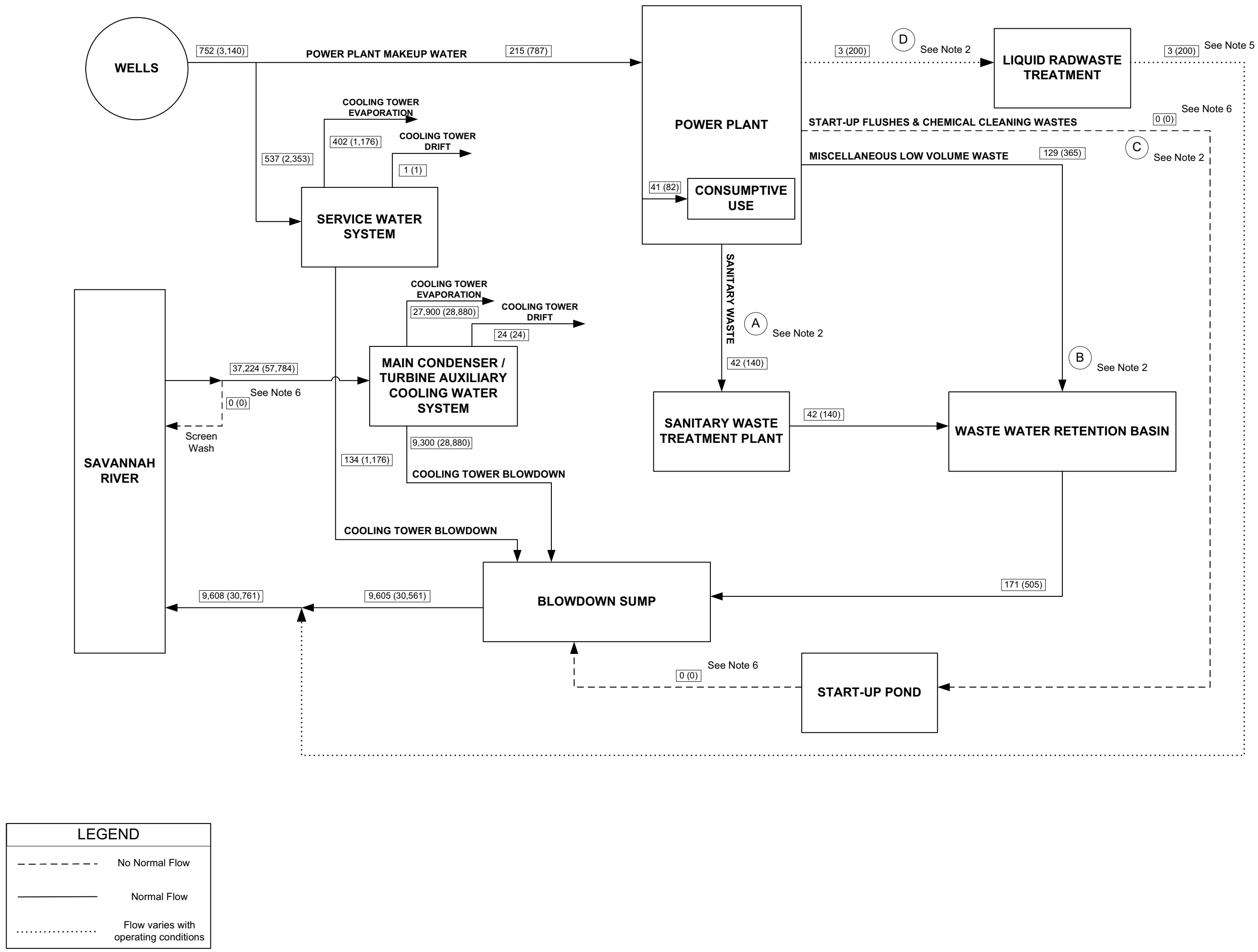
Table 3.3-1 Plant Water Use

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
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	

Table 3.3-1 (cont.) Plant Water Use

Stream Description	Normal Case[a] gpm	Maximum Case[a,b] gpm	Comments
o Miscellaneous Low Volume Waste	129	365	
o 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

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.



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.

