred to as Units 3 and 4, will be located west of and adjacent to the existing Units 1 and 2 as shown in Figure 3.1-2. The AP1000 has a thermal power rating of 3,400 MWt, with a net electrical output of 1,117 megawatts electrical (MWe). The projected commercial operation dates for Units 3 and 4 are May 2015 and May 2016, respectively.

The AP1000 units and support facilities proposed for the VEGP site will be designed around the Westinghouse standardized unit approach. The standardized unit design does not share common support facilities and structures between units. Each AP1000 unit is based on a "stand alone" concept and consists of five principal generation structures: the nuclear island, turbine building, annex building, diesel generator building, and radwaste building. Structures that make up the nuclear island include the containment building, shield building, and auxiliary building. The turbine building is a rectangular metal-siding building with its long axis oriented radially from the containment building. The turbine building will be located on the west end of the power block. The shield building and auxiliary building are constructed of reinforced concrete. The annex building is constructed of a combination of reinforced concrete and steel-framed structure with insulated metal siding. The diesel generator building is a steel-framed structure with insulated metal siding. The radwaste building, which will be located on the east end of the unit layout, will be a steel-framed structure with a combination of prefabricated concrete panels and metal siding. Units 3 and 4 will be constructed from materials architecturally similar and similar in color and texture to those used on Units 1 and 2. Figure 3.1-4 is an artist's rendering of the AP1000 design.

Units 3 and 4 will be constructed west of the Units 1 and 2 plant complex. The new units will be located in approximately the same area proposed for the original Units 3 and 4. Most of this area has already been graded to the same elevation as the current Units 1 and 2 and is planted in pine trees. The area also contains access roads, slabs from old construction buildings, and several structures supporting operation of the existing units. Unit 3 power block structures will be separated from the Unit 2 structures by approximately 1,000 ft. The center point of Unit 3 containment will be approximately 1,500 ft west and 200 ft south of the center point of the Unit 2 containment. The Unit 4 footprint will be separate from but adjacent to the Unit 3 footprint. The center point of Unit 4 will be approximately 900 ft west of the center point of Unit 3. The power block footprints of Units 3 and 4 will require an area of 77.5 acres. The proposed location integrates well with the existing units, and the layout has been designed to give the appearance of a plant site originally designed for four units. Figure 3.1-2 provides an artist's rendering of the VEGP site with the existing nuclear units and the two proposed units.

Units 3 and 4 will share a common river intake structure and certain support structures such as office buildings, water, wastewater, and waste-handling facilities. Paved site roadways will connect the new units to the rest of the VEGP site, providing routine and non-routine access to the existing and new units with minimal disturbance of the area.

The circulating water system for the new units will include two concrete natural-draft hyperbolic cooling towers (one for each unit) and common river intake and discharge structures. The Savannah River will be used for make-up water for the circulating water and the turbine plant cooling systems. The plant discharge will be returned to the Savannah River at a point downstream of the plant discharge for the existing units. The new river intake and discharge structures will be located at a sufficient distance from the existing river intake and discharge facilities to minimize any operational impacts to the existing units and any cumulative environmental impacts to the aquatic ecosystem. These facilities will be designed and constructed from materials architecturally similar to those used for Units 1 and 2.

The proposed natural-draft cooling towers will be architecturally similar to the existing cooling towers and will be located south of the proposed units as indicated in Figure 3.1-3. The cooling towers will be approximately 600 ft high and require an area of 69.3 acres for both towers and their supporting facilities.

In addition to the natural-draft cooling tower footprint, the new units also require space for the service water system cooling towers. These mechanical draft cooling towers will require an area of approximately 0.5 acre per unit, will be approximately 60 ft high, and will be located within the AP1000 power block area.

The elevation for the new units and associated cooling towers will be approximately the same elevation as the existing nuclear units. This will result in a consistent visual effect and promote a more pleasing overall aesthetic view (Figure 3.1-2).

Existing infrastructure will be modified to integrate the new units with the existing units; however, none of the existing units' structures or facilities that directly support power generation will be shared. The existing switchyard will be modified to provide interconnections with the new switchyard for the proposed units, and the transmission lines modified and rerouted as required to incorporate the new generation capacity into the electric grid. The existing security perimeter will be expanded to include the new units. The training center will be expanded to support the training needs for the new units. In addition, other support facilities such as the existing sewage treatment facility will be expanded to serve all four units. Existing administrative buildings, warehouses, and other minor support facilities will be used, expanded, or replaced, based on prudent economic and operational considerations. Figure 3.1-3 shows the integration of the new and existing units as well as site roadways and access.

After the completion of new unit construction, areas used for construction support will be graded, landscaped, and planted to enhance the overall site appearance. Previously forested areas cleared for temporary construction facilities will be revegetated, and harsh topographical features created during construction will be contoured to match the surrounding areas. These areas could include equipment laydown yards, module fabrication areas, concrete batch plant, areas around completed structures, and construction parking.

Figure 3.1-1 Photograph of Existing VEGP Site (view looking northeast)

Figure 3.1-2 Artist's Conception of New AP1000 Units Adjacent to Existing Nuclear Facility (view looking northeast)

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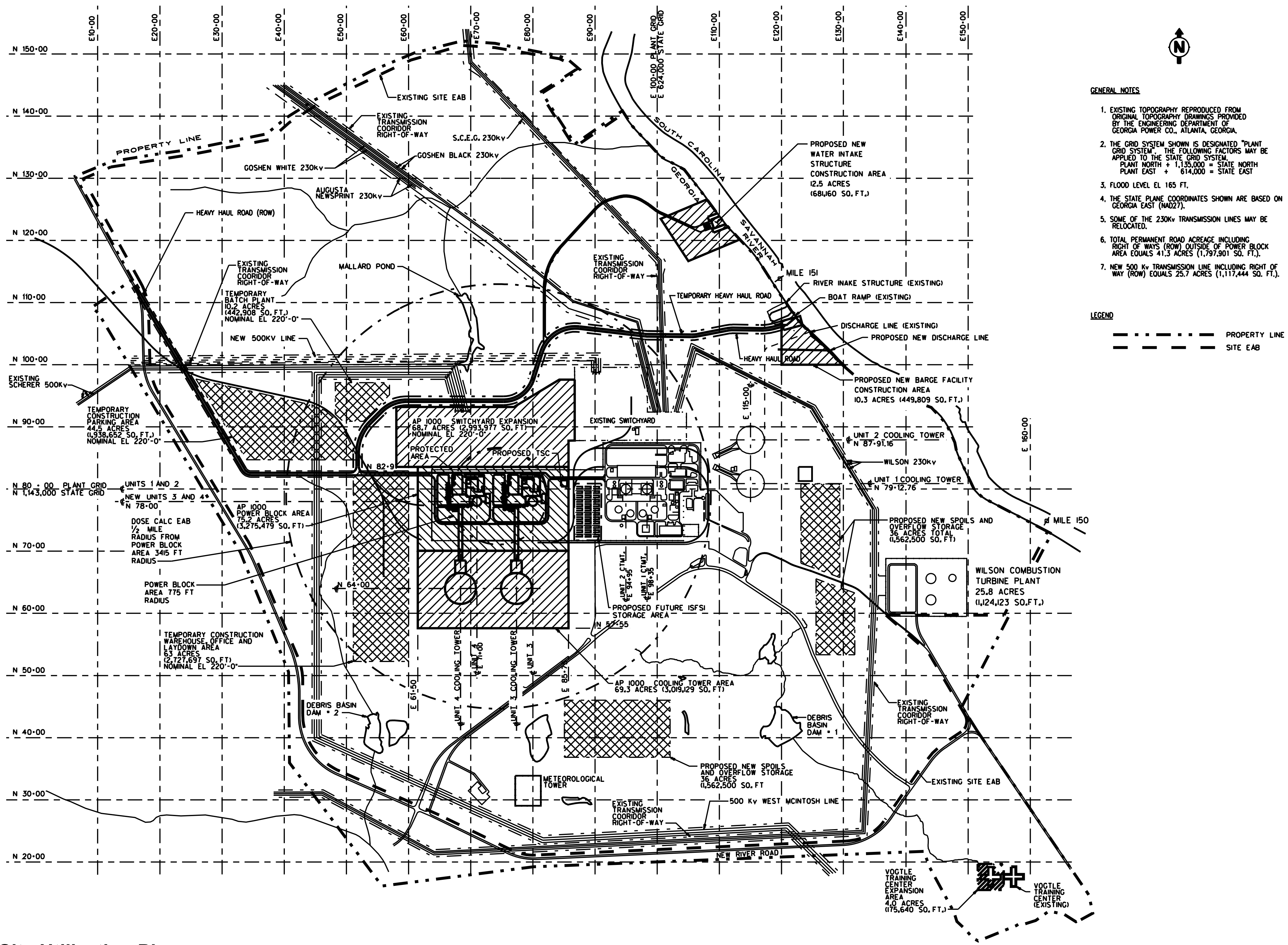

Figure 3.1-3 ESP Site Utilization Plan

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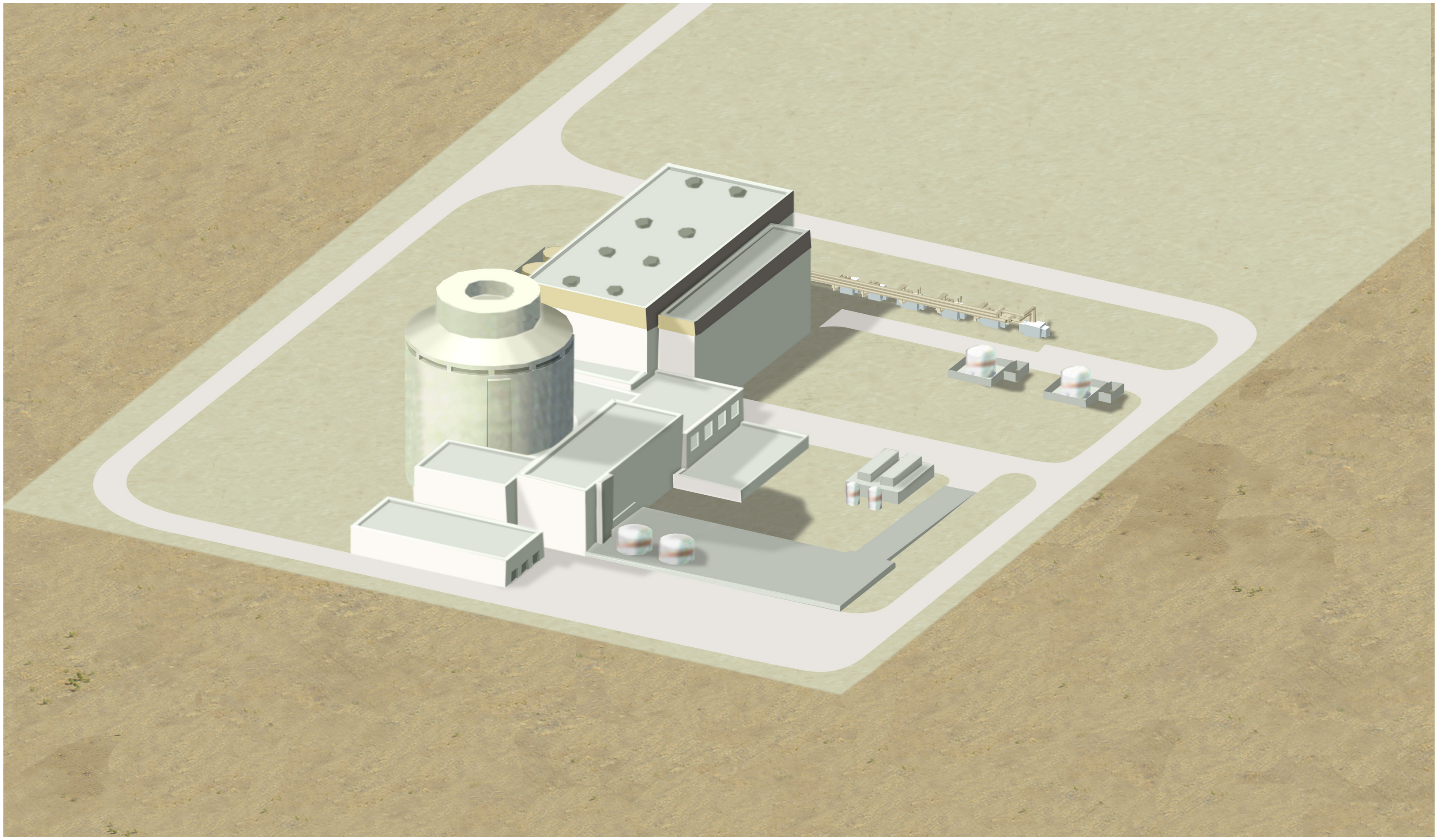

Figure 3.1-4 Artist's Rendering of AP1000 Standard Unit

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3.2 Reactor Power Conversion System

The AP1000 design is based on Westinghouse pressurized water reactor (PWR) technology. Major components include a single reactor pressure vessel, two steam generators (SGs), and four reactor coolant pumps for converting reactor thermal energy into steam. A single high pressure turbine and three low pressure turbines drive a single electric generator. The AP1000 was certified by the NRC under 10 CFR 52, Appendix D. Figure 3.2-1 provides a simplified depiction of the reactor power conversion system.

The AP1000 reactor is connected to two SGs via two primary hot leg pipes and four primary cold leg pipes. A reactor coolant pump is located in each primary cold leg pipe to circulate pressurized reactor coolant through the reactor core. The reactor coolant flows through the reactor core, making contact with the fuel rods that contain the enriched uranium dioxide fuel. As the reactor coolant passes through the reactor core, heat from the nuclear fission process is removed from the reactor. This heat is transported to the SGs by the circulating reactor coolant and passes through the tubes of the SGs to heat the feedwater from the secondary system. The reactor coolant is pumped back to the reactor by the reactor coolant pumps, where it is reheated to start the heat transfer cycle over again. Inside the SGs, the reactor heat from the primary system is transferred through the walls of the tubes to convert the incoming feedwater from the secondary system into steam. The steam is transported from the SGs by main steam piping to drive the high pressure and low pressure turbines connected to an electric generator to produce electricity. After passing through the three low pressure turbines, the steam is condensed back to water by cooled circulating water inside titanium tubes located in the three main condensers. The condensate is then preheated and pumped back to the SGs as feedwater to repeat the steam cycle. The circulating water is cooled by a natural-draft cooling tower. Each unit's cooling tower will reject the main condenser/turbine plant heat exchanger duty of approximately 7.54×10^9 BTU/hr (2,208 MWt) of waste heat to the atmosphere. The unit thermal efficiency of the complete cycle is approximately 35 percent.

The Rated Thermal Power (RTP) of the AP1000 reactor is 3,400 MWt, with a nuclear steam supply system rating of 3,415 MWt (core plus reactor coolant pump heat). The gross and minimum net electrical outputs of the AP1000 design are approximately 1,200 MWe (with an 87°F circulating water cold water temperature) and 1,117 MWe respectively, with maximum station and auxiliary service loads of 83 MWe.

The AP1000 reactor uses uranium dioxide enriched with U-235 for fissile material. The reactor fuel consists of individual cylindrical uranium pellets enclosed in a sealed ZIRLO™ tube to constitute a fuel rod. The AP1000 fuel assembly consists of 264 fuel rods grouped in a 17 x 17 array approximately 14 ft long. The AP1000 reactor contains 157 fuel assemblies consisting of

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41,488 total fuel rods. Total uranium dioxide fuel weight is 211,588 lb. Enrichment of the uranium will be approximately 2.35 to 4.45 weight percent U-235 for the initial reactor core load and 4.51 weight percent U-235 for core reloads. The expected burn-up of discharged fuel is approximately 48,700 megawatt-days per metric ton of uranium (MWD/MTU), with an expected cycle burn-up of 21,000 MWD/MTU. The maximum fuel rod average burn-up value for the AP1000 reactor is 60,000 MWD/MTU. The total fuel capacity for the AP1000 reactor is approximately 84.5 MTU. **(Westinghouse 2003, 2005)**

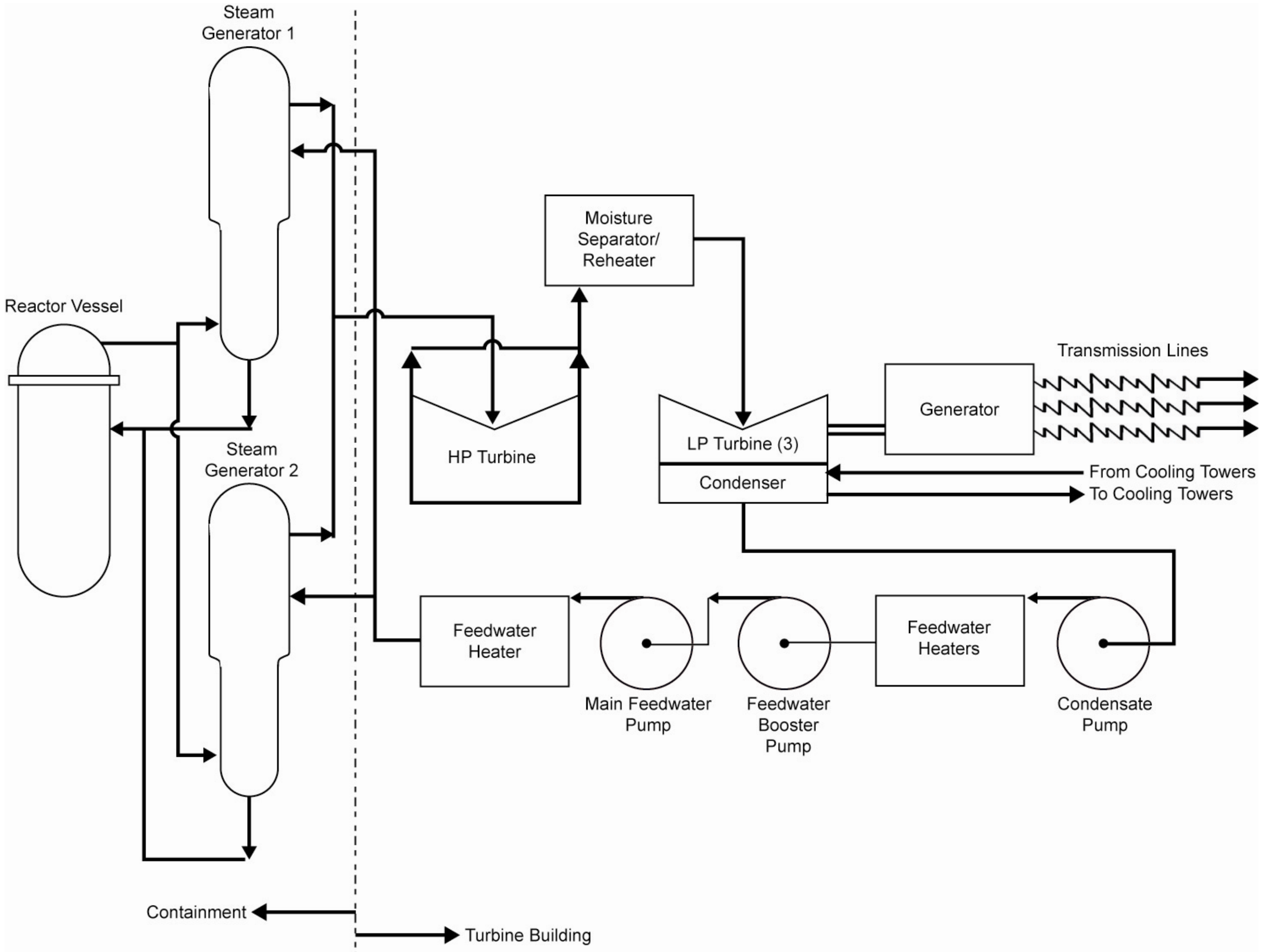

Figure 3.2-1 Simplified Flow Diagram of Reactor Power Conversion System

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3.3 Plant Water Use

The plant water consumption and water treatment for the proposed AP1000 units were determined from the *AP1000 Design Control Document* **(Westinghouse 2005)**, site characteristics, and engineering evaluations. The VEGP site has two sources of water available for plant water supply: surface water from the Savannah River and groundwater from the Cretaceous and Tertiary aquifers. Treated effluents from both sources will be returned to the Savannah River.

3.3.1 Water Consumption

The new AP1000 units require water for both plant cooling and operational uses. The Savannah River provides make-up water for the circulating water system (CWS) to replace the water lost to evaporation, drift, and blowdown. On-site wells provide groundwater make-up for the service water system (SWS). The wells also provide water for other plant systems, including the fire protection system, the plant demineralized water supply system, and the potable water system. Surface water consumptive use for the two AP1000 units' normal operation is 27,924 gpm, with a maximum of 28,904 gpm. Groundwater consumptive use is 752 gpm on average, with a maximum of 3,140 gpm. During normal operation, approximately 305 gpm of groundwater is returned as surface water to the Savannah River. Table 3.3-1 identifies the normal and maximum water demand and effluent streams for the AP1000 units, and Figure 3.3-1 provides a water balance diagram to illustrate the normal operational flows.

The CWS and SWS cooling towers lose water from evaporation and drift. Evaporation and drift from the CWS cooling towers is estimated at 27,924 gpm during normal operations. Evaporation and drift for the SWS cooling tower is estimated at 403 gpm. These values are based on site characteristics and AP1000 design parameters for the cooling systems as identified in Tables 3.4-1 and 3.4-2.

Table 3.3-1 provides the water release estimates for wastewater and blowdown discharged to the Savannah River. The water balances illustrated in Figure 3.3-1 include estimates for all wastewater flows from the site, including radiological effluent releases, sanitary waste, miscellaneous drains, and demineralizer discharges. The normal values listed are the expected limiting values for normal plant operation with two new units in operation. The maximum values are those expected for upset or abnormal conditions with two new units in operation.

Wastewater from the AP1000 units will be managed in the wastewater retention basin and discharged along with cooling tower blowdown to the blowdown sump. The final plant discharge stream will consist of the blowdown sump discharge stream and a small radwaste discharge stream. The final effluent discharge stream will be routed to the Savannah River downstream of the existing units' discharge. Stormwater discharges will be managed through the existing stormwater collection system and retention pond prior to discharge to the Savannah River.

The start-up pond identified in Figures 3.3-1 will be used during the initial plant start-up phase to collect system flushes. Wastewater will be treated, as required, before discharge to the blowdown sump. This facility may be used after initial plant start-up to collect system flushes warranted after system modification. Alternatively, the flush wastes may be collected in tanks and disposed of in accordance with applicable regulations.

3.3.2 Water Treatment

Water treatment systems for the new AP1000 units include technologies and methods to treat water supplies similar to those in use for the existing nuclear units. Some treatment systems, such as potable water, could be shared among all units. Treatment systems will be required for systems supplied by surface water and groundwater, including circulating water make-up, reactor water make-up, service water make-up, condensate, potable water, radwaste, fire protection, and utility water.

The Savannah River will be used to supply make-up water for the new units' circulating water system. Biocides will be injected at the intake structure to control biofouling in the circulating water system and associated piping. Additional chemicals will be added in the cooling tower basins to control scaling, corrosion, and solids deposition. The circulating water system chemical treatment regime will be very similar to the program for the existing units.

Groundwater supplied from site wells will provide make-up for the service water system, demineralized water system, potable water system, fire protection system, and other miscellaneous groundwater users.

Service water system make-up water may not require significant treatment. A biocide may be added to the cooling tower basin to control biofouling, if needed. The cooling tower cycles will be adjusted to prevent scale formation or deposition that could affect cooling tower performance.

Demineralized water for plant uses is produced by the plant demineralization system. Water is systematically treated by filtration and primary and secondary demineralization processes. These treatment processes result in highly purified water for various plant systems. Reverse osmosis is the primary demineralization treatment process designed to reduce solids, salts, organics, and colloids in the treated water. In the secondary stage of the purification process, an electrodeionization system or mixed bed is used to remove dissolved gaseous carbon dioxide and a majority of the remaining ions. The purified water is used as make-up to the following systems:

- Condensate system (including the condenser, condensate polishers, auxiliary boiler, and startup feedwater pumps)
- Reactor coolant system via the chemical and volume control system (CVS)

Treated condensate serves as a source of feedwater to the steam generators. The condensate passes through a condensate polisher resin bed to continuously remove contaminants and produce the high purity water to minimize corrosion in the condensate and feedwater systems. Wastewater generated by the regeneration of the condensate polishing system is discharged to the circulating water system. The auxiliary boiler also receives demineralized make-up water via the condensate system.

The demineralization system also provides pure water make-up to the reactor coolant system as needed through the CVS. Make-up water is supplied to the CVS make-up pumps to compensate for core burn-up and during start-up following refueling operations.

In addition to the services identified above, the demineralized water make-up system supplies make-up to other uses, including the spent fuel pool, turbine building closed cooling water system, component cooling water system, chilled water systems, and radwaste systems. Chemical corrosion inhibitors are used to treat the high quality demineralized water to minimize system component corrosion.

Discharges from the systems using demineralized water for make-up are routed to plant sumps or the liquid radwaste system prior to discharge.

The potable water system consists of a storage tank, pressure maintenance equipment, disinfection system, and distribution system. Additional water treatment such as filtration and corrosion control will be added, if necessary.

The fire protection system consists of make-up supply from groundwater wells, storage tanks, pressure maintenance equipment, and a distribution system. Treatment of the well water for fire system use consists of filtration through strainers as needed to prevent system fouling. This system does not normally require disinfection or other treatment. Additional treatment needs will be evaluated and implemented as appropriate. In addition to its use for fire suppression, the fire protection water system provides a back-up supply of water to other water systems, including the AP1000 passive containment cooling system.

Site wells also provide utility water for miscellaneous plant uses, including rinse water for demineralization system prefilter rinse and equipment washdown.

Figure 3.3-2 provides a diagram of plant systems supplied by groundwater.

Table 3.3-1 Plant Water Use

Stream Description	Normal Case[a] gpm	Maximum Case[a,b] gpm	Comments
Groundwater (Well) Streams:			
Plant Well Water Demand	752	3,140	
Well Water for Service Water System Makeup	537	2,353	
• Service Water System Consumptive Use	403	1,177	
- Service Water System Evaporation	402	1,176	
- Service Water System Drift	1	1	c
• Service Water System Blowdown	134	1,176	d
Well Water for Power Plant Make-up/Use	215	787	
• Demineralized Water System Feed	150	600	
- Plant System Make-up/Processes	109	519	
- Misc. Consumptive Use	41	81	
• Potable Water Feed	42	140	
• Fire Water System	10	12	
• Misc. Well Water Users	13	35	
Surface Water (Savannah River) Streams			
River Water for Circulating Water / Turbine Plant Cooling Water System Make-up	37,224	57,784	
• Circulating Water / Turbine Plant Cooling Water System Consumptive Use	27,924	28,904	
- Circulating Water / Turbine Plant Cooling Water System Evaporation	27,900	28,880	
- Circulating Water / Turbine Plant Cooling Water System Drift	24	24	c
• Circulating Water / Turbine Plant Cooling Water System Blowdown	9,300	28,880	d

Table 3.3-1 (cont.) Plant Water Use

Stream Description	Normal Case[a] gpm	Maximum Case[a,b] gpm	Comments
Plant Effluent Streams			
Final Effluent Discharge to River	9,608	30,761	
• Blowdown Sump Discharge	9,605	30,561	
- Wastewater Retention Basin Discharge	171	505	
○ Miscellaneous Low Volume Waste	129	365	
○ Treated Sanitary Waste	42	140	
- Service Water System Blowdown	134	1,176	d
- Circulating Water / Turbine Plant Cooling Water System Blowdown	9,300	28,880	d
- Start-up Pond Discharge	0	0	e
• Treated Liquid Radwaste	3	200	f

NOTES:

a The flow rate values are for two AP1000 units.

b These flows are not necessarily concurrent.

c The cooling tower drifts are 0.002% of the tower circulating water flow.

d For the normal case, the cooling towers are assumed operating at four cycles of concentration. For the service water cooling tower (maximum case), both unit towers are assumed operating at two cycles of concentration. For the main condenser / turbine auxiliary cooling water tower (maximum case), both towers are assumed operating at two cycles of concentration. Flows are determined by weather conditions, water chemistry, river conditions (circulating water / turbine plant cooling water system only) and operator discretion.

e Start-up flushes and start-up pond discharge would occur only during the initial plant start-up phase and potentially after unit outages when system flushes are required.

f The short-term liquid waste discharge flow rate may be up to 200 gpm. However, given the waste liquid activity level, the discharge rate must be controlled to be compatible with the available dilution (cooling tower blowdown) flow.

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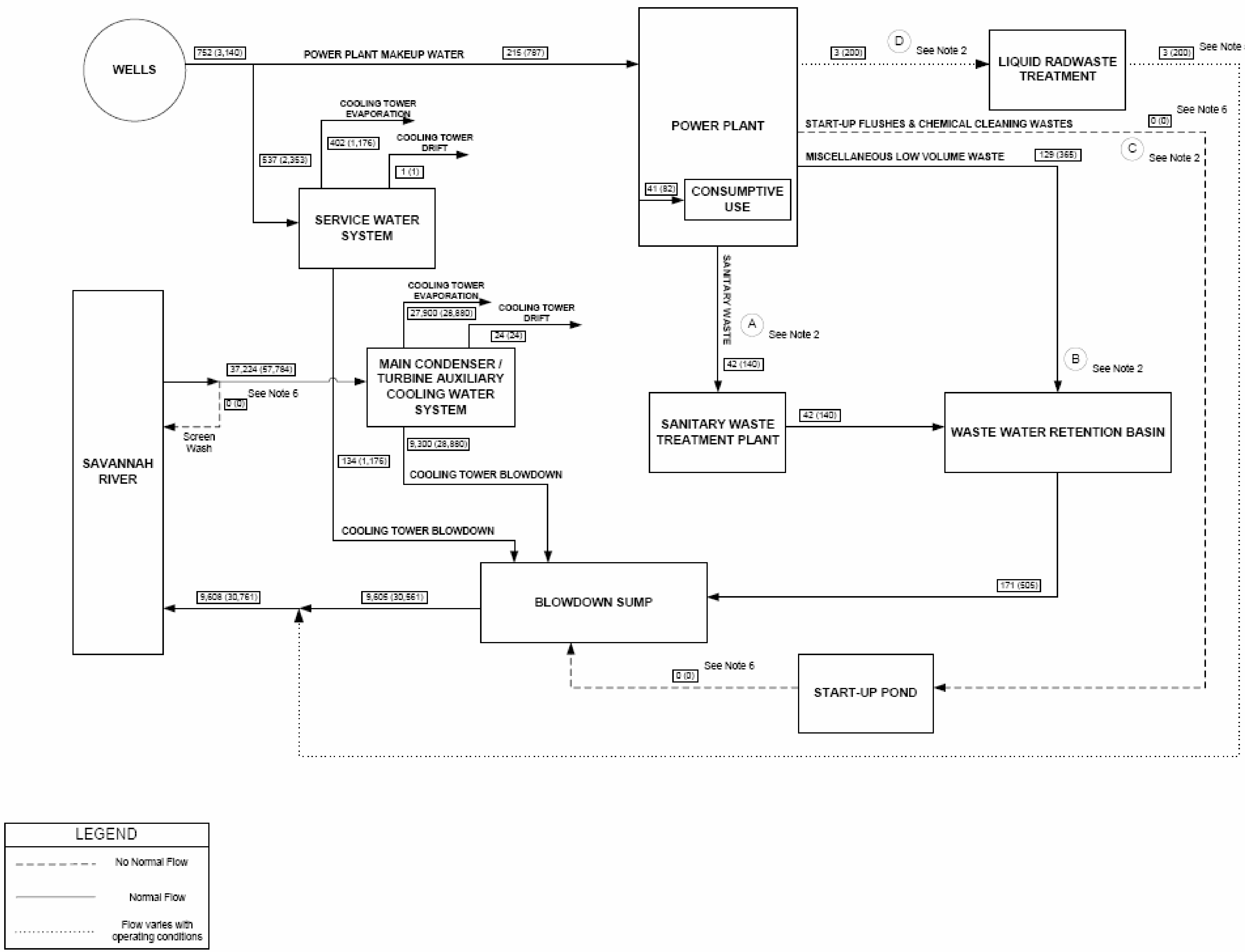

NOTES:

1. REFER TO THE WATER USE STREAM FLOW RATE TABLE (TABLE 3.3-1) FOR STREAM DESCRIPTIONS AND NOTES.

2. THE FLOW STREAMS FOR THE POWER PLANT INTERNAL PROCESSES ARE SHOWN ON FIGURE 3.3-2. SEE CORRESPONDING NODE (A THROUGH D) FOR UPSTREAM SOURCES INFORMATION

3. ALL FLOW VALUES SHOWN ARE IN GPM

4. MAXIMUM FLOW VALUES ARE SHOWN IN PARENTHESIS

5. THE SHORT TERM LIQUID WASTE DISCHARGE FLOW RATE MAY BE HIGHER. HOWEVER, GIVEN THE WASTE LIQUID ACTIVITY LEVEL, THE DISCHARGE RATE MUST BE CONTROLLED TO BE COMPATIBLE WITH THE AVAILABLE DILUTION (COOLING TOWER BLOWDOWN) FLOW.

6. FLOW IS INTERMITTENT AND THEREFORE CONSIDERED ZERO.

M:\SOUTHERN\Fig 3.3-1&2 rev. D.vsd

Figure 3.3-1 Water Use Diagram Summary

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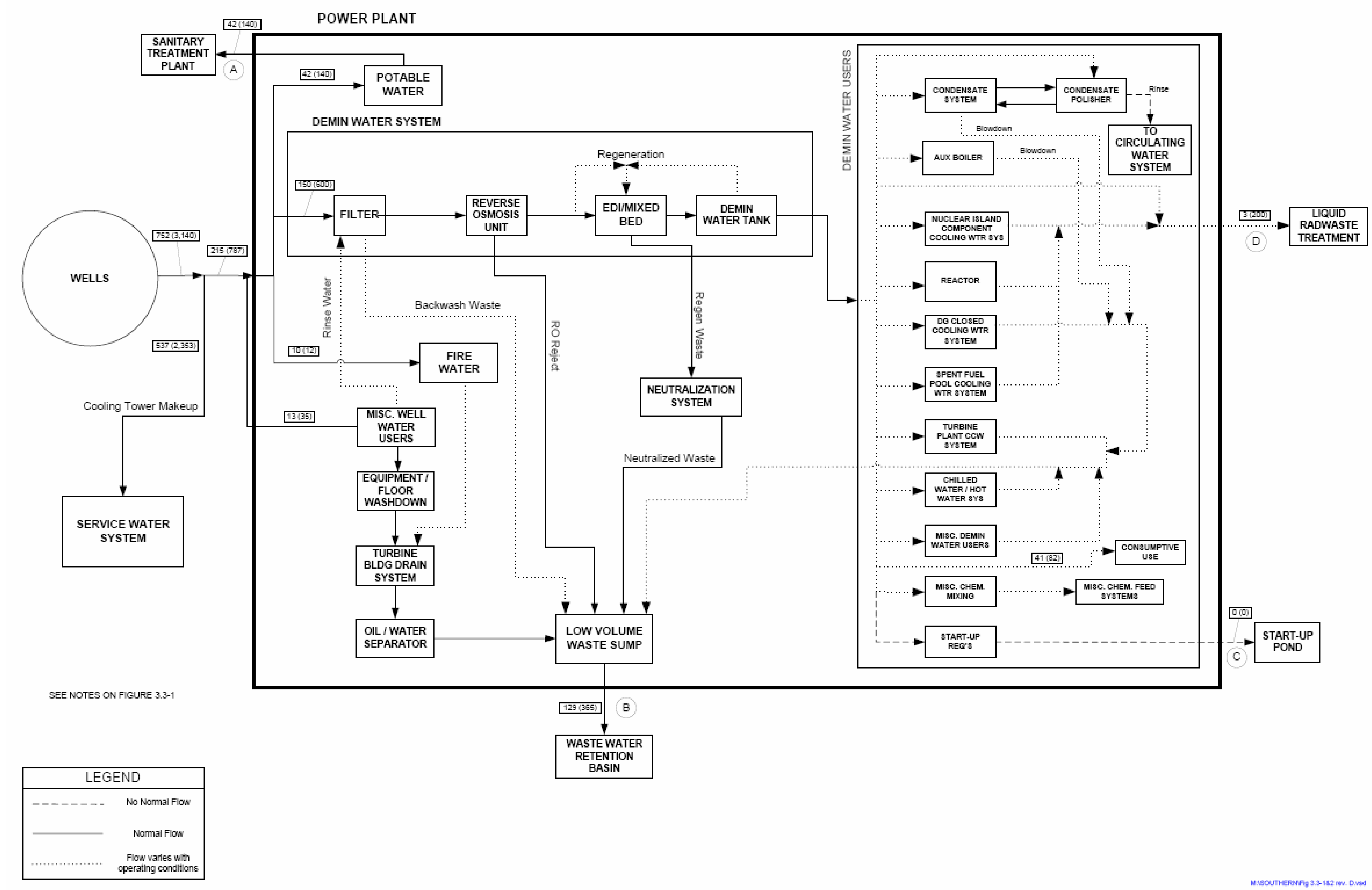

Figure 3.3-2 Water Use Diagram Details

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3.4 Cooling System

The proposed VEGP Units 3 and 4 cooling systems, operational modes, and component design parameters were determined from the *AP1000 Design Control Document (DCD)* **(Westinghouse 2005)**, site characteristics, and engineering evaluations. The plant cooling systems and the anticipated cooling system modes of operation are described in Section 3.4.1. Design data and performance characteristics for the cooling system components are presented in Section 3.4.2. The parameters provided are used to evaluate the impacts to the environment from cooling system operation. The environmental interfaces occur at the intake and discharge structures, the make-up wells, and the cooling towers. Figure 3.4-1 is a general flow diagram of the cooling water systems for VEGP Units 3 and 4.

3.4.1 Description and Operational Modes

Cooling system selection for VEGP Units 3 and 4 requires consideration of the total amount of waste heat generated as a byproduct of the proposed electricity generation and the impacts of the waste heat on the environment. For this application, site-specific characteristics are used in combination with the AP1000 design parameters to provide an evaluation of the impacts to the VEGP site from the addition of two AP1000 units.

3.4.1.1 Normal Plant Cooling

3.4.1.1.1 Circulating Water System/Turbine Plant Cooling Water Systems

Each AP1000 unit will use a circulating water system (CWS) to dissipate up to 7.55×10^9 BTU/hr (1.51×10^{10} BTU/hr for two units) of waste heat rejected from the main condenser, turbine building closed cooling water heat exchangers, and condenser vacuum pump seal water heat exchangers during normal plant operation at full station load **(Westinghouse 2005)**. A closed-cycle, wet cooling system will be used for the proposed VEGP units, consistent with the existing units. The system will use natural-draft cooling towers for heat dissipation, with the exhaust from the plant’s steam turbines directed to a surface condenser (i.e., main condenser), where the heat of vaporization is rejected to a closed loop of cooling water. The heated cooling water from the main condenser, turbine building closed cooling water heat exchangers, and condenser vacuum pump seal water heat exchangers will be circulated to the spray headers of the wet cooling tower, where heat content of the cooling water is transferred to the ambient air via evaporative cooling and conduction. After passing through the cooling tower, the cooled water will be recirculated back to the main condenser, turbine building closed cooling water heat exchangers, and condenser vacuum pump seal water heat exchangers to complete the closed cycle cooling water loop. Make-up water from the Savannah River will be required to replace evaporative water losses, drift losses, and blowdown discharge.

Make-up water will be taken from the Savannah River by pumps at a maximum rate of approximately 57,784 gpm (128.8 cfs) for two units. (This is based on maintaining two cycles of concentration in the cooling tower.) Normally the cooling water system is operated at four cycles of concentration, decreasing to two cycles of concentration when river water conditions necessitate, e.g., high suspended solids in the river water. The pumps will be installed in a new intake structure located upstream of the intake structure for the existing VEGP units. The make-up water will be pumped to the cooling tower collection basin directly. Blowdown from the cooling towers will discharge to a common blowdown sump to provide retention time for settling of suspended solids and to be treated, if required, to remove biocide residual before being discharged to the river. Figure 3.1-3 shows the proposed location of the intake structure and discharge for the new units.

The CWS for the AP1000 units will consist of pumps that circulate water at a nominal rate of 600,000 gpm (1,337 cfs) per unit. The water will be pumped through the main condenser, turbine building closed cooling water heat exchangers, and condenser vacuum pump seal water heat exchangers (all in parallel), and then to the natural-draft cooling tower to dissipate heat to the atmosphere. Figure 3.1-3 shows the location of the cooling towers for Units 3 and 4 on the VEGP site.

3.4.1.1.2 Service Water System

Each AP1000 unit will also have a non-safety-related service water system (SWS) to provide cooling water to the component cooling water heat exchangers located in the turbine building. The service water system will be used for normal operations, refueling, shutdown, and anticipated operational events. It will use a dedicated closed cycle system with a mechanical-draft cooling tower to dissipate heat during normal conditions, shutdown, or other operating conditions, in accordance with **Westinghouse 2005**. The service water will be pumped to the component cooling water heat exchangers for the removal of heat. Heated service water returns through piping to the distribution header of the mechanical draft cooling tower. Mechanical fans will provide air flow to cool the water droplets as they fall through the tower fill, rejecting heat from the service water to the atmosphere. The cooled water will be collected in the tower basin for return to the pump suction for recirculation through the system. Table 3.4-1 provides nominal service water flows and heat loads in different operating modes for the service water system. Each new unit’s evaporation water loss is expected to be about 201 gpm during normal conditions and 588 gpm during shutdown conditions. The blowdown flow from the service water towers will be discharged to the blowdown sump at a flow rate of up to 588 gpm per unit. Optionally, the blowdown may also be discharged to the CWS basin. Make-up water to the service water system will be supplied from site wells at a maximum flow rate of 2,353 gpm (two units) to accommodate a maximum 588-gpm-per-unit evaporation rate, 588-gpm-per-unit blowdown rate, and an insignificant drift loss (less than 1 gpm for both units) for the SWS cooling tower. Maximum SWS blowdown and make-up rates are based on maintaining two cycles of concentration in the cooling tower.

3.4.1.2 Ultimate Heat Sink

The AP1000 reactor design employs a passive ultimate heat sink (UHS) system using water stored in a tank above the containment structure for safety-related cooling. The Passive Containment Cooling System (PCS) does not require an active external safety-related UHS system to reach safe shutdown. The tank is filled and maintained filled with approximately 780,000 gal. of demineralized water. In the event of a Loss of Coolant Accident or Main Steam Line Break inside containment, water in the tank is dispersed over the steel containment, forming a water film over the containment dome and side walls of the structure. Water on the heated steel structure convects and evaporates to air in the plenum located between the steel containment and shield building concrete wall. The heated air naturally circulates upward in the plenum, exhausting to the atmosphere through the shield building chimney.

The PCS has no normal plant operation function. Once filled, the PCS storage tank above containment requires minimal demineralized water for evaporation make-up.

3.4.1.3 Other Operational Modes

3.4.1.3.1 Station Load Factor

The AP1000 units are expected to operate with a maximum capacity factor of 93 percent (annualized), considering scheduled outages and other plant maintenance. For the site, on a long-term basis, an average heat load of 1.40 $x10^{10}$ BTU/hr (i.e., 93 percent of the maximum rated heat load of 1.51 $x10^{10}$ BTU/hr) will be dissipated to the atmosphere.

3.4.1.3.2 River Water Temperature

Since the VEGP began operation, ice blockage that could render the make-up water system inoperable has not occurred. Historical water temperatures in the river show that the minimum temperature near the intake area will not produce significant icing of the intake structure. De-icing controls are not necessary for the existing VEGP units and will not be necessary at the intake structures of the AP1000 units.

3.4.1.3.3 Minimum Operating River Level

Since the existing VEGP units do not rely on the Savannah River for safe shutdown, no minimum river level is specified for continued unit operation in the VEGP Technical Requirements Manual. The AP1000 units will also not rely on river water for safe shutdown and will not require a specification for shutdown based on minimum river level.

3.4.1.3.4 Anti-Fouling Treatment

Bio-fouling will be controlled using chlorination and/or other treatment methods in the circulating water system cooling tower. The chemical addition to the cooling tower will ensure that the fill in the cooling tower remains free of organic deposits. An additional option for treating bio-fouling in the make-up water obtained from the Savannah River, to replenish the evaporative, blowdown, and drift losses, will be provided at the intake to ensure there is no biological fouling of the intake structure or the make-up water pipeline to the plant. Additional pre-treatment of the cooling tower make-up will not be required.

Bio-fouling control using chlorination and/or other treatment methods for the service water system cooling tower will be provided in the tower. Tower make-up water will be obtained from well water to replenish the evaporative, blowdown, and drift losses. Pre-treatment of the well water make-up will not be required.

3.4.2 Component Descriptions

The design data of the cooling system components and their performance characteristics during the anticipated system operation modes are described in this section. Site-specific estimates are used as the basis for discussion.

3.4.2.1 River Intake Structure

The river intake system consists of the intake canal, the intake structure, the make-up pumps, and the chlorination system. The general site location of the new intake system for VEGP Units 3 and 4 is shown in Figure 3.1-3. Figures 3.4-2 and 3.4-3 show the intake structure and canal in more details.

The intake canal will be an approximately 200-ft-long, 150-ft-wide structure with an earthen bottom at El. 70 ft msl and vertical sheet pile sides extending to El. 98 ft msl.

Because the river flow is almost perpendicular to the intake canal flow, the component of river velocity parallel to the canal flow velocity is very small, thus minimizing the potential of fish entering the canal. The flow through the canal is determined by plant operating conditions. Velocities also depend on the river water level. At the minimum river operating level (78 ft msl), the flow velocity along the intake canal would be about 0.1 fps, based on the site maximum make-up demand of 57,784 gpm (128.8 cfs). A canal weir will be located approximately 50 ft inside the canal. Since the intake canal will also act as the siltation basin, maintenance dredging could be required to maintain the canal invert elevation.

The new intake structure, located at the end of the intake canal, will be an approximately 80-ft-long, 100-ft-wide concrete structure with individual pump bays. Three 50-percent-capacity, vertical, wet-pit make-up pumps will be provided for each new unit, resulting in a total of six make-up pumps for the two units. The combined pumping flow rate from Savannah River for both AP1000 units will be up to 57,784 gpm (128.8 cfs). One make-up pump will be located at each pump bay, along with one dedicated traveling band screen and trash rack. The through-trash-rack and through-screen-mesh velocity will be less than 0.5 fps at a minimum river water level of 78 ft msl. Debris collected by the trash racks and the traveling water screens will be collected in a debris basin for cleanout and disposal as solid waste.

3.4.2.2 Final Plant Discharge

The final plant discharge from VEGP Units 3 and 4 will consist of cooling tower blowdown and other site wastewater streams, including the domestic water treatment and circulation water treatment systems. All biocides or chemical additives in the discharge will be among those approved by the U.S. Environmental Protection Agency or the state of Georgia as safe for humans and the environment, and the volume and concentration of each constituent discharged to the environment will meet requirements established in the National Pollutant Discharge Elimination System (NPDES) permit.

The discharge flow to the river will be from the blowdown sump, which collects all site non-radioactive wastewater and tower blowdown for all units. Discharge from the sump will occur through an approximately 3.5-ft-diameter discharge pipe. Before the discharge point, the pipe diameter will reduce to 2.0 ft. Treated liquid radioactive waste will be mixed with the sump discharge flow at a rate to maintain the required dilution rate. The normal discharge flow will be approximately 9,608 gpm (21.4 cfs) and the maximum discharge flow will be approximately 30,760 gpm (68.5 cfs).

The discharge structure will be designed to meet US Army Corps of Engineers navigation and maintenance criteria and to provide an acceptable mixing zone for the thermal plume per Georgia Mixing Zone Regulations. Figures 3.4-4 and 3.4-5 show preliminary details of the discharge system. The discharge point will be near the southwest bank of the Savannah River, extending about 50 ft into the river from the normal water line of El. 80 ft. The preliminary centerline elevation of the discharge pipe is 3 ft above the river bottom elevation. Riprap will be placed around the discharge point to resist potential erosion due to discharge jet from the pipe.

3.4.2.3 Heat Dissipation System

The circulating water system natural-draft cooling tower will be used as the normal heat sink. The cooling tower will have a concrete shell rising to a height of approximately 600 ft. Internal construction materials will include fiberglass-reinforced plastic (FRP) or polyvinyl chloride (PVC) for piping laterals, polypropylene for spray nozzles, and PVC for fill material. Natural-draft towers use natural air convection across sprayed water to reject heat to the atmosphere. To dissipate a maximum waste heat load of up to 1.51×10^{10} BTU/hr from the two units, operate with an 11°F approach temperature, and maintain a maximum 91°F return temperature at design ambient conditions, it is predicted that one natural-draft cooling tower per unit will be required. Table 3.4-2 provides specifications of the circulating water system cooling tower. The two cooling towers will occupy an area of about 69.3 acres. Figure 3.1-3 shows the location of the cooling towers. Figure 3.1-2 depicts the planned natural-draft hyperbolic towers, while Figure 3.4-6 provides plan and sectional views of a typical hyperbolic tower.

The service water system cooling tower will be a rectilinear mechanical draft structure. The cooling tower will be a counter flow, induced draft tower and will be divided into two cells. Each cell will use one fan, located in the top portion of the cell, to draw air upward through the fill, counter to the downward flow of water. One operating service water pump will supply flow to one operating cooling tower cell during normal plant operation. When the service water system is used to support plant shutdown cooling, both tower cells will normally be placed in service, along with both service water pumps, for increased cooling capacity. Table 3.4-1 provides system flow rates and the expected heat duty for various operating modes of the service water tower. The SWS cooling tower will maintain a maximum 88.5°F return temperature to the SWS heat exchangers under all operating modes. Temperature rise through the SWS heat exchangers will be approximately 18.5°F during normal operation and 31.5°F during cooldown operation based on the heat transfer rates defined in Table 3.4-1. Blowdown from the tower will be mixed with CWS blowdown. Each unit's SWS cooling tower will be located south of the power block, adjacent to the turbine building, within an area of approximately 0.5 acre.

Table 3.4-1 Nominal Service Water Flows and Heat Loads at Different Operation Modes per Unit (Westinghouse 2005)

	Flow (gpm)	Heat Transferred (BTU/hr)
Normal Operation (Full Load)	9,000	83 E6
Cooldown	18,000	296 E6
Refueling (Full Core Offload)	18,000	74 E6
Plant Startup	18,000	96 E6
Minimum to Support Shutdown Cooling and Spent Fuel Cooling	14,400	240 E6

Table 3.4-2 Circulating Water System Cooling Tower Design Specifications per Unit

Design Conditions	Natural-Draft Cooling Tower
Number of Towers	1 per unit
Heat Load	7.55E9 BTU/hr per unit
Circulating Water	600,000 gpm
Number of Cycles—normal	4
Approximate Dimensions	Height 600 ft Base diameter 550 ft Throat diameter 300 ft Exit diameter 330 ft
Design Dry Bulb Temperature	96.1°F[a]
Design Wet Bulb Temperature	80°F
Design Range	25.2°F
Design Approach	11°F
Air Flow Rate (at ambient design point)	50,000,000 cfm
Drift Rate	0.002%

[a] Based on tower design at 50% relative humidity.

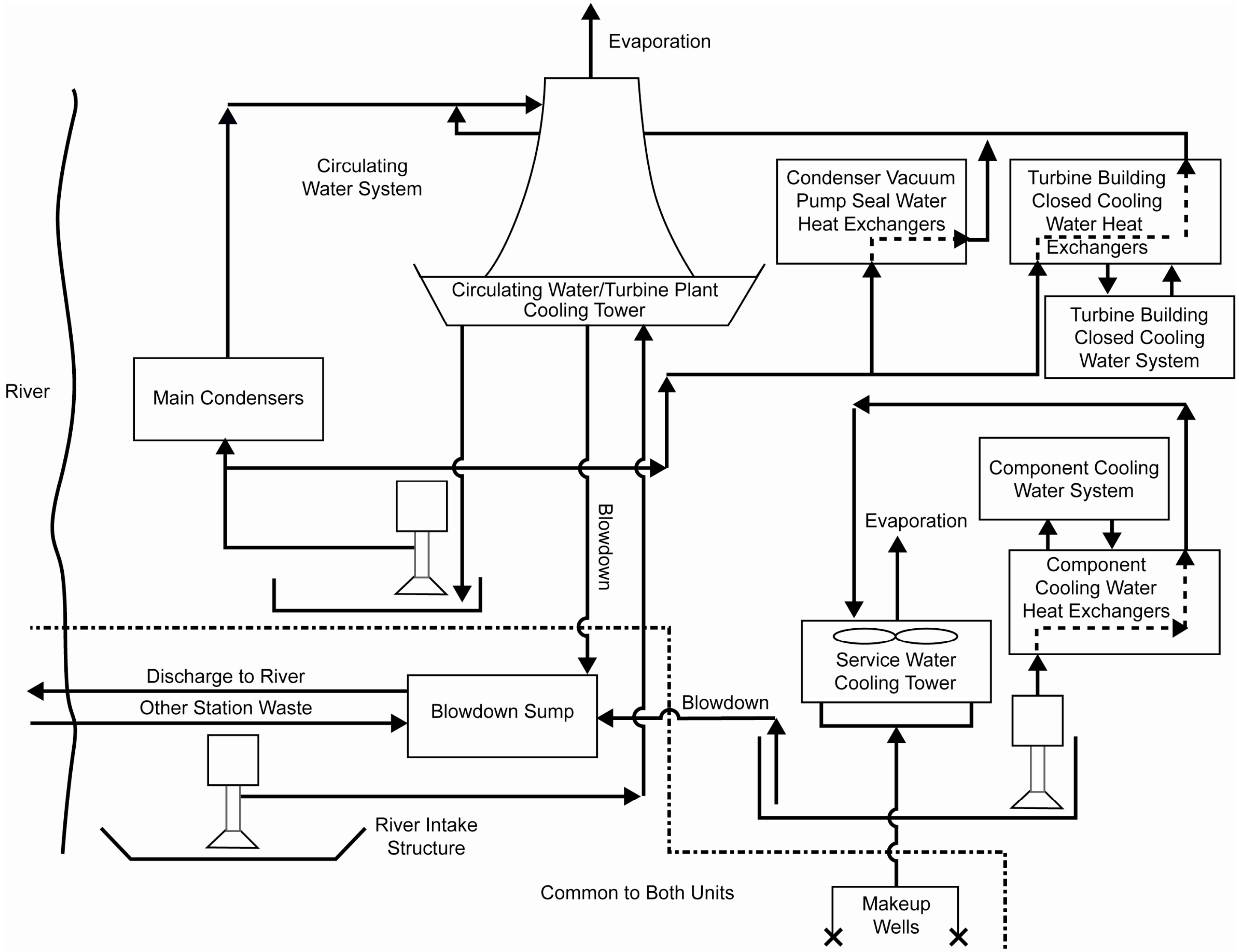


Figure 3.4-1 General Cooling System Flow Diagram

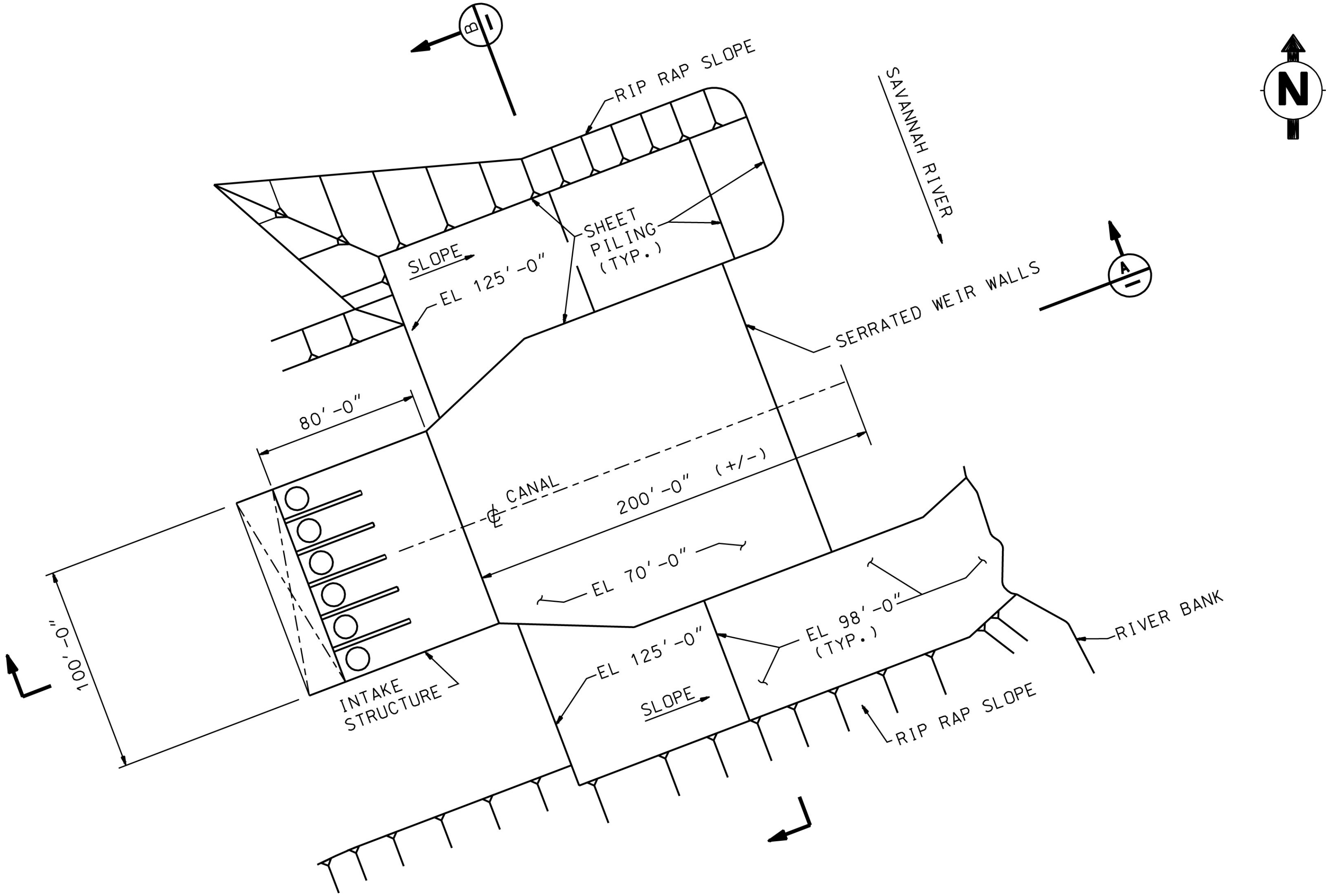
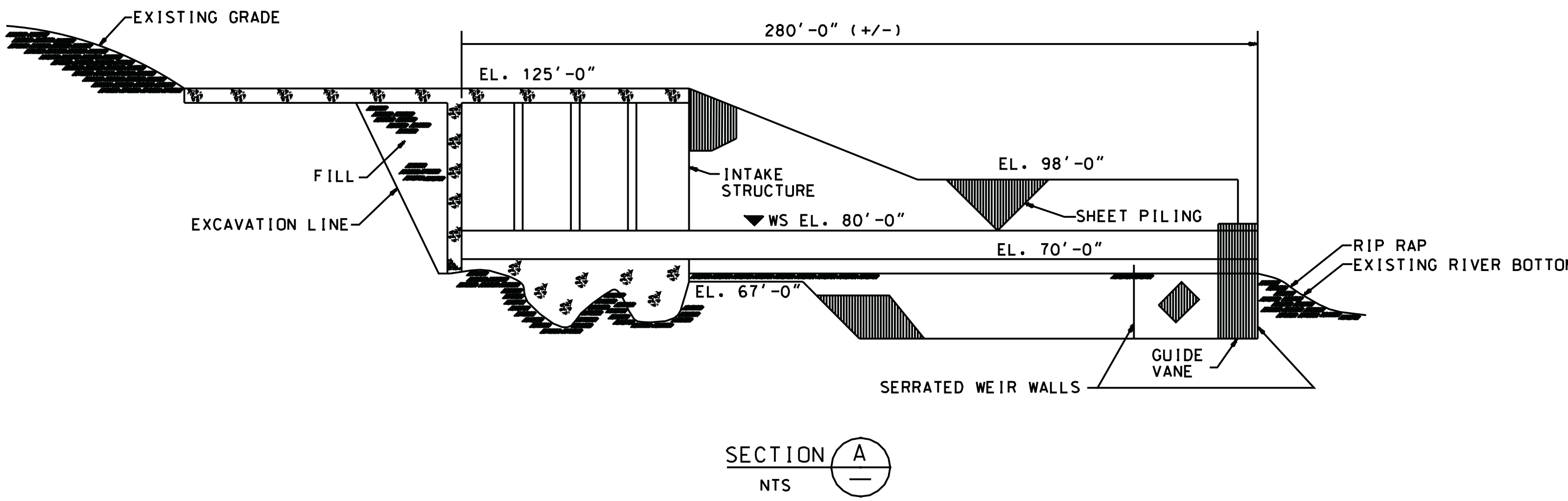


Figure 3.4-2 Plan View of River Intake System



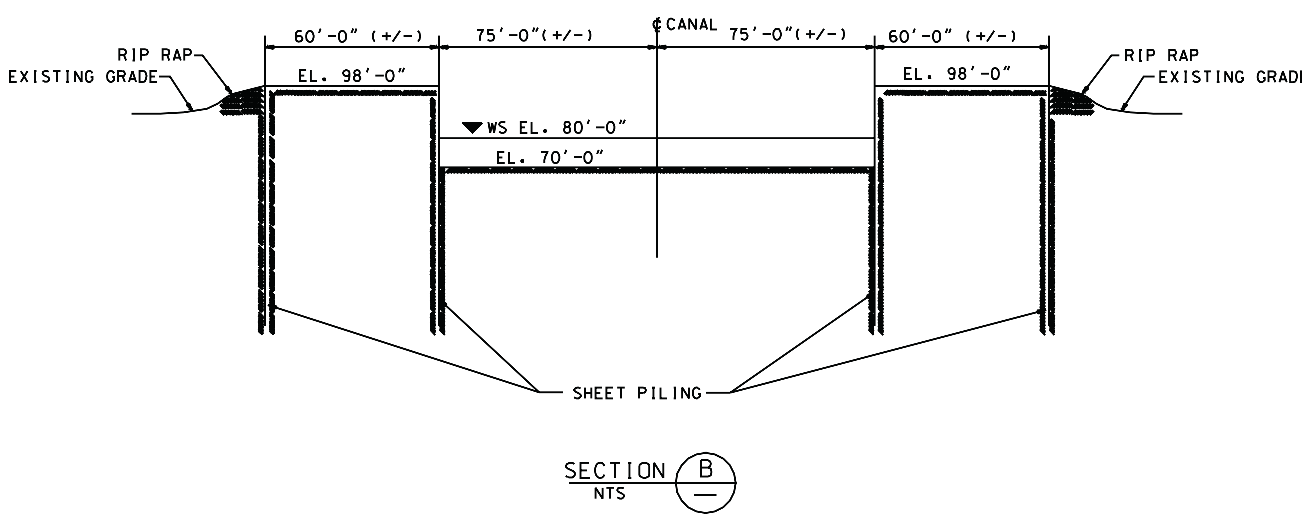


Figure 3.4-3 Section View of River Intake System

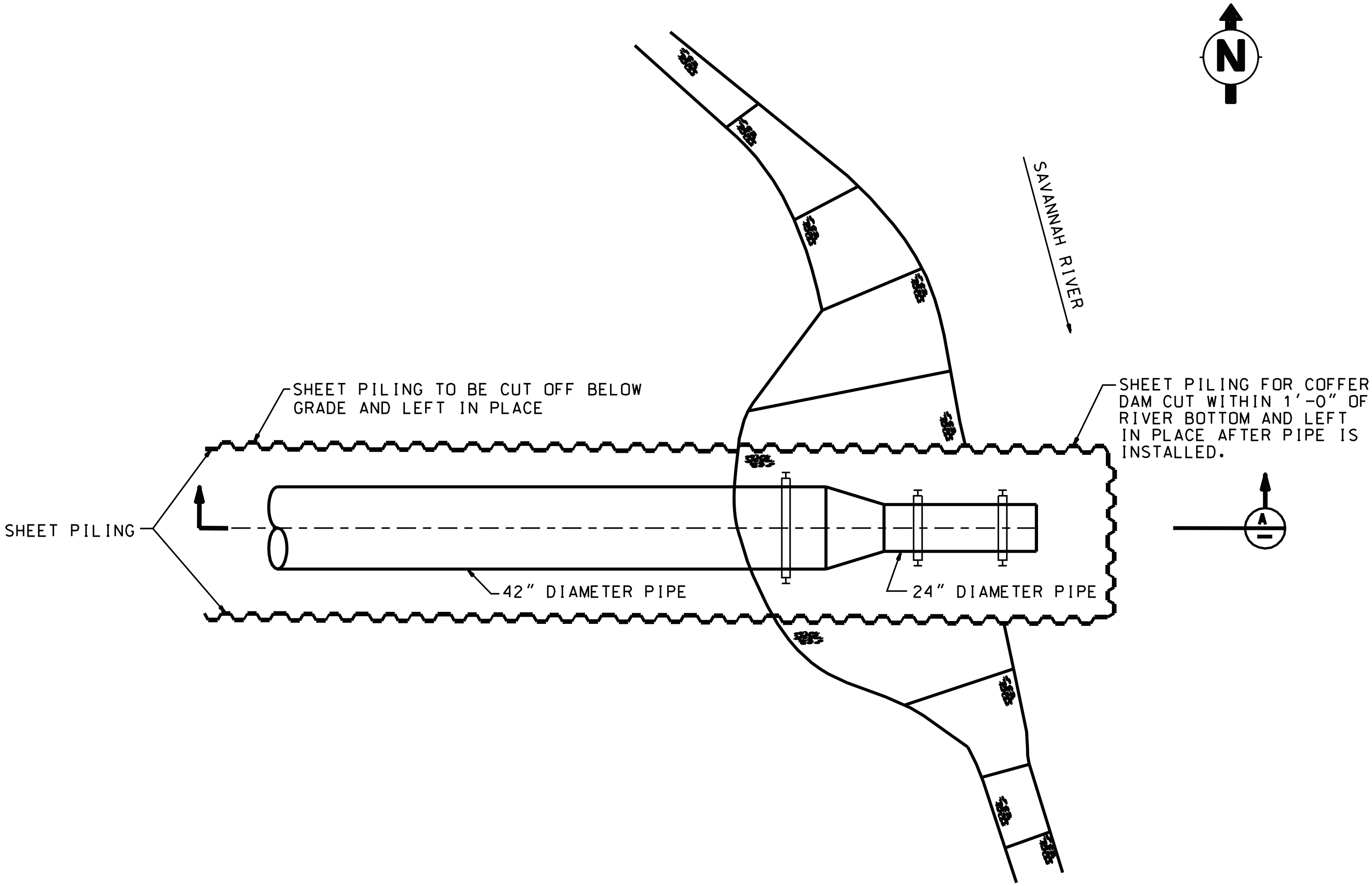


Figure 3.4-4 Plan View of New Discharge Outfall for the Discharge System

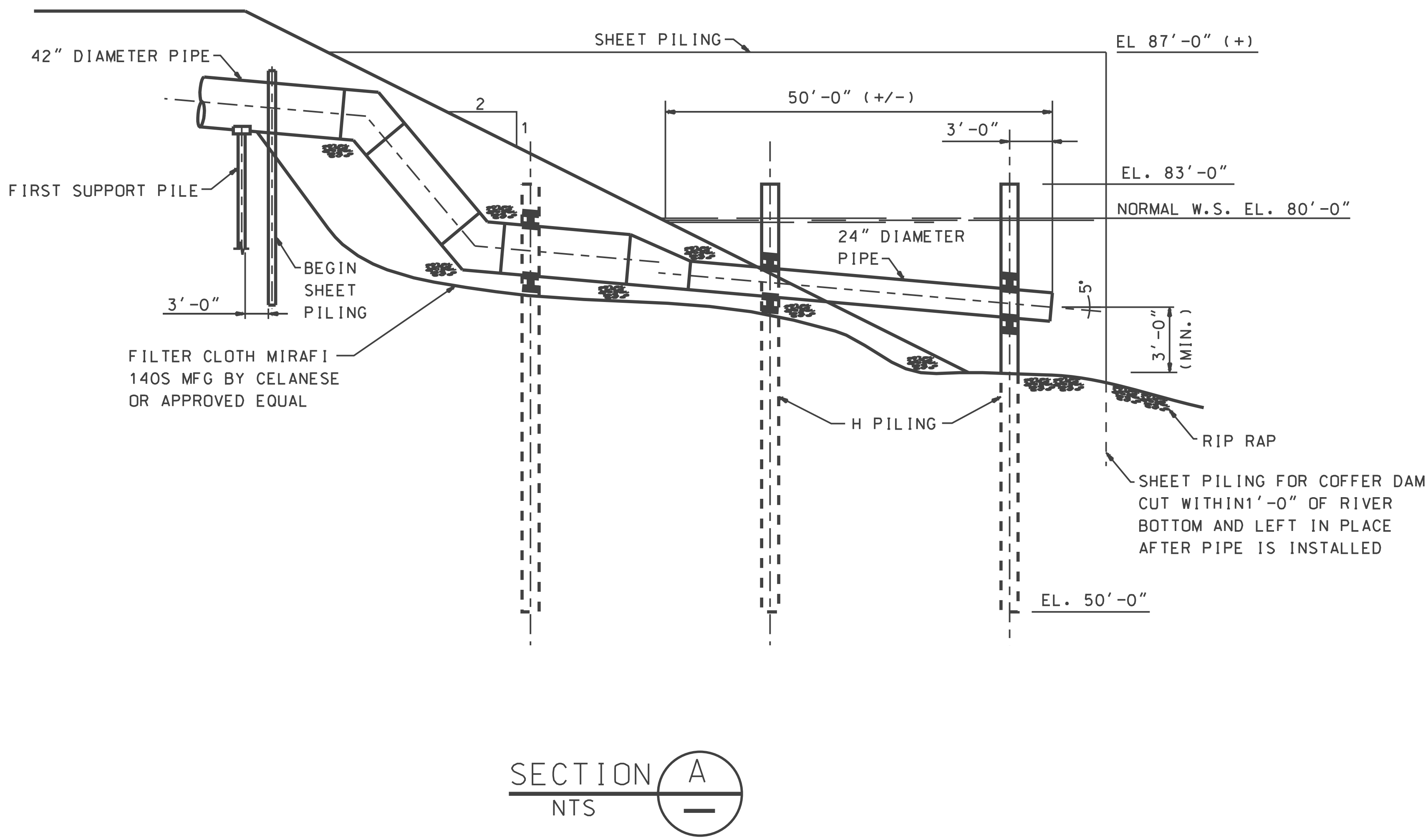


Figure 3.4-5 Section View of New Discharge Outfall for the Discharge System

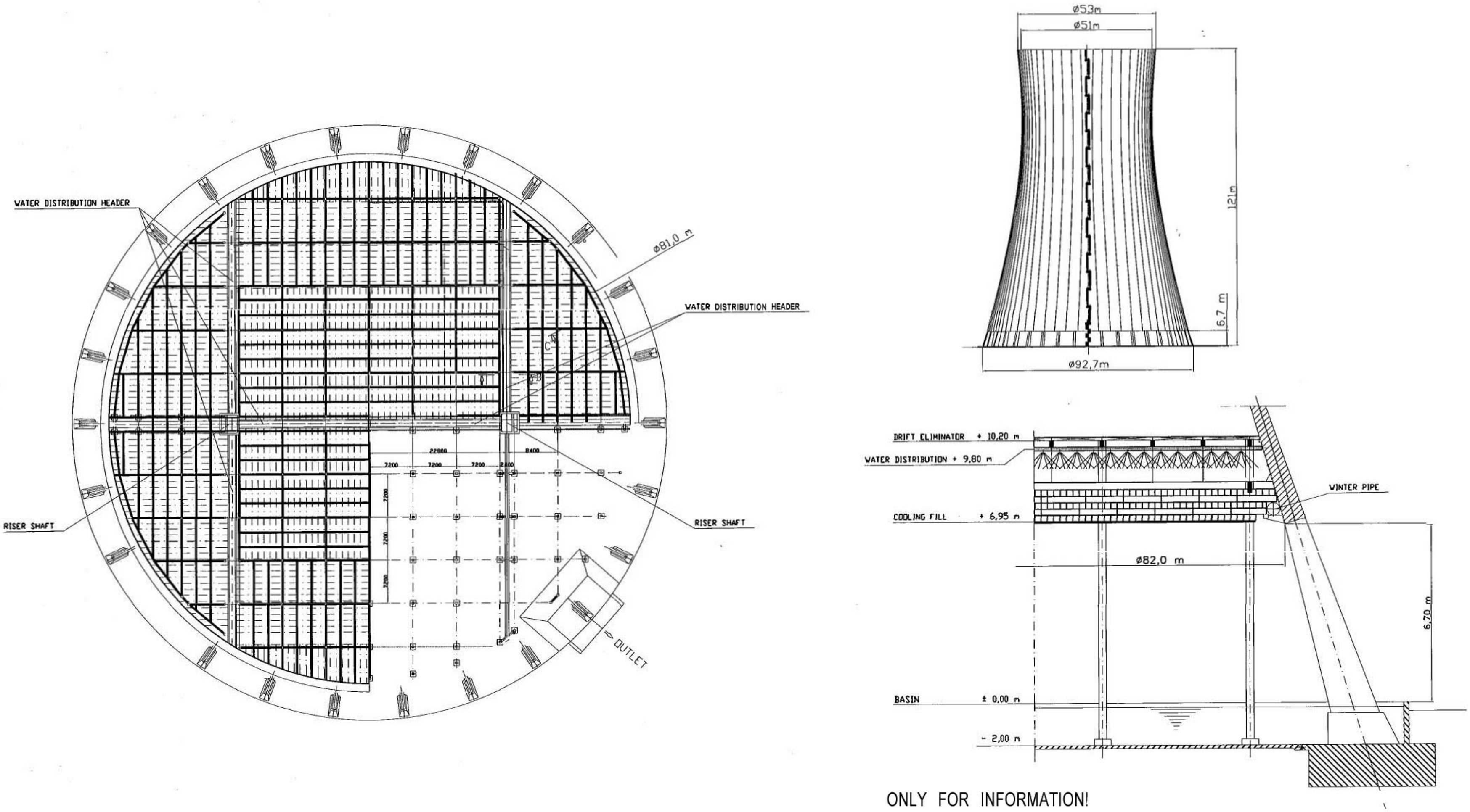


Figure 3.4-6 Natural-Draft Cooling Tower (Typical Design)

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3.5 Radioactive Waste Management System

Radioisotopes are produced during the normal operation of nuclear reactors, primarily through the processes of fission and activation. Fission products may enter the reactor coolant by diffusing from the fuel and then passing through the fuel cladding either through leaks or by diffusion. The primary cooling water may contain dissolved or suspended corrosion products and nonradioactive materials leached from plant components that can be activated by the neutrons in the reactor core as the water passes through the core. These radioisotopes can enter the reactor coolant either by plant systems designed to remove impurities, by small leaks that occur in the reactor coolant system and auxiliary systems, or by breaching of systems for maintenance. Therefore, the plant generates radioactive waste that can be liquid, solid, or gaseous.

Radioactive waste management systems will be designed to minimize releases from reactor operations to values as low as reasonably achievable (ALARA). These systems will be designed and maintained to meet the requirements of 10 CFR 20 and 10 CFR 50, Appendix I. Requirements for the design of these systems, and the plant effluents provided in the DCD **(Westinghouse 2005)** used to determine the maximum individual and population doses from normal plant operations, are as reported in Section 5.4.

The following discussions of the waste management systems are taken largely from the Westinghouse AP1000 DCD **(Westinghouse 2005)**.

3.5.1 Liquid Radioactive Waste Management System

The liquid waste management systems include the systems that may be used to process and dispose of liquids containing radioactive material. These include the following:

- Steam generator blowdown processing system
- Radioactive waste drain system
- Liquid radioactive (“radwaste”) system

The liquid radwaste system is designed to control, collect, process, handle, store, and dispose of liquid radioactive waste generated as the result of normal operation, including anticipated operational occurrences.

The liquid radwaste system provides holdup capacity as well as permanently installed processing capacity of 75 gallons per minute (gpm) through the ion exchange/filtration train. This will be adequate capacity to meet the anticipated processing requirements of the plant. The liquid radwaste system design can accept equipment malfunctions without affecting the capability of the system to handle both anticipated liquid waste flows and possible surge load due to excessive leakage.

The liquid radwaste system includes tanks, pumps, ion exchangers, and filters and is designed to process, or store for processing radioactively contaminated wastes in four major categories:

- Borated, reactor-grade, waste water -- this input will be collected from the reactor coolant system effluents received through the chemical and volume control system, primary sampling system sink drains and equipment leakoffs and drains.
- Floor drains and other wastes with a potentially high suspended solids content -- this input will be collected from various building floor drains and sumps.
- Detergent wastes -- this input will come from the plant hot sinks and showers, and some cleanup and decontamination processes. It generally has low concentrations of radioactivity.
- Chemical waste -- this input will come from the laboratory and other relatively small volume sources. It may be mixed (hazardous and radioactive) wastes or other radioactive wastes with a high dissolved-solids content.

Nonradioactive secondary-system waste normally will not be processed by the liquid radwaste system. Secondary-system effluent will be handled by the steam generator blowdown processing system and by the turbine building drain system. However, radioactivity could enter the secondary systems from steam generator tube leakage. If significant radioactivity were detected in secondary-side systems, blowdown will be diverted to the liquid radwaste system for processing and disposal. The following sections describe the radioactive waste streams.

3.5.1.1 Reactor Coolant System (RCS) Effluents

The effluent subsystem receives borated and hydrogen-bearing liquid from two sources: the reactor coolant drain tank and the chemical and volume control system. The reactor coolant drain tank will collect leakage and drainage from various primary systems and components inside containment. Effluent from the chemical and volume control system is produced mainly as a result of reactor coolant system heatup, boron concentration changes and RCS level reduction for refueling.

Input collected by the effluent subsystem normally contains hydrogen and dissolved radiogases. Therefore, it will be routed through the liquid radwaste system vacuum degasifier before being stored in the effluent holdup tanks.

The liquid radwaste system degasifier can also be used to degas the reactor coolant system before shutdown by operating the chemical and volume control system in an open loop configuration. This will be done by taking one of the effluent holdup tanks out of normal waste service and draining it. Then normal chemical and volume control system letdown will be directed through the degasifier to the dedicated effluent holdup tank. From there, it will be pumped back to the suction of the chemical and volume control system makeup pumps with the effluent holdup tank pump. The makeup pumps will return the fluid to the reactor coolant system in the normal fashion. This process will be continued as necessary for degassing the reactor coolant system.

The input to the reactor coolant drain tank is potentially at high temperature. Therefore, provisions have been made for recirculation through a heat exchanger for cooling. The tank will be inerted with nitrogen and vented to the gaseous radwaste system. Transfer of water from the reactor coolant drain tank will be controlled to maintain an essentially fixed tank level to minimize tank pressure variation. Reactor coolant system effluents from the chemical and volume control system letdown line or the reactor coolant drain subsystem will pass through the vacuum degasifier, where dissolved hydrogen and fission gases will be removed. These gaseous components will be sent via a water separator to the gaseous radwaste system. A degasifier discharge pump then will transfer the liquid to the currently selected effluent holdup tank. If flows from the letdown line and the reactor coolant drain tank are routed to the degasifier concurrently, the letdown flow will have priority and the drain tank input will be automatically suspended.

In the event of abnormally high degasifier water level, inputs will be automatically stopped by closing the letdown control and containment isolation valves. The effluent holdup tanks vent to the radiologically controlled area ventilation system and, in abnormal conditions, may be purged with air to maintain a low hydrogen gas concentration in the tanks' atmosphere. Hydrogen monitors are included in the tanks' vent lines to alert the operator of elevated hydrogen levels.

The contents of the effluent holdup tanks may be recirculated and sampled, recycled through the degasifier for further gas stripping, returned to the reactor coolant system via the CVS makeup pumps, processed through the ion exchangers, or directed to the monitor tanks for discharge without treatment. Processing through the ion exchangers will be the normal mode.

The AP1000 liquid radwaste system will process waste with an upstream filter followed by four ion-exchange resin vessels in series. Any of these vessels can be manually bypassed and the order of the last two can be interchanged, so as to provide complete usage of the ion exchange resin. The top of the first vessel will be normally charged with activated carbon, to act as a deep-bed filter and remove oil from floor drain wastes. Moderate amounts of other wastes could also be routed through this vessel. It could be bypassed for processing of relatively clean waste streams. This vessel will be somewhat larger than the other three, with an extra sluice connection to allow the top bed of activated carbon to be removed. This feature will be associated with the deep bed filter function of the vessel; the top layer of activated carbon collects particulates, and the ability to remove it without disturbing the underlying zeolite bed minimizes solid-waste production.

The second, third and fourth beds will be in identical ion-exchange vessels, which are selectively loaded with resin, depending on prevailing plant conditions. After deionization, the water will pass through an after-filter where radioactive particulates and resin fines will be removed. The processed water then enters one of three monitor tanks. When one of the monitor tanks is full, the system will automatically realigned to route processed water to another tank.

The contents of the monitor tank will be recirculated and sampled. In the unlikely event of high radioactivity, the tank contents will be returned to a waste holdup tank for additional processing. Normally, however, the radioactivity will be well below the discharge limits, and the dilute boric acid will be discharged for dilution by the circulating water blowdown. The discharge flow rate will be set to limit the boric acid concentration in the circulating water blowdown stream to an acceptable concentration for permit requirements. Detection of high radiation in the discharge stream would stop the discharge flow and operator action will be required to re-establish discharge. The raw water system which provides makeup for the circulating water system will be used as a backup source for dilution water when cooling tower blowdown is not available for the boric-acid discharge path.

