5.0 ENVIRONMENTAL EFFECTS OF STATION OPERATIONS

5.1 Land-Use Impacts

Section 2.2.1 describes the land use on the GGNS site and in the site vicinity. This section describes the potential impacts, of operating a new facility at the GGNS ESP Site, on the land use both within the site boundary and in the vicinity of the site. It is anticipated that operation of a new facility will have minimal impact on land use at the site or in the vicinity of the site.

5.1.1 The Site and Vicinity

Impacts to the site and vicinity due to a proposed new facility would primarily be limited to those experienced during construction, as documented in Section 4.1 of this report. Operation of a new facility is not expected to produce any additional significant impacts to land use on the site nor in the vicinity of the GGNS site.

The land around the existing site is used primarily for forestry, and there are some small pockets of agriculture (Figure 2.2-3). Impacts to land use in these areas around the site would be minimal or non-existent.

There are a number of recreational land use areas within the site vicinity as discussed in Section 2.2. These recreational areas may experience increased visitation due to the operational work force at a new facility. No other impacts to these recreational facilities would be expected.

Vehicular traffic would increase with the estimated 1160 operational workers (Table 3.0-1) for a new facility. This represents an increase of approximately 155% over current staffing at GGNS Unit 1. Figure 2.5-1 shows the roads that service the site vicinity, and the estimated year 2000 average daily vehicular traffic. There are no bridges on major roadways within the immediate site vicinity. The nearest bridges are located on Highway 61 north of Port Gibson, crossing the Little Bayou Pierre and the Bayou Pierre rivers, and crossing the Big Black river. The nearest bridge to the north that crosses the Mississippi River is located at Vicksburg MS. The nearest bridge to the south that crosses the Mississippi River is located at Natchez, MS. The vehicular infrastructure in the vicinity of the GGNS site has routinely handled a fluctuating work force during construction, and during outages at Unit 1. In addition, the State Route 18 extension (Section 2.5.2) from Port Gibson to Grand Gulf Road and the improvements to Highway 61 (Section 4.4.2.3.2), would further alleviate potential traffic problems during commuting times.

Potential impacts to land use from the operation of mechanical or natural draft cooling towers would be related to drift. Generally, drift from cooling towers using fresh water has low salt concentrations. Drifts associated with natural draft design can extend to greater distances relative to that from mechanical draft towers, which falls mostly within the immediate vicinity of the towers (Reference 1). However, in either case, the proposed location of the cooling towers would place them approximately 1000 ft from the nearest site boundary on the north side of the site property. Drift eliminators would be incorporated into the design of the cooling towers to minimize the potential for salt deposition. The bounding estimate of salt deposition from the operation of cooling towers would be approximately 8 lbm/100-acre-month (the detailed analysis of cooling tower drift is presented in Section 5.3.3.1.3). This amount of deposition would not be expected to cause damage to vegetation in the vicinity of the GGNS site. Therefore, no significant impact to land use from cooling tower drift is expected on the site. And, based on proposed cooling tower(s) distance from the site boundary, and the prevailing wind direction, none is expected beyond the site boundaries.

The effects of the cooling tower plumes from a new facility on fogging and icing on and around the GGNS site were evaluated in the ESP Application Part 2, Site Safety Analysis Report (SSAR), Section 2.3, and were determined to be minimal.

5.1.2 Transmission Corridors and Offsite Areas

There will be no new impacts created as a result of operation of a new facility with regards to maintenance of transmission corridors rights-of-way. A new facility would utilize the existing transmission system as discussed in Section 3.7. Therefore, the impacts due to operation of these existing transmission lines, with an added capacity of up to 1311 MWe, would be expected to be the same as those associated with the operation of GGNS Unit 1, and previously evaluated in Reference 2. Additional analysis would be necessary to confirm whether, beyond the addition of 1311 MWe, any supporting T&D system upgrades or changes would be required, and what the associated operational environmental impacts would be. This additional analysis was not pursued at ESP.

5.1.3 Historic Properties

Section 2.5.3 describes the historic resources in the vicinity of the GGNS site. Historic resources would not be impacted during the construction of the facility (Section 4.1.3). Impacts due to construction of the new facility would be expected to bound those due to plant operation; i.e., no additional impacts are expected from operation of the facility.

5.1.4 Noise Impacts

As discussed in Section 3.7, no additional transmission lines are evaluated in support of the possible future additional nuclear units at the GGNS site. A study concluded that the existing T&D system is adequate for at least an additional 1311 MWe of generating capacity, provided that certain modifications were accomplished. These modifications are expected to be equipment upgrades and changes in the GGNS switchyard such that no additional environmental impact would result. In any event, noise generated by transmission lines is dependent on the operating voltage used, and not on the current, or amount of power that the lines carry. Thus, no new noise source would be created along the transmission corridor as a result of the proposed action.

5.1.5 References

1. NRC, 1996, Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG-1437).
2. Mississippi Power and Light Company, Grand Gulf Nuclear Station Units 1 and 2 Final Environmental Report (FER), as amended through Amendment No. 8.

5.2 Water-Related Impacts

5.2.1 Hydrologic Alterations and Plant Water Supply

5.2.1.1 Cooling Water System

Makeup water (cooling tower makeup and other raw water needs) for a new facility would be supplied primarily from the Mississippi River via an embayment, and associated intake structure, located on the east bank of the river and on the north side of the existing barge slip.

The makeup water system would supply raw water for the circulating water system (Normal Plant Heat Sink) and the Ultimate Heat Sink, and possibly the demineralized water system, potable and sanitary water systems, and the fire protection system. Table 3.4-1 provides a breakdown of estimated plant water usage, including maximum and monthly average numbers. Figure 2.3-29 is a plant water use diagram.