Figure 3.3-1 Water Use Diagram Summary

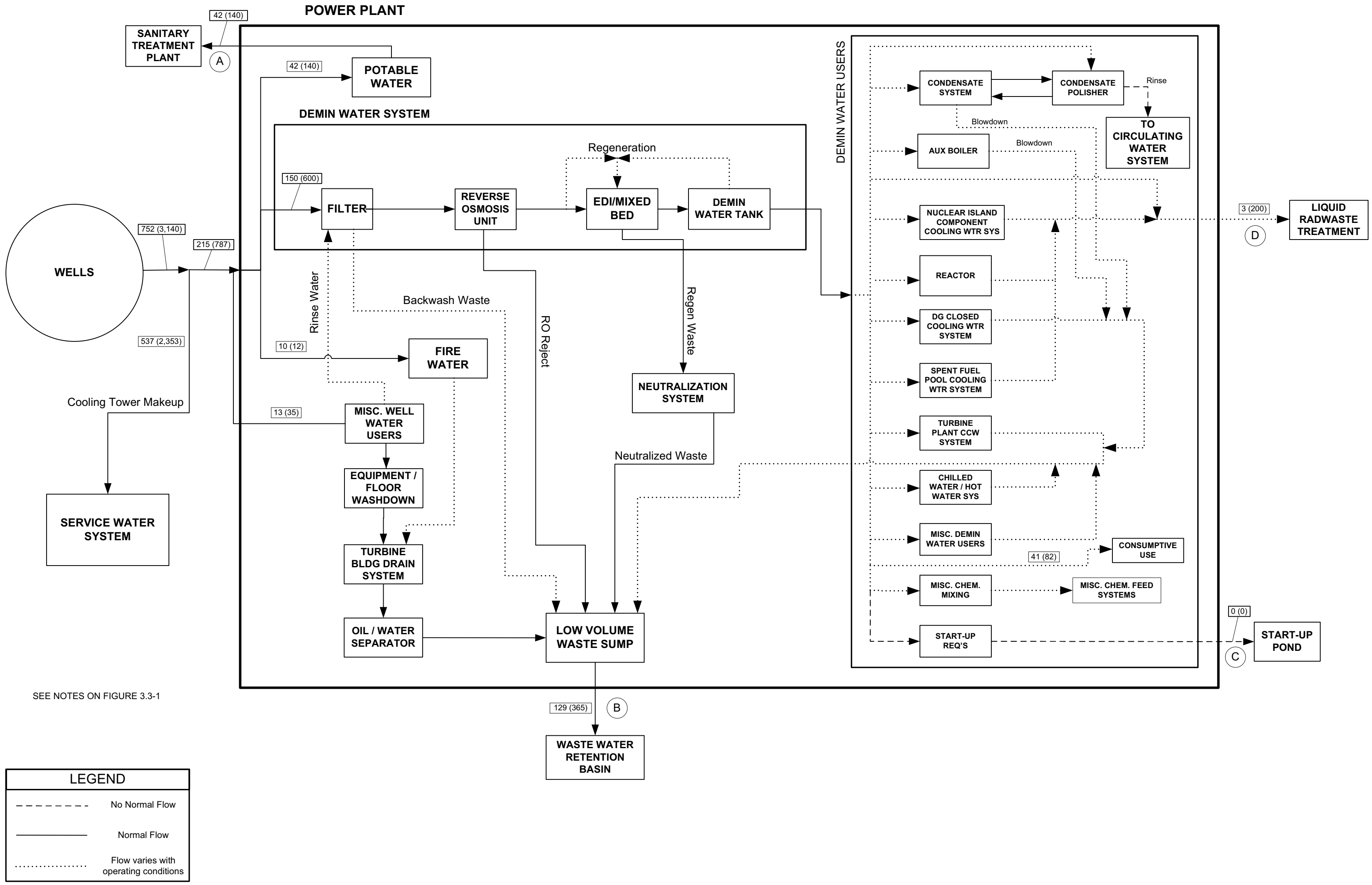


Figure 3.3-2 Water Use Diagram Details

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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 x 10^9 BTU/hr (1.51 x 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 structure and canal are sized to support three AP1000 units, should SNC desire to pursue a third unit some time in the future. However, only the mechanical components supporting VEGP Units 3 and 4 will be installed. The ER addresses water use and other operations impacts for only two units at this time.

The intake canal will be an approximately 240-ft-long, 170-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 90-ft-long, 125-ft-wide concrete structure with nine 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 additional three pump bays are provided for the possible addition of a third unit, if desired. No equipment installation or other action relative to a third unit will be taken at this time. Environmental impacts related to operation of the third unit are not considered in this ER. 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 x 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 west 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.