3.5.1.2 Floor Drains and Other Wastes with Potentially High Suspended Solid Contents

Potentially contaminated floor drain sumps and other sources that tend to be high in particulate loading will be collected in the waste holdup tank. Additives may be introduced to the tank to improve filtration and ion exchange processes. Tank contents may be recirculated for mixing and sampling. The tanks will have sufficient holdup capability to allow time for realignment and maintenance of the process equipment.

The waste water will be processed through the waste pre-filter to remove the bulk of the particulate loading. Next it will pass through the ion-exchangers and the waste after-filter before entering a monitor tank. The monitor tank contents will be sampled and, if necessary, returned to a waste holdup tank or recirculated directly through the filters and ion exchangers.

Waste water meeting the discharge limits will be discharged to the circulating water blowdown through a radiation detector that would stop the discharge if high radiation were detected.

3.5.1.3 Detergent Wastes

The detergent wastes from the plant hot sinks and showers contain soaps and detergents. These wastes will generally not be compatible with the ion-exchange resins. The detergent wastes will not be processed but collected in the chemical waste tank. If the detergent wastes activity is low enough, the wastes will be discharged without processing. Otherwise the waste will be treated onsite before being discharged, as they are for VEGP Units 1 and 2.

3.5.1.4 Chemical Wastes

Inputs to the chemical waste tank normally will be generated at a low rate. These wastes will be collected only; no internal processing will be provided. Chemicals could be added to the tank for pH or other adjustment. Because the volume of these wastes will be low, they can be shipped offsite.

3.5.1.5 Steam Generator Blowdown

Steam generator blowdown is normally accommodated within the steam generator blowdown system. If steam generator tube leakage results in significant levels of radioactivity in the steam generator blowdown stream, this stream will be redirected to the liquid radwaste system for treatment before release. In this event, one of the waste holdup tanks will be drained to prepare it for blowdown processing. The blowdown stream will be brought into that holdup tank, and continuously or in batches pumped through the waste ion exchangers. The number of ion exchangers in service will be determined by the operator to provide adequate purification without excessive resin usage. The blowdown will then be collected in a monitor tank, sampled, and discharged in a monitored fashion.

3.5.1.6 Radioactive Releases

Liquid waste is produced both on the primary side (primarily from adjustment of reactor coolant boron concentration and from reactor coolant leakage) and the secondary side (primarily from steam generator blowdown processing and from secondary side leakage). Primary and secondary coolant activity levels will be based on operating plant experience.

Except for reactor coolant system degasification in anticipation of shutdown, the AP1000 will not recycle primary side effluents for reuse. Primary effluents will be discharged to the environment after processing. Fluid recycling will be provided for the steam generator blowdown fluid which is normally returned to the condensate system.

The annual average release of radionuclides from the plant is determined using the PWR-GALE code. The PWR-GALE code models releases which use source terms derived from data obtained from the experience of operating PWRs. The code input parameters used in the analysis to model the AP1000 plant are listed in Table 11.2-6 of the DCD. The annual releases for a single unit are presented in Table 3.5-1.

In agreement with the DCD, the total releases include an adjustment factor of 0.16 curies per year to account for anticipated operational occurrences. The adjustment uses the same distribution of nuclides as the calculated releases.

3.5.2 Gaseous Radioactive Waste Management System

During reactor operation, radioactive isotopes of xenon, krypton, and iodine will be created as fission products. A portion of these radionuclides will be released to the reactor coolant because of a small number of fuel cladding defects. Leakage of reactor coolant thus results in a release to the containment atmosphere of the noble gases. Airborne releases can be limited both by restricting reactor coolant leakage and by limiting the concentrations of radioactive noble gases and iodine in the reactor coolant system.

Iodine will be removed by ion exchange in the chemical and volume control system. Removal of the noble gases from the reactor coolant system will not normally be necessary because the gases will not build up to unacceptable levels when fuel defects are within normally anticipated ranges. If noble gas removal is required because of high reactor coolant system concentration, the chemical and volume control system can be operated in conjunction with the liquid radwaste system degasifier, to remove the gases.

The AP1000 gaseous radwaste system is designed to perform the following major functions:

- Collect gaseous wastes that are radioactive or hydrogen-bearing
- Process and discharge the waste gas, keeping off-site releases of radioactivity within acceptable limits.

In addition to the gaseous radwaste system release pathway, release of radioactive material to the environment will occur through the various building ventilation systems. The estimated annual release includes contributions from the major building ventilation pathways.

3.5.2.1 System Description

The AP1000 gaseous radwaste system is a once-through, ambient-temperature, activated-carbon delay system. The system includes a gas cooler, a moisture separator, an activated carbon-filled guard bed, and two activated carbon-filled delay beds. Also included in the system are an oxygen analyzer subsystem and a gas sampling subsystem.

The radioactive fission gases entering the system will be carried by hydrogen or nitrogen gas. The primary influent source will be the liquid radwaste system degasifier. The degasifier extracts both hydrogen and fission gases from the chemical and volume control system letdown flow which is diverted to the liquid radwaste system or from the reactor coolant drain tank discharge.

Reactor coolant degassing will not be required during power operation with fuel defects at or below the design basis level of 0.25 percent. However, the gaseous radwaste system periodically receives influent when chemical and volume control system letdown are processed through the liquid radwaste system degasifier during reactor coolant system dilution and volume control operations. Since the degasifier is a vacuum type and requires no purge gas, the maximum gas influent rate to the gaseous radwaste system from the degasifier will equal the rate that hydrogen enters the degasifier (dissolved in liquid).

The other major source of input to the gaseous radwaste system will be the reactor coolant drain tank. Hydrogen dissolved in the influent to the reactor coolant drain tank will enter the gaseous radwaste system either via the tank vent or the liquid radwaste system degasifier discharge.

The tank vent will normally be closed, but can be periodically opened on high pressure to vent the gas that has come out of solution. The reactor coolant drain tank liquid will normally discharge to the liquid radwaste system via the degasifier, where the remaining hydrogen will be removed.

The reactor coolant drain tank will be purged with nitrogen gas to discharge nitrogen and fission gases to the gaseous radwaste system before operations requiring tank access. The reactor coolant drain tank will also be purged with nitrogen gas to dilute and discharge oxygen after tank servicing or inspection operations which allow air to enter the tank.

Influents to the gaseous radwaste system will first pass through the gas cooler where they will be cooled to about 45°F by the chilled water system. Moisture formed due to gas cooling will be removed in the moisture separator.

After leaving the moisture separator, the gas will flow through a guard bed that protects the delay beds from abnormal moisture carryover or chemical contaminants. The gas then will flow through two 100-percent capacity delay beds where the fission gases undergo dynamic adsorption by the activated carbon and are thereby delayed relative to the hydrogen or nitrogen carrier gas flow. Radioactive decay of the fission gases during the delay period significantly reduces the radioactivity of the gas flow leaving the system.

The effluent from the delay bed will pass through a radiation monitor and discharge to the ventilation exhaust duct. The radiation monitor will be interlocked to close the gaseous radwaste system discharge isolation valve on high radiation. The discharge isolation valve will also close on low ventilation system exhaust flow rate to prevent the accumulation of hydrogen in the aerated vent.

3.5.2.2 System Operation

The gaseous radwaste system will be used intermittently. Most of the time during normal operation of the AP1000, the gaseous radwaste system will be inactive. When there is no waste gas inflow to the system, a small nitrogen gas flow will be injected into the discharge line at the inlet of the discharge isolation valve. This nitrogen gas flow will maintain the gaseous radwaste system at a positive pressure, preventing the ingress of air during the periods of low waste gas flow.

When the gaseous radwaste system is in use, its operation will be passive, using the pressure provided by the influent sources to drive the waste gas through the system.

The largest input to the gaseous radwaste system will be from the liquid radwaste system degasifier, which processes the chemical and volume control system letdown flow when diverted to the liquid radwaste system and the liquid effluent from the liquid radwaste system reactor coolant drain tank.

The chemical and volume control system letdown flow will be diverted to the liquid radwaste system only during dilutions, borations, and reactor coolant system degassing in anticipation of shutdown. The design basis influent rate from the liquid radwaste system degasifier will be the full diversion of the chemical and volume control system letdown flow, when the reactor coolant system is operating with maximum allowable hydrogen concentration. Since the liquid radwaste system degasifier will be a vacuum type that operates without a purge gas, this input rate will be very small, about 0.5 standard cubic feet per minute (scfm).

The liquid radwaste system degasifier also will be used to degas liquid pumped out of the reactor coolant drain tank. The amount of fluid pumped out, and therefore the gas sent to the gaseous radwaste system, will be dependent upon the input into the reactor coolant drain tank. This will be smaller than the input from the chemical and volume control system letdown line.

The final input to the gaseous radwaste system will be from the reactor coolant drain tank vent. Nitrogen will be maintained as a cover gas in the reactor coolant drain tank, therefore this input consists of nitrogen, hydrogen, and radioactive gases. The tank operates at nearly constant level, with its vent line normally closed, so this input will be minimal. Venting will be required only after enough gas has evolved from the input fluid to increase the reactor coolant drain tank pressure.

The influent will first pass through a gas cooler. Chilled water will flow through the gas cooler at a fixed rate to cool the waste gas to about 45°F regardless of waste gas flow rate. Moisture formed due to gas cooling will be removed in the moisture separator, and collected water will be periodically discharged automatically. To reduce the potential for waste gas bypass of the gas cooler in the event of valve leakage, a float-operated drain trap will be provided which automatically closes on low water level.

The gas leaving the moisture separator will be monitored for moisture, and a high alarm will alert the operator to an abnormal condition requiring attention. Oxygen concentration also will be monitored. On a high oxygen alarm, a nitrogen purge will be automatically injected into the influent line.

The waste gas then will flow through the guard bed, where iodine and chemical (oxidizing) contaminants will be removed. The guard bed also will remove any remaining excessive moisture from the waste gas.

The waste gas then will flow through the two delay beds where xenon and krypton will be delayed by a dynamic adsorption process. The discharge line will be equipped with a valve that automatically closes on either high radioactivity in the gaseous radwaste system discharge line or low ventilation exhaust duct flow.

The adsorption of radioactive gases in the delay bed occurs without reliance on active components or operator action. Operator error or active component failure will not result in an uncontrolled release of radioactivity to the environment. Failure to remove moisture prior to the delay beds (due to loss of chilled water or other causes) would result in a gradual reduction in gaseous radwaste system performance. Reduced performance will be indicated by high moisture and discharge radiation alarms. High-radiation would automatically terminate a discharge.

3.5.2.3 Radioactive Releases

Releases of radioactive effluent by way of the atmospheric pathway occur due to:

- Venting of the containment which contains activity as a result of leakage of reactor coolant and as a result of activation of naturally occurring Argon-40 in the atmosphere to form radioactive Argon-41
- Ventilation discharges from the auxiliary building which contains activity as a result of leakage from process streams
- Ventilation discharges from the turbine building
- Condenser air removal system (gaseous activity entering the secondary coolant as a result of primary to secondary leakage is released via this pathway)
- Gaseous radwaste system discharges.

These releases would be on-going throughout normal plant operations. There will be no gaseous waste holdup capability in the gaseous waste management system and thus no criteria are required for determining the timing of releases or the release rates to be used.

3.5.2.4 Estimated Annual Releases

The annual average airborne releases of radionuclides from the plant are determined using the PWR-GALE code. The GALE code models releases using realistic source terms derived from data obtained from the experience of many operating pressurized water reactors. The expected annual releases for a single unit are presented in Table 3.5-2.

3.5.2.5 Release Points

Airborne effluents are normally released through the plant vent or the turbine building vent. The plant vent provides the release path for containment venting releases, auxiliary building ventilation releases, annex building releases, radwaste building releases, and gaseous radwaste system discharge. The turbine building vents provide the release path for the condenser air removal system, gland seal condenser exhaust and the turbine building ventilation releases.

3.5.3 Solid Radioactive Waste Management System

Solid radioactive wastes are produced in multiple ways at a nuclear power station. The waste can be either dry or wet solids, and the source can be an operational activity, maintenance, or another function. Solid radioactive waste from the new units will be treated, stored and disposed as the current units solid radioactive waste is handled.

The solid radioactive waste management system will collect, process, and package solid radioactive wastes generated as a result of normal plant operation, including anticipated operational occurrences. The system will be designed to have sufficient capacity, based on normal waste generation rates, to ensure that maintenance or repair of the equipment does not impact power generation.

The solid waste management system is designed to collect and accumulate spent ion exchange resins and deep bed filtration media, spent filter cartridges, dry active wastes, and mixed wastes generated as a result of normal plant operation, including anticipated operational occurrences. The system will be located in the auxiliary and radwaste buildings. Processing and packaging of wastes will be by portable systems in the auxiliary building rail car bay and in the portable systems facility part of the radwaste building. The packaged waste will be stored in the auxiliary and radwaste buildings until it is shipped offsite to a licensed disposal facility.

This system will not handle large, radioactive waste materials such as core components or radioactive process wastes from the plant's secondary cycle. However, the volumes and activities of the secondary cycle wastes are provided in this section.

System Description

The solid waste management system includes the spent resin system. The radioactivity of influents to the system will be dependent on reactor coolant activities and the decontamination factors of the processes in the chemical and volume control system, spent fuel cooling system, and the liquid waste processing system.

The radioactivity of the dry active waste would be expected to normally range from 0.1 curies per year to 8 curies per year with a maximum of about 16 curies per year. This waste would include spent HVAC filters, compressible trash, non-compressible components, mixed wastes and solidified chemical wastes. These activities will be produced by relatively long lived radionuclides (such as Chromium-51, Iron-55, Cobalt-58, Cobalt-60, Niobium-95, Cesium-134 and Cesium-137), and therefore, radioactivity decay during processing and storage will be minimal. These activities thus apply to the waste as generated and as shipped.

The estimated expected and maximum annual quantities of waste influents by source and form are listed in Table 3.5-3 with disposal volumes. The AP1000 has sufficient radwaste storage capacity to accommodate the maximum generation rate. The annual radwaste influent rates are derived by multiplying the average influent rate (e.g. volume per month, volume per refueling cycle) by one year of time. The annual disposal rate is determined by applying the radwaste packaging efficiency to the annual influent rate. The influent volumes are conservatively based on an 18-month refueling cycle. Annual quantities based on a 24-month refueling cycle are less than those for an 18-month cycle.

All AP1000 radwaste which is packaged and stored will be shipped for disposal. The AP1000 has no provisions for permanent storage of radwaste. Radwaste is stored ready for shipment.

Shipped volumes of radwaste for disposal are estimated in Table 3.5-3 from the estimated expected or maximum influent volumes by making adjustments for volume reduction and the expected container filling efficiencies. For drum compaction, the overall volume reduction factor, including packaging efficiency, is 3.6. For box compaction, the overall volume reduction factor is 5.4. These adjustments result in a packaged internal waste volume for each waste source, and the number of containers required to hold this volume is based on the container's internal volume. The disposal volume is based on the number of containers and the external (disposal) volume of the containers.

The expected disposal volumes of wet and dry wastes are approximately 547 and 1,417 cubic feet per year, respectively as shown in Table 3.5-3. The wet wastes shipping volumes include 510 cubic feet per year of spent ion exchange resins and deep bed filter activated carbon, 20 cubic feet of volume-reduced liquid chemical wastes and 17 cubic feet of mixed liquid wastes. The spent resins and activated carbon will be initially stored in the spent resin storage tanks located in the rail car bay of the auxiliary building. When a sufficient quantity has accumulated, the resin will be sluiced into two 158 cubic feet high-integrity containers in anticipation of transport for offsite disposal. Liquid chemical wastes will be reduced in volume and packaged into three 55-gallon drums per year (about 20 cubic feet) and are stored in the packaged waste storage room of the radwaste building. The mixed liquid wastes will fill less than three drums per year (about 17 cubic feet per year) and will be stored on containment pallets in the waste accumulation room of the radwaste building until shipped offsite for processing.

The two spent resin storage tanks (275 cubic feet usable, each) and one high-integrity container in the spent resin waste container fill station at the west end of the rail car bay of the auxiliary building will provide more than a year of spent resin storage at the expected rate, and several months of storage at the maximum generation rate. The expected radwaste generation rate is based upon the following:

- All ion exchange resin beds are disposed and replaced every refueling cycle.
- The gaseous radioactive waste system activated carbon guard bed is replaced every refueling cycle.
- The gaseous radioactive waste system delay beds are replaced every ten years.
- All wet filters are replaced every refueling cycle.
- Rates of compatible and non-compatible radwaste, chemical waste and mixed wastes are estimated using historical operating plant data.

The maximum radwaste generation rate is based upon the following:

- The ion exchange resin beds are disposed based upon operation with 0.25% fuel defects.
- The gaseous radioactive waste system activated carbon guard bed is replaced twice every refueling cycle.

- The gaseous radioactive waste system delay beds are replaced every five years.
- All wet filters are replaced based upon operation with 0.25% fuel defects.
- The expected rates of compatible and non-compatible radwaste, chemical waste and mixed wastes are increased by about 50%.
- Primary to secondary system leakage contaminates the condensate polishing system and blowdown system resins and membranes which are replaced.

The dry solid radwaste will include 1,383 cubic feet per year of compactible and non-compactible waste packed into about 14 boxes (90 cubic feet each) and ten drums per year. Drums are used for higher activity compactible and non-compactible wastes. Compactible waste will include HVAC exhaust filters, ground sheets, boot covers, hair nets, etc. Non-compactible waste will include about 60 cubic feet per year of dry activated carbon and other solids such as broken tools and wood. Solid mixed wastes will occupy 7.5 cubic feet per year (one drum). The low activity spent filter cartridges may be compacted to fill about 0.40 drums per year (3 ft^3/year) and are stored in the packaged waste storage room. Compaction is performed by mobile equipment or offsite. High activity filter cartridges will fill three drums per year (22.5 cubic feet per year) and will be stored in portable processing or storage casks in the rail car of the auxiliary building.

The total volume of radwaste to be stored in the radwaste building packaged-waste-storage room will be 1,417 cubic feet per year at the expected rate and 2,544 cubic feet per year at the maximum rate. The compactible and non-compactible dry wastes, packaged in drums or steel boxes, will be stored with the mixed liquid and mixed solid, volume-reduced liquid chemical wastes, and the lower activity filter cartridges. The amount of liquid radwaste stored in the packaged waste storage room of the radwaste building will consist of 20 cubic feet of chemical waste and 17 cubic feet of miscellaneous liquid waste. The useful storage volume in the packaged waste storage room will be approximately 3,900 cubic feet (10 feet deep, 30 feet long, and 13 feet high), which will accommodate more than one full offsite waste shipment using a tractor-trailer truck. The packaged waste storage room will provide storage for more than two years at the expected rate of generation and more than a year at the maximum rate of generation. One four-drum containment pallet provides more than 8 months of storage capacity for the liquid mixed wastes and the volume reduced liquid chemical wastes at the expected rate of generation and more than 4 months at the maximum rate.

A conservative estimate of solid wet waste includes blowdown material based on continuous operation of the steam generator blowdown purification system, with leakage from the primary to secondary cycles. The volume of radioactively contaminated material from this source is estimated to be 540 cubic feet per year. Although included here for conservatism, this volume of contaminated resin will be removed from the plant within the contaminated electrodeionization unit and not stored as wet waste.

The condensate polishing system will include mixed bed ion exchange vessels for purification of the condensate. Should the resins become radioactive, the resins will be transferred from the condensate polishing vessel directly to the temporary processing unit or to the temporary processing unit via the spent resin tank. The processing unit, located outside of the turbine building, will dewater and process the resins as required for offsite disposal. Radioactive condensate polishing resin will have very low activity. It will be disposed in containers as permitted by Department of Transportation (DOT) regulations. After packaging, the resins may be stored in the radwaste building. Based on a typical condensate polishing system operation of 30 days per refueling cycle with leakage from the primary system to the secondary system, the volume of radioactively contaminated resin is estimated to be 206 cubic feet per year (one 309 cubic foot bed per refueling cycle).

The parameters used to calculate the activities of the steam generator blowdown solid waste and condensate polishing resins are given in Table 3.5-3. Based on the above volumes, the disposal volume is estimated to be 939 cubic feet per year.

Tables 3.5-4 and 3.5-5 list the expected principal radionuclides in primary waste and secondary wastes, respectively. These values represent the radionuclide content in these wastes as shipped.

The spent fuel storage facility will house pools that will provide storage space for the irradiated fuel. Each unit will have a separate pool with capacity for at least 10 years of fuel discharges from the reactor. All portions of the spent fuel transfer operation will be completed underwater and the waterways will be of sufficient depth to maintain adequate shielding above the fuel. The spent fuel pools will have access to a cask loading pit for loading the spent fuel assemblies into transportation casks. The fuel handling building will also house equipment for the decontamination of the shipping cask before it leaves the building. DOE is responsible for spent fuel transportation from reactor sites to the repository (Nuclear Waste Policy Act of 1982, Section 302) and will make the decision on transport mode. In the future SNC expects to enter into a contract with DOE similar to the standard contract in 10 CFR 961 with similar requirements for onsite storage prior to transport to a disposal facility. The current DOE standard contract (10 CFR 961) requires spent fuel to be stored onsite for a minimum cooling time of 5 years before transport to a disposal facility.

Table 3.5-1 Annual Normal Liquid Releases, in Curies, from a Single AP1000 Reactor

Radionuclide	Ci/yr
Corrosion and Activation Products	
Na-22	0.0016
Cr-51	0.0018
Mn-54	0.0013
Fe-55	0.0010
Fe-59	2E-04
Co-58	0.0034
Co-60	4.4E-04
Zn-65	4.1E-04
W-187	1.3E-04
Np-239	2.4E-04
Fission Products	
Br-84	2E-05
Rb-88	2.7E-04
Sr-89	1E-04
Sr-90	1E-05
Sr-91	2E-05
Y-91m	1E-05
Y-93	9E-05
Zr-95	2.3E-04
Nb-95	2.1E-04
Mo-99	5.7E-04
Tc-99m	5.5E-04
Ru-103	0.0049
Rh-103m	0.0049
Ru-106	0.074
Rh-106	0.074
Ag-110m	0.0010
Ag-110	1.4E-04
Te-129m	1.2E-04
Te-129	1.5E-04
Te-131m	9E-05
Te-131	3E-05

Table 3.5-1 (cont.) Annual Normal Liquid Releases, in Curies, from a Single AP1000 Reactor

Radionuclide	Ci/yr
I-131	0.014
Te-132	2.4E-04
I-132	0.0016
I-133	0.0067
I-134	8.1E-04
Cs-134	0.0099
I-135	0.005
Cs-136	6.3E-04
Cs-137	0.013
Ba-137m	0.012
Ba-140	0.0055
La-140	0.0074
Ce-141	9E-05
Ce-143	1.9E-04
Pr-143	1.3E-04
Ce-144	0.00316
Pr-144	0.00316
All others	2E-05
Total (except tritium)	0.26
Tritium	1010

Source: **(Westinghouse 2005)** Table 11.2-7.

Table 3.5-2 Annual Normal Gaseous Releases, in Curies from a Single AP1000 Reactor

Radionuclide	Ci/yr
Noble Gases	
Ar-41	34
Kr-85m	36
Kr-85	4100
Kr-87	15
Kr-88	46
Xe-131m	1800
Xe-133m	87
Xe-133	4600
Xe-135m	7
Xe-135	320
Xe-138	6
Iodines	
I-131	0.12
I-133	0.4
Fission and Activation Products	
C-14	7.3
Cr-51	6.1E-04
Mn-54	4.3E-04
Co-57	8.2E-06
Co-58	0.023
Co-60	0.0087
Fe-59	7.9E-05
Sr-89	0.003
Sr-90	0.0012
Zr-95	0.001
Nb-95	0.0025
Ru-103	8.0E-05
Ru-106	7.8E-05
Sb-125	6.1E-05
Cs-134	0.0023

Table 3.5-2 (cont.) Annual Normal Gaseous Releases, in Curies from a Single AP1000 Reactor

Radionuclide	Ci/yr
Cs-136	8.5E-05
Cs-137	0.0036
Ba-140	4.2E-04
Ce-141	4.2E-05
Tritium	350
Total w/o tritium	1.1E+04

Source: **(Westinghouse 2005)** Table 11.3-3.

Table 3.5-3 Estimated Solid Radioactive Waste Volumes for a Single AP1000 Reactor

Source	Expected Generation (ft^3/yr)	Expected Shipped (ft^3/yr)	Maximum Generation (ft^3/yr)	Maximum Shipped (ft^3/yr)
Wet Wastes				
Primary Resins (includes spent resins and wet activated carbon)	400[2]	510	1,700[4]	2,160
Chemical	350	20	700	40
Mixed Liquid	15	17	30	34
Condensate Polishing Resin[1]	0	0	206[5]	259
Steam Generator Blowdown[1,6] Material (Resin and Membrane)	0	0	540[5]	680
Wet Waste Subtotals	765	547	3,176	3,173
Dry Wastes				
Compactible Dry Waste	4,750	1,010	7,260	1,550
Non-Compactible Solid Waste	234	373	567	910
Mixed Solid	5	7.5	10	15
Primary Filters (includes high activity and low activity cartridges)	5.2[3]	26	9.4[3]	69
Dry Waste Subtotals	4,994	1,417	7,846	2,544
Total Wet & Dry Wastes	5,759	1,964	11,020	5,717

1 Radioactive secondary resins and membranes result from primary to secondary systems leakage (e.g., SG tube leak).

2 Estimated activity basis is ANSI 18.1 source terms in reactor coolant.

3 Estimated activity basis is breakdown and transfer of 10% of resin from upstream ion exchangers.

4 Reactor coolant source terms corresponding to 0.25% fuel defects.

5 Estimated activity basis from (**Westinghouse 2005)** Tables 11.1-5, 11.1-7 and 11.1-8 and a typical 30-day process run time, once per refueling cycle.

6 Estimated volume and activity used for conservatism. Resin and membrane will be removed with the electrodeionization units and not stored as wet waste.

Table 3.5-4 Expected Annual Curie Content of Shipped Primary Wastes Per Single AP1000 Reactor

Isotope	Primary Resin Total Ci/yr	Primary Filter Total Ci/yr
I-131	0.0604	0.00604
Cs-134	2.81	2.8.1
Cs-136	0.0261	0.00261
Cs-137	4.61	4.6.1
Ba-137m	4.61	4.6.1
Cr-51	3.37	0.337
Mn-54	85	8.50
Fe-55	97.5	9.75
Fe-59	1.23	0.123
Co-58	85.1	8.51
Co-60	92.9	9.29
Zn-65	23.4	2.34
Sr-89	0.805	0.0805
Sr-90	1.13	0.113
Ba-140	0.48	0.048
Y-90	1.13	0.113
Y-91	4.03E-04	4.03E-05
La-140	0.552	0.0552
Zr-95	1.09E-04	1.09E-05
Nb-95	1.31E-04	1.31E-05
Ru-103	0.0011	1.10E-04
Ru-106	0.0538	0.00538
Rh-103m	0.00111	1.11E-04
Rh-106	0.0538	0.00538
Te-129m	2.10E-05	2.10E-06
Te-129	1.37E-05	1.37E-06
Total	**1,600**	**160**

Source: (**Westinghouse 2005**) Table 11.4-4

Table 3.5-5 Expected Annual Curie Content of Shipped Secondary Wastes Per Single AP1000 Reactor

Isotope	Secondary Resin Total Ci/yr
Cr-51	0.00455
Mn-54	0.024
Fe-55	0.0219
Fe-59	0.00114
Co-58	0.0325
Co-60	0.00995
Zn-65	0.00742
Sr-89	6.86E-04
Sr-90	2.36E-04
Y-90	2.31E-04
Y-91	6.71E-09
Zr-95	0.00252
Nb-95	0.00406
Nb-95m	0.00232
Ru-103	0.0234
Ru-106	1.38
Rh-103m	0.0287
Rh-106	1.77
Ag-110	0.0166
Ag-110m	0.0192
Te-129	3.44E-04
Te-129m	4.48E-04
I-131	7.32E-05
Cs-134	0.231
Cs-135	4.86E+10
Cs-136	1.56E-04
Cs-137	0.336
Ba136m	1.47E-04
Ba137m	0.34
Ba-140	8.97E-04
La-140	0.00105
Ce-141	3.13E-04

Table 3.5-5 (cont.) Expected Annual Curie Content of Shipped Secondary Wastes Per Single AP1000 Reactor

Isotope	Secondary Resin Total Ci/yr
Ce-144	0.0591
Pr-143	2.38E-05
Pr-144	0.0512
Total	4.38

Source: (**Westinghouse 2005**) Table 11.4-8

Section 3.5 References

(Westinghouse 2005) Westinghouse Electric Company, LLC, *AP1000 Design Control Document*, Revision 15, AP1000 Document APP-GW-GL-700, November 11, 2005.

3.6 Non-radioactive Waste Systems

The following sections provide descriptions and scopes of service for non-radioactive waste systems for the new units. These services are already in place to support the existing VEGP units, and necessary changes to support the new units are described. Typical non-radioactive waste systems need to address:

- waste streams with effluents containing chemicals or biocides
- sanitary effluents
- other effluents

3.6.1 Effluents Containing Chemicals or Biocides

Water treatment for surface water and groundwater used by the plant and cooling towers are described in Section 3.3.2 and possible chemicals that could be discharged are listed here in Table 3.6-1. Other than water treatment systems no other AP1000 systems have effluent streams containing chemical or biocides.

Because the new units would use make-up and process water from the Savannah River and groundwater as the existing units do, SNC has provided the water treatment chemicals currently used at VEGP. SNC expects that both systems will be treated in the same way. The current outfall meet NPDES limits and new outfalls will as well.

3.6.2 Sanitary System Effluents

VEGP maintains a private sanitary waste treatment system, in compliance with acceptable industry design standards, the Clean Water Act (CWA), and state regulatory authority (through the NPDES permit which dictates the quality of discharges to surface waters). The waste treatment system is monitored and controlled by trained operators. Periodically, sludge from this system is disposed through the Burke County water works facility.

The system is composed of three package plants operating in parallel. The plants incorporate design innovations which make them more efficient than previous VEGP sanitary wastewater treatment systems. As part of new reactor construction, the existing sanitary waste treatment system will be expanded by adding additional package units to support the increased volume.

If there is a need during peak construction (or outage support) activities for additional sanitary waste provisions, approved supplemental means will be employed.

3.6.3 Other Effluents

This section describes miscellaneous non-radioactive gaseous, liquid, or solid effluents not addressed in Section 3.6.1 or Section 3.6.2.

3.6.3.1 Gaseous Emissions

The auxiliary steam system (ASS) provides the steam required for plant use during startup, shutdown, and normal operation. The auxiliary boiler, which generates the steam, is located in the turbine building with an emissions release point 150 feet above grade. Standby diesel generators provide reliable power to various plant system electric loads. The generators are in the diesel generator building. Both the auxiliary boiler and the diesel generators use No. 2 diesel fuel and release permitted pollutants to the air. Table 3.6-2 describes annual estimated emissions. The new Technical Services Center will have a small diesel generator, as will several other miscellaneous buildings. All generators will have appropriate certificates of operation. Emissions from these small generators are not considered in Table 3.6-2.

Non-radioactive gaseous emissions will be permitted by the Georgia Department of Natural Resources. The permit will specify allowable quantities of emissions. No source of gaseous emissions other than diesel generators and the auxiliary boiler is planned for the new units.

3.6.3.2 Liquid Effluents

Non-radioactive liquid effluents that will be discharged to the Savannah River will be regulated under the NPDES permit. The VEGP list of permitted outfalls will be expanded to include any additional locations or constituents, adjusted flow paths, or increased volumes created by the construction and operation of the new units. The existing VEGP units do not discharge to groundwater, and the new units will not discharge to groundwater.

The waste water system collects and processes equipment and floor drains from nonradioactive building areas and is capable of handling the anticipated flow of waste water during normal plant operation and during plant outages.

The waste water system:

- Removes oil and/or suspended solids from miscellaneous waste streams generated from the plant.
- Collects system flushing wastes during startup prior to treatment and discharge.
- Collects and processes fluid drained from equipment or systems during maintenance or inspection activities.
- Directs nonradioactive equipment and floor drains which may contain oily waste to the building sumps and transfers their contents for proper waste disposal.

Wastes from the turbine building floor and equipment drains (which include laboratory and sampling sink drains, oil storage room drains, the main steam isolation valve compartment, auxiliary building penetration area and the auxiliary building HVAC room) are collected in the two turbine building sumps. Drainage from the diesel generator building sumps, the auxiliary building nonradioactive sump, and the annex building sump is also collected in the turbine building sumps. The turbine building sumps provide a temporary storage capacity and a controlled source of fluid flow to the oil separator. In the event radioactivity is present in the turbine building sumps, the waste water is diverted from the sumps to the liquid radwaste system for processing and disposal. A radiation monitor located on the common discharge piping of the sump pumps alarms upon detection of radioactivity in the waste water. The radiation monitor also trips the sump pumps and the waste water retention basin pumps on detection of radioactivity to isolate the contaminated waste water. Provisions are included for sampling the sumps.

The turbine building sump pumps route the waste water from either of the two sumps to the oil separator for removal of oily waste. The diesel fuel oil area sump pump also discharges waste water to the oil separator. A bypass line allows for the oil separator to be out of service for maintenance. The oil separator has a small reservoir for storage of the separated oily waste which flows by gravity to the waste oil storage tank. The waste oil storage tank provides temporary storage prior to shipment for offsite disposal.

The waste water from the oil separator flows by gravity to the waste water retention basin for settling of suspended solids and treatment, if required, prior to discharge. The waste water basin transfer pumps route the basin effluent to either the circulating water cooling tower basin or to the plant outfall, depending on the quality of the water in the waste water retention basin. The condenser waterbox drains are routed directly to the waste water retention basins.

3.6.3.3 Hazardous Wastes

Hazardous wastes are wastes with properties that make them dangerous or potentially harmful to human health or the environment, or that exhibit at least one of the following characteristics: ignitability, corrosivity, reactivity or toxicity. Federal Resource Conservation and Recovery Act regulations govern the generation, treatment, storage and disposal of hazardous wastes.

VEGP generates small quantities of hazardous wastes and is classified as a small-quantity generator, although SNC manages the hazardous waste program as if the site were a large quantity generator. Wastes are stored temporarily on site and periodically disposed at a permitted disposal facility. All hazardous wastes activities are performed in compliance with federal regulations and VEGP Units 1 and 2 waste handling procedures. VEGP Units 1 and 2 have procedures in place to minimize the impact in the unlikely event of a hazardous waste spill. The treatment, storage and disposal of wastes generated by construction and operation of the new units will be managed as current wastes are managed.

3.6.3.4 Mixed Wastes

As defined in the Atomic Energy Act (AEA) of 1954, as amended, (42 USC 2011 et seq.), mixed waste contains hazardous waste and a low-level radioactive source, special nuclear material, or byproduct material. Federal regulations governing generation, management, handling, storage, treatment, disposal, and protection requirements associated with these wastes are contained in 10 CFR (NRC regulations) and 40 CFR (Environmental Protection Agency regulations).

Mixed waste is generated during routine maintenance activities, refueling outages, health protection activities and radiochemical laboratory practices. Few disposal facilities are permitted to accept mixed wastes. Therefore, waste minimization is critical. Currently, VEGP has a comprehensive chemical product control program that includes measures to minimize the creation of mixed waste.

VEGP generates small volumes of mixed wastes. VEGP maintains procedures for the safe storage and disposal of mixed wastes. The treatment, storage and disposal of mixed wastes generated by the new units will be managed as current mixed wastes are managed.

3.6.3.5 Solid Effluents

Non-radioactive solid wastes include typical industrial wastes such as metal, wood, and paper, as well as process wastes such as non-radioactive resins and sludge. Non-radioactive resins and sludges will be disposed in a permitted industrial landfill. Universal wastes, scrap metal, and used oil and antifreeze will be managed for recycling or recovery. Office paper and aluminum cans will be recycled locally. Putrescible wastes will be disposed in a permitted offsite disposal facility. VEGP practices pollution prevention, including waste minimization. Solid wastes created by the construction and operation of the new units will be handled as current wastes are handled. Table 3.6-3 has the measures of wastes recycled from Units 1 and 2 to estimate the volumes that will be generated from Units 3 and 4.

VEGP has an existing solid waste landfill permitted by Georgia EPD as a Private Industry Landfill. It can receive only such inert material as concrete, bricks, rubble and the like. This landfill will be relocated to accommodate expansion of the switchyard for the proposed VEGP Units 3 and 4. The landfill will either be relocated on site, or the material will be removed and disposed in an offsite permitted facility.

Table 3.6-1 Water Treatment Chemicals that could be used in VEGP Units 3 and 4[1]

Zinc	Sodium bromide
Tolytriazole	Ammonium hydroxide
Dispersant	Soda ash
Antifoam	Ammoniium bisulfite
Hydrazine	Sodium chloride
NCS Corrosion Inhibitor	Antiscalant
Sodium hypochlorite	Coagulant
Boric acid	Stabrex ST70
Lithium hydroxide	Calcium hypochlorite (Sanuril)
Phosphate	Isothiozoline biocide
Methoxypropylamine (MPA)	

1 Based on chemicals now used in Units 1 and 2. This list is representative, not definitive.

Table 3.6-2 Annual Emissions (lbs/yr) from Diesel Generators and the Auxiliary Boiler Associated with Two AP1000 Reactors

	Diesel Generators[1]		
Pollutant Discharged	**Two 4000 kW Standby DGs (lb/yr)**	**Two 35 kW Ancillary DGs (lb/yr)**	**Auxiliary Boiler[2] (lb/yr)**
Particulates	<800	<10	28,750
Sulfur Oxides	<2,500	<5	86,250
Carbon Monoxide	<1,000	<30	ND
Hydrocarbons	<600	<11	83,500
Nitrogen Oxides	<112,000	<140	ND

Source: **Westinghouse 2005**

1 Based on 4 hrs/mo for each generator

2 Based on 30 days/yr operation

ND = No data

Table 3.6-3 Annual Measures of Wastes Recycled from Units 1 and 2 and Estimated Volumes that would be recycled from Units 3 and 4.

	Existing Units Average Annual	New Units Estimated Annual
Scrap metal[1]	300 tons	288 tons
Light bulbs[2]	18 drums	13 drums
Capacitors[1]	26 drums	25 drums
Batteries[1]	50 pallets	48 pallets

[1] Based on MW

[2] Based on staff

Section 3.6 References

(Westinghouse 2005) Westinghouse Electric Company, LLC, *AP1000 Design Control Document*, Revision 15, AP1000 Document APP-GW-GL-700, November 11, 2005.

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3.7 Power Transmission System

3.7.1 Switchyard Interfaces

The Vogtle switchyard will be expanded to support operation of VEGP Units 3 and 4. The switchyard will be electrically integrated with the existing switchyard, and will provide additional 500kV and 230kV connections. The switchyard will occupy a 2,830 foot by 1030 foot tract of land north of the new units and west of the existing switchyard.

Generation from the new units will be delivered to the grid via connections with the switchyard expansion. House loads for the new units can be supplied from either the reserve auxiliary transformers (one per unit) or the unit auxiliary transformers (two per unit). The unit auxiliary transformers are normally supplied directly by the respective unit's main generator. On loss of the main generator, the main transformers will remain energized and automatically back-feed to supply house loads via the unit auxiliary transformers. If the unit auxiliary transformers are unavailable, house loads can be supplied by the reserve auxiliary transformer for the respective unit. The reserve auxiliary transformers for the new units will receive power from the 230kV switchyard expansion.

All high voltage equipment and conductors will be designed to meet the requirements of the National Electrical Safety Code (NESC) and Georgia Power Company (GPC) engineering standards, which include provisions for earthquake, wind, and snow forces. Electrical clearances phase-to-phase and phase-to-ground will be determined by NESC and engineering requirements, but will not be less than 30 and 12 feet, respectively (center-to-center for bundles).

3.7.2 Transmission System

Construction of the new units will require relocation of an existing overhead 500-kV line which currently runs through the proposed new plant footprint. This line will be rerouted along the western and southern boundary of the site to intersect its existing right-of-way to the south (see Figure 3.1-3).

One new 500-kV transmission line will be constructed for the Vogtle site to handle the new generating capacity. The proposed new transmission line will be routed to an existing substation west of Augusta, Georgia. This substation will have been upgraded to contain a 500-kV bus by the time the connection is made. The specific route for this transmission line has not been determined, but land uses in the area that the line will traverse are indicated in Figure 2.2-4. Section 4.1.2 describes the principles that will be employed in routing the line.

This analysis assumes that 60 linear miles of a 200-foot wide corridor would be required for the new line. Total area required for the corridor would be approximately 2.0 sq mi. The new line would require approximately 390 towers, and each would require foundation excavations.

The layout of transmission lines to the new and existing switchyards will minimize the crossing of transmission lines to the extent possible. The corridors for the existing and new transmission lines are described in ER Sections 2.2.2 and 4.1.2, respectively. At this time GPC has not established the reconfiguration of the existing lines to serve the new units.

All 500-kV GPC transmission lines are currently constructed on steel, lattice-type towers designed to provide clearances consistent with the NESC and GPC engineering standards. At a minimum, all clearances will equal or exceed 45 feet phase-to-ground. For 500-kV lines, GPC uses a 3-subconductor-per-phase system with two overhead ground wires. All towers are grounded with either ground rods or a counterpoise system. Any new transmission lines will be constructed using the same standards. No transmission tower will be higher then 200 feet above ground surface, there fore no Federal Aviation Administration permits will be required.

GPC performs a detailed aerial inspection of all VEGP 500-kV transmission lines twice a year, using visual and infrared detection. Less detailed routine aerial patrols are conducted five times per year. Ground inspections and climbing inspections are performed on a 12-year cycle. Inspections check for deterioration due to rust, loose connections and bolts, condition of safety equipment, erosion, encroachment by vegetation, and overall condition of the equipment. These inspections insure that the design standards are maintained throughout the life of the transmission line.

Maintenance of the corridor, including vegetation management, is discussed in Section 5.6.1. A discussion on electric field strength, induced current hazards, corona noise, and radio/television interference is provided in Section 5.6.3.

3.8 Transportation of Radioactive Materials

This section describes transportation of radioactive materials associated with operating new reactors at the VEGP site. Analyses of transportation impacts are provided in Section 5.11.

3.8.1 Transportation of Unirradiated Fuel

Transportation of new fuel assemblies to the VEGP site from a fuel fabrication facility will be in accordance with DOT and NRC regulations. The initial fuel loading will consist of 157 fuel assemblies for one AP1000. On an annual basis, refueling will require an average of 43 fuel assemblies for one AP1000. The fuel assemblies will be fabricated at a fuel fabrication plant and shipped by truck to the VEGP site shortly before they are required. The details of the container designs, shipping procedures, and transportation routings will depend on the requirements of the suppliers providing the fuel fabrication services. The truck shipments will not exceed 73,000 pounds as governed by Federal or State gross vehicle weight restrictions.

3.8.2 Transportation of Irradiated Fuel

Spent fuel assemblies will be discharged from each unit annually and will remain in spent fuel pools associated with the new units while short half-life isotopes decay. As discussed in Section 3.5.3, each unit will have a spent fuel pool with capacity for at least 10 years of fuel discharges plus margin for a full core offload. After approximately 10 years the fuel will be removed from the pool and packaged in casks for onsite storage and offsite transport. Packaging of the fuel for offsite shipment will comply with applicable DOT and NRC regulations for transportation of radioactive material. By law, DOE is responsible for spent fuel transportation from reactor sites to a repository (See Nuclear Waste Policy Act of 1982, Section 302) and will make the decision on transport mode.

3.8.3 Transportation of Radioactive Waste

As described in Sections 3.5.3 and 5.5.4, low-level radioactive waste will be packaged to meet transportation and disposal site acceptance requirements. Packaging of waste for offsite shipment will comply with applicable DOT and NRC regulations for transportation of radioactive material. The packaged waste will be stored onsite on an interim basis before being shipped offsite to a licensed volume reduction facility or disposal site. Radioactive waste will be shipped from the VEGP site by truck.

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3.9 Pre-Construction and Construction Activities

Section 3.9 describes activities that form the basis for SNC analyses in Chapter 4, Environmental Impacts of Construction. Section 3.9 provides separate discussions of pre-construction activities and construction activities because these activities take place at different times, are authorized under separate NRC regulatory provisions, and can have environmental impacts that differ in magnitude and duration. Basically, pre-construction activities are not nuclear safety related whereas construction activities are. Section 1.3 discusses the relationship between these activities and the various NRC and other regulatory agency reviews, approvals, and consultations.

An ESP does not constitute a decision or approval to construct a new unit and SNC has not committed to any start date for construction. Pre-construction activities could start as early as ESP issuance and as late as 20 years from ESP issuance. With SNC ESP application submittal in 2006 and a 3-year NRC approval schedule, this would give a pre-construction start schedule ranging from 2009 to 2029. SNC estimates that it could start these same pre-construction activities 6 months before ESP issuance if it applied for, and NRC issued, an optional Limited Work Authorization (LWA) 1 (see Section 1.3). In order to ensure analysis that envelopes the full range of schedule possibilities, and to preserve its option of applying for an LWA-1, SNC has prepared its environmental report assuming an LWA-1 and 18-month pre-construction activity that could start as early as 2009 and as late as 2029.

Construction activities, which are nuclear safety related, are very unit-specific and SNC intends to have separate Unit 3 and Unit 4 construction schedules. Pre-construction activities tend to be less unit specific and more project- and site-wide in nature. For this reason, SNC is using a common pre-construction schedule for the two units.

As discussed in Section 1.3, SNC intends to pursue obtaining a COL and has the option of submitting a COL application prior to NRC issuance of the ESP. Construction could start as early as COL issuance. Assuming COL submittal in 2008 and a 3-year NRC approval schedule, this would give a construction start schedule of 2011. SNC estimates that it could start some nuclear safety related construction 6 months before COL issuance if SNC secured an optional LWA-2 (see Section 1.3). While SNC currently has no plans to do so, SNC is preserving its option by preparing its environmental report assuming an LWA-2 and a start of construction as early as 2010 and as late as 2032. Earliest start of commercial operation would be 2015 for Unit 3 and 2016 for Unit 4; latest would be 2037 and 2036, respectively.

SNC has analyzed the range of ESP and COL dates to ensure that the environmental report reasonably bounds potential impacts.

3.9.1 Preparatory Work

SNC requests that a Limited Work Authorization (LWA-1) be granted with the Early Site Permit (ESP) to allow performance of the pre-construction activities defined in Section 3.9.2. A Site Redress Plan, prepared in accordance with the requirements of 10 CFR 52.17(c), is provided as Part 4 of the ESP application. In addition, certain activities associated with Unit 1 and Unit 2 structures, systems, and components (SSCs) may be necessary to prior to construction. These activities will be managed under the requirements of the Unit 1 and Unit 2 licenses.

3.9.2 Pre-Construction Activities

See Section 1.3 for discussion of permits and other regulatory approvals that SNC will secure prior to initiating related pre-construction or construction activity.

Pre-construction includes the following general types of activities:

- Preparation of the site for facility construction (including clearing, grading, construction of temporary access roads and borrow areas);
- Installation of temporary construction support facilities (including such items as warehouse and shop facilities, utilities, concrete mixing plants, docking and unloading facilities, and construction support buildings);
- Excavation for facility structures;
- Construction of service facilities (including such facilities as roadways, paving, railroad spurs, fencing, exterior utility and lighting systems, transmission lines, and sanitary sewage treatment facilities);
- Construction of structures, systems and components that do not prevent or mitigate the consequences of postulated accidents that could cause undue risk to the health and safety of the public. This could include such items as cooling tower structures, circulating water lines, fire protection lines, switchyard and on-site interconnections.

The following paragraphs describe in more detail VEGP-specific pre-construction activities. SNC has estimated activity duration to facilitate evaluation of the duration of associated environmental impact. It should be noted, however, that the durations are not sequential; multiple activities will take place concurrently.

3.9.2.1 Installation and Establishment of Environmental Controls

Duration: 4 months

Activities will include the installation or establishment of:

- Groundwater monitoring wells
- Silt screens
- Debris basins
- Settling basins
- Dams
- Site drainage
- Stormwater management system
- Dust suppression controls
- Solid waste storage areas
- Backfill borrow, spoils, and topsoil storage areas
- Spill containment controls

As much as possible, SNC will utilize the existing site drainage systems installed during construction of VEGP Units 1 and 2, which are still in use. All design and installation of new systems will be in compliance with Federal, state and local environmental regulations and requirements.

3.9.2.2 Road and Rail Construction

Duration: 3 months

A heavy haul route approximately 1.6 miles in length will be built to support transport of heavy modules and components from the barge slip on the Savannah River to the construction site. A construction access route approximately 1 mile in length will be built from River Road to the new power block so that construction traffic will not disrupt traffic patterns for the existing units. An access road approximately 2 miles in length from the new power block area to the new intake structure will be built to support delivery of material to the intake construction site. The underground circulating water make-up lines will be routed adjacent to this road. The rail line that runs from its connection with the Norfolk and Southern line near Waynesboro (Greens Cut/Shell Bluff) to its termination at VEGP with spurs into the unloading areas, a distance of approximately 16 miles, may require some upgrade.

Temporary parking lots will be cleared, grubbed, graded and graveled or paved.

3.9.2.3 Security Construction

Duration: 3 months

Site security features will be installed during the early part of pre-construction activities. Security structures will include access control points, fencing, lighting, physical barriers and guard houses.

3.9.2.4 Temporary Utilities

Duration: 6 months

Temporary utilities include both above-ground and underground infrastructure for power, potable water, wastewater and waste treatment facilities, fire protection, and for construction gas and air systems. The temporary utilities will support the entire construction site and associated activities, including construction offices, warehouses, storage and lay-down areas, fabrication and maintenance shops, the power block, the barge facility, and intake/discharge areas.

3.9.2.5 Temporary Construction Facilities

Duration: 9 months

Temporary construction facilities including offices, warehouses, toilets, change rooms, training and personnel access facilities will be constructed. The site of the concrete batch plant will be prepared for aggregate unloading and storage, and the cement storage silos and the batch plant will be erected.

3.9.2.6 Lay-down, Fabrication, Shop Area Preparation

Duration: 5 months

Activities:

- Grade, stabilize and gravel lay-down areas
- Install construction fencing
- Install shop and fabrication areas including the concrete slabs for formwork lay-down, equipment parking and maintenance, fuel and lubricant storage
- Install concrete pads for cranes and crane assembly

3.9.2.7 Clearing, Grubbing, and Grading

Duration: 3 months

Spoils, backfill borrow and topsoil storage areas will be established in the southern and eastern parts of the VEGP site. Clearing and grubbing of the site will begin with the removal of trees and vegetation. Top soil will be removed to a storage area in preparation for excavation. The switchyard and cooling tower areas will be brought to grade in preparation for foundation installation.

3.9.2.8 Underground Pipe Installation

Duration: 4 months

Concurrent with the power block earthworks, non-safety related underground piping will be installed and backfilled.

3.9.2.9 Docking and Unloading Facilities Installation

Duration: 9 months

The existing barge slip must be enlarged to support unloading the AP1000 components and modules. The downstream sheet pile wall must be removed and the slip must be excavated to the correct dimensions. The downstream sheet pile wall will be reconstructed and the shore line stabilized prior to use. The barge facility will be needed to support the early receipt of materials and equipment that will be transported to the site by barge. Concurrently any crane foundations will be placed, and a heavy lift crane will be erected.

3.9.2.10 Intake/Discharge Coffer Dams and Piling Installation

Duration: 3 months

A sheet pile coffer dam and dewatering system will be installed on the west side of the Savannah River upstream of the VEGP intake to facilitate the construction of the Unit 3 and 4 intake structure and canal. Piling will also be driven to facilitate construction of the new discharge system downstream of the existing VEGP discharge line. Excavation, intake structure erection and piping installations will follow the piling operations and continue through pre-construction into plant construction.

3.9.2.11 Power Block Earthwork (Excavation)

Duration: 6 months

The excavation of the power block area will occur as part of pre-construction activities. The power block area will be excavated to approximately 90 feet below grade, removing sand, silt, and clay down to the marl layer. The excavation will be concurrent with the installation of a dewatering system, slope protection and retaining wall systems. Excavated material will be transferred to the spoils and backfill borrow storage areas. Acceptable material from the excavation will be stored and reused as structural backfill.

3.9.2.12 Module Assembly

Duration: 15 months

The AP1000 design calls for a high degree of modularization. It is planned that the steel module components in the nuclear island will be fabricated offsite and shipped to site via barge and/ or rail and assembled into complete modules prior to setting in the power block. Large module component shipments will arrive by barge, be offloaded at the barge facility, and transported over the heavy haul road to the fabrication assembly area. The size of the larger module components will be constrained to the minimum river bridge clearances of 90-foot span width and 38-foot low water height. Smaller rail module component shipments will arrive in sections with dimensions up to 12(H) x 12(W) x 80(L) feet weighing up to 80 tons and be offloaded in fabrication assembly areas. The assembly of the components into complete modules on site will begin during the pre-construction phase; pre-construction activities will include preparation of assembly work areas. The completion of early module assembly is planned to coincide with the completion of VEGP Unit 3 containment base mat foundation. The setting of completed modules will not occur until after receipt of the COL.

3.9.2.13 Nuclear Island Basemat Foundations

Duration: 5 months

Once the subsurface preparations are completed, the next sequential work operation is the installation of foundations. The deepest foundations in the power block are the reactor island and are the first to be installed. The detailed steps include installation of the grounding grid, mud-mat concrete work surface, reinforcing steel and civil, electrical, mechanical/piping embedded items, forming, and concrete placing and curing. The activities associated with the reactor island foundations are safety related. SNC will perform these activities as part of the pre-construction phase if it secures the optional LWA-2; otherwise, SNC will perform these activities as part of the construction phase.

3.9.2.14 Power Block Earthwork (Backfill)

Duration: 8 months

Backfill material will come from onsite borrow pits. The backfill will be installed up to the buildings' foundation grades. The installation of non-safety-related backfill to support non-safety-related structures or systems will occur as part of the pre-construction activities. The installation of safety related Category 1 structural backfill material placed under safety-related structures or systems is safety related. As for basemat foundation work, SNC may perform safety related backfill as pre-construction activity pursuant to an LWA-2 or as construction activity.

3.9.3 Construction

Major power plant construction of safety-related structures, systems and components (SSCs) will begin after the NRC issues a COL to SNC. Each AP1000 unit is a series of buildings and structures and is erected from the bottom up with the top remaining open until the major mechanical and electrical equipment and piping are placed on each elevation. Much of the commodity installation consists of the setting of prefabricated civil/structural, electrical, mechanical and piping modules with field connections.

The approximate construction duration for the two units is 66 months.

On-site construction involves the installation of civil, mechanical/HVAC, electrical, piping and instrumentation commodities.

Civil installations include:

- Concrete pipe
- Backfill
- Concrete formwork and structural modules
- Concrete
- Reinforcing and embedded steel
- Structural steel
- Painting

Mechanical/HVAC installations include:

- Vessels
- Pumps
- Compressors
- Tanks
- Heat exchangers
- Turbine generators
- Condensers
- Cooling Towers
- HVAC ductwork
- Process equipment

Electrical installations include:

- Transformers
- Electrical panels and instruments
- Switchgear
- Cable trays
- Conduit, cable, wire and electrical terminations

Pipe and Instrumentation installations include:

- Large- and small-bore piping
- Valves and hangers
- Instrument trays and tubing
- Control instruments

The sequence of activities from commodity installation to commercial operation will be:

1. Civil completion of structure with mechanical and electrical equipment installed

2. Bulk piping and electrical commodities installed
3. Completion of the mechanical, piping and electrical systems in each structure
4. Component testing, system testing, flush & hydro, and functional testing
5. Fuel load and power ascension testing
6. Commercial operation

3.9.3.1 Power Block Construction

With the pre-construction activities completed and switch yard area construction continuing, the construction focus will concentrate on the power block. As indicated above, each AP1000 Unit consists of a series of buildings or structures with systems within the structures.

Containment Building

Duration: 48 months

The containment building has the longest construction duration. The major activities associated with the containment building following the base-mat foundation placement including: (1) erecting the containment vessel, with the bottom head set and grout; (2) setting and welding out three rings; (3) installing the reactor vessel, steam generators, reactor coolant pumps and pipe; (4) setting the polar crane; and setting the upper head. The shield walls are installed, followed by the roof and Passive Containment Cooling System (PCS) tank. The piping, HVAC, and electrical begins in the lower elevations and continues to the upper elevations.

Auxiliary Building

Duration: 44 months

The auxiliary building modules will be preassembled and delivered to the site. After assembly onsite, its mechanical equipment will be installed, and the HVAC, piping, and electric work completed.

Other facilities

Duration: As noted below

Other facilities including the turbine building, radwaste building, diesel generator building, and administrative building will be constructed on site. Other ancillary structures such as the cooling towers and switchyard will also be constructed. The turbine building will be constructed over a 46 month time period. The radwaste building will require 11 months to construct, and the diesel generator building will require 9 months to construct. The annex building will require 17 months, and the administration and simulator buildings will require 12 months to construct. The make-up water intake and pump house, cooling tower, yard tanks, and discharge each will require about 12 months to construct. Construction of the switchyard and installation of the main transformers should require approximately 9 months.

3.9.3.2 Testing

Duration: As noted below

Testing of all building components and equipment will require approximately 39 months for each unit including functional and integrated leak testing. The first fuel load and power ascension testing will require 6 months.

3.9.4 Noise

Noise is generated by earthmoving equipment, portable generators, pile-drivers, pneumatic equipment, and hand tools. Although short-term noise levels from construction activities could be as high as approximately 110 dBa, (e.g., impulse noise during pile driving activities, see Table 3.9-1), these noise levels will not extend far beyond the boundaries of the project site. Table 3.9-1 illustrates the rapid attenuation of construction noise over relatively short distances. At 400 feet from the construction site, construction noise will range from approximately 60 to 80 dBa. Neither Georgia nor Burke County has noise regulations or ordinances.

Table 3.9-1 Peak and Attenuated Noise (in dBa) Levels Expected from Operations of Construction Equipment[1]

Source	Nose Level (peak)	Distance from Source			
		50 feet	100 feet	200 feet	400 feet
Heavy trucks	95a	84-89	78-83	72-77	66-71
Dump trucks	108	88	82	76	70
Concrete mixer	105	85	79	73	67
Jackhammer	108	88	82	76	70
Scraper	93	80-89	74-82	68-77	60-71
Dozer	107	87-102	81-96	75-90	69-84
Generator	96	76	70	64	58
Crane	104	75-88	69-82	63-76	55-70
Loader	104	73-86	67-80	61-74	55-68
Grader	108	88-91	82-85	76-79	70-73
Dragline	105	85	79	73	67
Pile driver	105	95	89	83	77
Fork lift	100	95	89	83	77

[1] Source: **Golden et al. (1980).**

Sections 3.9 References

(Golden et al. 1980) Golden, J., R. P. Ouellette, S. Saari, and P. N. Cheremisinoff, *Environmental Impact Data Book,* "Chapter 8: Noise," Second Printing, Ann Arbor Science Publishers, Inc., Ann Arbor, Michigan. 1980.

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3.10 Work Force Characterization

3.10.1 Construction Work Force

A construction work force consists of two components: field craft labor and field non-manual labor. Field craft labor is the largest component of the construction workforce, by far (typically 70 percent in conventional nuclear plant construction) and comprises civil, electrical, mechanical, piping, and instrumentation personnel. The field non-manual staff makes up the balance of the construction work force (typically 30 – 35 percent if the engineering is performed offsite) and comprises field management, field supervision, field engineers, Quality Assurance /Quality Control (QA/QC), safety and administrative staff (Table 3.10-1). Based on experience and information on the number of skilled and craft personnel currently in a 50-mile radius of the VEGP site, it is assumed that the project will draw 20 to 25 percent of that workforce. The remainder of the craft labor will come from outside the area. All non-manual labor is assumed to come from outside the area.

The AP1000 is designed to be constructed in modules (see Section 3.9.2). The amount of modularization depends on the characteristics of the site. Transportation route restrictions such as low bridges typically govern the size of modules. Some on-site assembly of modules may be required. This ratio of offsite versus onsite module construction determines the size of the onsite workforce; however, any modularization shifts some of the work (and work force) to another location that could be outside the 50-mile radius of the ESP site, and decreases the onsite construction duration. The construction duration and estimated on-site workforce presented here and used as the basis for the Chapter 4 analyses are based on SNC's evaluation of the offsite fabrication and onsite fabrication and construction, which are site-specific.

The total onsite construction work force for sequential construction of two units at the VEGP site is estimated to be approximately 20.5 job hours per kilowatt of generating capacity.

The maximum onsite workforce for two AP1000 units with a 12 month lag between construction starts is estimated to be 4,400 people, assuming 18 months of site preparation followed by 66 months of construction for both units (Table 3.10-2 and Figure 3.10-1).

3.10.2 Workers Relocation and Commuting

Construction workers typically commute up to 50 miles to the job site. Based on information on the workforce in the Central Savannah River Area and assuming 20 to 25 percent of that workforce will be available to the VEGP project, SNC anticipates approximately 1,000 local crafts people could be utilized to staff the VEGP Units 3 and 4 construction. The balance of the construction workforce will come from outside the 50-mile radius. For the analysis of construction impacts in Chapter 4, it is assumed that the non-manual labor workforce will relocate to the area from outside the 50-mile radius. Seventy to eighty percent of the construction work force will be employed for more than 4 years. SNC has assumed that most of the craft labor will seek temporary housing, and most of the non-manual staff will relocate permanently. Construction employees typically locate in the nearest metropolitan area to the site, therefore, most of the construction work force will locate in the Richmond, Columbia, and Burke County area.

3.10.3 Operations Work Force

A study commissioned by DOE **(DOE 2004)** estimated the additional operations work force for a new unit constructed at an existing two-unit PWR site. SNC reviewed this analysis and applied its estimates to the VEGP site. Based on this analysis, SNC has estimated that the additional onsite operations workforce will be 345 people for one unit, and that an additional unit will require an additional 317 employees.

Table 3.10-1 Percent Construction Labor Force by Skill Set

Labor	Installation Items - Responsibility	Percent of Total Work Force
Mechanical Equipment	NSSS, Turbine Generator, Condenser, Process Equipment, HVAC	3 – 4
Electrical	Equipment, Cable, Cable Tray, Conduit, Wire, Connections	10 - 12
Concrete	Concrete and Reinforcing Steel	10 - 15
Structural steel	Structural and Miscellaneous Steel	2 - 4
Other civil	Piling, Architectural Items, Painting, Yard Pipe	2 - 5
Piping/instrumentation	Pipe, tubing, valves, hangers/supports	14 – 20
Site support	Scaffolding, Equipment Operation, Transport, Cleaning, Maintenance, etc	20 - 30
Specialty labor	Fireproofing, Insulation, Rigging, etc	7 – 13
Non-manual labor	Management, Supervision, Field Engineering, QC/QA, Safety and Health, Administration	30 - 35

Table 3.10-2 Estimated Construction Work Force and Construction Duration for Two AP1000 Units

Month	Workforce Strength	Month	Workforce Strength	Month	Workforce Strength
Limited Work Authorized Activities		10	3500	38	4350
-18	80	11	3600	39	4275
-17	160	12	3700	40	4250
-16	230	Construction on Second Unit		41	4225
-15	300	13	3800	42	4200
-14	380	14	3850	43	4175
-13	460	15	3900	44	4150
-12	530	16	3950	45	4125
-11	610	17	4000	46	4100
-10	700	18	4050	47	4075
-9	820	19	4100	48	4050
-8	960	20	4150	49	4025
-7	1130	21	4175	50	4000
-6	1310	22	4200	51	3975
-5	1480	23	4250	52	3950
-4	1660	24	4275	53	3925
-3	1830	25	4300	54	3900
-2	2000	26	4350	55	3875
-1	2175	27	4375	56	3850
Construction on First Unit		28	4400	57	3825
1	2350	29	4400	58	3800
2	2525	30	4400	59	3700
3	2700	31	4400	60	3600
4	2870	32	4400	61	3500
5	3045	33	4400	62	3000
6	3180	34	4400	63	2500
7	3250	35	4400	64	2000
8	3300	36	4400	65	1000
9	3365	37	4350	66	500

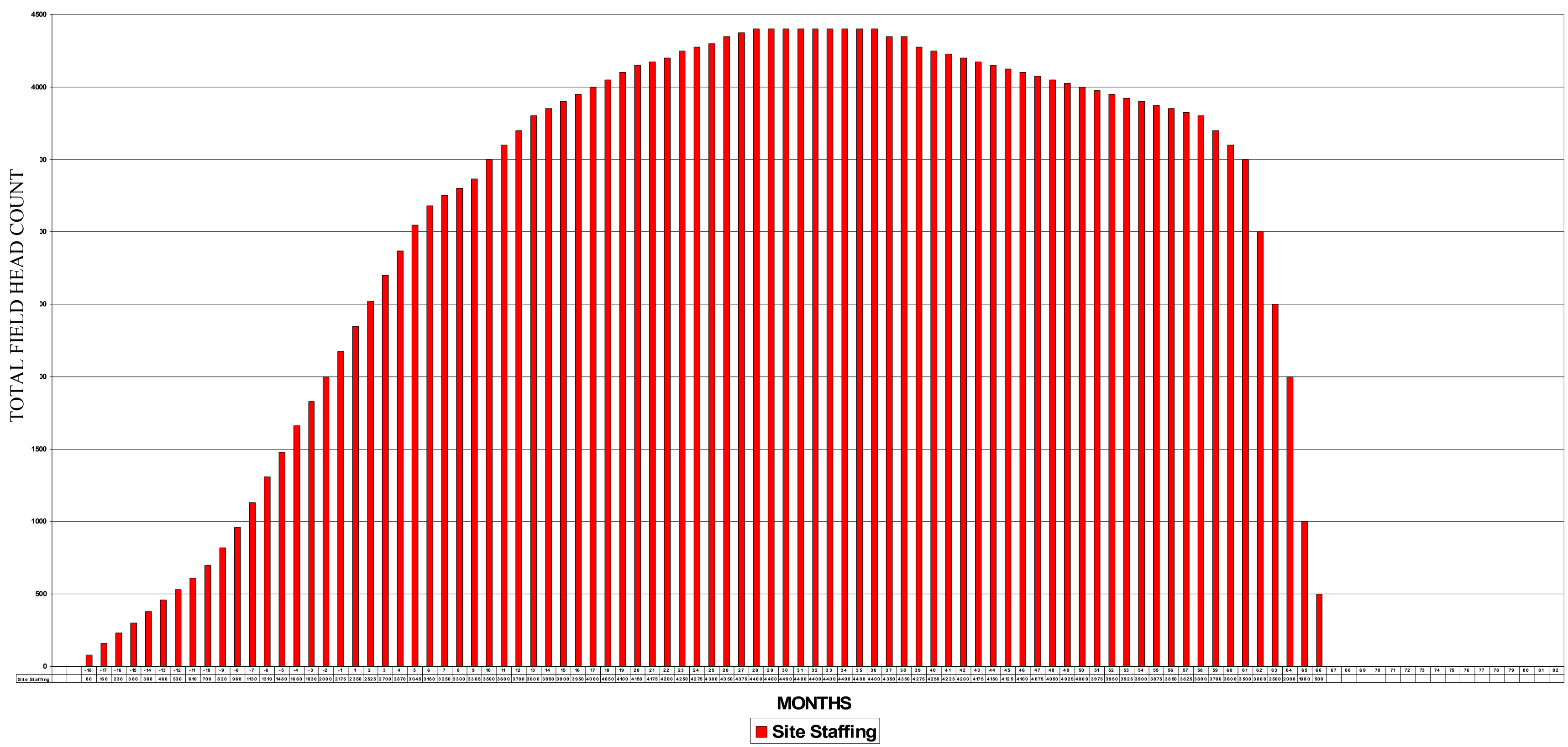

Figure 3.10-1 Projected Construction Workforce by Month, including Limited Work Authorization Activities for VEGP Units 3 and 4

Sections 3.10 References

(DOE 2004) U.S. Department of Energy, *Study of Construction Technologies and Schedules, O&M Staffing and Cost, Decommissioning Costs and Funding Requirements for Advanced Reactor Designs, Volume 2 – MPR-2627*, prepared under Cooperative Agreement DE-FC07-03ID14492, prepared by Dominion Energy, Inc., Bechtel Power Corporation, TLG, Inc., and MPR Associates, May 27, 2004.

Chapter 4 Environmental Impacts of Construction

Chapter 4 presents the potential impacts of construction of the new units at the Vogtle Electric Generating Plant (VEGP) site. In accordance with 10 CFR 51, impacts are analyzed, and a single significance level of potential impact to each resource (i.e., SMALL, MODERATE, or LARGE) is assigned 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.

This chapter is divided into seven sections:

- Land Use Impacts (Section 4.1)
- Water-Related Impacts (Section 4.2)
- Ecological Impacts (Section 4.3)
- Socioeconomic Impacts (Section 4.4)
- Radiation Exposure to Construction Workers (Section 4.5)
- Measures and Controls to Limit Adverse Impacts During Construction (Section 4.6)
- Non-radiological Health Impacts (Section 4.7)

The sections present potential ways to avoid, minimize, or mitigate adverse impacts to the maximum extent possible.

The following descriptions should help the reader understand the scope of the discussion:

- VEGP site – the 3,169-acre existing site as described in the Unit 1 and Unit 2 licenses
- New plant (VEGP Units 3 and 4) footprint – the approximately 500 acres within the existing VEGP site that will encompass the construction and operation of the new nuclear units
- Vicinity – the area within approximately the 6- to 10-mile (depending on the issue) radius around the VEGP site
- Region – the area within approximately the 50-mile radius around the VEGP site

Construction will occur in two phases:

- ESP site preparation activities are those activities which are allowed by the early site permit (ESP) Limited Work Authorization (LWA). Site preparation activities are predominately earth-work, development of construction support facilities, and construction of non-safety related structures.
- COL site construction activities will begin once the combined operating license (COL) is granted. Construction includes some earth-work but is predominately the construction or fabrication of the reactor buildings and associated and supporting facilities.

Section 3.9.2 describes site preparation, or pre-construction activities; those activities that could commence upon approval of the ESP permit. Section 3.9.3 describes construction activities.

4.1 Land-Use Impacts

The following sections describe the impacts of site preparation and construction to the Vogtle Electric Generating Plant (VEGP) site and the surrounding area. Section 4.1.1 describes impacts to the site and vicinity. Section 4.1.2 describes impacts that could occur along transmission lines, should the transmission system need upgrading as a result of the new units at VEGP. Section 4.1.3 describes impacts to historic and cultural resources at the site and along transmission lines. This section does not describe land uses attributable to increased tax revenues to Burke County. Those are addressed in Section 4.4.2.2.1.

4.1.1 The Site and Vicinity

4.1.1.1 The Site

VEGP Units 3 and 4 and supporting facilities will be located on the 3,169-acre VEGP site, adjacent to the existing nuclear units (Figure 3.1-3). Heavy equipment and reactor components will be barged up the Savannah River. A heavy haul road will be constructed from the barge slip on the Savannah River to the construction site. A construction access road will be constructed from River Road, near the rail spur crossing, to the construction site to provide access to the construction site without impeding traffic to the existing units. Another road will be constructed to the new intake structure. Approximately 310 acres of land will be dedicated permanently to the new units and their supporting facilities (Table 4.1-1). Temporary facilities and spoil storage will affect an additional 190 acres. Most of the land was most recently disturbed in the last 30 years and currently consists of planted pines and old fields. Less than 50 acres of mixed and bottom land hardwoods will be lost. One permitted landfill in the construction footprint (Landfill #3) will be relocated.

Areas for borrow pits have been identified on the northern part of the VEGP site though the extent of land required has not been determined. This land was not disturbed during previous construction and is characterized by pine forests with hardwood stands along the stream drainages (See Figure 2.4-1). The threatened and endangered species survey included this part of the VEGP site **(TRC 2006)**. A survey of cultural resources is scheduled to be completed in Fall, 2006. The impacts to land use from these borrow pits is not considered in SNC's conclusion, however it is unlikely, because of the nature of the habitat, that impacts would be other than small.

To accommodate the anticipated new construction, several onsite activities likely will occur prior to commencement of site preparation activities. As described in Section 3.9.1, numerous existing facilities will be relocated prior to receiving the ESP. The Thalmann (McIntosh) transmission line will be rerouted onsite to avoid the footprint of the new units. The Augusta Newsprint, Goshen, and South Carolina Electric & Gas (SCE&G) lines may be raised over the heavy haul road route to enable reactor components and heavy equipment barged up the river to be moved to the construction site.

An existing onsite landfill will be relocated onsite or the materials removed and disposed in an offsite permitted disposal facility.

Impacts of these projects are considered in this environmental report, even though the work likely will occur prior to initiation of site preparation activities.

All site preparation and construction activities will be conducted in accordance with federal, state and local regulations. As described in Section 3.9.2, Southern Nuclear Operating Company (SNC) will acquire all necessary permits and authorizations and implement environmental controls such as stormwater management systems, groundwater monitoring wells, and spill containment controls prior to commencement of earth disturbing activities. Site preparation and construction activities that will affect land use include clearing, grubbing, grading and excavating, and stockpiling soils. Permanently disturbed locations will be stabilized and contoured in accordance with design specifications. Re-vegetation will comply with site maintenance and safety requirements. Methods to stabilize areas and prevent erosion or sedimentation will comply with applicable laws, regulations, permit requirements and good engineering and construction practices, and recognized environmental best management practices. The Georgia Stormwater Management Manual **(ARC/DNR 2003)** and industry guidance will be followed to reduce stormwater quantity, improve stormwater quality, and protect receiving waters and downstream areas. SNC maintains a landfill at VEGP that is permitted for inert construction and demolition debris. Construction debris will be disposed either in this on-site landfill, or taken to an off-site permitted disposal facility.

The intake, discharge, and barge facilities will be located in the 100-year floodplain. With those exceptions, construction activities will be outside the 500-year floodplain **(FEMA 1989)**. As stated in Section 2.2.1.2, no mineral deposits occur in Burke County. As stated in Section 2.2.1.1, no prime farmland soils occur on the VEGP site. Burke County does not have zoning laws, therefore, the VEGP site does not have zoning requirements.

Approximately 310 acres of the 500 acres disturbed during site preparation and construction will be used for the new units and will be lost to other uses until after decommissioning of those reactors.

Most of the land that will be occupied by the new units and associated facilities was disturbed during the construction of the existing units, however some construction will occur on land that has not been as recently disturbed.

The new plant footprint is wholly contained on an existing dedicated nuclear site originally planned for four units and will not be available for other uses until decommissioning. SNC concludes that the site land use impacts will be SMALL and will not warrant mitigation.

4.1.1.2 The Vicinity

Land in the vicinity of the VEGP site is rural, or owned by the federal or state governments. Land within 6 miles of the site is predominantly forested (including forested wetlands) (Figure 2.2-2). The Yuchi Wildlife Management Area (WMA), immediately south of the site, comprises 7,800 acres of forest **(Georgia Outdoor 2003)**.

A recreational vehicle park and store within 6 miles of the site that operated during construction of the existing units could reopen, or local land owners could convert some property to mobile home parks. No other land use changes in the vicinity as a result of the construction workforce are anticipated.

SNC concludes that impacts to land use in the vicinity of VEGP from construction of the new units will be SMALL and will not require mitigation.

4.1.2 Transmission Corridors and Offsite Areas

The additional electricity generated from two new reactors on the VEGP site will require the addition of a 500-kilovolt transmission line. The new units will utilize the new line or some combination of new and existing lines. The probable route of the new line will be to an existing substation. The specific route of a proposed line has not been determined; however, it will be routed northwest from the VEGP site, passing west of Fort Gordon, a U.S. Army facility west of Augusta, Georgia, then north to an existing substation.

Georgia Power Company (GPC) will site the line in accordance with Georgia Code Title 22, Section 22-3-161, which states:

> *In selecting the route for the location of the electric transmission line, the utility shall consider existing land uses in the geographic area where the line is to be located, existing corridors, existing environmental conditions in the area, engineering practices related to the construction and operation of the line, and costs related to the construction, operation, and maintenance of the line.*

GPC has procedures for implementing this regulation, which involve data gathering on land uses, environmental issues, existing corridors, and cultural resources in the study area; consultation with the State Historic Preservation Officer, the U.S. Fish and Wildlife Service (USFWS), the Georgia Department of Natural Resources (GDNR), the U.S. Army Corps of Engineers (USACE); and evaluation of environmental, cultural, and land use issues. The environmental evaluation addresses crossings wetlands, National Forests, government lands under protection, and streams and rivers; and impacts to special habitats and threatened or endangered species. Alternative engineering practices, such as underground transmission, rebuilding existing facilities to accommodate new transmission, and construction on county or state road rights-of-way, will be evaluated by GPC.

SNC has reviewed the land use plans of the counties that could be affected by a new transmission corridor **(Burke County 1991, Jefferson County 2004, Warren County 2005, McDuffie County 1992)** and has not identified any conflicts, zoning or otherwise, that would preclude construction of a transmission line. Figure 2.2-4 provides a land use map of the region where the proposed corridor will be constructed. Section 3.7 estimates that approximately 2.0 sq mi will be required for a new transmission corridor. Land use in this new corridor is not known but SNC expects it will be a mix of agriculture, planted forest resources and natural forested land. Table 2.4-2 lists protected species in the counties the transmission line will cross.

GPC will comply with all applicable laws, regulations, permit requirements, and good engineering and construction practices.

Impacts to offsite land use from the construction of a new transmission corridor could be MODERATE, but will be mitigated by siting it to avoid sensitive land uses.

4.1.3 Historic Properties

Table 2.5.3-1 lists properties in Burke County which appear on the National Register of Historic Places. One property is within 10 miles of the VEGP site. The Savannah River Site has been identified as being eligible for the National Register because of its contributions to the Cold War.

As described in Section 2.5.3.2, the cultural resource survey of VEGP identified 10 archaeological sites, two of which are recommended as eligible for inclusion on the National Register. As a result of the survey, SNC moved the location of the intake structure, access road, and intake piping route to avoid disturbing one of the eligible sites. SNC has initiated correspondence with the Georgia and South Carolina State Historic Preservation Officers (SHPOs).

Excavations for the new units will extend down to the Blue Bluff marl. VEGP maintains procedures which include actions to protect cultural, historic, or paleontological resources. As part of the site preparations activities, before land-disturbing activities begin, SNC will prepare a similar procedure for construction activities.

Table 2.5.3-3 lists National Historic Register properties in the counties the new transmission corridor will cross.

Prior to the clearing of any new transmission corridor, SNC or GPC will correspond with the Georgia SHPO as required by Section 106 of the National Historic Preservation Act. All land disturbing activities associated with constructing a new transmission line will follow established GPC procedures as described in the previous section. SNC concludes that impacts to historic or cultural resources from construction will be SMALL and will not warrant additional mitigation.

Table 4.1-1 Construction Areas

Construction Zone	Acreage
Dedicated facilities for two units	310
Spoils storage	72
Temporary facilities	118

Section 4.1 References

(ARC/DNR 2003) Atlanta Regional Commission/Georgia Department of Natural Resources Environmental Protection Division, *Georgia Stormwater Management Manual*, Atlanta, Georgia, 2003.

(Burke County 1991) Burke County Board of Commission, Burke County Comprehensive Plan: 2010, Waynesboro, Georgia, January, 1991.

(FEMA 1989) Federal Emergency Management Agency, Flood Insurance Rate Map, Burke County, Georgia, National Flood Insurance Program, Washington, D.C., September 15, 1989.

(Georgia Outdoor 2003) Georgia's Outdoor Recreation and Adventure Guide, "Georgia's Wildlife Management Areas," available at http://www.n-georgia.com/wildlife.htm, Accessed June 21, 2005.

(Jefferson County 2004) Jefferson County, J*efferson County Joint Comprehensive Plan, 2004 - 2024*, Louisville, Georgia, 2004.

(McDuffie County 1992) McDuffie County, *Joint McDuffie County, City of Thomson, City of Dearing Comprehensive Plan: 2015*, Thomson, Georgia, April, 1992.

(Warren County 2005) Warren County, Georgia, *Land Use Ordinance*.

(TRC 2006) Third Rock Consultants, LLC, *Threatened and Endangered Species Survey Final Report, Vogtle Electric Generating Plant and Associated Transmission Corridors*, Lexington Kentucky, prepared for Tetra Tech NUS, Aiken, South Carolina, January 16, 2006.

4.2 Water-Related Impacts

Water-related impacts from construction of a nuclear power plant will be similar to those from any large construction project. Large construction projects can, if not properly planned, result in impacts to groundwater, the physical alteration of local streams and wetlands, and impact downstream water quality as a result of erosion and sedimentation or spills of fuel and lubricants used in construction equipment. Because of this potential for harming surface- and groundwater resources, applicants are required to obtain a number of permits prior to initiating construction. Tables in Section 1.3 provide a complete list of construction-related consultations and permits SNC will have to obtain prior to initiating construction activities.

4.2.1 Hydrological Alterations

This section identifies proposed construction activities that could result in impacts to the hydrology at the VEGP site, including:

- Clearing land at project site and constructing infrastructure such as roads and stormwater drainage systems
- Construction of new buildings (reactor containment structure, turbine building, cooling towers), structures (e.g., electrical sub-station), road/rails, and parking lots
- Construction of new cooling water intake structure and discharge structure on the Savannah River
- Modification of the existing barge slip
- Temporary disturbance of currently vegetated areas for construction laydown areas, concrete batch plants, sand/soil/gravel stockpiles, and construction-phase parking areas
- Dewatering of foundation excavations during construction

Potentially affected waterbodies include the unnamed on-site drainage associated with Mallard Pond, several on-site ponds created as sediment retention basins during the original site construction and their associated drainages, and the Savannah River.