A new facility would require a maximum flow rate of 85,000 gpm of water. This is a small amount of water relative to the normal river flow. Using a conversion factor of 0.0022280 to convert from gpm to cfs, the maximum flow rate for a new facility is equivalent to about 189 cfs. Using the most conservative minimum flow value at Vicksburg of 93,800 cfs (Section 2.3.1.1.4), the maximum withdrawal rate for a new facility would be approximately 0.2% of the minimum historical flow. Table 2.3-8 gives the 1-day, 7-day, and 30-day low flows for difference recurrence intervals at Vicksburg (obtained from the U. S. Geological Survey).

Due to the low percentage of the river flow that would be required for plant use, the maximum plant withdrawal would not have any adverse impact on the river hydraulic characteristics. In addition, operation of the intake pumping station would not impact the flow of water across the floodplain.

5.2.1.2 Potable Water System and Dewatering

Potable water for a new facility may be supplied by a groundwater well to the Catahoula formation similar to the existing ground water wells on the site. The monthly average bounding flow for the raw water supply to the potable water/sanitary waste system is expected to be 180 gpm (240 gpm maximum peak usage). The existing GGNS Unit 1 potable water wells are rated at 513, 535, and 577 gpm. As discussed in Section 4.2.1.1, a new well in the Catahoula formation would likely be required to support construction water needs. This same well could then be used to provide the new facility's potable water needs for operation. The additional of one new well with similar production rates as the existing wells would be adequate to meet the maximum expected peak usage of 240 gpm.

Dewatering from the perched water table may be necessary during operation of a new facility to ensure ground water levels don't exceed design specifications. This would cause a local depression in the perched water table. If permanent dewatering wells were required for the new facility, the design would likely be similar to those in use at the existing GGNS Unit 1 plant. The existing dewatering wells pump intermittently, only when the groundwater level exceeds a certain elevation. The withdrawal from the existing dewatering wells, as indicated in annual water use reports, is minimal.

5.2.1.3 Water Returns/Discharges

Effluent from a new facility would be combined with that from the existing GGNS Unit 1 discharge, and discharged into the river at a new location downstream of the embayment to preclude recirculation to the intake pipes. The discharge structure would be constructed to minimize erosion and scouring effects. The design of the discharge structure and the flow characteristics of the receiving water both affect dilution and distribution of the discharge heat and other effluent constituents. Discussion and analysis of the thermal discharge impact is provided in Section 5.3.2.

The bounding return flows for the discharge to the Mississippi River are as shown on Figure 2.3-29 and are listed in PPE Table 3.0-1.

5.2.1.4 Alterations to Local Streams and Lakes

Portions of Stream A and Stream B may be rerouted to accommodate facility structures. Natural drainage patterns would be maintained as much as is practicable. Appropriate permits would be obtained prior to modifications to the streams, as they are considered waters of the United States. These streams have been previously impacted by the construction of the GGNS Unit 1 facility. Additional impacts would not be expected to be significant.

No alterations to Gin Lake would be expected as a result of operation of a new facility.

No significant alterations to Hamilton Lake would be expected as a result of operation of a new facility. Sedimentation Basins A and B would be maintained to continue to minimize the increase in the sedimentation rate to Hamilton Lake. Discharges to Hamilton Lake would be maintained at levels acceptable under future NPDES permit requirements.

Discharges to Stream A and Stream B from a new facility would likely be similar to the existing GGNS facility, and may include increased discharge of treated effluent from the waste water treatment plant, building drains from support buildings, and stormwater. Discharges to these streams would be controlled in accordance with future NPDES permit requirements.

5.2.2 Water-Use Impacts

5.2.2.1 Surface Water

<u>Mississippi River</u>

Operation of the makeup water system for a new facility would have a negligible impact on the use and water supply of the river. A new facility would require only a small amount of water withdrawal relative to the total river flow, even at the lowest minimum river discharge conditions recorded for the area. Normal makeup flow rate to a new facility would be approximately 50,320 gpm, and maximum expected makeup flow would be 85,000 gpm. As discussed in Section 5.2.1, the maximum facility withdrawal would be about 0.2% of the minimum river flow.

Intake and embayment design would include consideration of the amount and rate of sediment deposition and littoral debris carried into the embayment. Current patterns in the immediate vicinity of the embayment may be modified slightly, but the embayment would be designed to minimize the potential for scouring. See Section 5.3 for the assessment of the aquatic environmental impact of operations associated with a new facility's intake system.

Periodic dredging of the embayment would be necessary during plant operation. Disposal of dredge spoils would be performed in a manner acceptable to the Corps of Engineers and the Mississippi DEQ. A temporary increase in turbidity would occur in the Mississippi River during dredging operations, but dredging operations would not affect long-term water quality.

This area of the Mississippi River is not used for recreational purposes. Commercial fishing is done on the Mississippi River, Big Black River and Bayou Pierre. Due to the proposed location and the small area of the river that would be affected by the proposed new facility, the intake structure is not expected to impact recreational or commercial fishing operations or otherwise restrict navigation on the Mississippi River.

The nearest downstream user of Mississippi River water is Southeast Wood Fiber located at the Claiborne County Port facility, approximately 0.8 miles downstream of the Grand Gulf site, and about 2 miles downstream of the existing barge slip. The maximum intake requirement for the Port Claiborne facility is estimated to be less than 0.9 million gallons/day (mgd), for industrial purposes. None of this intake is used as potable water. Therefore, no significant impacts are anticipated as a result of discharges from the new facility on the Southeast Wood Fiber facility.