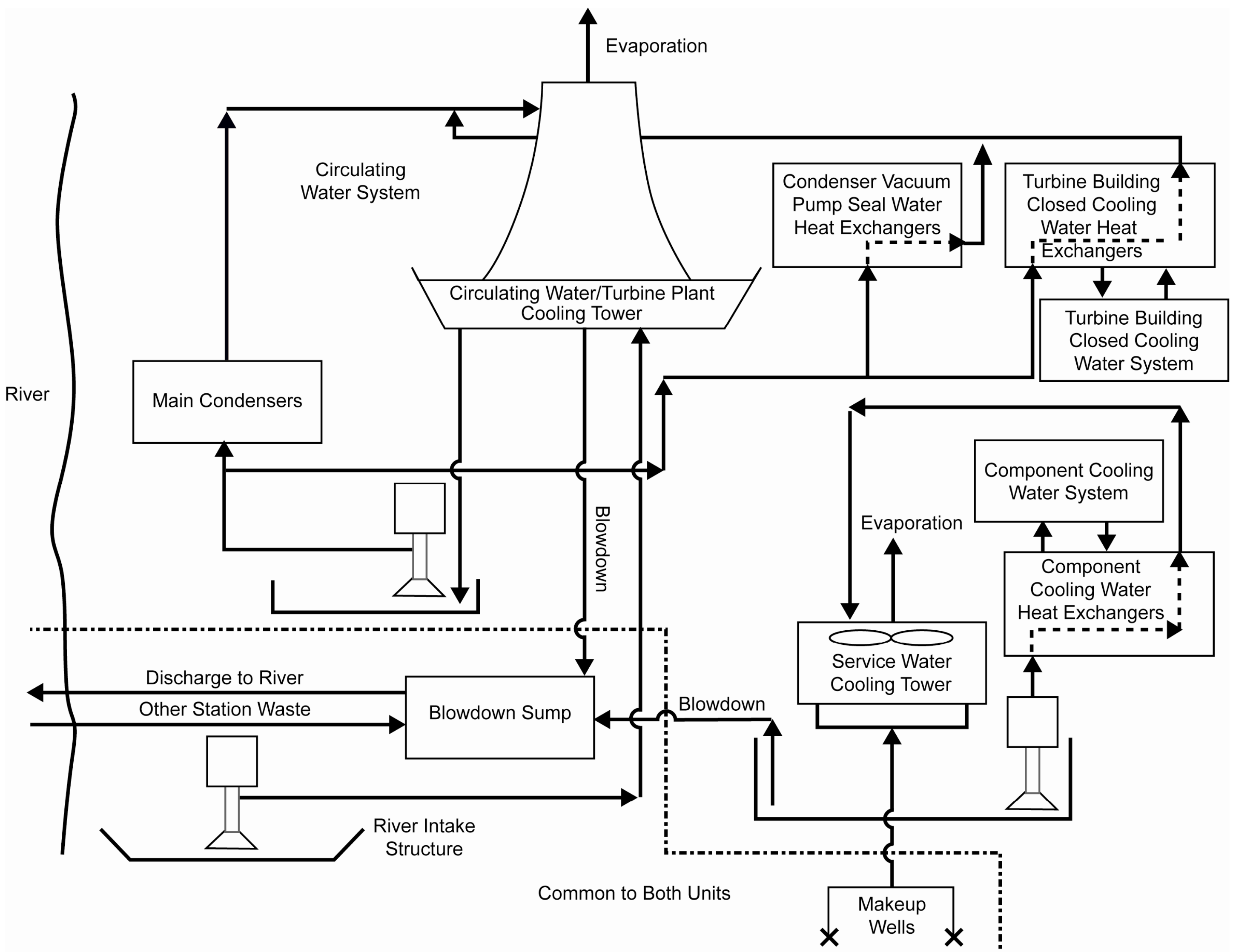


Figure 3.4-1 General Cooling System Flow Diagram

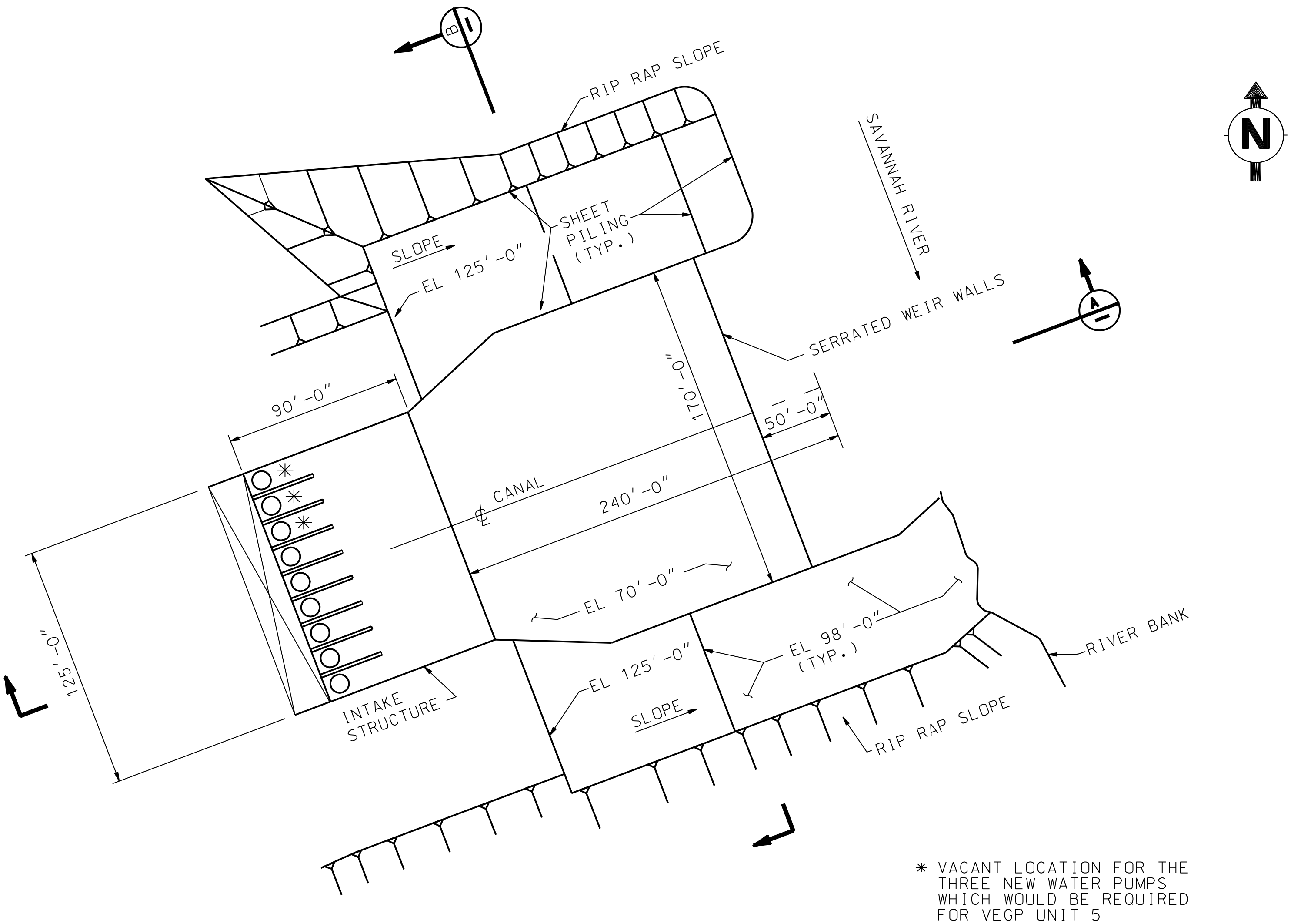
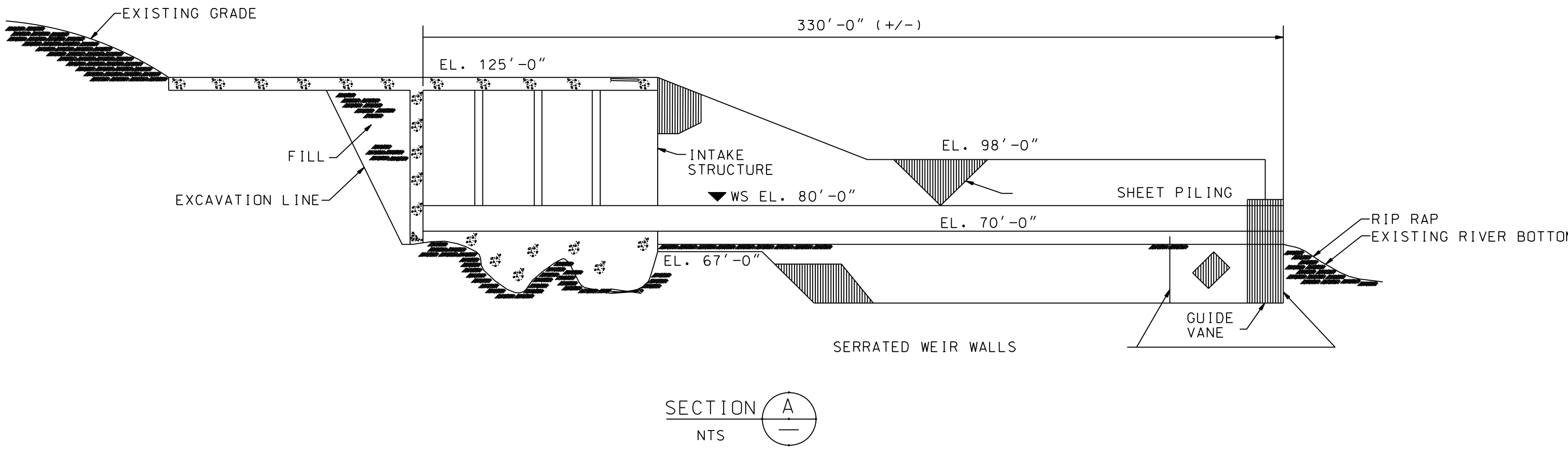