The State of Georgia NPDES Construction Stormwater Program requires industrial facilities that discharge to waters of the U.S. and plan construction that will disturb more than 5 acres of land to (1) obtain National Pollutant Discharge Elimination System (NPDES) permit coverage, (2) implement best management practices including structural (i.e., erosion control devices and retention ponds) and operational measures to prevent the movement of pollutants (including sediments) offsite via storm water runoff, and (3) develop a Storm Water Pollution Prevention Plan. The U.S. Environmental Protection Agency (EPA) has issued guidance on best (soil and erosion control) management practices and the development of Storm Water Pollution Prevention Plans **(EPA 1992)**. The old retention ponds used during the construction of the existing facilities will not be reused for the new construction. New retention ponds will be constructed to accommodate surface-water runoff and to allow sediment-laden water from dewatering activities to pass through them, if necessary, prior to discharge at an NPDES permitted outfall. Dewatering activities in the surficial aquifer will not impact local water well users because most local wells are located in the Tertiary or Floridan aquifer. Dewatering will occur within a limited area for a reasonably short period of time, slightly affecting the unconfined layer. Once dewatering ceases the water table-water level at the site is expected to return to normal levels. Dewatering would not present problems with subsidence. Groundwater pumped from wells installed to dewater large construction areas can be discharged directly to surface water without passing through a settlement basin. Dewatering an excavation within sheet piles, open excavation or behind a coffer dam could be pumped to a settling basin before discharge through a permitted NPDES outfall. SNC will follow best management practices for soil and erosion control as required by applicable federal and state laws and regulations. Therefore, impacts to the local hydrology from construction activities will be SMALL and will not warrant mitigation.

4.2.2 Water Use Impacts

SNC evaluated the proposed use of surface water from the Savannah River and groundwater during the construction phase of the project. Because of the presence of existing groundwater production wells at VEGP, SNC evaluated their production capacity and current use to determine if these wells will produce an adequate supply of water for use during construction. A description of the groundwater underlying VEGP is provided in Section 2.3.1.2.2. A description of current groundwater use at VEGP is provided in Section 2.3.2.2 and Table 2.9-1.

During VEGP construction in the 1970s, GPC used approximately 240 gallons per minute (gpm) of untreated well water for concrete batch plant operation, dust suppression, and potable needs **(GPC 1973)**. At the height of construction, well water usage peaked at approximately 420 gpm. Most of this water was supplied by makeup wells 1 and 2. One existing makeup well MU-2A will likely be replaced by a new well because it is in the footprint of the expanded Units 3 and 4 switchyard. If this change is implemented, the existing MU-2A will be closed and a new well of comparable size will be constructed. No net change in withdrawal will occur.

Water use requirements for construction of a nuclear plant are similar to those for other large industrial construction projects. SNC will obtain water for various standard construction uses, such as dust abatement and mixing concrete, and all potable water required by the construction workforce will be provided from the existing makeup wells including the replacement well noted in the previous paragraph. As noted in Sections 2.3.2.2.2 and 2.5.2.7, one makeup well supplies all necessary makeup water for normal plant operation, leaving two wells in standby. Two of these wells are screened in both the Cretaceous and Tertiary aquifers. The third well is screened in the deep Cretaceous aquifer only. The recharge areas' for these wells is north of

VEGP along a 10- to 30-mile wide zone across Georgia and South Carolina. Most local residential and agricultural wells are in the shallower Tertiary aquifer.

VEGP is permitted by the State of Georgia to withdraw groundwater at a monthly average rate of 6 million gallons per day (MGD) and an annual average of 5.5 MGD (Section 2.3.2.2.2). Average daily usage for the existing units is 1.052 MGD, for all purposes. Based on water use during the original construction, which peaked at 420 gpm (604,800 gallons per day [gpd]), the existing permitted groundwater withdrawal rates should be capable of providing all construction water needs. During construction, groundwater withdrawals will increase from an average of 730 gpm use by existing wells to 1,150 gpm assuming 420 gpm for construction. This could conservatively increase the current potentiometric surface drawdown at the property boundary by approximately 2.3 feet to approximately 6.5 feet. For one year startup procedures for Unit 3 will occur at the same time construction of Unit 4 is completed. This could conservatively result in water use of approximately 1,316 gpm and lower the current potentiometric surface at the property boundary by approximately 3.4 feet to approximately 7.8 feet. SNC prepared a calculation package supporting this analysis. Because the high yield wells at the site are under confined conditions, pumping at the proposed rates will reduce water pressure within the aquifer but will not affect the availability of water to off-site users. Groundwater use during construction will be in accordance with existing permits and in accordance with the Georgia Comprehensive State-wide Water Management Planning Act of 2004. Because most domestic water well users near VEGP use the Tertiary aquifer as their source of water, and the lack of impact from pumping, SNC concludes that impacts will be SMALL and will not warrant mitigation.

Excavation for new reactor building foundations will be to the top of the Blue Bluff marl layer, approximately 86 feet below grade. Dewatering systems will remove subsurface water associated with the shallow, water-table aquifer, which has a maximum depth of 80-100 feet below land surface **(AEC 1974; NRC 1985)**. The dewatering systems are expected to have no impact on the deeper Cretaceous and Tertiary aquifers from which all water for construction of the project will be obtained. There are no plans to use surface water during the construction phase of the project, but it is conceivable that relatively small amounts of water from the stormwater retention ponds could be used to wash construction equipment or sprayed on roads for dust control. Based on these considerations and their localized and temporary nature, SNC believes water use impacts from construction dewatering will be SMALL and will not warrant mitigation.

4.2.3 Water-Quality Impacts

4.2.3.1 Surface Water

Impacts to surface water quality can occur as the result of soil erosion due to soil disturbance during construction. Mallard Pond (Figure 2.1-1) will be the most likely on-site waterbody to be affected by construction. Beaverdam Creek/Telfair Pond also receives surface water from the site and could therefore be impacted by site disturbance activities but this is less likely because of the distance between the construction site and the waterway. Buffers of vegetated land exist between Mallard Pond, Telfair Pond, and the construction site that will reduce the likelihood of any impacts due to sedimentation. The proposed heavy-haul road will rise to the top of a hill overlooking a north-south ravine that drains into Mallard Pond and could convey storm water into the head of Mallard Pond. The new switchyard will be constructed just south of the heavy haul road. Land clearing, excavation, and grading associated with the heavy-haul road and the adjacent switchyard will disturb soil and could result in sediment moving downgradient into Mallard Pond with rainwater runoff. SNC will plan and carry out road building and other construction activities in accordance with all applicable regulations and best management practices including erosion control measures such as silt fences and sediment retention basins to prevent storm water from carrying soil into down-gradient waterbodies.

Because the area slated to be disturbed for facilities and supporting infrastructure is more than 5 acres, SNC will, in compliance with Georgia NPDES Construction Stormwater Program, do the following (see Section 3.9):

- Obtain Georgia General NPDES Permit for Construction Stormwater Discharges (for stand-alone construction projects).
- Develop an Erosion, Sedimentation and Pollution Control Plan.
- Implement Best Management Practices, including structural and operational controls to prevent the movement of pollutants (including sediments) into wetlands and waterbodies via storm water runoff.
- Obtain stream buffer variances from Georgia EPD.

SNC will have a passage dredged from the main channel of the Savannah River to the new barge slip to facilitate movement of heavy equipment and components to the site by barge. Dredge material will be removed and transported to a pre-approved spoil area for disposal. In addition to the dredging, there will be significant construction along the shoreline of the Savannah River in support of the existing barge slip expansion, new intake structure, and new discharge structure. These activities will inevitably disturb sediments (dredging, pile driving) and soils (shoreline construction), which will increase turbidity immediately downstream of the construction sites. Prior to construction in or adjacent to the Savannah River, SNC will install coffer dams to limit the distribution downstream of sediments and debris. The dredging and construction activities will require permits from the USACE. SNC will, to the extent practicable, carry out shoreline construction activities during periods when the Savannah River is low (summer, fall) to minimize impacts to water quality.

Based on the fact that any ground disturbing activities will be permitted and overseen by state and federal regulators, and guided by an approved Storm Water Pollution Prevention Plan, SNC believes any impacts to surface water during the construction phase will be SMALL and will not warrant mitigation beyond those best practices required by permits.

4.2.3.2 Groundwater

The VEGP site lies atop a hill bounded by stream channels that have cut down to relatively impermeable marl. The marl forms an aquiclude between the shallow water-table aquifer and the deep, confined aquifer. The streams act as interceptor drains for the groundwater in the sands overlying the marl. The water table aquifer beneath the plant is thus hydraulically isolated on an interfluvial high. The groundwater is replenished by natural precipitation that percolates to the water table and then moves laterally to one of the interceptor streams. As a consequence, any contaminants (e.g., diesel fuel, hydraulic fluid, antifreeze, or lubricants) spilled during construction would affect only the shallow, water-table aquifer and would ultimately move to surface waterbodies where they could be intercepted **(GPC 1973)**.

Any minor spills of diesel fuel, hydraulic fluid, or lubricants during construction of the project will be cleaned up quickly in accordance with the construction Erosion, Sedimentation, and Pollution Control Plan.

None of the planned construction activities has the potential to affect the deep, confined aquifers. In the unlikely event small amounts of contaminants escape into the environment, they will have only a small, localized, temporary impact on the shallow, water table aquifer. SNC believes that any impacts to groundwater quality will be SMALL and will not warrant mitigation beyond those described in this section or required by permit.

Section 4.2 References

(AEC 1974) U.S. Atomic Energy Commission, Final Environmental Statement related to the proposed Alvin W. Vogtle Nuclear Plant Units 1, 2, 3, and 4, Directorate of Licensing, Washington, DC, March, 1974.

(EPA 1992) U.S. Environmental Protection Agency, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices, Office of Water, Washington, DC, September, 1992.

(GPC 1973) Georgia Power Company, Environmental Report for Alvin W. Vogtle Nuclear Plant Units 1, 2, 3, and 4, Atlanta, Georgia, 1973.

(NRC 1985) U.S. Nuclear Regulatory Commission, Final Environmental Statement related to the operation of Vogtle Electric Generating Plant, Units 1 and 2, Office of Nuclear Reactor Regulation, Washington, DC, March, 1985.

4.3 Ecological Impacts

4.3.1 Terrestrial Ecosystems

4.3.1.1 The Site and Vicinity

Section 4.1.1 describes the impacts of construction to land-use at the site. Construction of the proposed facilities will result in the removal of essentially all forested habitat (approximately 500 acres) within the construction and support areas (Figure 2.1-1). Approximately 250 acres of the total 1,634 acres of pine forests at VEGP will be impacted by construction activities. Pine forests at VEGP (See Section 2.4.1.1) include some areas of naturally vegetated pines, but are mostly slash pine plantations. The 249 acres of pine forest that will be impacted by construction activities is almost exclusively planted slash pine. Approximately 25 acres of the total 612 acres of hardwood forest at VEGP will be impacted by construction activities. The remaining approximately 125 acres that will be impacted by construction consist of existing facilities and open, developed areas. The construction and support areas do not contain any old growth timber, unique or sensitive plants, or unique or sensitive plant communities and are largely planted slash pines and open areas. Therefore, construction activities will not noticeably reduce the local diversity of plants or plant communities. As stated in Section 2.4.1, there are no important species as defined in NUREG-1555 *Standard Review Plans for Environmental Reviews for Nuclear Power Plants 1999* (NUREG-1555) on the VEGP property except common game species such as deer, rabbits, squirrels, and game birds. No areas designated by the USFWS as critical habitat for endangered species exist at or in the vicinity of the VEGP site. No threatened or endangered plants or animals are known to occur in the construction area, and the proposed construction footprint does not provide suitable habitat for threatened or endangered plants or animals. Therefore, construction will have no impact on any threatened or endangered terrestrial species, or other important terrestrial species or habitats.

New intake and discharge structures will be constructed and the existing barge facility will be modified to support the new units. As part of the site preparation activities, any wetlands associated with the intake/discharge structures and barge facility or within the upland construction site will be delineated to determine impacts and any required mitigation.

Land clearing will be conducted according to Federal and state regulations, permit requirements, existing GPC or Southern Company procedures, good construction practices, and established best management practices (e.g., directed drainage ditches, silt fencing). Fugitive dust will be minimized by watering the access roads and construction site as necessary. Emissions and spills from construction equipment will be minimized through scheduled equipment maintenance procedures.

As the site undergoes clearing and grading, disturbance and habitat loss will displace mobile animals such as birds and larger mammals. Species that can adapt to disturbed or developed areas (e.g., raccoon, opossum, many bird species) may recolonize portions of the site where grasses and other vegetation are undisturbed or are replanted following construction. Species more dependent on forested habitat may be permanently displaced. Clearing and grading activities may result in the loss of some individuals, particularly less mobile animals such as reptiles, amphibians, and small mammals.

Section 3.9.4 discusses noise that will result from construction-related activities. As discussed in that section, construction-related noise rapidly attenuates over relatively short distances. At 400 feet from the construction activity, noises will range from approximately 60 to 80 dB. These noise levels are below the 80 to 85 dB threshold at which birds and small mammals are startled or frightened **(Golden et al. 1980)**. Thus, it is likely that noise from construction activities will not disturb wildlife beyond 400 feet from the perimeter of the construction site.

Avian collisions with man-made structures are the result of numerous factors related to species characteristics such as flight behavior, age, habitat use, seasonal and diurnal habitats; and to environmental characteristics such as weather, topography, land use, and orientation of the structures. Most authors on the subject of avian collisions with utility structures agree that collisions are not a biologically significant source of mortality for thriving populations of birds with good reproductive potential **(Brown 1993)**. The number of bird collisions with construction equipment, such as cranes, or new structures has not been quantitatively assessed, however, few avian collisions with existing structures at VEGP have been noted by SNC and it is expected that such collisions during the construction phase will also be negligible.

In summary, while construction-related impacts of habitat loss to local wildlife populations cannot be quantitatively assessed because population data for species on and adjacent to the VEGP site are not available, there are relatively large tracts of forest available to displaced animals to the north, west, and south of the VEGP site. Given the fact that approximately 500 acres of potentially affected habitat at the site represents a small portion of the available undeveloped land in the vicinity, the construction-related mortality or temporary displacement of wildlife will be minimal relative to wildlife populations in the vicinity. Construction activities will not reduce the local diversity of plants or plant communities, and will not impact endangered or threatened species. Noise-related impacts and bird collisions during construction will be negligible. Therefore, construction-related impacts to terrestrial resources in the vicinity will be SMALL, and mitigation beyond what is discussed in this section will not be warranted.

4.3.1.2 Transmission Corridors

As discussed in Section 3.7.2, the additional generation from the proposed new units will require the addition of a 500-kV transmission line. The new line likely will connect VEGP with a substation west of Augusta. The specific route of the line has not been determined, but it will exit the site to the west parallel to the Scherer corridor then turn northwest to an existing substation west of Augusta, Georgia. It will cross Burke, Jefferson, McDuffie, and Warren counties. No areas designated by USFWS as “critical habitat” for endangered species exist in these counties. As discussed in Section 4.1.2, GPC will site any new transmission line in accordance with Georgia Code Title 22, Section 22-3-161 and will comply with all applicable laws, regulations, permit requirements, and good engineering and construction practices.

GPC evaluated potential impacts to the local environment from preparing a transmission corridor, and constructing transmission towers, transmission-tower configurations, or transmission tower access roads have been evaluated with a bounding analysis to ensure that all reasonably foreseeable impacts to terrestrial resources are adequately considered. Because GPC will comply with all federal and state regulations regarding siting transmission lines, and use construction best management practices, impacts to terrestrial ecosystems in the region will likely be SMALL. Environmental effects will not destabilize or noticeably alter important terrestrial ecosystems.

4.3.2 Aquatic Ecosystems

Section 4.2 describes proposed construction activities that could potentially affect on- and offsite waterbodies. Impacts to aquatic ecosystems could result from sedimentation and, to a lesser extent, spills of petroleum products. The effects of construction-generated sediment on aquatic ecosystems have been widely studied and documented. Three major groups of aquatic organisms are typically affected: (1) aquatic plants (both periphyton and vascular plants), (2) benthic macroinvertebrates, and (3) fish. Turbidity associated with suspended sediments may reduce photosynthetic activity in both periphyton and rooted aquatic plants. Deposited sediments can smother these plants. Suspended sediment can interfere with respiration and filter feeding of macrobenthos (especially mussels and aquatic insect larvae), while heavy deposition of sediment on the streambed can blanket both surficial and interstitial habitats of these organisms. Suspended sediment in streams can interfere with respiration and feeding in both young and adult fish, but juvenile and adult fish are generally able to leave areas with high levels of silt and sediment. Deposited sediment may render formerly prime areas unsuitable for spawning or, if deposited after spawning has been completed, may actually destroy eggs and fry. Spills may adversely affect an ecosystem, but the impacts of small spills are generally short-lived.

The construction of the intake and discharge structures and barge facility, will result in the loss of some aquatic habitat permanently or temporarily; however no aquatic habitats in the Savannah River adjacent to the VEGP property are believed to be rare or unique. Fish will be displaced and other forms of aquatic life such as macroinvertebrates will be lost.

SNC will avoid or minimize constructions impacts to water resources through best management practices and good construction engineering practices such as stormwater retention basins and coffer dams as described in Section 4.2. Protecting water quality ensures the protection of aquatic ecosystems.

4.3.2.1 The Site and Vicinity

Based on the proposed locations of new facilities and infrastructure (see Figure 2.1-1), the only permanent waterbody on the VEGP site that could be affected by construction is Mallard Pond. It is possible that some sediment could move into the pond with rainfall runoff during construction of the new switchyard or the heavy-haul road. Best construction management practices will reduce the amount of erosion and sedimentation associated with construction in these areas, however, and will limit impacts to aquatic communities in down-gradient waterbodies. Although unlikely, it is also possible that excavated soil placed in the proposed spoils and overflow storage area south of the Main Plant Access Road (see Figure 2.1-1) could move with runoff into Telfair Pond or Beaverdam Creek via one of the small intermittent streams in the area.

Potential impacts of construction of the existing Units 1 and 2 intake and discharge structures and barge slip were assessed in the Atomic Energy Commission's (AEC) Final Environmental Statement on the Vogtle Nuclear Plant **(AEC 1974)**. The AEC estimated that one inch of sediment would be deposited over 18,200 square yards (3.76 acre) of Savannah River bottom as a result of riverbank construction **(AEC 1974)**. This translated into a 60 foot by 2,730 foot strip of river bottom covered. The AEC suggested that periphyton (attached algae), mussels, and aquatic insect larvae in this relatively small area could be adversely affected and that potential spawning sites for sunfish could be destroyed by silt and that eggs of sunfish could be smothered. Having identified these potential impacts, the AEC concluded that "impacts will be temporary since recolonization is expected to occur within a relatively short period" and "…there will be no significant long-term adverse effects resulting from activities associated with construction of the intake and discharge structures and the barge slip" **(AEC 1974)**. SNC concludes that similar impacts will result from the current project.

Based on the fact that any ground or river disturbing activities will be (1) of relatively short duration, (2) permitted and overseen by state and federal regulators, (3) guided by an approved Storm Water Pollution Prevention Plan, (4) any small spills will be mitigated according to the existing VEGP Spill Prevention, Control, and Countermeasures Plan, and (5) there are no sensitive habitats or species of interest at the proposed location, SNC concludes that impacts to aquatic communities from construction will be SMALL and temporary, and not warrant mitigation.

4.3.2.2 Transmission Corridors

As discussed in Section 3.7, GPC will build a new 500-kV transmission line to handle the new generating capacity. The new transmission line route will run northwest from the VEGP site and connect to an existing substation west of Augusta, GA. The precise route for this new line has not been selected, but it will cross Burke, Jefferson, Warren, and McDuffie counties.

As noted in Section 4.1.2, public utilities are required by Georgia state law to select routes for transmission lines based on a consideration of environmental factors as well as engineering and economic factors. To the extent practicable, GPC selects routes based on compatibility with existing land uses and the presence/absence of important cultural and ecological resources. With respect to aquatic resources, GPC tries to avoid impacts to streams, ponds, reservoirs, and wetlands.

The new transmission line could cross several intermittent and perennial streams in the upper Coastal Plain and lower Piedmont of Georgia. Brier Creek, a major tributary of the Savannah River, could be crossed by the new transmission line several times. Land clearing for transmission corridors could, if not properly managed, affect aquatic plants, aquatic insects, mussels, and fish in the streams crossed by the lines. GPC has procedures and Best Management Practices in place to protect aquatic communities and prevent degradation of water quality. For example, in accordance with Georgia Sediment and Erosion Control Act best management practices, a 25-foot buffer would be maintained along all waters of the state that need to be cleared for new transmission corridor right-of-way. No structures will be placed within the buffer. All buffers will be cleared with methods approved by the Georgia Environmental Protection Division (EPD). Access roads will be built only as necessary to construct and service the transmission facilities.

Only two listed aquatic species, the shortnose sturgeon and the Atlantic pigtoe mussel, are known to occur in the counties (Burke, Jefferson, Warren, and McDuffie) where the new line will be constructed (Table 2.4.6-2). As noted in Section 2.4.2, shortnose sturgeon spawn in the Savannah River. The new transmission line would not cross the Savannah River, but could cross one or more of its tributaries, including Brier Creek and McBean Creek. Because shortnose sturgeon do not leave the Savannah River during spawning runs to enter tributary streams **(Hall, Smith and Lamprecht 1991; Marcy et al. 2005)**, construction of this line will have no effect on spawning shortnose sturgeon.

The historical range of the Atlantic pigtoe mussel included the Savannah and Ogeechee River basins, but populations in both these river systems were assumed to have been extirpated until 1991, when a remnant population was discovered in Williamson Swamp Creek, a tributary of the Ogeechee River in Jefferson County **(Georgia DNR 2005, USACE 2006)**. Although the proposed new transmission line would cross Jefferson County, it would move through the northern portion of the county, and would not approach the Ogeechee River, which lies in the southern part of the county. SNC recognizes that both (USFWS) Georgia Ecological Services and Georgia DNR websites indicate that Atlantic pigtoe populations are found in two other countes (Burke and Warren) that would be crossed by the new 500-kV transmission line. The preponderance of evidence, however, suggests that Ogeechee River populations in Burke and Warren counties have been eliminated and these agency lists are based on older (pre-1990) records. It is conceivable that the Williamson Swamp Creek population has also been eliminated. A recent inventory of the mussels of the Ogeechee River drainage that included surveys of 50 sites in the drainage found no Atlantic pigtoe mussels **(Skelton et al. 2006)**.

In summary, Best Management Practices will be employed to minimize impacts of transmission line construction on aquatic life, including populations of state- and federally-listed species. With the implementation of these measures, impacts to water quality and aquatic ecosystems will be SMALL and of short duration, and will not require mitigation.

Section 4.3 References

(AEC 1974) U.S. Atomic Energy Commission, Final Environmental Statement related to the proposed Alvin W. Vogtle Nuclear Plant Units 1, 2, 3, and 4, Directorate of Licensing, Washington, DC, March, 1974.

(Brown 1993) Brown, W.M., "Avian Collisions with Utility Structures: Biological Prospectives." In *Proceedings: Avian Interactions with Utility Structures International Workshop*, Miami, Florida, September 13-16, 1992, prepared by Electric Power Research Institute, Palo Alto, California, December, 1993.

(GDNR 2005) Georgia Department of Natural Resources, Comprehensive Wildlife Conservation Strategy, Southern Coastal Plain, available at http://www.gadnr.org/cwcs/Documents/strategy.html.

(Golden et al. 1980) Golden, J., R. P. Ouellette, S. Saari, and P. N. Cheremisinoff, "Chapter 8: Noise" In *Environmental Impact Data Book* (Second Printing), Ann Arbor Science Publishers, Inc., Ann Arbor, Michigan, 1980.

(Hall, Smith, and Lamprecht 1991) Hall, J. W., T. I. J. Smith, and S. D. Lamprecht, *Movements and Habits of Shortnose sturgeons, Acipenser brevirostrum, in the Savannah River*, Copeia 199(3) 695-702.

(Marcy et al. 2005) Marcy, B.C., D. E. Fletcher, F. D. Martin, M. H. Paller, and M. J. M. Reichert 2005, *Fishes of the Middle Savannah River Basin With Emphasis on the Savannah River Site*, The University of Georgia Press, Athens, Georgia, 2005.

(McCord 2004) American eel (*Anguilla rostrata*), Species account prepared for South Carolina Department of Natural Resources, available at http://www.dnr.state.sc.us/wcp/pdf/American Eel.pdf

(Skelton et al. 2006) Skelton, C.E., J.D. Williams, G.R. Dinkins, and E.M. Schilling, *Inventory of freshwater mussels (Family Unionidae) in the Ogeechee River drainage, Georgia, with emphasis on Atlantic Pigtoe (Fusconaia mason) and other rare taxa*, presented at the 2006 Annual meeting of the North American Benthological Society, Anchorage, Alaska, available at http://www.benthos.org/database/allnabstracts.cfm/db/Anchorage2006abstracts/id/730.

(USACE 2006) U.S. Army Corps of Engineers, *Threatened & Endangered Species of the Upper Savannah River Basin, Atlantic Pigtoe Mussel (Fusconaia mason)*, available at http://www.sas.usace.army.mil/imussel.htm.

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4.4 Socioeconomic Impacts

4.4.1 Physical Impacts

Construction activities can cause temporary and localized physical impacts such as noise, odors, vehicle exhaust, and dust. Vibration and shock impacts are not expected, due to the strict control of blasting and other shock-producing activities. This section addresses potential construction impacts that may affect people, buildings, and roads. Any physical impacts will be small and, therefore, all are presented qualitatively.

The new VEGP Unit 3 and 4 footprint is in an industrial area, surrounded by forests. All construction activities will occur within the construction site boundary. Therefore, impacts on existing VEGP facilities from constructing new units will be small incremental impacts to those associated with their normal operation. The use of public roadways and railways will be necessary to transport construction materials and equipment. The roadways could require some minor repairs or upgrading, such as patching and filling potholes to allow safe equipment access. The railroad was recently upgraded to support the replacement of a transformer, but will be inspected to ensure its condition. However, no extensive work is planned to the existing public roads or railways and no new offsite routes will be required.

4.4.1.1 Groups or Physical Features Vulnerable to Physical Impacts

4.4.1.1.1 People

Approximately 3,500 people live within 10 miles of VEGP. The vicinity is predominately rural and characterized by farmland and wooded tracts. No significant industrial or commercial facilities other than the VEGP nuclear units exist or are planned for the vicinity. Population distribution details are given in Section 2.5.1.

People who could be vulnerable to noise, fugitive dust, and gaseous emissions resulting from construction activities are listed below in order of most vulnerable to least vulnerable:

- Construction workers and personnel working onsite
- People working or living immediately adjacent to the site
- Transient populations (i.e., temporary employees, recreational visitors, tourists)

Construction workers will have adequate training and personal protective equipment to minimize the risk of potentially harmful exposures. Emergency first-aid care will be available at the construction site, and regular health and safety monitoring will be conducted during construction.

People working onsite or living near the VEGP site will not experience any physical impacts greater than those that will be considered an annoyance or nuisance. In the event that atypical or noisy construction activities will be necessary, public announcements or notifications will be provided. These activities will be performed in compliance with local, state, and federal regulations, and site-specific permit conditions.

Fugitive dust and odors could be generated as a result of normal construction activities. Mitigation measures (e.g., paving disturbed areas, water suppression, reduced material handling) will prevent or reduce such occurrences. Additional mitigation control measures will address any nuisance issues on a case-by-case basis. Odors could result from exhaust emissions and will dissipate on site.

Exhaust emissions from construction equipment will have no discernible impact on the local air quality. All equipment will be serviced regularly and operated in accordance with local, state, and federal emission requirements (see Section 4.4.1.3).

Reasonable efforts will be made to ensure that transient populations (mostly sportsmen using the GPC Savannah River boat landing or the Yuchi WMA) are aware of the potential impacts of construction activities. Signs will be posted at or near construction site entrances and exits to make the public aware of the potential for high construction traffic.

4.4.1.1.2 Buildings

Construction activities will not impact any offsite buildings because of distance. The nearest residence is approximately 1 mile from the construction site. In the event that pile driving is necessary, the building(s) most vulnerable to shock and vibration will be those within the VEGP boundary. Onsite buildings have been constructed to safely withstand any possible impacts, including shock and vibration from construction activities associated with the proposed activity. No historically significant buildings (see Section 2.5.3) exist in the VEGP site vicinity.

4.4.1.1.3 Roads

The transportation network in Burke County is already a well-developed system, and will not be significantly physically impacted as a result of construction activities. The construction workforce will use a construction access road, not the VEGP access road. Material transportation routes (haul routes) will be selected based on equipment accessibility, existing traffic patterns, and noise restrictions, logistics, distance, costs, and safety. Methods to mitigate potential impacts include: (1) avoiding routes that could adversely affect sensitive areas (e.g., housing, hospitals, schools, retirement communities, businesses) to the extent possible and (2) restricting activities and delivery times to daylight hours.

No new public roads will be required as a result of construction activities. No public roads will be altered (e.g., widened) as a result of construction activities. Some minor road repairs and improvements in the vicinity of VEGP (e.g., patching cracks and potholes, adding turn lanes, re-enforcing soft shoulders) will be necessary to enable equipment accessibility and reduce safety risks.

The construction site exit onto River Road will be marked clearly with signs maintained such that they are clear of debris and markings are visible. Any damage to public roads, markings, or signs caused by construction activities will be repaired to pre-existing conditions or better.

A new access road to the construction site and a heavy haul route from the barge facility on the Savannah River will support construction activities (Figure 3.1-3). Both will be private and fully contained within the existing site boundary.

Any effects of physical impacts will be SMALL and will not warrant mitigation.

4.4.1.2 Predicted Noise Levels

As presented previously, Burke County is predominantly farmland and wooded tracts. Areas that are subject to farming are prone to seasonal noise-related events such as planting and harvesting. Wooded areas provide natural noise abatement control to reduce noise propagation. Table 4.4.1-1 identifies expected noise levels in the immediate vicinity (less than 10 feet) of operating construction tools.

Noise level attenuates with distance. A 10-dB decrease is perceived as roughly halving loudness; a 10-dB increase doubles the loudness. The noise from an earth mover can be as high as 94 decibels (dB) from 10 feet away, and 82 dB from 70 feet away. A crane lifting a load can make 96 dB of noise; at rest, it may make less than 80 dB. Moderate auto traffic at a distance of 100 feet (30 m) rates about 50 dB. To a driver with a car window open or a pedestrian on the sidewalk, the same traffic rates about 70 dB **(CPWR 2006)**; that is, it sounds four times louder. The level of normal conversation is about 50 to 60 dB.

Section 3.9 discusses noise levels during construction, which could be as high as 110 dB in the immediate area of the equipment. Construction workers will use hearing protection per good construction practices. Noise attenuates quickly with distance (see Table 3.9-1) so that the loudest construction noise will register 60 – 80 dBa 400 feet from the source, and will continue to attenuate with distance.

The exclusion area boundary is greater than ½ mile in all directions from the new Unit 3 and 4 footprint. No major roads, public buildings or residences are located within the exclusion area.

The following controls or similar ones could be incorporated into activity planning to further minimize noise and associated impacts:

- Regularly inspect and maintain equipment to include noise aspects (e.g., mufflers)
- Restrict noise-related activities (e.g., pile driving) to daylight hours
- Restrict delivery times to daylight hours

Impacts from the noise of construction activities will be SMALL and temporary and will not require mitigation.

4.4.1.3 Air Quality

Burke County Georgia is part of the Augusta-Aiken Interstate Air Quality Control Region (AQCR) (40 CFR 81.114). All areas within the Augusta-Aiken AQCR are classified as achieving attainment with the National Ambient Air Quality Standards (NAAQS) (40 CFR 81.311 and 40 CFR 81.341). The NAAQS define ambient concentration criteria for sulfur dioxide (SO_2), particulate matter with aerodynamic diameters of 10 microns or less (PM_{10}), particulate matter with aerodynamic diameters of 2.5 microns or less ($PM_{2.5}$), carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), and lead (Pb). These pollutants are generally referred to as "criteria pollutants." Areas of the United States having air quality as good as or better than the NAAQS are designated by EPA as attainment areas. Areas having air quality that is worse than the NAAQS are designated by EPA as non-attainment areas. The nearest non-attainment area to VEGP is the Columbia, South Carolina metropolitan area, a non-attainment area under the 8-hour ozone standard, which is located approximately 80 miles northeast of the plant.

Temporary and minor impacts to local ambient air quality could occur as a result of normal construction activities. Fugitive dust and fine particulate matter emissions – including those less than 10 microns (PM_{10}) in size, will be generated during earth-moving and material-handling activities. Construction equipment and offsite vehicles used for hauling debris, equipment, and supplies also produce emissions. The pollutants of primary concern include PM_{10} fugitive dust, reactive organic gases, oxides of nitrogen, carbon monoxide, and, to a lesser extent, sulfur dioxides. Variables affecting construction emissions (e.g. type of construction vehicles, timing and phasing of construction activities, and haul routes) cannot be accurately determined until the project is initiated. Actual construction-related emissions cannot be effectively quantified before the project begins. General estimates are available and the impacts on air quality can be minimized by compliance with all federal, state and local regulations that govern construction activities and emissions from construction vehicles.

Specific mitigation measures to control fugitive dust will be identified in a dust control plan, or similar document, prepared prior to project construction. These mitigation measures could include any or all of the following:

- Stabilize construction roads and spoil piles
- Limit speeds on unpaved construction roads
- Periodically water unpaved construction roads to control dust
- Perform housekeeping (e.g., remove dirt spilled onto paved roads)
- Cover haul trucks when loaded or unloaded
- Minimize material handling (e.g., drop heights, double-handling)
- Cease grading and excavation activities during high winds and during extreme air pollution episodes

- Phase grading to minimize the area of disturbed soils
- Re-vegetate road medians and slopes

While emissions from construction activities and equipment will be unavoidable, a mitigation plan will minimize impacts to local ambient air quality and the nuisance impacts to the public in proximity to the project. The mitigation plan will include:

- Phase construction to minimize daily emissions
- Perform proper maintenance of construction vehicles to maximize efficiency and minimize emissions

Impacts to air quality from construction will be SMALL and will not warrant mitigation.

4.4.2 Social and Economic Impacts

This section evaluates the demographic, economic, infrastructure, and community impacts to the region as a result of constructing two Westinghouse AP1000 nuclear units at the VEGP. The evaluation assesses impacts of construction related activities and of the construction workforce on the region.

4.4.2.1 Demography

SNC based the following analyses on the estimated peak construction workforce. SNC assumed that the construction workforce will locate in the 50-mile region in approximately the same proportion as the existing workforce, that is, 79 percent will relocate to Richmond, Columbia, or Burke Counties, and the remainder will be scattered throughout the region. Therefore, this analysis is restricted to the three counties most affected by the construction workforce.

The 2000 population within the 50-mile radius was approximately 670,000 and it is projected to grow to approximately 1,000,000 by 2030, for an average annual growth rate during the ESP banking period of 1.8 percent (see Table 2.5.1-1). SNC anticipates employing 4,400 construction workers at peak construction activity (Table 3.10-2). (Figure 3.10-1 illustrates the distribution of the construction workforce over the construction period.) Based on the information presented in Section 3.10, SNC anticipates that approximately 1,000 workers will already reside within the 50-mile region. The remainder will migrate into the region. Of the peak construction jobs filled by in-migrating workers, 2,700 will last two or more years, and are considered permanent jobs in this analysis. The remainder will be for less than two years and are considered temporary in this analysis (Table 4.4.2-1).

The in-migration of approximately 3,400 workers, will create new indirect jobs in the area because of the multiplier effect. In the multiplier effect, each dollar spent on goods and services by a construction worker becomes income to the recipient who saves some but re-spends the rest. In turn, this re-spending becomes income to someone else, who in turn saves part and re-spends the rest. The number of times the final increase in consumption exceeds the initial dollar spent is called the “multiplier.” The U.S. Department of Commerce Bureau of Economic Analysis, Economics and Statistics Division provides multipliers for industry jobs and earnings **(BEA 2005)**. The economic model, RIMS II, incorporates buying and selling linkages among regional industries and was used to estimate the impact of new nuclear plant-related expenditure of money in the three-county region of interest. For every construction worker, an estimated additional 0.70 jobs will be created in the three-county area (Table 4.4.2-2). **(BEA 2005)**

Construction will create approximately 4,600 permanent (direct + indirect) jobs in 50-mile region, and approximately 1,200 temporary (direct + indirect) jobs. SNC assumes that the indirect jobs created by the temporary construction workforce will also be temporary.

Most indirect jobs are service-related and not highly specialized, so, for this analysis, SNC has assumed that most indirect jobs will be filled by the existing workforce within the 50-mile region, particularly the three-county area, because 79 percent of the workforce is expected to settle there. The total number of indirect jobs that will be generated by construction (approximately 2,400) is approximately 31 percent of the unemployed persons in the three-county region in 2004 (Table 4.4.2-2).

SNC has conservatively assumed that each permanent direct worker will bring a family. The average household size in Georgia is 2.65 people **(USCB 2005)**. Therefore, construction will increase the population in the 50-mile region by 7,200 people (Table 4.4.2-2).

The majority of the current VEGP workforce lives in Burke (20 percent), Richmond (26 percent), or Columbia (34 percent) Counties (Section 2.5). SNC assumes that the residential distribution of the permanent construction workforce will resemble the residential distribution of the current VEGP workforce. Of the total population increase due to the construction workforce, 1,400 people (20 percent of 7,200) will settle in Burke County, 1,900 people will settle in Richmond County, and 2,400 people will settle in Columbia County. These numbers constitute 6 percent, 1 percent, and 3 percent of the 2000 Census populations of Burke, Richmond, and Columbia Counties, respectively.

The construction employees and their families will represent small to moderate increases to Burke County’s total population, small increases to Richmond and Columbia Counties’ total populations, and even smaller increases to the total populations of the other counties in the 50-mile region.

4.4.2.2 Impacts to the Community

This section evaluates the social, economic, infrastructure, and community impacts to the three county area and 50-mile region as a result of constructing new nuclear units at the VEGP. It is expected that site preparation and construction activities will continue for approximately 7 years and employ as many as 4,400 construction workers.

4.4.2.2.1 Economy

The impacts of construction on the local and regional economy depend on the region's current and projected economy and population. The ESP, if approved, will be in effect for 20 years after approval, and construction could begin anytime in that 20 years. For this analysis, the assumed construction schedule projects a construction start date in 2010 with a commercial operation date of 2015 for Unit 3 and 2016 for Unit 4.

As stated previously, the construction workforce will create additional jobs in the region through the multiplier effect of direct employment. The expenditures of the construction workforce in the region for shelter, food and services could, through the multiplier effect of expenditures, also create a number of new jobs. An influx of 3,400 workers migrating into the region would create 2,400 indirect jobs, permanent or temporary, for a total of 5,800 jobs (Table 4.4.2-2).

The employment of such a large workforce over a 7-year period could have small to large positive economic impacts on the surrounding region. The creation of such a large pool of jobs would inject millions of dollars into the regional economy, reducing unemployment and creating business opportunities for housing and service-related industries. Burke County will probably be the most affected. Beyond Burke County, the impacts will become more diffuse as a result of interacting with the larger economic base of other counties, particularly Richmond and Columbia Counties.

The magnitude of the positive economic impacts would be less discernible diffused in the larger economic bases of Richmond and Columbia Counties. Burke County as the site of the construction would be affected more than Richmond and Columbia Counties. SNC concludes that the impacts of construction on the economy of the region would be beneficial and SMALL everywhere in the region except Burke County, where the positive impacts could be MODERATE to LARGE, and that mitigation would not be warranted.

4.4.2.2.2 Taxes

Several types of taxes will be generated by construction activities and purchases and by workforce expenditures, including income taxes on corporate profits and on wages and salaries, sales and use taxes on SNC and employee purchases, property taxes related to the building of new nuclear units, and property taxes on owned real property. Increased taxes collected are viewed as a benefit to the state and the local jurisdictions in the region.

Personal and Corporate Income Taxes

As discussed in Section 2.5.2.3, Georgia has personal and corporate income taxes. Construction workers will pay taxes on their wages and salaries to Georgia if (1) their residence is in Georgia, (2) they are nonresidents working in Georgia and filing a federal return which will include income from sources in Georgia that exceeds five percent of income from all sources, or (3) they have income that is subject to Georgia tax that is not subject to federal income tax.

While the exact amount of income taxes the project will generate for Georgia cannot be known, it could be fairly large over a 7-year pre-construction and construction period.

Corporations undertaking the construction of new nuclear units at the VEGP will pay corporate income taxes on the net income earned from the construction activity. Again, while the exact amount of tax revenue cannot be known, it could be fairly large, in absolute terms, over the 7-year construction period.

In addition, the wages and salaries of the construction workforce will have a multiplier effect, where money will be spent and re-spent within the region. Because of the multiplier effect, businesses, particularly retail and service sector businesses, in the 50-mile region, and particularly in the Augusta-Richmond County, GA-SC, Metropolitan Statistical Area (MSA), will experience an increase in business. This could provide opportunities for new start-up businesses and increased job opportunities. The businesses will generate additional profits and additional employees will receive salaries or wages upon all of which income taxes will be paid.

Sales and Use Taxes

The 50-mile region will experience an increase in the amount of sales and use taxes generated by retail expenditures (restaurants, hotels, merchant sales, and food) of the construction workforce.

The region will also experience an increase in the sales and use taxes collected from construction materials and supplies purchased for the project. It is difficult to assess which counties and local jurisdictions will be most affected, but it is probable that Burke County could receive a large increase in taxes relative to their current tax use given it has a relatively small population.

Property Taxes

VEGP's current tax payments to Burke County represent approximately 80 percent of the total county property tax revenues (see Table 2.5.2-8). SNC has chosen not to estimate tax payments on the new units that will occur during construction. During construction the new units will be assessed at some negotiated valuation that will likely be greater than $0 and less than actual cost. It is likely that this negotiated value will be no more than 50 percent of the invested capital each year. The owners will pay some taxes to Burke County during the 5-year construction period.

A second source of revenue from property taxes will be housing purchased by the permanent construction workforce. In-migrating workers will construct new housing or increase the demand for existing housing, which will drive housing prices up, increasing values (and property taxes levied). The increased housing demand will have little effect on tax revenues in the more heavily populated jurisdictions but in rural Burke County, the effects could be more significant.

Summary of Tax Impacts

In summary, the amount of income taxes collected over a potential 7-year pre-construction/construction period could be large in absolute amount, but small when compared to the total amount of taxes that Georgia and South Carolina collect in any given year or in a 7-year period. In absolute terms, the amount of sales and use taxes collected over a potential 7-year construction period could be large, but small when compared to the total amount of taxes collected by Georgia, South Carolina, and the governmental jurisdictions within the region. However, given its smaller economic base, Burke County could be the exception and the sales and use taxes collected could have a moderate impact. The construction site-related property taxes collected and distributed to Burke County will be large when compared to the total amount of taxes Burke County collects in any given year or will collect over the 7-year construction term. Also, Burke, Richmond, and Columbia Counties will benefit from an increase in housing values and inventory caused by the influx of the permanent construction workforce, thereby increasing the counties' property tax revenues. Therefore, SNC concludes that the potential beneficial impacts of taxes collected during construction will be LARGE in Burke County and SMALL in Richmond and Columbia Counties and the remainder of the 50-mile region and that mitigation will not be warranted.

4.4.2.2.3 Land Use

In the Generic Environmental Impact Statement (*GEIS) for License Renewal of Nuclear Plants* (NUREG-1437, 1999), the NRC presents their method for defining the impact significance of offsite land use during refurbishment (i.e. large construction activities). SNC reviewed this methodology and determined that the significance levels were appropriate to apply to an assessment of off-site land use impacts as a result of new construction. Burke County is the focus of the land use analysis because the new units will be built there and approximately one-fifth of the construction workforce will reside there. Even higher percentages of the workforce will live in Richmond and Columbia Counties, but those counties are heavily populated and land use changes there are influenced by a variety of other socioeconomic forces. Those forces will dilute potential land use impacts created by the construction of the new units.

In NUREG-1437, the NRC concluded that land-use changes [during refurbishment] at nuclear plants would be:

Small - if population growth results in very little new residential or commercial development compared with existing conditions and if the limited development results only in minimal changes in the area's basic land use pattern.

Moderate - if plant-related population growth results in considerable new residential and commercial development and the development results in some changes to an area's basic land use pattern.

Large - if population growth results in large-scale new residential or commercial development and the development results in major changes in an area's basic land-use pattern.

Further, NRC defined the magnitude of population changes as follows:

Small - if plant-related population growth is less than five percent of the study area's total population, especially if the study area has established patterns of residential and commercial development, a population density of at least 60 persons per square mile, and at least one urban area with a population of 100,000 or more within 50 miles.

Moderate - if plant-related growth is between five and 20 percent of the study area's total population, especially if the study area has established patterns of residential and commercial development, a population density of 30 to 60 persons per square mile, and one urban area within 50 miles.

Large - if plant-related population growth is greater than 20 percent of the area's total population and density is less than 30 persons per square mile.

Land Use in the Area

At 830 sq mi **(USCB 2006)** Burke County has the second largest land area of any county in Georgia and includes six small incorporated municipalities and a very large unincorporated area. The predominant land uses are agriculture and forestry (76 percent of the unincorporated area in the County in 1990) (Section 2.2). In 1990, developed areas represented approximately 6 to 7 percent of the total land area in the County (Section 2.2). Most industry is related to forestry and manufacturing and no new industries have been located in the area as a result of the VEGP's presence. The majority of the current VEGP workforce does not live in Burke County.

As stated in Sections 2.2 and 2.5.2.4, Burke County and municipalities within the County use comprehensive land use planning, land development codes, zoning, and subdivision regulations to guide development. From 1990 to 2000, the Burke County population grew at an average annual growth rate of 0.8 percent. The County encourages growth in areas where public facilities, such as water and sewer systems, exist or are scheduled to be built in the future. Burke County promotes the preservation of its communities' natural resources and has no growth control measures. The County is revising its comprehensive plan and developing a zoning plan.

Construction-Related Population Growth

Construction of VEGP Units 1 and 2 had large indirect impacts on the economy in Burke County, as evidenced by an upswing in residential and commercial activity, but those were temporary and the economy returned to pre-construction levels when construction was completed.

As stated in Section 2.5.1, the 2000 population of Burke County was 22,243 with a population density of 27 persons per square mile. At peak, construction-related population growth in Burke County will reach 1,400 people (workers and families, Section 4.4.2.1). According to NRC guidelines, construction-related population changes will be considered MODERATE as plant-related population will be six percent of Burke County's total population, the area has an established pattern of residential and commercial development, a population density of at nearly 30 persons per square mile, and at least one urban area with a population of 100,000 or more (Augusta: 195,182) within 50 miles.

The increase in population from the construction workforce will be small in Richmond, Columbia, and other counties in the region. Using 2000 Census data, Richmond has a population density of 609 people per square mile and the construction population will increase the total population less than 1 percent. Columbia County has a population density of 251 people per square mile and the in-migrating construction workforce would increase its population by 2.6 percent.

Conclusion

From a land use perspective, Burke County is still predominantly rural, and land in the County will likely continue to be used for agriculture and forestry into the foreseeable future. Commercial and residential development is minimal and has experienced little change. Similar to the construction of the existing VEGP units, the construction of two Westinghouse AP1000 units will create a temporary upswing in residential and commercial activity, possibly converting some land to other uses, such as trailer parks, convenience stores, hotel/motel property, etc. Some construction workers may become long-term residents, staying two or more years. However, SNC estimates based on the Units 1 and 2 construction experience, upon project completion most in-migrating construction workers and their families will leave the 50-mile radius, and residential and commercial activity will return to pre-construction levels. Therefore, employing NRC criteria, off-site land use changes will be considered SMALL in all surrounding counties with the exception of Burke County, where impacts will be MODERATE, but temporary, and will not warrant mitigation.

4.4.2.2.4 Transportation

Impacts of the proposed construction on transportation and traffic will be most obvious on the rural roads of Burke County, particularly River Road, a two-lane highway which provides the only access to VEGP. Impacts of construction on traffic are determined by five elements: (1) the number of construction workers and their vehicles on the roads; (2) the number of shift changes for the construction workforce; (3) the number of truck deliveries to the construction site; (4) the projected population growth rate in Burke County, the county most affected by the construction; and (5) the capacity of the roads.

For this analysis, SNC has assumed that there will be four construction shifts and each shift will include 25 percent of the total construction workforce. While it is a common practice for construction workers to car pool, this analysis conservatively assumes one worker per vehicle. In addition to construction workers, SNC estimated approximately 100 truck deliveries will be made daily to the construction site. Both truck deliveries and construction worker vehicles will enter the site via the Construction Access Road (Figure 3.1-3). The construction workforce, the existing units' workforce (and outage workforces) will all access the VEGP site via River Road.

Georgia Department of Transportation (GDOT) assumes road capacity on two lane highways to be 1,700 passenger cars per hour (pc/h) for one direction and 3,200 pc/h for both directions combined **(TRB 2000)**. GDOT considers tractor trailers as equivalent to 3 to 3½ passenger vehicles. Smaller trucks such as cement trucks and other delivery trucks could be considered the equivalent of two passenger vehicles. Traffic on River Road north of VEGP, as measured by the 2004 Average Annual Daily Traffic (AADT) was 1,277 in one direction (see Table 2.5.2-6 and Figure 2.5.2-2; location 33). Most traffic on River Road is related to VEGP, although there is some local traffic.

SNC doubled the 2004 AADT unidirectional count on River Road to arrive at an estimate of 2,554 vehicles on River Road north of the VEGP site in a single 24-hour period. For purposes of analysis SNC assumed that 100 percent of the 2,554 vehicles were attributable to the current VEGP workforce (60 percent day shift; 30 percent night shift; 10 percent graveyard shift). The AADT does not consider hourly traffic volume. After conservatively assuming that all traffic is due to VEGP workers, SNC assumed that all traffic on River Road occurred during shift change. SNC assumes that the afternoon shift change results in the highest hourly traffic count as approximately 800 day shift workers leave and 400 night shift workers arrive. Therefore, SNC used 1,200 cars per hour as the basis of predicting the impacts of construction traffic.

The 2000 Burke County population was 22,243 (Table 2.5.1-4) and is expected to increase by 10 percent by 2010, the earliest date SNC estimates construction activities can begin, however because most of the traffic on River Road is plant-related and because of the conservative assumptions SNC has made regarding the timing of VEGP traffic on River Road, local traffic was not factored into the analysis.

The capacity of River Road is 3,200 cars per hour, so there is enough capacity for an additional 2,000 passenger cars or equivalent beyond the current 1,200 cars per hour use now. For the proposed construction, road capacity could be reached during Year 2 of construction and exceeded through Year 5 (month 50) (Table 4.4.2-4).

In addition to the operations and construction work force analyzed above, an average outage work force of approximately 800 workers for the current VEGP Units 1 and 2 uses River Road for approximately 1 month during every refueling outage (which occur on 18 month schedules for each reactor).

Construction workers will have a MODERATE to LARGE impact on the two-lane highways in Burke County, particularly River Road and the highways that feed into it. Mitigation may be necessary to accommodate the additional vehicles on Burke County roads, particularly River Road.

Mitigation measures will be included in a construction management traffic plan developed prior to the start of construction. Potential mitigation measures could include installing turn lanes at the construction entrance, establishing a centralized parking area away from the site and shuttling construction workers to the site in buses or vans, encouraging carpools, and staggering construction shifts so they don't coincide with operational shifts. SNC could also establish a shuttle service from the central Augusta area, where many of the construction workforce is likely to settle. The operations work force will continue to enter the plant at the current entrance on River Road which has a left turn lane allowing through north-south traffic to pass, alleviating congestion at that entrance.

4.4.2.2.5 Aesthetics and Recreation

As part of construction, the approximately 500-acre new Units 3 and 4 footprint will be cleared and excavated, temporary roads and a barge facility will be constructed, and heavy equipment will be brought to the site. Most of the clearing will be at the location of the new units, however, approximately 12.5 acres of river shoreline will be cleared, excavated, and graded for the water intake structure, approximately 10 acres will be cleared and graded for the barge facility, and discharge pipe. The two construction sites will be approximately 1,500 feet apart. The clearing and excavation for the new units and adjacent support facilities will not be visible from offsite roads. However, clearing and construction activities for the riverfront facilities will be visible from the river. SNC will use best management practices to prevent erosion and sedimentation, including seeding bare earth, but the affected riverfront will clearly be a construction site for the duration of the time necessary to build the barge dock and intake and discharge structures. Construction of the reactors will require a 250-foot tall crane tower. The steel tower could be visible from the River Road and the Savannah River, but because it has an open structure does not significantly impact the aesthetes at the site or the surrounding area. Because the aesthetic impacts of construction will be localized and because that reach of the river is not popular for recreational boating except by fishermen, SNC has determined that impacts will be SMALL and not warrant mitigation.

The Yuchi WMA is immediately south of the SNC property. GPC has a boat landing on the Savannah River downstream of the VEGP property. The WMA is used by hunters and the boat landing by fishermen during the appropriate seasons. Use of the WMA/boat landing is seasonal and it will be unlikely that hunters and fishermen will be on River Road at the same time as the construction shifts. Construction impacts such as noise, and air pollutants will be limited to the VEGP site and will not be noticeable from offsite. Construction will not affect any other recreational facilities in the 50-mile region. Impacts will be SMALL and will not warrant mitigation.

4.4.2.2.6 Housing

Rental property is scarce in the rural counties in proximity to VEGP, but is more plentiful supply in the larger municipalities such as Augusta, North Augusta, Martinez, and Evans. Generally, the counties with larger populations (Richmond and Columbia Counties) have more available vacant housing. Tables 2.5.2-10 and 2.5.2-11 detail housing in Burke, Richmond, and Columbia Counties.

Impacts on housing from the construction workforce depend on the number of workers already residing within the 50-mile region and the number that will relocate and require housing.

Based on assumptions presented in Table 4.4.2-1, approximately 3,400 construction workers will in-migrate to the 50-mile region. Of these, approximately 2,700 will purchase or rent permanent housing. Of these, approximately 540 workers will settle in Burke County. The 680 temporary workers will rent temporary (e.g., hotels, motels, rooms in private home) or permanent housing, or bring their own housing in the form of campers and mobile homes.

In 2000, there were 4,466 vacant rental units and 1,997 vacant housing units for sale in Burke, Richmond, and Columbia Counties. SNC estimates that, in absolute numbers, the available housing would be sufficient to house the permanent and temporary construction workforce. However, there may not be enough housing of the type desired by the workers in any of the three counties of interest, especially Burke County. In this event, workers would relocate to other areas within the 50-mile region, have new homes constructed, bring their own housing, or live in hotels and motels. Given this increased demand for housing, prices of existing housing could rise to some degree. Burke County (and other counties to a lesser extent) will benefit from increased property values and the addition of new houses to the tax rolls. Increasing the demand for homes could increase rental rates and housing prices. It is possible that some low-income populations could be priced out of their rental housing due to upward pressure on rents. The increased demand for housing could increase new home construction and temporary housing. With time market forces will increase the housing supply to meet demand. Construction employment would increase gradually, reaching the peak of 4,400 workers after four to five years (Table 4.4.2-4), allowing time for market forces to accommodate the influx, causing housing prices and rental rates to stabilize.

Because Burke County contains the proposed construction site, has a small population, and has a relatively small economy, its housing market would likely be the most impacted. Richmond and Columbia Counties' housing markets would also experience an impact, though not as large.

The greatest shortage of housing would be in Burke County and there could be upward pressure on rents and housing prices. Richmond and Columbia Counties would experience a similar impact, though to a lesser extent. The majority of these impacts will be mitigated by normal market forces and impacts caused by housing temporary workers in temporary housing will cease when construction is complete. SNC concludes that the potential impacts on housing will be SMALL in Richmond and Columbia Counties and MODERATE to LARGE in Burke County and that mitigation would not be warranted where the impacts were small. Mitigation of the moderate impacts will most likely be market- driven.

4.4.2.2.7 Public Services

Water Supply Facilities

SNC considered both construction demand and population increases on local water resources. Construction could bring as many as 7,200 people to the region. Peak onsite construction workforce could be as high as 4,400 workers. The average per capita water usage in the U.S. is 90 gallons per day per person. Of that, 26 gallons is used for personal use **(EPA 2003)**. The balance is used for bathing, laundry and other household uses.

VEGP does not use water from a municipal system. Onsite wells provide potable water, and will provide the water for the construction project as well. Therefore, water usage by the workforce, while onsite, will not impact municipal water suppliers. The VEGP wells pump an average of 1.052 million gallons of water per day for all uses (Section 4.2.2). VEGP is permitted to take an annual average of 5.5 million gallons of groundwater per day. During peak construction, an additional 4,400 people on site could increase potable consumption by a maximum of 114,400 gpd (4,400 x 26 gpd) for personal use. Estimated maximum construction use is 420 gpm (Section 4.2.2) for batch plant operations, dust abatement and potable needs. Therefore, SNC conservatively estimated that total daily groundwater usage during construction, including usage by the existing VEGP units, will be 1.8 million gpd, well within the permitted limits. However, in reality, potable water consumption will be less because most of the construction workforce will have access to stand-alone drinking water stations, and portable toilets, and 420 gpm will be peak use during batch plant operation, rather than continuous use. Construction impacts to VEGP groundwater use will be SMALL and will not warrant mitigation.

Municipal water suppliers in the region have excess capacity (see Table 2.5.2-12). The impact to the local water supply systems from construction-related population growth can be estimated by calculating the amount of water that will be required by total population increase. The average person in the U.S. uses about 90 gpd **(EPA 2003)**. Construction-related population increase of 7,200 people could increase consumption by 648,000 gpd in a region where the excess public water supply capacity from groundwater in Burke County, alone, is approximately 3,000,000 gpd and aquifer yields of 2,000 gpm are common. Impacts of the in-migrating construction workforce on municipal water supplies will be SMALL and will not warrant mitigation.

Waste Water Treatment Facilities

VEGP has a private wastewater treatment facility sized for the two existing units. As part of the new units' construction project, the facility will be expanded to support the increased capacity due to construction and the additional units. During construction the temporary office and warehouse facilities will be tied in to the existing facility. In addition, portable toilets will be provided in the construction area. Therefore, construction will not impact the VEGP wastewater treatment facility.

Section 2.5.2.7 describes the public waste water treatment systems in the three counties, their permitted capacities, and current demands. Waste water treatment facilities in the three counties have excess capacity (see Table 2.5.2-13). The impact to local waste water treatment systems from construction-related population increases can be determined by calculating the amount of water that will be used and disposed of by these individuals. The average person in the U.S. uses about 90°gpd **(EPA 2003)**. To be conservative, SNC estimates that 100 percent of this water will be disposed of through the waste water treatment facilities. The construction-related population increase of 7,200 people could require 648,000 gpd of additional waste water treatment capacity in an area where the excess treatment capacity is approximately 19 million gpd. Impacts of the in-migrating construction workforce on waste water treatment facilities in the region will be SMALL and will not warrant mitigation.

Police, Fire, and Medical Facilities

In 2001, Burke, Richmond, and Columbia Counties' persons per police officer ratios were 271:1, 998:1, and 992:1, respectively (see Table 2.5.2-14). Burke County has the largest police force relative to the size of its population. Local planning officials state that police protection is adequately provided throughout the Central Savannah River Area (CSRA) region, but future expansions and facility upgrades may be needed to accommodate future population growth and advancements in technology (CSRARDC 2005). SNC does now and will continue to employ its own security force at VEGP.

The construction project will produce an influx of approximately 1,400 new residents to Burke County. Approximately 1,900 new residents will move into Richmond County, and approximately 2,400 will move into Columbia County. The rest of the construction workforce and families will live in other counties in the 50-mile region. These population increases will increase the persons per police officer ratios slightly (Table 4.4.2-5). The percent increase in ratio attributed to construction will be 6, 1, and 3 percent in Burke, Richmond, and Columbia counties, respectively.

Based on the percentage increase in "persons per police officer" ratios, the impact of the construction on police services will be insignificant in Richmond and Columbia Counties. In Burke County, however, the percentage increase in "persons per police officer" ratio will be significant. Therefore, SNC concludes that the potential impacts of construction on police services in Richmond and Columbia Counties will be SMALL and that mitigation will not be warranted in those counties. SNC concludes that the potential impacts on police services will be MODERATE in Burke County and will most likely be mitigated by using increased property tax revenues from the construction project to fund additional police manpower and facilities.

This conclusion is based in part on an analysis NRC performed of nuclear plant refurbishment impacts based on impacts sustained during original plant construction (in NUREG-1437). NRC selected seven case study plants whose characteristics resembled the spectrum of nuclear plants in the United States today. NRC reported that, "(n)o serious disruption of public safety services occurred as a result of original construction at the seven case study sites. Most communities showed a steady increase in expenditures connected with public safety departments. Tax contributions from the plant often enabled expansion of public safety services in the purchase of new buildings and equipment and the acquisition of additional staff."

In 2000, Burke, Richmond, and Columbia Counties' persons per firefighter ratios were 890:1, 666:1, and 676:1, respectively (Table 2.5.2-14). The construction project will produce an influx of approximately 1,400 new residents to Burke County. Approximately 1,900 new residents will move into Richmond County, and approximately 2,400 will move into Columbia County. The rest of the construction workforce and families will live in other counties in the 50-mile region. These population increases will increase the persons per firefighter ratios slightly (Table 4.4.2-6). The percent increase in ratio attributed to construction will be 6, 1, and 3 percent in Burke, Richmond, and Columbia Counties, respectively. Local planning officials state that fire protection may be under-funded in some counties. Burke County has the highest "persons per firefighter" rate and a relatively high fire insurance rating. Local officials state that high fire insurance ratings and below-expected fire expenditures indicate a need for additional funding for manpower and equipment for fire protection services in Burke County **(CSRARDC 2005)**. Local planners consider Burke County fire fighting capabilities under-staffed and under-equipped.

At 1 and 3 percent in Richmond and Columbia Counties, respectively, the percent increase in "persons per firefighter" ratio attributed to construction is not considered significant. At 6 percent in Burke County, the percent increase in "persons per firefighter" ratio is considered significant.

The construction workforces and their families will not have a significant impact on existing fire protection services in Richmond and Columbia Counties. Therefore, SNC concludes that the potential impacts of nuclear plant construction on fire protection services in Richmond and Columbia Counties will be SMALL and that mitigation will not be warranted. SNC concludes that the potential impacts on fire protection services will be MODERATE in Burke County and will most likely be mitigated by using increased property tax revenues to fund additional firefighters and facilities. As with the analysis of the adequacy of police protection the conclusions of this analysis are based in part on NRC's review of original construction impacts on public services. As stated in the previous section, in NUREG-1437, NRC performed an analysis of nuclear plant refurbishment impacts based on impacts sustained during original plant construction. NRC reported that, "(n)o serious disruption of public safety services occurred as a result of original construction at the seven case study sites. Most communities showed a steady increase in expenditures connected with public safety departments. Tax contributions from the plant often enabled expansion of public safety services in the purchase of new buildings and equipment and the acquisition of additional staff." Based on this statement, SNC concludes that the moderate impacts to fire protection services in Burke County would be mitigated by the increase in tax contributions made by the owners of the plant to the local taxing jurisdictions. It is noted that local planners state that Burke County is already under-staffed and under-equipped in its firefighting capabilities.

Detailed information concerning the medical services in the three-county region is provided in Section 2.5.2.7. Minor injuries to construction workers will be assessed and treated by onsite medical personnel. Other injuries will be treated at one of the hospitals in the three-county region, depending on severity of the injury. For the existing VEGP workforce, agreements are in place with some local medical providers to support emergencies. SNC will reach similar agreements to provide emergency medical services to the construction workforce. Construction activities should not burden existing medical services.

The medical facilities in the three-county region provide medical care to much of the population within the 50-mile region. The peak construction workforce will increase the population in the 50-mile region by less than 1 percent. The potential impacts of construction on medical services will be SMALL and mitigation will not be warranted.

Social Services

This section focuses on the potential impacts of construction on the social and related services provided to disadvantaged segments of the population. This section is distinguished from environmental justice issues, which are discussed in Section 4.4.3.

Construction could be viewed as economically beneficial to the disadvantaged population served by the Department of Human Resources. The constructing contractor could hire local unemployed people, thus improving their economic position, and decreasing their need for the services provided by the Department of Human Resources. At a minimum, the spending by the construction workforce for goods and services will have a multiplier effect, increasing the number of jobs that could be filled by the economically disadvantaged.

SNC concludes that the potential impacts of construction on the demand for social and related services will be SMALL and positive and will not warrant mitigation.

4.4.2.2.8 Education

SNC assumes that 2,700 of the peak construction workforce will relocate to the 50-mile region with their families, increasing the population by approximately 7,200 people. Approximately 20 percent will settle in Burke County, 26 percent in Richmond County, and 34 percent in Columbia County. The remaining 20 percent will be distributed across the 25 other counties within the region.

In Georgia 26.5 percent of the population is under 18 years old (Table 2.5.1-5). Therefore, SNC conservatively estimates that in a construction-workforce related population of 7,200, approximately 1,900 will be school-aged. Table 4.4.2-7 applies the population distribution percentage assumptions to the number of school-aged children in the construction workforce population to estimate the number of construction workforce-related school-aged children in each of the three counties.

It is likely that the Richmond and Columbia County school systems could accommodate the increase in student population. The analysis is based on the peak construction workforce, which will not be reached sooner than the third year of construction, giving schools several years to make accommodations for the additional influx of students.

Additionally, Richmond and Columbia Counties plan to build additional schools before the construction period begins (although they have no plans to include space for these hypothetical students). The impact to these counties will be SMALL. The Burke County student population could increase by 9 percent, which will be a MODERATE impact on its education system and will require mitigation. Burke County is not planning to construct additional schools.

The quickest mitigation will be to hire additional teachers and move modular classrooms to existing schools. Increased property and special option sales tax revenues as a result of the increased population, and, in the case of Burke County, property taxes on the new reactors, will fund additional teachers and facilities. No additional mitigation will be warranted.

4.4.3 Environmental Justice Impacts

Environmental justice refers to a Federal policy under which each Federal agency identifies and addresses, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority or low-income populations. The NRC has a policy on the treatment of environmental justice matters in licensing actions (69 FR 52040).

SNC evaluated whether the health or welfare of minority and low-income populations could be disproportionately adversely affected by potential impacts.

SNC located minority and low-income populations within the 50-mile radius of VEGP (Figures 2.5.4-1 through 2.5.4-4). VEGP is in a predominantly Black Races census block group, and adjacent census block groups also have predominantly Black Races populations.

SNC identified the most likely pathways by which adverse environmental impacts associated with construction at the VEGP site could affect human populations. Exhaust emissions from construction equipment and dust will cause minor and localized adverse impacts to air quality; however, the air quality at the site boundary will not be affected. No contaminants, including sediments, are expected to reach the Savannah River because all construction will be done using Best Management Practices as discussed in Section 3.9. Land use impacts could occur in Burke County, as the influx of construction workers could cause landowners to convert some undeveloped land to other uses, such as trailer parks, convenience stores, hotel/motel property, etc. Local low-income and minority populations could benefit by gaining access to new services or employment at them. However, the new uses are considered temporary, as completion of the construction project will eliminate the demand for the services. Traffic could increase beyond the capacity of some local roads, but SNC will mitigate impacts by encouraging car pooling, providing van pools, or staggering work shifts. The large construction project likely will provide additional temporary jobs for some of the unemployed work force, thus decreasing their need for social services, and freeing funding up for other populations in need. Burke County's police and fire protection services will be impacted by the increase in population due to construction, but the increase in property tax revenues as a result of the construction project will fund facilities, equipment, and additional personnel to meet these needs. The local Burke County school systems will be adversely affected by an influx of new students, however the additional property tax revenues will fund additional teachers and facilities. Rental housing rates could increase, potentially displacing low-income renters. However, it is unlikely the construction workforce will need low-income housing. Except for increased rental housing rates no adverse impacts in Burke County will disproportionably affect minority or low-income populations.

Impacts in the other counties in the 50-mile region of interest will be all SMALL.

SNC also investigated the possibility of subsistence-living populations in the vicinity of VEGP by contacting local government officials, the staff of social welfare agencies, and local businesses concerning any known unusual resource dependencies or practices that could result in potentially disproportionate impacts to minority and low-income populations. SNC asked about the presence of minority, low-income, or migrant populations of particular concern, and whether subsistence living conditions were evident. No agency reported such dependencies or practices, as subsistence agriculture, hunting, or fishing, through which the populations could be disproportionately adversely affected by the construction project.

Construction-related moderate adverse impacts were identified in Burke County. However, except for increased rental housing rates, no adverse impacts in Burke County will disproportionately affect minority or low-income populations. Impacts in the other counties in the 50-mile region of interest will all be SMALL. Mitigation beyond that previously described will not be warrented .

Table 4.4.1-1 Equipment and Approximate Noise Level in the Immediate Vicinity of the Equipment[1]

Equipment	Noise Level (dB) within 10 ft
Pneumatic chip hammer	103-113
Earth tamper	90-96
Jackhammer	102-111
Crane	90-96
Concrete joint cutter	99-102
Hammer	87-95
Skilsaw	88-102
Gradeall	87-94
Front-end loader	86-94
Bulldozer	93-96
Backhoe	84-93

1 Source: **(CPWR 2006)**

Table 4.4.2-1 Construction Workforce for the VEGP Site

Construction Workforce	AP1000 2 units
Total peak workforce	4,400
Number of available local skilled craft labor who will join the project[1]	1,000
In-migrate	3,400
80% will stay more than 2 years[2]	2,720
20% will stay less than two years[3]	680

1 Based on the assumption used for large construction projects that approximately 20 to 25 percent of the local skilled craft workforce will join the project
2 In the analysis in Chapter 4, these are considered permanent residents
3 In the analysis in Chapter 4, these are considered temporary residents

Table 4.4.2-2 Impacts of the Construction Workforce on Three Counties of Interest

Demographic	AP1000 2 Units
In-migrating Construction Workforce Peak	3,400
Permanent	2,700
Temporary	680
Indirect Jobs	
Permanent (2,700 x 0.70)	1,900
Temporary (680 x 0.70)	480
2004 unemployed in three counties[1]	7,800
Total number of indirect jobs as a percent of unemployed population in 3-county area	31%
New Residents	
50-mile region (2,700 x 2.65)	7,200
Burke County – 20%	1,400
Richmond – 26%	1,900
Columbia – 34%	2,400

1 See Table 2.5.2-3

Table 4.4.2-4 Number of Construction Workforce Passenger Cars/Hour on River Road During Shift Changes During Construction

Construction Phase	Timeline by Month	Number of Workers	Number of Construction Workforce Passenger Cars on the two-lane highways during shift change, both directions
Preconstruction - 18-Month Duration			
First month of preconstruction	Month -18	80	40
Final month of preconstruction	Month -1	2,175	1,087
Construction - 66-Month Duration			
Year 1	Month 5	3,045	1,088
Year 2	Month 17	4000	2000
Year 3	Month 28-36	4,400	2,200
Year 5	Month 49-50	4,000	2,000
Year 6	Month 62	3,000	1,500
	Month 64	2,000	1,000
	Month 65	1,000	500
	Month 66	500	250

Note: Shaded months represent peak construction workforces during each phase.

Table 4.4.2-5 Police Protection in the Three Counties of Interest, Adjusted for the Construction Workforce and Associated Population Increase

County	Total Population in 2000	Additional Population Due to New Plant Construction	Total Population	Police Protection in 2001[1]	Persons per Police Officer Ratio	Percent Increase from 2001 Persons per Police Officer Ratio
Burke	22,243	1,400	23,643	82	288:1	6
Richmond	199,775	1,900	201,675	200	1,008:1	1
Columbia	89,288	2,400	91,688	90	1,019:1	3

1 Source: **CSRARDC 2005**

Table 4.4.2-6 Fire Protection in the Three Counties of Interest, Adjusted for the Construction Workforce and Associated Population Increase

County	Total Population In 2000	Additional Population Due to New Plant Construction	Total Population	Firefighters (Full time and Volunteer) in 2001[1]	Persons per Firefighter	Percent Increase from Current Persons per Firefighter Ratio
Burke	22,243	1,400	23,643	25	946:1	6
Richmond	199,775	1,900	201,675	300	672:1	1
Columbia	89,288	2,400	91,688	132	695:1	3

[1] Source: **CSRARDC 2005**

Table 4.4.2-7 Estimated Additional Public School Age Students in the Three-County Region as a Result of Construction

County	Construction-Related Population Increase	Construction-related Population under age 18	Percentage of Additional Public School Children per County
Burke	1,400	382	9
Richmond	1,900	496	1
Columbia	2,400	649	3

Section 4.4 References

(BEA 2005) U.S. Bureau of Economic Analysis, "Re: RIMS II Multipliers for the Augusta, GA Region," Regional Economic Analysis Division, Economics and Statistics Administration, August 8, 2005.

(CPWR 2006) Center to Protect Worker's Rights, "Construction Noise Hazard Alert," available at http://www.cpwr.com/hazpdfs/kfnoise.PDF, Accessed March 24, 2006.

(CSRARDC 2005) Central Savannah River Area Regional Development Center, *Draft Central Savannah River Area Regional Plan, 2005-2025, Technical Staff Report,* "Community Facilities", March, 2005.

(EPA 2003) U.S. Environmental Protection Agency, Water on Tap: What You Need to Know, EPA 815- K-03-007, Office of Water, Office of Water, Washington, DC, 2003.

(TRB 2000) Transportation Research Board, *Highway Capacity Manual*, National Academics of Science, Washington DC. 2000.

(GPC 1973) Georgia Power Company, *Environmental Report for Alvin W. Vogtle Nuclear Plant Units 1, 2, 3, and 4*, Atlanta, Georgia, 1973.

(USCB 2005) U.S. Census Bureau, *State and County Quickfacts, Georgia and South Carolina,* U.S. Census Bureau, 2005, available at http://www.census.gov/, Accessed August 10, 2005.

(USCB 2006) U.S. Census Bureau, *State and County Quickfacts, Burke County, Georgia*, available at http://www.quickfacts.census.gov, Accessed July 13.

4.5 Radiation Exposure to Construction Workers

4.5.1 Site Layout

The physical location of the new units relative to the existing units VEGP is depicted on Figure 3.1-3. As shown, the new units will be immediately west of the existing units. Construction activity will take place outside the existing protected area, but inside the restricted area boundary.

4.5.2 Radiation Sources

During the construction of the new units, the construction workers could be exposed to radiation sources from the routine operation of the existing units as described in the following paragraphs.

4.5.2.1 Direct Radiation

The existing units' principal sources contributing to direct radiation exposure at the construction site include the reactor buildings and the planned Independent Spent Fuel Storage Installation (ISFSI), which will be located west of the existing Unit 2 (See Figure 3.1-3). Because the primary sources of gamma-emitting radioactivity associated with the existing units are contained within heavily shielded areas or containers, external radiation doses from these facilities are expected to be indistinguishable from background.

4.5.2.2 Gaseous Effluents

Sources of gaseous releases for the existing units are currently confined to six paths: plant vents (Unit 1 and Unit 2), the condenser air ejector, the steam packing exhauster systems (Unit 1 and Unit 2), Radwaste Processing Facility and the DAW (Dry Active Waste Building). Waste gas decay tanks are batch released through the Unit 1 plant vent. The containment purges are released through their respective plant vents. **(SNC 2004a)**

The annual releases for 2003 were reported as 3.09 curies of fission and activation products, 0 curies of I-131, 1.79×10^{-5} curies of particulates with half-lives greater than eight days, and 56.9 curies of tritium **(SNC 2004a)**. The annual releases for 2003 are typical for the existing units.

4.5.2.3 Liquid Effluents

Effluents from the liquid waste disposal system result in small amounts of radioactivity in the Savannah River. The annual liquid radioactivity releases for 2001 were reported as 0.0992 curies of fission and activation products, 1,930 curies of tritium, and 0.00219 curies of dissolved and entrained gases **(SNC 2004a)**. The annual releases for 2001 are typical for the existing units.

4.5.3 Measured and Calculated Dose Rates

The measured or calculated dose rates used to estimate worker dose are presented below.

4.5.3.1 Direct Radiation

The average accumulated exposure from VEGP Protected Area internal and general area thermoluminscent dosimeters (TLDs) over a 365 day period is 50 mrem. The average Environmental Plant Site Boundary TLD exposure over a 365 day period is 13 mrem. The measured radiation dose from the internal and general area TLDs minus the Environmental Plant Site Boundary TLDs, is:

50 mrem per year – 13 mrem per year = 37 mrem per year

The estimated dose to construction workers from the planned ISFSI is estimated to be 15 mrem per year for the Unit 3 construction workforce and negligible for the Unit 4 construction workforce**.** SNC will put the ISFSI in service during the final months of Unit 3 construction, therefore doses to construction workers from the ISFSI will be for only a short time, and less than that estimated for a year of exposure. The highest direct radiation dose to construction workers will be during Unit 3 construction and is estimated to be 51 mrem per year.

4.5.3.2 Gaseous Effluents

The Annual Radioactive Effluent Release Report for 2003 **(SNC 2004a)** indicates a total body dose of 3.66×10^{-4} millirem, and a critical organ dose of 3.66×10^{-4} millirem to the maximally exposed member of the public due to the release of gaseous effluents from the existing units, calculated in accordance with the existing units' Offsite Dose Calculation Manual **(SNC 2004b)**.

4.5.3.3 Liquid Effluents

The Annual Radioactive Effluent Release Report for 2003 **(SNC 2004)** reports a whole body dose of 0.0684 millirem and a critical organ dose of 0.0749 millirem to the maximally exposed member of the public due to the release of liquid effluents from the existing units, calculated in accordance with the existing units' Offsite Dose Calculation Manual **(SNC 2004b)**.

4.5.4 Construction Worker Doses

Construction worker doses were conservatively estimated using the following information (see Section 4.4.2):

- The estimated maximum dose rate for each pathway
- An exposure time of 2080 hours per year
- A peak loading of 4,400 construction workers per year total for two AP1000 units

The estimated maximum annual dose for each pathway as well as the total dose is shown in Table 4.5-1.

4.5.4.1 Direct Radiation

At the VEGP Protected Area internal and general area, Section 4.5.3 indicates an average annual dose of 51 millirem based on TLD measurements and estimates for the ISFSI dose. TLD measurements reflect continuous exposures for long periods of time. The average measured dose rate of 51 millirem/yr is based on continuous exposure.

Adjusting for an exposure time of 2080 hours/year yields an annual worker whole body or total effective dose equivalent (TEDE) dose of 12.1 millirem.

4.5.4.2 Gaseous Effluents

The annual gaseous effluent doses to the maximally exposed member of the public (Section 4.5.3.2) are based on continuous occupancy. Adjusted for an exposure time of 2080 hours/year and multiplying by a factor of 10 to conservatively account for the fact that the worker is located closer to the effluent release point than is the maximally exposed member of the public, the estimated worker doses are 8.69×10^{-4} millirem for the total body, and 8.69×10^{-4} millirem for the critical organ.

4.5.4.3 Liquid Effluents

As the annual liquid effluent doses to the maximally exposed member of the public in Section 4.5.3 are based on continuous occupancy, they were adjusted for an exposure time of 2080 hr/yr. Although it is unlikely that the construction workers will be exposed to liquid effluent pathways, it is assumed that the liquid effluent dose rates to which the workers will be exposed are the same as those for the maximally exposed member of the public. The resulting doses are 0.016 millirem for the whole body and 0.018 millirem for the critical organ.

4.5.4.4 Total Doses

The annual doses from all three pathways are summarized in Table 4.5-1 and compared to the public dose criteria in 10 CFR 20.1301 and 40 CFR 190 in Table 4.5-2 and Table 4.5-3, respectively. The unrestricted area dose rate in Table 4.5-2 was estimated from the annual TLD doses. Since the calculated doses (12.1 mrem per year and 0.006 mrem per hour) meet the public dose criteria of 10 CFR 20.1301 and 40 CFR 190, the workers will not need to be classified as radiation workers. Table 4.5-4 shows that the doses also meet the design objectives of 10 CFR 50, Appendix I, for gaseous and liquid effluents.

The maximum annual collective dose to the AP1000 construction work force (4,400 workers) is estimated to be 53 person-rem. The calculated doses are based on available dose rate measurements and calculations. It is possible that these dose rates will increase in the future as site conditions change. However, the VEGP site will be continually monitored during the construction period and appropriate actions will be taken as necessary to ensure that the construction workers are protected from radiation.

Table 4.5-1 Annual Construction Worker Doses

	Annual Dose (mrem)	
	Total Body	Critical Organ
Direct irradiation	12.1	NA
Gaseous effluents	8.69E-4	8.69E-4
Liquid effluents	0.016	0.018
Total	12.1	0.018

Table 4.5-2 Comparison with 10 CFR 20.1301 Criteria for Doses to Members of the Public

Criterion	Dose Limit	Estimated Dose
Annual dose (millirem)	100	12.1
Unrestricted area dose rate (millirem/hour)	2	0.006

Table 4.5-3 Comparison with 40 CFR 190 criteria for doses to members of the public

	Annual Dose (mrem)	
Organ	Limit	Estimated
Total body	25	12.1
Thyroid	75	0.014
Other organ	25	0.018

Table 4.5-4 Comparison with 10 CFR 50, Appendix I criteria for effluent doses

	Annual dose (mrem)	
	Limit	Estimated
Total body dose from liquid effluents	3	0.016
Organ dose from liquid effluents	10	0.018
Total body dose from gaseous effluents	5	8.69E-4
Organ dose from radioactive iodine and radioactive material in particulate form	15	8.69E-4

Section 4.5 References

(SNC 2004a) Southern Nuclear Company, Vogtle Electric Generating Plant – Units 1 And 2, NRC Docket Nos. 50-424 and 50-425, Facility Operating License Nos. NPF-68 and NPF-81, Annual Radioactive Effluent Release Report for January 1 2003 To December 31, 2003

(SNC 2004b) Southern Nuclear Company, *Offsite Dose Calculation Manual for Southern Nuclear Operating Company Vogtle Electric Generating Plant, Version 22*, June 25.