The makeup water intake structure and the embayment are located away from the main channel of the Mississippi River, on the eastern shore. Operation of the embayment and intake would not impair normal river traffic; therefore, the embayment and intake structure would not have an impact on navigational uses of the river.

There are only three public water supply systems in the state of Mississippi that use surface water as a potable water source, and none of these are located within 50 miles of the GGNS site. There are no downstream intakes within 100 miles of the GGNS site that use the Mississippi River as a potable water supply. Therefore, the operation of the new facility would have no impact on potable water supplies in the region surrounding the GGNS site.

<u>Local Streams</u>

Discharges to Stream A and Stream B from a new facility would be in accordance with future NPDES permit requirements, so the impacts would not be significant.

<u>Local Lakes</u>

Water quality of Gin Lake would be largely unaffected by plant operation due to its location to the north and west of the plant operation areas. Stream A and Stream B have no active connection to Gin Lake, so any changes in water quality of these streams should not impact Gin Lake.

Although Stream A and Stream B feed in to Hamilton Lake, water quality of Hamilton Lake would be largely unaffected by plant operation. The sedimentation basins would continue to prevent runoff of increased sediments to the lake. Continued NPDES monitoring would ensure that water discharged by a new facility meets future applicable water quality standards.

No impacts to recreational fishing in Gin and Hamilton Lakes would be expected due to operation of a new facility on the site.

5.2.2.2 Ground Water

Dewatering may be necessary during operation of a new facility at a location to ensure ground water levels don’t exceed design specifications.

Three groundwater wells completed in the Catahoula Formation are currently used to supply water for general site purposes including potable and sanitary water systems, air conditioning, and landscape maintenance. Two wells are used on a routine basis and the third well is used as a backup. A fourth well was plugged due to silting problems. These wells are located on the western boundary of the proposed new facility power block construction area, and pre-treatment sampling is conducted on a routine basis. Recent water quality sample data for these wells is included in Table 2.3-34. This data indicates that water quality in the Catahoula aquifer had not changed significantly since the initial sampling was conducted in 1972. The use of one additional well at a rate of 180 gpm (240 gpm maximum peak usage) for facility operation should not have a significant impact on groundwater quality. In addition, for reasons discussed below, the additional well to support a new facility is not likely to adversely impact site groundwater levels or availability of ground water to offsite water users in the area.

No new wells in the alluvial aquifer at the river are proposed for operation of the new facility, so no impacts would be anticipated on the alluvial aquifer.

Aside from GGNS, the primary use of ground water in Claiborne County is for public supply purposes with a small percentage used for domestic water, irrigation, and livestock. Within a two-mile radius of the site, essentially all ground water is used for domestic purposes. Therefore, aside from plant use, future ground water demands in the vicinity of the site may be estimated on the basis of projected population growth.

According to the population projections in Section 2.5, the population within a two-mile radius of the site is projected to be 58 people by the year 2070. Based on published USGS sources, users of self-supplied water systems typically use 45 gpd. If the entire projected population utilizes groundwater as a source, the estimated groundwater withdrawal within a two-mile radius of the site by the year 2070 would be 2,610 gpd. This offsite withdrawal rate would not likely be large enough to impact groundwater use at the GGNS ESP Site, and the anticipated ground water use by the new facility would also not be large enough to impact offsite users. There are no groundwater users down-gradient (west) of the proposed location of a new facility, so no impacts to down-gradient users are anticipated.

The ground water levels in the site area were slightly modified as a result of the effects of radial collector well field pumpage, construction dewatering (temporary), topographic modifications, relocation of surface drainage systems, and structure installation for the existing GGNS facility. North and south of the plant area, the regional ground water level occurs at an elevation of about 75 feet, based on contours of average water levels measured between 1984 and 1990. Groundwater levels beneath the existing GGNS structures have historically been at elevations higher than the surrounding regional levels and averaged 100 feet in elevation between 1984 and 1990 (Reference 4). Groundwater levels have been higher as a result of a rise in the top of the Catahoula formation and from previous leakage from the cooling tower basin. There has been no significant lowering of the groundwater table around the plant structures during operation of GGNS Unit 1, so no significant lowering is expected from operation of a new facility. Overall, the proposed groundwater use due to the addition of one additional well, is not expected to have adverse impact on site groundwater capacity or to offsite ground water users in the area. Nor is projected use of groundwater offsite expected to have impact on the expected site use of groundwater (including consideration of GGNS Unit 1 needs combined with a new facility's needs).

Plant service water for the existing GGNS Unit 1 plant is supplied from radial collector wells located in the floodplain that parallels the Mississippi River. The collector wells are designed to derive water from the Mississippi River via induced infiltration (Reference 2). The final location for the embayment and intake structure would be chosen such that there would be inconsequential interference, if any, with the pumping ability of the surrounding existing GGNS Unit 1 radial wells. The location of the south radial well field (only the south well field is used), and the existing radial wells locations are shown on Figure 2.3-20. GGNS Unit 1 radial well no. 5 is located about 250 ft. to the south of the existing barge slip, and has one lateral line which extends directly beneath the barge slip inlet area. This lateral line is located at a depth of about (-) 40 ft. msl, which is well below the depth of excavation that would be required for the river intake (estimated at about 10 ft. msl). A proposed well no. 6 would be located about 1000 ft.

north of the existing barge slip area, well outside of the area proposed for the embayment and intake structure (refer to the Site Safety Analysis Report, Part 2, Figure 2.4-40, of this application for the approximate location for well no. 6). Operation of the makeup water system for the new facility would have no impact on the water supply of the river; therefore, production of the radial wells would not be impacted by the new facility.