Figure 3.4-2 Plan View of River Intake System



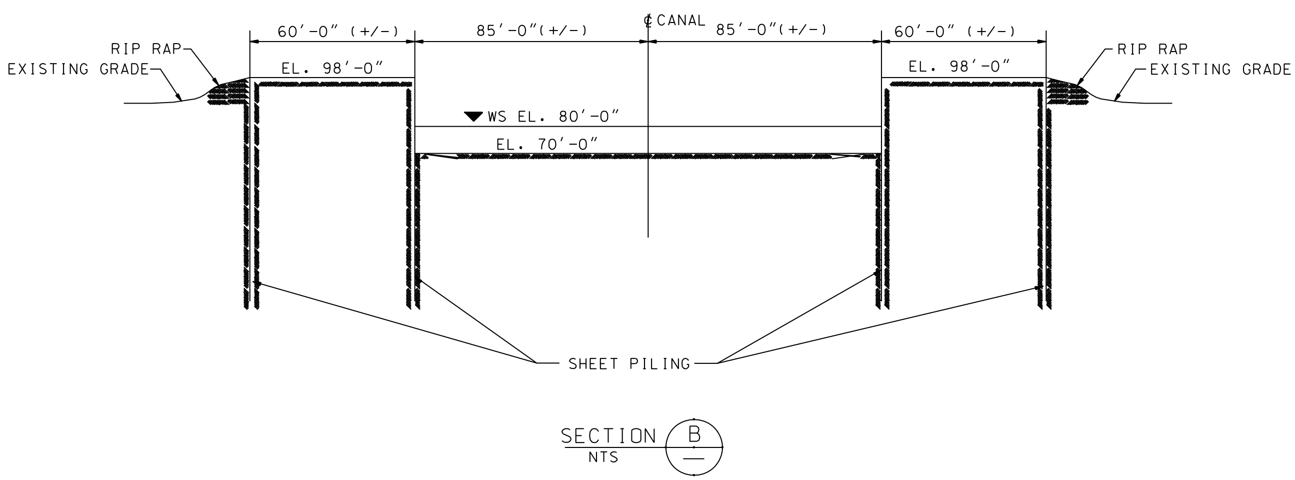


Figure 3.4-3 Section View of River Intake System

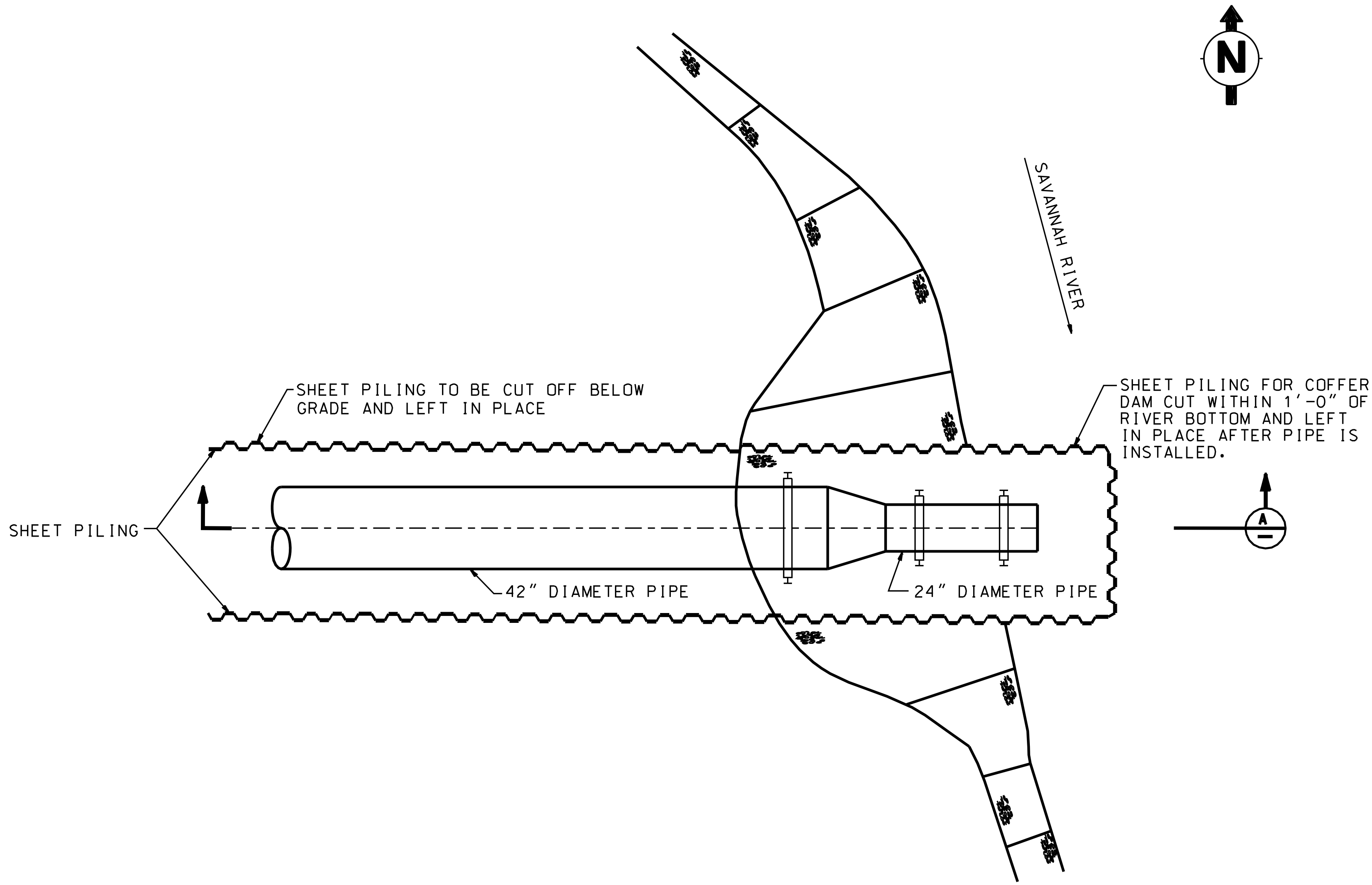


Figure 3.4-4 Plan View of New Discharge Outfall for the Discharge System

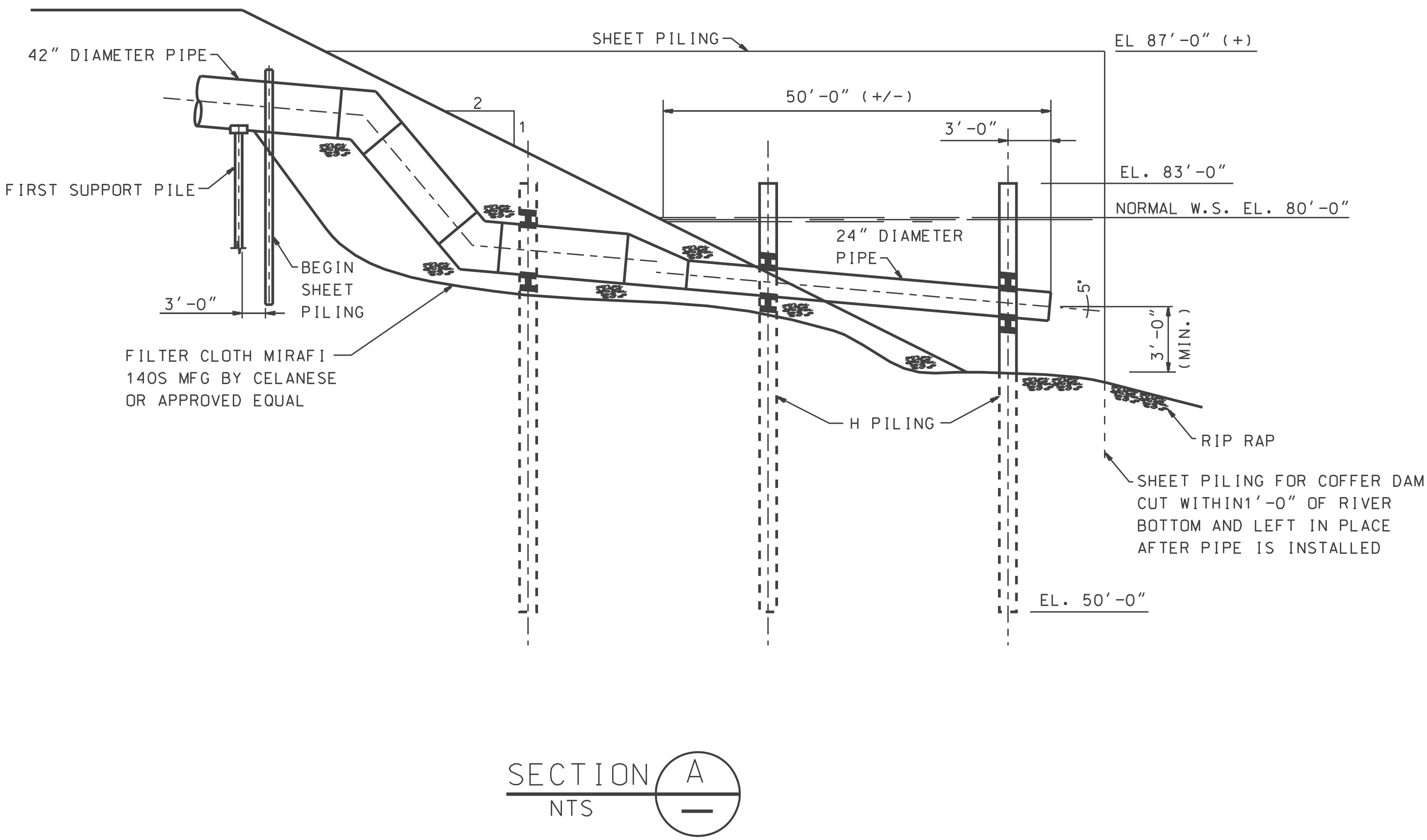


Figure 3.4-5 Section View of New Discharge Outfall for the Discharge System

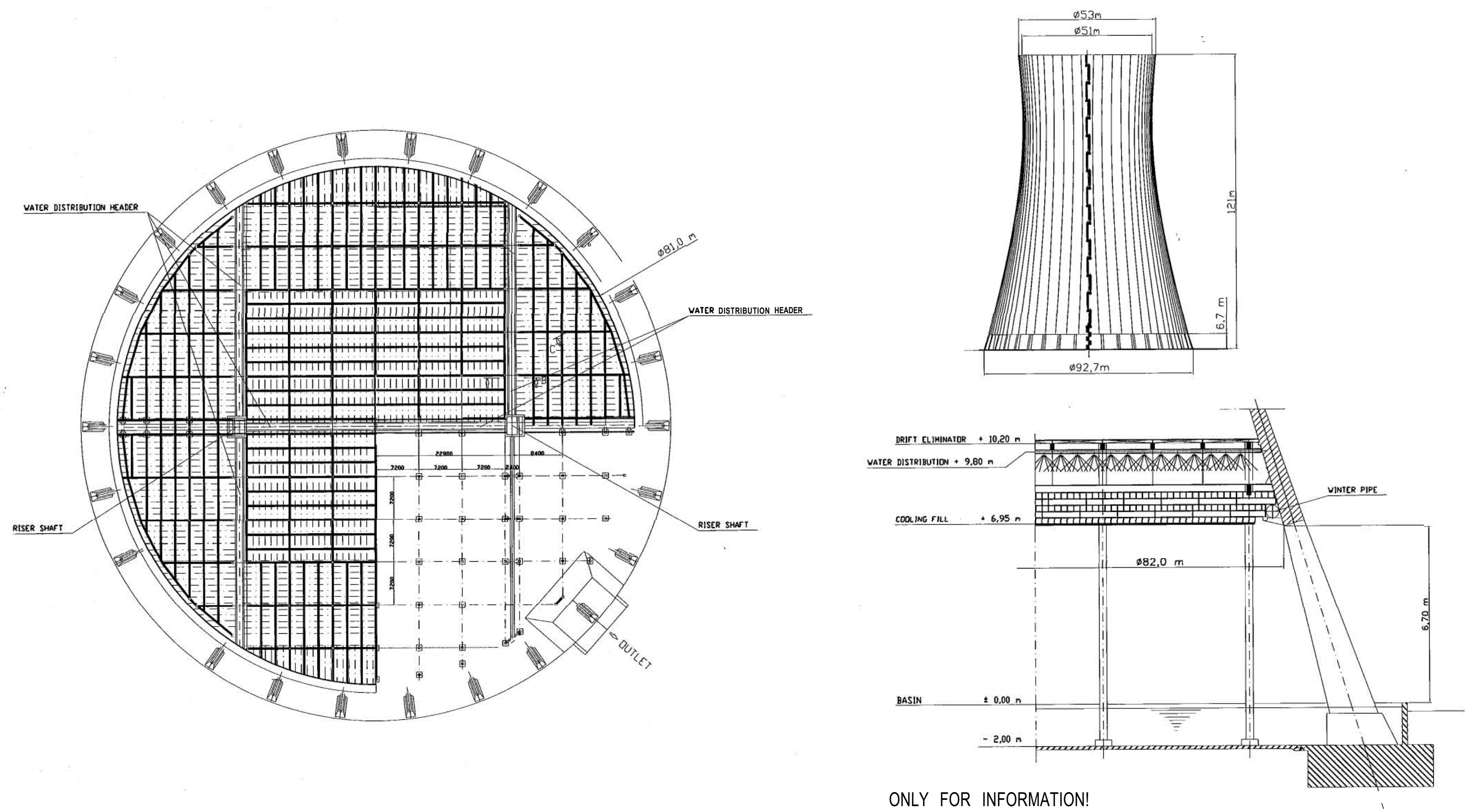


Figure 3.4-6 Natural-Draft Cooling Tower (Typical Design)

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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 area 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 new barge slip, intake structure, and 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 sediment controls to limit the distribution downstream of sediments and debris. The dredging and construction activities will require permits from the USACE. 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 that 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.

Georgia. It will cross Burke, Glasscock, Jefferson, McDuffie, Richmond, and Warren counties. No areas designated by USFWS as “critical habitat” for endangered species exist inthe macro-corridor. 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 evaluates potential impacts to the local environment from preparing a transmission corridor, and constructing transmission towers, transmission-tower configurations, or transmission tower access roads 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 sediment controls 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 the Thomson substation west of Augusta, GA. The exact route for this new line has not been selected, but a macro-corridor study has been conducted to delineate the routing options to support the NEPA analysis (**Photo Science 2007)**. The new line will cross Burke, Glascock, Jefferson, Richmond, 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 2.4-2). As noted in Section 2.4.2, shortnose sturgeons 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.

(Photo Science 2007) Photo Science, Corridor Study: Thompson – Vogtle 500-kV Transmission Project. Prepared for Georgia Power Company. Norcross, Ga. January.

(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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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: (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 and drift losses 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 flow moving 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 consumed (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, SNC likely will use one groundwater well per unit to supply makeup water for each unit's Nuclear Island service water system, fire protection, demineralization system, and 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 wells 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 though all water uses pumped from a single onsite well. SNC has not determined the locations of the Units 3 and 4 wells, as a result this environmental report used the existing units' MU-2A well for the drawdown analysis 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 (3.1×10^{-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 typically 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. 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 does not anticipate the need for treatment of raw water to prevent biofouling in the intake structure and makeup water piping. 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 at one time were 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. Chromium has never been used at VEGP.

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 segment 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. The level of treatment chemical residual in the VEGP plume is extremely low, since oxidant residuals have been neutralized and other chemicals are used in very low concentrations. 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 and is endorsed by EPA **(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 two 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 State of Georgia designates five classes of water use: Drinking Water Supply; Recreation; Fishing; Coastal Fishing; Wild River; and Scenic River. 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 (ambient) 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