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4.6 Measures and Controls to Limit Adverse Impacts During Construction

The following measures and controls would limit adverse environmental impacts:

- Compliance with applicable local, state, and federal, ordinances, laws and regulations intended to prevent or minimize the adverse environmental effects of construction activities on air, water and land, workers and the public.
- Compliance with existing permits and licenses for the existing units.
- Compliance with existing SNC or Georgia Power Company procedures and processes applicable to construction projects
- Incorporation of environmental requirements of construction permits in construction contracts

In Table 4.6-1, the significance of potential impacts are identified as (S)mall, (M)oderate or (L)arge, based on the analyses done in this chapter.

Table 4.6-1 Summary of Measures and Controls to Limit Adverse Impacts During Construction

Section Reference		Noise	Erosion and Sediment	Air Quality	Traffic	Wastes	Surface Water	Groundwater	Land Use	Water Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomic	Radiation Exposure	Other (site-specific)	Impact Description or Activity	Specific Measures and Controls
		Potential Impact Significance[1,2]															
4.1	Land-Use Impacts																
4.1.1	The Site and Vicinity		S				S		S							• Ground disturbing activities including grading and recontouring • Removal of existing vegetation. • Stockpiling of soils onsite • Construction of new buildings and impervious surfaces	• Conduct ground disturbing activities in accordance with regulatory and permit requirements. Use adequate erosion controls and stabilization measures to minimize impacts. • Limit vegetation removal to the area within the VEGP site designated for construction activities • Minimize potential impacts to wetlands through avoidance and compliance with applicable permitting requirements • Restrict soil stockpiling and reuse to designated areas on the VEGP site • Restrict construction activities to the ESP site
4.1.2	Transmission Corridors and Offsite Areas		S				S		S							• Construction of transmission line in a new corridor	• Site new corridor to avoid critical or sensitive habitats/species as much as possible • Limit vegetation removal and construction activities to corridor, and to fall and winter to avoid nesting activities • Restrict sites of access to corridor for construction equipment • Minimize potential impacts through avoidance and compliance with permitting requirements and best management practices

Table 4.6-1 (cont.) Summary of Measures and Controls to Limit Adverse Impacts During Construction

		Potential Impact Significance[1,2]															
Section	Reference	Noise	Erosion and Sediment	Air Quality	Traffic	Wastes	Surface Water	Groundwater	Land Use	Water Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomic	Radiation Exposure	Other (site-specific)	Impact Description or Activity	Specific Measures and Controls
4.1.3	Historic Properties and Cultural Resources														S	• Ground disturbing activities including grading, excavation, and recontouring, and construction of new transmission lines	• Conduct cultural resource surveys, including subsurface sampling prior to initiating ground disturbing activities to identify buried historic or cultural or paeleontological resources • Follow established VEGP procedures to stop work if a potential historic/cultural or paeleontological resource is discovered • Follow established VEGP procedure to contact appropriate regulatory agencies if a potential historic/ cultural or paleontological resource is discovered
4.2	Water-Related Impacts																
4.2.1	Hydrologic Alterations							S								• Excavation to marl layer, through the shallow aquifer, and subsequent dewatering of shallow aquifer	• Adhere to applicable regulations, and permits • Install drainage controls to direct dewatering runoff • Wells in area are in deep aquifer which should not be affected by construction
4.2.2	Water-Use Impacts									S						• Using groundwater as the source for all water used for construction	• No measures or controls will be necessary because impacts will be less than anticipated by existing permits

Table 4.6-1 (cont.) Summary of Measures and Controls to Limit Adverse Impacts During Construction

Potential Impact Significance[1,2]

Section Reference	Noise	Erosion and Sediment	Air Quality	Traffic	Wastes	Surface Water	Groundwater	Land Use	Water Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomic	Radiation Exposure	Other (site-specific)	Impact Description or Activity	Specific Measures and Controls
4.2.3 Water Quality Impacts						S	S		S						• Construction of barge facility and intake and discharge structures and dredging of channels in the Savannah River • Potential minor spills of petroleum products or other chemicals • Potential erosion, sediment and stormwater runoff from construction activities into the Savannah River or site ponds	• Install coffer dams in Savannah River • Install stormwater drainage system at construction sites and stabilize disturbed soils • Use Best Management Practices to minimize erosion and sedimentation • Use good construction practices to maintain equipment, and prevent spills and leaks • Invoke VEGP's existing SPCC plan for construction activities

Table 4.6-1 (cont.) Summary of Measures and Controls to Limit Adverse Impacts During Construction

Section Reference		Potential Impact Significance[1,2]: Noise	Erosion and Sediment	Air Quality	Traffic	Wastes	Surface Water	Groundwater	Land Use	Water Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomic	Radiation Exposure	Other (site-specific)	Impact Description or Activity	Specific Measures and Controls
4.3	Ecological Impacts (i.e., impacts on the physical environment)																
4.3.1	Terrestrial Ecosystems	S		S							S					• Clearing and grading and habitat loss will displace animals such as birds and mammals from the construction site and will kill less mobile animals • Wildlife may be startled or frightened away by construction noises • Potential impacts from bird collisions with man-made structures (cranes, buildings) during construction	• No measures or controls will be necessary because impacts will be small

Table 4.6-1 (cont.) Summary of Measures and Controls to Limit Adverse Impacts During Construction

	Potential Impact Significance[1,2]															
Section Reference	**Noise**	**Erosion and Sediment**	**Air Quality**	**Traffic**	**Wastes**	**Surface Water**	**Groundwater**	**Land Use**	**Water Use**	**Terrestrial Ecosystems**	**Aquatic Ecosystems**	**Socioeconomic**	**Radiation Exposure**	**Other (site-specific)**	**Impact Description or Activity**	**Specific Measures and Controls**
4.3.2 Aquatic Ecosystems		S				S					S				• Potential impacts to surface water from spills • Potential impacts to surface water from increased sediment load during construction • Temporarily degraded aquatic habitat due to construction on Savannah River shoreline • Temporary loss of benthic habitat due to construction	• Develop and implement a construction Storm Water Pollution Prevention Plan (SWPPP) • Invoke existing VEGP SPCC plan for construction activities • Implement erosion and sediment control plans that incorporates recognized best management practices • Install appropriate barriers in river prior to construction

Table 4.6-1 (cont.) Summary of Measures and Controls to Limit Adverse Impacts During Construction

Section Reference	Potential Impact Significance[1,2]: Noise	Erosion and Sediment	Air Quality	Traffic	Wastes	Surface Water	Groundwater	Land Use	Water Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomic	Radiation Exposure	Other (site-specific)	Impact Description or Activity	Specific Measures and Controls
4.4 Socioeconomic Impacts (i.e., Impacts on the Human Community)																
4.4.1 Physical Impacts	S		S	S	S										• Potential temporary and limited impacts to sensitive populations from noise, fugitive dust, and exhaust emissions during construction • Potential for increased traffic accidents with increased construction traffic • Potential for construction accidents • Increased debris to existing landfills	• Train and appropriately protect VEGP employees and construction workers to reduce the risk of potential exposure to noise, dust and exhaust emissions • Provide on-site services for emergency first aid, and conduct regular health and safety monitoring • Provide appropriate job-training to construction workers • Make public announcements or prior notification of atypically loud construction activities • Use dust control measures (such as watering, stabilizing disturbed areas, covering trucks) • Manage concerns from adjacent residents or visitors on a case-by-case basis through an SNC concerns resolution program • Post signs near construction entrances and exits to make the public aware of potentially high construction traffic areas • Develop traffic control mitigation plan

Table 4.6-1 (cont.) Summary of Measures and Controls to Limit Adverse Impacts During Construction

Section Reference		Noise	Erosion and Sediment	Air Quality	Traffic	Wastes	Surface Water	Groundwater	Land Use	Water Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomic	Radiation Exposure	Other (site-specific)	Impact Description or Activity	Specific Measures and Controls
									Potential Impact Significance[1,2]								
4.4.2	Social and Economic Impacts				M-L				S-M				S -L	S	M-L	• Potential impacts to existing traffic in the vicinity of VEGP due to increased construction traffic • Potential short-term housing shortage • Potential short-term ability of schools to accommodate influx of students without additional facilities and teachers	• Stagger shifts, encourage car or van pooling; time deliveries to avoid shift change or commute times • Erect signs alerting drivers of the construction and the potential for increased construction traffic • Mitigation of any housing shortage will be through new construction in anticipation of arrival of construction workforce • Increased tax revenues as a result of the large construction project will fund additional school resources, police and fire protection
4.4.3	Environmental Justice Impacts				M-L				S-M				S-L	S	S-L	• No disproportionably high or adverse impacts identified	• No mitigation measures required beyond those listed above
4.5	Radiation Exposure to Construction Workers													S		• No impacts identified	• No mitigation measures required
4.7	Non-Radiological Health Impacts														S	• Potential of construction accidents requiring first aid or medical treatment	• Provide job-training and institute procedures to ensure a safe working environment • Provide first aid capabilities at the construction site

1 The assigned significance levels [(S)mall, (M)oderate, or (L)arge are based on the assumption that for each impact, the associated proposed mitigation measures and controls (or equivalents) will be implemented.

2 A blank in the elements column denotes “no impact” on that specific element due to the assessed impacts.

4.7 Non-radiological Health Impacts

4.7.1 Public Health

Members of the public can potentially be put at risk by construction activities at the VEGP site. Nonradiological air emissions and dust can transport offsite through the atmosphere to where people are living. Noise can also propagate offsite. The increase in traffic from commuting construction workers and deliveries can result in additional air emissions and traffic accidents.

Section 4.4.1, "Physical Impacts" addresses the impacts to the public from construction activities.

4.7.2 Occupational Health

Construction of the new units and associated transmission lines will involve risk to workers from accidents or occupational illnesses. These risks could result from construction accidents (e.g., falls, electrocutions, burns), exposure to toxic or oxygen-replacing gases, and other causes. SNC has a health and safety program that addresses these risks, with procedures on such topics as electrical work practices, confined space entry, industrial hygiene for specific chemicals and materials, heat stress, and other topics with the goal of reducing them to the extent practicable.

The Bureau of Labor Statistics maintains records of a statistic known as total recordable cases (TRC), which are a measure of work-related injuries or illnesses that include death, days away from work, restricted work activity, medical treatment beyond first aid, and other criteria. The nationwide TRC rate published by the Bureau of Labor Statistics for utility system construction is 6.9 percent **(BLS 2003a)**. The same statistic for the State of Georgia is 4.9 percent **(BLS 2003b)**. During 1984 and 1985, more than 10,000 workers were involved in the construction of the existing units at VEGP. During those two years, the VEGP construction TRC rate was 10.5 percent and 6.7 percent, respectively.

SNC has calculated the TRC incidence for the proposed construction project as the TRC rate times the number of workers. Using monthly employment numbers and the annual average TRCs over the 84 months of pre-construction and construction, the average TRCs per year will then be as follows:

Maximum No. Workers	TRC Incidence U.S. Rate	TRC Incidence Georgia Rate	TRC Incidence VEGP Rate
4,400	217	154	271

Seven construction deaths occurred during the construction of VEGP Units 1 and 2. The Bureau of Labor Statistics reports that the nationwide annual rate of fatal occupational injuries is 0.036 percent for utility system construction **(BLS 2003a; BLS 2003c)**. Therefore, it is possible that construction deaths could occur. Using monthly construction employment predictions and national average statistics, SNC estimates 8 deaths during Units 3 and 4 construction.

Construction deaths are a serious issue. Nevertheless, SNC does not believe that the construction of new reactors will produce more construction deaths than for other similarly sized heavy construction projects.

Section 4.7 References

(BLS 2003a) Bureau of Labor Statistics "Table 1, Incidence rates of nonfatal occupational injuries and illnesses by industry and case types, 2003," available at http://www.bls.gov/iif/, Accessed July 14, 2005.

(BLS 2003b) Bureau of Labor Statistics "Table 6, Incidence rates of nonfatal occupational injuries and illnesses by industry and case types, 2003, Georgia," available at http://www.bls.gov/iif/, Accessed July 14, 2005.

(BLS 2003c) Bureau of Labor Statistics "Table A-1, Fatal occupational injuries by industry and event or exposure, All United States, 2003." available at http://www.bls.gov/iif/, Accessed July 14, 2005.

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Chapter 5 Environmental Impacts of Station Operation

Chapter 5 presents the potential environmental impacts of operation of the new Vogtle Electric Generating Plant (VEGP) Units 3 and 4. In accordance with 10 CFR 51, impacts are analyzed and a single significance level of potential impact to each resource (i.e., small, moderate, or large) is assigned consistent with the criteria that the Nuclear Regulatory Commission (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.

Mitigation of adverse impacts, if appropriate, is presented. This chapter is divided into 12 sections:

- Land Use Impacts (Section 5.1)
- Water Related Impacts (Section 5.2)
- Cooling System Impacts (Section 5.3)
- Radiological Impacts of Normal Operations (Section 5.4)
- Environmental Impacts of Waste (Section 5.5)
- Transmission System Impacts (Section 5.6)
- Uranium Fuel Cycle Impacts (Section 5.7)
- Socioeconomics Impacts (Section 5.8)
- Decommissioning Impacts (Section 5.9)
- Measures and Controls to Limit Adverse Impacts During Operations (Section 5.10)
- Transportation of Radioactive Materials Impacts (Section 5.11)
- Non-radiological Health Impacts (Section 5.12)

The following definitions should help the reader understand the scope of the discussion:

- VEGP site – the 3,169 acres existing site as described in the Unit 1 and Unit 2 licenses

- New plant (VEGP Units 3 and 4) foot-print – the approximately 500 acres within the existing VEGP site that will encompass the construction and operation of the new nuclear units
- Vicinity – the area within approximately the 6- to 10-mile (depending on the issue) radius around the VEGP site
- Region – the area within approximately the 50-mile radius around the VEGP site

5.1 Land Use Impacts

The following sections describe the impacts of Units 3 and 4 operations on land use at the VEGP site, the 6-mile vicinity, and associated transmission line corridors, including impacts to historic and cultural resources. Operation of VEGP Units 3 and 4 is not anticipated to affect any current or planned land uses.

5.1.1 The Site and Vicinity

5.1.1.1 The Site

Land use impacts from construction are described in Section 4.1.1. The only additional impacts to land use from operations will be the impacts of solids deposition from cooling tower drift. Cooling tower design is discussed in Section 3.4.2 and impacts of the heat dissipation system, including deposition, are discussed in Section 5.3.3.1 and 5.3.3.2. Impacts will be restricted to an area of approximately 3,300 feet around the towers, most in a north-northeast direction. The towers will be approximately 3,300 feet from the nearest site boundary to the west and approximately 6,400 feet to the north-northeast site boundary, so any effects will be localized on VEGP property. As discussed in Section 5.3.3.1.3, the predicted solids deposition is below the concentrations which could damage sensitive vegetation. Southern Nuclear Company (SNC) concludes that impacts to land use from Units 3 and 4 operations will be SMALL and will not warrant mitigation.

5.1.1.2 The Vicinity

As described in Section 2.5, the impact evaluation assumes that the residences of the new units' employees will be distributed across the region in the same proportion as those of the current employees. SNC estimates the new two unit-work force will be 660 additional on-site employees (Section 3.10.2). Section 5.8.2 describes the impact of 660 new employees on the region's housing market and the increases in tax revenues. Understanding tax revenues is important because some land-use changes can be driven by increased property taxes.

Approximately 20 percent (132) of the new employees are expected to settle in Burke County. Relatively few employees live in Burke County in the vicinity of VEGP; the area is rural, with few utilities or amenities. Much of the land is part of the Yuchi Wildlife Management Area (WMA) or owned by Georgia Power Company (GPC), and unavailable for development. It is likely that the new employees who choose to settle in Burke County will purchase homes or acreage in the Waynesboro area, 15 miles from VEGP. Based on the 20 years of experience of the existing units, increased tax revenues will not spur development in the vicinity of VEGP.

Land within the vicinity on the South Carolina side of the Savannah River is in Barnwell County and is owned by the Federal government and unavailable for development. No VEGP tax revenues will go to Barnwell County, South Carolina.

SNC concludes that impacts to land use in the vicinity will be SMALL and not warrant mitigation.

5.1.2 Transmission Corridors and Offsite Areas

Land use impacts to transmission corridors from operation of new units will be identical to impacts from existing units: GPC acquires transmission line rights-of-way (either by outright purchase of the land or easement) that give it access and control over how the land in the transmission corridor is managed. GPC ensures that land use in the corridors and underneath the high-voltage lines is compatible with the reliable transmission of electricity. Vegetation communities in these corridors are kept at an early successional stage by mowing and application of herbicides and growth-regulating chemicals. In some instances, GPC allows farmers to grow feed (hay, wheat, corn) for livestock or graze livestock in these rights-of-way. GPC also allows hunt clubs and individuals to plant wildlife foods for quail, dove, wild turkey, and white-tailed deer. GPC's control and management of these rights-of-way precludes virtually all residential and industrial uses of the transmission corridors, however. GPC has established corridor vegetation management and line maintenance procedures that will be used to maintain the new corridor and transmission line. SNC concludes that impacts to land use in transmission corridors or offsite areas will be SMALL and not require mitigation.

VEGP Units 3 and 4 will generate low-level radioactive wastes that will require disposal in permitted radioactive waste disposal facilities (Table 3.5-3) and non-radioactive wastes that will require disposal in permitted land fills (Table 3.6-3). Both types of waste are commonly generated and permitted facilities are located throughout the country. One of the goals of the Burke County comprehensive plan is to identify and acquire a site for a landfill. Units 3 and 4 will generate spent fuel, which will be stored on site until such time as DOE constructs and NRC licenses a high-level waste disposal facility. SNC concludes that impacts to offsite land use due to disposal of wastes generated at VEGP Units 3 and 4 would be SMALL and would not warrant mitigation.

5.1.3 Historic Properties and Cultural Resources

Table 2.5.3-3 lists properties in Burke County on the National Register of Historic Places. One property is within 10 miles of the VEGP site. The Savannah River Site (SRS) has been identified as being eligible for the National Register because of its contributions to the Cold War **(NSA 2006)**. As described in Section 2.5.3, the cultural resource survey identified 10 sites on VEGP, two of which are recommended for inclusion on the National Register and two for possible inclusion. Impacts to historic or cultural resources during operations will be less than the impacts of construction described in Section 4.1.3. All earth-disturbing activities at VEGP are conducted under procedures which prescribe actions to be taken if significant archaeological or paleontological artifacts are encountered.

GPC has a procedure that has identified 196 cultural properties on existing Vogtle transmission lines as noted in Section 2.2.2. The procedure also provides specifications for protecting them. The specifications address periodic reclearing, tree removal and trimming, inspections, normal maintenance, vehicle access, artifact collection, and protecting the Francis Plantation complex. The precise routes of new transmission corridors have not been determined, however, Table 2.5.3-3 lists National Register sites in the counties the line will cross. The procedure will be updated to include any cultural properties identified on the new corridor. SNC has determined that Units 3 and 4 operations will have a SMALL impact on historic or cultural resources and will not require mitigation.

Section 5.1 References

(NSA 2006) New South Associates, Intensive Archaeological Survey of the Proposed Expansion Areas at the Vogtle Electric Generating Plant, Burke County, Georgia, August.

5.2 Water Related Impacts

5.2.1 Hydrology Alterations and Plant Water Supply

VEGP Units 3 and 4 closed-cycle cooling systems will require makeup water to replace that lost to evaporation, drift (entrained in water vapor), and blowdown (water released to purge solids). As discussed in Chapter 3, makeup water for the natural draft cooling towers will be pumped from the Savannah River. The expected rate of withdrawal of Savannah River water to replace water losses from the circulating water system will be 18,612 and 37,224 gallons per minute (gpm) for one and two-unit operations, respectively (see Table 3.0-1). The maximum rate of withdrawal will be 28,892 and 57,784 gpm for one and two-unit operation, respectively.

Water withdrawn for cooling tower makeup is either (1) returned to the river with blowdown, (2) lost as evaporation, or (3) lost as drift. Water released to the river as blowdown is not lost to downstream users or downstream aquatic communities. Evaporative losses, on the other hand, are not replaced and are considered “consumptive” losses. Drift losses are very small compared to evaporative losses and were not considered in the analysis.

The assessment that follows is therefore focused on water use in the strictest sense, meaning water that it lost via evaporation rather than water that is withdrawn from, and later returned to, the Savannah River.

5.2.2 Water Use Impacts

5.2.2.1 Surface Water

Long-term (1985-2005) daily river flow records from the middle reaches of the Savannah River were used to estimate the monthly and annual average and low flows of the Savannah River at VEGP.

Current evaporative consumptive loss for the existing units is 30,000 gpm (Table 2.9-1). Based on the planned cooling system configuration, cooling tower evaporation rates are estimated to be 13,950-14,440 for one unit and 27,900-28,880 gpm for two units (see Table 3.0-1). The long-term monthly average Savannah River flows at the VEGP site varies from 3,157,000 to 6,381,000 gpm (Table 5.2-1).

Less than one percent (0.45 to 0.91 percent) of the monthly average Savannah River flows past VEGP will be lost to evaporation from the new units’ cooling towers. Less than two percent (1.34 to 1.55 percent) of the monthly 7Q10 flows will be lost. When the amount of water lost to evaporation is compared to river flow, consumptive use is expected to be highest in summer and fall and lowest in the winter and spring (Table 5.2-1).

Consumptive losses of this magnitude will, under normal circumstances (typical flows), be barely discernible. During low-flow periods, operation of the proposed new units at VEGP will have a SMALL impact on the availability of water downstream of the plant, because no more than 1.55 percent of the river's flow will be diverted and lost (Table 5.2-1). The cumulative impacts of four operating units are discussed in Section 10.5.

To evaluate the impact of consumptive water use on river level (river surface elevation), SNC calculated the effect of cooling tower evaporation on river stage and determined that predicted two-unit evaporative losses will lower the river level by 0.6 inch and 0.8 inch for average annual flow and annual 7Q10 flow, respectively. A water level reduction of this magnitude will not affect recreational boating in summer, when river use is at its highest, even during extreme low flow conditions. Consumptive water use will have a SMALL impact on river level and will not warrant mitigation.

5.2.2.2 Groundwater

As discussed in Section 2.3.2, groundwater wells will be used to supply makeup water for the Nuclear Island service water system, fire protection, the plant demineralization system, and the potable water system. Existing wells at VEGP are permitted to withdraw 6 million gallons per day monthly average (MGD) (4,167 gpm) and average 5.5 MGD annually (3,819 gpm).

As discussed in Section 2.3.2.2.2, three of VEGP's nine groundwater wells are capable of producing large volumes of water that can be used as a makeup water supply. Wells MU-1 and MU-2A are the site's primary production wells with Well TW-1 used as a backup well. Each of these wells is screened in the confined Cretaceous aquifer and two are also screened in the Tertiary. The wells have design yields of 2,000 gpm, 1,000 gpm, and 1,000 gpm, respectively. Any one of these wells is capable of providing enough water for current makeup water operations. The recharge area for these well is located north of the site along a 10 to 30-mile wide zone across Georgia and South Carolina. The remaining six wells (Table 2.3.2-11) are located in the confined tertiary aquifer and are capable of providing water for specific site operations. As discussed, SNC plans to close MU-2A because it is in the new plant footprint and replace it with a new well of similar capacity.

In order to determine potential offsite impact during the operations phase of the new units, cumulative projected water usage was used to calculate drawdown at the site boundary as thought all water uses pumped from a single onsite well. Well MU-2A was chosen due to its close proximity to the VEGP property boundary (5,700 feet) and because it is one of the site's primary production wells. Data used to input to an analytical distance-drawdown model was taken from VEGP's updated Final Safety Analysis Report (SNC 2005). A Transmissivity value of 158,000 gpd/ft was used. The Storativity value used (3.1x10-4) in these calculations is an average of the values listed in Table 2.4.12-8 of the FSAR, calculated for the deeper production wells. Total VEGP groundwater use reported to EPD from 2001 through 2004 averaged 730 gpm. **(SNC 2000a,b, 2001a,b, 2002a,b,c, 2003a,b, 2004a,b)** This value was used as groundwater use value for the existing facility. SNC prepared a calculation package supporting this analysis.

Projected groundwater production requirements for the new units will average 752 gpm under normal operating conditions with a maximum use of 3,140 gpm during off-normal operations (Table 3.0-1). Off-normal operations for the existing units could use a maximum of 2,300 gpm groundwater.

Total groundwater use for all four units will be approximately 1,482 gpm under normal operating conditions. Modeling results have the two existing units reducing the potentiometric surface in the Cretaceous aquifer, measured at the VEGP property line, by approximately 5.9 feet by 2025. Two additional units (assuming they become operational in 2015/2016) will increase this drawdown to 12 feet by 2025, using the conservative assumptions in the model. By 2045, the potentiometric surface reduction will increase to 12.6 feet. For comparison, the two existing units would reduce the potentiometric surface to 6.1 feet by 2045.

Because pumping does not drawdown a confined aquifer, the availability of water for offsite users in the Cretaceous aquifer will not change. Local wells (Section 2.3.2.2.1) are generally within the overlying surficial or confined Tertiary aquifers and are much shallower than the VEGP wells. Local wells generally provide water for domestic use and agricultural use, and are typically wells of lower yield. Impacts to local water users will be SMALL and the existing permit withdrawal limits will not be exceeded under normal conditions. In the unlikely event several units look to operate under off-normal conditions permitted groundwater withdrawals could be exceeded. The cumulative impacts of four units on groundwater resources are discussed in Section 10.5. Impacts to groundwater will be SMALL during normal operations. Although off-normal conditions could result in exceeding existing permit limits for a short period of time, impacts to the Cretaceous aquifer will be SMALL.

5.2.3 Water Quality Impacts

5.2.3.1 Chemical Impacts

Cooling-tower based heat dissipation systems, such as the ones proposed for the new units at VEGP, remove waste heat by allowing water to evaporate to the atmosphere. The water lost to evaporation must be replaced continuously with makeup water to prevent the accumulation of solids and solid scale formation. To prevent build up of these solids, a small portion of the circulating water stream with elevated levels of solids is drained or blown down.

Because cooling towers concentrate solids (minerals and salts) and organics that enter the system in makeup water, cooling tower water chemistry must be maintained with anti-scaling compounds and corrosion inhibitors. Similarly, because conditions in cooling towers are conducive to the growth of fouling bacteria and algae, some sort of biocide must be added to the system. This is normally a chlorine or bromine-based compound, but occasionally hydrogen peroxide or ozone is used. Table 3.6-1 list water treatment chemicals used for VEGP Units 1 and 2, which likely will be used in Units 3 and 4, as well.

SNC expects limited treatment of raw water to prevent biofouling in the intake structure and makeup water piping. Additional water treatment will take place in the cooling tower basins, and will include the addition of biocides, anti-scaling compounds, and dispersants. Sodium hypochlorite and sodium bromide are used to control biological growth in the existing circulating water system and will likely be used in the new system as well. VEGP's National Pollutant Discharge Elimination System (NPDES) permit (Permit No. GA0026786), issued in May 2004, limits concentrations of Free Available Chlorine (when chlorine is used) and Free Available Oxidants (when bromine or a combination of bromine and chlorine is used) in cooling tower blowdown when the dechlorination system is not in use. Lower limits apply to discharge from the dechlorination system (which is released into the Savannah River via the Final Plant Discharge) when it is in use. The current VEGP NPDES permit contains discharge limits (for discharges from the cooling towers) for two priority pollutants, chromium and zinc, which are widely used in the U.S. as corrosion inhibitors in cooling towers. The use of zinc was discontinued at VEGP Units 1 and 2 in 2005.

Operation of the new cooling towers will be based on four cycles of concentration, meaning that solids and chemical constituents in makeup water will be concentrated four times before being discharged and replaced with fresh water from the Savannah River. As a result, levels of solids and organics in cooling tower blowdown will be approximately four times higher than ambient concentrations. The projected blowdown flow of 28,880 gpm (Table 3.0-1) is 0.45 to 0.91 percent of the average flow and 1.34 to 1.55 percent of the average 7Q10 flow calculated for the VEGP site (Table 5.2-1). This equates to a dilution factor of from 60 to 120, depending on the time of year. Because the blowdown stream will be small relative to the flow of the Savannah River, concentrations of solids and chemicals used in cooling tower water treatment will return to ambient levels very soon after exiting the discharge pipe.

Even though cooling tower blowdown entering the Savannah River from VEGP cooling towers will be small and the chemicals it contains relatively innocuous, the discharge will have to be (NPDES) permitted by Georgia DNR and comply with applicable state water quality standards (Chapter 391-3-6 of the Rules and Regulations of the State of Georgia, "Rules and Regulations for Water Quality Control"). The seqment of the Savannah River associated with Savannah Harbor is included on the Georgia Clean Water Act Section 303(d) List because of low dissolved oxygen (DO). Although the segment of the Savannah River adjacent to Vogtle is not on the 303(d) List, EPD will have to consider the effects of the discharge from all Vogtle units on the Savannah Harbor DO in developing the VEGP NPDES Permit. However, no effect is expected from the Units 3 and 4 discharge plume on the DO in the Savannah River Harbor. Therefore, impacts of chemicals in the permitted blowdown discharge on the Savannah River water quality will be SMALL and will not warrant mitigation.

5.2.3.2 Thermal Impacts

As noted in the previous section, discharges from proposed new units will be permitted under the state of Georgia's NPDES program, which regulates the discharge of pollutants into waters of the state. In this context, waste heat is regarded as thermal pollution and is regulated in much the same way as chemical pollutants. SNC used CORMIX **(Jirka, Doneker and Hinton 1996)** Version 4.3 model to simulate the temperature distribution in the Savannah River resulting from discharge of Vogtle blowdown water. CORMIX is a U.S. Environmental Protection Agency (EPA) supported mixing zone model which emphasizes the role of boundary interactions to predict steady state mixing behavior and plume geometry. It is widely used and recognized as a state of the art tool for discharge mixing zone analyses **(CORMIX 2006a)**. The model has been validated in numerous applications **(CORMIX 2006b)**. SNC prepared a calculation package supporting this analysis.

Onsite hourly meteorological data for five years (1998-2002) were used as input to the simulation. River temperature data collected over the January 1985 – August 1996 period at a Savannah River monitoring station (Shell Bluff Landing) near VEGP were used to establish a correlation between water temperature and time of year (date). Long term daily river flow records in the Savannah River were obtained from U.S. Geological Survey (USGS) gaging stations upstream (Augusta) and downstream (Millhaven) of the VEGP location. Data were also obtained from the recently installed Waynesboro gaging station (at VEGP) for the period 1/22/05 through 9/30/05. The relationship among the flows at the three locations was used to synthesize a 20-year record of monthly low and average flows at VEGP. A (**USGS 2006**) river stage-discharge (river surface elevation versus river flow) rating curve table was used to define gage height for a given river flow. Cooling tower operating design curves were supplied by the tower manufacturer.

As discussed earlier in this section, the normal intake/discharge operating mode will be four cycles of concentration. When the river water contains high levels of dissolved and suspended solids, the plant may operate at twp cycles of concentration in order to maintain circulating water concentrations within design bounds. Discharge (blowdown) flow rates were simulated for each hour of the data period for both two- and four-cycle operation.

Tables 5.2-2 through 5.2-5 give the range of blowdown parameters for each month of the year, based on hourly simulations over a 5-year period. The right-hand columns show the range for the entire 5-year period.

Based on the 5-year hourly simulation, the maximum blowdown temperature is expected to be 91.5°F, in July (Table 5.2-2); the blowdown temperature is expected to exceed 90°F for less than 7 hours per year. The maximum ΔT (blowdown temperature minus river temperature) is 30.9°F, and is expected to occur in winter (Table 5.2-3); ΔT of 20°F is exceeded 5 percent of the hours during the 5-year period. The maximum ΔT corresponds with the maximum heat discharge (discharge flow * ΔT). The minimum ΔT is -14.0°F, occurring in October. Negative

ΔTs are seen 8 percent of the time; ΔTs less than -6.5°F are seen 0.5 percent of the time. Blowdown flow for four and two cycles of concentrations are presented in Tables 5.2-4 and 5.2-5. Table 5.2-6 summarizes discharge conditions over the five-year period for both two- and four-cycles of concentration.

5.2.3.3 Georgia Mixing Zone Regulations

The Savannah River at VEGP is classified as water used for "fishing." Georgia water quality regulations require that temperatures of such waters cannot exceed 90°F nor can they be increased by more than 5°F above intake temperature. Specific sizes of mixing zones are not specified however, "[U]se of a reasonable and limited mixing zone may be permitted on receipt of satisfactory evidence that such a zone is necessary and that it will not create an objectionable or damaging pollution condition." **(DNR 2004)**

5.2.3.4 Discharge Design

Determination of the proposed 2-unit AP1000 blowdown discharge design described in Section 3.4.2.2 was based on the mixing zone necessary under worst case conditions: max-ΔT, 2 cycles of concentration (maximum discharge flow), and 7Q10 (minimum) river flow. A single submerged port with a vertical angle of 5° down from horizontal and 3' off the bottom was the conceptual discharge design used in the model. This configuration is similar to the placement and orientation of the existing VEGP discharge. If the mixing zone resulting from such a design was unreasonably large, a more complex multi-port diffuser would then have been considered.

The mixing zone size, shape and orientation are insensitive to the choice of vertical orientation of the port (i.e., angle in the vertical plane from horizontal) and height of the discharge above the river bottom. This is because discharge plume quickly attaches to the river bottom as a result of low pressure effects due to effluent jet entrainment requirements and the proximity of the river bottom to the discharge.

Changes in the port horizontal orientation (i.e., angle in the horizontal plane from downstream) changed the orientation of the mixing zone but only small changes were seen in the zone's extent as long as the port was not pointed downstream. As this angle increased from 0 (downstream) to 90 degrees (cross-stream), the mixing zone changed from a downstream to cross-stream orientation. The existing VEGP discharge is oriented 70 degrees counterclockwise from downstream (facing away from the near shoreline). That discharge is successfully operating; the horizontal orientation of the proposed discharge was chosen to mimic that of the existing discharge.

The size of the mixing zone decreases with decreasing port diameter. This is a result of the greater entrainment of blowdown into the river resulting from an increase in discharge velocity (the discharge velocity increases as the diameter decreases for the same flow). A design choice of port diameter is a compromise between mixing zone size (favored by smaller diameter) on one hand and pumping costs (possibly required to move the necessary flow through the discharge port at higher velocity) and river bed scour (caused by high jet velocity along the bed) on the other.

CORMIX results indicate that the mixing zone for a port diameter of 2 feet has less than half the extent as does one for a port diameter of 3 feet. Smaller proportional reductions in mixing zone extent per unit port area are seen for diameters less than 2 feet. Discharge velocities, on the other hand, increase dramatically (being inversely proportional to the square of the diameter). For discharge port diameters of 3, 2, and 1 foot, the discharge velocities for the worst case conditions considered are 8, 17, and 70 feet per second (fps), respectively. A 2-foot diameter port was chosen as a compromise between mixing zone and velocity considerations. It is noted that the existing VEGP blowdown discharge is successfully operating with a single 2-foot diameter port.

5.2.3.5 Bathymetry

In support of this analysis, river bottom elevations were surveyed from one bank to the other from the existing discharge to well downstream of the proposed discharge location (Appendix B). Figure 5.2-1 shows the river cross-section at and 25 meters downstream from location of the proposed discharge. Note that the figure is drawn with a tenfold vertical scale exaggeration so that details are clearly delineated. As will be shown (see Proposed Discharge Mixing Zone), this river stretch encompasses the proposed mixing zone.

As depicted in Figure 5.2-1, the river has a maximum depth of approximately 11.5 feet in the immediate area of the proposed discharge under low river flow (7Q10) conditions. However, that depth decreases by a foot within about 20 feet in the cross-stream direction and decreases by about 2.5 feet within 25 meters downstream of the proposed discharge location. Therefore, the river depth at the blowdown discharge (an input parameter required by the CORMIX model) was chosen as 9 feet (for 7Q10 river flow). The choice of this parameter is not important for design conditions because of the discharge's attachment to the river bottom (see Discharge Design, above). However, it is a conservative choice for less severe conditions, such as 4-cycles of concentration with average river flow. Note that, for average river flow, the river surface is 4.5 feet higher than for 7Q10 river flow.

CORMIX requires that the river cross-section be represented by a rectangle of dimensions [width x depth]. Cross-sections for low and average river flow were chosen such that the river cross-sectional areas were equal to those depicted in Figure 5.2-1. The low river flow cross-section was chosen as 290 feet x 9 feet and the average river flow cross-section as 303 feet x 13.5 feet. The river velocity (river flow rate/ cross-sectional area) is approximately 1.5 and 2.3 fps for low and average river flow, respectively.

5.2.3.6 Existing Discharge

The mixing zone temperature excess of 5°F is based on the intake river temperature, which is upstream from both the existing and proposed discharges. The temperature analysis for the proposed new units' blowdown discharge must therefore include a component representing the effect of the existing VEGP blowdown discharge. The existing cooling tower design curves and 5-year meteorology were used to simulate the hourly blowdown temperatures from existing operations in the same manner as was described for the proposed towers. The existing blowdown temperature was that one calculated for the hour concurrent with that of each of the proposed blowdown discharge cases (see Table 5.2-6). The existing blowdown discharge flow rate was taken as 10,000 gpm (Table 2.9-1).

The river cross-section at the existing discharge was represented by a cross-section of 310 feet x 8 feet for low flow and 327 feet x 12.5 feet for average flow, with an additional 2 feet below the discharge. As described previously, the existing single-port discharge has the same diameter and orientation as that chosen for the proposed discharge.

CORMIX was used to calculate the temperature excess (above ambient) in the river resulting from the existing discharge at the proposed discharge location, 404 feet downstream. Table 5.2-7 gives the maximum (centerline of cross-section) temperature excess at that location for each of the discharge cases analyzed.

The existing discharge centerline temperature excess for the average case exceeds that for the max-T case. This reflects the temperature distribution of the former being narrower than that of the latter. If an average temperature excess over the width of the proposed plume were taken, the existing discharge component for the max-T case will exceed that of the average case. The use of centerline temperatures is conservative.

5.2.3.7 Proposed Discharge Mixing Zone

As described previously (see Georgia Mixing Zone Regulations) the mixing zone is defined in terms of the 5°F temperature excess (increase above intake temperature or ambient) and 90°F river temperature. The centerline temperature increase from the existing discharge was added in each case to the ambient river temperature prior to simulating the proposed discharge effects. The mixing zone temperature excess for the proposed discharge was then re-defined by decreasing the maximum allowable 5°F difference by the river temperature increase due to the existing discharge component from Table 5.2-7; the proposed discharge 90°F isotherm (only applicable for the max-T case) was defined based on the proposed discharge blowdown temperature and the ambient river temperature incremented as described.

Linear, areal, and volume characteristics of the mixing zone for the proposed discharge after the described adjustments are given in Table 5.2-8.

The 2 cycle, max-ΔT case results in the largest mixing zone; this case corresponds to the maximum heat discharge to the river. Even for this case, the mixing zone is demonstrably small. Allowing for approximately 20 feet between the river bank and the discharge port and adding the maximum cross-stream extent of 37 feet, less than 20 percent of the river width is impacted by the mixing zone and discharge structure. Approximately 11 percent of the bank to bank cross-sectional area of the river is impacted by the mixing zone and discharge structure (20 ft x 9 ft for the structure + 114.7 2 ft for the heated water). The volume of water affected by the mixing zone, 782 ft^3, is less than 1 percent of the volume (290 ft x 9 ft x 32.5 ft) in the river stretch from the discharge to the plumes furthest downstream extent.

Figures 5.2-2 and 5.2-3 show the max-ΔT mixing zone in the river for 2 and 4-cycle operation, respectively. Note that the vertical axis is exaggerated in order to depict greater plume detail. Although the four-cycle mixing zone is smaller than the two-cycle mixing zone, affecting less area and volume of water, it extends further downstream. Higher flows during two-cycle operation result in more advective (horizontal) heat transfer, and higher discharge velocities during two-cycle operation result in more mechanical (turbulent) heat transfer. As a result, the mixing zone predicted under normal four-cycle operation has a smaller area and volume but greater centerline temperatures.

The change in the 4-cycle max-ΔT mixing zone appearance approximately 40 to 50 feet along the plume trajectory reflects a flow change. In this region the plume is transitioning from a bottom attached jet to a more quiescent plume that is lifting off the river bottom. The plume is nearly parallel to the river flow at this point.

5.2.3.8 Bottom Scour

The cooling water system will typically be operating at 4 cycles of concentration. The discharge velocity for such operation is in the range of 3.1 to 6.7 fps (minimum and maximum blowdown flow from Table 5.2-4 divided by the discharge port area). The average river velocity is 2.3 fps. Because of these relatively low discharge velocities (<2 to <3 times average velocity) and rapid plume dilution, only minor scouring of the river bottom is expected.

During periods of 2 cycle operation, discharge velocities will range from 9.4 to 20.1 fps (see Table 5.2-5 for blowdown flow range) and somewhat more scouring could be expected. In any case, such scouring will be localized, as exhibited in Figure 5.2-4 which depicts the stream cross-section at the existing discharge and 25 meters downstream from it. One can infer from that figure that scouring occurs right at the discharge; evidence of scouring is apparent neither 25 meters downstream nor about 10 meters across-stream from the discharge.

5.2.4 Future Water Use

The water resources of the Savannah River are managed primarily by the Savannah District of the U.S. Army Corps of Engineers (USACE), which operates three large water management and control projects (Hartwell Dam and Lake, Richard B. Russell Dam and Lake, J. Strom Thurmond Dam and Lake) on the main stem of the river upstream of Augusta, a smaller lock and dam structure (New Savannah Bluff Lock and Dam) just downstream of Augusta, and maintains the Savannah Harbor navigation channel. Each of the three upstream dams is equipped with hydroelectric generating facilities, and the way water is stored at these dams and released to generate electricity influences Savannah River flows and the availability of water downstream of the J. Strom Thurmond Dam, including in the vicinity of VEGP.

More than 100 municipalities, industrial facilities, power plants, and agricultural operations withdraw water from the Savannah River. The majority of these water users are on the Georgia side of the river, downstream of Augusta **(USACE undated)**. The Savannah River supplies drinking water to two Georgia urban centers, Augusta and Savannah, and two booming coastal resort communities in South Carolina, Beaufort and Hilton Head. As salt water intrudes into coastal area aquifers, the fresh water of the Savannah River is expected to become an even more important source of drinking water.

Recognizing that numerous municipal and industrial users in two states were potentially at odds over the shared resource and planning for increased demands was essential, Congress authorized a comprehensive study of the Savannah River as one of the elements of the Water Resources Development Act of 1996 (PL 104-303). Section 414 of the Act directed the Secretary of the Army (Corps of Engineers) to conduct a comprehensive study to “address the current and future needs for flood damage prevention and reduction, water supply, and other related needs in the Savannah River Basin.”

The reconnaissance phase of the comprehensive study was ultimately funded in Fiscal Year 1998. During the reconnaissance phase, the Corps of Engineers worked closely with stakeholders in the basin to revalidate the major resources issues in the basin and outline and scope technical investigations. The *Savannah River Basin Comprehensive Reconnaissance Study (Study),* issued in July 1999, identified water reallocation issues in the Savannah River Basin and evaluated the extent of state interest in sharing the costs of the necessary feasibility studies **(USACE 1999)**. It also defined the issues and seven areas of concern, which it listed as water supply allocation, flood control, hydropower, water quality and flow, fish and wildlife, aquatic plant control, and recreation.

With regard to water supply, the *Study* noted that rapid population growth and industrial growth in the region had sharply increased demand for Savannah River water. The *Study* noted that there was no coordinated management of the Savannah River’s water supplies; regulatory agencies in Georgia and South Carolina operated independently and did not always coordinate assessments of Savannah River water use and availability. It called for studies to “properly assess” current water demand and allocation.

As regards water quality and flow, the *Study* reported that water quality in the Savannah River Basin was generally improving, the result of restrictions on pesticide use, improved sediment and erosion control, and better management of municipal and industrial wastewater. The *Study* identified two flow-related issues that required study, flows in the lower river in the area of Savannah and releases at the Thurmond Dam (Thurmond Power Plant). Adequate freshwater flows are necessary in the lower river to prevent salt water from moving upstream and degrading fish and wildlife habitat, particularly in the Savannah National Wildlife Refuge. Adequate releases at the Thurmond Dam are necessary to allow for assimilation of NPDES-permitted wastewaters entering the river in the Augusta area.

Since completion of the reconnaissance phase, Georgia and South Carolina have signed on as co-sponsors of the Comprehensive Study and taken on some of the financial burden. Study participants and stakeholders have met on a regular basis to identify issues of concern and discuss the use and storage of water in the basin. The needs identified by upper and lower basin users/stakeholders are different. Upper basin stakeholders are primarily concerned with adequate water storage in the pools of the various impoundments for activities such as recreation, lake shore development, and hydroelectric power. Lower basin stakeholders are more concerned with improving and optimizing flows in the unimpounded lower reaches of the river.

Table 5.2-1 Comparison of Savannah River Flows and VEGP Cooling Water Flows

	Average Flow[1,2]	7Q10 Flow	Maximum Withdrawal for CT Makeup (2 units)	Maximum CT Evaporation Rate (2 units)	Percent of Average Flow Lost to Evaporation	Percent of 7Q10 Flow Lost to Evaporation	Blowdown Flow	Blowdown as Percent of Average Flow	Blowdown as Percent of 7Q10 Flow
Jan	4,425,015	2,045,318	57,784	28,880	0.65	1.41	28,880	0.65	1.41
Feb	5,450,143	2,142,714	57,784	28,880	0.53	1.35	28,880	0.53	1.35
Mar	6,381,016	2,161,116	57,784	28,880	0.45	1.34	28,880	0.46	1.34
Apr	4,933,988	2,055,193	57,784	28,880	0.59	1.41	28,880	0.59	1.41
May	3,886,868	1,932,213	57,784	28,880	0.74	1.49	28,880	0.74	1.49
June	3,503,567	1,879,700	57,784	28,880	0.82	1.54	28,880	0.82	1.54
July	3,531,394	1,907,079	57,784	28,880	0.82	1.51	28,880	0.82	1.51
Aug	3,653,925	1,916,504	57,784	28,880	0.79	1.51	28,880	0.79	1.51
Sept	3,294,412	1,969,017	57,784	28,880	0.88	1.47	28,880	0.88	1.47
Oct	3,490,551	1,858,605	57,784	28,880	0.83	1.55	28,880	0.83	1.55
Nov	3,157,070	1,891,818	57,784	28,880	0.91	1.53	28,880	0.91	1.53
Dec	3,999,524	1,956,001	57,784	28,880	0.72	1.48	28,880	0.72	1.48

1 all flows in gallons per minute
2 based on data from 1985-2005

Table 5.2-2 Monthly and Five-Year Blowdown Temperatures (°F)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Five Year
Min	42.4	44.0	46.1	52.8	60.7	67.9	69.5	65.5	62.2	53.9	49.6	42.6	42.4
Average	62.6	64.4	66.8	72.4	76.9	81.4	83.1	82.3	78.2	73.3	68.1	62.5	72.6
Max	81.5	80.3	83.0	85.4	88.3	90.4	91.5	91.1	88.4	86.3	81.3	81.0	91.5

Table 5.2-3 Monthly and Five-Year ΔT (Blowdown Temperature Excess Above Ambient River, °F)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Five Year
Min	-9.1	-8.5	-6.5	-8.9	-7.2	-5.1	-8.4	-10.9	-9.8	-14.0	-9.7	-10.8	-14.0
Average	11.6	13.1	11.8	11.1	8.7	7.2	5.7	5.2	4.9	6.2	8.1	8.4	8.5
Max	30.9	29.1	28.0	25.0	20.8	17.5	13.6	14.1	15.6	19.1	23.1	26.2	30.9

Table 5.2-4 Blowdown Flow for Four Cycles of Concentration Operation (gpm per unit)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Five Year
Min	2208	2315	2448	2783	3168	3504	3657	3332	3198	2833	2684	2228	2208
Average	3302	3436	3566	3796	3994	4053	4098	4098	3982	3764	3592	3343	3751
Max	4160	4268	4346	4486	4570	4681	4601	4713	4614	4410	4264	4201	4713

Table 5.2-5 Blowdown Flow for Two Cycles of Concentration Operation (gpm per unit)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Five Year
Min	6624	6945	7344	8348	9503	10513	10971	9995	9594	8498	8053	6685	6624
Average	9905	10308	10697	11389	11981	12158	12293	12293	11945	11291	10776	10029	11252
Max	12480	12804	13038	13458	13711	14043	13802	14138	13842	13230	12791	12602	14138

Table 5.2-6 Discharge Parameters For Blowdown Modeling

Case	Discharge Temperature (°F)	Discharge ΔT (°F)	Discharge Flow (4 Cycles of Concentration, gpm per unit)	Discharge Flow (2 Cycles of Concentration, gpm per unit)
Max-T	91.5	13.6	4576	13728
Max-ΔT	81.5	30.9	4094	12281
Min-ΔT	54.4	-14.0	2869	8605
Average	72.6	8.5	3751	11252

Table 5.2-7 Temperature Excess (Above Ambient) at the Proposed Discharge Location as a Result of the Existing Vogtle Discharge

Discharge Case	River Temperature Increase 404 feet Downstream from Existing Discharge (°F)
Max-T	0.30
Max-ΔT	0.81
Min-ΔT	-0.32
Average	0.36

Table 5.2-8 Proposed Discharge Mixing Zone Statistics

Case	Furthest downstream extent, ft from discharge	Furthest cross-stream extent, ft from discharge	Surface area (horizontal projection), ft^2	Cross-sectional area (vertical projection perpendicular to flow), ft^2	Volume, ft^3
5°F Temperature Increase Above Intake Temperature, 2 Cycles of Concentration					
Max-T	11.2	20.9	57.0	25.4	61.8
Max-ΔT	32.5	37.3	295.9	114.7	781.6
Min-ΔT	11.1	17.1	50.3	21.5	55.7
Average	5.4	10.0	13.4	6.0	7.4
5°F Temperature Increase Above Intake Temperature, 4 Cycles of Concentration					
Max-T	9.7	11.1	33.1	13.0	33.6
Max-ΔT	57.2	21.8	197.4	47.9	375.0
Min-ΔT	9.9	8.1	26.6	9.1	25.7
Average	2.1	2.2	2.2	1.7	0.8
90°F River Temperature					
Max-T (2 Cycles of Concentration)	2.6	6.3	2.0	0.9	0.2
Max-T (4 Cycles of Concentration)	2.2	4.3	1.3	0.6	0.2

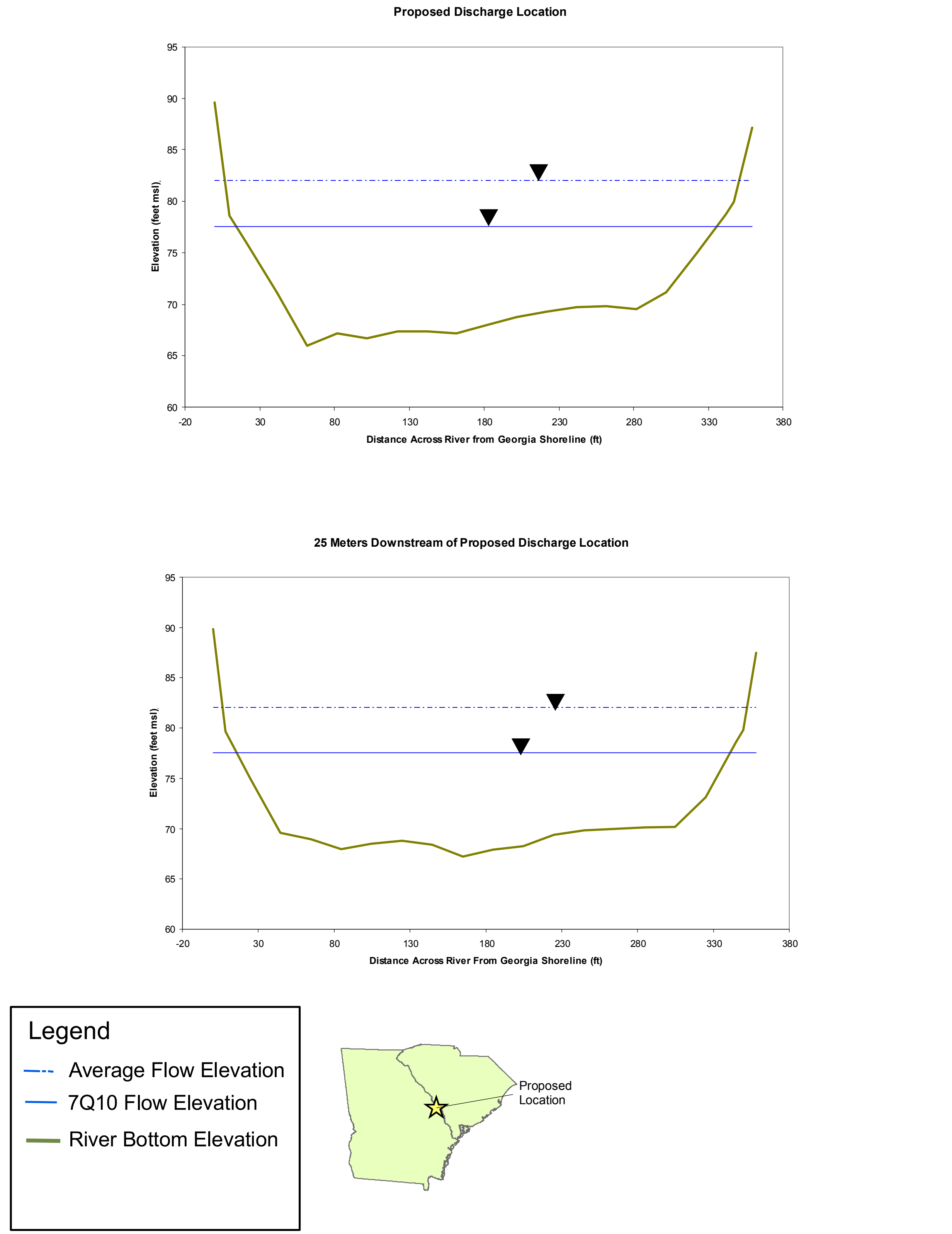

Figure 5.2-1 River Cross Sections at Proposed Discharge Location

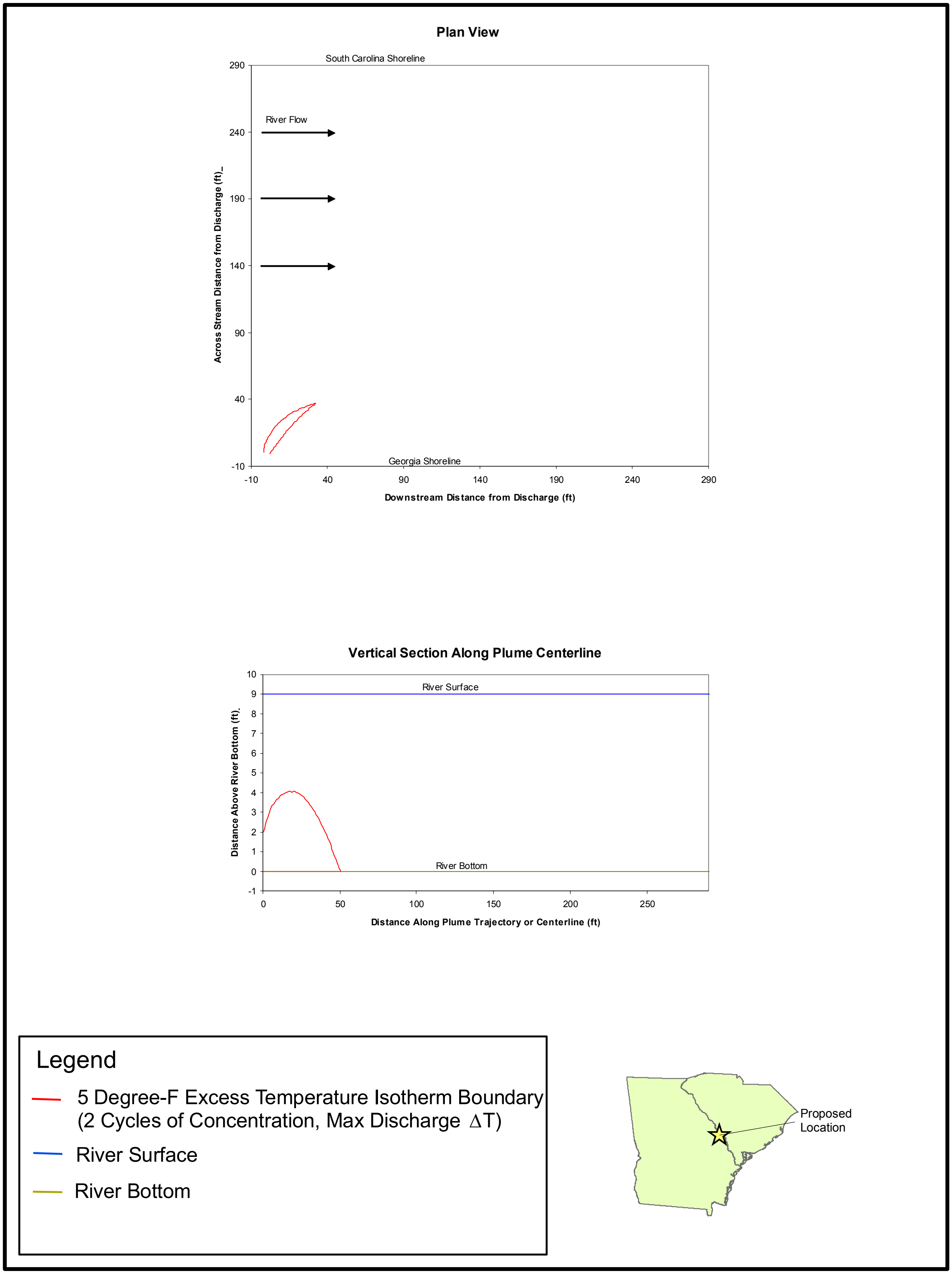

Figure 5.2-2 Mixing Zone for 2 Cycles of Concentration and Maximum Discharge ΔT

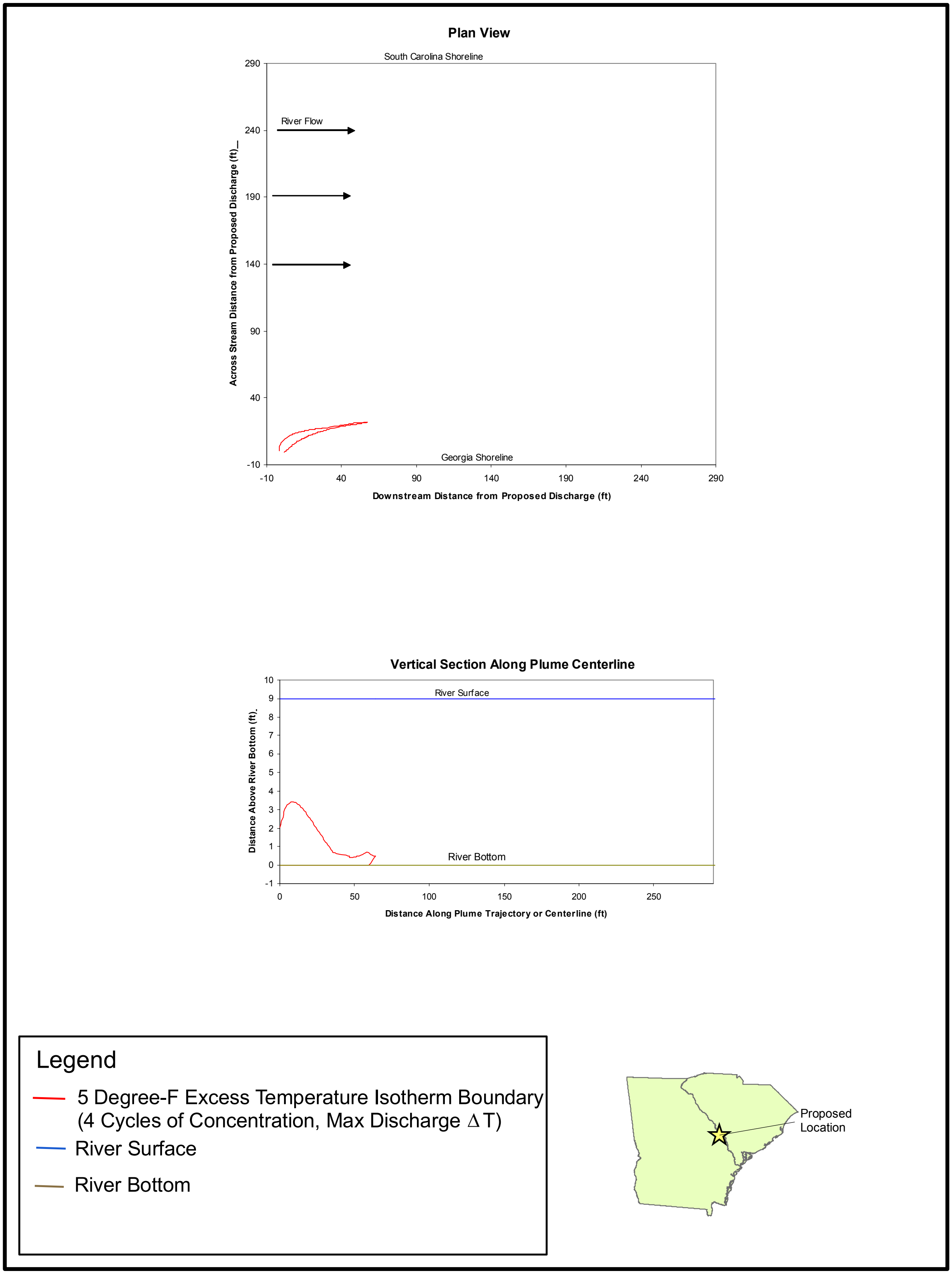

Figure 5.2-3 Mixing Zone for 4 Cycles of Concentration and Maximum Discharge ∆T

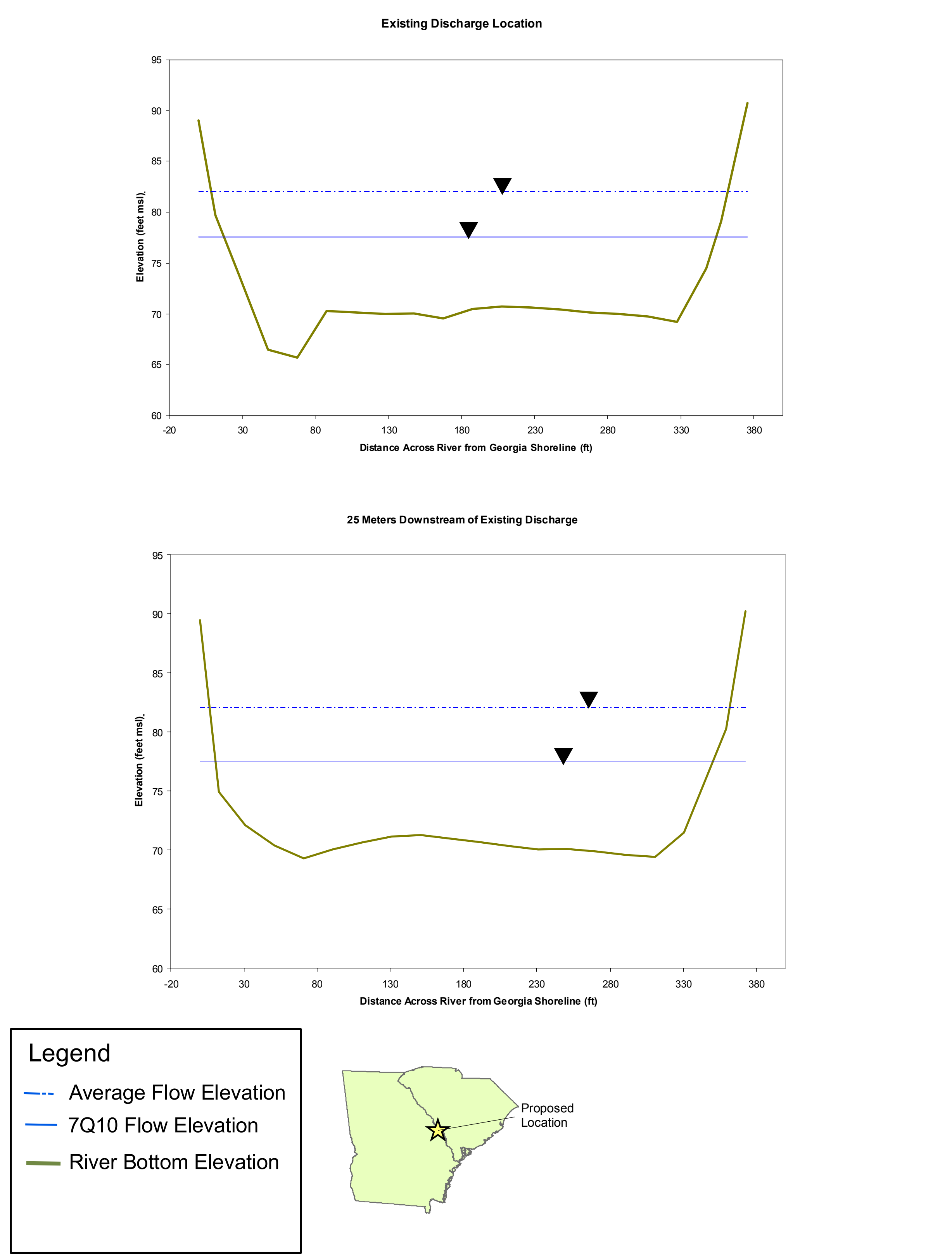

Figure 5.2-4 River Cross Sections at Existing Discharge Location

Section 5.2 References

(CORMIX 2006a) CORMIX Mixing Zone Applications, found on the internet at: http://www.cormix.info/applications.php.

(CORMIX 2006b) Independent CORMIX Validation Studies, found on the internet at: http://www.cormix.info/validations.php.

(DNR 2004) Georgia Department of Natural Resources, Rules and Regulations for Water Quality Control, Chapter 391-3-6, Environmental Protection Division, Atlanta, Georgia, revised November 2004, found on the internet at: http://www.state.ga.us/dnr/environ//rules_files/exist_files/391-3-6.pdf.

(Jirka, Doneker and Hinton 1996) User's Manual For Cormix: A Hydrodynamic Mixing Zone Model and Decision Support System for Pollutant Discharges into Surface Waters, Office of Science and Technology, U.S. EPA, Washington, D.C., September 1996.

(SNC 2000a) Southern Nuclear Company, Groundwater Use Report – September 1999 to February 2000.

(SNC 2000b) Southern Nuclear Company, Groundwater Use Report – March 2000 to August 2000**.**

(SNC 2001a) Southern Nuclear Company, Groundwater Use Report – September 2000 to February 2001.

(SNC 2001b) Southern Nuclear Company, Groundwater Use Report – March 2001 to August 2001.

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(SNC 2002b) Southern Nuclear Company, Groundwater Use Report – March 2002 to August 2002**.**

(SNC 2002c) Southern Nuclear Company, Groundwater Use Report – July 2002 to December 2002.

(SNC 2003a) Southern Nuclear Company, Groundwater Use Report – January 2003 to June 2003.

(SNC 2003b) Southern Nuclear Company, Groundwater Use Report – July 2003 to December 2003.

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(SNC 2004b) Southern Nuclear Company, Groundwater Use Report – July 2004 to December 2004.

(SNC 2005) Southern Nuclear Company, Updated Final Safety Evaluation Report, Revision 13, January 31.

(USACE undated) U.S. Army Corps of Engineers, Savannah River Basin Fact Sheet - Water Users, found at http://www.sas.usace.army.mil/drought/sheet9.pdf.

(USACE 1999) U.S. Army Corps of Engineers, Savannah River Basin Comprehensive Reconnaissance Study, found at http://www.sas.usace.army.mil/srb/reconrpt.htm.

(USGS 2006) U.S. Geological Survey, National Water Information System, NWIS Rating for Savannah River near Waynesboro, Ga., found on the internet at: http://nwis.waterdata.usgs.gov/nwisweb/data/exsa_rat/021973269.rdb.

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5.3 Cooling System Impacts

5.3.1 Intake System

Section 3.4.2.1 describes the proposed intake system and the following sections describe its impact on physical and biological systems in the Savannah River.

5.3.1.1 Hydrodynamic Descriptions and Physical Impacts

Nuclear power plants that use closed-cycle, re-circulating cooling systems (cooling towers) withdraw significantly less water for condenser cooling than open-cycle or once-through units. Depending on the type of cooling tower installed and the quality of the makeup water, power plants with closed-cycle, re-circulating (versus "helper") cooling towers withdraw only 5 to 10 percent as much water as plants of the same size with once-through cooling systems.

As discussed, makeup water will be withdrawn directly from the Savannah River. The new facility will withdraw 28,892 gpm if one unit and three makeup pumps are operating and 57,784 gpm if both units and all six makeup pumps are operating. Although specific design details have not been worked out, the basic design of the intake structure has been formulated (see Section 3.4, Figures 3.4-2 and 3.4-3). The Cooling Water Intake Structure (CWIS) will incorporate a number of design features that will reduce impingement and entrainment of aquatic organisms. These include (1) the basic orientation of the cooling water intake structure and canal, perpendicular to the river and its flow, (2) extremely low current velocities along the length of the intake canal, and correspondingly low approach velocities at the traveling screens to the makeup water pumps, and (3) a submerged weir across the intake canal. The CWIS proposed for the new units at VEGP will be in compliance with Section 316(b) of the Clean Water Act by virtue of its closed-cycle design, which incorporates these measures to mitigate impacts to aquatic biota.

5.3.1.2 Aquatic Ecosystems

This discussion is limited to the new units. Cumulative impacts of four units are discussed in Section 10.5. The EPA's Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities (69 FR 131, July 9, 2004) note (page 41601) that "reducing the cooling water intake structure's [water withdrawal] capacity is one of the most effective means of reducing entrainment (and impingement)" and go on to say that facilities located in freshwater areas with closed-cycle, re-circulating cooling water systems can..."reduce water use by 96 to 98 percent from the amount they will use if they had once-through cooling." Regulation 40 CFR 125.94(a)(1)(i) indicates that if a facility's flow is commensurate with a closed-cycle recirculating system, the facility has met the applicable performance standards and is not required to demonstrate that it meets impingement mortality and entrainment performance standards. Power plants with closed-cycle, re-circulating cooling systems, such as the systems proposed for the new units at VEGP, meet the rule's performance standards because they are "deemed to satisfy any applicable impingement mortality and entrainment standard for all waterbodies." The design of the new cooling water intake system (CWIS) will be compliant with the EPA's regulation for Cooling Water Intake Structures (and, by extension, represents the "Best Available Technology" for reducing impacts to aquatic communities).

The NRC evaluated entrainment at the existing intake structure in the FES for operation of the existing units at VEGP, assuming (1) the drift community was uniformly distributed, (2) two percent of the flow of the Savannah River will pass through the plant, and (3) 100 percent mortality of entrained organisms. The NRC's most conservative analysis assumed a maximum withdrawal rate 120 cfs (53,860 gpm) for cooling tower makeup and a "minimum guaranteed" river flow of 5,800 cfs (2,603,214 gpm). The NRC staff concluded that the loss of two percent of the drift community in the VEGP cooling system will not have a significant impact on resident fishes and suggested that anadromous fishes also will be largely unaffected because no important spawning areas were found in the area of the plant. With respect to impingement, the NRC noted that a number of modifications had been made in the original design of the intake structure to protect adult and juvenile fish and concluded that there will be no significant effects on Savannah River fishes as a result of impingement.

The hydrological analysis in the previous section (Section 5.2.1) uses updated, site-specific flow data and more conservative values (7Q10 flows) than the NRC analysis, producing a slightly higher estimate (up to 3.1 percent) of river flow that will pass through the new units during low-discharge periods. During spring (March-April), when important anadromous species such as American shad, hickory shad, and blueback herring ascend the Savannah River to spawn, approximately 0.9 to 1.2 percent of the river's average flow and 2.7 to 2.8 percent of the river's 7Q10 flow will pass through the new units. In late spring and summer, when many Lepomids (bluegill, redbreast, redear sunfish) and Ictalurids (white catfish, channel catfish) popular with local fishermen spawn, approximately 1.5 to 1.7 percent of the river's average flow and 3.0 to 3.1 percent of the river's 7Q10 flow will pass through the new units. The proportion of Savannah River flow diverted for cooling tower makeup during peak spawning periods is therefore expected to range from 0.9 to 1.7 percent in most years, and will approach 3.0 percent approximately once per decade.

Basing entrainment estimates on cooling water withdrawal rates (and assuming uniform distribution of eggs and larvae) almost certainly overstates the rate of entrainment because the reproductive habits of many species of fish make it less likely that their eggs and larvae will be entrained. Some species spawn in sloughs and backwater areas rather than in the main river channel, making their eggs and young less vulnerable to entrainment. Other species spawn in the main river channel but have eggs that are heavier than water, so they sink to the bottom where they are less likely to be entrained. Still other species have adhesive eggs that attach to logs, sticks, debris, and aquatic vegetation until they hatch. Species that broadcast eggs in the main channels of rivers and expend no energy on "parental care" have eggs and young more vulnerable to entrainment than species that build and guard nests in areas removed from the main channel of the river, such as bluegill, largemouth bass and other centrarchids.

Based on the facts that (1) the proposed cooling-tower-based heat dissipation system will, under normal circumstances, withdraw small amounts of Savannah River water, (2) the design of the new CWIS incorporates a number of features that will reduce impingement and entrainment, and (3) twenty years of operating experience suggest that Savannah River fish populations have not been adversely affected by operation of the existing VEGP units, SNC concludes that cooling water system intake impacts will be SMALL and will not warrant mitigation measures beyond the design features previously discussed.

5.3.2 Discharge Systems

This discussion is limited to the new units. Cumulative impacts of four units are discussed in Section 10.5.

5.3.2.1 Thermal Discharges and Other Physical Impacts

Cooling tower blowdown from the new facility will be discharged directly into the Savannah River by means of a new discharge structure that will be constructed approximately 400 feet down-river of the existing discharge. The new discharge structure will be approximately 2,500 feet downstream of the intake, meaning that recirculation of heated effluent to the intake will not be an issue.

Cooling tower blowdown temperatures were modeled by applying cooling tower manufacturer's information (tower design curves) to site meteorology. Simulations used five years of site-specific meteorological data and ten years of river temperature data that were synthesized from monitoring data collected up- and downstream of VEGP (see Section 5.2.2.1). Based on the CORMIX simulations, the maximum blowdown temperature, 91.5°F, is expected in July. Blowdown temperatures are expected to exceed 90°F for less than seven hours each year. The maximum ΔT (blowdown temperature minus river temperature) of 30.9°F is expected to occur in January. As expected, simulated ΔT values were highest in winter months, when river temperatures are lowest and cooling tower efficiencies are at their highest.

In addition to simulating end-of-pipe blowdown temperatures, SNC conducted a thermal plume analysis, focusing on the portion of the discharge area with temperatures five or more degrees Fahrenheit higher than ambient temperatures. SNC selected a 5°F ΔT value to define the thermal plume because the Georgia water quality standard (Rules and Regulations of the State of Georgia, Chapter 391-3-6, Rules and Regulations for Water Quality Control) limits water temperature increases in "fishing waters" to 5°F. The modeling assumed worst-case conditions: maximum ΔT, maximum discharge flows, and minimum (7Q10) Savannah River flow.

Discharge effects were evaluated in terms of both maximum allowable temperature (the 90°F state standard) and maximum allowable temperature increase (the 5°F state standard). The CORMIX simulation indicated that the >90°F plume will occupy a surface area of 57.0 square feet (0.001 acre) and a cross-sectional area of 25.4 square feet when cooling towers are employing two cycles of concentration, and a surface area of 33.1 square feet and a cross-sectional area of 13.0 square feet when cooling towers are employing four cycles of concentration. The corresponding volume of heated water for the two cases will be 62 and 34 cubic feet, respectively. The CORMIX simulation indicated that the >5°F maximum ΔT plume will occupy a surface area of 295.9 square feet (0.006 acre) and a cross-sectional area of 114.7 square feet when cooling towers are employing two cycles of concentration and a surface area of 197.4 square feet (0.004 acre) and a cross-sectional area of 47.9 square feet when cooling towers are employing four cycles of concentration. The corresponding volume of heated water for the two cases will be 782 and 375 cubic feet, respectively. As discussed previously in Section 5.2.2, the two-cycle, maximum ΔT case corresponds to the maximum heat discharge to the river and produced the largest thermal plume.

As illustrated in Figures 5.2-2 and 5.2-3, the thermal plume is expected to extend only a short distance across the Savannah River, which is approximately 300 feet wide at the VEGP site. Under two cycles of concentration the maximum ΔT case, the thermal plume extends 37.3 feet across the river and 32.5 feet downstream of the discharge structure. Even for this case, the thermal plume is relatively small: less than 20 percent of the river's width is involved. Under the maximum temperature case, the thermal plume extends 20.9 feet across the river and 11.2 feet downstream.

When operating at four cycles of concentration, the discharge velocity will be in the range of 3.1 to 6.7 feet per second (fps). These velocities are slightly higher than the average river velocity of 2.3 fps. Because of these relatively low discharge velocities and rapid plume dilution, only minor scouring of the river bottom is expected. During infrequent periods of two-cycle operation, discharge velocities will range from 9.4 to 20.1 fps and somewhat more scouring could be expected.

As discussed in Section 5.2.2 (and illustrated in Figure 5.2-4), a bathymetric study conducted by SNC in 2006 revealed a shallow (3-to-5-foot-deep) trough immediately downstream of the existing discharge structure that is presumed to have been caused by scouring of the river bottom. There was no evidence of this depression 75 feet further downstream, however, indicating that the scouring was restricted to a very small area in the immediate area of the discharge opening.

5.3.2.2 Aquatic Ecosystems

5.3.2.2.1 Thermal Effects

The CORMIX simulation indicates that the heated discharge (cooling tower blowdown) from the proposed new units will affect a small part of the river in the immediate area of the discharge port. Because most of the water column is unaffected by the blowdown, even under extreme (worst-case) conditions, the thermal plume will not create a barrier to upstream or downstream movement of important migrating fish species, including American shad, hickory shad, blueback herring, striped bass, Atlantic sturgeon, shortnose sturgeon, and American eel. There will be no thermal impacts beyond some thermally-sensitive species possibly avoiding the immediate area of the discharge opening. Impacts to aquatic communities will be SMALL and will not warrant mitigation.

5.3.2.2.2 Chemical Impacts

As discussed in Section 5.2.2, operation of the new cooling towers will be based on four cycles of concentration, meaning that solids and chemical constituents in makeup water will be concentrated four times before being discharged. As a result, levels of solids and organics in cooling tower blowdown will be approximately four times higher than ambient or upstream concentrations. Because the blowdown stream will be very small relative to the flow of the Savannah River, however, concentrations of solids and chemicals used in cooling tower water treatment will return to ambient levels almost immediately downstream of the discharge pipe. The projected blowdown flow of 28,880 gpm is 0.45 to 0.91 percent of the average flow and 1.34 to 1.55 percent of the 7Q10 flow estimated for the VEGP site. This equates to a dilution factor of 60 to 120, depending on the time of year. The discharge will be permitted by Georgia DNR and comply with applicable state water quality standards (Chapter 391-3-6 of the Rules and Regulations of the State of Georgia, “Rules and Regulations for Water Quality Control”). Any impacts to aquatic biota will be SMALL and will not warrant mitigation.

5.3.2.2.3 Physical Impacts

Based on predicted discharge velocities (see previous section), some localized bottom scouring is expected in the immediate vicinity of the discharge opening. Assuming the degree/extent of bottom scouring associated with operation of the new discharge is similar to that associated with operation of the existing discharge, an area of several hundred square feet could be rendered unsuitable for benthic organisms, including larval aquatic insects and mussels. Other than a local reduction in numbers of benthic organisms, there will be no effect on Savannah River macrobenthos or fish. No important aquatic species or its habitat will be affected. Physical impacts to aquatic communities will therefore be SMALL and will not warrant mitigation.

5.3.3 Heat Dissipation Systems

5.3.3.1 Heat Dissipation to the Atmosphere

SNC will use a single natural draft cooling towers for each AP1000 unit to remove excess heat from the circulating water system (CWS). Cooling towers evaporate water to dissipate heat to the atmosphere. The evaporation is followed by partial recondensation which creates a visible mist or plume. In addition to evaporation small water droplets drift out of the tops of the cooling towers. The plume creates the potential for shadowing, fogging, icing, localized increases in humidity, and possibly water deposition. The drift of water droplets can deposit dissolved solids on vegetation or equipment.

The Final Environmental Statement for construction of the existing VEGP units **(AEC 1974)** examined fogging and solids deposition for the four cooling towers proposed at that time. The AEC analysis determined that there would be no measurable increase in ground-level fogging in the area and that the effect of solids deposition will be negligible. In the FES for operation **(NRC 1985)**, NRC concluded that for the two units then under construction, increases in ground-level fogging, precipitation, icing, cloud formation, and shading would be inconsequential. Drift deposition was examined in detail and determined to be negligible.

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

Engineering data for the AP1000 was used to develop input to the SACTI model. The model assumed two identical cooling towers, each with a heat rejection rate of 7.54×10^9 BTU/hr and circulating water flows of 600,000 gallons per minute. The tower height was set at 600 feet. Four cycles of concentration were assumed for normal operations. The meteorological data was from the VEGP meteorological tower for the year 1999, which had the most complete data set.

5.3.3.1.1 Length and Frequency of Elevated Plumes

The SACTI code calculated the expected plume lengths by season and direction for the combined effect of two natural draft cooling towers. The longest plume lengths will occur in the winter months and the shortest in the summer. The plumes will occur in all compass directions. No impacts other than aesthetic will result from the plumes. Although visible from offsite, the plumes resemble clouds and will not disrupt the aesthetic view (see Section 5.8.1.4).