5.2.3 Water Use/Water Quality Regulations

The Corps of Engineers and the State of Mississippi do not currently restrict the quantity of water that can be withdrawn from the Mississippi River. The Mississippi Department of Environmental Quality (MDEQ) issues permits for surface water withdrawals that are effective for 10 years. The permit may then be renewed for an additional 10 years.

GGNS will be required to obtain a permit from the MDEQ for installation of any additional groundwater wells that may be necessary for operation of the new facility. An Annual Water Use Survey must also be submitted to the MDEQ. Construction standards for water supply wells will be in accordance with applicable standards published in MDEQ groundwater use and protection regulations, and necessary permits will be obtained from MDEQ. Current regulations state that the MDEQ permit board may deny a permit or reduce the allowable withdrawal rate if such use would interfere with existing permitted uses, or is in conflict with the public interest. Surface water and ground water use and permitting requirements are addressed in the MDEQ Office of Land and Water Resources, Surface Water and Ground Water Use and Protection Regulations adopted in June, 1988 and amended through December, 1994.

Dewatering may be necessary during operation of a new facility to ensure ground water levels don’t exceed design specifications. Construction standards for any required temporary and/or permanent dewatering wells will be in accordance with applicable standards published in MDEQ groundwater use and protection regulations, and necessary permits will be obtained from MDEQ.

Water quality sampling for potable water wells must be conducted in accordance with Mississippi State Department of Health (MSDH), Water Supply Division requirements. The MSDH is responsible for assuring that public water supplies meet federal and Mississippi Safe Drinking Water Law requirements.

Federal financially assisted projects that have the potential to contaminate a designated sole source aquifer are subject to EPA review. Federal financial assistance is defined as any financial benefits provided directly as aid to a project by a department, agency or instrumentality of the federal government in any form, including contracts, grants, and loan guarantee (Reference 3). The U.S. Department of Energy (DOE) is participating with U.S. power generating companies to conduct a regulatory demonstration project for Early Site Permit (ESP) applications to the Nuclear Regulatory Commission (NRC) in accordance with 10 CFR Part 52. The Secretary of Energy unveiled the Nuclear Power 2010 initiative aimed at building new nuclear power plants in the United States before the end of the decade. The President's National Energy Policy calls for the expansion of nuclear energy as part of the nation's energy policy as part of the means to achieve energy security in America while finding clean, affordable alternatives to carbon emitting power plants. Implementation of the Nuclear Power 2010 regulatory demonstration activities is an important first step toward achieving expanded use of nuclear energy. DOE has been working with the nuclear industry in an effort to identify the issues and barriers affecting future near-term deployment of new nuclear power plants. DOE has chosen a two-phase government/industry cost-shared project to demonstrate the ESP licensing process. Entergy is participating in this government/industry cost-shared project (DOE

Agreement Number DE-FC07-02ID14413) and is, therefore, receiving federal funds in support of this ESP application process.

The U. S. Department of Agriculture Rural Development Office (Mississippi Office) would initially screen the project and then would refer the matter to the EPA Sole Source Aquifer Program (Reference 3). During operation of a new facility, appropriate measures would be taken to prevent introduction of contaminants into the Sole Source Aquifer.

GGNS is currently required to conduct surface water sampling and flow measurements in accordance with the site water pollution control permit to ensure that discharges do not exceed the water quality standards stipulated in the permits. It is anticipated that the new facility will also be required to meet these or similar water quality standards.

The State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Water adopted November 16, 1995 will dictate the maximum temperature rise allowed in the Mississippi River from plant discharges. The regulations also give other minimum water quality criteria that must be met by plant discharges. Discharges from operation of a new facility will meet the state water quality standards. See Section 5.3.2 for discussion of thermal discharges and the associated impacts.

There are no local or tribal agencies that have published water quality or water use regulations that would impact GGNS.

5.2.4 References

1. Mississippi Power and Light Company, Grand Gulf Nuclear Station Units 1 and 2 Final Environmental Report (FER), as amended through Amendment No. 8.
2. Mississippi Department of Environmental Quality, Office of Land and Water Resources, Surface Water Withdrawal Permit Information provided by Cliff Hornbeak, July 2002.
3. U.S. Environmental Protection Agency, Region 4, and U.S.D.A. Rural Development, Mississippi State Office, “Sole Source Aquifer Memorandum of Understanding,” 1998.
4. Bechtel Corp., Grand Gulf Nuclear Station, Ground Water Assessment, Engineering Report GGNS-92-0026, Rev. 0.
5. Grand Gulf Nuclear Station Updated Final Safety Analysis Report (UFSAR).

5.3 Cooling System Impacts

This section describes potential impacts from the operation of the cooling system of a new power plant at GGNS.

The predominant water use at a new facility is associated with removal of waste heat from the electrical power generation process via the normal plant heat sink (NHS). Other plant needs add to the total plant water use requirements for the new facility (Figure 2.3-29). For a new facility at the GGNS ESP Site, the bounding flow for makeup water intake from the Mississippi River is estimated at a maximum average of 50,320 gpm (gallons per minute), with a maximum peak flow of 85,000 gpm. An intake flow of 85,000 gpm is about 0.2% of the river flow at GGNS at extreme low flow conditions (Section 4.2.2).

In closed-cycle systems such as the NHS, the cooling water is recirculated through the condenser or heat exchanger(s) after the waste heat is removed by dissipation to the atmosphere usually by circulating the water through cooling towers. Because the predominant cooling mechanism associated with closed-cycle systems is evaporation, some of the water used for cooling evaporates and is required to be replenished through makeup from the river. Some of the makeup to the cooling system is returned to the water source in the form of blowdown, which is used to help control water quality in the cooling system.