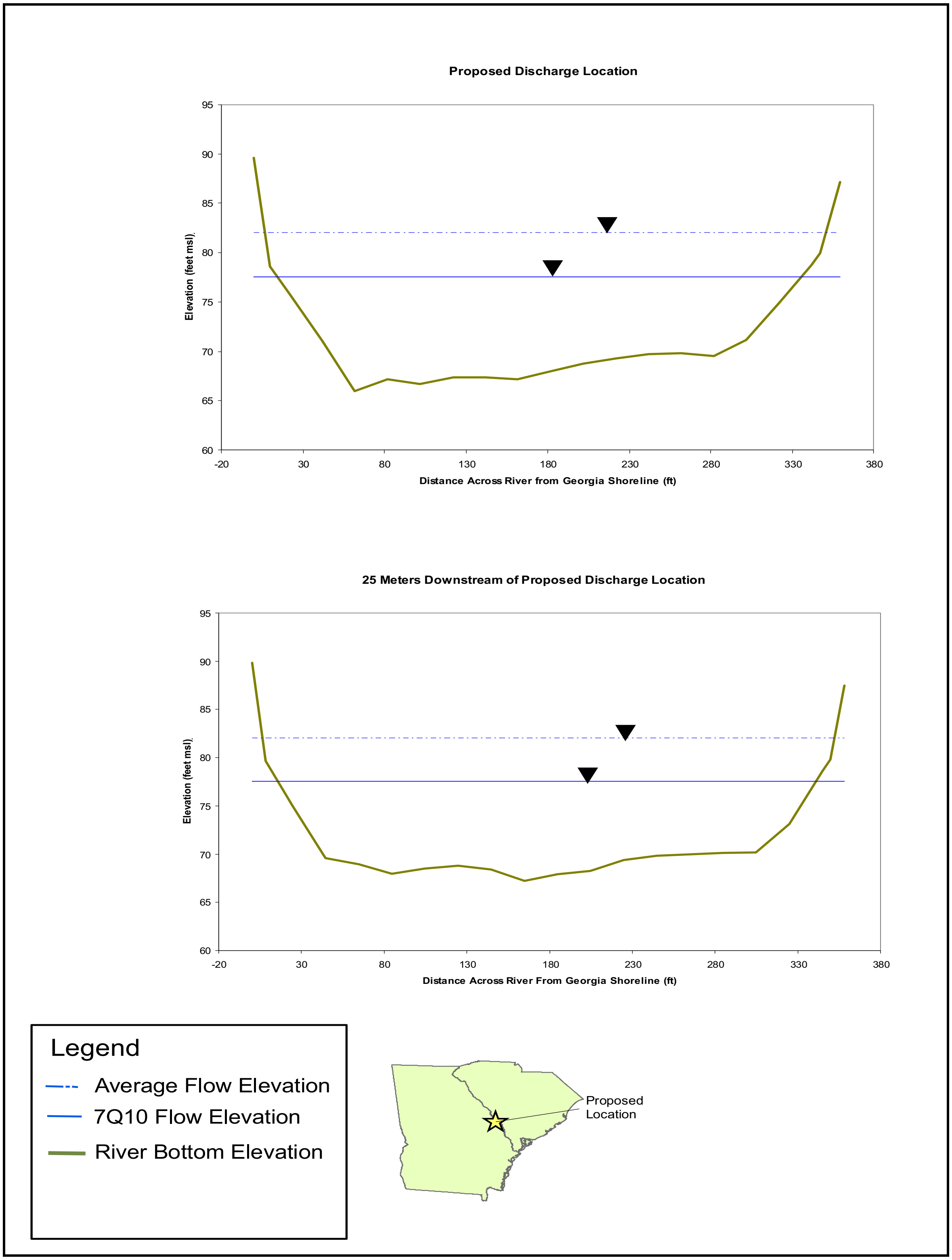

Figure 5.2-1 River Cross Sections at Proposed Discharge Location

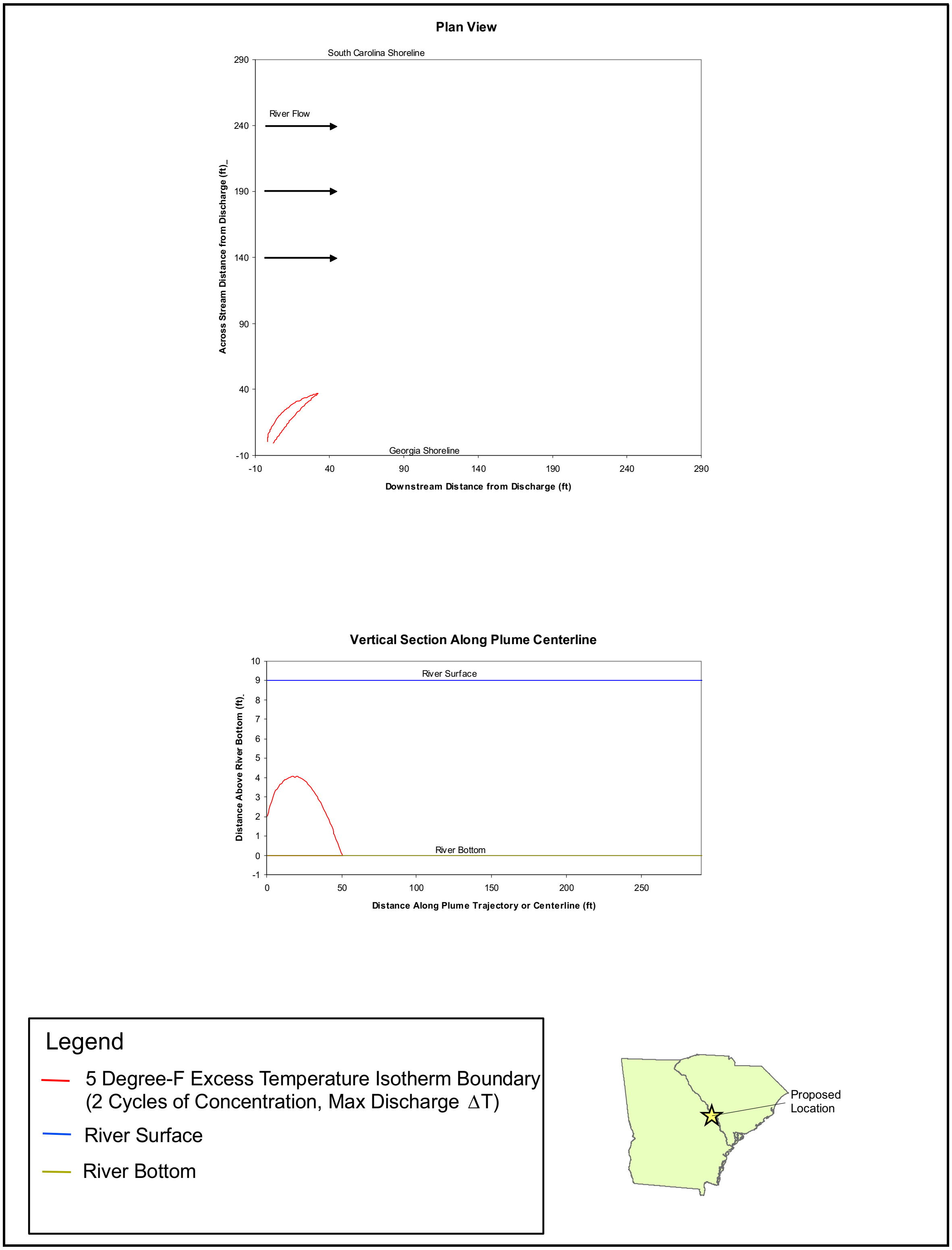

Figure 5.2-2 Mixing Zone for 2 Cycles of Concentration and Maximum Discharge ΔT

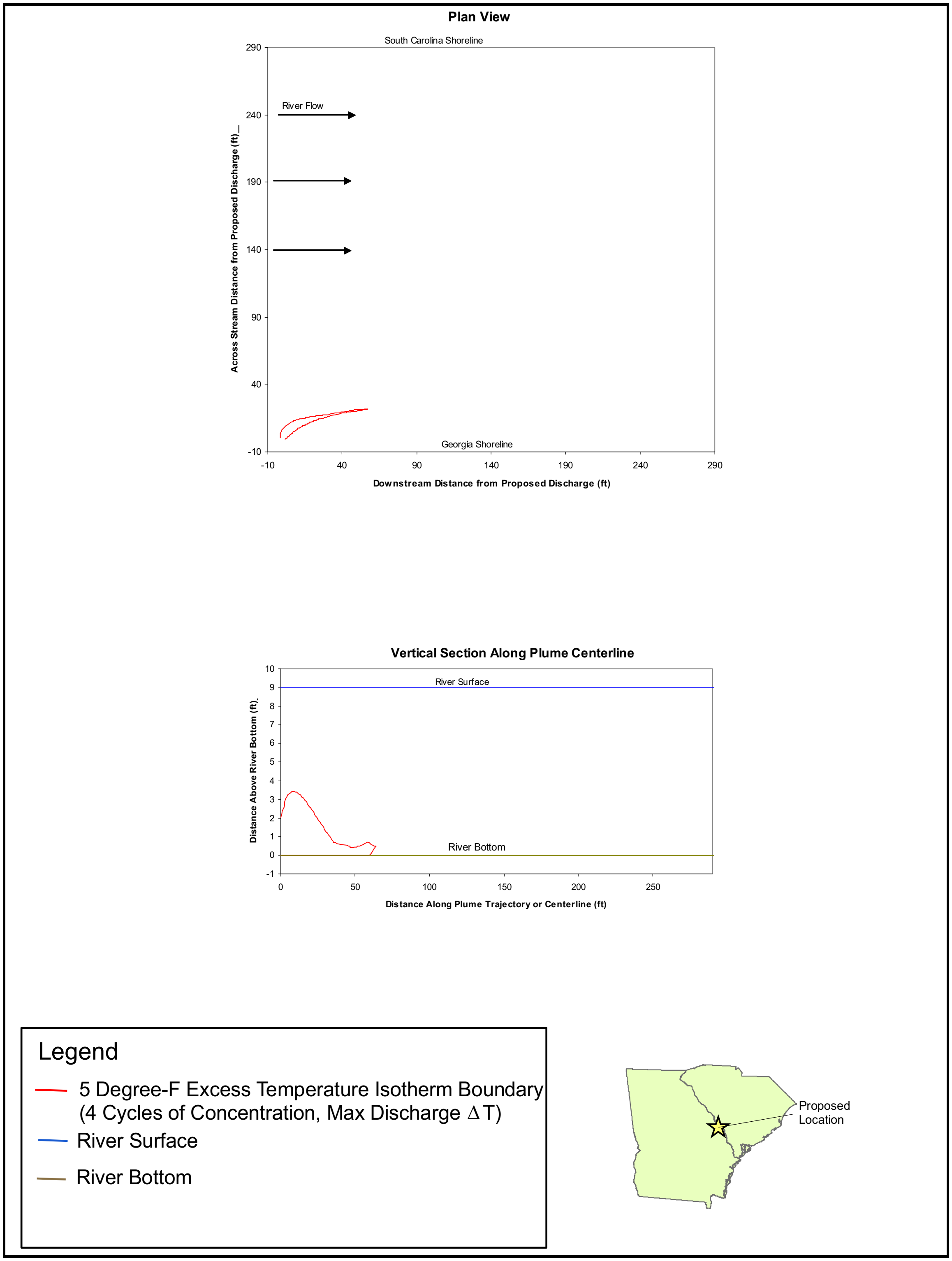