Modeled plumes from proposed cooling towers will be as follows:

	Winter	Summer
Median plume length (miles)	0.4	0.4
Predominant direction	S, ENE, E	NNE
Longest plume length (miles)	6.0	1.7
Frequency of longest plume (percent)	2.4	0.14

5.3.3.1.2 Ground-Level Fogging and Icing

Fogging from the natural draft cooling towers is not expected due to their height. Icing will not occur from these towers. The existing cooling towers at VEGP, which are 550 feet high, do not produce ground-level fogging or icing. As reported in Section 2.7.4.1.4, natural fogging occurs approximately 35 days per year. Impacts from fogging or icing will be SMALL and not warrant mitigation.

5.3.3.1.3 Solids Deposition

Water droplets drifting from the cooling towers will have the same concentration of dissolved and suspended solids as the water in the cooling tower basin. The water in the cooling tower basin is assumed to have solid concentrations four times that of the Savannah River, the source of cooling water makeup. Therefore, as these droplets evaporate, either in the air or on vegetation or equipment, they deposit these solids.

The maximum predicted solids deposition rate from a single tower will be as follows:

Maximum pounds per acre per month	2.5
Feet to maximum deposition	3,300
Direction to maximum deposition	north-northeast

The maximum predicted solids deposition from both towers (5.0 pounds per acre per month) is below the NUREG-1555 significance level of 8.9 pounds per acre per month.

Impact from salt deposition from the new towers will be SMALL and will not require mitigation. Cumulative impacts of salt deposition from the four towers are discussed in Section 10.5.

5.3.3.1.4 Cloud Shadowing and Additional Precipitation

Vapor from cooling towers can create clouds or contribute to existing clouds. Rain and snow from vapor plumes are known to have occurred. The SACTI code predicted the precipitation expected from the proposed cooling towers. The towers will produce a maximum of approximately 0.14 inches of precipitation per year at 0.4 miles north-northeast of the towers. This value is very small compared to the annual precipitation of 33 inches from the year of meteorological data used in this analysis, which was a year of low rainfall. The 30-year average rainfall at Augusta is 45 inches and at Waynesboro is 47 inches (1971-2000) **(NOAA 2002)**. Impacts will be SMALL and will not require mitigation.

5.3.3.1.5 Interaction with Existing Pollution Sources

The extent of influence of the proposed cooling towers is limited. No other sources of pollution occur in the vicinity except the existing VEGP cooling towers. The centroid of the proposed cooling towers is approximately 4,000 feet from the centroid of the existing towers. Given this distance, cumulative effects will occur only when the wind is in the approximate direction of the line connecting these two points. The cumulative effect will be SMALL and transitory and will not require mitigation.

5.3.3.1.6 Ground-Level Humidity Increase

The potential for increases in absolute and relative humidity exist where there are visible plumes, however, the increase will be SMALL and mitigation will not be warranted.

5.3.3.2 Terrestrial Ecosystems

Heat dissipation systems associated with nuclear power plants have the potential to impact terrestrial ecosystems through salt drift, vapor plumes, icing, precipitation modifications, noise, and bird collisions with structures (e.g., cooling towers). Each of these topics is discussed below.

No important terrestrial species or important habitats exist within the vicinity of the proposed project (see Sections 2.4.1.1 and 4.3.1).

5.3.3.2.1 Salt Drift

Vegetation near the cooling towers could be subjected to salt deposition attributable to drift from the towers. Salt deposition could potentially cause vegetation stress, either directly by deposition of salts onto foliage or indirectly from accumulation of salts in the soil.

An order-of-magnitude approach is typically used to evaluate salt deposition on plants, since some plant species are more sensitive to salt deposition than others, and tolerance levels of most species are not known with precision. In this approach, deposition of sodium chloride at rates of approximately 1 to 2 pounds/acre/month is generally not damaging to plants, while deposition rates approaching or exceeding 9 pounds/acre/month in any month during the growing season could cause leaf damage in many species (NUREG-1555); NRC presented this data in metric units which SNC converted to American standards for this discussion). An alternate approach for evaluating salt deposition is to use 9 to 18 pounds/acre/month of sodium chloride deposited on leaves during the growing season as a general threshold for visible leaf damage (NUREG-1555).

As presented in Section 5.3.3.1.3, the maximum expected salt deposition rate will be 2.5 pounds/acre/month per cooling tower. This conservative maximum rate is less than one third of the 9 pounds/acre/month rate that is considered a threshold for leaf damage in many species. Even if both towers deposited the maximum expected concentration on the same area the total is less than 9lb/acre/mo. Any impacts from salt drift on the local terrestrial ecosystems will therefore be SMALL and not warrant mitigation. Cumulative impacts are discussed in Section 10.5.

5.3.3.2.2 Vapor Plumes and Icing

As concluded in Section 5.3.3.1.1, the expected longest plumes will be 6.2 miles, but will occur only about 2.5 percent of the time. As discussed in Section 5.3.3.1.2, ground level fogging and icing do not occur at VEGP towers, therefore the impacts of fogging and icing on terrestrial ecosystems will be SMALL and not warrant mitigation.

5.3.3.2.3 Precipitation Modifications

As discussed in Section 5.3.3.1.4, the predicted maximum precipitation from the cooling towers will be approximately 0.14 inch of rain per year within 0.4 mile of the towers. This amount is very small compared to the average annual precipitation of approximately 33 inches from the year of metorological data used in this analysis, which was a year of low rain fall. The 30-year average rainfall at Augusta is 45 inches and at Waynesboro is 47 inches (1971-2000) **(NOAA 2002)**. Thus, additional precipitation resulting from operation of the proposed units on local terrestrial ecosystems will be SMALL and will not warrant mitigation.

5.3.3.2.4 Noise

As presented in Section 5.3.4.2. Noise from the operation of the new cooling towers will be similar to background and to current noise levels to which local species are adapted. Therefore, noise impacts to terrestrial ecosystems will be SMALL and will not warrant mitigation.

5.3.3.2.5 Avian Collisions

The natural draft cooling towers associated with the AP1000 will be 600 feet high. Existing natural draft cooling towers at VEGP are 550 feet high, and SNC has observed occasional, incidental occurrences of bird collisions with the towers. Because collisions with existing VEGP cooling towers are rare, it is likely that bird collisions with the new towers will be minimal. In addition, the NRC concluded in NUREG-1437, The *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), that effects of bird collisions with existing cooling towers are minimal. Therefore, impacts to bird species from collisions with the cooling towers will be SMALL and will not warrant mitigation.

5.3.4 Impacts to Members of the Public

This section describes the potential health impacts associated with the cooling system for the new units. Specifically, impacts to human health from thermophilic microorganisms and from noise resulting from operation of the cooling system are addressed.

As described in Section 3.4, a closed-cycle cooling system will be used for the new units, similar to the existing units' cooling systems. Because the system will use natural draft cooling towers, thermal discharges will be to the atmosphere.

5.3.4.1 Thermophilic Microorganism Impacts

Consideration of the impacts of thermophilic microorganisms on public health are important for facilities using cooling ponds, lakes, canals, or small rivers, because use of such water bodies may significantly increase the presence and numbers of thermophilic microorganisms. These microorganisms are the causative agents of potentially serious human infections, the most serious of which is attributed to *Naegleria fowleri*.

Naegleria fowleri is a free-living ameba that occurs worldwide. It is present in soil and virtually all natural surface waters such as lakes, ponds, and rivers. *Naegleria fowleri* grows and reproduces well at high temperatures (104º to 113ºF) and has been isolated from waters with temperatures as low as 79.7ºF.

Section 5.2.3 describes the thermal plume expected from cooling tower blowdown to the Savannah River. Theoretically, thermal additions to the Savannah River from cooling tower blowdown could support *Naegleria fowleri* and other thermophilic microorganisms. However, the thermal plume will have maximum temperatures in the range of 91ºF with a very small mixing zone, thus limiting the conditions necessary for optimal growth. The maximum recorded temperature in the Savannah River in 2003 was 78.3ºF (Table 2.3.3-2). Savannah River temperatures are not optimal for *Naegleria fowleri* reproduction. Therefore SNC determined the risk to public health from thermophilic microorganisms will be SMALL and will not warrant mitigation.

5.3.4.2 Noise Impacts

The new units will produce noise from the operation of pumps, cooling towers, transformers, turbines, generators, switchyard equipment and loudspeakers. NUREG-1555 notes that the principal sources of noise include natural draft cooling towers and pumps that supply the cooling water. As described in Section 4.4.1, neither Georgia nor Burke County has noise regulations. Additionally, neither the state nor the county provides guidelines or limitations for impulse noise like a sharp sound pressure peak occurring in a short interval of time. The nearest residence is approximately two-thirds of a mile from the site boundary or approximately one mile from the site of the new units, and distance and vegetation will attenuate any noise. SNC has not received complaints about the noise of the existing units.

Most equipment will be located inside structures, reducing the outdoor noise level. Except in the case of the river water pumps, which fishermen, canoeists and kayakers on the Savannah River will hear, noise will be further attenuated by distance to the site boundary. The cooling towers and diesel generators (which will operate intermittently) could have noise emissions as high as 55 dBa at distances of 1,000 feet (Westinghouse 2005). The nearest boundary is about 1,500 feet away from the planned cooling towers location.

As reported in NUREG-1437, and referenced in NUREG-1555, noise levels below 60 to 65 dBA are considered of small significance. Therefore, the noise impact at the nearest residence will be SMALL and no mitigation will be warranted.

Commuter traffic will be controlled by speed limits. The access road to the VEGP site is paved. Good road conditions and appropriate speed limits will minimize the noise level generated by the work force commuting to the VEGP site.

Section 2.7 of Regulatory Guide 4.2 (RG 4.2) suggests an assessment of the ambient noise level within 5 miles of the proposed site, particularly noises associated with high voltage transmission lines. No noise assessment has been done due to the rural character of the area. However, as presented in Section 5.6.3.3 SNC has not received any reports of nuisance noise from the existing transmission lines. It is unlikely any new lines will generate more noise than existing lines.

Section 5.3 References

(AEC 1974) Atomic Energy Commission 1974, Final Environmental Statement related to the proposed Alvin W. Vogtle Nuclear Plant, Units 1, 2, 3, and 4, Georgia Power Company, Directorate of Licensing, Washington, D.C., March.

(NOAA 2002) National Oceanic and Atmospheric Administration, Monthly Station Normals of Temperature, Precipitation and Heating and Cooling Degree Days 1971-2000, Georgia, Climatography of the United States No. 81, National Climate Data Center, Asheville, NC.

(NRC 1985) U.S. Nuclear Regulatory Commission 1985, Final Environmental Statement Related to the Operation of Vogtle Electric Generating Plant, Units 1 and 2, NUREG-1087, Office of Nuclear Reactor Regulation, Washington, D.C., March.

(Policastro et al. 1993) Policastro, A. J., W. E. Dunn, and R. A. Carhart, A Model for Seasonal and Annual Cooling Tower Impacts, Atmospheric Environment Vol. 28, No. 3, pp. 379-395, Elsevier Science Ltd, Great Britain.

(Westinghouse 2005) Westinghouse Electric Company, LLC. AP1000 Siting Guide: Site Information for an Early Site Permit Application, APP-0000-XI-001, Revision 3, April 24.

5.4 Radiological Impacts of Normal Operation

This section describes the radiological impacts of normal plant operation on members of the public, plant workers, and biota. Section 5.4.1 describes the exposure pathways by which radiation and radioactive effluents could be transmitted from the new units to organisms living near the plant. Section 5.4.2 estimates the maximum doses to the public from the operation of one new unit. Section 5.4.3 evaluates the impacts of these doses by comparing them to regulatory limits for one unit. In addition, the impact of two new units in conjunction with the two existing units is compared to the corresponding regulatory limit. Section 5.4.4 considers the impact to non-human biota. Section 5.4.5 describes the radiation doses to plant workers from the new units.

5.4.1 Exposure Pathways

Small quantities of radioactive liquids and gases will be discharged to the environment during normal operation of the new units. The impact of these releases and any direct radiation to individuals, population groups, and biota in the vicinity of the new units was evaluated by considering the most important pathways from the release to the receptors of interest. The major pathways are those that could yield the highest radiological doses for a given receptor. The relative importance of a pathway is based on the type and amount of radioactivity released, the environmental transport mechanism, and the consumption or usage factors of the receptor.

The exposure pathways considered and the analytical methods used to estimate doses to the maximally exposed individual (MEI) and to the population surrounding the new units are based on NRC Regulatory Guide 1.109, *Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50*, Appendix I (Rev.1, October 1977) (RG 1.109) and NRC Regulatory Guide 1.111, Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors (Revision 1, July 1977) (RG 1.111). An MEI is a hypothetical member of the public located to receive the maximum possible calculated dose. The MEI allows dose comparisons with established criteria for the public.

5.4.1.1 Liquid Pathways

The new units will release effluents to the Savannah River. The equations and parameters in the VEGP Offsite Dose Calculation Manual (ODCM) **(SNC 2004a)** were used to calculate the doses to offsite receptors from new units. These methods are based on the NRC endorsed LADTAP II computer program. This program implements the radiological exposure models described in Reg. Guide 1.109 for radioactivity releases in liquid effluent. The following exposure pathways are considered in LADTAP II:

- Ingestion of aquatic organisms as food
- Ingestion of drinking water

Irrigation was not considered as a pathway because there is no irrigated garden vegetation pathway downstream of VEGP **(SNC 2004a)**. The input parameters for the liquid pathway are presented in Table 5.4-1 and Table 5.4-2. It should be noted that the dilution factor is a conservative low value of 10.

5.4.1.2 Gaseous Pathways

The equations and parameters in the VEGP ODCM **(SNC 2004a)** were used to calculate the doses to offsite receptors from the new units. These methods are based on the NRC endorsed GASPAR II computer program. This program implements the radiological exposure models described in NRC Reg. Guide 1.109 to estimate the radioactive releases in gaseous effluent and the subsequent doses.

The following exposure pathways are considered in GASPAR II:

- External exposure to contaminated ground
- External exposure to noble gases in air
- Inhalation of airborne activity
- Ingestion of contaminated meat
- Ingestion of contaminated garden vegetables

The input parameters for the gaseous pathway are presented in Table 5.4-3 and Table 5.4-4, and the receptor locations are shown in Table 5.4-5.

5.4.1.3 Direct Radiation from Units 3 and 4

Contained sources of radiation at the new units will be shielded. The AP1000 is expected to provide shielding that is at least as effective as existing light water reactors (LWR). An evaluation of all operating plants by the NRC states that:

> *"…because the primary coolant of an LWR is contained in a heavily shielded area, dose rates in the vicinity of light water reactors are generally undetectable and are less than 1 mrem/year at the site boundary. Some plants [mostly BWRs] do not have completely shielded secondary systems and may contribute some measurable off-site dose." (NUREG-1437, Section 4.6.1.2)*

Thus, the direct radiation from normal operation will result in small contributions at site boundaries. Therefore, direct dose contribution from the new units will be SMALL and will not warrant additional mitigation.

5.4.2 Radiation Doses to Members of the Public

In this section, doses to MEIs from liquid and gaseous effluents from one new unit are estimated using the methodologies and parameters specified in Section 5.4.1.

5.4.2.1 Liquid Pathway Doses

Based on the parameters shown in Table 5.4-1 and Table 5.4-2, the LADTAP II computer program was used to calculate doses to the MEI via the following activities:

- Eating fish caught in the Savannah River
- Drinking water from the Savannah River

The liquid activity releases (source terms) for each radionuclide are shown in Table 3.5-1. The calculated annual doses to the total body, the thyroid, and the maximally exposed organ are presented in Table 5.4-6. The maximum annual dose of 0.015 mrem (millirem or 1/1,000 of a rem) will be to the liver of the maximally exposed adult.

5.4.2.2 Gaseous Pathway Doses

Based on the parameters in Table 5.4-3 and Table 5.4-4, the GASPAR II computer program was used to calculate doses to the maximally exposed individual child, represents the bounding age group. The gaseous activity releases (source terms) for each radionuclide are shown in Table 3.5-2. The calculated annual total body, thyroid, and other organ doses are presented in Table 5.4-7. These calculations are conservative and do not represent actual doses to individuals near the VEGP site.

5.4.3 Impacts to Members of the Public

In this section, the radiological impacts to individuals and population groups from liquid and gaseous effluents are presented using the methodologies and parameters specified in Section 5.4.1. Table 5.4-8 estimates the total body and organ doses to the MEI from liquid effluents and gaseous releases from the new units for analytical endpoints prescribed in 10 CFR 50, Appendix I. The total liquid and gaseous effluent doses from the two existing units plus the new units will be well within the regulatory limits of 40 CFR 190 (Table 5.4-9). As indicated in NUREG-1555, demonstration of compliance with the limits of 40 CFR 190 is considered to be in compliance with the 0.1 rem limit of 10 CFR 20.1301. Table 5.4-10 shows the collective total body to doses the population within 50 miles of the VEGP site that are attributable to the new units. Impacts to members of the public from operation of the new units will be SMALL and will not warrant additional mitigation.

5.4.4 Impacts to Biota Other than Members of the Public

Radiation exposure pathways to biota were examined to determine if the pathways could result in doses to biota greater than those predicted for humans. This assessment used species that provide representative information about the various dose pathways potentially affecting broader classes of living organisms.

Important biota considered were federal and state-protected species commercially or recreationally valuable, and species important to the local ecosystem. Table 5.4-11 identifies the important biota near the VEGP site and the assigned surrogates employed in the assessment of radiation doses. The aquatic species listed in the table are those that may potentially exist in the counties immediately adjacent to the VEGP site, the Savannah River upstream or downstream of the VEGP site, and tributary streams crossed by transmission lines. The terrestrial species listed are those that exist or may potentially exist within the VEGP site or the associated transmission line rights-of-way. The doses are calculated using pathway models adopted from RG 1.109.

5.4.4.1 Liquid Pathway

The LADTAP II computer program was used to calculate doses to the biota via the following exposure pathways:

- Fish – Internal exposure from bioaccumulation of radionuclides and external exposure from sediments
- Shrew – Internal exposure from ingestion of food and external exposure from terrestrial activities
- Mink – Internal exposure from ingestion of invertebrates and external exposure from shoreline activities
- Heron, osprey – Internal exposure from ingestion of fish and external exposure from shoreline activities

Food consumption rates, body masses, and effective body radii used in the dose calculations are shown in Table 5.4-12. In determining shoreline doses, adjustments were made for the fact that biota will be closer to any potential shoreline contamination than humans. Other biota parameters are taken from RG 1.109 and *LADTAP II – Technical Reference and User Guide* (NUREG/CR-4013, April 1986).

5.4.4.2 Gaseous Pathway

Gaseous effluents contribute to the terrestrial doses. Immersion and ground deposition doses are largely independent of organism size, and the doses for the MEI, as described in Section 5.4.2, can be applied to biota. However, the external ground deposition doses, as calculated by GASPAR II, were increased by a factor of two to account for the closer proximity of terrestrial organisms to the ground, similar to the adjustments made for biota exposures to shoreline sediments in LADTAP II.

5.4.4.3 Biota Doses

Doses to biota from liquid and gaseous effluents are shown in Table 5.4-13. Dose criteria are applicable to humans and are considered conservative when applied to biota. The total body dose is taken as the sum of the internal and external dose. In humans, the internal dose from individual organs is weighted by factors less than unity to arrive at the whole body dose equivalent. Thus, a unity factor is assumed for the entire internal dose. Annual doses to all of the surrogates meet the requirements of 40 CFR 190 (Table 5.4-13).

Use of exposure guidelines, such as 40 CFR 190, which apply to members of the public in unrestricted areas, is considered very conservative when evaluating calculated doses to biota. The International Council on Radiation Protection states that "...if man is adequately protected then other living things are also likely to be sufficiently protected," and uses human protection to infer environmental protection from the effects of ionizing radiation **(ICRP 1977, 1991)**. This assumption is appropriate in cases where humans and other biota inhabit the same environment and have common routes of exposure. It is less appropriate in cases where human access is restricted or pathways exist that are much more important for biota than for humans. Conversely, it is also known that biota with the same environment and exposure pathways as man can experience higher doses without adverse effects.

Species in most ecosystems experience dramatically higher mortality rates from natural causes than man. From an ecological viewpoint, population stability is considered more important to the survival of the species than the survival of individual organisms. Thus, higher dose limits could be permitted. In addition, no biota have been discovered that show significant changes in morbidity or mortality due to radiation exposures predicted from nuclear power plants.

An international consensus has been developing with respect to permissible dose exposures to biota. The International Atomic Energy Agency **(IAEA 1992)** evaluated available evidence including the *Recommendations of the International Commission on Radiological Protection* **(ICRP 1977)**. The IAEA found that appreciable effects in aquatic populations will not be expected at doses lower than 1 rad/day and that limiting the dose to the maximally exposed individual organisms to less than 1 rad/day will provide adequate protection of the population. The IAEA also concluded that chronic dose rates of 0.1 rad/day or less do not appear to cause observable changes in terrestrial animal populations. The assumed lower threshold occurs for terrestrial rather than for aquatic animals primarily because some species of mammals and reptiles are considered more radiosensitive than aquatic organisms. The permissible dose rates are considered screening levels and higher species-specific dose rates could be acceptable with additional study or data.

The calculated total body doses in Table 5.4-13 can be compared to the 1 rad/day dose criteria evaluated in the *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards* **(IAEA 1992)**. The biota doses meet the dose guidelines by a large margin. In these cases, the annual dose to biota is much less than the daily allowable doses to aquatic and terrestrial organisms. Impacts to biota other than members of the public from exposure to sources of radiation will be SMALL and will not warrant mitigation.

5.4.5 Occupational Radiation Doses

Based on the available data on the AP1000 design being considered, the maximum annual occupational dose is estimated to be similar to or less than that for the current units. For 2004, the collective radiation dose to workers at VEGP Units 1 and 2 was 80.7 person-rem **(NRC 2005)**. Impacts to workers from occupational radiation doses will be SMALL and will not warrant additional mitigation.

Table 5.4-1 Liquid Pathway Parameters

Parameter	Value
Release Source Terms	Table 3.5-1
Effluent discharge rate	1.3 gpm with 6,000 gpm dilution[1]
Dilution factor for discharge	10[2]
Transit time to receptor	48 hours[2]
Impoundment reconcentration model	None
Population distribution	Table 2.5.1-1

1 Source: DCD, Section 11.2.3
2 Source: **SNC 2004a**

Table 5.4-2 Liquid Pathway Consumption Factors for Maximally Exposed Individual

Consumption Factor	Annual Consumption Rate
Fish consumption (kg/yr)	21
Drinking water consumption (l/yr)	730 l/yr

Source: **SNC 2004a**

Table 5.4-3 Gaseous Pathway Parameters

Parameter	Value
Release Source Terms	Table 3.5-2.
Population distribution	Table 2.5.1-1
Atmospheric dispersion factors	**SNC (2004a)**, Table 3-7.
Ground deposition factors	**SNC (2004a)**, Table 3-7.

Table 5.4-4 Gaseous Pathway Consumption Factors for Maximally Exposed Individual

	Annual Rate			
Consumption Factor	**Infant**	**Child**	**Teen**	**Adult**
Milk consumption (l/yr)	330	330	400	310
Meat consumption (kg/yr)	0	41	65	110
Fresh leafy garden vegetable consumption (kg/yr)	0	26	42	64
Stored leafy garden vegetable consumption (kg/yr)	0	520	630	520

Source: **SNC 2004a**, Table 9-5.

Table 5.4-5 Gaseous Pathway Receptor Locations

Receptor	Direction	Distance (miles)
Nearest site boundary	NW	0.75
Maximally exposed individual	SSW	4.7

Source: **SNC 2004a**, Table 3-7.

Table 5.4-6 Liquid Pathway Doses for Maximally Exposed Individual (1 Unit) (mrem per year)

Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
0.0077	0.015	0.011	0.0024	0.0058	0.0027	0.0021

GI-LLI = Gastrointestinal-lining of lower intestine.
mrem = millirem

Table 5.4-7 Gaseous Pathway Doses for Maximally Exposed Individual (millirem)

Ground Plane Pathway, All Age Groups

Total Body	Skin
3.18E-03	3.74E-03

Inhalation Pathway, Child Age Group

Bone	Liver	Total Body	Thyroid	Kidney	Lung)	GI-LLI
9.49E-04	1.08E-03	1.09E-03	5.72E-03	1.08E-03	1.34E-03	1.06E-03

Inhalation Pathway, Adult Age Group

Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
6.20E-04	1.14E-03	1.15E-03	4.54E-03	1.14E-03	1.34E-03	1.14E-03

Cow Meat Pathway, Child Age Group

Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
3.42E-04	3.46E-04	3.17E-04	8.53E-02	2.86E-04	2.18E-04	4.32E-04

Garden Vegetation Pathway, Child Age Group

Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
1.04E-01	2.18E-02	2.52E-02	9.17E-02	2.07E-02	2.00E-02	2.05E-02

Table 5.4-8 Comparison of Maximally Exposed Individual Doses with 10 CFR 50, Appendix I Criteria

		Annual Dose	
Type of Dose	**Location**	**AP1000 (per unit)**	**Limit**
Liquid effluent			
Total body (mrem)	Beaufort, SC	0.011	3
Maximum organ – liver (mrem)	Beaufort, SC	0.015	10
Gaseous effluent			
Gamma air (mrad)	Site boundary	0.06	10
Beta air (mrad)	Site boundary	0.24	20
Total body (mrem)	Site boundary	0.05	5
Skin (mrem)	Site boundary	0.19	15
Iodines and particulates (all effluents)			
Maximum organ – thyroid (mrem)	4.7 miles, SSW	0.05	15

Table 5.4-9 Comparison of Maximally Exposed Individual Doses with 40 CFR 190 Criteria – (millirem per year)

	Two new units			Existing Units[1]	Site Total	Regulatory Limit
	Liquid	**Gaseous**	**Total**			
Total body	0.022	0.1	0.12	0.091	0.21	25
Thyroid	0.0048	0.009	0.014	0.073	0.09	75
Other organ - liver	0.03	0.021	0.05	0.1	0.15	25

[1] Source: **SNC 2004b**.

Table 5.4-10 Collective Total Body Doses within 50 Miles (millirem per year)

	AP1000 (two units)	Existing Units
Noble gases	2.6E-08	2.44E-11
Iodines and particulates	0.24	1.81E-06
Tritium and C-14	0.11	0.006
Total	0.13	0.006
Natural background	2.17E+05	2.17E+05

Note: Natural background dose is based on a dose rate of 325 mrem/person/yr and a population of 667,092 (Table 2.5.1-1).

Table 5.4-11 Terrestrial and Aquatic Biota Species Analyzed

Animal Class	Species Analyzed
Terrestrial	
Bird	Osprey
	Heron
	Wood Stork
	Eagle
Mammal	Mink
	Shrew
Aquatic	
Fish	Bass
	Minnow

Table 5.4-12 Terrestrial Biota Parameters

Biota	Effective body radius (cm)	Body mass (kg)	Consumption of food (kg/year)
Osprey	3	1.6	122
Heron	5	2.3	146
Wood Stork	10	3.0	146
Eagle	10	4.5	197
Mink	7	0.80	40.2
Shrew	2	0.0097	1.9

Table 5.4-13 Doses to Biota from Liquid and Gaseous Effluents

Biota	Dose (mrad/yr)			Dose (mrad/day)
	Liquid effluents	Gaseous effluents	Total	
Osprey	0.5	0.4	0.9	0.0014
Heron	0.5	0.4	0.9	0.0013
Wood Stork	0.4	0.4	0.8	0.0012
Eagle	0.4	0.4	0.8	0.0011
Mink	0.1	0.4	0.5	0.00027
Shrew	0.15	0.4	0.55	0.0004
Bass	0.03	0	0.03	0.000087
Minnow	0.004	0	0.004	0.00001

Section 5.4 References

(IAEA 1992) International Atomic Energy Agency, Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards, Report Series No. 332.

(ICRP 1977) International Council on Radiation Protection, *Recommendations of the International Commission on Radiological Protection*, ICRP Publication 26.

(ICRP 1991) International Council on Radiation Protection, *Recommendations of the International Commission on Radiological Protection*, ICRP Publication 60.

(NRC 2005) U.S. Nuclear Regulatory Commission, *Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities 2004*, Thirty-Seventh Annual Report, NUREG-0713, Vol.26, Office of Nuclear Regulatory Research, Washington D.C., November.

(SNC 2004a) Southern Nuclear Company, Vogtle Electric Generating Plant – Units 1 And 2, NRC Docket Nos. 50-424 And 50-425, Facility Operating License Nos. NPF-68 and NPF-81, Annual Radioactive Effluent Release Report for January 1 2003 to December 31, 2003.

(SNC 2004b) Southern Nuclear Operating Company, Offsite Dose Calculation Manual for Southern Nuclear Operating Company Vogtle Electric Generating Plant, Version 22, June 25.

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5.5 Environmental Impact of Waste

This section describes the environmental impacts that could result from the operation of the non-radioactive waste system and from storage and disposal of mixed wastes, and radioactive wastes.

5.5.1 Non-radioactive Waste System Impacts

Descriptions of the existing units' waste systems for non-radioactive wastes are presented in Section 3.6.

All non-radioactive wastes generated at the VEGP site, including those from the new units (i.e., solid wastes, liquid wastes, air emissions) will be managed in accordance with applicable federal, state and local laws and regulations, and permit requirements as they are now. Management practices will be the same as for the existing units and will include the following:

- Non-radioactive solid waste (e.g., office waste, recyclables) will be collected and stored temporarily on the VEGP site and disposed or recycled locally.
- Organic debris collected on trash racks and screens at the water intake structures will be disposed of onsite.
- Scrap metal, universal wastes, used oil and antifreeze will be collected and stored temporarily on the VEGP site and recycled or recovered at an offsite permitted recycling or recovery facility, as appropriate.
- Water from cooling and auxiliary systems will be discharged to the Savannah River through permitted outfalls.
- Wastewater treatment sludge will be disposed in an offsite permitted industrial waste landfill.
- Sewage sludge will be transported to the Burke County water works for disposal.

No site-specific waste disposal activities will be unique to the new units.

5.5.1.1 Impacts of Discharges to Water

Non-radioactive wastewater discharges to surface water from the new units will include cooling water blowdown, permitted wastewater from the new units' auxiliary systems, and storm water runoff from impervious surfaces. Table 3.6-1 lists water treatment chemicals that could be used in the new units. VEGP maintains engineering controls that prevent or minimize the release of harmful levels of constituents to the Savannah River. Concentrations of constituents in the cooling water discharge will be limited by NPDES requirements and will be minimal or non-detectable in the river (see Section 5.2.3).

Smaller-volume discharges associated with plant auxiliary systems will be discharged in accordance with applicable NPDES requirements. Therefore, potential impacts from constituents in the cooling water and plant auxiliary systems' discharges from the new units will be SMALL and will not warrant mitigation.

SNC will revise the existing VEGP Storm Water Pollution Prevention Plan, which prevents or minimizes the discharge of harmful quantities of pollutants with the storm water discharge, to reflect the addition of new paved areas and facilities and changes in drainage patterns. Impacts from increases in volume or pollutants in the storm water discharge will be SMALL and will not warrant mitigation.

5.5.1.2 Impacts of Discharges to Land

Operation of the new units will result in an increase in the total volume of non-radioactive solid waste generated at the VEGP site. Anticipated volumes of non-radioactive wastes are presented in Table 3.6-3. However, there will be no fundamental change in the characteristics of these wastes or the way in which they are managed currently at VEGP. All applicable federal, state, and local requirements and standards will be met for handling, transporting, and disposing of the solid waste. All solid waste will be reused or recycled to the extent possible. Solid wastes appropriate for recycling or reclamation (e.g., used oil, antifreeze, scrap metal, universal wastes) will be managed using approved and licensed contractors. All non-radioactive solid waste destined for offsite land disposal will be disposed of at approved and licensed offsite commercial waste disposal site(s). Therefore, potential impacts from land disposal of non-radioactive solid wastes will be SMALL and will not warrant mitigation.

5.5.1.3 Impacts of Discharges to Air

Operation of the new units will increase gaseous emissions to the air by a small amount, primarily from equipment associated with plant auxiliary systems (e.g., auxiliary boilers, emergency diesel generators). Emissions from the diesel-fueled equipment are provided in Table 3.6-3. Cooling tower impacts on terrestrial ecosystems are addressed in Section 5.3.3.2.

All air emission sources associated with the new units will be managed in accordance with federal, state, and local air quality control laws and regulations. Impacts to air quality will be SMALL and will not require mitigation.

5.5.1.4 Sanitary Waste

The existing facility's sanitary waste treatment system (see Section 3.6) will be expanded to accommodate the increases in sanitary wastes associated with the larger workforce. Sanitary wastes will be managed on site and disposed of off site in compliance with applicable laws, regulations, and permit conditions imposed by federal, state, and local agencies.

Potential impacts associated with increases in sanitary waste from operation of the new units will be SMALL and will not warrant mitigation.

5.5.2 Mixed Waste Impacts

The term “mixed waste” refers specifically to waste that is regulated as both radioactive and hazardous waste. As defined in the Atomic Energy Act (AEA) of 1954, as amended, (42 USC 2011 et seq.), mixed waste contains hazardous waste and a low-level radioactive source, special nuclear material, or byproduct material. Radioactive materials at nuclear power plants are regulated by the NRC under the AEA. Hazardous wastes are regulated by the state of Georgia as an EPA-authorized state under the Resource Conservation and Recovery Act (RCRA; 42 USC 6901 et seq.).

Nuclear power plants are not large generators of mixed waste. Proper chemical handling techniques and pre-job planning ensures that only small quantities of mixed waste will be generated by the new units.

The specific types and quantities of mixed waste that could be generated in new operating reactors are not available. However, each AP1000 reactor is estimated by the manufacturer to generate a maximum of 5,759 ft^3 per year of solid low-level radioactive waste (Table 3.0-1) before compaction. The two existing VEGP units generate approximately 1,730 ft^3 annually of low-level radioactive waste (from Table 2.9-1). NUREG-1437 estimates that the volume of mixed wastes produced at nuclear power plants accounts for less than 3 percent by volume of the annual solid low level waste generated at these plants. Therefore, to be conservative, SNC has assumed that the non-compacted volume of mixed waste generated by the two AP1000 units will be approximately 346 ft^3 annually, but, from VEGP experience the non-compacted of mixed waste volume will more likely be approximately 52 ft^3.

SNC will handle mixed wastes generated at the new facilities in accord with existing procedures.

SNC has in place for the existing units contingency plans, emergency preparedness plans, and spill prevention procedures that will be implemented in the unlikely event of a mixed waste spill. Personnel who are designated to handle mixed waste or to respond to mixed waste emergency spills have appropriate training to enable them to perform their work properly and safely. The existing emergency procedures will limit any onsite impacts.

SNC believes that any impacts from the treatment, storage and disposal of mixed wastes generated by the new units will be SMALL and will not warrant mitigation beyond what has been described in the previous paragraphs.

5.5.3 Waste Minimization Plan

VEGP’s existing pollution prevention and waste minimization program will apply to the new units. The previous sections have incorporated components of the waste minimization program in their discussions.

5.5.4 Radioactive Waste

Low-level radioactive waste (LLW) is described in Section 3.5. Westinghouse estimates that one AP1000 will generate approximately 5,759 ft^3 of non-compacted LLW annually. Compaction could reduce the volume by 50 percent or more.

LLW is normally stored on site on an interim basis before being shipped off site for permanent disposal. On-site storage facilities are designed to minimize personnel exposures. High-dose-rate LLW is isolated in a shielded storage area and is easily retrievable. The lower-dose-rate LLW is stacked or stored to maximize packing efficiencies. NRC requirements and guidelines ensure that LLW is stored in facilities that are designed and operated properly and that public health and safety and the environment are adequately protected. The requirements and guidelines include the following:

- The amount of material allowed in a storage facility and the shielding used should be controlled by dose rate criteria for both the site boundary and any adjacent off-site areas. Direct radiation and effluent limits are restricted by 10 CFR Part 20 and 40 CFR Part 190. The exposure limits given in 10 CFR 20.1301 apply to unrestricted areas.
- Containers and their waste forms should be compatible to prevent significant corrosion within the container. After a period of storage, the subsequent transportation and disposal should not cause a container breach.
- Gases generated from organic materials in waste packages should be evaluated periodically with respect to container breach. After a period of storage, the subsequent transportation and disposal should not cause a container breach.
- Gases generated from organic materials in waste packages should be evaluated periodically with respect to container breach. High-activity resins should not be stored more than 1 year unless they are in containers with special vents.
- A program of at least quarterly visual inspection should be established.
- A liquid drainage collection and monitoring system should be in place. Routing of the drain should be to a radwaste processing system.

Commercial low-level waste disposal facilities are sited and operated consistent with 10 CFR 61 and other appropriate regulations, ensuring minimal environmental impact. Waste generators must meet the waste acceptance criteria established for the facility and adhere to packaging requirements. VEGP currently sends wastes to Envirocare in Utah and the Barnwell Low-level Waste Radioactive Management Disposal Facility in South Carolina. Barnwell will no longer accept wastes from Georgia after June 30, 2008. SNC is currently developing alternate disposal plans if the Barnwell facility is no longer available.

VEGP maintains procedures for shipping and handling LLW. SNC determined that the environmental impacts of LLW generation by the new units will be SMALL and not warrant mitigation.

The environmental impacts of on-site LLW management activities, including interim storage, at existing nuclear plants are described in NUREG-1437. Any impacts will result principally from exposure to radioactivity. Workers receive external doses from exposure to radiation while handling and packaging the waste materials and from periodic inspections of the packaged materials and any other handling operations required during interim storage. Such doses account for a small fraction of the total radiation dose commitment to workers and, as discussed in Section 5.4, the total dose commitment is well within regulatory limits. Radiation doses to off-site individuals and biota from interim LLW storage will be SMALL.

5.5.5 Conclusions

Minimal chemical constituents will be discharged to the water or air from operation of the new units. Waste minimization programs will reduce the amount of wastes, including mixed wastes, generated by operation of the new units. All radioactive wastes will be managed according to established laws, regulations, and exposure limits. No new waste streams will be generated. Therefore, impacts of waste generation will be SMALL and will not warrant mitigation.

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5.6 Transmission System Impacts

This section discusses the environmental impacts of the transmission system during operation of the new units. As discussed in Section 3.7, SNC has not finalized the transmission system design for the proposed new generating capacity. However, the proposed new units will require changes to the currently configured transmission and distribution system. Section 3.7.2 describes the proposed new transmission line route.

Current corridor maintenance activities for the VEGP lines are the responsibility of Georgia Power Company (GPC) and are in compliance with applicable federal, state, and local laws and regulations and applicable permit requirements. Maintenance activities on any new transmission line likewise will be the responsibility of GPC and in compliance with all requirements. Section 5.6.1 and Section 5.6.2 discuss the terrestrial and aquatic impacts associated with maintenance activities. Section 5.6.3 discusses the potential impacts to members of the public.

5.6.1 Terrestrial Ecosystems

Section 2.4.1.2 describes the terrestrial ecology along the existing transmission corridors. Impacts of building, operating, and maintaining the existing transmission facilities for Units 1 and 2 were assessed in the FESs for construction **(AEC 1974)** and operation **(NRC 1985)** of the existing units.

GPC has established maintenance procedures summarized below. In addition to the various practices and procedures GPC uses to minimize impacts of transmission facility maintenance across its transmission system, GPC has made a number of commitments to the NRC concerning the maintenance of transmission corridors associated with VEGP. These commitments are part of the existing units' operating licenses, and thus are binding in the manner of the Technical Specifications. Commitments include, but are not limited to, keeping records of herbicide usage that must be readily available to the NRC upon request and reporting unusual occurrences (or mortality) of a federally endangered or threatened species to the GPC Environmental Affairs Department within 24 hours of the discovery.

GPC performs aerial inspections, typically by helicopter, five times each year to support routine maintenance activities. Noise from the fly-overs may startle and temporarily displace local fauna. These impacts are short-term and limited to a localized area. Impacts associated with aerial inspections will be SMALL.

The transmission corridors are managed to prevent woody growth from encroaching on the transmission lines and potentially causing disruption in service or becoming a general safety hazard. Most transmission corridors are recleared on a 3-year maintenance cycle. This cycle may vary depending on public concerns, local ordinances, line maintenance, or environmental considerations. As part of the maintenance cycle, transmission lines and corridors are inspected from the ground and monitored for clearance. Corridor vegetation management involves the use of light equipment (e.g., saws, mowers), herbicides, and hand tools. Mowing is the primary method for maintaining the corridors. Hand cutting and/or herbicides are used in areas where mowing is impractical or undesirable. Herbicides are handled and applied by specialty contractors in accordance with manufacturer specifications and guidance from jurisdictional regulatory agencies. Contractors are appropriately trained and licensed to perform such work.

The use of light equipment (e.g., pick-up trucks, tractors with mower attachments, small-engine hand tools) in transmission corridors could result in incidental spills of fuel and/or lubricants. Whenever these materials are taken into the field, adequate spill response materials are available for immediate clean-up of any spills. Additionally, personnel are trained in how to respond to, clean-up, and report a spill. Contaminated material is managed and disposed of in accordance with federal and state laws and regulations.

Keeping the corridors free of woody vegetation can create suitable habitat for protected plant species (e.g., rare, threatened, endangered) that depend on open conditions. GPC cooperates with the Georgia DNR Natural Heritage Program in management of sensitive sites within transmission corridors.

These same vegetation management practices will be applied to new corridors.

No areas designated by the U.S. Fish and Wildlife Service (USFWS) as “critical habitat” for endangered species exist on or adjacent to existing VEGP transmission lines. The transmission corridors do not cross state or federal parks. Approximately 4.4 miles of the Scherer transmission corridor passes through the Oconee National Forest. Approximately 0.4 miles of the Thallman transmission corridor passes through the Ebenezer Creek Swamp, a privately-owned National Natural Landmark. GPC procedures specifically address corridor and transmission line maintenance in this swamp in accordance with the VEGP Environmental Protection Plan. For example, routine maintenance involving tree trimming is done by hand in this area. The Thallman transmission corridor also crosses the Yuchi Wildlife Management Area, which is adjacent to VEGP, and the Tuckahoe Wildlife Management Area, approximately 30 miles south of VEGP.

Although almost all portions of the VEGP transmission corridors are located in Georgia, approximately 17 miles of the 21.5-mile South Carolina Electric & Gas Company (SCE&G) transmission corridor are in South Carolina. This portion of the corridor is maintained by SCE&G which has its own set of transmission line maintenance procedures that are protective of the environment.

Potential impacts associated with corridor maintenance activities will be SMALL.

Until the new transmission corridor is sited, the environmental impacts can not be quantified. However, GPC has a history of working with regulatory agencies to protect all ecological resources along existing lines, as evidenced by this discussion. Impacts of transmission lines on terrestrial resources during operations will be SMALL and will not warrant mitigation.

Transmission line corridor management was evaluated in NUREG-1437. The impacts were found to be of small significance at operating nuclear power plants. Based on OPC procedures and the NRC analysis of the impacts of corridor management, SNC concludes that the effects of transmission corridor maintenance on the new transmission line corridor will be SMALL.

The effects of transmission line maintenance and vegetation management on floodplains and wetlands were evaluated in NUREG-1437. The impacts were found to be of small significance at operating nuclear power plants. Based on GPC procedures and the NRC analysis, SNC concludes that the effects of new transmission corridor maintenance on floodplains and wetlands will be SMALL.

Transmission line and corridor maintenance personnel have not reported dead birds from collisions or contact with VEGP transmission lines. GPC has an Avian Protection Plan in place to monitor and address the impacts of transmission lines or structures on birds. All issues are coordinated with the U.S. Fish and Wildlife Service as provided for in the Avian Protection Plan. Any additional transmission line will not be expected to cause significant avian mortality, and overall impacts will be SMALL.

5.6.2 Aquatic Ecosystems

This section discusses potential impacts of operation and maintenance of the transmission system on important aquatic habitats and species. Impacts of building, operating, and maintaining the existing transmission facilities for Units 1 and 2 were assessed in the FESs for construction **(AEC 1974)** and operation **(NRC 1985)** of the existing units. Section 4.1.2 discusses the proposed new transmission line. The proposed new line route will cross Burke, Jefferson, Warren, and McDuffie counties.

GPC has issued guidelines and procedures to its transmission engineering and delivery personnel to ensure that transmission lines are maintained and transmission rights-of-way are managed in such a way that important aquatic habitats are preserved and important aquatic species are protected. For example, the company's Routine Line Inspection and Maintenance Procedures require Transmission Delivery personnel to check transmission corridors at least three times a year for encroachment, erosion problems, or evidence of unauthorized logging or construction activity adjacent to the lines. Correcting erosion problems and curtailing unauthorized logging and construction serve to benefit aquatic communities in down-gradient streams and wetlands.

In addition to inspections intended to identify and correct problems, GPC has adopted practices and procedures for mitigating environmental impacts from maintenance of transmission lines.

GPC requires line crews engaged in operation and maintenance of transmission lines crossing waterways to:

- Keep vegetative disturbance to a minimum
- Grade and grass disturbed areas to prevent erosion and sedimentation
- Avoid environmentally sensitive areas including National Wild and Scenic Rivers, waterfowl nesting areas, water supply intakes, “concentrated” shellfish spawning areas, and endangered species habitats
- Build crossings so as to minimize placement of fill material in the waterway or adjacent wetland
- Remove (temporary) fill material in its entirety and restore the area to its original elevation

Among the maintenance commitments memorialized in the VEGP operating license, GPC has agreed that maintenance within designated wetland areas must be conducted so as to not disturb the bottom substrate. When necessary, board roads or mats will be employed to prevent substrate damage. No dredge or fill activities that will result in a discharge of sediment within the wetland areas is allowed without a USACE permit.

5.6.2.1 Important Habitats

The proposed 500 kV transmission line is unlikely to cross any state parks, national parks, state conservation areas, state or national wildlife refuges, or critical habitat for any federally listed species because Georgia can require that types of protected areas to be avoided if possible. The proposed new line will be routed northwest from the VEGP site, and could cross perennial or intermittent streams and associated floodplains or wetlands. Programs in place for the current transmission lines associated with VEGP provide controls to ensure protection of threatened and endangered species, wetlands, and cultural resources. These programs or similar programs will be utilized for the new transmission line and will provide an equivalent level of protection for ecological and cultural resources. Impacts of transmission lines on ecological resources during operations will be SMALL and will not warrant mitigation.

5.6.2.2 Important Species

Only two listed aquatic species, the shortnose sturgeon and the Atlantic pigtoe mussel, are known to occur in the counties crossed by the proposed transmission line. As noted in Section 2.4.2, shortnose sturgeon spawn in the Savannah River. Brier Creek, a major tributary of the Savannah River, will likely be crossed by the proposed transmission line. Because shortnose sturgeon do not leave the Savannah River during spawning runs to enter tributary streams, operation and maintenance of this line will have no effect on spawning shortnose sturgeon.

As discussed in Section 2.4.2, the Atlantic pigtoe mussel is found in a tributary of the Ogeechee River (Willamson Swamp Creek) in Jefferson County. The new line could pass within two miles of the creek. Because of the distance, transmission line maintenance associated with the new line will have no effect on Williamson Swamp Creek, thus no effect on the creek's Atlantic pigtoe mussels.

As discussed throughout this section, GPC has procedures in place to ensure that erosion and sedimentation are controlled and herbicides are used sparingly. Because GPC has adopted practices and procedures to prevent impacts to surface waters and wetlands, impacts to aquatic ecosystems from operation and maintenance of transmission lines will be SMALL and will not warrant mitigation measures beyond the commitments already identified in this section.

5.6.3 Impacts to Members of the Public

5.6.3.1 Electrical Shock

Objects located near transmission lines can become electrically charged due to their immersion in the lines' electric field. This charge results in a current that flows through the object to the ground. The current is called "induced" because there is no direct connection between the line and the object. The induced current can also flow to the ground through the body of a person who touches the object. An object that is insulated from the ground can actually store an electrical charge, becoming what is called "capacitively charged." A person standing on the ground and touching a vehicle or a fence receives an electrical shock due to the sudden discharge of the capacitive charge through the person's body to the ground. After the initial discharge, a steady-state current can develop, the magnitude of which depends on several factors, including the following:

- the strength of the electric field which, in turn, depends on the voltage of the transmission line as well as its height and geometry
- the size of the object on the ground
- the extent to which the object is grounded.

The National Electrical Safety Code (NESC) has a provision that describes how to establish minimum vertical clearances to the ground for electric lines having voltages exceeding 98 kilovolts. The clearance must limit the induced current due to electrostatic effects to 5 milliamperes if the largest anticipated truck, vehicle, or equipment were short-circuited to ground. By way of comparison, the setting of ground fault circuit interrupters used in residential wiring (special breakers for outside circuits or those with outlets around water pipes) is 4 to 6 milliamperes.

As described in Section 3.7, two 500-kilovolt lines are proposed to service new generation considered for the Vogtle site, which may be configured in any combination of existing and potential new transmission lines. To determine the impacts of these lines on induced current shock, SNC analyzed a hypothetical span of a 500-kilovolt line originating at VEGP. The hypothetical case is for a ruling span that represents a template for the design of all the spans. The analyzed case is the most extreme condition expected on the line, given that the design standard for 500-kilovolt lines requires a minimum clearance of 45 feet to ground.

SNC calculated electric field strength and induced current using a computer code called ACDCLINE, produced by the Electric Power Research Institute. The results of this computer program have been field-verified through actual electrostatic field measurements by several utilities. The input parameters included the design features of the ruling span at the point of lowest clearance, the NESC requirement that line sag be determined at 120ºF conductor temperature, and the maximum vehicle size under the lines (a tractor-trailer).

The analysis determined that 500-kilovolt lines that connect to VEGP have the capacity to induce up to 3.8 milliamperes in a vehicle parked beneath the line. Should a new transmission line be constructed in the same corridor as an existing line, it is possible that the induced current beneath the two lines could exceed the 3.8 milliamp value calculated for a single line alone. Due to vector summing, the cumulative impact could also be less. SNC commits to design any new transmission lines to ensure compliance with the 5-milliamp standard for the two lines acting in concert. Consequently, impacts will be SMALL.

5.6.3.2 Electromagnetic Field Exposure

In 1992, the U.S. Congress established a research and educational program designed to determine if exposure to extremely low frequency electric and magnetic fields (ELF-EMF) was harmful to humans. The research and information compilation effort was conducted by the National Institute of Environmental Health Sciences (NIEHS), the National Institutes of Health, and the Department of Energy. Their findings **(NIEHS 1999)** state, “The scientific evidence suggesting that ELF-EMF exposures pose any health risk is weak.” Nevertheless, NIEHS concluded that such exposure could not be ruled as entirely safe, but that the evidence was insufficient to warrant aggressive regulatory concern. SNC concurs with this finding, but nonetheless continues to monitor industry research on this subject.

5.6.3.3 Noise

High-voltage transmission lines can emit noise when the electric field strength surrounding them is greater than the breakdown threshold of the surrounding air, creating a discharge of energy. This energy loss, known as corona discharge, is affected by ambient weather conditions such as humidity, air density, wind, and precipitation and by irregularities on the energized surfaces. GPC transmission lines are designed and constructed with hardware and conductors with features to eliminate corona discharge. Nevertheless, during wet weather, the potential for corona loss increases, and nuisance noise could be present if insulators or other hardware have any defects. Corona-induced noise along the existing transmission lines is very low or inaudible, except possibly directly below the line on a quiet, humid day. Such noise does not pose a risk to humans. In its Environmental Protection Plan **(SNC 1989)**, SNC committed to monitor complaints on transmission line noise and report them to NRC; SNC has not received any reports of nuisance noise from members of the public. Accordingly, SNC does not expect complaints on nuisance noise from the proposed ESP transmission lines and concludes impacts will be SMALL.

5.6.3.4 Radio and Television Interference

GPC very seldom receives complaints on electromagnetic interference with radio or television reception. In those few cases, the cause was from corona discharge from defective insulators or hardware. GPC replaced the defective component to correct the problem. As described in section 5.6.3.3, GPC transmission lines are designed to be corona-free up to their maximum operating voltage. A 1974 study on radio noise around GPC 500-kilovolt lines near Atlanta indicated that radio noise outside a 150-foot corridor is minimal. SNC expects that radio and television interference from any new lines will be SMALL.

5.6.3.5 Visual Impacts

Should new transmission lines be constructed for new generation at the Vogtle site, they will be sited in accordance with long-standing procedures that take into consideration environmental and visual values. SNC will attempt to maintain important viewscapes. Where possible natural vegetation will be retained at road crossings to help minimize ground-level visual impacts. Contractors performing routine vegetation control on the transmission lines will be instructed to maintain a screen of natural vegetation in the right-of-way on each side of major highways and rivers, unless engineering requirements dictate otherwise. Accordingly, the visual impacts to members of the public from the transmission system will be SMALL.

Section 5.6 References

(AEC 1974) U.S. Atomic Energy Commission, Final Environmental Statement related to the proposed Alvin W. Vogtle Nuclear Plant Units 1, 2, 3, and 4, Directorate of Licensing, Washington, DC, March.

(NIEHS 1999) "NEIHS Report on Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields," Publication No. 99-4493, Research Triangle Park, North Carolina, 1999.

(NRC 1985) U.S. Nuclear Regulatory Commission, Final Environmental Statement related to the operation of Vogtle Electric Generating Plant, Units 1 and 2, Office of Nuclear Reactor Regulation, Washington, DC, March.

(SNC 1989) Appendix B to Facility Operating License No. NPF-68 and Facility Operating License No. NPF-81, Vogtle Electric Generating Plant Units 1 and 2, Docket Nos. 50-424 and 50-425, Environmental Protection Plan (Nonradiological), Birmingham, Alabama, March 31.

5.7 Uranium Fuel Cycle Impacts

This section discusses the environmental impacts from the uranium fuel cycle for the AP1000. The uranium fuel cycle is defined as the total of those operations and processes associated with provision, utilization, and ultimate disposal of fuel for nuclear power reactors.

The regulations in 10 CFR 51.51(a) state that

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

Table S-3 is used to assess environmental impacts. Its values are normalized for a reference 1000-MWe LWR at an 80-percent capacity factor. The 10 CFR 51.51(a) Table S-3 values are reproduced as the “Reference Reactor” column in Table 5.7-1. SNC has analyzed an AP1000 unit operating at 93 percent capacity factor in this ESP application. The results of this analysis are also included in Table 5.7-1.

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

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

The following assessment of the environmental impacts of the fuel cycle for an AP1000 at VEGP is based on the values in Table S-3 and the NRC's analysis of the radiological impacts from radon-222 and technetium-99 in NUREG-1437 which SNC has reviewed and updated for this analysis. NUREG-1437 and Addendum 1 to the GEIS **(NRC 1999)**, provide a detailed analysis of the environmental impacts from the uranium fuel cycle. Although NUREG-1437 is specific to impacts related to license renewal, the information is relevant to this review because the advanced LWR designs considered here use the same type of fuel.

The fuel impacts in Table S-3 are based on a reference 1000-MWe LWR operating at an annual capacity factor of 80 percent for a net electric output of 800 MWe. SNC is considering operating two AP1000 at VEGP. The standard configuration (a single unit) will be used to evaluate uranium fuel cycle impacts relative to the reference reactor. In the following evaluation of the environmental impacts of the fuel cycle, SNC conservatively assumed a gross electrical output of 1,150 MWe **(Westinghouse 2003)** and a capacity factor of 93 percent for a total gross electric output of approximately 1,070 MWe for the AP1000, the AP1000 output is approximately one and one third times the output used to estimate impact values in Table S-3 (reproduced here as the first column of Table 5.7-1) for the reference reactor. Analyses presented here are scaled from the 1000-MWe reference reactor impacts to reflect the output of one AP1000.

Recent changes in the fuel cycle may have some bearing on environmental impacts; however, as discussed below, SNC is confident that the contemporary fuel cycle impacts are bounded by values in Table S-3. The NRC calculated the values in Table S-3 from industry averages for the performance of each type of facility or operation associated with the fuel cycle. NRC chose assumptions so that the calculated values will not be under-estimated. This approach was intended to ensure that the actual values will be less than the quantities shown in Table S-3 for all LWR nuclear power plants within the widest range of operating conditions. Since Table S-3 was promulgated changes in the fuel cycle and reactor operations have occurred. For example, the estimate of the quantity of fuel required for a year's operation of a nuclear power plant can now reasonably be calculated assuming a 60-year lifetime (40 years of initial operation plus a 20-year license renewal term). This was done in NUREG-1437 for both BWR and PWRs, and the highest annual requirement (35 metric tonnes [MT] of uranium made into fuel for a BWR) was used in NUREG-1437 as the basis for the reference reactor year. A number of fuel management improvements have been adopted by nuclear power plants to achieve higher performance and to reduce fuel and enrichment requirements, reducing annual fuel requirements. For example, an AP1000 requires about 23 MTU per year. Therefore, Table S-3 remains a conservative estimate of the environmental impacts of the fuel cycle fueling nuclear power reactors operating today.

Another change is the elimination of the U.S. restrictions on the importation of foreign uranium. The economic conditions of the uranium market now and in the foreseeable future favor full utilization of foreign uranium at the expense of the domestic uranium industry. These market conditions have forced the closing of most U.S. uranium mines and mills, substantially reducing the environmental impacts in the United States from these activities. However, the Table S-3 estimates have not been adjusted accordingly so as to ensure that these impacts, which will have been experienced in the past and may be fully experienced in the future, are considered. Factoring in changes to the fuel cycle suggests that the environmental impacts of mining and tail millings could drop to levels below those in Table S-3. Section 6.2 of NUREG-1437 discusses the sensitivity of these changes in the fuel cycle on the environmental impacts.

Finally, the no-recycle option might not always be the only option for spent fuel disposition in this country. The Energy Policy Act of 2005 (Pub. L. No. 109-58) directs the U. S. Department of Energy (DOE) to conduct an advanced fuel recycling technology research, development, and demonstration program to evaluate proliferation-resistant fuel recycling and transmutation technologies. DOE has reported to Congress on a plan to begin limited recycling of fuel with current reactors by 2025, and transitional recycling with current reactors by 2040 **(DOE 2005)**. Thus, during the 40-year term of the licenses to operate VEGP, it is possible that spent fuel recycling becomes available. However, many actions on the part of DOE will be necessary before this research and development concept becomes a technological reality. For this reason, SNC has concluded that this option is too speculative to warrant further consideration for VEGP.

5.7.1 Land Use

The total annual land requirements for the fuel cycle supporting an AP1000 will be about 150 acres. Approximately 17 acres will be permanently committed land, and 130 acres will be temporarily committed. A “temporary” land commitment is a commitment for the life of the specific fuel cycle plant (e.g., a mill, enrichment plant, or succeeding plants). Following decommissioning the land could be released for unrestricted use. “Permanent” commitments represent land that may not be released for use after decommissioning because decommissioning does not result in the removal of sufficient radioactive material to meet the limits of 10 CFR 20, Subpart E for release of an area for unrestricted use.

In comparison, a coal-fired plant of 1100 MWe capacity using strip-mined coal requires about 270 acres per year for fuel alone. The impacts on land use will be SMALL and will not warrant mitigation.

5.7.2 Water Use

Principal water use for the fuel cycle supporting this ESP application will be that required to remove waste heat from the power stations supplying electricity to the enrichment process. Scaling from Table S-3, of the total annual water use of 1.52×10^{10} gallons for the AP1000 fuel cycle, about 1.48×10^{10} will be required for the removal of waste heat. Evaporative losses from fuel cycle process cooling will be about 2.1×10^{8} gallons per year and mine drainage will account for 1.7×10^{8} gallons per year. Impacts on water use will be SMALL and not warrant mitigation.

5.7.3 Fossil Fuel Impacts

Electric energy and process heat are required during various phases of the fuel cycle process. The electric energy is usually produced by the combustion of fossil fuel at conventional power plants. Electric energy associated with the fuel cycle represents about 5 percent of the annual electric power production of the reference 1000-MWe LWR. Process heat is primarily generated by the combustion of natural gas. This gas consumption, if used to generate electricity, will be less that 0.14 percent of the electrical output from the reference reactor. The direct and indirect consumption of electrical energy for fuel cycle operations will be small relative to the power production of the proposed units.

5.7.4 Chemical Effluents

The quantities of liquid, gaseous and particulate discharges associated with the fuel cycle processes are given in Table S-3 (Table 5.7-1) for the reference 1000-MWe LWR. The quantities of effluents for an AP1000 will be approximately one and one-third times greater than those in Table S-3 (Table 5.7-1). The principal effluents are SO_x, NO_x, and particulates. Based on the U.S. Environmental Protection Agency National Air Pollutant Emissions Estimates for 2000 **(EPA 2005)**, these emissions constitute less than 0.1 percent of all SO_2 emissions in 2000, and 0.02 percent of all NO_X emissions in 2000.

Liquid chemical effluents produced in the fuel cycle processes are related to fuel enrichment and fabrication and may be released to receiving waters. All liquid discharges into navigable waters of the United States from facilities associated with fuel cycle operations are subject to requirements and limitations set by an appropriate federal, state, regional, local or Tribal regulatory agency. Tailing solutions and solids are generated during the milling process and are not released in quantities sufficient to have a significant impact on the environment. Impacts from chemical effluents will be SMALL and will not warrant mitigation.

5.7.5 Radioactive Effluents

Radioactive gaseous effluents estimated to be released to the environment from waste management activities and certain other phases of the fuel cycle are set forth in Table S-3 (Table 5.7-1). From these data the 100-year environmental dose commitment to the U.S. population was calculated for one year of the fuel cycle for the AP1000 in this ESP application (excluding reactor releases and dose commitments due to radon-222 and technetium-99). The dose commitment to the U.S. population will be approximately 5.3 person-Sv (530 person-rem) per year of operation of the AP1000.

The additional whole body dose commitment to the U.S. population from radioactive liquid wastes effluents due to all fuel cycle operations other than reactor operation will be approximately 2.7 person-Sv (270 person-rem) per year of operation. Thus the estimated 100-year environmental dose commitment to the U.S. population from the fuel cycle is approximately 8 person-Sv (800 person-rem) to the whole body per reactor-year for the AP1000.

The radiological impacts of radon-222 and technetium-99 releases are not included in Table S-3. Principal radon releases occur during mining and milling operations and as emissions from mill tailings. Principal technetium-99 releases occur as releases from the gaseous diffusion enrichment process. Three previous applicants provided an evaluation of technetium-99 and radon-222 which NRC included in the subsequent EISs. SNC has reviewed the evaluation, considers it reasonable, and has provided it as part of this ESP application.

Section 6.2 of NUREG-1437 estimates radon-222 releases from mining and milling operations, and from mill tailings for a year of operation of the reference 1000-MWe LWR. The estimated releases of radon-222 for one AP1000 reactor year are 6,900 Ci. Of this total, about 78 percent will be from mining, 15 percent from milling, and 7 percent from inactive tails before stabilization. Radon releases from stabilized tailings were estimated to be 1.5 Ci per year for the AP1000; that is one and one-third times the NUREG-1437 estimate for the reference reactor year. The major risks from radon-222 are from exposure to the bone and lung, although there is a small risk from exposure to the whole body. The organ-specific dose weighting factors from 10 CFR 20 were applied to the bone and lung doses to estimate the 100-year dose commitment from radon-222 to the whole body. The 100-year estimated dose commitment from mining, milling and tailings before stabilization for the AP1000 will be approximately 12 person-Sv (1,200 person-rem) to the whole body. From stabilized tailing piles, the same estimated 100-year environmental dose commitment will be approximately 0.23 person-Sv (23 person-rem) to the whole body.

NUREG-1437 considered the potential health effects associated with the releases of technetium-99. The estimated releases for the AP1000 will be 0.0094 Ci from chemical processing of recycled uranium hexafluoride before it enters the isotope enrichment cascade and 0.0067 Ci into groundwater from a high-level-waste repository. The major risks from technetium are from exposure of the gastrointestinal tract and kidneys, and a small risk from whole-body exposure. Applying the organ-specific dose-weighting factors from 10 CFR 20 to the gastrointestinal tract and kidney doses, the total-body 100-year dose commitment from technetium-99 is estimated to be 1.3 person-Sv (130 person-rem) for the AP1000.

Although radiation can cause cancer at high doses and high dose rates, no data unequivocally establish a relationship between cancer and low doses or low dose rates, below about 100 mSv (10,000 mrem). However, to be conservative radiation protection experts assume that any amount of radiation may pose some risk of cancer, or a severe hereditary effect, and that higher radiation exposures create higher risks. Therefore, a linear, no-threshold dose response relationship is used to describe the relationship between radiation dose and detrimental effects. Based on this model, risk to the public from radiation exposure can be estimated using the nominal probability coefficient (730 fatal cancers, non-fatal cancers or severe hereditary effects per 10,000 person-Sv [1,000,000 person-rem]) from the International Commission on Radiation Protection Publication 60 **(ICRP 1991)**. This coefficient, multiplied by the sum of the estimated whole-body population doses estimated above for the AP1000, approximately 13 person-Sv per year (1,300 person-rem per year), estimates that the U.S. population could incur a total of approximately 0.02 fatal cancers, non-fatal cancers or severe hereditary effects from the annual fuel cycle for the AP1000. This risk is small compared to the number of fatal cancers, non-fatal cancers and severe hereditary effects that will be estimated to occur in the U.S. population annually from exposure to natural sources of radiation using the same risk estimation methods.

Based on these analyses, SNC concludes that the environmental impacts of radioactive effluents from the fuel cycle will be SMALL and will not warrant mitigation.

Table 5.7-1 10 CFR 51.51 Table S-3 of Uranium Fuel Cycle Environmental Data (normalized to model LWR annual fuel requirement [WASH-1248] or reference reactor year [NUREG-0116])[1] compared to proposed AP1000 configuration

	Ref. Reactor	AP1000
MWe	1000	1150
Capacity	0.8	0.93
MWe	800	1070
Environmental Considerations		
Natural Resource Use		
Land (acres)		
Temporarily committed[2]	100	130
Undisturbed area	79	110
Disturbed area	22	29
Permanently committed	13	17
Overburden moved (million of MT)	2.8	3.7
Water (millions of gallons)		
Discharged to air	160	210
Discharged to water bodies	11,090	15,000
Discharged to ground	127	170
Total	11,377	15,000
Fossil fuel		
Electrical energy (thousands of MW-hour)	323	430
Equivalent coal (thousands of MT)	118	160
Natural gas (millions of scf)	135	180
Effluents - Chemicals (MT)		
Gases (including entrainment)[3]		5,900
SO_x	4400	1,600
NO_x[4]	1190	19
hydrocarbons	14	40
CO	29.6	1,500
particulates	1154	
Other gases		
F	0.67	0.90
HCl	0.014	0.019

Table 5.7-1 (cont.) 10 CFR 51.51 Table S-3 of Uranium Fuel Cycle Environmental Data (normalized to model LWR annual fuel requirement [WASH-1248] or reference reactor year [NUREG-0116])[1] compared to proposed AP1000 configuration

	Ref. Reactor	AP1000
Environmental Considerations		
Liquids		
SO^{4-}	9.9	13
NO^{3-}	25.8	34
fluoride	12.9	17
Ca^{++}	5.4	72
Cl^{-}	8.5	11
Na^{+}	12.1	16
NH_3	10	13
Fe	0.4	0.53
Tailings solutions (thousands of MT)	240	320
Solids	91,000	120,000
Effluents – radiological (curies)		
Gases		
$Rn^{222(5)}$		
Ra^{226}	0.02	0.027
Th^{230}	0.02	0.027
U	0.034	0.045
H^{3} (thousands)	18.1	24
C^{14}	24	32
Kr^{85} (thousands)	400	530
Ru^{106}	0.14	0.19
I^{129}	1.3	1.7
I^{131}	0.83	1.1
$Tc^{99(5)}$		
Fission products and TRU	0.203	0.27
Liquids		
U and daughters	2.1	2.8
Ra^{226}	0.0034	0.0045
Th^{230}	0.0015	0.0020

Table 5.7-1 (cont.) 10 CFR 51.51 Table S-3 of Uranium Fuel Cycle Environmental Data (normalized to model LWR annual fuel requirement [WASH-1248] or reference reactor year [NUREG-0116])[1] compared to proposed AP1000 configuration

	Ref. Reactor	AP1000
Environmental Considerations		
Th^{234}	0.01	0.013
fission and activation	5.90E-06	7.9E-06
Solids buried		
not HLW (shallow)	11,300	15,000
TRU and HLW (deep)	1.10E+07	1.5E+07
Effluents – thermal (Billions of Btu)	4063	5400
Transportation (person rem)		
exposure of workers and the general public	2.5	3.3
occupational exposure	22.6	30

TRU transuranic
HLW high level waste

1 In some cases where no entry appears in Table S-3 it is clear from the background documents that the matter was addressed and that, in effect, the table should be read as if a specific zero entry had been made. However, there are other areas that are not addressed at all in the table. Table S-3 does not include health effects from the effluents described in the table, or estimates of releases of radon-222 from the uranium fuel cycle or estimates of technetium-99 released from waste management or reprocessing activities. Radiological impacts of these two radionuclides are addressed in NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants, (1996) and it was concluded that the health effects from these two radionuclides posed a small significance.

Data supporting Table S-3 are given in the "Environmental Survey of the Uranium Fuel Cycle", WASH-1248 (April 1974); the "Environmental Survey of Reprocessing and Waste Management Portion of the LWR Fuel Cycle," NUREG-0116 (Supplement 1 to WASH-1248); the "Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," NUREG-0216 (Supp. 2 to WASH-1248); and in the record of final rule making pertaining to "Uranium Fuel Cycle Impacts from Spent Fuel Reprocessing and Radioactive Waste Management, Docket RM-50-3." The contributions from reprocessing, waste management and transportation of wastes are maximized for either of the two fuel cycles (uranium only and fuel recycle). The contribution from transportation excluded transportation of cold fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor which are considered in Table S-4 of § 51.20(g). The contributions from the other steps of the fuel cycle are given in columns A-E of Table S-3A of WASH-1248.

2 The contributions to temporarily committed land from reprocessing are not prorated over 30 years, since the complete temporary impact accrues regardless of whether the plant services one reactor for one year or 57 reactors for 30 years.

3 Estimated effluents based upon combustion of coal for equivalent power generation.

4 1.2 percent from natural gas use and processes.

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

Section 5.7 References

(DOE 2005) U.S. Department of Energy, 2005, Report to Congress: Advanced Fuel Cycle Initiative Objectives, Approach and Technology Summary. Executive Summary, Office of Nuclear Energy, Science and Technology, Washington, D.C. May.

(EPA 2005) U.S. Environmental Protection Agency, Air Emission Trends – Continued Program through 2004, available at http://www.epa.gov/cgi-bin/epaprintonly.cgi. Accessed August 30, 2005

(ICRP 1991) 1990 Recommendations of the International Commission of Radiological Protection, ICRP Publication 60, Annals of the ICRP 21(1-3), Pergammon Press, New York, New York, 1991.

(NRC 1999) U.S. Nuclear Regulatory Commission, 1996, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Section 6.3, "Transportation," and Table 9-1, "Summary of findings on NEPA issues for license renewal of nuclear power plants," NUREG-1437, Volume 1, Addendum 1, Office of Nuclear Regulatory Research, Washington D.C., August.

(Westinghouse 2003) Westinghouse Electric Company, LLC, AP1000 Siting Guide: Site Information for an Early Site Permit Application, APP-0000-X1-001, Revision 3, April 24.

5.8 Socioeconomic Impacts

5.8.1 Physical Impacts of Station Operation

This section assesses the potential physical impacts due to operation of the new units on the nearby communities or residences. Potential impacts include noise, odors, exhausts, thermal emissions, and visual intrusions. These physical impacts will be managed to comply with applicable federal, state and local environmental regulations and will not significantly affect the VEGP site and its vicinity.

There are no residential areas located within the site boundary. The area within 10 miles of the VEGP site is estimated to be populated by approximately 3,500 people (see Section 2.5). This area is predominately rural and characterized by farmland and wooded tracts. No significant industrial or commercial facilities other than VEGP exist or are planned for this area. Population distribution details are given in Section 2.5.1.1.

5.8.1.1 Air

Burke County is part of the Augusta-Aiken Interstate Air Quality Control Region (AQCR) (40 CFR 81.114). All areas within the Augusta-Aiken AQCR are classified as achieving attainment with the National Ambient Air Quality Standards (NAAQS) (40 CFR 81.311 and 40 CFR 81.341). The NAAQS define ambient concentration criteria for sulfur dioxide (SO_2), particulate matter with aerodynamic diameters of 10 microns or less (PM_{10}), particulate matter with aerodynamic diameters of 2.5 microns or less ($PM_{2.5}$), carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), and lead (Pb). These pollutants are generally referred to as “criteria pollutants.” Areas of the United States having air quality as good as or better than the NAAQS are designated by the U.S. Environmental Protection Agency (EPA) as attainment areas. Areas with air quality that is worse than the NAAQS are designated by EPA as non-attainment areas. The nearest non-attainment area to VEGP is the Columbia, South Carolina metropolitan area, a non-attainment area under the 8-hour ozone standard, which is located approximately 80 miles northeast of the plant.

The new units will have standby diesel generators and auxiliary power systems. Emissions from those sources are described in Section 3.6.3. Certificates to operate these pieces of equipment will ensure that air emissions comply with regulations. The generators and auxiliary boilers will be operated periodically on a limited short-term basis. The impact of the operation of the new units on air quality will be SMALL, and will not warrant mitigation.

Good access roads and appropriate speed limits will minimize the amount of dust generated by the commuting work force.

During normal plant operation, the new units will not use chemicals in amounts that will generate odors exceeding the odor threshold value.

5.8.1.2 Thermal Emissions

Heat dissipation to the atmosphere from operation of the cooling towers is described in Section 5.3.3.1. Because there is no residential area within the site boundary, there will be no heat impacts on nearby communities.

5.8.1.3 Visual Intrusions

The nearest residence is more than one mile from the site of the proposed new units and is shielded by forested land. Given this distance, residents will not have a clear view of the new units. The intake structure will be clearly visible from the Savannah River, and the towers and top of the containment domes likely will be glimpsed from some locations on the river. However, the viewscape will be similar to the existing viewscape.

The visual impacts of the operation of the cooling towers will be the towers themselves and plumes resembling lines of clouds. Modeling indicated that the plumes will be most noticeable in the winter months. A plume could extend 5 to 6 miles from the VEGP site. The longest plume will occur 1 percent of the time or less in each direction.

Figure 5.8-1 depicts the amount of time that the modeled visible plume heads in each direction during the winter months. The length of the bars represents the frequency of a plume in each direction. The modeled plume heads towards the Savannah River Site (SRS) 45 percent of the time. The next most predominant frequencies are to the south and southwest.

Figure 5.8-2 depicts the maximum modeled plume length by direction and the frequency that the plume reaches the maximum length during the winter months. Many of the maximum modeled plume lengths are from 5 to 6 miles long, but only the southwest direction has a frequency greater than 1 percent.

Figures 5.8-3 and 5.8-4 depict the same information modeled for the summer months. The modeled plume heads towards the SRS 43 percent of the time. The next most predominant frequencies for the plume direction are to the north-northwest, northwest, and west-southwest. The modeled maximum plume lengths are much shorter during the summer months and do not travel much farther than the VEGP site boundary.

5.8.1.4 Other Impacts

Roads within the vicinity of the VEGP site will experience a temporary increase in traffic at the beginning and the end of the workday. However, the current road network has sufficient capacity to accommodate the increase, as detailed in Section 5.8.2.2. Therefore, no significant traffic congestion will result from operation of the new units.

5.8.1.5 Conclusion

Physical impacts to the surrounding population as a result of operation of the new units will be SMALL and will not warrant mitigation.

5.8.2 Social and Economic Impacts

This section evaluates the demographic, economic, infrastructure, and community impacts to the region as a result of operating two AP1000 nuclear units at the VEGP site. The evaluation assesses impacts of operation and of demands placed by the workforce on the region. Operation of the new nuclear units could continue for 60 years (a potential 40-year initial operating license, plus 20 additional years of operation under a renewed license). A two-unit facility will require approximately 660 onsite employees.

It is likely that operation of the new units will overlap for a time with the continued operation of the existing units, which employ 890 onsite staff. The Units 1 and 2 VEGP refueling outages last approximately 4 to 6 weeks and require approximately 800 additional workers. For the new units, refueling outages will last 3 to 5 weeks and employ as many as 1000 additional workers.

5.8.2.1 Demography

The 2000 population within the 50-mile radius of the region was approximately 670,000 and is projected to grow to approximately 4.5 million by 2090, for an average annual growth rate over the 90-year period of 2.1 percent (see Table 2.5.1-1). SNC anticipates employing 660 operations workers at the new units. To be conservative, SNC assumes that all of the new units' employees will migrate into the region, and that each operations worker will bring a family. The average household size in Georgia and South Carolina are 2.65 and 2.53, respectively. To be conservative, SNC used the Georgia household size of 2.65 to estimate the increase in population in the 50-mile region. An operational workforce of 660 will increase the population in the 50-mile region by approximately 1,750 people.

Seventy-nine percent of the current VEGP workforce is distributed across Burke (20 percent), Richmond (26 percent), and Columbia (34 percent) Counties, and 20 percent is distributed across 25 other counties in the two-state region. SNC assumes that the new units' workforces' residential distribution will resemble that of the current VEGP workforce. Therefore, approximately 350 people will live in Burke County, 460 will live in Richmond County, and 590 will live in Columbia County. These numbers constitute 1.6 percent, 0.2 percent, and 0.7 percent of the 2000 populations of Burke, Richmond, and Columbia Counties, respectively.

The remaining employees and their families will be scattered throughout the other 25 counties within the 50-mile radius of VEGP. The operations workers and their families will represent a very small percent of the existing population.

Additional jobs in the region will result from the multiplier effect attributable to the new operations workforce. In the multiplier effect, each dollar spent on goods and services by an operations worker becomes income to the recipient who saves some but re-spends the rest. The recipients re-spending becomes income to someone else, who in turn saves part and re-spends the rest. The number of times the final increase in consumption exceeds the initial dollar spent is called the "multiplier." The U.S. Department of Commerce Bureau of Economic Analysis Economics and Statistics Division provides multipliers for industry jobs and earnings **(BEA 2005)**. The economic model, RIMS II, incorporates buying and selling linkages among regional industries and was used to estimate the impact of new nuclear plant-related expenditure of money in the region of interest. For every operations job at the new units, an estimated additional 1.41 jobs will be created in the 50-mile region, which means that 660 direct jobs will result in an additional 930 indirect jobs for a total of approximately 1,600 new jobs in the region. Since most indirect jobs are service-related and not highly specialized, SNC assumes that most, if not all, indirect jobs will be filled by the existing workforce within the 50-mile region.

5.8.2.2 Impacts to the Community

5.8.2.2.1 Economy

The impacts of the new units' operation on the local and regional economy depend on the region's current and projected economy and population. The economic impacts of a potential 60-year period of operation are discussed below.

SNC assumes, conservatively, that all new operating personnel would come from outside of the 50-mile region. The employment of the operations workforce for such an extended period of time would have economic and social impacts on the surrounding region. Burke County will be the most affected county in the 50-mile region (i.e., the relationship of the net economic benefits of new nuclear units to the total economy of a county will be greatest in Burke County) because it is the most rural of the three counties that will be most affected, and because it will receive property tax revenues assessed on the new units, in addition to tax revenues generated by the operations workforce that will settle in the county.

The wages and salaries of the operating workforce will have a multiplier effect that could result in an increase in business activity, particularly in the retail and service industries. As stated previously (Section 5.8.2.1), for every new operations job an estimated additional 1.41 indirect jobs would be created, which means that the 660 direct jobs would result in an additional 930 jobs for a total of 1,600 jobs. SNC assumes that 132 direct operations workers (20 percent) would relocate to Burke County and 186 indirect workers (20 percent) would already reside in Burke County. SNC estimates that most indirect jobs would be service-related, not highly specialized, and filled by the existing workforce within the 50-mile region, particularly the three counties of interest. There are currently 7,800 unemployed workers in the three counties and 936 in Burke County. SNC anticipates that some or all of the indirect jobs created by the operations workforce will be filled by unemployed workers in these counties, especially Burke County. This will have a positive impact on the economy by providing new business and job opportunities for local residents. In addition, these businesses and employees will generate additional profits, wages, and salaries, upon which taxes will be paid.

SNC concludes that the impacts of Units 3 and 4 operations on the economy will be beneficial and SMALL everywhere in the region except Burke County, where the impacts will be beneficial and MODERATE, and that mitigation will not be warranted.

5.8.2.2.2 Taxes

Personal and Corporate Income Taxes

Georgia has a personal and corporate income tax. Employees of VEGP's new nuclear units will pay taxes on their wages and salaries to Georgia if (1) their residence is in Georgia, (2) they are nonresidents working in Georgia and filing a federal return which will include income from sources in Georgia that exceeds five percent of income from all sources, or (3) they have income that is subject to Georgia tax that is not subject to federal income tax.

GPC will pay Georgia a corporate income tax on the profits received from the sale of electricity generated by the new units. While the exact amount of tax payable to Georgia is not known, it could be substantial over the potential 60-year life of the plant. Although the taxes collected over the potential lifetime of the project could be large in absolute amounts, they will be small when compared to the total amount of taxes Georgia collects in any given year or over the 60-year period.

New businesses will pay income taxes, and will hire workers who will be taxed on wages and salaries. Thus, the tax base in the region will expand, particularly in the three counties most affected by the influx of new workers.

Sales and Use Taxes

Georgia, South Carolina, and the counties surrounding the VEGP site will experience an increase in the amount of sales and use taxes collected. Additional sales and use taxes will be generated by retail expenditures of the operating workforce.

Currently, it is difficult to assess which counties and local jurisdictions will be most impacted by sales and use taxes collected from the new workforce. Burke County is rural with limited shopping or entertainment options, although this will likely change over the estimated 60-year life of the new units. The retail center of the 50-mile region is the Augusta metropolitan area, so it is likely that the Augusta metropolitan area will realize the greatest increase in and derive the greatest benefit from sales and use taxes.

In absolute terms, the amount of sales and use taxes collected over a potential 60-year operating period could be large, but small when compared to the total amount of taxes collected by Georgia and South Carolina, and the affected counties.