5.3.1 Intake System

Makeup water for a new facility would be withdrawn directly from the Mississippi River. Although the specific design details have not been finalized for an intake, it is anticipated that an intake structure and embayment would be constructed on the river shore, at or near the existing GGNS barge slip location (Figures 2.2-1 and 5.3-1). The intake would consist of "screened" makeup water intake suction pipes supplying the makeup water pumps. Sections 3.3 and 3.4 provide a discussion of the proposed intake and the raw water usage requirements for a new facility.

5.3.1.1 Hydrodynamic Descriptions and Physical Impacts

5.3.1.1.1 Physical and Operational Impacts of The Intake

The proposed raw water makeup system from the river would be composed of three main parts: river intake screens and makeup water suction pipelines from the embayment; a dry pit pumphouse structure; and piping routed from the pumphouse structure to the plant site along the heavy haul road. The system would be required to deliver a maximum flow rate to the plant of approximately 85,000 gpm, based on the requirements given in Table 3.0-1 and Figure 2.3-29.

The embayment would be located on the east bank of the Mississippi River near the existing GGNS barge slip. Dredging would be required to form the embayment; and rip-rap, or other appropriate means, would be used to stabilize the banks of the embayment and the river shoreline around the embayment. The final embayment design and configuration would be based on actual river conditions and location. The proposed embayment configuration and layout shown in Figures 5.3-1 and 5.3-2 are based on a similar river water intake on the Mississippi River at the River Bend Station (RBS) in St. Francisville, LA (Reference 6, RBS USAR, Section 2.4.11).

The embayment would be configured to minimize the amount and rate of sediment deposition and littoral debris carried into the embayment. The base of each intake screen would be at an elevation that would give sufficient separation between the screens and the embayment dredged bottom, such that dredging due to sedimentation would not be required frequently (e.g., not more frequent than once per year).

Screens would be located at the entrance to each suction pipe to minimize the uptake of aquatic biota and river debris. The intake screens would be sized so that the through-screen velocity is less than 0.5 fps, as required by the Federal Register 40 CFR Parts 9, 122, et al., "Regulations Addressing Cooling Water Intake Structures for New Facilities". A similar screen design is currently being used for the River Bend Station intake and should provide an effective means of minimizing aquatic organism mortality from impingement and entrainment (Reference 11).

Entrance to a pumphouse structure would be located at or above the Mississippi River Project Design Flood level to protect the equipment and allow access in high water conditions. The pumphouse structure will house the pumps, motors and supporting system components as well as supporting equipment and components needed for operation and maintenance of the water intake system. Figure 5.3-2 shows an elevation view of the proposed intake, suction pipelines and intake screens. The intake pumps discharge pipelines extending from the pumphouse structure would carry the makeup water to the plant site along the heavy haul road. Piping would be buried beneath a soil cover for protection from physical damage and freezing.

The makeup water intake structure and the embayment would be located away from the main channel of the Mississippi River. The intake structure would be located so as to not impair normal river traffic. A barge slip located within the embayment would be used for delivery of plant equipment during plant construction.

The new facility will require a small amount of water withdrawal relative to normal river flow; makeup flow requirements are estimated at approximately 85,000 gpm which is less than 0.2% of river flow at extreme low flow conditions - approximately 129,000cfs (57.9 million gpm) per Reference 7.

5.3.1.1.2 Maintenance of Intake Structure and Components

Final design of the embayment, based on good engineering practice and requirements, would minimize the amount and rate of sediment deposition and littoral debris carried into the embayment. Periodic dredging of the intake embayment may be necessary, depending on final design configuration. Disposal of dredge spoils from embayment construction and spoils from periodic dredging, if required, would be performed in a manner acceptable to the U.S. Army Corps of Engineers and the MDEQ, and would be in accordance with provisions in permits required for the activity. A temporary increase in turbidity would occur in the Mississippi River near the site during dredging activities, but it is expected that dredging operations would not affect long-term water quality. The base of each intake screen would be at an elevation that would give sufficient separation from the embayment dredged bottom such that dredging due to sedimentation would not be required more than once per year.

5.3.1.2 Aquatic Ecosystems

The U.S. Nuclear Regulatory Commission (USNRC) published an extensive study of the impacts of operating nuclear plants (Reference 1). In considering the effects of the intake structure for closed-cycle cooling systems on aquatic ecology, the authors evaluated (1) impingement (or trapping) of fish and shellfish on the intake structure screens, (2) entrainment, or drawing into the cooling water stream, of fish and shellfish early life stages, and (3) entrainment of phytoplankton and zooplankton. Studies of intake effects of closed-cycle cooling systems have generally judged all of these impacts to be insignificant (References 1, 2, and 3).

5.3.1.2.1 Fish Impingement and Entrainment

Cooling towers are mitigative measures to reduce entrainment and impingement losses of fish, primarily because of the relatively small volumes of makeup water needed for the evaporative loss of water from the cooling towers (Reference 4). However, even low rates of entrainment and impingement may be a concern when an unusually important resource is affected. Such aquatic resources considered important would include threatened, endangered, and other species of special interest, critical habitat, or anadromous fish that are undergoing restoration.