Figure 5.2-3 Mixing Zone for 4 Cycles of Concentration and Maximum Discharge ΔT

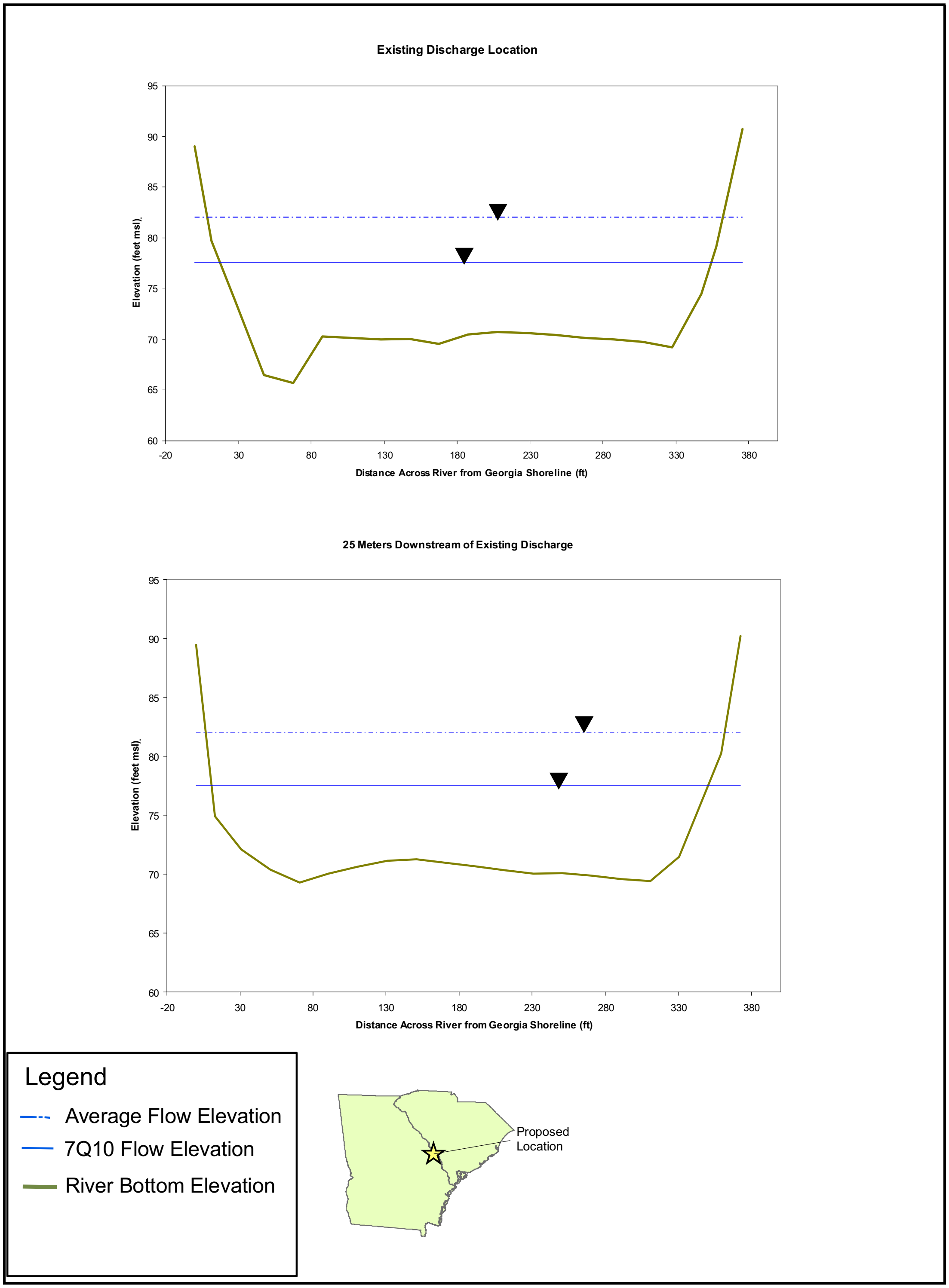

Figure 5.2-4 River Cross Sections at Existing Discharge Location

Section 5.2 References

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(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.