Property Taxes

One of the main sources of economic impact related to the operation of new units will be property taxes assessed on the facility. Currently VEGP's tax payments represent 80-82 percent of the total property taxes received by Burke County (see Table 2.5.2-8). Property taxes that will be paid by the co-owners for the new units during operations depend on many factors, most of which are unknown at this time, including millage rates and the percent ownership of each co-owner. In order to provide some sense of the impacts of tax revenues, SNC made simplifying assumptions to develop an estimate of tax payments. For example, SNC has assumed that, beginning with the first year of construction, the new units will be valued annually by the Georgia Department of Revenue. A construction start date and operations schedule were assumed only to support this analysis and may be considerably different in actuality. Tax payments are calculated using different methodologies for investor-owned utilities and municipally-owned utilities or electric cooperatives, so for purposes of this analysis, SNC estimated property taxes by disregarding any joint ownership arrangements and assuming that the units will be subject to the ad valorem tax in Burke County as though owned by a single entity filing on a non-unit basis. Some percent of the new units will be exempt from the ad valorem property tax. Because the actual percent is not known, SNC made a preliminary assumption based on other generating facilities in Georgia. Neither the value of the Allowance for Funds Used During Construction (AFUDC; the cost of money), nor how much of AFUDC will be allowed to be recouped in the rate base is known. Therefore, SNC used generic assumptions. SNC based costs on reasonable assumptions supported by several independent studies **(MIT 2003, UC 2004, EIA 2004, OEDC 2005)** and the company's own analyses.

Table 5.8.2-1 provides SNC estimates of property taxes that the new nuclear units could provide annually to Burke County during the 40-year period of operation. This estimated range is based on the range of estimated costs of the new units generated by information provided by GPC to the Georgia Public Service Commission (which has not been publicly disclosed) and costs taken from the studies mentioned above. The table shows decreasing tax payments over time due to the affect of depreciation.

The second source of property taxes will be on housing owned by the new workforce. To be conservative, SNC anticipates that the entire operations workforce will relocate from outside the region. New workers could construct new housing or increase the demand for existing housing, which could increase housing prices, increasing home values and property tax assessments. In the larger municipalities in the region, the increase in property taxes paid, though important and large when aggregated over time, will be insignificant compared to the total property taxes collected. In the less populated jurisdictions, such as Burke County, the effects could be more significant. For example, local planners consider Burke County fire-fighting capabilities to be under-staffed and under-funded. Increased tax revenues could be used to upgrade the Burke County fire-fighting capabilities.

Summary of Tax Impacts

SNC believes that the impact of additional taxes will be SMALL in the 50-mile region, except for Burke County where they will be MODERATE to LARGE and mitigation will not be warranted.

5.8.2.2.3 Land Use

NUREG-1437 presents an analysis of offsite land use during license renewal (i.e., operations) that is based on (1) the size of plant-related population growth compared to the area's total population, (2) the size of the plant's tax payments relative to the community's total revenue, (3) the nature of the community's existing land-use pattern, and (4) the extent to which the community already has public services in place to support and guide development. In the same document, NRC presents an analysis of offsite land use during refurbishment (i.e. large construction activities) that is based on population changes caused by refurbishment activities. SNC reviewed the criteria and methodology in NUREG-1437 and determined that NRC's criteria and methodology are appropriate to evaluate socioeconomic impacts of operation of new units.

Burke County is the focus of the land use analysis because the new units and a percentage of the workforce will reside there. A larger percentage of the workforce will live in Richmond and Columbia Counties, but those counties are heavily populated and land use changes there are influenced by a variety of other socioeconomic forces. Those forces will significantly dilute potential land use impacts created by the operation of the new units.

Based on the case-study analysis of refurbishment, in NUREG-1437 NRC concluded that all new land-use changes at nuclear plants will be:

SMALL — if population growth results in very little new residential or commercial development compared with existing conditions and if the limited development results only in minimal changes in the area's basic land use pattern.

MODERATE — if plant-related population growth results in considerable new residential and commercial development and the development results in some changes to an area's basic land use pattern.

LARGE — if population growth results in large-scale new residential or commercial development and the development results in major changes in an area's basic land-use pattern.

Second, NRC defined the magnitude of refurbishment-related population changes as follows:

SMALL if plant-related population growth is less than five percent of the study area's total population, especially if the study area has established patterns of residential and commercial development, a population density of at least 60 persons per square mile, and at least one urban area with a population of 100,000 or more within 50 miles.

MODERATE if plant-related growth is between five and 20 percent of the study area's total population, especially if the study area has established patterns of residential and commercial development, a population density of 30 to 60 persons per square mile, and one urban area within 50 miles.

LARGE if plant-related population growth and density is greater than 20 percent of the area's total population is less than 30 persons per square mile.

Third, NRC defined the magnitude of license renewal-related tax impacts as:

SMALL if the payments are less than 10 percent of revenue.

MODERATE if the payments are between 10 and 20 percent of revenue.

LARGE if the payments are greater than 20 percent of revenue.

Finally, NRC determined that, if the plant's tax payments are projected to be a dominant source of the community's total revenue, new tax-driven land-use changes will be large. This would be especially true where the community has no pre-established pattern of development or has not provided adequate public services to support and guide development in the past.

Off-site Land Use in Burke County

Burke County (830 sq mi); **(USCB 2006)** has the second largest land area of any county in Georgia and includes six small incorporated municipalities and a very large unincorporated area. The predominant land uses are agriculture and forestry (76 percent of the unincorporated area in the County in 1990) (Section 2.2). In 1990, developed areas represented approximately 6 to 7 percent of the total land area in the County (Section 2.2). Most industry is related to forestry and manufacturing and no new industries have located in the area as a result of VEGP's presence. Most of the current VEGP workforce does not live in Burke County.

As stated in Sections 2.2 and 2.5.2.4, Burke County and municipalities within the county use comprehensive land use planning, land development codes, zoning, and subdivision regulations to guide development. From 1990 to 2000, the Burke County population grew at an average annual growth rate of 0.8 percent. The County encourages growth in areas where public facilities, such as water and sewer systems, exist or are scheduled to be built in the future. Burke County promotes the preservation of its communities' natural resources and has no growth control measures. The County is revising its comprehensive plan and developing a zoning plan.

Operations-Related Population Growth

This analysis assumes that 20 percent of the workforce needed to operate the new units will reside in Burke County. As stated in Section 2.5.1, the 2000 population of Burke County was approximately 22,243 with a population density of 27 persons per square mile. Burke County could gain 130 new families and 350 people or 2 percent, of the total 2000 populations of Burke County.

According to NRC guidelines, operations-related population changes will be considered small if plant-related population growth will be less than five percent of the study area's total population, the area has an established pattern of residential and commercial development, a population density of at least 60 persons per square mile, and at least one urban area with a population of 100,000 or more (Augusta: 195,182) within 50 miles. With the exception of population density, Burke County meets the NRC criteria and SNC concludes that changes to the population of Burke County due to VEGP operations will be SMALL. Anticipated population increases attributable to VEGP's workforce would represent 0.2 percent of the 2000 Richmond County population, 0.7 percent of the 2000 Columbia County population and even smaller percentage of the population of other counties in the 50-mile region. SNC concludes that impacts would be SMALL.

Tax Revenue-Related Impacts

VEGP's tax payments represent 80-82 percent of the total property taxes received by Burke County (see Table 2.5.2-8). Using NRC's criteria, SNC's tax payments are of large significance to Burke County. As described in Section 5.8.2.2.2, SNC expects that the new nuclear units will generate similar property tax revenue for Burke County.

Conclusion

Burke County is still predominantly rural, and land in the county will likely continue to be used for agriculture and forestry into the foreseeable future. Commercial and residential development is minimal and has experienced little change over the 20 years of existing plant operations. As stated in Section 2.5.2.6, Burke County has 900 vacant housing units, therefore the influx of operations workers and their families will not spur residential development, particularly since the operations workforce will arrive as the much larger construction workforce is leaving the area. The County's infrastructure and public services are sufficient to support the existing populations and will not be significantly impacted by the in-migration of the new workers and their families. SNC concludes that Burke County is capable of meeting the needs of the anticipated work force without additional housing, infrastructure or public utilities and that impacts to other counties will be less significant than those in Burke County.

Although SNC property tax payments will continue to be of large significance, the population and land use in Burke County have not changed significantly since the construction of the original VEGP units, indicating that the tax revenues are not leading to significant land use impacts. Tax revenues assist with funding schools, emergency management systems, road maintenance, and county facilities.

Therefore, by NRC criteria, off-site land use changes will be SMALL and will not warrant mitigation.

5.8.2.2.4 Transportation

Impacts of new units' operations on transportation and traffic will be greatest on the rural roads of Burke County, particularly River Road, a two-lane highway which provides the only access to VEGP. Impacts on traffic are determined by four elements: (1) the number of operations workers and their vehicles on the roads; (2) the number of shift changes for the operations workforce; (3) the projected population growth rate in Burke County, and (4) the capacity of the roads.

SNC estimates it will employ an operation workforce of 660 workers at the new units. This analysis conservatively assumes one worker per vehicle. The existing units' workforce of 890 (and outage workforces of up to 1000) also will access VEGP via River Road.

Traffic congestion will be most noticeable during shift-change, which will occur three times a day. To enter the plant, the workforce will use the current access road that has a left turn lane from River Road to allow workers to enter the plant and other traffic to continue on, alleviating congestion.

Georgia Department of Transportation (DOT) assumes road capacity on two lane highways to be 1,700 passenger cars per hour (pc/h) for one direction and 3,200 pc/h for both directions combined **(TRB 2000)**. Traffic on River Road north of VEGP, as measured by the 2004 Average Annual Daily Traffic (AADT) was 1,277 in one direction (see Table 2.5.2-6 and Figure 2.5.2-2; location 33). Most traffic on River Road is related to VEGP, although there is some local traffic.

SNC doubled the 2004 AADT unidirectional count on River Road to arrive at an estimate of 2,554 vehicles on River Road in a single 24-hour period. For purposes of analysis SNC assumed that 100 percent of the 2,554 vehicles are attributable to the current VEGP workforce (60 percent day shift; 30 percent night shift; 10 percent graveyard shift). The AADT does not consider hourly traffic volume. After conservatively assuming that all traffic is due to VEGP workers, SNC assumed that all traffic on River Road occurred during shift change. SNC assumes that the afternoon shift change results in the highest hourly traffic count as approximately 800 day shift workers leave and 400 night shift workers arrive. Therefore, SNC uses 1,200 cars per hour as the basis for predicting the impacts of additional operations traffic.

The 2000 Burke County population was 22,243 (Table 2.5.1-3) and will increase by an estimated 20 percent by 2020, the earliest date SNC estimates operations activities will begin, however because most of the traffic on River Road is plant-related and because of the conservative assumptions SNC has made regarding the timing of VEGP traffic, local traffic was not factored into the analysis.

The capacity of River Road is 3,200 cars per hour, so there is enough capacity for an additional 2,000 passenger cars or equivalent beyond the current 1,200 cars per hour use now. AP1000 operations will increase the existing VEGP workforce by 660 workers, divided into four shifts. There could also be as many as 1,000 outage workers per unit (divided between two shifts) for approximately 1 month annually or semiannually. SNC assumes that the number of new operations workers per shift will be similar, in percentage, to the current operations workforce. Therefore, during the afternoon shift change, approximately 60 percent of the 660 operations workers will leave the VEGP site while 30 percent will arrive, increasing the vehicles on River Road by approximately 600, for a total of 1,800 vehicles. VEGP operations traffic will not exceed road capacity. During outages, assuming 1,000 additional vehicles, the number of vehicles on River Road could be 2,800 per hour, nearing but still less than, capacity.

SNC will stagger outage schedules so only one unit will be down at a time. Therefore, SNC is confident that road capacity will not be exceeded. SNC concludes that impacts to traffic will be SMALL at most times and MODERATE during shift changes during outages and that mitigation is not warranted.

5.8.2.2.5 Aesthetics and Recreation

As with the original units, SNC will work to minimize the visual impact of the structures through use of topography, design, materials and color. People boating on the Savannah River are used to seeing intake canals on that reach of the river, and people who reside in the area are used to the existing towers and plumes. Trees will screen the other plant facilities from view from the river and from River Road. The new towers will be similar in design to the existing towers, and the additional plumes will resemble cumulus clouds when seen from a distance. SNC has determined that impacts of operations on aesthetics will be SMALL and will not warrant mitigation.

The Yuchi WMA and a boat landing on the Savannah River are immediately south of VEGP on River Road. Additional worker traffic on River Road could adversely affect hunters and fishermen using the road to get to these recreation facilities. However, use of the WMA/boat landing is seasonal and not likely to coincide with shift traffic. Because it will be unlikely that hunters and fishermen will be on River Road at the same time as the workers, impacts will be SMALL and will not warrant mitigation. The operation of new nuclear units at the existing VEGP site will not affect any other recreational facilities in the 50-mile region.

5.8.2.2.6 Housing

While there is no way of accurately estimating the number of available housing units at the commencement of operations, Section 2.5.2.6 reviews the year 2000 availability of housing in the region.

In 2000, there were 4,466 vacant rental units and 1,997 vacant housing units for sale in Burke, Richmond, and Columbia Counties. It is likely adequate housing will be available, especially in the larger metropolitan areas, at the time the workforce was needed. If 20 percent of the new workforce moved to Burke County, about 130 families will move into the county. While there is currently enough housing to accommodate all the new families expected in Burke County, not all housing may be the type sought by the new workforce. Therefore, a percentage of the operations workforce that could be expected to reside in Burke County could choose to live elsewhere in the three-county region or to construct new homes.

In all three counties, the average income of the new workforce will be expected to be higher than the median or average income in the county, therefore, the new workforce could exhaust the high-end housing market and some new construction could result. Burke County is the most likely county for this to happen. However, the availability of high-end housing in the region could mitigate any impacts. The majority of the current VEGP workforce lives in Richmond and Columbia Counties and the Columbia County housing market is rapidly expanding, as is evidenced by its four percent increase in housing between 1990 and 2000 (Table 2.5.2-10).

Refueling outages will occur at least annually, and sometimes semiannually, when the new and existing units are all operational. SNC estimates that the maximum increase in workforce will be 1,000 outage workers. These workers will need temporary (3 to 5 weeks) housing. Most of the outage workers will stay in local extended stay hotels, rent rooms in local homes or bring travel trailers. The outage workforce will not affect the permanent housing market in the region.

SNC concludes that the potential impacts on housing will be SMALL in Richmond and Columbia Counties and the 50-mile region of operations and SMALL to MODERATE in Burke County. Because the lead time for constructing and operating a nuclear facility is several years, and because the community will be aware of this construction project, people will recognize the opportunity for additional housing and construct new homes in anticipation of the arrival of the workforce. Additional mitigation will not be warranted.

5.8.2.2.7 Public Services

Water Supply Facilities

SNC considered both plant demand and plant-related population growth demands on local water resources. Section 2.5.2.7 describes the public water supply systems in the area, their permitted capacities, and current demands. The average per capita water usage in the U.S. is

90 gallons per day per person. Of that, 26 gallons is used for personal use **(EPA 2003)**. The balance is used for bathing, laundry and other household uses.

VEGP does not use water from a municipal system. Onsite wells provide potable water, and will provide the water for the new units as well. Therefore, water usage at the VEGP site, will not impact municipal water suppliers. VEGP is permitted to take an annual average of 5.5 million gallons of groundwater per day (mgd). The VEGP wells provided an average of 1.052 mgd of water between 2001 and 2004 for sanitary water facilities, central water supply, cooling water, process water, and irrigation (Section 4.2.2).

SNC has conservatively assumed that each new worker will require 26 gallons of potable water per day, for a total of 17,160 additional gallons. Impacts to groundwater from the additional workforce will be SMALL and not require mitigation.

Municipal water suppliers in the region have excess capacity (see Table 2.5.2-12). The impact to the local water supply systems from operations-related population growth can be estimated by calculating the amount of water that will be required by these individuals. The average person in the U.S. uses about 90 gallons per day **(EPA 2003)**. The operation-related population increase of 1,750 people could increase consumption by 157,500 gallons per day in an area where the excess public water supply capacity from groundwater in Burke County, alone, is approximately 3,000,000 gallons per day and regional aquifer yields of 2,000 gallons per minute are common. Impacts to municipal water suppliers from the operations related population increase will be SMALL and not warrant mitigation.

Waste Water Treatment Facilities

VEGP has a private wastewater treatment facility sized for the two existing units. As part of the new units' construction project, the facility will be expanded to support the increased capacity of the additional units. Therefore, operations will not impact the VEGP wastewater treatment facility.

Section 2.5.2.7 describes the public waste water treatment systems in the three counties, their permitted capacities, and current demands. Waste water treatment facilities in the three counties have excess capacity (see Table 2.5.2-13). The impact to local waste water treatment systems from operations-related population increases can be determined by calculating the amount of water that will be used and disposed of by these individuals. The average person in the U.S. uses about 90 gallons per day **(EPA 2003)**. To be conservative, SNC estimates that 100 percent of this water will be disposed of through the waste water treatment facilities. The operations-related population increase of 1,750 people could require 157,500 gallons per day of additional waste water treatment capacity in an area where the excess treatment capacity is approximately 19 million gallons per day. Impacts to waste water treatment facilities will be SMALL and not warrant mitigation.

Police Services

In 2001, Burke, Richmond, and Columbia Counties' persons per police officer ratios were 271:1, 998:1, and 992:1, respectively (see Table 2.5.2-14). Ratios are in part, dependent on population density. Fewer officers are necessary for the same population if the population resides in a smaller area. Local planning officials consider the level of police protection in the Central Savannah River Area, that includes the three counties, as adequate for the population **(CSRARDC 2005)**. SNC does now and will continue to employ its own security force at VEGP.

Burke County will see an influx of approximately 350 new residents. Approximately 460 new residents will move into Richmond County, and approximately 590 will move into Columbia County. The rest of the workforce will live in other counties in the 50-mile region. These population increases will increase the persons per police officer ratios (Table 5.8.2-1) by 0.3 and 0.7 percent in Richmond, and Columbia Counties, respectively. Burke County's person per police officer ratio will increase 1.8 percent, but the county will still have the lowest person to officer ratio of the three.

Based on the percentage increase in persons per police officer ratios, operations-related population increases will not adversely affect existing police services in Burke, Richmond or Columbia Counties.

SNC concludes that the potential impacts of new unit operations on police services in Burke, Richmond and Columbia Counties and in the 50-mile region will be SMALL and will not warrant mitigation.

Fire Protection Services

In 2001, Burke, Richmond, and Columbia Counties' persons per firefighter ratios were 890:1, 666:1, and 676:1, respectively (Table 2.5.2-14).

For new unit operations, Burke County will see an influx of approximately 350 new residents. Approximately 460 new residents will move into Richmond County, and approximately 590 will move into Columbia County. The rest of the workforce will live in other counties in the 50-mile region. These population increases will increase the persons per firefighter ratios (Table 5.8.2-2) by 0.2 and 0.7 percent in Richmond, and Columbia Counties, respectively. Burke County's person per firefighter ratio will increase 1.6 percent.

Based on the percentage increase in persons per firefighter ratios, operations-related population increases will not have a significant impact on existing fire protection services in Burke, Richmond, or Columbia Counties.

SNC concludes that the potential impacts of the new reactors' workforce on fire protection services in Burke, Richmond and Columbia Counties and the 50-mile region will be SMALL and mitigation will not be warranted.

Medical Services

Information on medical services in the three-county region is provided in Section 2.5.2.6. Minor injuries to operations workers will be assessed and treated by onsite medical personnel. Other injuries will be treated at one of the hospitals in the three-county region, depending on severity of the injury. SNC has agreements with some local medical providers to support emergencies at VEGP. SNC will revise the agreements to include emergency medical services for the additional workforce. Operation activities are not expected to burden existing medical services.

The medical facilities in the three county region provide medical care to much of the population within the 50-mile region. The operations workforce will increase the population in the 50-mile region by much less than one percent. The potential impacts of operations on medical services will be SMALL and mitigation will not be warranted**.**

5.8.2.2.8 Social Services

New reactors and the associated population influx likely will economically benefit the disadvantaged population served by the Georgia Department of Human Resources. The additional direct jobs will increase indirect jobs that could be filled by currently unemployed workers, thus removing them from social services client lists. Many of these benefits could accrue to Burke County, where, because of the smaller economic base, they might have a more noticeable impact. Impacts will be SMALL and positive and not require mitigation.

5.8.2.2.9 Education

SNC assumes that the new workforce will relocate to the 50-mile region with their families, increasing the population by approximately 1,750 people. Approximately 20 percent will settle in Burke County, 26 percent in Richmond County, and 34 percent in Columbia County. The remaining 20 percent will be distributed across the 25 other counties within the region.

In Georgia 26.5 percent of the population is under 18 years old **(USCB 2005)**. Therefore, SNC conservatively estimates that in an operations-workforce related population of 1,750, approximately 464 will be school-aged (Table 5.8.2-4).

Burke County will see the largest increase in school-age population of 3 percent. However, when spread over K-12 grades it is unlikely this increase will be noticeable on class size, particularly since these children will attend schools that were losing the children of construction workers.

Increased property and special option sales tax revenues as a result of the increased population, and, in the case of Burke County, property taxes on the new reactors, will fund additional teachers and facilities.

SNC concludes that impacts to the three counties school systems and school systems within the region will be SMALL and will not warrant mitigation.

5.8.3 Environmental Justice

Environmental justice refers to a Federal policy under which each Federal agency identifies and addresses, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority or low-income populations. The NRC has a policy on the treatment of environmental justice matters in licensing actions (69 FR 52040).

SNC evaluated whether the health or welfare of minority and low-income populations could be disproportionately adversely affected by potential impacts.

SNC identified the most likely pathways by which adverse environmental impacts associated with the operation of new units at the VEGP site could affect human populations. In this document, SNC analyzed potential operations impacts on the following resource areas: land use, water, air, socioeconomic, ecological, health and safety, waste, and cultural resources. SNC has identified SMALL impacts in all resources areas in the 50-mile radius, with the exception of Burke County. In Burke County, SMALL impacts were found in all resource areas except:

- Economy – beneficial and MODERATE
- Property tax revenue – beneficial and MODERATE to LARGE
- Transportation – MODERATE at shift change during outages
- Housing – MODERATE

Increased property tax revenues and their boost to the local economy are considered by most people to be beneficial. Moderate increases in traffic will mostly affect people living along or traveling on River Road and 56 spur during morning and afternoon shift change. However, the capacity of the roads will not be exceeded. MODERATE impacts to housing are expected to be mitigated by new housing construction and should not affect homeowners or renters already residing in Burke County.

SNC located minority and low-income populations within the 50-mile radius of VEGP (Figures 2.5.4-1 through 2.5.4-4). VEGP is in a predominantly Black Races census block group, and adjacent census block groups also have predominantly Black Races populations.

SNC also investigated the possibility of subsistence-living populations in the vicinity of VEGP by contacting local government officials, the staff of social welfare agencies, and businesses concerning unusual resource dependencies or practices that could result in potentially disproportionate impacts to minority and low-income populations. SNC asked about minority, low-income, and migrant populations or locations of particular concern, and whether subsistence living conditions were evident. No one contacted reported such dependencies or practices, as subsistence agriculture, hunting, or fishing, through which the populations could be disproportionately adversely affected by the construction project.

In summary, no operations-related adverse health or environmental effects that will disproportionately affect impacting minority or low-income populations were identified. Therefore, SNC concludes that impacts of operations of new nuclear units at the VEGP site on minority and low-income populations will be SMALL and mitigation will not be warranted.

Table 5.8.2-1 Estimated Property Taxes Generated by VEGP Units 3 and 4.

Years of Operation	Range of Average Annual Tax Payments to Burke County for Units 3 and 4	
2015 - 2024	20,000,000	29,000,000
2025 - 2034	16,000,000	23,000,000
2035 - 2044	14,000,000	10,000,000
2045 - 2055	3,500,000	5,000,000

Table 5.8.2-2 Police Protection in the Three Counties, Adjusted for the AP1000 Workforce and Associated Population Increase

County	Total Population	Additional Population Due to New Plant Operations	Total Population	Police Protection in 2001	Estimated Persons per Police Officer Ratio	2001 Person Per Police Officer Ratio	Percent Increase from 2001 Persons per Police Officer Ratio
Burke	22,243	350	22,593	82	276:1	271:1	1.8
Richmond	199,775	460	200,235	200	1,001:1	998:1	0.3
Columbia	89,288	590	89,878	90	999:1	992:1	0.7

Source: **CSRARDC 2005**

Table 5.8.2-3 Fire Protection in the Three Counties, Adjusted for the AP1000 Workforce and Associated Population Increase

County	Total Population	Additional Population Due to New Plant Operations	Total Population	Firefighters (Full time and Volunteer)	Estimated Persons per Firefighter Ratio	2001 Persons Per Firefighter Ratio	Percent Increase from Current Persons per Firefighter Ratio
Burke	22,243	350	22,593	25	904:1	890:1	1.6
Richmond	199,775	460	200,235	300	667:1	666:1	0.2
Columbia	89,288	590	89,878	132	680:1	676:1	0.7

Source: **CSRARDC 2005**

Table 5.8.2-4 Estimated Additional Public School Age Students in the Three Counties as a Result of Operation of the AP1000

County	Population Increase	Population under age 18	Percentage of Additional Public School Children per County
Burke	350	93	2
Richmond	460	122	<1
Columbia	590	156	<1

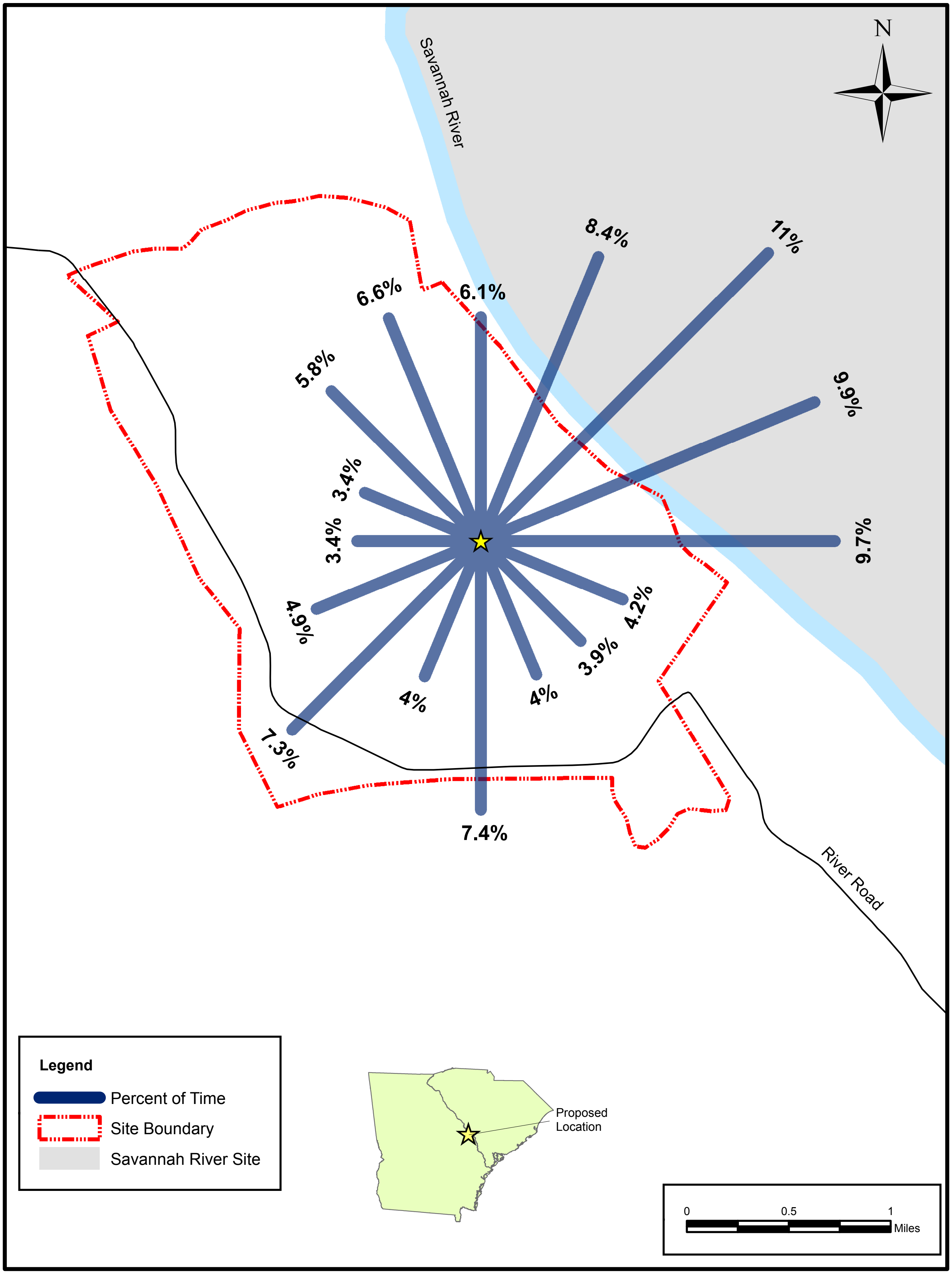

Figure 5.8-1 Modeled Plume Direction During Winter Months

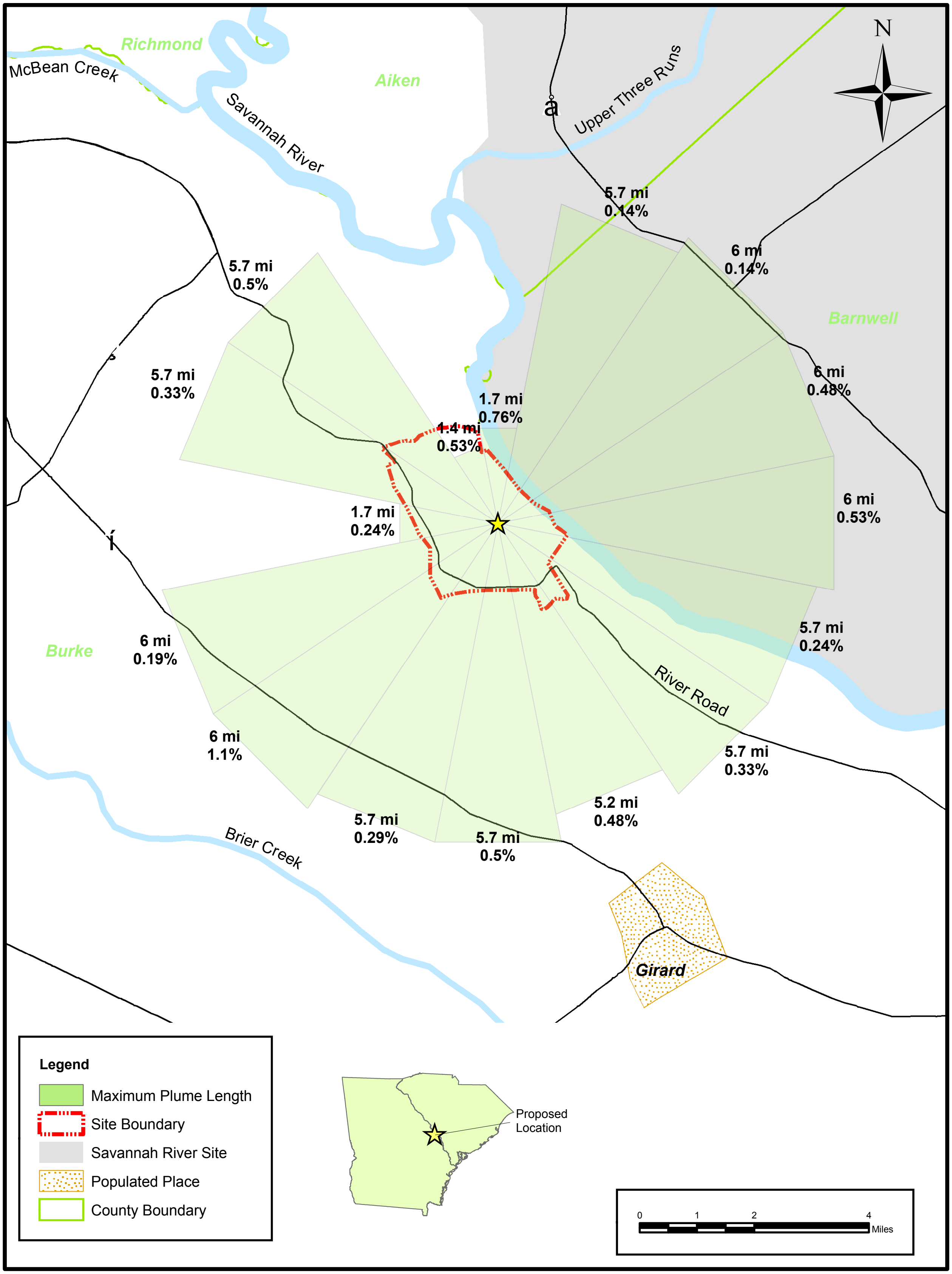

Figure 5.8-2 Maximum Modeled Plume Length and Frequency During Winter Months

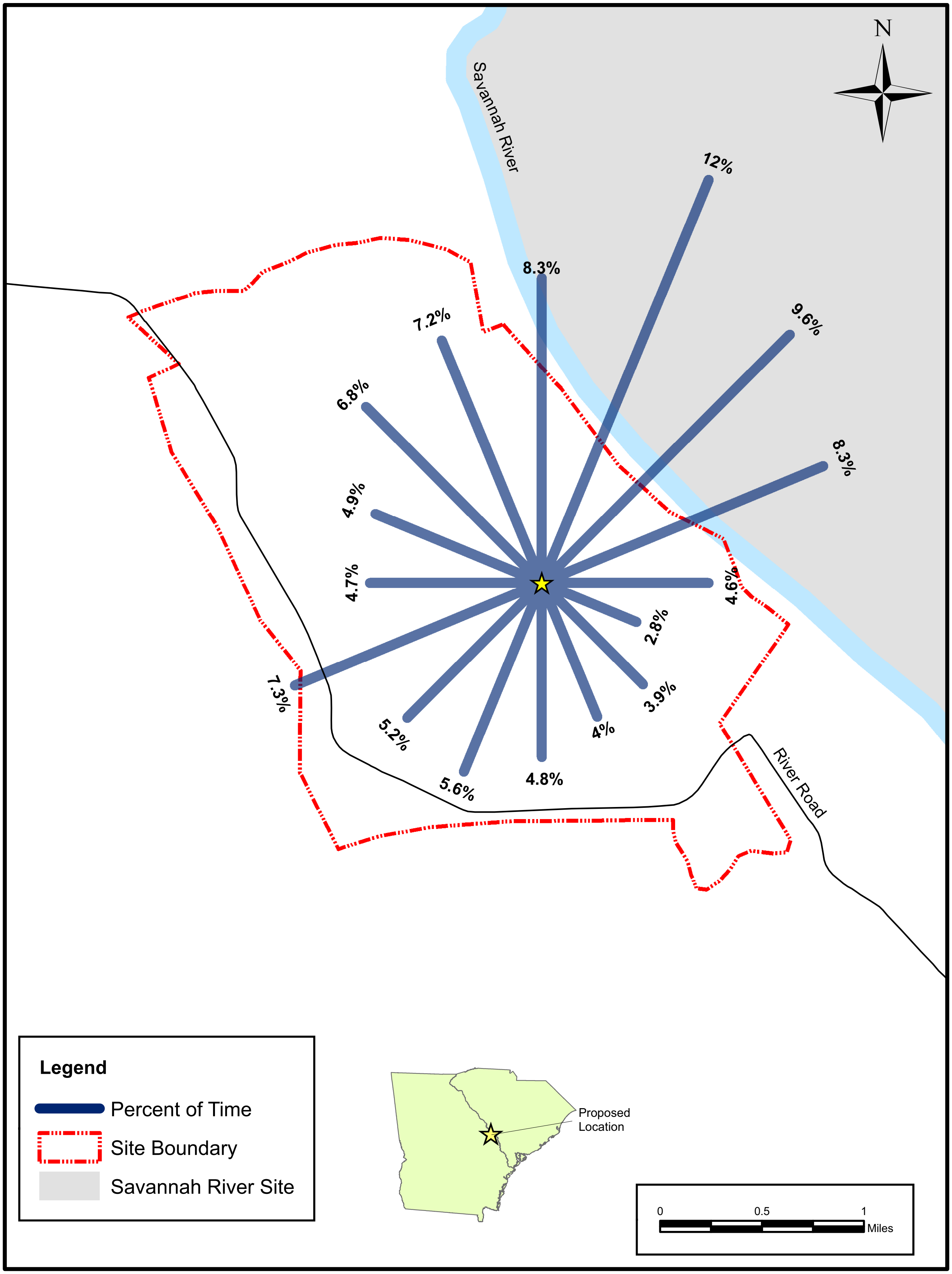

Figure 5.8-3 Modeled Plume Direction During Summer Months

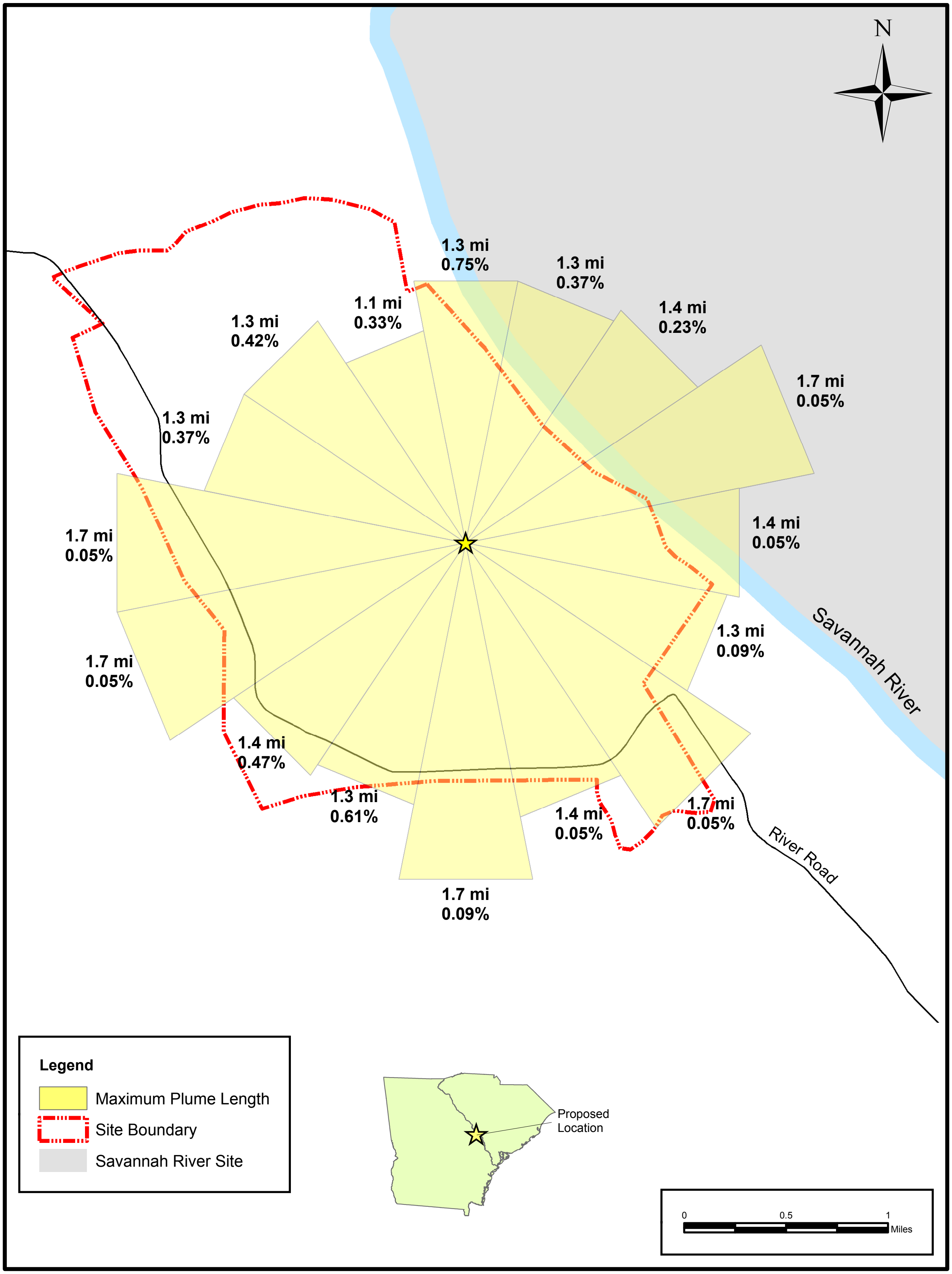

Figure 5.8-4 Maximum Modeled Plume Length and Frequency During Summer Months

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(USCB 2006) U.S. Census Bureau, State and County Quickfacts, Burke County, Georgia, available at http://www.quickfacts.census.gov, accessed July 13, 2006.

(Westinghouse 2003) Westinghouse Electric Company, LLC, AP1000 Siting Guide: Site Information for an Early Site Permit Application, APP-0000-X1-001, Revision 3, April 24.

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5.9 Decommissioning

NRC defines decommissioning as the safe removal of a nuclear facility from service and the reduction of residual radioactivity to a level that permits release of the property and termination of the license (10 CFR 50). NRC regulation 10 CFR 50.82 specifies the regulatory actions that NRC and a licensee must take to decommission a nuclear power facility. NRC regulation 10 CFR 20, Subpart E identifies the radiological criteria that must be met for license termination. These requirements apply to the existing fleet of power reactors and to advanced reactors such as the AP1000.

Decommissioning must occur because NRC regulations do not permit an operating license holder to abandon a facility after ending operations. However, NRC prohibits licensees from performing decommissioning activities that result in significant environmental impacts not previously reviewed [10 CFR 50.82(a)(6)(ii)]. Therefore, NRC has indicated that licensees for existing reactors can rely on the information in a generic environmental impact statement (GEIS) on the environmental impacts of decommissioning the existing fleet of domestic nuclear power reactors **(NRC 2002)**.

The U.S. Department of Energy (DOE) funded a study that compares activities required to decommission existing reactors to those required for advanced reactors, including the AP1000 **(DOE 2004)**. In addition, SNC has prepared a decommissioning cost analysis for the AP1000 at VEGP, which relies on technical information provided in the DOE-funded study and site-specific information for the currently operating units at VEGP. SNC has concluded that the DOE-funded study and the SNC cost analysis form a basis for concluding that the environmental impacts that the decommissioning GEIS identifies are representative of impacts that can be reasonably expected from decommissioning the AP1000. The following sections summarize the decommissioning GEIS, the DOE-funded study, the SNC cost analysis, and the SNC conclusion.

5.9.1 NRC Generic Environmental Impact Statement Regarding Decommissioning

The *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities* (NUREG-0586, Supplement 1, November 2002) describes decommissioning regulatory requirements, the decommissioning process, and environmental impacts of decommissioning. Prior to presenting impacts, the GEIS describes the NRC process for evaluating impacts. Activities and impacts that NRC considered to be within the scope of the GEIS include:

- Activities performed to remove the facility from service once the licensee certifies that the facility has permanently ceased operations, including organizational changes and removal of fuel from the reactor

- Activities performed in support of radiological decommissioning, including decontamination and dismantlement (D&D) of radioactive structures, systems, and components (SSCs) and any activities required to support the decontamination and dismantlement process such as isolating the spent fuel pool to reduce the scope of required safeguards and security systems so D&D can proceed on the balance of the facility without affecting the spent fuel
- Activities performed in support of dismantlement of nonradiological SSCs, such as diesel generator buildings and cooling towers
- Activities performed up to license termination and their resulting impacts as provided by the definition of decommissioning, including shipment and processing of radioactive waste
- Nonradiological impacts occurring after license termination from activities conducted during decommissioning
- Activities related to release of the facility
- Human health impacts from radiological and nonradiological decommissioning activities.

According to Section 5.9 of NUREG-1555, studies of social and environmental effects of decommissioning large commercial power generating units have not identified any significant impacts beyond those considered in the final GEIS on decommissioning. The GEIS evaluates the environmental impact of the following three decommissioning methods:

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

NRC regulations do not require an ESP applicant to select one of these decommissioning alternatives or to prepare definite plans for decommissioning. These plans are required (by 10 CFR 50.82) after a decision has been made to cease operations. The general environmental impacts are summarized in this section, because decommissioning plans and reports (and consequently detailed analyses of alternatives) are not prepared until cessation of operations.

According to the NRC, decommissioning a nuclear facility that has reached the end of its useful life generally has a positive environmental impact. The air quality, water quality, and ecological impacts of decommissioning are expected to be substantially smaller than those of power plant construction or operation because the level of activity and the releases to the environment are expected to be smaller during decommissioning than during construction and operation. The major environmental impact, regardless of the specific decommissioning option selected, is the commitment of small amounts of land for waste burial in exchange for the potential reuse of the land where the facility is located. Socioeconomic impacts of decommissioning will result from the demands on, and contributions to, the community by the workers employed to decommission a power plant. (NUREG-0586)

Experience with decommissioned power plants has shown that the occupational exposures during the decommissioning period are comparable to those associated with refueling and plant maintenance when it is operational (NUREG-0586). Each potential decommissioning alternative will have radiological impacts from the transport of materials to their disposal sites. The expected impact from this transportation activity will not be significantly different from normal operations (NUREG-1555).

5.9.2 DOE-Funded Study on Decommissioning Costs

The total cost of decommissioning depends on many factors, including the sequence and timing of the various stages of the program, location of the facility, current radioactive waste burial costs, and plans for spent fuel storage. So that a lack of funds does not result in delays in or improper conduct of decommissioning that may adversely affect public health and safety, 10 CFR 50.75 requires that operating license applicants and licensees provide reasonable assurance that adequate funds for performing decommissioning will be available at the end of operation. To provide this assurance, the regulation requires that two factors be considered, the amount of funds needed for decommissioning and the method used to provide financial assurance. At its discretion, an applicant may submit a certification based either on the formulas provided in 10 CFR 50.75 or, when a higher funding level is desired, on a facility-specific cost estimate that is equal to or greater than that calculated using the formula in 10 CFR 50.75. (Regulatory Guide 1.159, Revision 1. *Assuring the Availability of Funds for Decommissioning Nuclear Reactors*, October 2005) (RG 1.159)

NRC regulations do not require the establishment of decommissioning financial assurances to support an ESP application (NUREG-1555). However, DOE commissioned the *Study of Construction Technologies and Schedules, O&M Staffing and Cost, and Decommissioning Costs and Funding Requirements for Advanced Reactor Designs* **(DOE 2004)** to support development of advanced reactors for production of electric power and to establish the requirements for providing reasonable assurance that adequate funds for performing decommissioning will be available at the end of plant operations. The study presents estimates of the costs to decommission the advanced reactor designs following a scheduled cessation of plant operations. Four reactor types were evaluated in this report: the Toshiba and General Electric (GE) Advanced Boiling Water Reactor (ABWR), the GE Economic Simplified Boiling Water Reactor (ESBWR), the Westinghouse Advanced Passive pressurized water reactor (AP1000), and the Atomic Energy of Canada, Limited's (AECL) Advanced CANDU Reactor (ACR-700). The cost analysis described in the study is based upon the prompt decommissioning alternative, or DECON as defined by the NRC. The DECON alternative is also the basis for the NRC funding regulations (10 CFR 50.75) and the use of the DECON alternative for the advanced reactor designs facilitates the comparison with NRC's own estimates and financial provisions.

DECON comprises four distinct periods of effort: (1) preshutdown planning/engineering, (2) plant deactivation and transition (no activities are conducted during this period that will affect the safe operation of the spent fuel pool), (3) Decontamination and dismantlement with concurrent operations in the spent-fuel pool until the pool inventory is zero, and (4) license termination. Each of the decommissioning activities evaluated in the GEIS is performed during one or more of the periods identified above. Because of the delays in development of the federal waste management system, it may be necessary to continue operation of a dry fuel storage facility on the reactor site after the reactor systems have been dismantled and the reactor nuclear license terminated. However, these latter storage costs are considered operations costs under 10 CFR 50.54(b)(b) and are not considered part of decommissioning (NUREG-0586, Supplement 1).

The cost estimates described in the DOE study were developed using the same cost estimating methodology used by NRC and consider the unique features of a generic site located in the Southeast, including the nuclear steam supply systems, power generation systems, support services, site buildings, and ancillary facilities; and are based on numerous fundamental assumptions, including labor costs, low-level radioactive waste disposal costs and practices, regulatory requirements, and project contingencies. The primary cost contributors identified in the study are either labor-related or associated with the management and disposition of the radioactive waste. These are the same primary cost contributors that NRC identified in its *Revised Analysis of Decommissioning for the Reference Pressurized Water Reactor Power Station*, (NUREG/CR-5884; November 1995). Overall, the DOE study concluded that with consistent operating and management assumptions, the total decommissioning costs projected for the advanced reactor designs are comparable to those projected by NRC for operating reactors with appropriate reductions in costs due to reduced physical plant inventories. **(DOE 2004)**

5.9.3 SNC Decommissioning Cost Analysis

Although NRC regulations do not require the establishment of decommissioning financial assurances to support an ESP application (NUREG-1555), SNC commissioned a cost analysis to assess its financial obligations pertaining to the eventual decommissioning of the Westinghouse AP1000 advanced reactor assuming one is constructed on the VEGP site. The cost to decommission the AP1000 was evaluated for the DECON decommissioning alternative; and relies upon technical information from the DOE study and certain site-specific information for the currently operating units at VEGP. The estimate assumes the removal of all contaminated and activated plant components and structural materials such that the owner may then have unrestricted use of the site with no further requirements for an operating license. The estimate also assumes that the spent fuel pool will remain operational for a minimum of five years following cessation of operations. The pool will be isolated and an independent spent fuel island created to allow decommissioning operations to proceed in and around the pool area. The methodology and assumptions for estimating decommissioning costs for the AP1000 at VEGP is the same as that used in the DOE study. Like the NRC and DOE studies, the primary cost contributors identified in the SNC cost analysis are either labor-related or associated with the management and disposition of the radioactive waste.

The SNC projected cost to decommission one AP1000 using the DECON alternative is estimated to be $427.4 million, as reported in 2006 dollars. The minimum certification amounts were calculated using the formula delineated in 10 CFR 50.75(c)(1) and escalation indices provided in NUREG-1307, dated June 2005, for both waste recycling and burial only options. The funding levels calculated for the AP1000, in 2006 dollars, are $340.6 million for the waste recycling option and $664.1 million for the burial only option.

5.9.4 Conclusions

SNC compared the activities analyzed in the GEIS of the environmental impacts of decommissioning the existing fleet of domestic nuclear power reactors (NUREG-0586, Supplement 1) with the activities that form the basis for decommissioning cost estimates prepared by DOE **(DOE 2004)** and SNC for advanced reactor designs and determined that the scope of activities are the same. Projected physical plant inventories associated with advanced reactor designs will generally be less than those for currently operating power reactors due to advances in technology that simplify maintenance, and benefit decommissioning. Based on this comparison, SNC has concluded that the environmental impacts identified in the GEIS are representative of impacts that can be reasonably expected from decommissioning the AP1000.

SNC projected total site-specific decommissioning costs for an AP1000 at VEGP using the same cost estimating methodology and assumptions used by NRC as the basis for decommissioning funding regulations in 10 CFR 50.75. The SNC projected the cost to decommission the AP1000 using the DECON alternative is estimated to be $427.4 million, as reported in 2006 dollars.

Section 5.9 References

(DOE 2004) U.S. Department of Energy, Study of Construction Technologies and Schedules, O&M Staffing and Cost, and Decommissioning Costs and Funding Requirements for Advanced Reactor Designs, prepared by Dominion Energy Inc., Bechtel Power Corporation, TLG, Inc., and MPR Associates for United States Department of Energy Cooperative Agreement DE-FC07-03ID14492, Contract DE-AT01-020NE23476, May 27, 2004.

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5.10 Measures and Control to Limit Adverse Impacts During Operations

The following measures and controls would limit adverse environmental impacts of operations:

- Compliance with applicable local, state, and federal, ordinances, laws and regulations intended to prevent or minimize adverse environmental effects.
- Compliance with the applicable requirements of all environmental permits and licenses.
- Compliance with SNC or Georgia Power procedures and processes.

In Table 5.10-1, the significance of potential impacts are identified as (S)mall, (M)oderate or (L)arge, based on the analyses done in this chapter. Mitigation measures briefly describe the types of programs and controls SNC will put in place to ensure that adverse impacts to the environment are minimized.

Table 5.10-1 Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Potential Impact Significance[1,2]

Section Reference	Noise	Erosion and Sediment	Air Quality	Traffic/Transportation	Wastes	Surface Water	Groundwater	Land-Use	Water-Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomic	Radiation Exposure	Public Health & Safety	Other (site-specific)	Impact Description or Activity	Feasible and Adequate Measures/Controls
5.1 Land-Use Impacts																	
5.1.1 The Site and Vicinity								S-M				S				• Although Burke County does not have zoning designations, the land use as VEGP will not change from current land use • Some of the workforce may chose to live in the immediate vicinity of the project • Property taxes on new units could provide county with revenues to develop additional land in the county	• No mitigation measures will be required

Table 5.10-1 (cont.) Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Section Reference	Noise	Erosion and Sediment	Air Quality	Traffic/Transportation	Wastes	Surface Water	Groundwater	Land-Use	Water-Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomic	Radiation Exposure	Public Health & Safety	Other (site-specific)	Impact Description or Activity	Feasible and Adequate Measures/Controls
	Potential Impact Significance[1,2]																
5.1.3 Trans mission Corridors and Offsite Areas								S		S	S					• Possible new corridor could affect land use, terrestrial and aquatic ecosystems	• Maintenance practices will protect sensitive habitats and protected species, including wetlands and water crossings. • Routing decisions would consider protected species and critical habitats
5.1.3 Historic Properties															S	• No impacts beyond those associated with construction of the proposed new units and transmission corridors	• No mitigation will be required
5.2 Water-Related Impacts																	
5.2.1 Hydrologic Alterations and Plant Water Supply						S	S										

Table 5.10-1 (cont.) Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

	Potential Impact Significance[1,2]																
Section Reference	**Noise**	**Erosion and Sediment**	**Air Quality**	**Traffic/Transportation**	**Wastes**	**Surface Water**	**Groundwater**	**Land-Use**	**Water-Use**	**Terrestrial Ecosystems**	**Aquatic Ecosystems**	**Socioeconomic**	**Radiation Exposure**	**Public Health & Safety**	**Other (site-specific)**	**Impact Description or Activity**	**Feasible and Adequate Measures/Controls**
5.2.2 Water-Use Impacts						S	S									• For start time during off-normal operations groundwater withdrawal could exceed permit limits • Maximum consumptive surface water use will be less than 2 percent of 7Q10 flow	• No mitigation will be required
5.2.3 Water Quality Impacts						S	S				S					• Discharges to surface water will be permitted and limited • Maximum thermal plume will have a volume of less than 800 ft3	• No mitigation will be required

Table 5.10-1 (cont.) Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Potential Impact Significance[1,2]

Section Reference	Noise	Erosion and Sediment	Air Quality	Traffic/Transportation	Wastes	Surface Water	Groundwater	Land-Use	Water-Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomic	Radiation Exposure	Public Health & Safety	Other (site-specific)	Impact Description or Activity	Feasible and Adequate Measures/Controls
5.2.4 Future Water Use						S	S									VEGP will not adversely affect future water use	• No mitigation will be required
5.3 Cooling System Impacts																	
5.3.1 Intake System																	
5.3.1.1 Hydro dynamic Descriptions and Physical Impacts																	
5.3.1.2 Aquatic Ecosystems											S					• Intake structure will be constructed using Best Available Technology	• No mitigation will be required

Table 5.10-1 (cont.) Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Potential Impact Significance[1,2]

Section Reference	Noise	Erosion and Sediment	Air Quality	Traffic/Transportation	Wastes	Surface Water	Groundwater	Land-Use	Water-Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomic	Radiation Exposure	Public Health & Safety	Other (site-specific)	Impact Description or Activity	Feasible and Adequate Measures/Controls
5.3.2 Discharge System																	
5.3.2.1 Thermal Description and Other Physical Impacts											S					Thermal plume will not impede fish passage Scam will be SMALL and localized	No mitigation will be required.
5.3.2.2 Aquatic Ecosystems											S						
5.3.3 Heat-Discharge System																	
5.3.3.1 Heat Dissipation to the Atmosphere	S		S							S						• Median plume length will be about 0.5 miles long with a maximum plume length of 6.2 miles expected 3.5 percent of the time	• None

Table 5.10-1 (cont.) Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Potential Impact Significance[1,2]

Section Reference	Noise	Erosion and Sediment	Air Quality	Traffic/Transportation	Wastes	Surface Water	Groundwater	Land-Use	Water-Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomic	Radiation Exposure	Public Health & Safety	Other (site-specific)	Impact Description or Activity	Feasible and Adequate Measures/Controls
5.3.3.1 Heat Dissipation to the Atmosphere (cont'd)																Maximum salt deposition will be 2.5 pounds per acre per month per tower, approximately half that which is considered a threshold for leaf damage • Cooling tower noise levels will be undistinguishable from above ground • Potential for bird collisions with towers is low, based on current VEGP operations	•
5.3.3.2 Terrestrial Ecosystems										S						• No impacts identified	• No mitigation will be required

Table 5.10-1 (cont.) Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

	Potential Impact Significance[1,2]																
Section Reference	**Noise**	**Erosion and Sediment**	**Air Quality**	**Traffic/Transportation**	**Wastes**	**Surface Water**	**Groundwater**	**Land-Use**	**Water-Use**	**Terrestrial Ecosystems**	**Aquatic Ecosystems**	**Socioeconomic**	**Radiation Exposure**	**Public Health & Safety**	**Other (site-specific)**	**Impact Description or Activity**	**Feasible and Adequate Measures/Controls**
5.3.4 Impacts to Members of the Public	S													S		• Offsite noise will be less than 10dB above background • Discharges to the Savannah River will not result in a significant increase in	• No mitigation will be required
5.3.4 Impacts to Members of the Public (cont'd)																temperature of the river or an increase in thermophilic organisms.	•

Table 5.10-1 (cont.) Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Potential Impact Significance[1,2]

Section Reference		Noise	Erosion and Sediment	Air Quality	Traffic/Transportation	Wastes	Surface Water	Groundwater	Land-Use	Water-Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomic	Radiation Exposure	Public Health & Safety	Other (site-specific)	Impact Description or Activity	Feasible and Adequate Measures/Controls
5.4	Radiological Impacts of Normal Operation																	
5.4.1	Exposure Pathways			S			S			S		S	S	S	S		• Potential for small discharges of radioactive liquids and gases to the environment • Direct dose contribution from the new units will be negligible	• Releases of radiation will be within all regulatory limits
5.4.2	Radiation Doses to Members of the Public													S	S		• See Section 5.4.2 for a discussion of impacts to members of the public	

Table 5.10-1 (cont.) Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Potential Impact Significance[1,2]

Section Reference	Noise	Erosion and Sediment	Air Quality	Traffic/Transportation	Wastes	Surface Water	Groundwater	Land-Use	Water-Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomic	Radiation Exposure	Public Health & Safety	Other (site-specific)	Impact Description or Activity	Feasible and Adequate Measures/Controls
5.4.3 Impacts to Members of the Public													S	S		• Potential doses to the public from liquid effluent releases to the Savannah River and gaseous releases to the atmosphere. Calculated doses to the public will be within the design objectives of 10 CFR 50 Appendix I and within regulatory limits of 40 CFR 190.	• No mitigation will be necessary

Table 5.10-1 (cont.) Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

	Potential Impact Significance[1,2]																
Section Reference	Noise	Erosion and Sediment	Air Quality	Traffic/Transportation	Wastes	Surface Water	Groundwater	Land-Use	Water-Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomic	Radiation Exposure	Public Health & Safety	Other (site-specific)	Impact Description or Activity	Feasible and Adequate Measures/Controls
5.4.4 Impacts to Biota Other than Members of the Public										S	S		S			• Potential doses to biota from liquid and gaseous effluents. Although there are no acceptance criteria specifically for biota, there is no scientific evidence that chronic doses below 100 mrad/day are harmful to plants or animals. The biota doses are less than 0.1 mrad/day	• No mitigation is required.

Table 5.10-1 (cont.) Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Section Reference	Noise	Erosion and Sediment	Air Quality	Traffic/Transportation	Wastes	Surface Water	Groundwater	Land-Use	Water-Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomic	Radiation Exposure	Public Health & Safety	Other (site-specific)	Impact Description or Activity	Feasible and Adequate Measures/Controls
	Potential Impact Significance[1,2]																
5.5 Environmental Impact of Waste																	
5.5.1 Nonradioactive-Waste-System Impacts					S	S		S			S					• Increased volume of discharged effluents • Increased chemicals and other pollutants in the discharge • Increased stormwater discharge • Increased air emissions • Increase in total volume of sanitary waste generated	• All discharges will comply with Georgia NPDES permit and applicable water quality standards • Revise the existing VEGP Storm Water Pollution Prevention Plan or prepare and implement a new one to avoid/minimize releases of contaminated storm water. • Revise the existing VEGP Spill Prevention Countermeasures and Control Plan or prepare and implement a new one to avoid/minimize contamination from spills. • Use approved transporters and offsite landfills for disposal of solid wastes. Continue the existing program of waste minimization reuse and recycling. Operate minor air emission sources in accordance with applicable regulations and certificates.

Table 5.10-1 (cont.) Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Section Reference	Noise	Erosion and Sediment	Air Quality	Traffic/Transportation	Wastes	Surface Water	Groundwater	Land-Use	Water-Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomic	Radiation Exposure	Public Health & Safety	Other (site-specific)	Impact Description or Activity	Feasible and Adequate Measures/Controls
	Potential Impact Significance[1,2]																
5.5.1 Nonradioactive-Waste-System Impacts (cont'd)								S									• If necessary, modify the existing sanitary waste treatment system to accommodate increased volume.
5.5.2 Mixed Waste Impacts					S					S			S		S	• Expected annual generation of 350 ft^3 mixed waste per year. • Potential chemical hazard and occupational exposure to radiological materials during handling and storage • Potential exposure to offsite workers and emergency response	• Limit mixed waste generation through source reduction, recycling, and treatment options • Develop a Waste Minimization Program to address mixed waste inventory management, equipment maintenance, recycling and reuse, segregation, treatment (decay in storage), work planning, waste tracking, and awareness training Revise the existing VEGP Spill Prevention Countermeasures and Control Plan or prepare and implement a new one to avoid/minimize contamination from spills.

Table 5.10-1 (cont.) Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Potential Impact Significance[1,2]

Section Reference		Noise	Erosion and Sediment	Air Quality	Traffic/Transportation	Wastes	Surface Water	Groundwater	Land-Use	Water-Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomic	Radiation Exposure	Public Health & Safety	Other (site-specific)	Impact Description or Activity	Feasible and Adequate Measures/Controls
5.5.2	Mixed Waste Impacts (cont'd)																personnel during accidental releases and cleanup activities	•
5.5.3	Waste Minimization					S			S									• Develop a Waste Minimization Program to address mixed waste inventory management, equipment maintenance, recycling and reuse, segregation, treatment (decay in storage), work planning, waste tracking, and awareness training
5.5.4	Radioactive Waste																• Expected annual generation of uncompacted radioactive waste of 5,759 ft^3.	• Develop a Waste Minimization Program to address mixed waste inventory management, equipment maintenance, recycling and reuse, segregation, treatment (decay in storage), work planning, waste tracking, and awareness training

Table 5.10-1 (cont.) Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Potential Impact Significance[1,2]

Section Reference	Noise	Erosion and Sediment	Air Quality	Traffic/Transportation	Wastes	Surface Water	Groundwater	Land-Use	Water-Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomic	Radiation Exposure	Public Health & Safety	Other (site-specific)	Impact Description or Activity	Feasible and Adequate Measures/Controls
5.6 Transmission System Impacts																	
5.6.1 Terrestrial Ecosystems	S		S							S						• Exhaust and nuisance noise from aerial surveys of transmission corridors. Current maintenance practices will be continued on any new lines.	• No mitigation is required.
5.6.2 Aquatic Ecosystems											S					• Current maintenance practices will be continued on any new lines	• No mitigation is required.
5.6.3 Impacts to Members of the Public	S													S		• New lines will be built to specifications to minimize noise and electric shock	• No mitigation is required.

Table 5.10-1 (cont.) Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Section Reference	Noise	Erosion and Sediment	Air Quality	Traffic/Transportation	Wastes	Surface Water	Groundwater	Land-Use	Water-Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomic	Radiation Exposure	Public Health & Safety	Other (site-specific)	Impact Description or Activity	Feasible and Adequate Measures/Controls
	Potential Impact Significance[1,2]																
5.7 Uranium Fuel Cycle Impacts																	
5.7 Uranium Fuel Cycle Impacts (i.e., relative to the reference LWR)		S	S	S		S		S	S				S			• Yellowcake production and uranium conversion and mining will affect energy requirements, erosion, emissions, and water • Air emissions from fossil fuel plants supplying the gaseous diffusion plant. • Production of UO2 during fuel fabrication • Radioactive waste management from operations, and decontamination and decommissioning	• Select mining techniques that minimize potential impacts • Consider use of new technology that requires less uranium hexafluoride • Consider use of centrifuge process over gaseous diffusion process, which could significantly reduce energy requirements and environmental impacts • Consider use of new technologies with less fuel loading to reduce energy, emissions and water usage.

Table 5.10-1 (cont.) Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Potential Impact Significance[1,2]

Section Reference		Noise	Erosion and Sediment	Air Quality	Traffic/Transportation	Wastes	Surface Water	Groundwater	Land-Use	Water-Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomic	Radiation Exposure	Public Health & Safety	Other (site-specific)	Impact Description or Activity	Feasible and Adequate Measures/Controls
5.8	Socioeconomic Impacts																	
5.8.1	Physical Impacts of Units 3 and 4 operations	S		S	S											S	• Noise from industrial facility will be below a level considered nuisance to public at nearest residence • Potential impacts from air emissions associated with diesel generators and auxiliary power systems • Potential visual impacts from Savannah River and roadways in the region due to additional cooling towers and new buildings	• Comply with permit limits and regulations for installing and operating air emission sources • Perform view scape study for new structures on site, including cooling towers, as part of final design • Consider staggering outage shifts to reduce plant-associated traffic on local roads during shift changes

Table 5.10-1 (cont.) Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Section Reference	Potential Impact Significance[1,2]: Noise	Erosion and Sediment	Air Quality	Traffic/Transportation	Wastes	Surface Water	Groundwater	Land-Use	Water-Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomic	Radiation Exposure	Public Health & Safety	Other (site-specific)	Impact Description or Activity	Feasible and Adequate Measures/Controls
5.8.1 Physical Impacts of Units 3 and 4 operations (cont.)																• Local roads will experience increased operations traffic	
5.8.2 Social and Economic Impacts of Units 3 and 4 operations				S-M								S-L				• Increase the population in the region by as many as 2,600 people. Overall impacts to community services in the surrounding counties will be small. Predicted workforce is a small fraction of the total projected population in the region	• Lead time will allow developers to construct new homes.

Table 5.10-1 (cont.) Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Section Reference	Potential Impact Significance[1,2]: Noise	Erosion and Sediment	Air Quality	Traffic/Transportation	Wastes	Surface Water	Groundwater	Land-Use	Water-Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomic	Radiation Exposure	Public Health & Safety	Other (site-specific)	Impact Description or Activity	Feasible and Adequate Measures/Controls
5.8.2 Social and Economic Impacts of Units 3 and 4 operations (cont.)				S-M								S L				• Revenue from property taxes paid for the new units will benefit Burke county • The available housing in Burke County may not support influx of operational workers • Increased traffic on highways and roads during shift change	

Table 5.10-1 (cont.) Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Potential Impact Significance[1,2]

Section Reference		Noise	Erosion and Sediment	Air Quality	Traffic/Transportation	Wastes	Surface Water	Groundwater	Land-Use	Water-Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomic	Radiation Exposure	Public Health & Safety	Other (site-specific)	Impact Description or Activity	Feasible and Adequate Measures/Controls
5.8.3	Environ mental Justice Impacts				S-M								S-L				• No disproportion nately high impacts on minority or low-income populations resulting from operation of the proposed new units except moderate increases in traffic during shift change	• No mitigation required; traffic volume will not exceed road capacities.
5.9	Decommissioning																	
5.9	Decom missioning					S	S		S					S			• Potential radiation exposure related to decommissioning, including transportation of materials to disposal sites.	• The significance of impacts is unknown because the decommissioning methods have not been chosen. No mitigation measures or controls are proposed at this time.

Table 5.10-1 (cont.) Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

		Potential Impact Significance[1,2]															
Section Reference		**Noise**	**Erosion and Sediment**	**Air Quality**	**Traffic/Transportation**	**Wastes**	**Surface Water**	**Groundwater**	**Land-Use**	**Water-Use**	**Terrestrial Ecosystems**	**Aquatic Ecosystems**	**Socioeconomic**	**Radiation Exposure**	**Public Health & Safety**	**Other (site-specific)**	**Impact Description or Activity**	**Feasible and Adequate Measures/Controls**
5.9	Decom missioning (cont.)					S	S		S					S			• Decommissioning methods are expected to produce impacts equivalent to operations	
5.11	Transportation of Radioactive Waste																	
5.11	Transpor tation of Radioactive Waste				S									S	S		• Transportation risks are very small, including accidents	• No mitigation is required

Table 5.10-1 Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations (cont.)

Potential Impact Significance [a, b]

Section Reference	Noise	Erosion and Sediment	Air Quality	Traffic/Transportation	Wastes	Surface Water	Groundwater	Land-Use	Water-Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomic	Radiation Exposure	Public Health & Safety	Other (site-specific)	Impact Description or Activity	Feasible and Adequate Measures/Controls
5.12 Non-Radiological Health Impacts																	
5.12 Non-Radiological Health Impacts														S		• Incidence rate of recordable cases at VEGP is less than the national average. New units will likely follow the same trend.	• No mitigation required.

1 The assigned significance levels [(S)mall, (M)oderate, or (L)arge are based on the assumption that for each impact, the associated proposed mitigation measures and controls (or equivalents) will be implemented.
2 A blank in the elements column denotes “no impact” on that specific element due to the assessed impacts.

5.11 Transportation of Radioactive Materials

This section addresses radioactive materials transportation associated with operating a new reactor at the VEGP site. The analysis is based on the reactor characteristics described in Section 3.2 and radioactive waste management systems described in Section 3.5. Information regarding preparation and packaging of the radioactive materials for transport offsite can be found in Section 3.8.

5.11.1 Transportation Assessment

The NRC regulations in 10 CFR 51.52 state that:

> *"Every environmental report prepared for the construction permit stage of a light-water-cooled nuclear power reactor, and submitted after February 4, 1975, shall contain a statement concerning transportation of fuel and radioactive wastes to and from the reactor. That statement shall indicate that the reactor and this transportation either meet all of the conditions in paragraph (a) of this section or all of the conditions in paragraph (b) of this section."*

NRC evaluated the environmental effects of transportation of fuel and waste for LWRs in the Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Plants (WASH-1238; AEC 1972) and Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants, Supplement 1 (NUREG-75/038; NRC 1975) and found the impacts to be SMALL. These NRC analyses provided the basis for Table S-4 in 10 CFR 51.52 (see Table 5.11-1), which summarizes the environmental impacts of transportation of fuel and radioactive wastes to and from a reference reactor. The table addresses two categories of environmental considerations: (1) normal conditions of transport and (2) accidents in transport.

To analyze the impacts of transporting AP1000 fuel to Table S-4, the fuel characteristics for the AP1000 were normalized to a reference reactor-year. The reference reactor is an 1100 MWe reactor that has an 80 percent capacity factor, for an electrical output of 880 MWe per year. The advanced LWR technology being considered for VEGP is the AP1000. The proposed configuration for this new plant is two units. The standard configuration (a single unit) for the AP1000 will be used to evaluate transportation impacts relative to the reference reactor.

Subparagraphs 10 CFR 51.52(a)(1) through (5) delineate specific conditions the reactor licensee must meet to use Table S-4 as part of its environmental report. For reactors not meeting all of the conditions in paragraph (a) of 10 CFR 51.52, paragraph (b) of 10 CFR 51.52 requires a further analysis of the transportation effects.

The conditions in paragraph (a) of 10 CFR 51.52 establishing the applicability of Table S-4 are reactor core thermal power, fuel form, fuel enrichment, fuel encapsulation, average fuel irradiation, time after discharge of irradiated fuel before shipment, mode of transport for unirradiated fuel, mode of transport for irradiated fuel, radioactive waste form and packaging, and mode of transport for radioactive waste other than irradiated fuel. The following sections describe the characteristics of the AP1000 relative to the conditions of 10 CFR 51.52 for use of Table S-4. Information for the AP1000 fuel is taken from the AP1000 Design Control Document **(Westinghouse 2005)** and supporting documentation prepared by the Idaho National Engineering and Environmental Laboratory.

5.11.1.1 Reactor Core Thermal Power

Subparagraph 10 CFR 51.52(a)(1) requires that the reactor have a core thermal power level not exceeding 3800 megawatts. The AP1000 has a thermal power rating of 3400 MWt and meets this condition.

The core power level was established as a condition because, for the LWRs being licensed when Table S-4 was promulgated, higher power levels typically indicated the need for more fuel and therefore more fuel shipments than was evaluated for Table S-4. This is not the case for the new LWR designs due to the higher unit capacity and higher burnup for these reactors. The annual fuel reloading for the reference reactor analyzed in WASH-1238 was 30 metric tons of uranium (MTU) while the annual fuel loading for the AP1000 is 23 MTU. When normalized to equivalent electric output, the annual fuel requirement for the AP1000 is approximately 20 MTU or two-thirds that of the reference LWR.

5.11.1.2 Fuel Form

Subparagraph 10 CFR 51.52(a)(2) requires that the reactor fuel be in the form of sintered uranium dioxide (UO_2) pellets. The AP1000 uses a sintered UO_2 pellet fuel form.

5.11.1.3 Fuel Enrichment

Subparagraph 10 CFR 51.52(a)(2) requires that the reactor fuel have a uranium-235 enrichment not exceeding 4 percent by weight. For the AP1000, the enrichment of the initial core varies by region from 2.35 to 4.45 percent and the average for reloads is 4.51 percent (Table 3.0-1). The AP1000 fuel exceeds the 4 percent U-235 condition.

5.11.1.4 Fuel Encapsulation

Subparagraph 10 CFR 51.52(a)(2) requires that the reactor fuel pellets be encapsulated in Zircaloy rods. Paragraph 10 CFR 50.44 also allows use of ZIRLO™. License amendments approving use of ZIRLO™ rather than Zircaloy have not involved a significant increase in the amounts or significant change in the types of any effluents that may be released offsite, or significant increase in individual or cumulative occupational radiation exposure. AP1000 uses either Zircaloy or ZIRLO cladding and meets this subsequent evaluation condition.

5.11.1.5 Average fuel irradiation

Subparagraph 10 CFR 51.52(a)(3) requires that the average burnup not exceed 33,000 megawatt-days per MTU. The average burnup is 48,700 megawatt-days per MTU for the AP1000 (Table 3.0-1), which exceeds this condition.

5.11.1.6 Time after discharge of irradiated fuel before shipment

Subparagraph 10 CFR 51.52(a)(3) requires that no irradiated fuel assembly be shipped until at least 90 days after it is discharged from the reactor. The WASH-1238 for Table S-4 assumes 150 days of decay time prior to shipment of any irradiated fuel assemblies. *Environmental Effects of Extending Fuel Burnup Above 60 Gwd/MTU*, (NUREG/CR-6703, January 31, 2001) updated this analysis to extend Table S-4 to burnups of up to 62,000 megawatt-days per MTU assumes a minimum of five years between removal from the reactor and shipment. Five years is the minimum decay time expected before shipment of irradiated fuel assemblies. The U.S. DOE's contract for acceptance of spent fuel, as set forth in 10 CFR 961, Appendix E, requires a five-year minimum cooling time. In addition, NRC specifies five years as the minimum cooling period when it issues certificates of compliance for casks used for shipment of power reactor fuel (NUREG-1437, Addendum 1). As described in Section 3.5, the new units will have storage capacity exceeding that needed to accommodate five-year cooling of irradiated fuel prior to transport off site.

5.11.1.7 Transportation of unirradiated fuel

Subparagraph 10 CFR 51.52(a)(5) requires that unirradiated fuel be shipped to the reactor site by truck. Fuel is currently transported to the reactors at VEGP by truck. SNC will receive fuel via truck shipments for the AP1000 units being considered for this site.

Table S-4 includes a condition that the truck shipments not exceed 73,000 pounds as governed by federal or state gross vehicle weight restrictions. The fuel shipments to the VEGP site will comply with Federal or state weight restrictions.

5.11.1.8 Transportation of irradiated fuel

Subparagraph 10 CFR 51.52(a)(5) allows for truck, rail, or barge transport of irradiated fuel. This condition will be met for the AP1000. For the impacts analysis described in Section 5.11.2, SNC assumed that all spent fuel shipments will be made using legal weight trucks. DOE is responsible for spent fuel transportation from reactor sites to the repository and will make the decision on transport mode (10 CFR 961.1).

5.11.1.9 Radioactive waste form and packaging

Subparagraph 10 CFR 51.52(a)(4) requires that, with the exception of spent fuel, radioactive waste shipped from the reactor be packaged and in a solid form. As described in Section 3.5.3, SNC will solidify and package the radioactive waste. Additionally, SNC will comply with NRC

(10 CFR 71) and DOT (49 CFR 173 and 178) packaging and transportation regulations for the shipment of radioactive material.

5.11.1.10 Transportation of radioactive waste

Subparagraph 10 CFR 51.52(a)(5) requires that the mode of transport of low-level radioactive waste be either truck or rail. SNC will ship radioactive waste from the new units by truck.

Radioactive waste shipments are subject to a weight limitation of 73,000 pounds per truck and 100 tons per cask per rail car. Radioactive waste from the AP1000 is capable of being shipped in compliance with Federal or state weight restrictions.

5.11.1.11 Number of truck shipments

Table S-4 limits traffic density to less than one truck shipment per day or three rail cars per month. SNC has estimated the number of truck shipments that will be required assuming that all radioactive materials (fuel and waste) are received at the site or transported offsite via truck.

Table 5.11-2 summarizes the number of truck shipments of unirradiated fuel. The table also normalizes the number of shipments to the electrical output for the reference reactor analyzed in WASH-1238. When normalized for electrical output, the number of truck shipments of unirradiated fuel for the AP1000 is less than the number of truck shipments estimated for the reference LWR.

For the AP1000, the initial core load is estimated at 84.5 MTU per unit and the annual reload requirements are estimated at 23 MTU/yr per unit. This equates to about 157 fuel assemblies in the initial core (assuming 0.5383 MTU per fuel assembly) and 43 fuel assemblies per year for refueling. The vendor is designing a transportation container that will accommodate one 14-foot fuel bundle. Due to weight limitations, the number of such containers will be limited to 7 to 8 per truck shipment. For the initial core load, the trucks are assumed to carry 7 containers to allow for shipment of core components along with the fuel assemblies. Truck shipments will be able to accommodate 8 containers per shipment for refueling.

The numbers of spent fuel shipments were estimated as follows. For the reference LWR analyzed in WASH-1238, NRC assumed that 60 shipments per year will be made, each carrying 0.5 MTU of spent fuel. This amount is equivalent to the annual refueling requirement of 30 MTU per year for the reference LWR. For this transportation analysis, SNC assumed that for the AP1000 it will also ship spent fuel at a rate equal to the annual refueling requirement. The shipping cask capacities used to calculate annual spent fuel shipments were assumed to be the same as those for the reference LWR (0.5 MTU per legal weight truck shipment). This results in 46 shipments per year for one AP1000. After normalizing for electrical output, the number of spent fuel shipments is 39 per year for the AP1000. The normalized spent fuel shipments for the AP1000 will be less than the reference reactor that was the basis for Table S-4.

Table 5.11-3 presents estimates of annual waste volumes and numbers of truck shipments. The values are normalized to the reference LWR analyzed in WASH-1238. The normalized annual waste volumes and waste shipments for the AP1000 will be less than the reference reactor that was the basis for Table S-4.

The total numbers of truck shipments of fuel and radioactive waste to and from the reactor are estimated at 65 per year for the AP1000. These radioactive material transportation estimates are well below the one truck shipment per day condition given in 10 CFR 51.52, Table S-4. Doubling the estimated number of truck shipments to account for empty return shipments still results in number of shipments well below the one-shipment-per-day condition.

5.11.1.12 Summary

Table 5.11-4 summarizes the reference conditions in paragraph (a) of 10 CFR 51.52 for use in Table S-4, and the values for the AP1000. The AP1000 does not meet the conditions for average fuel enrichment or average fuel irradiation. Therefore, Sections 5.11.2 and 7.4 present additional analyses of fuel transportation effects for normal conditions and accidents, respectively. Transportation of radioactive waste met the applicable conditions in 10 CFR 51.52 and no further analysis is required.

5.11.2 Incident-Free Transportation Impacts Analysis

Environment impacts of incident-free transportation of fuel are discussed in this section. Transportation accidents are discussed in Section 7.4.

NRC analyzed the transportation of radioactive materials in its assessments of environmental impacts for the proposed ESP sites at North Anna, Clinton, and Grand Gulf. SNC reviewed the NRC analyses for guidance in assessing transportation impacts for the VEGP site.

The NRC assessments included the AP1000 reactor technology being considered for the SNC ESP site. In many cases, the assumptions used by NRC are “generic” (i.e., independent of the reactor technology). For example, the radiation dose rate associated with fuel shipments is based on the regulatory limit rather than the fuel characteristics or packaging. SNC used these same generic assumptions in assessing transportation impacts for unirradiated fuel shipments to the VEGP site.

Although NRC did not consider VEGP as an alternative site, they did assess transportation impacts for the Savannah River Site. SNC reviewed the assumptions and parameters used in NRC’s analysis of transportation impacts for spent fuel shipments from the Savannah River Site described in NUREG-1811 (Section 6.2 and Appendix G). The proposed VEGP site is located directly across the Savannah River from DOE’s Savannah River Site. The truck shipment routes evaluated for the Savannah River Site and VEGP are identical except for approximately 30 miles (about 1 percent of the distance to the repository) from either point of origin.