Based on reviews of literature and operational monitoring reports, it was concluded that the relatively small volume of water withdrawn from the Mississippi River for a new facility at GGNS would have minimal impact on the resident population of fish. The proposed intake structure is based on a design currently in use at the River Bend facility in Louisiana. As with the intake structure at the River Bend facility, the intake velocity at the screens would be 0.5 fps or lower, which meets the current requirements of Section 316(b) of the Clean Water Act. In the Final Environmental Statement (Reference 11) for the River Bend Station it was concluded that impingement of organisms on the intake screens is not likely to be a problem because of low intake velocities (Section 5.3.1.1). Therefore, a similar conclusion could be made for an intake of similar design for a new facility at the GGNS site.

The location of the proposed intake structure, in an embayment, means it will not block fish movement past the site, and it is not located in an important biological area.

None of the resource agencies contacted in connection with the preparation of this report commented on the occurrence of any critical aquatic or terrestrial habitat on or near the GGNS site (Section 2.4). And, there are no wildlife sanctuaries, refuges, or preserves in the immediate area. Accordingly, there is little potential that operation of the makeup and cooling system such as that proposed for a new facility at the GGNS ESP Site would impact any such areas.

The agencies contacted, however, noted the possible occurrence of eight aquatic species of special interest on or near the GGNS site (Table 2.4-2). These eight species could potentially occur there now.

There are no confirmed reports of the gulf sturgeon (one of the eight identified species of interest) from the mainstream of the Mississippi River. As an anadromous species, this sturgeon only returns to freshwater streams to breed. Accordingly, it is, at best, a seasonal migrant or transient in the Mississippi River at GGNS. Like the pallid sturgeon, lamprey, and paddlefish, any adult fish that swim into the embayment at GGNS would likely be prevented from entering the cooling system by screens placed on the intake pipelines.

Of the remaining seven species of interest identified, the bayou darter is endemic to Mississippi but occurs exclusively in the Bayou Pierre river, south of the site, and its larger tributaries. It does not occur at the GGNS site (Section 2.4.2.2). Similarly, the blue sucker, black buffalo, and crystal darter have not been found on the GGNS site. Suitable habitat is lacking there, although the black buffalo may inhabit the Mississippi River adjacent to the site where other species of buffalo fish are caught commercially. As for the others discussed above, intake screens will would minimize the impingement and entrainment of adult fish.

A study of larval fish in the river at the GGNS site in 1972-73 (Reference 7) did not result in the collection of any species of special interest, as identified in Section 2.4.2.2. In general, numbers of fish larvae were low. The amount of water that would be withdrawn from the river, about 0.2% at extreme low flow conditions, and the low flow velocities at the intake screens in the embayment, would result in a minimal impact on the numbers of fish larvae in the GGNS site area. Fish larvae are at the mercy of river currents, thus the majority of the larvae in the river channel would likely be carried past the intake embayment.

There are no wildlife sanctuaries, refuges, or preserves in the immediate area of the GGNS site. Accordingly, there is little potential that operation of the cooling system intake for a new facility at the GGNS ESP Site will impact any such areas.

5.3.2 Discharge System

5.3.2.1 Thermal Description and Physical Impacts

The effluent discharge from the new facility would be directly into the Mississippi River, and would be located downstream of the intake embayment to avoid recirculation of effluents into the river water intake. For this ESP evaluation, it was assumed that the effluent outfall would be located approximately 500 to 600 ft downstream of the intake screens, and at approximately 30 ft above the low water reference plane established by the U. S. Army Corps of Engineers at el. 37.5 ft msl (Figure 2.3-21). A study done for the River Bend Station river intake design showed that for a similar intake configuration the discharge location at the above distance from the intake would be out of the influence zone of the vortex formed in the embayment (Reference 6). Final design would determine details of the exact location of the discharge point and its elevation relative to river level. For this evaluation, the above assumptions are considered adequate and bounding to determine impact from the expected maximum thermal discharge from a new facility.

The mathematical modeling tool CORMIX (Cornell Mixing Zone Expert System – Jirka, Donerker and Hinton, 1996) is a computer code for the analysis, prediction, and design of aqueous toxic or conventional pollutant discharges into diverse water bodies. It is an EPA recommended analysis tool for the permitting of industrial, municipal, thermal, and other point source discharges to receiving waters. The CORMIX 3 system, which is used for prediction of buoyant surfaces discharges, was used exclusively for this analysis. A comparison of actual thermal discharges at Point Beach Nuclear Power Plant and Palisades Nuclear Power Plant with the predicted values from CORMIX 3 showed that the CORMIX predictions provided adequate agreement with both the geometry of the flow and the surface temperatures (Reference 10).

Dilution and distribution of the discharge heat as well as other effluent constituents are affected by both the design of the discharge structure and the flow characteristics of the receiving water. Table 3.0-1 and Figure 2.3-29 show the projected average discharge parameters and the maximum expected discharge rates for a new facility. In order to closely match the outflow when discharge is above the river level, a shoreline diffuser is assumed at the termination of the discharge piping to provide a uniform ribbon flow of effluent into the river above the shoreline. This outfall type produces a surface thermal plume which is attached to the shoreline, thus allowing the majority of the heat transfer to take place at the bottom and the river channel side of the plume. This creates a physically larger plume, which is conservative with regards to impact to the river biota. Figure 5.3-3 shows CORMIX 3 dilution factors along the surface plume centerline as a function of distance from the outfall. As can be seen, the discharge plume is diluted rapidly within a relatively short distance from the outfall. Thermal plumes were also evaluated using a flush 36" discharge pipe, with the top of the pipe located at water surface level and below. The thermal plumes were found to be smaller in extent in the river using this configuration, thus verifying the conservatism (produces larger plumes) of the diffused surface discharge.