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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 in Chapter 3, 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. As a result, SNC has evaluated the impacts and technical analysis EPA developed in promulgating the Section 316(b) rules and has applied those assessments to the proposed Vogtle cooling system as discussed in the following sections.

5.3.1.2 Aquatic Ecosystems

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." Regulations at 40 CFR 125.94(a)(1)(i) indicate that if a facility's flow is commensurate with a closed-cycle recirculating system, the facility has met the applicable 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). Vogtle participated in the EPA survey to characterize cooling systems in the Steam Electric Generating Plant source category by providing details on the design and operation of the Vogtle cooling water intake structure. The design and operation of the Vogtle cooling water intake structure meets EPA's definition of closed cycle cooling.

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). Actual withdrawal rates are significantly lower. 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 NRC, in the FES for the existing units, noted that modifications had been made to the design of the intake structure that would result in minimal impacts to the biota of the Savannah River from entrainment and impingement **(NRC 1985)**. The new intake structure will incorporate similar design features, including a recessed intake, and a weir system consistent with currently available technology to minimize velocity and ensure a uniform flow in the intake canal.

Importantly, the analysis in the ER is even more conservative because SNC has assumed only a 7Q10 river flow of 3828 cfs. This low flow occurs during the Fall of the year. Variations in river flow would affect the relative impact because present aquatic species, including the drift community, would become, on balance, more diffused. Thus, by focusing on low flow instances, the analysis here bounds the impacts. Additionally, the lower 7Q10 flow occurs during a time of year outside of the spawning period for most species in the Savannah River. This ER relies on the same methodology utilized by the NRC in the 1985 FES but applies a more conservative flow regime, resulting in a more conservative assessment of the impacts.

Accordingly, 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 1985 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, the monthly river flows are higher such that 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 theoretically approach 3.1 percent approximately once per decade. A comprehensive discussion of all aquatic species likely to inhabit this reach of the Savannah River is included in Section 2.4 and the impacts above are generally representative of all of these species. Since most species spawn in the Spring to early Summer, the use of 7Q10 flows overstates the impacts to these species and provides additional conservatism to the evaluation.

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. Consequently, the assumption of uniform drift is reasonably accurate for some species who provide no "parental care", and otherwise completely bounds the potential impact to the drift community of other species. In either event, the assumption is valid for purposes of characterizing the bounded level of potential impact.

While no impingement or entrainment sampling has been conducted specifically in the VEGP intake structure, several studies have been performed just upstream of VEGP at the SRS intake structures. In 1977, McFarlane et al. completed a detailed assessment of the fish communities and ichthyoplankton in the Savannah River, the impacts associated with impingement and entrainment at the SRS intake structures, and the thermal impacts associated with the discharge of cooling water from the SRS reactors. At the time, SRS operated three once-through cooling water intake systems with a combined capacity to pump over 750,000 gpm from the Savannah River with an estimated average though-screen velocity of 1.25 fps. Even at those high volumes and screen velocities, the average impingement rate for the combined SRS intake structures averaged 7.3 fish per day (predominantly shad). Entrainment was highly seasonal, occurring primarily from March until June with approximately 9.1 to 9.5% of the river's susceptible ichthyoplankton entrained at the three intake structures supporting SRS. **(McFarlane et al. 1978)**

In 1982, GPC published its pre-operational biological study of the VEGP site, including the Savannah River. GPC characterized numerous aquatic communities including resident and anadromous fish, larval fish and plankton **(Wiltz 1982)**. From 1983 to 1985, Paller, et al., performed numerous studies characterizing the fish and ichthyoplankton populations on the Savannah River at SRS. These works also focused on impingement and entrainment rates and impacts at the three SRS intake structures. In 1987, the Comprehensive Cooling Water Study described resident fish and ichthyoplankton populations in the Savannah River in the vicinity of the SRS (and VEGP). The study evaluated the impingement and entrainment rates and thermal impacts associated with the three intake and discharge systems at SRS. **(Du Pont 1987)**. It relied heavily on the data of Paller et al., from 12 stations on the Savannah River, including 3 at the VEGP site. Rates of impingement at the 3 SRS structures averaged 18 fish per day in 1984 and 7.7 fish per day in 1985. SRS entrainment rates were calculated at approximately 8.3% and 12.1% of the total susceptible ichthyoplankton entrained in 1984 and 1985, respectively **(Du Point 1987)**. The SRS intakes are long canals with significant in-canal and across-screen velocities operating at once-through flow rates of up to 750,000 gpm. The VEGP intake is an approximately 200 foot long canal with a weir system designed to protect adult and juvenile fish. A simple ratio of flow rates would predict a reduction in potential for impingement to less than one fish per day. All of these studies make it appropriate to rely on the conclusions reached by NRC in its FES. The only revisions to the assumptions makes the current analysis of the proposed units even more conservative.

Thus, based on the facts that (1) the proposed cooling-tower-based heat dissipation system will withdraw small amounts of Savannah River water (28,892 gpm), (2) the design of the new CWIS incorporates a number of features that, according to EPA's detailed technical evaluation, will reduce impingement and entrainment; and, (3) twenty years of operating experience indicating essentially no impingement of fish resulting from operation of the intake screens; and, over 50 years of aquatic community data collected from field studies in the immediate vicinity of the VEGP and SRS intakes suggest that Savannah River fish populations and the general aquatic community 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 down-stream 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 of Georgia Water Quality Standard) and maximum allowable temperature increase (the 5°F State of Georgia Water Quality 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 very 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 5.2.3 (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. The extremely small cross section of the thermal plume limits the exposure of the drift community to elevated temperature and results in only minimal impact. 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 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 maximum 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 normal blowdown flow of 9300 gpm results in an even larger range of dilution factors 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 tower 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)	0.25	0.19
Predominant direction	N, NE, ENE, E	N, NNE. W
Longest plume length (miles)	6.0	6.0
Frequency of longest plume (percent)	3.9	0.5

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	3.6
Feet to maximum deposition	1,600
Direction to maximum deposition	North

The maximum predicted solids deposition from both towers (7.2 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 less than one inch (0.00003 inches) of precipitation per year at 0.4 miles east 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 7.2 pounds/ acre/month. This conservative maximum rate is less than 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 3.9 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 less than one 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 meteorological 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

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