SNC also reviewed the analysis of transportation impacts for spent fuel shipments from the Savannah River Site and VEGP in DOE's Yucca Mountain EIS. The Savannah River Site-Yucca Mountain truck shipment route used in the NRC analysis is the same route evaluated in the Yucca Mountain EIS. Parameter values used in the NRC analyses (e.g., vehicle speed, traffic count, dose rate, packaging, and attributes associated with vehicle stops) are consistent with those used in the Yucca Mountain EIS and DOE guidance on transportation risk assessment (**DOE 2002a**) and other NRC evaluations of spent fuel shipments **(Sprung et al. 2000)**. The parameter values selected by NRC are commonly used and are considered standard values for RADTRAN applications such as environmental impact statements. Thus they are appropriate to assess transportation impacts of spent fuel shipments from the VEGP site.

Based on its review of the NRC transportation analyses and Yucca Mountain EIS, SNC concluded the transportation impacts associated with spent fuel shipments from the proposed ESP site at VEGP would be nearly identical to and slightly less than those projected in NRC's transportation analysis for the Savannah River Site. SNC analyzed the potential impacts for spent fuel shipments (both incident-free transportation and transportation accidents) based on the results of NRC's assessment for the Savannah River Site.

5.11.2.1 Transportation of Unirradiated Fuel

Table S-4 of 10 CFR 51.52 includes conditions related to radiological doses to transport workers and members of the public along transport routes. These doses, based on calculations in WASH-1238, are a function of the radiation dose rate emitted from the unirradiated fuel shipments, the number of exposed individuals and their locations relative to the shipment, the time of transit (including travel and stop times), and the number of shipments to which the individuals are exposed. In its assessments of environmental impacts for other proposed ESP sites, NRC calculated the radiological dose impacts of unirradiated fuel transportation using the RADTRAN 5 computer code **(NRC 2004, 2005, 2006)**. The RADTRAN 5 calculations estimated worker and public doses associated with annual shipments of unirradiated fuel.

One of the key assumptions in WASH-1238 for the reference LWR unirradiated fuel shipments is that the radiation dose rate at 1 meter from the transport vehicle is about 0.1 millirem per hour. This assumption was also used by NRC to analyze advanced LWR unirradiated fuel shipments for other proposed ESP sites **(NRC 2004, 2005, 2006)**. This assumption is reasonable for all of the advanced LWR types because the fuel materials will all be low-dose-rate uranium radionuclides and will be packaged similarly (inside a metal container that provides little radiation shielding). The per-shipment dose estimates are "generic" (i.e., independent of reactor technology) because they were calculated based on an assumed external radiation dose rate rather than the specific characteristics of the fuel or packaging. Thus, the results can be used to evaluate the impacts for any of the advanced LWR designs. Other input parameters used in the radiation dose analysis for advanced LWR unirradiated fuel shipments are summarized in Table 5.11-5. The results for this “generic” fresh fuel shipment based on the RADTRAN 5 analyses are as follows:

Population Component	Dose
Transport workers	0.00171 person-rem/shipment
General public (Onlookers – persons at stops and sharing the highway)	0.00665 person-rem/shipment
General public (Along Route – persons living near a highway)	1.61 x 10^{-4} person-rem/shipment

These unit dose values were used to estimate the impacts of transporting unirradiated fuel to the VEGP site. Based on the parameters used in the analysis, these per-shipment doses are expected to conservatively estimate the impacts for fuel shipments to a site in the SNC region of interest. For example, the average shipping distance of 2000 miles used in the analyses is likely to exceed the shipping distance for fuel deliveries to the VEGP site.

The unit dose values were combined with the average annual shipments of unirradiated fuel to calculate annual doses to the public and workers that can be compared to Table S-4 conditions. The numbers of unirradiated fuel shipments were normalized to the reference reactor analyzed in WASH-1238. The numbers of shipments per year were obtained from Table 5.11-2. The results are presented in Table 5.11-6. As shown, the calculated radiation doses for transporting unirradiated fuel to the SNC ESP site are within the Table S-4 conditions.

Although radiation may cause cancers at high doses and high dose rates, currently there are no data that unequivocally establish the occurrence of cancer following exposures to low doses and dose rates, below about 1E+04 millirem. However, radiation protection experts conservatively assume that any amount of radiation may pose some risk of causing cancer or a severe hereditary effect and that the risk is higher for higher radiation exposures. Therefore, a linear, no-threshold dose response relationship is used to describe the relationship between radiation dose and detriments such as cancer induction. Simply stated, any increase in dose, no matter how small, results in an incremental increase in health risk. This theory is accepted by the NRC as a conservative model for estimating health risks from radiation exposure, recognizing that the model may over-estimate those risks. A recent review by the National Academy of Sciences Committee to Assess Health Risks from Low Levels of Ionizing Radiation supports the linear no-threshold model **(NAS 2005)**.

Based on this model, the risk to the public from radiation exposure is estimated using the nominal probability coefficient for total detriment (730 fatal cancers, nonfatal cancers, and severe hereditary effects per 1 x 10^6 person-rem) from International Commission on Radiation Protection (ICRP) Publication 60 **(ICRP 1990)**. All the public doses presented in Table 5.11-6 are less than 0.1 person-rem per year; therefore, the total detriment estimates associated with these doses will all be less than 1 x 10^4 fatal cancers, nonfatal cancers, and severe hereditary effects per year. These risks are very small compared to the fatal cancers, nonfatal cancers, and severe hereditary effects that the same population will incur annually from exposure to natural sources of radiation.

5.11.2.2 Transportation of Spent Fuel

This section provides the environmental impacts of transporting spent fuel from the VEGP site to a spent fuel disposal facility using Yucca Mountain, Nevada as a possible location for a geologic repository. The impacts of the transportation of spent fuel to a possible repository in Nevada provides a reasonable bounding estimate of the transportation impacts to a monitored retrievable storage facility because of the distances involved and the representative exposure of members of the public in urban, suburban, and rural areas **(NRC 2004, 2005, 2006)**.

Incident-free transportation refers to transportation activities in which the shipments reach their destination without releasing any radioactive cargo to the environment. Impacts from these shipments will be from the low levels of radiation that penetrate the heavily shielded spent fuel shipping cask. Radiation doses will occur to (1) persons residing along the transportation corridors between the ESP site and the proposed repository; (2) persons in vehicles passing a spent-fuel shipment; (3) persons at vehicle stops for refueling, rest, and vehicle inspections; and (4) transportation crew workers.

This analysis is based on shipment of spent fuel by legal-weight trucks in casks with characteristics similar to casks currently available (i.e., massive, heavily shielded, cylindrical metal pressure vessels). Each shipment is assumed to consist of a single shipping cask loaded on a modified trailer. These assumptions are consistent with assumptions made in evaluating of environmental impacts of spent fuel transportation in Addendum 1 to NUREG-1437. As discussed in NUREG-1437, these assumptions are conservative because the alternative assumptions involve rail transportation or heavy-haul trucks, which will reduce the overall number of spent fuel shipments.

In its assessments of other proposed ESP sites, NRC calculated the environmental impacts of spent fuel transportation using the RADTRAN 5 computer code **(Neuhauser et al. 2003)**. Routing and population data used in the RADTRAN 5 for truck shipments were obtained from the TRAGIS routing code **(Johnson and Michelbaugh 2000)**. The population data in the TRAGIS code were based on the 2000 census.

NRC assumed all spent fuel shipments will be transported by legal weight trucks to the potential Yucca Mountain site over designated highway route-controlled quantity (HRCQ) routes. The routes used for the NRC analyses of other proposed ESP sites are the same as those used in the Yucca Mountain EIS **(DOE 2002b)**.

Although shipping casks have not been designed for the advanced LWR fuels, the advanced LWR fuel designs will not be significantly different from existing LWR designs. Current shipping cask designs were used for analysis.

Radiation doses are a function of many parameters, including vehicle speed, traffic count, dose rate at 1 meter from the vehicle, packaging dimensions, number in the truck crew, stop time, and population density at stops. A listing of the values for the parameters used in the NRC analyses can be found in Appendix G of the *Draft Environmental Impact Statement for an Early Site Permit (ESP) at the North Anna Site* (NUREG-1811; November 2004).

The transportation route selected for a shipment determines the total potentially exposed population and the expected frequency of transportation-related accidents. For truck transportation, the route characteristics most important to the risk assessment include the total shipping distance between each origin-destination pair of sites and the population density along the route.

Representative shipment routes for the VEGP site and alternative sites were identified using the TRAGIS (Version 1.5.4) routing model **(Johnson and Michelhaugh 2000)** for the truck shipments. The Highway data network in TRAGIS is a computerized road atlas that includes a complete description of the interstate highway system and of all U.S. highways. The TRAGIS database version used was Highway Data Network 4.0. The population densities along a route are derived from 2000 census data from the U.S. Bureau of the Census. This transportation route information is summarized in Table 5.11-7 along with the characteristics for the Savannah River Site-Yucca Mountain route.

The VEGP site, is directly across the Savannah River from the DOE's Savannah River Site. The transportation impacts associated with shipments of spent fuel from VEGP will be nearly identical to and slightly less than the NRC transportation analyses for the Savannah River Site because of the proximity of the two sites. As analyzed in the Yucca Mountain EIS **(DOE 2002b)**, the truck shipment routes from the Savannah River Site and VEGP site converge at Interstate 520, a distance of approximately 30 miles from either point of origin or about 1 percent of the total one-way shipping distance to the repository. The remainder of the highway transportation routes to the proposed repository is identical. SNC analyzed potential transportation impacts from VEGP based on the results for spent fuel shipments from the Savannah River Site.

TRAGIS was recently updated to reflect use of the Las Vegas Beltway (Interstate 215/CC-215) as a preferred route for transportation to Yucca Mountain. This change resulted in a decrease of approximately 45,000 in the total exposed population (persons that live within 800 meters of the transportation route) for each transportation route. The total exposed populations within the 800-meter buffer zone are 722,000 for the Hatch site, 764,000 for the VEPG site, and 766,000 for the Farley site. These values are bounded by the total exposed population of greater than 800,000 for the Savannah River Site - Yucca Mountain route.

By using the results for the Savannah River Site-Yucca Mountain transportation route, SNC has conservatively estimated the potential impacts for spent fuel transportation from an ESP site.

Based on the transportation route information shown in Table 5.11-7, the impacts of spent fuel shipments originating at the VEGP site are expected to be greater than the impacts for the alternative sites with existing nuclear plants (Farley, Hatch). The impacts of transportation of spent fuel from a green field site located in the SNC region of interest will also be less than the transportation impacts for the VEGP site.

Based on the Savannah River Site-Yucca Mountain transportation route results presented in Table G-6 of NUREG-1811, the radiation dose estimates to the transport workers and the public for spent fuel shipments from VEGP are as follows:

Population	Dose
Transport workers	0.099 person-rem/shipment
General public (Onlookers)	0.35 person-rem/shipment
General public (Along Route)	0.010 person-rem/shipment

These per-shipment dose estimates are independent of reactor technology because they were calculated based on an assumed external radiation dose rate emitted from the cask, which was fixed at the regulatory maximum of 10 millirem per hour at 2 meters. For purpose of this analysis, the transportation crew consists of two drivers. Stop times were assumed to accrue at the rate of 30 minutes per 4-hour driving time.

The numbers of spent fuel shipments for the transportation impacts analysis were derived as described in Section 5.11.1. The normalized annual shipments values and corresponding population dose estimates per reactor-year are presented in Table 5.11-8. The population doses were calculated by multiplying the number of spent fuel shipments per year for the AP1000 by the per-shipment doses. For comparison to Table S-4, the population doses were normalized to the reference LWR analyzed in WASH-1238.

As shown in Table 5.11-8, population doses to the transport crew and the onlookers for both the AP1000 and the reference LWR exceed Table S-4 values. Two key reasons for these higher population doses relative to Table S-4 are the number of spent fuel shipments and the shipping distances assumed for these analyses relative to the assumptions used in WASH-1238.

- The analyses in WASH-1238 used a "typical" distance for a spent fuel shipment of 1,000 miles. The shipping distance used in this assessment is about 2,600 miles.
- The numbers of spent fuel shipments are based on shipping casks designed to transport shorter-cooled fuel (i.e., 150 days out of the reactor). This analysis assumed that the shipping cask capacities are 0.5 MTU per legal-weight truck shipment. Newer cask designs are based on longer-cooled spent fuel (i.e., 5 years out of reactor) and have larger capacities. For example, spent fuel shipping cask capacities used in the Yucca Mountain EIS (**DOE 2002b,** Table J-2) were approximately 1.8 MTU per legal-weight truck shipment. Use of the newer shipping cask designs will reduce the number of spent fuel shipments and

decrease the associated environmental impacts (since the dose rates used in the impacts analysis are fixed at the regulatory limit rather than based on the cask design and contents).

If the population doses were adjusted for the longer shipping distance and larger shipping cask capacity, the population doses from incident-free spent fuel transportation from VEGP will fall within Table S-4 requirements.

Other conservative assumptions in the spent fuel transportation impacts calculation include:

- Use of the regulatory maximum dose rate (10 millirem per hour at 2 meters) in the RADTRAN 5 calculations. The shipping casks assumed in the Yucca Mountain EIS **(DOE 2002b)** transportation analyses were designed for spent fuel that has cooled for 5 years. In reality, most spent fuel will have cooled for much longer than 5 years before it is shipped to a possible geologic repository. NRC developed a probabilistic distribution of dose rates based on fuel cooling times that indicates that approximately three-fourths of the spent fuel to be transported to a possible geologic repository will have dose rates less than half of the regulatory limit **(Sprung et al. 2000)**. Consequently, the estimated population doses in Table 5.11-8 could be divided in half if more realistic dose rate projections are used for spent fuel shipments from VEGP.
- Use of 30 minutes as the average time at a truck stop in the calculations. Many stops made for actual spent fuel shipments are short duration stops (i.e., 10 minutes) for brief visual inspections of the cargo (checking the cask tie-downs). These stops typically occur in minimally populated areas, such as an overpass or freeway ramp in an unpopulated area. Based on data for actual truck stops, NRC concluded that the assumption of a 30-minute stop for every 4-hours of driving time used to evaluate other potential ESP sites will overestimate public doses at stops by at least a factor of two **(NRC 2004, 2005, 2006)**. Consequently, the doses to onlookers given in Table 5.11-8 could be reduced by a factor of two to reflect more realistic truck shipping conditions.

Impact of accident free transportation of unirradiated and spent fuel will be SMALL and will not warrant additional mitigation.

Table 5.11-1 Summary of Environmental Impacts of Transportation of Fuel and Waste to and from One LWR, Taken from 10 CFR 51.52 Table S-4[1]

Normal Conditions of Transport			
		Environmental Impact	
Heat (per irradiated fuel cask in transit)		250,000 Btu/hr.	
Weight (governed by Federal or State restrictions)		73,000 lbs. per truck; 100 tons per cask per rail car.	
Traffic density:			
Truck		Less than 1 per day.	
Rail		Less than 3 per month.	
Exposed Population	**Estimated Number of Persons Exposed**	**Range of Doses to Exposed Individuals[2] (per reactor year)**	**Cumulative Dose to Exposed Population (per reactor year)[3]**
Transportation workers	200	0.01 to 300 millirem	4 man-rem.
General public:			
Onlookers	1,100	0.003 to 1.3 millirem	3 man-rem.
Along Route	600,000	0.0001 to 0.06 millirem	

Accidents in Transport	
Types of Effects	**Environmental Risk**
Radiological effects	Small[4]
Common (nonradiological) causes	1 fatal injury in 100 reactor years; 1 nonfatal injury in 10 reactor years; $475 property damage per reactor year.

1 Data supporting this table are given in the Commission's "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," WASH-1238, December 1972, and Supp. 1 NUREG-75/038, April 1975.

2 The Federal Radiation Council has recommended that the radiation doses from all sources of radiation other than natural background and medical exposures should be limited to 5,000 millirem per year for individuals as a result of occupational exposure and should be limited to 500 millirem per year for individuals in the general population. The dose to individuals due to average natural background radiation is about 130 millirem per year.

3 Man-rem is an expression for the summation of whole body doses to individuals in a group. Thus, if each member of a population group of 1,000 people were to receive a dose of 0.001 rem (1 millirem), or if 2 people were to receive a dose of 0.5 rem (500 millirem) each, the total man-rem dose in each case will be 1 man-rem.

4 Although the environmental risk of radiological effects stemming from transportation accidents is currently incapable of being numerically quantified, the risk remains small regardless of whether it is being applied to a single reactor or a multi-reactor site.

Table 5.11-2 Number of Truck Shipments of Unirradiated Fuel

Reactor Type	Number of Shipments per Unit: Initial Core[1]	Annual Reload	Total[2]	Unit Electric Generation, MWe[3]	Capacity Factor[3]	Normalized Shipments Total[4]	Normalized Shipments Annual[5]
Reference LWR	18[6]	6.0	252	1100	0.8	252	6.3
AP1000	23	5.3	231	1115	0.93	196	4.9

1 Shipments of the initial core have been rounded up to the next highest whole number.
2 Total shipments of fresh fuel over 40-year plant lifetime (i.e., initial core load plus 39 years of average annual reload quantities).
3 Unit generating capacities from **Westinghouse (2005)** and capacity factors for advanced LWRs from Table 3.0-1. 93 percent used in normalization calculations where >92 percent indicated by Table 3.0-1.
4 Normalized to electric output for WASH-1238 reference plant (i.e., 1100 MWe) plant at 80 percent or an electrical output of 880 MWe).
5 Annual average for 40-year plant lifetime
6 The initial core load for the reference BWR in WASH-1238 was 150 MTU. The initial core load for the reference PWR was 100 MTU. Both types result in 18 truck shipments of fresh fuel per reactor.

Table 5.11-3 Number of Radioactive Waste Shipments

Reactor Type	Waste Generation, ft³/yr, per unit	Annual Waste Volume, ft³/yr, per site	Electrical Output, MWe, per site	Capacity Factor	Normalized Waste Generation Rate, ft³/ reactor-year[1]	Normalized Shipments/ reactor-year[2]
Reference LWR	3800	3800	1100	0.80	3800	46
AP1000	2000	3900	2230[3]	0.93	1700	21

1 Annual waste generation rates normalized to equivalent electrical output of 880 MWe for reference LWR (1100-MWe plant with an 80 percent capacity factor) analyzed in WASH-1238.
2 The number of shipments was calculated assuming the average waste shipment capacity of 82.6 ft^3 per shipment (3800 ft^3/yr divided by 46 shipments/yr) used in WASH-1238.
3 The AP1000 site includes two reactor units at net 1115 MWe per unit.

Table 5.11-4 AP1000 Comparisons to Table S-4 Reference Conditions

Characteristic	Table S-4 Condition	AP1000 Single Unit 1115 MWe
Reactor Power Level (MWt)	not exceeding 3800 per reactor	3415
Fuel Form	sintered UO_2 pellets	sintered UO_2 pellets
U235 Enrichment (%)	Not exceeding 4	Initial Core Region 1: 2.35 Region 2: 3.40; Region 3: 4.45 Reload Average 4.51
Fuel Rod Cladding	Zircaloy rods; NRC has also accepted ZIRLO™ per 10 CFR 50.44	Zircaloy or ZIRLO™
Average burnup (MWd/MTU)	Not exceeding 33,000	48,700
Unirradiated Fuel		
Transport Mode	truck	truck
No. of shipments for initial core loading[1]		23
No. of reload shipments per year[1]		5.3
Irradiated Fuel		
Transport mode	truck, rail or barge	truck, rail
Decay time prior to shipment	Not less than 90 days is a condition for use of Table S-4; 5 years is per contract with DOE	10 years
No. of spent fuel shipments by truck[1]		46 per year
No. of spent fuel shipments by rail		not analyzed
Radioactive Waste		
Transport mode	truck or rail	truck
Waste form	solid	solid
Packaged	yes	yes
No. of waste shipments by truck[1]		24 per year
Traffic Density		
Trucks per day[2] (normalized total)	Less than 1	<1 (65 per year)
Rail cars per month	Less than 3	not analyzed

1 Table provides the total numbers of truck shipments of fuel and waste for the AP1000. These values are then normalized based on electric output and summed for comparison to the traffic density condition in Table S-4.

2 Total truck shipments per year calculated after normalization of estimated fuel and waste shipments for equivalent electrical output to the reference reactor analyzed in WASH-1238.

Table 5.11-5 RADTRAN 5 Input Parameters for NRC Analysis of Unirradiated Fuel Shipments

Parameter	RADTRAN 5 Input Value
Shipping distance, miles[1]	2000
Travel Fraction – Rural	0.90
Travel Fraction – Suburban	0.05
Travel Fraction – Urban	0.05
Population Density – Rural, persons/mi^2	25.9
Population Density – Suburban, persons/mi^2	904
Population Density – Urban, persons/mi^2	5850
Vehicle speed – Rural, miles/hr	55
Vehicle speed – Suburban, miles/hr	55
Vehicle speed – Urban, miles/hr	55
Traffic count – Rural, vehicles/hr	530
Traffic count – Suburban, vehicles/hr	760
Traffic count – Urban, vehicles/hr	2400
Dose rate at 1 meter from vehicle, mrem/hr	0.1
Packaging length, ft	22
Number of truck crew	2
Stop time, hr/trip	4.5
Population density at stops, persons/mi^2	166,500

Source: **NRC (2004, 2005, 2006)**.

1 WASH-1238 had a range of shipping distances between 25 and 3000 miles for unirradiated fuel shipments. A 2000-mile "average" shipping distance was used in the NRC analyses of other potential ESP sites.

Table 5.11-6 Radiological Impacts of Transporting Unirradiated Fuel to VEGP by Truck

Reactor Type	Normalized Average Annual Shipments	Cumulative Annual Dose, person-rem per reference reactor year		
		Transport Workers	General Public - onlookers	General Public - along route
Reference LWR	6.3	0.011	0.042	0.0010
AP1000	4.9	0.0084	0.033	7.9×10^{-4}
10 CFR 51.52 Table S-4 condition	365 (<1 per day)	4	3	3

Table 5.11-7 Transportation Route Information for Spent Fuel Shipments from VEGP to the Potential Yucca Mountain Disposal Facility

Reactor Site	One-way Shipping Distance, miles				Population Density, persons per square mile			Stop Time per trip, hr
	Total	Rural	Suburban	Urban	Rural	Suburban	Urban	
SRS[1]	2649	2026	547	76	28.5	859	5986	5
VEGP	2564	2009	488	67	25.0	856	5879	5
Hatch	2595	2043	489	63	25.1	838	5872	5
Farley	2559	2043	450	67	24.8	867	6076	5

1 SRS transportation route information presented in Table G-4 of **NRC (2004)**.

Table 5.11-8 Population Doses from Spent Fuel Transportation, Normalized to Reference LWR

		Reactor Type	
		Reference LWR	AP1000
		Normalized Number of Spent Fuel Shipments per year	
		60	39
Exposed Population	**Cumulative dose limit specified in Table S-4, person-rem per reactor year**	**Environmental Effects, person-rem per reactor year**	
Crew	4	5.9	3.8
Onlookers	3	21	14
Along route	3	0.60	0.39

Section 5.11 References

(DOE 2002a) U.S. Department of Energy, A Research Handbook on DOE Transportation Risk Assessment, DOE/EM/NTP/HB-01, Washington, D.C.

(DOE 2002b) U.S. Department of Energy, Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada, DOE/EIS-0250, Office of Civilian Radioactive Waste Management, U.S. Department of Energy, Washington, D.C., February, 2002.

(Johnson and Michelbaugh 2000) Johnson, P. E. and R. D. Michelhaugh, *Transportation Routing Analysis Geographic Information System (WebTRAGIS) User's Manual*, ORNL/TM-2000/86, Oak Ridge National Laboratory, Oak Ridge, Tennessee, available on the Internet at http://www.ornl.gov/~webworks/cpr/v823/rpt/106749.pdf.

(**NAS 2005)** National Research Council, National Academy Press, "Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII – Phase 2," Committee to Assess Health Risks From Exposure to Low Levels of Ionizing Radiation, Board on Radiation Effects Research, Division of Earth and Life Studies, Washington, D.C., 2005, available on the Internet at http://www.nap.edu/books/030909156X/html.

(Neuhauser et al. 2003) Neuhauser, K. S., F. L. Kanipe, and R. F. Weiner, *RADTRAN 5 User Guide*. SAND2003-2354, Sandia National Laboratories, Albuquerque, New Mexico, available on the Internet at http://infoserve.sandia.gov/sand_doc/2003/032354.pdf.

(NRC 2004) U.S. Nuclear Regulatory Commission, Draft Environmental Impact Statement for an Early Site Permit (ESP) at the North Anna ESP Site, NUREG-1811, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, D.C., November 2004.

(NRC 2005) U.S. Nuclear Regulatory Commission, Draft Environmental Impact Statement for an Early Site Permit (ESP) at the Exelon ESP Site, NUREG-1815, Office or Nuclear Reactor Regulation, Washington, D.C., February.

(NRC 2006) U.S. Nuclear Regulatory Commission, Environmental Impact Statement for an Early Site Permit (ESP) at the Grand Gulf ESP Site, NUREG-1817, Office or Nuclear Reactor Regulation, Washington, D.C., April.

(Sprung et al. 2000) Sprung, J. L., D. J. Ammerman, N. L. Breivik, R. J. Dukart, F. L. Kanipe, J. A. Koski, G. S. Mills, K. S. Neuhauser, H. D. Radloff, R. F. Weiner, and H. R. Yoshimura, Reexamination of Spent Fuel Shipment Risk Estimates, NUREG/CR-6672, Volume 1, Office of

Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, D.C., March.

(Westinghouse 2005) Westinghouse Electric Company LLC, AP1000 Design Control Document, Revision 15, Pittsburgh, PA, November 11.

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5.12 Nonradiological Health Impacts

5.12.1 Public Health

New units at VEGP could cause non-radiological health impacts to the public. Nonradiological air emissions can move offsite to nearby residences or businesses. Noise can be heard offsite. The electrical transmission system can produce induced currents in metal fences and vehicles beneath the transmission lines. In the Savannah River, pathogenic organisms could exist due to the heated effluent from the plant.

Section 5.3.4, Impacts to Members of the Public (from cooling system operation), addresses the impacts to the public from pathogenic organisms and noise concludes that the impacts to the public from both are small. Section 5.6.3, Impacts to Members of the Public (from transmission line operation), examines the risk from electric shock from induced currents under transmission lines. The magnitude of the shock will be within the limits established by the National Electrical Safety Code. Section 5.8.1, Physical Impacts, describes the risks from air pollution and concludes that the risks are small.

Impacts to members of the public will be SMALL and will not warrant mitigation.

5.12.2 Occupational Health

Workers at the new nuclear units could be susceptible to industrial accidents (e.g., falls, electric shock, burns), or occupational illnesses due to noise exposure, exposure to toxic or oxygen-replacing gases, exposure to thermophilic organisms in the condenser bays, and exposure to caustic agents. SNC has a health and safety program that addresses industrial safety risks and that will be invoked for the new units. In accordance with this plan, SNC maintains records of a statistic known as total recordable cases (TRC). TRCs include work-related injuries or illnesses that include death, days away from work, restricted work activity, medical treatment beyond first aid, and other criteria.

The incidence rate of recordable cases at Plant Vogtle between 2000 and 2004 averaged 1.8 cases per 100 workers or 1.8 percent. This compares favorably to the nationwide TRC rate for electrical power generation workers of 3.5 percent **(BLS 2003a)** and of 4.5 percent for Georgia **(BLS 2003b)**.

SNC estimates that two AP1000s will employ 662 workers. During outages, these numbers could increase significantly for short durations.

The number of total recordable cases per year for the new units can be estimated as the number of workers times the VEGP TRC rate. Therefore, the estimated TRC incidence will be:

No. Workers	TRC Incidence at U.S. Rate	TRC Incidence at Georgia Rate	TRC Incidence at VEGP Rate
662	23	30	12

Section 5.12 References

(BLS 2003a) Bureau of Labor Statistics, “Table 1, Incidence rates of nonfatal occupational injuries and illnesses by industry and case types, 2003,” available on the internet from http://www.bls.gov/iif/, accessed July 14, 2005.

(BLS 2003b) Bureau of Labor Statistics, “Table 6, Incidence rates of nonfatal occupational injuries and illnesses by industry and case types, 2003, Georgia,” available on the internet from http://www.bls.gov/iif/, accessed July 14, 2005.

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Chapter 6 Environmental Measurements and Monitoring Programs

This chapter describes the environmental measurement and monitoring programs for the new units. Programs now in place for the existing units will be modified to include requirements for the new units where appropriate. The discussion of environmental measurements and monitoring programs is divided into the following sections:

- Thermal Monitoring (Section 6.1)
- Radiological Monitoring (Section 6.2)
- Hydrological Monitoring (Section 6.3)
- Meteorological Monitoring (Section 6.4)
- Ecological Monitoring (Section 6.5)
- Chemical Monitoring (Section 6.6)
- Summary of Monitoring Programs (Section 6.7)

Monitoring details (e.g., sampling equipment, constituents, parameters, frequency, and locations) for each specific phase of the overall program are described in each of these sections.

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6.1 Thermal Monitoring

The Georgia Department of Natural Resources, Environmental Protection Division (EPD), specifies thermal monitoring requirements as part of the National Pollutant Discharge Elimination System (NPDES) permit process.

6.1.1 Existing Thermal Monitoring Program

National Pollutant Discharge Elimination system (NPDES) permit number GA0026786 (**GDNR 2004**) for the existing Vogtle Electric Generating Plant (VEGP) units does not require routine thermal monitoring of discharges to the Savannah River. Thermal monitoring of the intake and final plant discharge is performed once every five years to support renewal of the NPDES permit.

6.1.2 Pre-Operational and Operational Thermal Monitoring

Modeling done for this application indicates that the discharge from the new units will affect a very small percent of the river volume in the immediate vicinity of the discharge, and the effects will dissipate over a short distance downstream (see Section 5.3.2).

A new or amended NPDES permit will be necessary for the future combined operation of the existing units and the new units, but it is unlikely that routine thermal monitoring will be a requirement of the new or amended permit.

Section 6.1 References

(GDNR 2004) Georgia Department of Natural Resources, Authorization to Discharge under the National Pollutant Discharge Elimination System, Environmental Protection Division, Atlanta, GA, May 21.

6.2 Radiological Monitoring

The VEGP radiological monitoring program is not expected to change as a result of adding Units 3 and 4.

6.2.1 Existing Radiological Environmental Monitoring Program Basis

The existing Radiological Environmental Monitoring Program (REMP) is described in the VEGP Offsite Dose Calculation Manual **(SNC 2004)** and is discussed in the following sections.

6.2.2 Existing Radiological Environmental Monitoring Program Contents

Pre-operational data collected in the 1980s provided a baseline for the existing units. The measurement of radiation levels, concentrations (including surface area), and/or other quantities of radioactive material, are used to evaluate potential exposures and doses to members of the public and the environment.

The following radiation exposure pathways are monitored.

- Direct (dosimeters)
- Airborne (iodine and particulates)
- Waterborne (surface water and river sediment)
- Aquatic (fish tissue analysis)
- Ingestion (milk, fish tissue, and drinking water)
- Vegetation (forage)

Sampling results and locations are evaluated to determine effects from seasonal yields and variations. Figures 6.2-1 through 6.2-3 show existing radiological sampling locations. Table 6.2-1 provides details of the radiation exposure pathways monitored and the frequency of monitoring. Trending and comparison reviews provide information regarding changes in background levels and determine the adequacy of analytical techniques in light of program results and changes in technology, when compared to baseline measurements. Changes in program implementation (including sampling techniques, frequencies and locations) may occur as a result of monitoring results.

6.2.3 Existing Radiological Environmental Monitoring Program Reporting

An Annual Radiological Environmental Operating Report for the VEGP site is submitted in accordance with the existing units' Technical Specifications and Offsite Dose Calculation Manual. Results from REMP implementation and evaluation are compared to results from previous years' for measurement trends, methodology consistency, and indications that the program is adequate and does not need revisions.

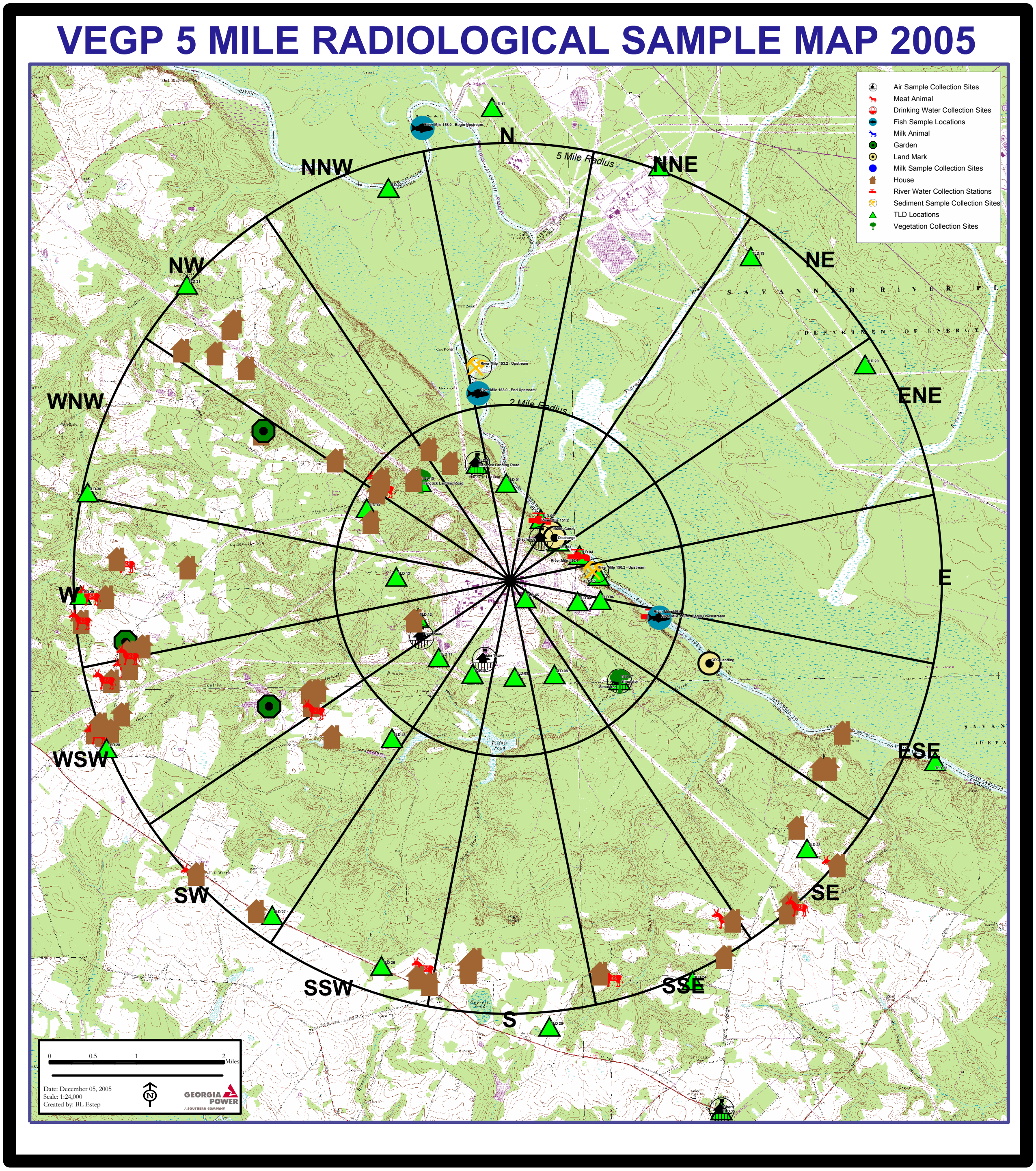
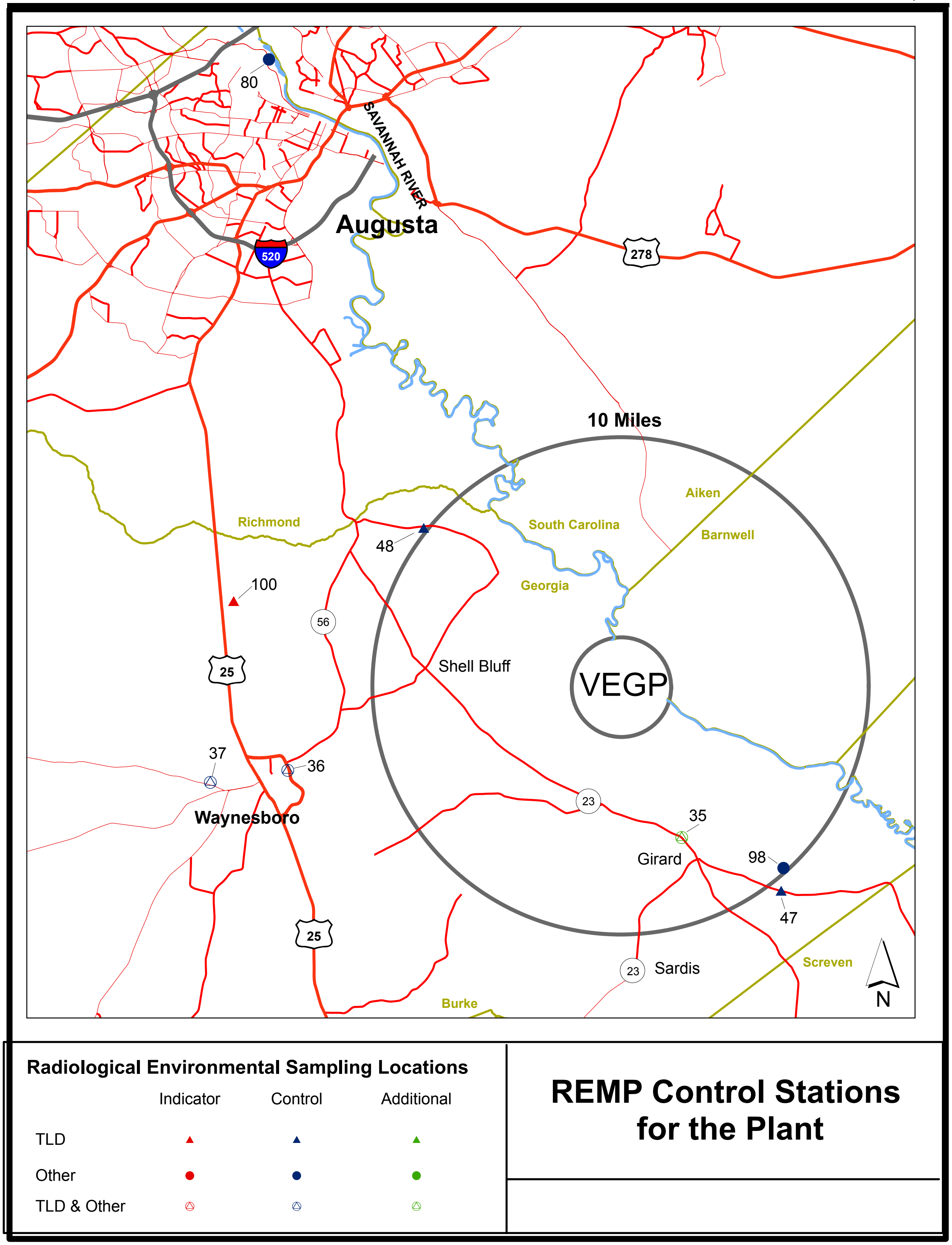


Figure 6.2-1 Locations of REMP Sampling Stations within 5 miles of VEGP



REMP Control Stations for the Plant

Figure 6.2-2 Locations of REMP Sampling Stations between 5 and 10 Miles of VEGP

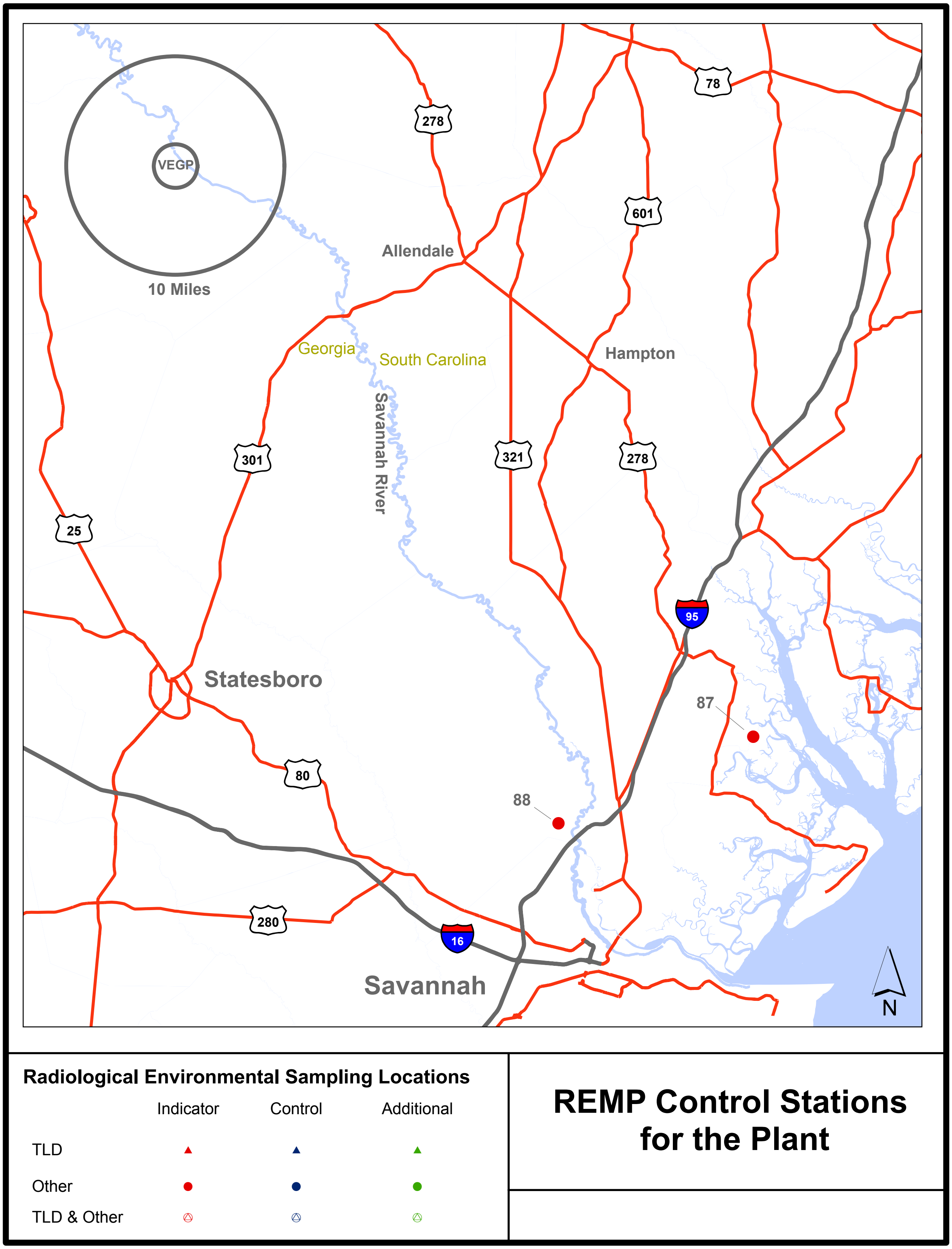


Figure 6.2-3 Locations of REMP Downstream Water Sampling Stations

An Inter-laboratory Comparison Program verifies the accuracy and precision of radioactive analyses of environmental samples. These results are reported in the Annual Radiological Environmental Monitoring Report.

A land use census is conducted annually within a designated distance of the VEGP site, currently 5 miles, to determine sampling yields and locations, and to ascertain if changes to the Radiological Environmental Monitoring Program are warranted. Information collected includes locations of nearest residence, milk-producing animal, and garden with broad-leaf vegetation in each of the 16 compass directions. Compass directions that fall on the Savannah River Site (SRS) are excluded from this census because SRS has restricted access (no one resides on SRS property) and DOE maintains a similar monitoring program. Results of the land use census are included in the Annual Radiological Environmental Operating Report. An annual River Water Users Survey is also conducted to identify any new users of surface water for drinking or irrigation.

6.2.4 Existing Quality Assurance Program

The Radiological Environmental Monitoring Program is conducted in accordance with NRC Regulatory Guide 4.15, *Quality Assurance for Radiological Monitoring Programs (Normal Operations) -- Effluent Streams and the Environment, Revision 1*, 1979 (RG 4.15). Quality assurance is provided in the existing NRC-approved Radiological Environmental Monitoring Program through quality training, program implementation by periodic tests, the Inter-laboratory Comparison Program, and administrative and technical procedures.

6.2.5 Pre-operational and Operational Radiological Monitoring Programs

The existing VEGP Units 1 and 2 REMP will serve as the preoperational radiological monitoring program. The Radiological Environmental Monitoring Program (REMP) for the new units will be based on *Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors*, 1991 (NUREG-1301) and the NRC's Branch Technical Position Paper, *Acceptable Radiological Environmental Monitoring Program, Revision 1*, 1979.

The Offsite Dose Calculation Manual, based on the Units 1 and 2 Technical Specifications, will be modified for the new units and will address the requirements of 10 CFR 50 Appendix I. One of the requirements is the publication of the Annual Radiological Environmental Operating Report. As noted in the AP1000 Design Control Document, Section 16.1.1.5.6, Reporting Requirements (**Westinghouse 2005**), a single report can be prepared for a multiple-unit station. Therefore, the VEGP REMP will address the releases from the VEGP site as a whole. This modified REMP will continue to comply with the VEGP Units 1 and 2 Technical Specifications and Offsite Dose Calculation Manual.

Table 6.2-1 Radiological Monitoring Program (Pathways)[1]

Radiation Exposure Pathway Monitored	Parameters	Frequency of Analysis
Direct	Gamma dose	Quarterly
Airborne	Radioiodine	Weekly
	Particulates: Gross beta radioactivity; gamma isotopic analysis	Weekly Quarterly
Waterborne	Surface water: Gamma isotopic analysis	Monthly
	Surface water: Tritium	Quarterly
	Drinking water: Radioiodine	Biweekly or monthly, depending on calculated dose
	Drinking water: Gross beta radioactivity and gamma isotopic analysis	Monthly
	Drinking water: Tritium	Quarterly
	Sediment: gamma isotopic analysis	Semiannually
Ingestion	Milk: gamma isotopic analysis and radioiodine	Biweekly
	Fish: gamma isotopic analysis	Semiannually
	Grass or leafy vegetation: gamma isotopic analysis	Monthly

[1] Radiological monitoring programs for pre-application, construction/pre-operations and operations

Section 6.2 References

(SNC 2004) Southern Nuclear Company, Offsite Dose Calculation Manual for Vogtle Electric Generating Plant, Ver. 22, June 25.

(Westinghouse 2005) Westinghouse Electric Company, LLC, AP1000 Design Control Document, Revision 15, Pittsburgh, PA, November 11.

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6.3 Hydrological Monitoring

This section discusses the hydrological monitoring program that will be implemented to monitor the effects of the new units at the VEGP site, including monitoring of flow rates, water levels, sediment loads, and groundwater levels.

6.3.1 Existing Hydrological Monitoring

Hydrological monitoring at VEGP includes both surface water and groundwater. Each program, is discussed below.

Presently, SNC conducts hydrological monitoring of surface waters in accordance with NPDES Permit No. GA0026786 (**GDNR 2004**) and Industrial Stormwater General Permit No. GAR000000. Surface water monitoring includes monitoring flow from permitted outfalls (Table 6.3-1).

Two monitoring programs measure drawdown and levels of groundwater at VEGP. One program is conducted to meet Georgia EPD requirements. The other program, designed to monitor piezometric levels across the site, is commonly referred to as the “NRC groundwater monitoring program”.

In compliance with the Georgia EPD Groundwater Use Permit, SNC monitors monthly total, daily maximum and monthly average groundwater use from the nine groundwater pumping wells on site (Figure 6.3-1). The data are reported to the Georgia EPD semiannually. SNC also monitors static and pumping water levels of selected (primary) wells and submits results to the Georgia EPD semiannually (Table 6.3-2). Annually, SNC determines the specific conductivity and temperature of the water from two selected primary wells and submits results to the EPD. Figure 6.3-2 locates all the observation and pumping wells at VEGP. For the “NRC program”, measurements are performed quarterly in four water table aquifer wells in the area of the powerblock backfill (Table 6.3-3 and Figure 6.3-2, LT series) and four other water table aquifer wells are monitored semiannually (Table 6.3-3 and Figure 6.3-2, 802A, 805A, 806B, and 808). See Section 2.3.1.2.3 for discussion of these wells.

Measurements of groundwater elevations in most wells are obtained by either a slope water level indicator or a portable well sounder. Water elevation is a reference elevation at ground level minus the marked distance on the probe. In one well, an air line is pressurized and the static gauge pressure is recorded. The pressure and the marked distance on the airline can be converted to depth to groundwater. The pumping water level elevations are also measured. Drawdown is the difference between static and pumping water elevation.

6.3.2 Construction and Pre-Operational Monitoring

Sixteen groundwater observation wells were installed at the VEGP site in 2005 to establish groundwater levels, flow paths, and gradients near the new units (Table 6.3-3 and Figure 6.3-2). These wells are monitored monthly for groundwater elevation. In addition, the monitoring programs for the existing units will continue. These monitoring programs support the baseline groundwater hydrological conditions for the new units. Although no significant impacts to groundwater aquifers are anticipated during construction, monitoring will provide a means of detecting any unanticipated changes should they occur.

Prior to construction of the new units, SNC will prepare an Erosion, Sedimentation and Pollution Control Plan in support of the Georgia General NPDES Construction Stormwater Discharge Permit for Stand Alone Construction Projects process. The Plan will provide for periodic visual inspection of erosion and sediment control best management practices. The Plan will also describe a monitoring program that meets specific criteria outlined in the Construction Stormwater Permit. Stream buffer variances will be obtained as needed for encroachment on state stream buffers. U.S. Army Corps of Engineer permits will be obtained as needed for impacts to rivers, wetlands and other water bodies affected by construction. Any monitoring of the Savannah River required in conjunction with permits associated with construction of the barge facility or the water intake or discharge structures will be conducted in accordance with a Water Quality Certification issued under Section 401 of the Clean Water Act.

6.3.3 Operational Monitoring

Operational monitoring programs for groundwater and surface water will be developed in coordination with the State of Georgia and NRC and incorporated into new or amended groundwater use, NPDES, and industrial stormwater discharge permits. Because the permitted site is already a nuclear power station, it is anticipated that the monitoring requirements of the new/amended permits will be similar to the existing permits.

Prior to initiation of new unit operations, the existing Storm Water Pollution Prevention Plan will be revised to include the new units, or a separate plan for the new units will be developed and approved, as required by the Georgia General NPDES Permit for Industrial Stormwater Discharges.

Table 6.3-1 Existing Surface Water Hydrological Monitoring Program

Monitoring Location	Parameter (units)	Frequency	Sample Type
Outfall 001(Final Plant Discharge [combined plant waste streams from Units 1 and 2])	Flow (mgd)	Annually	Flow study
002 (Unit 1 cooling tower blowdown) and 003 (Unit 2 cooling tower blowdown	Flow (mgd)	Annually	Flow study
004 (Unit 1 waste water retention basin) and 005 (Unit 2 waste water retention basin)	Flow (mgd)	Annually	Flow study
006 (Sewage treatment plant emergency overflow)	Flow (mgd)	1/discharge	Estimate
007 (Liquid radwaste systems discharge Unit 1) and 008 (Liquid radwaste system Unit 2)	Flow (mgd)	Annually	Flow study
009 (Nuclear service cooling tower blowdown [Units 1 and 2])	Flow (mgd)	Annually	Flow study

mgd = million gallons per day

Table 6.3-2 Groundwater Pumping Wells

Well Number	Monitoring Program	Construction Depth (feet)	Parameters Monitored
MU-1	Georgia	851	Static water elevation, pumping water elevation, gallons pumped
MU-2A[1]	Georgia	884	Static water elevation, pumping water elevation, gallons pumped
IW-4	Georgia	370	Gallons pumped
Sec	Georgia	320	Gallons pumped
SW-5	Georgia	200	Gallons pumped
CW-3	Georgia	220	Gallons pumped
SB	Georgia	340	Gallons pumped
Recreation [1]	Georgia	265	Static water elevation, pumping water elevation, gallons pumped
TW-1	Georgia	860	Gallons pumped

1 EPD requires drawdown information from the two highest yielding wells, normally MU-1 and MU-2A, however MU-2A has proved difficult to monitor. EPD granted an exception and has accepted drawdown measurements from the Rec well.

Table 6.3-3 Groundwater Hydrological Monitoring Program[1]

Well Number	Monitoring Program	ESP Program	Construction Depth (feet) or Aquifer	Parameters Monitored
LT-1B	NRC[2]	√	93	Well water elevation well depth
LT-7A	NRC	√	92	Well water elevation well depth
LT-12	NRC	√	89	Well water elevation well depth
LT-13	NRC	√	91	Well water elevation well depth
802A	NRC	√	89	Well water elevation well depth
805A	NRC	√	125	Well water elevation well depth
806B	NRC	√	70	Well water elevation well depth
808	NRC	√	75	Well water elevation well depth
142	Not part of any existing monitoring program, but redeveloped for the ESP sampling program	√		Well water elevation
179		√		Well water elevation
803A		√		Well water elevation
804		√		Well water elevation
809		√		Well water elevation
27		√		Well water elevation
29		√		Well water elevation
850A		√		Well water elevation
851A		√		Well water elevation
852		√		Well water elevation
853		√		Well water elevation
854		√		Well water elevation
855		√		Well water elevation
856		√		Well water elevation

Table 6.3-3 (cont.) Groundwater Hydrological Monitoring Program[1]

Well Number	Monitoring Program	ESP Program	Depth Interval Tested (feet)	Parameters Monitored
New Groundwater Observation Wells				
OW-1001A		√	77 - 93	Well water elevation
OW-1002		√	216 - 237	Well water elevation
OW-1003		√	72 - 91	Well water elevation
OW-1004		√	150 - 187	Well water elevation
OW-1005		√	143 - 169	Well water elevation
OW-1006		√	113 - 134	Well water elevation
OW-1007		√	99 - 120	Well water elevation
OW-1008		√	226 - 247	Well water elevation
OW-1009		√	81 - 98	Well water elevation
OW-1010		√	70 - 92	Well water elevation
OW-1011		√	197 - 218	Well water elevation
OW-1012		√	71 - 94	Well water elevation
OW-1013		√	81 - 104	Well water elevation
OW-1014		√	179 - 197	Well water elevation
OW-1015		√	90 - 120	Well water elevation

1 Wells are located on Figure 6.3-2. SNC performs all monitoring and reports results to Georgia EPD or NRC.

2 This program, commonly referred to as the “NRC groundwater monitoring program”, measures water levels in certain wells in concert with the evaluation of settlement of onsite structures.

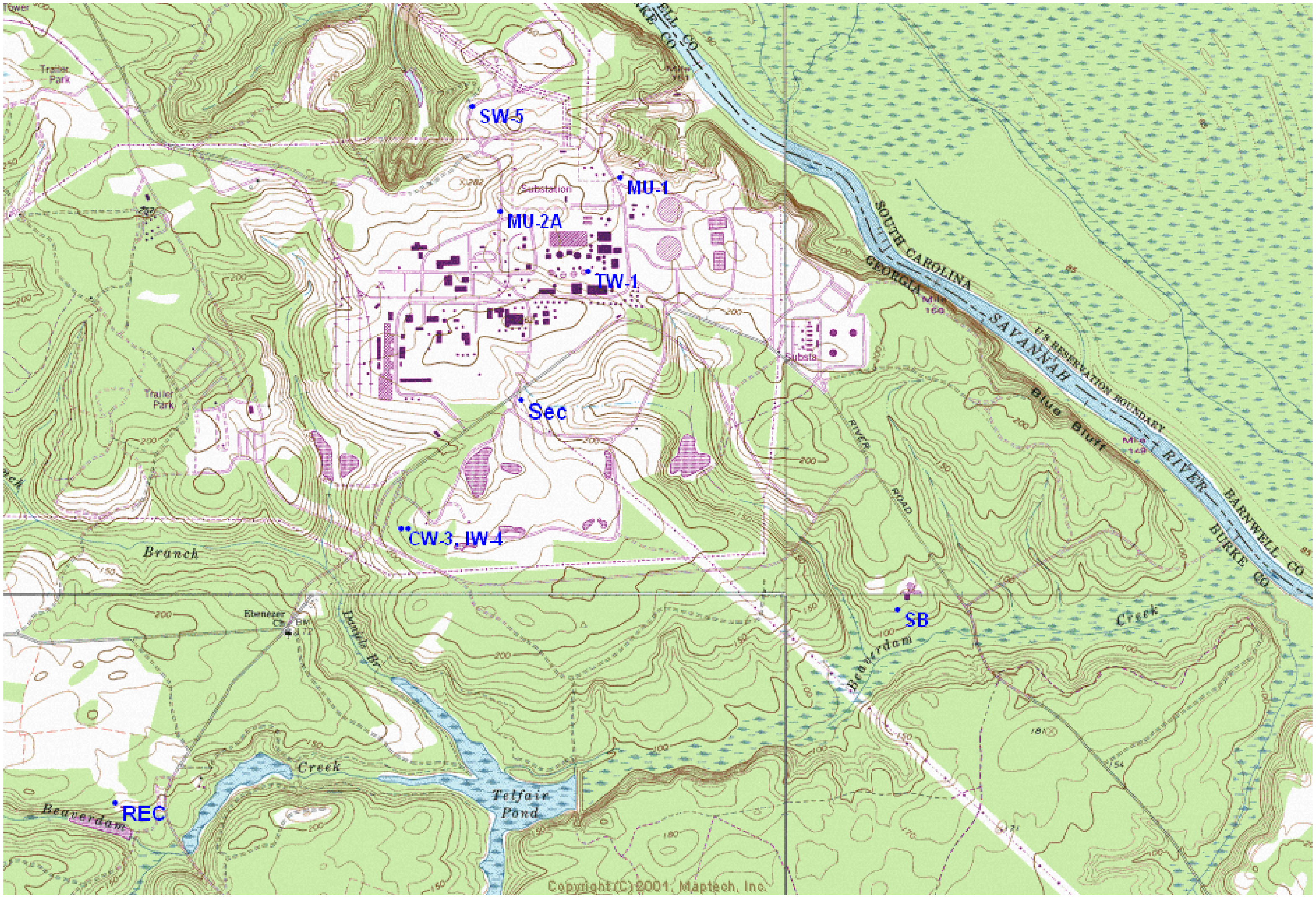

Figure 6.3-1 Groundwater pumping wells

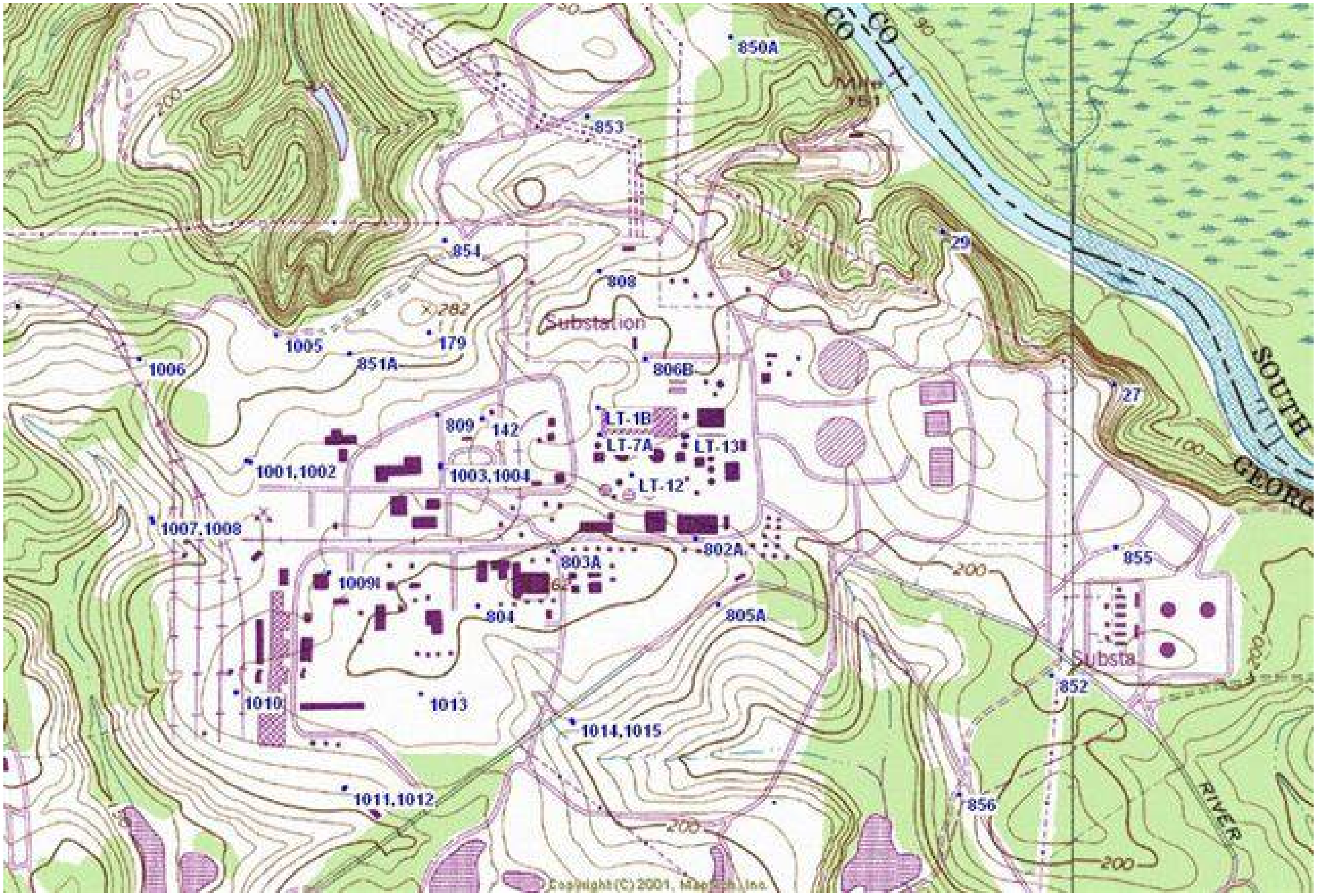

Figure 6.3-2 Locations of groundwater monitoring wells at VEGP

Section 6.3 References

(GDNR 2004) Georgia Department of Natural Resources, *Authorization to Discharge under the National Pollutant Discharge Elimination System,* Environmental Protection Division, Atlanta, GA, May 21.

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6.4 Meteorological Monitoring

6.4.1 Existing Onsite Meteorological Monitoring Program

SNC plans to use the existing VEGP meteorological monitoring program for the new units. The existing program is described in the VEGP UFSAR, Section 2.3 and various VEGP procedures. The existing program is suited for the new units' required onsite meteorological measurements because the new units will be immediately adjacent to the existing units, making the location of the existing meteorological monitoring towers appropriate for all units.

The current onsite VEGP meteorological measurements program conforms to the requirements of 10 CFR 50.47 and the guidance criteria set forth in

- *Functional Criteria for Emergency Response Facilities, Final Report*, 1981 (NUREG-0696)
- *Clarification of TMI Plan Requirements*, 1980 (NUREG-0737)
- FEMA-REP-1, *Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants, Revision 1*, Appendix 2, 1996, (NUREG-0654)
- Regulatory Guide 1.111, *Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors, Revision 1*, 1977 (RG 1.111)
- Regulatory Guide 1.21, *Measuring, Evaluating, and Reporting Radioactivity in Solid Waste and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants, Revision 1*, 1974 (RG 1.21)
- Regulatory Guide 1.23, *Meteorological Programs in Support of Nuclear Power Plants, Proposed Revision 1*, 1980 (RG 1.23), and
- *American National Standards for Determining Meteorological Information at Nuclear Facilities*, 1984 (ANSI/ANS 2.5).

System accuracy conforms to ANSI/ANS 2.5.

The meteorological program has the following basic functions:

- Collecting meteorological data
- Generating real-time predictions of atmospheric effluent transport and diffusion
- Providing the appropriate organizations access (by remote interrogation) to the atmospheric measurements and predictions

Meteorological measurements are available from both a primary tower and a backup tower, as required in 10 CFR 50, Appendix E. The primary and backup towers are completely separate systems located approximately 230 feet apart. Data from the backup tower can be available even when the primary tower is out of service. The backup system is designed to function when the primary system is out of service, providing assurance that basic meteorological information will be available during and immediately following an accidental airborne radioactive release.

The primary and backup towers are located in a cleared area approximately 5,000 feet south-southwest of Unit 2 (Figure 3.1-3). They will be approximately 3,000 feet south of the new units' cooling towers. A relocation study was performed using NRC-specified meteorology. Relocation of the meteorological towers will not be required. The study confirmed that the proposed location of the new cooling towers does not significantly impact air flow to the existing meteorological tower location.

The primary meteorological tower is a 196.9-ft (60-m) tower with permanent sensors located at the 32.8-ft (10-m) level and the 196.9-ft (60-m) level. Wind speed, wind direction, and temperature are measured at the 196.9-ft elevation. Wind direction fluctuation is calculated as the standard deviation of the wind direction. Wind speed, wind direction, and ambient temperature, and dew point temperature are measured at the 32.8-ft elevation. The differential temperature is calculated as the difference between the 10-m temperature and 60-m temperature. Precipitation is monitored at ground level.

The backup meteorological tower is a 147.6-ft (45-m) tower in the same clearing as the primary tower. Sensors at the 32.8-ft (10-m) elevation monitor wind speed, wind direction, and ambient temperature. The signal path, instrument shelter and data recording are the same as those at the primary tower described below. All data from the backup tower is collected, stored and routed by the Meteorological Data Collection Center (MDCC).

Data collection includes strip chart recorders (digital strip chart recorders which temporarily store short term data). The signals from the primary and backup meteorological instruments are processed by equipment in the primary meteorological tower shelter, located near the base of the towers. Five-second sample data are then transferred to the interprocess communication system (IPC) via the local area network. These data are stored on the IPC and transferred via the local area network to a PC currently located in the service building. Software provided by ABS Consulting/Southern Company Engineering calculates 15-minute and hourly averages of each parameter and stores this data in a format that can be used for RG 1.21 reporting. Data are transmitted to the IPC via the local area network where it is available for access by control room personnel, Technical Support Center (TSC) personnel, and Emergency Operations Facility personnel through the Unit 1 plant computer. The system also provides for telephone communication to the meteorological shelter and for MDCC trouble alarms. The data collection center in the meteorological shelter has an Uninterruptible Power Supply that prevents the loss of meteorological data in the event of the loss of off-site power.

Because of the proximity of the new units to the existing units, meteorological parameters collected at the onsite primary and backup towers will be representative of the dispersion conditions at the new units.

6.4.1.1 Location, Elevation, and Exposure of Instruments

The nearest elevated structures are more than 450 feet from the towers. Trees surrounding the tower clearing have been topped to heights that prevent channeling and unprecedented aerodynamic effects. The area within 450 feet of both towers is inspected weekly to ensure that no trees or other obstructions have been introduced into this area. Ground cover at the towers is mown grass. Weekly checks ensure that guy wires are stable, anemometers are turning (or no wind), wind vanes are responsive and aligned, and aspirators are operational. The met towers are inspected annually by a consultant to verify vertical alignment and guy wire tension.

The proposed 600-ft tall natural draft cooling towers for VEGP Units 3 and 4 will be approximately 3000 feet north of the meteorological towers. Industry guidance suggests that meteorological equipment and potential obstructions should be separated by a distance 10 times the obstruction height (from ANSI/ANS 3.11). However, there is precedent at nuclear facilities for the separation to be less than the recommended distance. SNC performed an evaluation to ascertain that Units 3 and 4 cooling towers would have no effect on wind velocities at the meteorological tower in its current location. Statistical analysis of the results showed that there was no significant difference, on the average, in the measured wind velocities at the meteorological tower location with and without the new structures. The addition of the additional proposed structures should have no measurable impact on the data measured at the meteorological tower.

SNC uses Climatronics Corporation meteorological systems for the instrumentation and Yokagawa data recorders to record the data at the instrumentation shelter. The equipment is powered by dual Hewlett Packard power supplies. The MDCC, located in the primary tower shelter, houses the strip charts and computer system which store data. Table 6.4-1 provides instrument descriptions. Instrument accuracies for all systems are in conformance with ANSI/ANS 2.5.

Wind speed and wind direction are measured at 60 m and 10 m on the main tower and 10 m on the backup tower.

Ambient temperature is collected at 10 m on both the main and backup towers and delta temperature between 10 – 60 m on the main tower.

Dew point temperature data are recorded from 10 m on the primary tower.

Precipitation is collected at 2 meters in the rain gauge located near the primary tower shelter. Daily rainfall readings are obtained on Monday through Friday from a plastic rainfall cup used only as a comparison for the system rainfall gauges. The system gauge is a tipping bucket style with each tip of the bucket representing 0.01 inches of precipitation.

6.4.2 Instrument Calibration and Maintenance

The meteorological monitoring system is calibrated at least semi-annually at both the primary and backup towers. Inspection, service, and maintenance are performed according to the instrument manuals, to maintain at least 90 percent data recovery in accordance with the guidance of RG 1.23. Each parameter is tested at the sensor, processor, and at the computer for end-to-end results that are compared with expected values. Site-based instrument technicians have the requisite expertise to service and, in the event of a system failure, to repair the monitoring equipment.

6.4.3 Data Recording Systems

Per the guidance of NUREG-0654, Appendix 2, all meteorological data systems should have the capability of being remotely interrogated. The meteorological data collected onsite are transmitted on a real-time basis to the Unit 1 control room, the TSC and the Emergency Operations Facility. This satisfies the guidance provided in NUREG-0654.

Digital strip chart recorders are located at the primary meteorological shelter. Data are stored for a short duration and displayed on these strip chart recorders. Data are transmitted every 5 seconds to a PC running ABS Consulting/Southern Company Engineering software which calculates 15-minute and hourly-averages of data. The data on the PC is used for RG 1.21 reporting. These 5-second data are converted to 15-minute and 1-hour averages. Data from the IPC are also displayed in the Control Room.

6.4.4 Meteorological Data Analysis Procedure

Meteorological data control and monitoring is performed as required in VEGP procedures. SNC personnel responsible for meteorological data check the hourly averages of wind, temperature, and humidity data. The basic reduced data are compiled monthly, seasonally and annually.

SNC personnel check rainfall daily, and weekly checks the towers and instruments on the towers to ensure they are secure and working properly (anemometers turning, etc.). Verification that the data sensors are operating, and reviews of the data charts for anomalies are performed weekly. Both primary and backup instruments are ensured to be operating correctly by running screening software (MIDAS software from ABS Consulting) that compares readings from each type of sensor (wind speed, direction, and temperature). Personnel also clean the rain gauge and checks for obstructions within 1450 feet of the towers.

6.4.5 Pre-operational and Operational Monitoring

The current VEGP meteorological monitoring program will serve as the preoperational monitoring program for the new units. The existing meteorological data comprise a database that adequately establishes a baseline for operation of the new units. This database satisfies the guidance specified in RG 1.111, Section C.4, for providing representative meteorological data for evaluating environmental impacts.

Because the existing onsite meteorological monitoring program is conducted in accordance with the guidance criteria and the system accuracy specified in ANSI/ANS 2.5, the current system will serve as the operational monitoring program for any new units at the VEGP site. Additional data links to the new facilities will be required for the new units.

Table 6.4-1 VEGP Onsite Meteorological Instruments

Parameter	Range	System Accuracy	Starting Threshold	Distance Constant	Damping Ratio	Elevation (m)
			45-m Tower Instruments			
Windspeed	0-100 mph (0-56 mps)	±0.5 mph (±0.22 mps)	1.0 mph (0.45 mps)	-	-	10
Wind direction	0°-540°	±5°	1.0 mph (0.45 mps)	6.56 ft 2 m	0.4-0.6 with deflection of 15° and delay distance of 2 m	10
Ambient temperature	-10°F to 120°F (-23° to 49°C)	±0.9°F (±0.5°C)	-	-	-	10
Sigma theta	0°-100°	-	-	-	See wind direction	10
			60-m Tower Instruments			
Windspeed	0-100 mph (0-56 mps)	±0.5 mph (±0.22 mps)	1.0 mph (0.45 mps)	-	-	10 60
Wind direction	0°-540°	±5°	1.0 mph (0.45 mps)	6.56 ft 2 m	0.4-0.6 with deflection of 15° and delay distance of 2 m	10 60
Ambient temperature	-10°F to 120°F (-23° to 49°C)	±0.9°F (±0.5°C)	-	-	-	10
Differential temperature	-5°F to 10°F (-20°C to -12°C)	+0.27°F (±0.15°C) per 50-m height	-	-	-	10-60
Dewpoint	-10°F to 120°F (-23° to 49°C)	±2.7°F (±1.5°C)	-	-	-	10
Precipitation	0-1.00 inch	±10% of the total accumulated catch	Resolution of 0.01 in. (0.25 mm)	-	-	Tower base
Sigma theta	0°-100°	-	-	-	See wind direction	10 60

Source: adapted from Units 1 and 2 Final Safety Analysis Report, Table 2.3.2-2

6.5 Ecological Monitoring

This section demonstrates that ecological monitoring is not warranted for construction or operation of the new units.

6.5.1 Existing Ecological Monitoring

6.5.1.1 Terrestrial Resources

As described in Section 2.4.1, much of the VEGP site consists of existing generation and maintenance facilities, parking lots, roads, cleared areas, and mowed grass. These areas are devoid of rare plants, and are not desirable wildlife habitat. Wildlife and plant species found in the less disturbed forested portions of the VEGP site are those typically found in forests of eastern Georgia. Electric transmission corridors that originate at VEGP pass through forested and agricultural lands typical of eastern Georgia. No areas designated by the U.S. Fish and Wildlife Service (USFWS) as “critical habitat” exist at the VEGP site or adjacent to associated transmission corridors.

Georgia Power Company (GPC) has established maintenance procedures for transmission corridors. The transmission corridors are managed to prevent woody growth from encroaching on the transmission lines and potentially causing disruption in service or becoming a general safety hazard. Right-of-way clearing on most transmission corridors is conducted on a three year maintenance cycle. As part of the maintenance cycle, transmission lines and corridors are inspected and monitored for clearance. Corridor vegetation management involves light equipment (e.g., saws, mowers), herbicides, and hand tools. Mowing is the primary method for maintaining the corridors. Hand cutting and/or herbicides are used in areas where mowing is impractical or undesirable. EPA-registered and state-approved herbicides are handled and applied by specialty contractors in accordance with manufacturer specifications and guidance from jurisdictional regulatory agencies. (See Section 5.6.1 for additional detail).

As reported in Section 2.4.1 no protected species, important species (NUREG-1555), critical habitats or important habitats (NUREG-1555) are found within the footprint of the proposed new units. No state resource protection agency requires formal monitoring programs at the VEGP site or along the transmission corridors.

SNC has placed bluebird and wood duck nest boxes in suitable habitats at the VEGP site; these are used as nesting cavities by bluebirds and wood ducks and maintained by SNC personnel.

6.5.1.2 Aquatic Resources

The current VEGP NPDES permit does not require monitoring of aquatic ecological resources.

No protected fish species spawn in the vicinity of VEGP and no protected species, including mussels, occur in the vicinity of VEGP.

GPC Environmental Affairs stays abreast of aquatic resource issues related to Savannah River resources. GPC Environmental Affairs personnel track the status of species of interest, including state and federally protected species, regularly interface with State and Federal resource agencies, participate in recovery groups, and are members of various species-specific organizations.

6.5.2 Construction, Pre-Operational, and Operational Monitoring

6.5.2.1 Terrestrial Resources

The proposed project foot-print is on a previously disturbed industrial site, consisting largely of planted pines and early successional species of undergrowth. Therefore, construction will not reduce the local or regional diversity of plants or plant communities. Because the potentially impacted forested habitat is of poor quality, and represents a small portion of the available undeveloped land in the region of the VEGP site, the displacement and construction-related mortality of wildlife will be small relative to wildlife populations in the region.

Construction of a new barge slip and cooling water intake and discharge structures will require permits under the Georgia General NPDES Permit for Construction Stormwater Discharge for Stand Alone Construction Projects and from the U.S. Army Corps of Engineers. Encroachment on any stream buffers will require stream buffer variances from Georgia Environmental Protection Division (EPD).

Because no protected species, important species (NUREG-1555), critical habitats or important habitats (NUREG-1555) are found within the footprint of the proposed new units and because the vegetation community on the proposed new units' footprint do not provide good wildlife habitat, monitoring of terrestrial plant and animal resources at VEGP during plant construction, or during pre-operational, or operational periods is not warranted, and is not proposed. Similarly, plant and animal resources along existing transmission corridors will not be impacted by construction or operation of the new units, and therefore, monitoring is not warranted. Corridor clearing and line construction for the new transmission line will be accomplished in accordance with applicable regulations and GPC implementing procedures that are designed to protect important habitats and species along transmission lines. As discussed in Section 2.4.1, the transmission corridors are managed to prevent woody growth from reaching the transmission lines, and transmission line corridors are maintained in accordance with established procedures. The removal of woody species can provide outstanding grassland and marsh habitat for many rare plant species dependent on open conditions. Monitoring of terrestrial resources is not warranted nor planned for any new transmission corridors.

6.5.2.2 Aquatic Resources

The construction activities that could adversely affect aquatic organisms include expansion of the existing barge slip, a new cooling water intake structure, and a new discharge structure.

These activities will disturb sediments (dredging, pile driving) and soils (shoreline construction) at the construction site. Prior to construction in or adjacent to the Savannah River, SNC will use best management practices, such as installation of coffer dams, to limit the distribution downstream of sediments and debris. The dredging and construction activities will require permits from the U.S. Army Corps of Engineers (see Table 1.3-2). Based on the fact that any ground- or river-disturbing activities will be of relatively short duration, permitted and overseen by state and federal regulators, guided by an approved Storm Water Pollution Prevention Plan, and that any small spills will be mitigated according to the existing VEGP Spill Prevention, Control, and Countermeasures Plan, and that there are no sensitive habitats or species of interest at the proposed location, SNC concludes that impacts to aquatic communities from construction will be small, localized and temporary, and will not warrant formal monitoring. Because the operation of the new intake and discharge structures will have small impacts on the water quantity or water quality, no aquatic monitoring will be required.

The new transmission line could cross intermittent and perennial streams in the upper Coastal Plain and lower Piedmont of Georgia. Construction of transmission lines will require permits under the Georgia General NPDES Permit for Construction Stormwater Discharge for Stand Alone Construction Projects and perhaps from the U.S. Army Corps of Engineers. Encroachment on any stream buffers will require stream buffer variances from Georgia EPD. As discussed in Section 4.3, Best Management Practices will be employed to minimize impacts of transmission line construction on aquatic life.

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6.6 Chemical Monitoring

The following section describes the chemical monitoring program for surface water and groundwater quality, which includes the following topics:

- Pre-application monitoring that supports the water quality and baseline environmental water quality descriptions in Chapter 2 and Chapter 3,
- Construction/pre-operational monitoring that will evaluate potential impacts from site preparation and new unit construction and that will establish a baseline for identifying and assessing environmental impacts from operation of the new units, and
- Operational monitoring that will identify impacts from operation of the new units.

6.6.1 Pre-Application Monitoring

The objective of the pre-application monitoring program is to provide information that supports the assessment of potential impacts that could result from the construction and operation of the new units. The pre-application monitoring program is composed of the ongoing NPDES permit-mandated surface water monitoring programs, groundwater withdrawal permit monitoring programs, and the historic VEGP database comprised of this water quality data.

6.6.1.1 Chemical Surface Water Monitoring

Table 6.6-1 lists the surface water quality parameters currently monitored for the NPDES permit.

6.6.1.2 Chemical Groundwater Monitoring

There are two groundwater programs that require chemical monitoring. The onsite landfills, permitted by EPD, monitor for methane and certain chemicals as required. The potable water systems utilize groundwater and meet the criteria for a public water system, which are subject to state and federal safe drinking water rules.

The VEGP site has two active onsite landfills permitted by EPD. The groundwater monitoring well network consists of four wells (well numbers GWA-2, GWC-3, GWB-4, AND GWC-11) located along the north, east, and south as close as practical to Landfill #2 and nine wells (well numbers GWC-5, GWB-6, GWA-7, GWA-13, GWC-14, GWA-15, GWB-16, GWA-17, AND GWC-18) located along the perimeter of Landfill #3.

Landfill #2, Permit No. 017-006D(L)(I), is located approximately 0.5 miles north of the switchyard. It has one active cell remaining and is used exclusively for asbestos disposal. Landfill #2 is subject only to semi-annual monitoring of (Georgia EPD Rule 391-3-4) Appendix I parameters because none of the contaminants have been detected in quantities statistically significant above background.

Landfill #3, Permit No. 017-007D(L)(I), is located approximately 3,000 feet west of the existing switchyard and has been used for private industry waste and inert debris disposal. Sampling frequency for the last three years of record (2003-2005) was semi-annually. Two metals, barium and copper, and nine organics (1,1-dichloroethane, chlorobenzene, 1,4-dicholorbenzene, methylene chloride, cis 1,2-dichloroethene, trichlorofluoromethane, 1,1-dichloroethene, xylenes [total], and vinyl chloride) have been detected occasionally in concentrations statistically significantly higher than background. A groundwater contamination assessment was conducted for Landfill #3 in 2005. It concluded that these contaminants did not pose a significant hazard to groundwater. However, Landfill #3 is subject to monitoring of all Appendix II parameters annually due to the concentrations of detected Appendix I constituents. Mercury is the only Appendix II constituent detected, at concentrations just above its minimum detectable concentration. As such, mercury is sampled semi-annually, with the Appendix I sampling.