An analysis of thermal plumes resulting from plant effluent discharges was done for conditions of summer mean, summer mean low, summer extreme, summer extreme low, winter mean, winter mean low, winter extreme and winter extreme low (see Figures 5.3-4 through 5.3-11). For this evaluation, it was assumed that the effluent from the existing GGNS Unit 1 discharge is combined with that of a new facility into a common discharge. The effluent flow rate was assumed constant at approximately 52,900 gpm (3.3 m^3/s). This flow represents the total of the maximum expected cooling tower blowdown, plus other miscellaneous effluents, from the new facility of about 41,700 gpm (Figure 2.3-29), plus the normal cooling tower blowdown flow for the existing GGNS Unit 1 plant of about 11,200 gpm (Reference 9). For the annual average river flow case, river water and ambient wet bulb temperatures for the month of June were used to determine the plume characteristics since the average river flow for the month of June is most representative of the annual average river flow (Reference 7).

Summaries of the predicted plume analysis data are provided in Table 5.3-2. For the maximum delta-T condition, winter extreme, mean flow, the surface area within a 5°F (2.8°C) temperature isotherm is estimated to be 16,424 sq ft (1526 sq m). On the water surface, these isotherms extend approximately 614 ft (187 m) downstream from the outfall. The maximum width of the 5°F (2.8°C) isotherm is about 54 ft (16 m) which is about 2 percent of the width of the river, which is approximately 3,000 ft at the average river flow condition (Reference 7), hence the formation of a thermal barrier is precluded. The bending force exerted by the ambient crossflow causes the discharge plume trajectory to curve around and run parallel to the river flow. This effect is pronounced and results in the plume extending offshore only a few feet from the discharge point.

The combined maximum blowdown flow rate of approximately 52,900 gpm (3.3 m^3/s) for the site is less than 0.10 percent of the extreme minimum flow for the Mississippi River near the site given as 57.9 Mgpm (3653m^3/s) per Reference 7. Under winter extreme operating conditions, the greatest temperature difference (delta-T) of 66°F (37°C) exists between the river water at 34°F (1.1°C) (Reference 7) and the effluent discharge, which is conservatively assumed to be at a temperature of 100°F for this analysis. Actual mixed effluent discharge temperatures would be lower than 100°F, and have been provided as indicated in Table 5.3-1.

The predicted thermal plume resulting from the proposed discharge system was modeled for the combined discharge using the CORMIX. Thermal predictions for the worst-case winter conditions assumed plant discharge conditions as above, and an ambient river flow velocity of 6.2 fps (1.9m/s). Results of this model show a thermal plume attached to the near shore and extending far downstream (Figure 5.3-8). Dimensions of the predicted plume are provided in Table 5.3-2.

5.3.2.2 Aquatic Ecosystems

The potential effects of the discharge of heated water would be effectively minimized by the use of a closed loop cooling system with cooling towers. The majority of the waste heat is discharged to the atmosphere and not the Mississippi River. Some limited thermal effects may be associated with the discharge of heated water to the river. Based on the analysis above, the thermal plume would have the greatest potential of causing minor impacts to the river bank habitat at and downstream of the barge slip. This area of the river bank has been stabilized with concrete mats and riprap.

As stated above, the effluent would flow from a shoreline diffuser at the discharge location, into the river. The proposed diffuser would be a concrete structure extending above the river water line at normal river levels. This section of the river bank is protected from erosion by riprap above the normal water level and concrete mat revetments below the water. Thus, the river bank is protected from any potential scouring caused by the effluent flow.

The authors of NRC studies evaluated the potential impacts of the discharge of heated water to an aquatic system including: (1) thermal discharge effects; (2) cold shock; (3) effects on movement and distribution of aquatic biota; (4) premature emergence of aquatic insects; (5) stimulation of nuisance organisms; (6) losses from predation; (7) parasitism and disease; (8) gas supersaturation of low dissolved oxygen in the discharge; and (9) accumulation of contaminants in sediments or biota. In general, for plants employing cooling tower systems, the impacts were found to be minor (References 1 and 3).

As described in Section 5.3.2.1, the thermal plume, measured at the 5 °F isotherm, is relatively small in relation to the width of the Mississippi River at the GGNS site. The FER (Reference 7) states that fish populations residing in the river bank habitat near the barge slip outlet are not expected to be adversely affected by the discharge plume. This FER analysis was done assuming discharge from two units (only one of which was actually completely constructed and is operating). The combined thermal plume from the existing GGNS Unit 1 and a new facility, while slightly larger in some cases than that described in the FER, would be expected to cause a similar minor impact; that is, it is anticipated that fish and other resident aquatic populations along the river bank would experience little impact to normal trophic or population dynamics.

In the winter, some fish may be attracted by the elevated temperatures of the plume with some species possibly residing in the plume for extended periods. This, in turn could result in accelerated spawning times, possibly leading to increased larval mortality from asynchrony with food source development or cold shock of migrant larvae. These impacts are expected to be minimal, having a negligible effect on total river populations because of the relatively small size of the plume.

An impact could potentially occur to drifting benthos, plankton, and larval fish passing through the thermal plume at the site during the winter. The longest transit time through the plume would be in the area along the river bank. This type of an impact was discussed in the GGNS FER (Reference 7) for two reactor units operating at GGNS, and was found to be negligible. The thermal plume from a new facility, combined with that of the existing GGNS unit, would be larger than that evaluated in the FER, and the resulting degree of impact may be slightly greater; however, no negative effects on the population dynamics of these organisms in the river would be expected.