All other landfills on the site have been closed and do not require post-closure monitoring.

VEGP withdraws groundwater for, among other uses, potable water. Georgia EPD regulates public drinking water systems. VEGP maintains three public water systems. The main plant drinking water system, a non-transient non-community public water system, is supplied by makeup wells MU-1 and MU-2A located near the power block. The Training Center, or Simulator Building, is also a non-transient non-community public water system and is supplied by makeup well SB. The Recreation Center is considered a transient non-community system and is supplied by makeup well Rec. Finished water samples are obtained from numerous points (taps) in the distribution systems. The samples are analyzed for the parameters identified in Table 6.6-2. Monitoring occurs on a daily, weekly, monthly or annual schedule, depending on the parameter. SNC collects the water samples and ships them to the Georgia Department of Natural Resources Water Laboratory for analysis. VEGP has detailed sampling procedures in place.

6.6.2 Construction and Pre-Operational Monitoring

The required surface water quality monitoring program and groundwater monitoring programs for the existing units will continue. These ongoing monitoring programs provide the data necessary to assess potential changes in groundwater and surface water quality associated with construction of the new units and historic monitoring results provide a baseline for the identification and measurement of water quality impacts from operation of the new units.

6.6.3 Operational Monitoring

An operational monitoring program will be implemented to identify any changes in water quality that may result from the operation of the new units and to assess the effectiveness of the related effluent treatment systems. The specific elements of the operational monitoring program will be developed in consultation with the state of Georgia during the process to revise the existing NPDES and groundwater withdrawal permits.

Given that the new units will represent an expansion of the existing nuclear power generation facilities, it is likely that any new monitoring will be similar to that described in the current state-regulated program.

Table 6.6-1 Surface Water Quality Monitoring Program

Monitoring Location	Constituent (units)	Frequency	Sample Type
001 (Final Plant Discharge [combined waste streams from Units 1 and2])	Hydrazine (not specified)	When requested by EPD	Grab
	pH	2/month	Grab
002 (Unit 1 cooling tower blowdown) and 003 (Unit 2 cooling tower blowdown, 002A (Unit 1 Emergency Overflows to storm drains), and 003A (Unit 2 Emergency Overflows to storm drains)	Free available chlorine (mg/L)	1/week	Grab
	Total residual chlorine (mg/L)	1/week	Grab
	Time of total residual chlorine discharge	1/week	
	Total chromium (mg/L)	1/quarter (or 1/year if Chromium is not in maintenance chemicals)	Grab
	Total zinc (mg/L)	1/quarter	Grab
004 (Unit 1 waste water retention basin) and 005 (Unit 2 waste water retention basin)	Total suspended solids (mg/L)	2/month	Grab
	Oil and grease (mg/L)	2/month	Grab
006 (Sewage treatment plant emergency overflow)	BOD-5 day (mg/L)	1/discharge	Grab
	pH	1/discharge	Grab
007 (Liquid radwaste systems discharge unit 1) and 008 (Liquid radwaste system unit 2	Total suspended solids (mg/L)	1/quarter	Grab
	Oil and grease (mg/L)	1/quarter	Grab
009 (Nuclear service cooling tower blowdown [Units 1 and 2])	Free available chlorine (mg/L)	1/discharge	Grab

Source: **GDNR 2004**

Table 6.6-2 Drinking Water Wells Monitoring Program

	pH	Residual Chlorine	Ortho P	Alkalinity	Lead/ Copper	IOC	VOC	SOC	Coliform	Nitrate/ Nitrite	TTHM/ HAA5
Make Up Wells PG0330017	daily	daily	2 X week	2 X week	1 X 3 yrs	1 X 3 yrs	1 X 3 yrs	1X 3 yrs	quarterly	annual	annual
Training Center PG0330035	daily[1]	daily[a]	2 X week	2 X week	1 X 3 yrs	1 X 3 yrs	1 X 3 yrs	1 X 3 yrs	quarterly	annual	annual
Recreation Center NG0330036	daily[a]	daily[a]	NA	NA	NA	NA	NA	NA	quarterly	annual	NA

1 Daily when operating

IOC = inorganic contaminants

VOC = volatile organic compounds

SOC = synthetic organic contaminant

TTHM/HAA5 = total trihalomethanes/haloacetic acids

Section 6.6 References

(GDNR 2004) Georgia Department of Natural Resources, *Authorization to Discharge under the National Pollutant Discharge Elimination System,* Environmental Protection Division, Atlanta, GA, May 21.

6.7 Summary of Monitoring Programs

This section summarizes all of the environmental monitoring programs described in Chapter 6. The summary is divided into three sections:

- Pre-application monitoring
- Construction and Pre-Operational monitoring
- Operational monitoring

6.7.1 Pre-Application Monitoring

Pre-application monitoring requirements for the new units will be fulfilled by the ongoing radiological, chemical, hydrological, and meteorological monitoring programs for the existing units. In addition to pre-existing hydrological monitoring, additional observation wells were installed as discussed in Section 6.3.2 in and around the proposed project footprint in order to better characterize the site hydrologically. Information collected historically and on-going will form a basis from which to assess the impacts of the new units. Because thermal inputs to the Savannah River and impacts to terrestrial and aquatic resources from effluents and emissions will be small and localized, no thermal or ecological pre-application monitoring will be required.

6.7.2 Construction and Pre-Operational Monitoring

The current radiological, hydrological, meteorological and chemical monitoring programs for the existing units will be continued through the construction and pre-operational phases of the new units. Tables 6.2-1, 6.3-1, 6.3-2, 6.3-3, 6.4-1, 6.6-1 and 6.6-2 describe these programs.

6.7.3 Operational Monitoring

While specific operational monitoring requirements and programs for the new units have not yet been established, they will be similar to and tiered from or added to those monitoring programs described in the previous sections which currently monitor the impacts of Units 1 and 2 on the surrounding environment.

The existing and future operational monitoring programs could be modified as a result of future consultations with state regulatory agencies. The need for modifications to established monitoring locations, parameters, collection techniques, or analytical procedures to name a few, will be assessed prior to and during the course of operation, as is done now for the existing units.

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Chapter 7 Environmental Impacts of Postulated Accidents Involving Radioactive Materials

This chapter assesses the environmental impacts of postulated accidents involving radioactive materials. Section 7.1 evaluates design basis accidents, Section 7.2 considers the impact of severe accidents, Section 7.3 addresses severe accident mitigation alternatives (SAMA), and Section 7.4 pertains to transportation accidents.

7.1 Design Basis Accidents

7.1.1 Selection of Accidents

The design bases accidents (DBAs) considered in this section are from the *AP1000 Design Control Document (DCD)* **(Westinghouse 2005)** and SSAR Chapter 15 in Part 2 of this ESP application. Table 7.1-1 lists the DBAs having the potential for releases to the environment and shows the NUREG-0800 Standard Review Plan (SRP) section numbers and accident descriptions as well as the corresponding accidents as defined in the AP1000 DCD. The radiological consequences of the accidents listed in Table 7.1-1 are assessed to demonstrate that new units can be sited at the VEGP site without undue risk to the health and safety of the public.

7.1.2 Evaluation Methodology

The AP1000 DCD presents the radiological consequences for the accidents identified in Table 7.1-1. The DCD design basis analyses are updated with VEGP site data to demonstrate that the DCD analyses are bounding for the VEGP site. The basic scenario for each accident is that some quantity of activity is released at the accident location inside a building and this activity is eventually released to the environment. The transport of activity within the plant is independent of the site and specific to the AP1000 design. Details about the methodologies and assumptions pertaining to each of the accidents, such as activity release pathways and credited mitigation features, are provided in the DCD.

The dose to an individual located at the exclusion area boundary (EAB) or the low population zone (LPZ) is calculated based on the amount of activity released to the environment, the atmospheric dispersion of the activity during the transport from the release point to the offsite location, the breathing rate of the individual at the offsite location, and activity-to-dose conversion factors. The only site-specific parameter is atmospheric dispersion. Site-specific doses are obtained by adjusting the DCD doses to reflect site-specific atmospheric dispersion factors (χ/Q values). Since the site-specific χ/Q values are bounded by the DCD χ/Q values, this approach demonstrates that the site-specific doses are within those calculated in the DCD.

SSAR Chapter 15, Accident Analysis, uses conservative assumptions to perform bounding safety analyses that substantially overstate the environmental impact of the identified accidents. Among the conservative assumptions in SSAR Chapter 15 is the use of time-dependent χ/Q values corresponding to the top 5th percentile meteorology during the first two hours of the accident, meaning that conditions would be more favorable for dispersion 95% of the time. The doses in this environmental report are calculated based on the 50th percentile site-specific χ/Q values during the first two hours of the accident, reflecting more realistic meteorological conditions. The χ/Q values are calculated using the methodology of Regulatory Guide 1.145, *Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants*, Revision 1 (RG 1.145) with site-specific meteorological data. As indicated in Section 2.7.5, the RG 1.145 methodology is implemented in the NRC-sponsored PAVAN computer program. This program computes χ/Q values at the EAB and the LPZ for each combination of wind speed and atmospheric stability for each of 16 downwind direction sectors and then calculates overall (non direction-specific) χ/Q values. For a given location, either the EAB or the LPZ, the 0 – 2 hour χ/Q value is the 50th percentile overall value calculated by PAVAN. For the LPZ, the χ/Q values for all subsequent times are calculated by logarithmic interpolation between the 50th percentile χ/Q value and the annual average χ/Q value. Releases are assumed to be at ground level, and the shortest distances between the power block and the offsite locations are selected to conservatively maximize the χ/Q values.

The accident doses are expressed as total effective dose equivalent (TEDE), consistent with 10 CFR 50.34. The TEDE consists of the sum of the committed effective dose equivalent (CEDE) from inhalation and the effective dose equivalent (EDE) from external exposure. The CEDE is determined using the dose conversion factors in Federal Guidance Report 11 **(EPA 1988)**, while the EDE is based on the dose conversion factors in Federal Guidance Report 12 **(EPA 1993)**. Appendix 15A of the AP1000 DCD provides information on the methodologies used to calculate CEDE and EDE values. As indicated in Regulatory Guide 1.183, *Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors*, July 2000 (RG 1.183), the dose conversion factors in Federal Guidance Reports 11 and 12 are acceptable to the NRC staff.

7.1.3 Source Terms

The design basis accident source terms in the AP1000 DCD are calculated in accordance with RG 1.183, based on 102 percent of the rated core thermal power of 3400 MW. The time-dependent isotopic activities released to the environment from each of the evaluated accidents are presented in Tables 7.1-2 to 7.1-10.

7.1.4 Radiological Consequences

Environmental report design basis accident doses are evaluated based on more realistic meteorological conditions than in the site safety analysis report. For each of the accidents identified in Table 7.1-1, the site-specific dose for a given time interval is calculated by multiplying the AP1000 DCD dose by the ratio of the site χ/Q value, developed in Section 2.7.5.2, to the DCD χ/Q value as indicated in *AP1000 Accident Releases and Doses as Function of Time* **(Westinghouse 2006b)**. The time-dependent DCD χ/Q values and the time-dependent site χ/Q values and their ratios are shown in Table 7.1-11. As all site χ/Q values are bounded by DCD χ/Q values, site-specific doses for all accidents are also bounded by DCD doses. The total doses are summarized in Table 7.1-12, based on individual accident doses presented in Tables 7.1-13 to 7.1-22. For each accident, the EAB dose shown is for the two-hour period that yields the maximum dose, in accordance with RG 1.183.

The results of the VEGP site analysis contained in the referenced tables demonstrate that all accident doses meet the site acceptance criteria of 10 CFR 50.34. The acceptance criteria in 10 CFR 50.34 apply to accidents of exceedingly low probability of occurrence and low risk of public exposure to radiation. For events with a higher probability of occurrence, more restrictive dose limits are specified in RG 1.183. Where applied, the more restrictive dose limit is either 10 or 25 percent of the 10 CFR 50.34 limit of 25 rem TEDE. Although conformance to these more restrictive dose limits is not required for an environmental report, they are shown in the tables for comparison purposes.

The TEDE dose limits shown in Tables 7.1-12 to 7.1-22 are from RG 1.183, Table 6, for all accidents except Reactor Coolant Pump Shaft Break (SRP Section 15.3.4) and Failure of Small Lines Carrying Primary Coolant Outside Containment (SRP Section 15.6.2). Although RG 1.183 does not address these two accidents, NUREG-0800 indicates a dose limit of 2.5 rem for these accidents. All doses are within the acceptance criteria.

Table 7.1-1 Selection of Accidents

SRP/DCD Section	SRP Description	DCD Description	Identified in NUREG-1555 Appendix A	Comment
15.1.5A	Radiological Consequences of Main Steam Line Failures Outside Containment of a PWR	Steam System Piping Failure	Yes	Addressed in DCD Section 15.1.5
15.2.8	Feedwater System Pipe Breaks Inside and Outside Containment (PWR)	Feedwater System Pipe Break	Yes	In the DCD, this is bounded by Section 15.1.5 accident
15.3.3	Reactor Coolant Pump Rotor Seizure	Reactor Coolant Pump Shaft Seizure (Locked Rotor)	Yes	
15.3.4	Reactor Coolant Pump Shaft Break	Reactor Coolant Pump Shaft Break	Yes	In the DCD, this is bounded by Section 15.3.3 accident
15.4.8	Spectrum of Rod Ejection Accidents (PWR)	Spectrum of Rod Cluster Control Assembly Ejection Accidents	No	Evaluated for completeness
15.6.2	Radiological Consequences of the Failure of Small Lines Carrying Primary Coolant Outside Containment	Failure of Small Lines Carrying Primary Coolant Outside Containment	Yes	
15.6.3	Radiological Consequences of Steam Generator Tube Failure (PWR)	Steam Generator Tube Rupture	Yes	
15.6.5A	Radiological Consequences of a Design Basis Loss of Coolant Accident Including Containment Leakage Contribution	Loss-of-Coolant Accident Resulting from a Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary	Yes	Addressed in DCD Section 15.6.5
15.6.5B	Radiological Consequences of a Design Basis Loss of Coolant Accident: Leakage From Engineered Safety Feature Components Outside Containment	Loss-of-Coolant Accident Resulting from a Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary	Yes	Addressed in DCD Section 15.6.5
15.7.4	Radiological Consequences of Fuel Handling Accidents	Fuel Handling Accident	Yes	

Table 7.1-2 Activity Releases for Steam System Piping Failure with Pre-Existing Iodine Spike

	Activity Release (Ci)				
Isotope	**0-2 hr**	**2-8 hr**	**8-24 hr**	**24-72 hr**	**Total**
Kr-85m	6.86E-02	1.14E-01	6.80E-02	6.18E-03	2.57E-01
Kr-85	2.82E-01	8.46E-01	2.25E+00	6.69E+00	1.01E+01
Kr-87	2.76E-02	1.34E-02	5.29E-04	8.60E-08	4.15E-02
Kr-88	1.12E-01	1.37E-01	4.04E-02	8.27E-04	2.91E-01
Xe-131m	1.28E-01	3.79E-01	9.81E-01	2.70E+00	4.19E+00
Xe-133m	1.59E-01	4.51E-01	1.04E+00	2.05E+00	3.70E+00
Xe-133	1.18E+01	3.45E+01	8.64E+01	2.16E+02	3.49E+02
Xe-135m	3.04E-03	1.33E-05	0.00E+00	0.00E+00	3.06E-03
Xe-135	3.10E-01	6.90E-01	8.35E-01	3.38E-01	2.17E+00
Xe-138	3.99E-03	1.14E-05	0.00E+00	0.00E+00	4.00E-03
I-130	3.59E-01	1.42E-01	2.09E-01	1.33E-01	8.44E-01
I-131	2.40E+01	1.21E+01	3.10E+01	8.22E+01	1.49E+02
I-132	3.05E+01	4.14E+00	8.06E-01	6.55E-03	3.55E+01
I-133	4.34E+01	1.90E+01	3.53E+01	3.98E+01	1.37E+02
I-134	6.74E+00	1.63E-01	1.43E-03	4.54E-09	6.91E+00
I-135	2.60E+01	8.16E+00	7.54E+00	1.71E+00	4.34E+01
Cs-134	1.90E+01	1.95E-01	5.19E-01	1.54E+00	2.12E+01
Cs-136	2.82E+01	2.86E-01	7.43E-01	2.06E+00	3.13E+01
Cs-137	1.37E+01	1.41E-01	3.74E-01	1.11E+00	1.53E+01
Cs-138	1.01E+01	1.02E-03	4.42E-07	0.00E+00	1.01E+01
Total	2.15E+02	8.15E+01	1.68E+02	3.56E+02	8.21E+02

Table 7.1-3 Activity Releases for Steam System Piping Failure with Accident-Initiated Iodine Spike

	Activity Release (Ci)				
Isotope	0-2 hr	2-8 hr	8-24 hr	24-72 hr	Total
Kr-85m	6.86E-02	1.14E-01	6.80E-02	6.18E-03	2.57E-01
Kr-85	2.82E-01	8.46E-01	2.25E+00	6.69E+00	1.01E+01
Kr-87	2.76E-02	1.34E-02	5.29E-04	8.60E-08	4.15E-02
Kr-88	1.12E-01	1.37E-01	4.04E-02	8.27E-04	2.91E-01
Xe-131m	1.28E-01	3.79E-01	9.81E-01	2.70E+00	4.19E+00
Xe-133m	1.59E-01	4.51E-01	1.04E+00	2.05E+00	3.70E+00
Xe-133	1.18E+01	3.45E+01	8.64E+01	2.16E+02	3.49E+02
Xe-135m	3.04E-03	1.33E-05	0.00E+00	0.00E+00	3.06E-03
Xe-135	3.10E-01	6.90E-01	8.35E-01	3.38E-01	2.17E+00
Xe-138	3.99E-03	1.14E-05	0.00E+00	0.00E+00	4.00E-03
I-130	4.20E-01	9.95E-01	1.58E+00	1.01E+00	4.01E+00
I-131	2.60E+01	5.73E+01	1.56E+02	4.13E+02	6.53E+02
I-132	4.62E+01	9.74E+01	2.24E+01	1.82E-01	1.66E+02
I-133	4.91E+01	1.14E+02	2.27E+02	2.55E+02	6.45E+02
I-134	1.34E+01	1.86E+01	2.65E-01	8.42E-07	3.23E+01
I-135	3.24E+01	7.74E+01	7.83E+01	1.77E+01	2.06E+02
Cs-134	1.90E+01	1.95E-01	5.19E-01	1.54E+00	2.12E+01
Cs-136	2.82E+01	2.86E-01	7.43E-01	2.06E+00	3.13E+01
Cs-137	1.37E+01	1.41E-01	3.74E-01	1.11E+00	1.53E+01
Cs-138	1.01E+01	1.02E-03	4.42E-07	0.00E+00	1.01E+01
Total	2.51E+02	4.03E+02	5.78E+02	9.20E+02	2.15E+03

Table 7.1-4 Activity Releases for Reactor Coolant Pump Shaft Seizure

	Activity Release (Ci)				
	No Feedwater	Feedwater Available			
Isotope	0-1.5 hr	0-2 hr	2-8 hr	6-8 hr	Total
Kr-85m	8.16E+01	1.05E+02	1.74E+02	4.13E+01	2.79E+02
Kr-85	7.58E+00	1.01E+01	3.03E+01	1.01E+01	4.04E+01
Kr-87	1.20E+02	1.43E+02	6.97E+01	5.43E+00	2.13E+02
Kr-88	2.08E+02	2.62E+02	3.20E+02	6.05E+01	5.82E+02
Xe-131m	3.77E+00	5.03E+00	1.49E+01	4.95E+00	1.99E+01
Xe-133m	2.02E+01	2.69E+01	7.64E+01	2.48E+01	1.03E+02
Xe-133	6.66E+02	8.87E+02	2.60E+03	8.57E+02	3.49E+03
Xe-135m	3.24E+01	3.28E+01	1.43E-01	2.68E-06	3.30E+01
Xe-135	1.59E+02	2.08E+02	4.64E+02	1.32E+02	6.72E+02
Xe-138	1.29E+02	1.30E+02	3.72E-01	3.01E-06	1.30E+02
I-130	8.45E-01	1.17E-01	1.33E+00	5.65E-01	1.45E+00
I-131	3.77E+01	5.39E+00	7.51E+01	3.46E+01	8.05E+01
I-132	2.79E+01	3.45E+00	1.48E+01	3.95E+00	1.83E+01
I-133	4.86E+01	6.86E+00	8.29E+01	3.64E+01	8.98E+01
I-134	2.88E+01	2.76E+00	2.98E+00	2.09E-01	5.74E+00
I-135	4.19E+01	5.68E+00	5.22E+01	2.05E+01	5.79E+01
Cs-134	1.29E+00	1.82E-01	2.40E+00	1.11E+00	2.59E+00
Cs-136	5.63E-01	8.45E-02	7.79E-01	3.47E-01	8.63E-01
Cs-137	7.74E-01	1.10E-01	1.41E+00	6.51E-01	1.52E+00
Cs-138	6.08E+00	7.29E-01	3.35E+00	1.13E+00	4.08E+00
Rb-86	1.33E-02	1.83E-03	2.73E-02	1.27E-02	2.91E-02
Total	1.62E+03	1.84E+03	3.99E+03	1.23E+03	5.82E+03

Note: The release period of 6–8 hr yields the maximum 2-hr EAB dose with feedwater available.

Table 7.1-5 Activity Releases for Spectrum of Rod Cluster Control Assembly Ejection Accidents

	Activity Release (Ci)					
Isotope	**0-2 hr**	**2-8 hr**	**8-24 hr**	**24-96 hr**	**96-720 hr**	**Total**
Kr-85m	1.12E+02	6.48E+01	3.87E+01	1.77E+00	2.51E-05	2.18E+02
Kr-85	5.01E+00	5.60E+00	1.49E+01	3.35E+01	2.88E+02	3.47E+02
Kr-87	1.82E+02	2.60E+01	1.03E+00	8.37E-05	0.00E+00	2.09E+02
Kr-88	2.91E+02	1.18E+02	3.49E+01	3.59E-01	8.41E-09	4.45E+02
Xe-131m	4.94E+00	5.46E+00	1.42E+01	2.86E+01	1.16E+02	1.69E+02
Xe-133m	2.67E+01	2.81E+01	6.49E+01	8.45E+01	5.31E+01	2.57E+02
Xe-133	8.79E+02	9.58E+02	2.40E+03	4.27E+03	8.45E+03	1.70E+04
Xe-135m	7.34E+01	5.30E-02	4.33E-09	0.00E+00	0.00E+00	7.35E+01
Xe-135	2.15E+02	1.72E+02	2.09E+02	4.35E+01	1.79E-01	6.39E+02
Xe-138	2.99E+02	1.38E-01	3.19E-09	0.00E+00	0.00E+00	2.99E+02
I-130	4.90E+00	7.28E+00	4.32E+00	2.03E-01	2.95E-04	1.67E+01
I-131	1.36E+02	2.45E+02	2.31E+02	3.10E+01	1.68E+01	6.60E+02
I-132	1.53E+02	9.94E+01	9.85E+00	8.24E-03	0.00E+00	2.62E+02
I-133	2.72E+02	4.40E+02	3.18E+02	2.28E+01	2.41E-01	1.05E+03
I-134	1.66E+02	2.85E+01	1.37E-01	4.48E-08	0.00E+00	1.95E+02
I-135	2.39E+02	2.97E+02	1.19E+02	2.39E+00	7.32E-05	6.57E+02
Cs-134	3.08E+01	6.22E+01	6.03E+01	7.76E+00	5.16E+00	1.66E+02
Cs-136	8.79E+00	1.75E+01	1.67E+01	2.05E+00	6.58E-01	4.57E+01
Cs-137	1.79E+01	3.62E+01	3.51E+01	4.52E+00	3.05E+00	9.68E+01
Cs-138	1.09E+02	7.05E+00	1.68E-03	0.00E+00	0.00E+00	1.16E+02
Rb-86	3.62E-01	7.27E-01	6.96E-01	8.67E-02	3.42E-02	1.91E+00
Total	3.23E+03	2.62E+03	3.58E+03	4.53E+03	8.93E+03	2.29E+04

Table 7.1-6 Activity Releases for Failure of Small Lines Carrying Primary Coolant Outside Containment

Isotope	Activity Release (Ci) 0-2 hr
Kr-85m	1.24E+01
Kr-85	4.40E+01
Kr-87	7.05E+00
Kr-88	2.21E+01
Xe-131m	1.99E+01
Xe-133m	2.50E+01
Xe-133	1.84E+03
Xe-135m	2.59E+00
Xe-135	5.20E+01
Xe-138	3.65E+00
I-130	1.89E+00
I-131	9.26E+01
I-132	3.49E+02
I-133	2.01E+02
I-134	1.58E+02
I-135	1.68E+02
Cs-134	4.16E+00
Cs-136	6.16E+00
Cs-137	3.00E+00
Cs-138	2.21E+00
Total	3.02E+03

Table 7.1-7 Activity Releases for Steam Generator Tube Rupture with Pre-Existing Iodine Spike

	Activity Release (Ci)			
Isotope	**0-2 hr**	**2-8 hr**	**8-24 hr**	**Total**
Kr-85m	5.53E+01	1.93E+01	7.53E-03	7.46E+01
Kr-85	2.20E+02	1.09E+02	1.34E-01	3.29E+02
Kr-87	2.39E+01	3.61E+00	9.12E-05	2.75E+01
Kr-88	9.22E+01	2.65E+01	5.43E-03	1.19E+02
Xe-131m	9.96E+01	4.88E+01	5.91E-02	1.48E+02
Xe-133m	1.24E+02	5.91E+01	6.61E-02	1.83E+02
Xe-133	9.19E+03	4.47E+03	5.29E+00	1.37E+04
Xe-135m	3.44E+00	5.86E-03	0.00E+00	3.45E+00
Xe-135	2.46E+02	1.02E+02	7.10E-02	3.47E+02
Xe-138	4.56E+00	5.07E-03	0.00E+00	4.57E+00
I-130	1.79E+00	5.39E-02	2.68E-01	2.12E+00
I-131	1.21E+02	5.27E+00	3.06E+01	1.56E+02
I-132	1.42E+02	7.43E-01	1.92E+00	1.44E+02
I-133	2.16E+02	7.63E+00	4.06E+01	2.64E+02
I-134	2.74E+01	4.40E-03	4.23E-03	2.74E+01
I-135	1.27E+02	2.70E+00	1.17E+01	1.42E+02
Cs-134	1.63E+00	6.05E-02	2.16E-01	1.90E+00
Cs-136	2.42E+00	8.86E-02	3.14E-01	2.82E+00
Cs-137	1.17E+00	4.37E-02	1.56E-01	1.37E+00
Cs-138	5.64E-01	2.91E-06	5.73E-07	5.64E-01
Total	1.07E+04	4.85E+03	9.14E+01	1.56E+04

Table 7.1-8 Activity Releases for Steam Generator Tube Rupture with Accident-Initiated Iodine Spike

	Activity Release (Ci)			
Isotope	**0-2 hr**	**2-8 hr**	**8-24 hr**	**Total**
Kr-85m	5.53E+01	1.93E+01	7.53E-03	7.46E+01
Kr-85	2.20E+02	1.09E+02	1.34E-01	3.29E+02
Kr-87	2.39E+01	3.61E+00	9.12E-05	2.75E+01
Kr-88	9.22E+01	2.65E+01	5.43E-03	1.19E+02
Xe-131m	9.96E+01	4.88E+01	5.91E-02	1.48E+02
Xe-133m	1.24E+02	5.91E+01	6.61E-02	1.83E+02
Xe-133	9.19E+03	4.47E+03	5.29E+00	1.37E+04
Xe-135m	3.44E+00	5.86E-03	0.00E+00	3.45E+00
Xe-135	2.46E+02	1.02E+02	7.10E-02	3.47E+02
Xe-138	4.56E+00	5.07E-03	0.00E+00	4.57E+00
I-130	8.87E-01	1.62E-01	8.24E-01	1.87E+00
I-131	4.36E+01	1.14E+01	6.76E+01	1.23E+02
I-132	1.47E+02	4.86E+00	1.29E+01	1.65E+02
I-133	9.33E+01	2.00E+01	1.08E+02	2.22E+02
I-134	5.59E+01	6.04E-02	5.94E-02	5.60E+01
I-135	7.61E+01	9.88E+00	4.38E+01	1.30E+02
Cs-134	1.63E+00	6.05E-02	2.16E-01	1.90E+00
Cs-136	2.42E+00	8.86E-02	3.14E-01	2.82E+00
Cs-137	1.17E+00	4.37E-02	1.56E-01	1.37E+00
Cs-138	5.64E-01	2.91E-06	5.73E-07	5.64E-01
Total	1.05E+04	4.88E+03	2.40E+02	1.56E+04

Table 7.1-9 Activity Releases for Loss-of-Coolant Accident Resulting from a Spectrum of Postulated Piping Breaks within the Reactor Coolant Pressure Boundary

	Activity Release (Ci)					
Isotope	**1.4-3.4 hr**	**0-8 hr**	**8-24 hr**	**24-96 hr**	**96-720 hr**	**Total**
I-130	5.64E+01	1.12E+02	5.37E+00	7.10E-01	1.27E-02	1.18E+02
I-131	1.68E+03	3.49E+03	2.66E+02	2.39E+02	7.19E+02	4.71E+03
I-132	1.23E+03	2.14E+03	1.64E+01	1.46E-02	0.00E+00	2.15E+03
I-133	3.23E+03	6.54E+03	3.83E+02	1.04E+02	1.04E+01	7.04E+03
I-134	6.60E+02	1.14E+03	2.96E-01	6.79E-08	0.00E+00	1.14E+03
I-135	2.56E+03	4.89E+03	1.58E+02	6.09E+00	3.16E-03	5.06E+03
Kr-85m	1.42E+03	3.77E+03	1.87E+03	8.56E+01	1.22E-03	5.73E+03
Kr-85	8.31E+01	2.97E+02	7.06E+02	1.59E+03	1.36E+04	1.62E+04
Kr-87	1.10E+03	1.95E+03	4.97E+01	4.05E-03	0.00E+00	1.99E+03
Kr-88	3.11E+03	7.26E+03	1.70E+03	1.75E+01	4.09E-07	8.97E+03
Xe-131m	8.26E+01	2.94E+02	6.79E+02	1.37E+03	5.57E+03	7.91E+03
Xe-133m	4.43E+02	1.54E+03	3.15E+03	4.11E+03	2.58E+03	1.14E+04
Xe-133	1.47E+04	5.19E+04	1.16E+05	2.06E+05	4.07E+05	7.80E+05
Xe-135m	1.06E+01	3.59E+01	2.14E-07	0.00E+00	0.00E+00	3.59E+01
Xe-135	3.15E+03	9.64E+03	1.01E+04	2.11E+03	8.68E+00	2.19E+04
Xe-138	3.11E+01	1.20E+02	1.58E-07	0.00E+00	0.00E+00	1.20E+02
Rb-86	3.04E+00	6.32E+00	2.99E-01	9.83E-02	5.13E-01	7.23E+00
Cs-134	2.58E+02	5.38E+02	2.57E+01	9.11E+00	7.74E+01	6.50E+02
Cs-136	7.33E+01	1.52E+02	7.16E+00	2.28E+00	9.88E+00	1.72E+02
Cs-137	1.51E+02	3.13E+02	1.50E+01	5.32E+00	4.57E+01	3.79E+02
Cs-138	1.50E+02	3.30E+02	2.18E-03	0.00E+00	0.00E+00	3.30E+02
Sb-127	2.42E+01	4.80E+01	2.29E+00	5.67E-01	7.82E-01	5.16E+01
Sb-129	5.10E+01	8.94E+01	1.51E+00	4.95E-03	4.90E-08	9.09E+01
Te-127m	3.15E+00	6.30E+00	3.16E-01	1.11E-01	8.71E-01	7.60E+00
Te-127	2.05E+01	3.83E+01	1.15E+00	2.75E-02	1.33E-04	3.94E+01
Te-129m	1.07E+01	2.15E+01	1.07E+00	3.65E-01	2.36E+00	2.52E+01

Table 7.1-9 (cont.) Activity Releases for Loss-of-Coolant Accident Resulting from a Spectrum of Postulated Piping Breaks within the Reactor Coolant Pressure Boundary

	Activity Release (Ci)					
Isotope	**1.4-3.4 hr**	**0-8 hr**	**8-24 hr**	**24-96 hr**	**96-720 hr**	**Total**
Te-129	1.88E+01	2.83E+01	2.69E-02	3.54E-08	0.00E+00	2.84E+01
Te-131m	3.17E+01	6.20E+01	2.64E+00	3.35E-01	7.81E-02	6.50E+01
Te-132	3.23E+02	6.40E+02	3.02E+01	7.04E+00	7.83E+00	6.85E+02
Sr-89	9.23E+01	1.85E+02	9.24E+00	3.19E+00	2.26E+01	2.20E+02
Sr-90	7.95E+00	1.59E+01	7.99E-01	2.84E-01	2.44E+00	1.94E+01
Sr-91	9.68E+01	1.81E+02	5.46E+00	1.35E-01	7.06E-04	1.87E+02
Sr-92	6.83E+01	1.13E+02	1.01E+00	5.15E-04	0.00E+00	1.14E+02
Ba-139	5.44E+01	8.30E+01	1.49E-01	9.91E-07	0.00E+00	8.32E+01
Ba-140	1.63E+02	3.25E+02	1.61E+01	5.11E+00	2.17E+01	3.68E+02
Mo-99	2.15E+01	4.25E+01	1.98E+00	4.29E-01	3.78E-01	4.53E+01
Tc-99m	1.47E+01	2.66E+01	6.05E-01	5.27E-03	1.33E-06	2.72E+01
Ru-103	1.73E+01	3.46E+01	1.73E+00	5.93E-01	3.99E+00	4.09E+01
Ru-105	8.18E+00	1.44E+01	2.48E-01	8.86E-04	1.17E-08	1.46E+01
Ru-106	5.70E+00	1.14E+01	5.73E-01	2.03E-01	1.70E+00	1.39E+01
Rh-105	1.03E+01	2.02E+01	8.81E-01	1.29E-01	4.14E-02	2.12E+01
Ce-141	3.89E+00	7.78E+00	3.88E-01	1.32E-01	8.45E-01	9.15E+00
Ce-143	3.46E+00	6.78E+00	2.93E-01	4.05E-02	1.14E-02	7.13E+00
Ce-144	2.94E+00	5.89E+00	2.96E-01	1.05E-01	8.68E-01	7.15E+00
Pu-238	9.16E-03	1.83E-02	9.21E-04	3.27E-04	2.82E-03	2.24E-02
Pu-239	8.06E-04	1.61E-03	8.10E-05	2.88E-05	2.48E-04	1.97E-03
Pu-240	1.18E-03	2.37E-03	1.19E-04	4.22E-05	3.63E-04	2.89E-03
Pu-241	2.66E-01	5.31E-01	2.67E-02	9.48E-03	8.14E-02	6.49E-01
Np-239	4.48E+01	8.87E+01	4.08E+00	8.15E-01	5.70E-01	9.41E+01
Y-90	8.08E-02	1.60E-01	7.44E-03	1.59E-03	1.35E-03	1.70E-01
Y-91	1.19E+00	2.37E+00	1.19E-01	4.12E-02	3.00E-01	2.83E+00
Y-92	7.89E-01	1.35E+00	1.80E-02	2.86E-05	0.00E+00	1.37E+00
Y-93	1.21E+00	2.28E+00	7.08E-02	1.98E-03	1.42E-05	2.35E+00

Table 7.1-9 (cont.) Activity Releases for Loss-of-Coolant Accident Resulting from a Spectrum of Postulated Piping Breaks within the Reactor Coolant Pressure Boundary

	Activity Release (Ci)					
Isotope	**1.4-3.4 hr**	**0-8 hr**	**8-24 hr**	**24-96 hr**	**96-720 hr**	**Total**
Nb-95	1.60E+00	3.19E+00	1.59E-01	5.44E-02	3.55E-01	3.76E+00
Zr-95	1.59E+00	3.18E+00	1.59E-01	5.52E-02	4.08E-01	3.80E+00
Zr-97	1.43E+00	2.74E+00	1.03E-01	6.73E-03	3.71E-04	2.85E+00
La-140	1.67E+00	3.29E+00	1.46E-01	2.36E-02	9.62E-03	3.47E+00
La-141	1.03E+00	1.79E+00	2.71E-02	6.41E-05	2.01E-10	1.81E+00
La-142	5.38E-01	8.31E-01	2.09E-03	3.39E-08	0.00E+00	8.33E-01
Nd-147	6.16E-01	1.23E+00	6.06E-02	1.90E-02	7.29E-02	1.38E+00
Pr-143	1.39E+00	2.78E+00	1.37E-01	4.40E-02	1.94E-01	3.15E+00
Am-241	1.20E-04	2.39E-04	1.20E-05	4.27E-06	3.68E-05	2.92E-04
Cm-242	2.82E-02	5.65E-02	2.83E-03	9.98E-04	8.08E-03	6.84E-02
Cm-244	3.46E-03	6.93E-03	3.48E-04	1.24E-04	1.06E-03	8.47E-03
Total	3.53E+04	9.85E+04	1.35E+05	2.15E+05	4.30E+05	8.79E+05

Table 7.1-10 Activity Releases for Fuel Handling Accident

Isotope	Activity Release (Ci) 0-2 hr
Kr-85m	3.42E+02
Kr-85	1.11E+03
Kr-87	6.00E-02
Kr-88	1.07E+02
Xe-131m	5.54E+02
Xe-133m	2.80E+03
Xe-133	9.66E+04
Xe-135m	1.26E+03
Xe-135	2.49E+04
I-130	2.51E+00
I-131	3.76E+02
I-132	3.01E+02
I-133	2.40E+02
I-135	3.94E+01
Total	1.29E+05

Table 7.1-11 Atmospheric Dispersion Factors

Accident	Location	Time (hr)	DCD χ/Q (sec/m^3)	Site χ/Q (sec/m^3)	χ/Q Ratio (Site/DCD)
LOCA	EAB	0 – 2	5.10E-04	6.62E-05	1.30E-01
	LPZ	0 – 8	2.20E-04	1.25E-05	5.68E-02
		8 – 24	1.60E-04	1.10E-05	6.88E-02
		24 – 96	1.00E-04	8.40E-06	8.40E-02
		96 – 720	8.00E-05	5.75E-06	7.19E-02
Other Accidents	EAB	0 – 2	8.00E-04	6.62E-05	8.28E-02
	LPZ	0 – 8	5.00E-04	1.25E-05	2.50E-02
		8 – 24	3.00E-04	1.10E-05	3.67E-02
		24 – 96	1.50E-04	8.40E-06	5.60E-02
		96 – 720	8.00E-05	5.75E-06	7.19E-02

Note: The DCD χ/Q values for LOCA are consistent with AP1000 DCD Table 15A-5. Although not indicated as such in the DCD, a different set of χ/Q values was used by Westinghouse to calculate doses for accidents other than LOCA **(Westinghouse 2006b)**. It is seen that the site χ/Q values are bounded by the DCD χ/Q values for all time steps.

Table 7.1-12 Summary of Design Basis Accident Doses

DCD/SRP Section	Accident	Site Dose (rem TEDE) EAB	LPZ	Limit[1]	Dose Table
15.1.5	Steam System Piping Failure				
	Pre-Existing Iodine Spike	0.07	0.02	25	7.1-13
	Accident-Initiated Iodine Spike	0.07	0.07	2.5	7.1-14
15.2.8	Feedwater System Pipe Break	[2]	[2]		
15.3.3	Reactor Coolant Pump Shaft Seizure				
	No Feedwater	0.06	0.01	2.5	7.1-15
	Feedwater Available	0.04	0.02	2.5	7.1-16
15.3.4	Reactor Coolant Pump Shaft Break	[3]	[3]		
15.4.8	Spectrum of Rod Cluster Control Assembly Ejection Accidents	0.24	0.15	6.3	7.1-17
15.6.2	Failure of Small Lines Carrying Primary Coolant Outside Containment	0.14	0.03	2.5	7.1-18
15.6.3	Steam Generator Tube Rupture				
	Pre-Existing Iodine Spike	0.15	0.03	25	7.1-19
	Accident-Initiated Iodine Spike	0.07	0.02	2.5	7.1-20
15.6.5	Loss-of-Coolant Accident Resulting from a Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary	3.2	1.4	25	7.1-21
15.7.4	Fuel Handling Accident	0.46	0.09	6.3	7.1-22

1 NUREG-1555 specifies a dose limit of 25 rem TEDE for all design basis accidents. The more restrictive limits shown in the table apply to safety analysis report doses, but are shown here to demonstrate that even these more restrictive limits are met.

2 Feedwater System Pipe Break is bounded by Steam System Piping Failure, as indicated in AP1000 DCD.

3 Reactor Coolant Pump Shaft Break is bounded by Reactor Coolant Pump Shaft Seizure, as indicated in AP1000 DCD.

Table 7.1-13 Doses for Steam System Piping Failure with Pre-Existing Iodine Spike

	DCD Dose (rem TEDE)		χ/Q Ratio	Site Dose (rem TEDE)	
Time	**EAB**	**LPZ**	**(Site/DCD)**	**EAB**	**LPZ**
0-2 hr	8.0E-01		8.28E-02	6.62E-02	
0-8 hr		5.81E-01	2.50E-02		1.45E-02
8-24 hr		7.18E-02	3.67E-02		2.63E-03
24-96 hr		1.08E-01	5.60E-02		6.05E-03
96-720 hr		0.00E+00	7.19E-02		0.00E+00
Total	8.0E-01	7.61E-01		6.62E-02	2.32E-02
Limit				25	25

Table 7.1-14 Doses for Steam System Piping Failure with Accident-Initiated Iodine Spike

	DCD Dose (rem TEDE)		χ/Q Ratio	Site Dose (rem TEDE)	
Time	**EAB**	**LPZ**	**(Site/DCD)**	**EAB**	**LPZ**
0-2 hr	9.00E-01		8.28E-02	7.45E-02	
0-8 hr		1.02E+00	2.50E-02		2.56E-02
8-24 hr		3.77E-01	3.67E-02		1.38E-02
24-96 hr		5.36E-01	5.60E-02		3.00E-02
96-720 hr		0.00E+00	7.19E-02		0.00E+00
Total	9.00E-01	1.94E+00		7.45E-02	6.94E-02
Limit				2.5	2.5

Table 7.1-15 Doses for Reactor Coolant Pump Shaft Seizure with No Feedwater

	DCD Dose (rem TEDE)		χ/Q Ratio	Site Dose (rem TEDE)	
Time	EAB	LPZ	(Site/DCD)	EAB	LPZ
0-2 hr	7.00E-01		8.28E-02	5.79E-02	
0-8 hr		3.89E-01	2.50E-02		9.73E-03
8-24 hr		0.00E+00	3.67E-02		0.00E+00
24-96 hr		0.00E+00	5.60E-02		0.00E+00
96-720 hr		0.00E+00	7.19E-02		0.00E+00
Total	7.00E-01	3.89E-01		5.79E-02	9.73E-03
Limit				2.5	2.5

Table 7.1-16 Doses for Reactor Coolant Pump Shaft Seizure with Feedwater Available

	DCD Dose (rem TEDE)		χ/Q Ratio	Site Dose (rem TEDE)	
Time	EAB	LPZ	(Site/DCD)	EAB	LPZ
6-8 hr	5.00E-01		8.28E-02	4.14E-02	
0-8 hr		7.94E-01	2.50E-02		1.99E-02
8-24 hr		0.00E+00	3.67E-02		0.00E+00
24-96 hr		0.00E+00	5.60E-02		0.00E+00
96-720 hr		0.00E+00	7.19E-02		0.00E+00
Total	5.00E-01	7.94E-01		4.14E-02	1.99E-02
Limit				2.5	2.5

Table 7.1-17 Doses for Spectrum of Rod Cluster Control Assembly Ejection Accidents

	DCD Dose (rem TEDE)		χ/Q Ratio	Site Dose (rem TEDE)	
Time	EAB	LPZ	(Site/DCD)	EAB	LPZ
0-2 hr	2.90E+00		8.28E-02	2.40E-01	
0-8 hr		4.58E+00	2.50E-02		1.15E-01
8-24 hr		7.84E-01	3.67E-02		2.87E-02
24-96 hr		6.32E-02	5.60E-02		3.54E-03
96-720 hr		2.06E-02	7.19E-02		1.48E-03
Total	2.90E+00	5.45E+00		2.40E-01	1.48E-01
Limit				6.3	6.3

Table 7.1-18 Doses for Failure of Small Lines Carrying Primary Coolant Outside Containment

	DCD Dose (rem TEDE)		χ/Q Ratio	Site Dose (rem TEDE)	
Time	EAB	LPZ	(Site/DCD)	EAB	LPZ
0-2 hr	1.70E+00		8.28E-02	1.41E-01	
0-8 hr		1.02E+00	2.50E-02		2.55E-02
8-24 hr		0.00E+00	3.67E-02		0.00E+00
24-96 hr		0.00E+00	5.60E-02		0.00E+00
96-720 hr		0.00E+00	7.19E-02		0.00E+00
Total	1.70E+00	1.02E+00		1.41E-01	2.55E-02
Limit				2.5	2.5

Table 7.1-19 Doses for Steam Generator Tube Rupture with Pre-Existing Iodine Spike

	DCD Dose (rem TEDE)		χ/Q Ratio	Site Dose (rem TEDE)	
Time	EAB	LPZ	(Site/DCD)	EAB	LPZ
0-2 hr	1.80E+00		8.28E-02	1.49E-01	
0-8 hr		1.16E+00	2.50E-02		2.90E-02
8-24 hr		7.24E-02	3.67E-02		2.65E-03
24-96 hr		0.00E+00	5.60E-02		0.00E+00
96-720 hr		0.00E+00	7.19E-02		0.00E+00
Total	1.80E+00	1.23E+00		1.49E-01	3.17E-02
Limit				25	25

Table 7.1-20 Doses for Steam Generator Tube Rupture with Accident-Initiated Iodine Spike

	DCD Dose (rem TEDE)		χ/Q Ratio	Site Dose (rem TEDE)	
Time	EAB	LPZ	(Site/DCD)	EAB	LPZ
0-2 hr	9.00E-01		8.28E-02	7.45E-02	
0-8 hr		6.27E-01	2.50E-02		1.57E-02
8-24 hr		1.69E-01	3.67E-02		6.20E-03
24-96 hr		0.00E+00	5.60E-02		0.00E+00
96-720 hr		0.00E+00	7.19E-02		0.00E+00
Total	9.00E-01	7.96E-01		7.45E-02	2.19E-02
Limit				2.5	2.5

Table 7.1-21 Doses for Loss-of-Coolant Accident Resulting from a Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary

	DCD Dose (rem TEDE)		χ/Q Ratio	Site Dose (rem TEDE)	
Time	**EAB**	**LPZ**	**(Site/DCD)**	**EAB**	**LPZ**
1.4-3.4 hr	2.43E+01		1.30E-01	3.15E+00	
0-8 hr		2.17E+01	5.68E-02		1.23E+00
8-24 hr		7.69E-01	6.88E-02		5.29E-02
24-96 hr		3.71E-01	8.40E-02		3.12E-02
96-720 hr		8.70E-01	7.19E-02		6.25E-02
Total	2.43E+01	2.37E+01		3.15E+00	1.38E+00
Limit				25	25

Table 7.1-22 Doses for Fuel Handling Accident

	DCD Dose (rem TEDE)		χ/Q Ratio	Site Dose (rem TEDE)	
Time	**EAB**	**LPZ**	**(Site/DCD)**	**EAB**	**LPZ**
0-2 hr	5.60E+00		8.28E-02	4.63E-01	
0-8 hr		3.44E+00	2.50E-02		8.60E-02
8-24 hr		0.00E+00	3.67E-02		0.00E+00
24-96 hr		0.00E+00	5.60E-02		0.00E+00
96-720 hr		0.00E+00	7.19E-02		0.00E+00
Total	5.60E+00	3.44E+00		4.63E-01	8.60E-02
Limit				6.3	6.3

Section 7.1 References

(EPA 1988) Federal Guidance Report 11, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion, U.S. Environmental Protection Agency, EPA-520/1-88-020, 1988.

(EPA 1993) Federal Guidance Report 12, *External Exposure to Radionuclides in Air, Water, and Soil,* U.S. Environmental Protection Agency, EPA-402-R-93-081, 1993.

(Westinghouse 2005) AP1000 Document APP-GW-GL-700, *AP1000 Design Control Document,* Revision 15, Westinghouse Electric Company, 2005.

(Westinghouse 2006b) Westinghouse Document No. LTR-CRA-06-21, *AP1000 Accident Releases and Doses as Function of Time*, Westinghouse Electric Company, February 1, 2006.

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7.2 Severe Accidents

This section evaluates the potential environmental impacts of severe accidents on the VEGP site from the proposed Units 3 and 4 Westinghouse AP1000 reactors. Southern Nuclear Company (SNC) has updated the Westinghouse AP1000 DCD severe accident analysis with VEGP-specific data to demonstrate the Vogtle Electric Generating Plant (VEGP) site is bounded by the Nuclear Regulatory Commission (NRC)-approved analysis **(Westinghouse 2004; NRC 2005)**.

Severe accidents are defined as accidents with substantial damage to the reactor core and degradation of containment systems. Because the probability of a severe accident is very low for the AP1000, such accidents are not part of the design basis for the plant. However, the NRC requires, in its *Policy Statement on Severe Reactor Accidents Regarding Future Designs and Existing Plants*, 1985, the completion of a probabilistic risk assessment (PRA) for severe accidents for new reactor designs. This requirement is codified in regulation 10 CFR 52.47, Contents of Applications.

Westinghouse completed a probabilistic risk assessment for the AP1000 design **(Westinghouse 2004)** as part of their application for design certification. The AP1000 design was reviewed by NRC and the review was documented in NUREG-1793, *Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design*, 2004. Subsequently NRC certified the design, concluding that [following resolution of open items] this advanced design meets NRC's safety goals and represents an improvement in safety over currently operating reactors in the U.S.

The Westinghouse analysis used generic (but conservative) meteorology and regional characteristics. SNC presents in this section an update of the generic probabilistic risk assessment analysis of severe accidents to include site-specific characteristics of the VEGP site and impacts over the entire life cycle of a severe accident. The purpose is to disclose the complete impacts of a severe accident, demonstrate that the impacts are less than those approved for the AP1000 certification, and support the severe accident mitigation alternatives analyses in Section 7.3.

7.2.1 Westinghouse Methodology

The Westinghouse probabilistic risk assessment for the AP1000 established a containment event tree which defined the possible end states of the containment following a severe accident. These end states can logically be grouped into three categories: (1) an intact containment with normal leakage or a larger leak with a containment isolation failure, (2) a containment breach, possibly due to high containment pressure or a hydrogen detonation, and (3) containment bypass such as a steam generator tube rupture. Using the Electric Power Research Institute code Modular Accident Analysis Program (MAAP), Westinghouse determined that six source term categories would represent the entire suite of potential severe accidents. An accident frequency ("core damage frequency") was assigned to each of the six categories (Table 7.2-1).

The six source term categories or accident classes are as follows:

Intact Containment – Containment integrity is maintained throughout the accident. The release of radioactivity to the environment is due to nominal design leakage.

Containment Bypass – Radioactivity is released from the reactor coolant system to the environment via the secondary system or other interfacing system bypass. Containment failure occurs prior to the onset of core damage. This accident class contributes to the large, early release frequency.

Containment Isolation Failure – Radioactivity is released through a failure of the valves that close the penetrations between containment and the environment. Containment failure occurs prior to the onset of core damage. This accident class contributes to the large, early release frequency.

Early Containment Failure – Radioactivity release occurs through a containment failure caused by some dynamic severe accident phenomenon after the onset of core damage but prior to core relocation. Such phenomena could include hydrogen detonation, hydrogen diffusion flame, steam explosions, or vessel failures. This accident class contributes to the large, early release frequency.

Intermediate Containment Failure – Radioactivity release occurs through a containment failure caused by some dynamic severe accident phenomenon after core relocation but before 24 hours have passed since initiation of the accident. Such phenomena could include hydrogen detonation and hydrogen deflagration. This accident class contributes to large releases but does not occur early in the accident life cycle.

Late Containment Failure – Radioactivity release occurs through a containment failure caused by some dynamic severe accident phenomenon more than 24 hours after initiation of the accident. Such phenomena could include the failure of containment heat removal. This accident class contributes to large releases but does not occur early in the accident life cycle.

Westinghouse then used the NRC code MACCS2 **(Chanin and Young 1997)** to model the environmental consequences of the severe accidents. MACCS2 was developed specifically for NRC to evaluate severe accidents at nuclear power plants. The meteorology Westinghouse used to represent a generic AP1000 site is specified in the Electric Power Research Institute's Utility Requirements Document **(EPRI 1999)**. This meteorology is an actual site database selected because it is expected to provide impacts greater than those that would be expected at 80 to 90 percent of U.S. operating plants. The population considered also was selected to provide impacts greater than those that would be expected at 80 to 90 percent of the plants. The Westinghouse analysis focused on 24 hours following core damage and did not address the ingestion pathway.

Additional details on the Westinghouse analysis are found in Westinghouse **(2004)** and reported in the AP1000 Design Control Document **(Westinghouse 2005)**.

7.2.2 SNC Methodology

SNC also used the MACCS2 computer code to evaluate consequences of severe accidents. The pathways modeled include external exposure to the passing plume, external exposure to material deposited on the ground and skin, inhalation of material in the passing plume or resuspended from the ground, and ingestion of contaminated food and surface water. The MACCS2 code primarily addresses dose from the air pathway, but also calculates dose from surface runoff and deposition on surface water. The code also evaluates the extent of contamination. A significant difference between the Westinghouse generic analysis and the VEGP site-specific analysis is that SNC used site-specific meteorology and population data and included the ingestion pathway over the entire life cycle of the accident.

To assess human health impacts, SNC determined the collective dose to the 50-mile population, number of latent cancer fatalities, and number of early fatalities associated with a severe accident. Economic costs were also determined, including the costs associated with short-term relocation of people, decontamination of property and equipment, and interdiction of food supplies.

Five input files provide information to a MACCS2 analysis. One provides data to calculate the amount of material released to the atmosphere that is dispersed and deposited. The calculation uses a Gaussian plume model. Important site-specific inputs in this file include the core inventory, release fractions, and geometry of the reactor and associated buildings. These input data are the same as those in the MACCS2 input files used by Westinghouse in the generic probabilistic risk assessment. A second file provides inputs to calculations regarding exposure in the time period immediately following the release. Important site-specific information includes emergency response information such as evacuation time. The third input file provides data for calculating long-term impacts and economic costs and includes region-specific data on agriculture and economic factors (The Westinghouse analysis did not include this third file). These files access a meteorological file, which uses actual [VEGP] meteorological monitoring data from 1999 and a site characteristics file which is built using SECPOP2000 **(NRC 2003)**. SECPOP2000 incorporates 2000 census data for the 50-mile region around the VEGP site. For this analysis the census data were modified to include transient populations and projected to the year 2065. Population data for 2060 and 2070 are presented in Table 2.5.1-1. SNC prepared a calculation package supporting this analysis.

SNC used the results of the MACCS2 calculations and accident frequency information to determine risk. The sum of the accident frequencies is known as the core damage frequency and includes only internally initiated events. Risk is the product of frequency of an accident times the consequences of the accident. The consequence can be either radiation dose or economic cost. Dose-risk is the product of the collective dose times the accident frequency. Because the AP1000's severe accident analysis addressed a suite of accidents, the individual risks are summed to provide a total risk. The same process was applied to estimating cost-risk. Therefore, risk can be reported as person-rem per reactor year or dollars per reactor year.

7.2.3 Consequences to Population Groups

This section evaluates impacts of severe accidents from air, surface water and groundwater pathways. The MACCS2 code was used to evaluate the doses from the air pathway and from drinking water with VEGP site-specific data. MACCS2 does not model other surface water and groundwater dose pathways. These were analyzed qualitatively based on a comparison of the AP1000 atmospheric doses to those of the existing nuclear fleet.

The current U.S. nuclear fleet has an exceptional safety record. The AP1000 is one of a new generation of reactors that incorporated passive safety features, making it inherently safer than existing reactors. The core damage frequency (CDF) is a measure of the impacts of potential accidents. CDF is estimated using PRA modeling which evaluates how changes to the reactor or auxiliary systems can change the severity of the accident. The CDF for the AP1000 is less than the CDFs for the current nuclear fleet.

7.2.3.1 Air Pathways

The potential severe accidents for the AP1000 were grouped into the six accident classes based on similarity of characteristics. Each class was assigned a set of characteristics representative of the elements of that class. Each accident class was analyzed with MACCS2 to estimate population dose, number of early and latent fatalities, cost, and farm land requiring decontamination. The analysis assumed that 95 percent of the population was evacuated following declaration of a general emergency.

For each accident class, SNC calculated the risk for each analytical endpoint (population dose, fatalities, cost, and contaminated land) by multiplying it by the accident class frequency. The results are provided in Table 7.2-1. The calculation considers other analytical endpoints such as evacuation costs, value of crops contaminated and condemned, value of milk contaminated and condemned, cost of decontamination of property, and indirect costs resulting from loss of use of the property and incomes derived as a result of the accident.

7.2.3.2 Surface Water Pathways

People can be exposed to radiation when airborne radioactivity is deposited onto surface water. The exposure pathway can be from drinking the water, external radiation from submersion in the water, external radiation from activities near the shoreline, or ingestion of fish or shellfish. MACCS2 only calculates the dose from drinking the water. The MACCS2 severe accident dose-risk to the 50-mile population from drinking water is 2.1×10^{-3} person-rem per reactor year for the AP1000. This value is the sum of all six accident class risks.

Surface water pathways involving swimming, fishing, and boating are not modeled by MACCS2. Surface water bodies within the 50-mile region of VEGP include the Savannah River, other rivers, creeks, and ponds. The NRC evaluated doses from the aquatic food pathway (fishing) for the current nuclear fleet discharging to small rivers (including the Savannah River) in NUREG-1437, the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (1996). The NRC evaluation estimated the aquatic food pathway dose risk as 0.4 person-rem per reactor year.

The NRC concluded in NUREG-1437 that population doses from drinking water and aquatic food pathways are small relative to the atmospheric pathway for most sites (including VEGP). Because the AP1000 atmospheric pathway doses are significantly lower that those of the current nuclear fleet, the doses from surface water sources would be consistently lower for the AP1000 as well.

7.2.3.3 Groundwater Pathways

People can also receive a dose from groundwater pathways. Radioactivity released during an accident can enter groundwater that serves as a source of drinking water or irrigation, or can move through an aquifer that eventually discharges to surface water. (SNC has evaluated the consequences of a radioactive spill not associated with an accident in the ESP SSAR Section 2.4.13 and determined that if radioactive liquids were released directly to groundwater, all isotopes would be below maximum permissible concentrations before they reached the Savannah River. NUREG-1437 also evaluated the groundwater pathway dose, based on the analysis in NUREG-0440 (1978), the *Liquid Pathway Generic Study (LPGS)*. NUREG-0440 analyzed a core meltdown that contaminated groundwater that subsequently contaminated surface water. However, NUREG-0440 did not analyze direct drinking of groundwater because of the limited number of potable groundwater wells.

The LPGS results provide conservative, uninterdicted population dose estimates for six generic categories of plants. These dose estimates were one or more orders of magnitude less than those attributed to the atmospheric pathway. NUREG-1437 compared potential contamination at the existing VEGP site to the results of NUREG-0440 and found it to be 10^{-5} to 10^{-4} times the NUREG-0440 conclusions for a small river site. The proposed location for VEGP Units 3 and 4 has the same groundwater characteristics as the location of the existing units and the CDF for the AP1000 is lower that that of the existing units, therefore, the doses from the AP1000 groundwater pathway would be smaller than from the existing units.

7.2.4 Conclusions

The total calculated dose-risk to the 50-mile population from airborne releases from an AP1000 reactor at VEGP will not exceed 0.042 person-rem per reactor year (Table 7.2-1). This value is less than the 0.043 reported by Westinghouse in the Design Control Document **(Westinghouse 2005)**. The difference is more pronounced than it appears, because the Westinghouse analysis is based on a 24-hour dose but the SNC analysis is based on the entire life-cycle of the accidents considered.

The AP1000 dose-risk at the VEGP site is less than the population risk for all current reactors that have undergone license renewal, and less than that for the five reactors analyzed in RG 1.174, *An approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis*. As reported in NUREG-1793 *Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design*, 2004, the minimum dose-risk reported for reactors currently undergoing license renewal is 0.55 person-rem per reactor year. The airborne pathway dose-risk from severe accidents for the existing VEGP reactors is 35 person-rem per reactor year (50 FR 32138).

Two population centers near the mouth of the Savannah River, Savannah, Georgia and Beaufort County, S.C., use the Savannah River as a source of drinking water. Also, shell-fishing near the mouth of the river provides foods to the population. SNC's qualitative analysis indicates that risk from the surface water pathway is small. The risks of groundwater contamination from an AP1000 accident are several orders of magnitude less than the risk from surface water contamination for currently licensed reactors. The risk of groundwater contamination from an AP14000 accident is smaller than the risk from currently licensed reactors. Additionally, interdiction could substantially reduce the groundwater pathway risks.

For comparison, as reported in Section 5.4, the total collective dose from normal operations is expected to be 0.2 person-rem per year for the AP1000. As previously described, dose-risk is dose times frequency. Normal operations has a frequency of one. Therefore, the dose-risk for normal operations is 0.2 person-rem per reactor year. Comparing this value to the severe accident dose-risk of 0.042 person-rem per reactor year indicates that the dose risk from severe accidents is approximately 20 percent of dose risk from normal operations.

The probability-weighted risk of an early cancer fatality from a severe accident for the AP1000 at VEGP is reported in Table 7.2-1 as 2.8×10^{-7} fatalities per reactor year. The lifetime probability of an individual dying from any cancer is 2.3×10^{-1}.

Table 7.2-1 Impacts to the Population and Land from Severe Accidents Analysis for the AP1000

		Environmental Risk				
			Number of Fatalities (per reactor year)			
Accident Class	Core Damage Frequency (per reactor year)[1]	Population Dose-Risk (person-rem/reactor year)	Early	Late	Cost in Dollars (per reactor year)	Land Requiring Decontamination (acres/reactor year)
1. Intact containment	2.2×10^{-7}	7.0×10^{-4}	0	9.7×10^{-8}	0.18	0
2. Containment bypass	1.1×10^{-8}	3.2×10^{-2}	1.5×10^{-7}	5.3×10^{-6}	40	5.3×10^{-4}
3. Containment isolation failure	1.3×10^{-9}	1.6×10^{-3}	9.5×10^{-9}	2.5×10^{-7}	1.4	0
4. Early containment failure	7.5×10^{-9}	8.0×10^{-3}	5.5×10^{-8}	1.2×10^{-6}	9.6	6.5×10^{-5}
5. Intermediate containment failure	1.9×10^{-10}	2.8×10^{-4}	6.9×10^{-8}	4.4×10^{-8}	.25	8.0×10^{-7}
6. Late containment failure	3.5×10^{-13}	6.7×10^{-7}	0	9.8×10^{-11}	0.0012	2.2×10^{-8}
Total	2.4×10^{-7}	4.2×10^{-2}	2.8×10^{-7}	6.9×10^{-6}	51	6.0×10^{-4}

1 Source: **Westinghouse 2004**

Section 7.2 References

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

(EPRI 1999) Electric Power Research Institute, Advanced Light Water Reactor Utility Requirements Document, Volume III, ALWR Passive Plant, Revision B, Palo Alto, California, March.

(NRC 2003) U.S. Nuclear Regulatory Commission, SECPOP2000: Sector Population, Land Fraction, and Economic Estimation Program, NUREG/CR-6525, Rev. 1, Washington, D.C. August.

(NRC 2005) U.S. Nuclear Regulatory Commission, Environmental Assessment by the U.S. Nuclear Regulatory Commission Relating to the Certification of the AP1000 Standard Plant Design, Docket No. 52-006, SECY 05-0227 (accession number ML053630176), Washington D.C., January 24.

(Westinghouse 2004) Westinghouse Electric Company, LLC, *Probabilistic Risk Assessment*, Revision 8, Pittsburgh, Pennsylvania.

(Westinghouse 2005) Westinghouse Electric Company, LLC, *Design Control Document, Revision 15*, Appendix 1B, "Severe Accident Mitigation Design Alternatives," NRC Accession Number ML053460409, U.S. Nuclear Regulatory Commission, Washington, D.C., November 11.

7.3 Severe Accident Mitigation Measures

This section updates the Westinghouse DCD Severe Accidents Mitigation Measures analysis **(Westinghouse 2005)** with VEGP site and regional data. The VEGP-site specific analysis demonstrates that the severe accident mitigation alternatives determined not to be cost beneficial by Westinghouse are also not cost beneficial when VEGP site-specific data are considered **(NRC 2005)**.

Regulations of the Council on Environmental Quality (CEQ) regarding the National Environmental Policy Act require that a discussion on environmental consequences include mitigation measures (40 CFR 1502.16(h). CEQ has stated that mitigation measures should be considered even for impacts that, by themselves, would not be significant, if the overall proposed action could have significant impacts. As described in Chapters 4 and 5, the construction and operation of a nuclear power plant has significant impacts.

As described in Section 7.2, Westinghouse performed a generic severe accident analysis for the AP1000 as part of the design certification process **(Westinghouse 2005)**. The Westinghouse analysis determined that severe accident impacts are small and that no potential mitigating design alternatives are cost-effective, that is, appropriate mitigating measures are already incorporated into the plant design. Section 7.2 extends the Westinghouse generic severe accident analysis to examine the SNC proposed new nuclear units at VEGP and determined that the generic conclusions remain valid for the VEGP site. The analysis in this section provides assurance that there are no cost-beneficial design alternatives that would need to be implemented at SNC's site to mitigate these small impacts. SNC prepared a calculation package supporting this analysis.

7.3.1 The SAMA Analysis Process

Design or procedural modifications that could mitigate the consequences of a severe accident are known as severe accident mitigation alternatives (SAMAs). In the past SAMAs were known as SAMDAs, severe accident mitigation design alternatives, which primarily focused on design changes and did not consider procedural modification SAMAs. The Westinghouse DCD analysis is a SAMDA analysis. For an existing plant with a well-defined design and established procedural controls, the normal evaluation process for identifying potential SAMAs includes four steps:

1. Define the base case – The base case is the dose-risk and cost-risk of severe accident before implementation of any SAMAs. A plant's probabilistic risk assessment is a primary source of data in calculating the base case. The base case risks are converted to a monetary value to use for screening SAMAs. Section 7.2 presents the base case for the ESP project, without the monetization step.

2. Identify and screen potential SAMAs – Potential SAMAs can be identified from the plant's Individual Plant Examination, the plant's probabilistic risk assessment, and the results of other plants' SAMA analyses. This list of potential SAMAs is assigned a conservatively low implementation cost based on historical costs, similar design changes and/or engineering judgement, then compared to the base case screening value. SAMAs with higher implementation cost than the base case are not evaluated further.
3. Determine the cost and net value of each SAMA – Each SAMA remaining after Step 2, has a detailed engineering cost evaluation developed using current plant engineering processes. If the SAMA continues to pass the screening value Step 4 is performed.
4. Determine the benefit associated with each screened SAMA – Each SAMA that passes the screening in Step 3, is evaluated using the probabilistic risk assessment model to determine the reduction in risk associated with implementation of the proposed SAMA. The reduction in risk benefit is then monetized and compared to the detailed cost estimate. Those SAMAs with reasonable cost-benefit ratios are considered for implementation.

In the absence of a completed plant with established procedural controls, the ESP analysis is limited to demonstrating that the VEGP site is bounded by the Westinghouse DCD analysis and determining what magnitude of plant-specific design or procedural modification would be cost-effective. Determining the magnitude of cost-effective design or procedural modifications is the same as "1. Define base case" for existing nuclear units. The base case benefit value is calculated by assuming you could reduce the current dose risk of the unit to zero and assigning defined dollar value for this change in risk. Any design or procedural change cost that exceeded the benefit value would not be considered cost-effective. The dose-risk and cost-risk results (Section 7.2 analyses) are monetized in accordance with methods established in NUREG/BR-0184, *Regulatory Analysis Technical Evaluation Handbook*, 1997. NUREG/BR-0184 presents methods for determination of the value of decreases in risk, using four types of attributes: public health, occupational health, offsite property, and onsite property. Any SAMAs in which the conservatively low implementation cost exceeds the base case monetization would not be expected to pass the screening in Step 2. If the SNC baseline analysis produces a value that is below that expected for implementation of any reasonable SAMA, no matter how inexpensive, then the remaining steps of the SAMA analysis are not necessary. SNC prepared a calculation package supporting this analysis.

7.3.2 The AP1000 SAMA Analysis

In the certification process, only design alternatives are of interest. The Westinghouse SAMDA analysis is presented in Appendix 1B of the AP1000 Design Control Document **(Westinghouse 2005)**.

Westinghouse compiled a list of potential SAMDAs based on the AP600 analysis and other plant designs and suggestions from the AP600/AP1000 design staff. Some SAMDAs were then screened out based on their inapplicability to the AP1000 or the fact that they were already included in the AP1000 design. Rough implementation costs that far exceeded any reasonable benefit were also excluded. The 15 SAMDAs that passed the screening process are as follows and are described more fully in the DCD.

- Chemical volume and control system upgrade to mitigate small loss-of-coolant accidents
- Filtered containment vent
- Normal residual heat removal system inside containment
- Self-actuating containment isolation valves
- Passive containment spray
- Active high-pressure safety injection system
- Steam generator shell-side passive heat removal system
- Steam generator safety valve flow directed to in-containment refueling water storage tank
- Increased steam generator secondary side pressure capacity
- Secondary containment filtered ventilation
- Diverse in-containment refueling water storage tank injection values
- Diverse containment recirculation valves
- Ex-vessel core catcher
- High-pressure containment design
- Improved reliability of diverse actuation system

These remaining SAMDAs were quantified by the probabilistic risk assessment model to determine the reduction in risk for implementing the SAMDA. Each SAMDA was assumed to reduce the risk of the accident sequences that they address to zero, a conservative assumption. Using the cost-benefit methodology of NUREG/BR-0184 the maximum averted cost risk was calculated for each SAMDA. The maximum averted cost risk calculation used the dose-risks and cost-risks calculated for the severe accidents described in Section 7.2.1. Westinghouse calculated the base case maximum averted cost risk to be $21,000 using a 7 percent discount rate.

Westinghouse next compared the implementation costs for each SAMDA to the $21,000 value and found that none of the SAMDAs would be cost effective. The least costly SAMDA, self-actuating containment isolation valves, had an implementation cost of approximately $30,000, with the others having costs at least an order of magnitude greater. The one potential SAMDA was further evaluated but not found to be cost-effective.

In its Finding of No Significant Impact relating to the certification of the AP1000 design NRC **(2006)** concluded, “none of the potential design modifications evaluated are justified on the basis of cost-benefit considerations. The NRC further concludes that it is unlikely that any other design changes would be justified in the future on the basis of person-rem exposure because the estimated CDFs [core damage frequency] are very low on an absolute scale.”

7.3.3 Monetization of the VEGP Units 3 and 4 Base Case

The principal inputs to the calculations are the core damage frequency (reported in Section 7.2), dose-risk and cost-risk (reported in Table 7.2-1), dollars per person-rem ($2,000 as provided by NRC in NUREG/BR-0184), licensing period (40 years), and economic discount rate (7% and 3% are NRC precedents). For this project, the base-case core damage frequency, dose-risk, and cost-risk were escalated in this analysis to account for not only internal events but also external events, both at power and at shutdown. With these inputs, the monetized value of reducing the base case core damage frequency to zero is presented in Table 7.3-1. The monetized value, known as the maximum averted cost-risk, is conservative because no SAMA can reduce the core damage frequency to zero.

The maximum averted cost-risk of $18,000 for a single AP1000 at SNC's proposed site, is so low that SNC does not believe there are any design changes, over those already incorporated into the advanced reactor designs, that could be determined to be cost-effective. Even with a conservative three percent discount rate, the valuation of the averted risk is only $34,000. Conceivably, there could be administrative changes applicable to both AP1000 units that could be less than the combined project averted risk monetization.

These values compare to the Westinghouse generic analysis results of $21,000 for the seven percent discount rate and $43,000 for the three percent discount rate. The SNC analysis used actual population and meteorological characteristics that would result in lower impacts than did the conservative values used in the generic analysis.

Accordingly, further evaluation of design-related SAMAs is not warranted. Evaluation of administrative SAMAs would not be appropriate until a plant design is finalized and plant administrative processes and procedures are being developed. At that time, appropriate administrative controls on plant operations would be incorporated into the plants' management systems as part of its baseline.

Table 7.3-1 Monetization of the SNC AP1000 Base Case

	7% Discount Rate	3% Discount Rate
Offsite exposure cost	$693	$2,191
Offsite economic cost	$421	$1,331
Onsite exposure cost	$176	$380
Onsite cleanup cost	$6,093	$12,708
Replacement power cost	$10,578	$17,651
Total	$17,960	$34,261

Section 7.3 References

(NRC 2005) U.S. Nuclear Regulatory Commission, Environmental Assessment by the U.S. Nuclear Regulatory Commission Relating to the Certification of the AP1000 Standard Plant Design, Docket No. 52-006, SECY 05-0227 (accession number ML053630176), Washington D.C., January 24.

(Westinghouse 2005) Westinghouse Electric Corporation, *Design Control Document, Revision 15*, Appendix 1B, “Severe Accident Mitigation Design Alternatives,” NRC Accession Number ML053460409, U.S. Nuclear Regulatory Commission, Washington, D.C., November 11, 2005.

7.4 Transportation Accidents

Section 5.11.2 described the methodology used by SNC to analyze the impacts of transportation, including accidents.

7.4.1 Transportation of Unirradiated Fuel

Accidents involving unirradiated fuel shipments are addressed in Table S-4 of 10 CFR 51.52. Accident risks are calculated as frequency times consequence. Accident frequencies for transportation of fuel to future reactors are expected to be lower than those used in the analysis in AEC **(1972)**, which forms the basis for Table S-4 of 10 CFR 51.52, because of improvements in highway safety and security. Traffic accident, injury, and fatality rates have fallen over the past 30 years. The consequences of accidents that are severe enough to result in a release of unirradiated particles to the environment from fuel for advanced LWRs fuels are not significantly different from those for current generation LWRs. The fuel form, cladding, and packaging are similar to those LWRs analyzed in AEC (1972). Consequently, as described in NUREG-1811, *Draft Environmental Impact Statement for an Early Site Permit at North Anna Power Station ESP Site*, 2004; NUREG-1815, *Draft Environmental Impact Statement for an Early Site Permit at Exelon ESP Site*, 2005; and NUREG-1817, *Environmental Impact Statement for an Early Site Permit at Grand Gulf ESP Site*, 2006, the risks of accidents during transport of unirradiated fuel to the VEGP site would be expected to be smaller than the reference LWR results listed in Table S-4.

7.4.2 Transportation of Spent Fuel

In its assessments of other proposed ESP sites, NRC used the RADTRAN 5 computer code to estimate impacts of transportation accidents involving spent fuel shipments. RADTRAN 5 considers a spectrum of potential transportation accidents, ranging from those with high frequencies and low consequences (i.e., “fender benders”) to those with low frequencies and high consequences (i.e., accidents in which the shipping container is exposed to severe mechanical and thermal conditions).

NRC obtained the radionuclide inventories of the advanced LWR spent fuel after five years decay from INEEL (2003) and performed a screening analysis to select the dominant contributors to accident risks to simplify the RADTRAN 5 calculations. This screening identified the radionuclides that would contribute more than 99.999 percent of the dose from inhalation of radionuclides released following a transportation accident. NRC found that the dominant radionuclides are similar regardless of the fuel type. The spent fuel inventory used in the NRC analysis for the AP1000 is presented in Table 7.4-1.

Massive shipping casks are used to transport spent fuel because of the radiation shielding and accident resistance required by 10 CFR 71. Spent fuel shipping casks must be certified Type B packaging systems, meaning they must withstand a series of severe hypothetical accident conditions with essentially no loss of containment or shielding capability. According to Sprung et al. **(2000)**, the probability of encountering accident conditions that would lead to shipping cask failure is less than 0.01 percent (i.e., more than 99.99 percent of all accidents would result in no release of radioactive material from the shipping cask). The NRC analysis assumed that shipping casks for advanced LWR spent fuels would provide equivalent mechanical and thermal protection of the spent fuel cargo.

NRC performed the RADTRAN 5 accident risk calculations using unit radionuclide inventories (curies/metric ton uranium [Ci/MTU]) for the spent fuel shipments from the advanced LWRs. The resulting risk estimates were multiplied by the expected annual spent fuel shipments (MTU/yr) to derive estimates of the annual accident risks associated with spent fuel shipments from each potential advanced LWR. The amounts of spent fuel shipped per year were assumed to be equivalent to the annual discharge quantities: 23 MTU/yr for the AP1000. (This discharge quantity has not been normalized to the reference LWR. The normalized value is presented in Table 7.4-2.)

NRC used the release fractions for current generation LWR fuels to approximate the impacts from the advanced LWR spent fuel shipments. This assumes that the fuel materials and containment systems (i.e., cladding, fuel coatings) behave similarly to current LWR fuel under applied mechanical and thermal conditions.

Using RADTRAN 5, NRC calculated the population dose from the released radioactive material for five possible exposure pathways:

1. external dose from exposure to the passing cloud of radioactive material
2. external dose from the radionuclides deposited on the ground by the passing plume (the NRC analysis included the radiation exposure from this pathway even though the area surrounding a potential accidental release would be evacuated and decontaminated, thus preventing long-term exposures from this pathway)
3. internal dose from inhalation of airborne radioactive contaminants
4. internal dose from resuspension of radioactive materials that were deposited on the ground (the NRC analysis included the radiation exposures from this pathway even though evacuation and decontamination of the area surrounding a potential accidental release would prevent long-term exposures)
5. internal dose from ingestion of contaminated food (the NRC analysis assumed interdiction of foodstuffs and evacuation after an accident so no internal dose due to ingestion of contaminated foods was calculated).

A sixth pathway, external doses from increased radiation fields surrounding a shipping cask with damaged shielding, was considered but not included in the analysis. It is possible that shielding materials incorporated into the cask structures could become damaged as a result of an accident. However, NRC did not include loss of shielding events in its analysis because their contribution to spent fuel transportation risk is much smaller than the dispersal accident risks from the pathways listed above.

NRC calculated the environmental consequences of transportation accidents when shipping spent fuel from other potential new reactor sites to a spent fuel repository assumed to be at Yucca Mountain, Nevada. The shipping distances and population distribution information for the routes were the same as those used for the "incident-free" transportation impacts analysis (described in Section 5.11.2).

SNC used the results of the NRC analysis for transportation of spent fuel from the Savannah River Site to Yucca Mountain to conservatively estimate the potential impacts for spent fuel transportation from VEGP, due to the proximity of the two sites (see Section 5.11.2.1 for further discussion). As discussed in Section 5.11.2.1, analysis of this transportation route is also bounding for the alternative sites (Farley, Hatch) or a green field site within the SNC region of interest. The NRC analysis included the AP1000 reactor design.

Table 7.4-2 presents unit (per MTU) accident risks associated with transportation of spent fuel from the VEGP site to the proposed Yucca Mountain repository. The accident risks are provided in the form of a collective population dose (i.e., person-rem over the shipping campaign). The table also presents estimates of accident risk per reactor year normalized to the reference reactor analyzed in AEC (1972).

7.4.3 Conclusion

Considering the uncertainties in the data and computational methods, NRC concluded that the overall transportation accident risks associated with advanced LWR spent fuel shipments are likely to be SMALL and are consistent with the risks associated with transportation of spent fuel from current generation reactors presented in Table S-4 of 10 CFR 51.52. The same conclusion is true of the transportation accident risks associated with the spent fuel from proposed new reactors at the VEGP site.

Table 7.4-1 Radionuclide Inventory Used in Transportation Accident Risk Calculations for the AP1000

Radionuclide	AP1000 Inventory Ci/MTU
Am-241	727
Am-242m	13.1
Am-243	33.4
Ce-144	8870
Cm-242	28.3
Cm-243	30.7
Cm-244	7750
Cm-245	1.21
Cs-134	4.80E+4
Cs-137	9.31E+4
Eu-154	9.13E+3
Eu-155	4620
Pm-147	1.76E+4
Pu-238	6070
Pu-239	255
Pu-240	543
Pu-241	6.96E+4
Pu-242	1.82
Ru-106	1.55E+4
Sb-125	3830
Sr-90	6.19E+4
Y-90	6.19E+4

Source: NUREG-1811, NUREG-1815, NUREG-1817
Ci/MTU = curies per metric ton uranium

Table 7.4-2 Spent Fuel Transportation Accident Risks for the AP1000

Unit Population Dose (person-rem per MTU)[1]	MTU per reference reactor year	Population Dose (person-rem per reference reactor year)[2]
2.4×10^{-6}	19.5	4.7E-5

[1] Based on SRS information presented in Table G-13 of NUREG-1811 for AP1000. Value presented is the product of probability times collective dose.

[2] Value presented is the product of probability times collective dose.

Section 7.4 References

(AEC 1972) U.S. Atomic Energy Commission, Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants, WASH-1238, U.S. Atomic Energy Commission, Washington, D.C., December.

(INEEL 2003) Idaho National Engineering and Environmental Laboratory, Early Site Permit Environmental Report Sections and Supporting Documentation, Engineering Design File Number 3747, Idaho National Engineering and Environmental Laboratory, Idaho Falls, Idaho.

(Sprung et al. 2000) Sprung, J. L., D. J. Ammerman, N. L. Breivik, R. J. Dukart, F. L. Kanipe, J. A. Koski, G. S. Mills, K. S. Neuhauser, H. D. Radloff, R. F. Weiner, and H. R. Yoshimura, Reexamination of Spent Fuel Shipment Risk Estimates, NUREG/CR-6672, Volume 1, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, D.C., March.