Thermal discharges from a new facility would be discharged to the Mississippi River and not to any wetlands in the floodplain. Therefore, no impacts to wetlands or the bottomland floodplain would be expected. During the flood season, the discharge structure and the entire floodplain would be below the river level. The amount of water and swift current would minimize the time for mixing of the effluent with the river water, thus minimizing any potential impacts.

5.3.3 Heat-Discharge System

Operation of a new facility at the Grand Gulf site will influence the local climatology. A discussion of the expected extent of this influence is presented in this section. The Normal Plant Heat Sink (NHS) that will be used to dissipate heat from the turbine cycle for the new facility will utilize cooling towers to dissipate the heat directly to the atmosphere. The discussion in this section is aimed at an evaluation of cooling tower plume effects.

5.3.3.1 Heat Dissipation to the Atmosphere

Cooling systems which depend on evaporation of water for a major portion of the heat dissipation can be expected to create visible vapor plumes. These vapor plumes cause shadowing of nearby lands, salt deposition, and can increase the potential for fogging or icing.

Two different options for cooling towers, for the NHS, were evaluated for the new facility. One of the NHS cooling tower options considered in the evaluation consists of four natural draft cooling towers (NDCTs). The other option considered in the evaluation utilizes four 20-cell linear mechanical draft cooling towers (LMDCTs). In both cases, the total heat rejected to the atmosphere is as defined in Table 3.0-1. The heat load used is a bounding value from the Plant Parameters Envelope (PPE) and is the primary source of conservatism in the study. Reasonable estimates were made for cooling tower dimensions, layout, and airflow rates, since final design of the facility is not known. Typical drift rates for cooling towers of these types, and average Mississippi River water dissolved solids and salt concentrations were used to support deposition calculations. See Figure 2.3-1 for the planned general location of the cooling towers for the new facility.

In addition to the NHS, a service water system (SWS) and/or an Ultimate Heat Sink (UHS) may be included in the design for the new facility, and each may have an associated cooling tower. The SWS heat load dissipated during normal plant operation is included in the NHS heat load utilized in the analysis. The heat dissipated by the SWS cooling tower during plant shutdown/cooldown would be orders of magnitude less than the heat dissipated by the NHS cooling towers, and the heat dissipated by the NHS cooling towers would decrease as the plant shuts down and would be zero when the plant is shutdown; therefore, the environmental impact that would be associated with SWS system cooling tower operating in conjunction with the NHS cooling tower, or alone, is bounded by the NHS cooling tower analysis. The UHS would not typically operate during normal plant operation; it would typically be operated during plant shutdown/cooldown conditions or accident conditions; i.e., it is not additive to the environmental impact of the NHS cooling towers. Like the SWS system, the heat dissipated by the UHS cooling tower would be orders of magnitude less than the heat dissipated by the NHS cooling towers. Therefore, the environmental impact that would be associated with the UHS system cooling tower operating in conjunction with the NHS cooling tower, or alone, is bounded by the NHS cooling tower analysis.

The original GGNS site analysis relied on simple conservative equations to bound the impact of the originally proposed two-unit, two natural draft cooling tower configuration (Reference 7). The second unit at GGNS was never completed, and the second natural draft cooling tower was never constructed. Subsequent to initial licensing of GGNS, an auxiliary mechanical draft cooling tower was added to supplement the original natural draft cooling tower for GGNS Unit 1. During evaluation of the addition of the auxiliary cooling tower in 2001 (Reference 9), it was determined that significant improvements in plume modeling had occurred since initial GGNS plant licensing. The NRC has identified several plume-related codes as acceptable methodologies. A model endorsed by NUREG-1555, Environmental Standard Review Plan (Reference 12), was Carhart and Policastro (Reference 13). In NUREG-1555, the NRC accepted Carhart and Policastro's conclusion that their code predicts the plume rise within a factor of 2 about 75% of the time and visible plume length within a factor of 2.5 about 70% of the time. This model was embedded into EPRI's Seasonal/Annual Cooling Tower Impact Prediction Code (SACTI) in 1991, and later modified in accordance with References 14 and 15. The current version of the SACTI program was used to develop the model for the auxiliary cooling tower added for GGNS Unit 1. Likewise, an evaluation of potential plumes from the addition of a new power production facility with cooling towers at the Grand Gulf site, and the potential cooling tower plume impacts was performed (Reference 16) using the SACTI plume modeling code (Reference 17). In some cases, the results of the evaluation are compared to the evaluation performed for the existing GGNS facility in the following discussions to provide a frame of reference.

As discussed earlier, the heat dissipation system for the NHS for the new facility will use either natural draft cooling towers (NDCTs) or linear mechanical draft cooling towers (LMDCTs). The height of the discharge for the NDCTs is anticipated to be between 475 feet above grade (cooling tower vendor preliminary estimate per Reference 16) and 550 feet above grade (PPE bounding value per Table 3.0-1) depending on the final design. A height of 550 feet is bounding from a physical structure perspective, however, based on a sensitivity analysis (Reference 16), a cooling tower with a height of 475 feet produced slightly more bounding environmental impacts for the NDCT. Therefore, a NDCT height of 475 feet was used in the model for conservatism. The bounding height of the discharge of the LMDCTs fans is anticipated to be approximately 60 feet above grade (PPE bounding value per Table 3.0-1 and cooling tower vendor preliminary estimate) and this value was used in the evaluation for the LMDCTs.

The mixing height data for the model was taken from Table 2.7-61 (data in table from Reference 18). This table contains average mixing heights for the morning and afternoon by month at the Jackson Airport, which as discussed in Reference 9, is appropriate for use at the GGNS site.

In order to determine the potential impact of solid deposition due to the cooling tower plumes, the concentrations of salts and dissolved solids in the NHS circulating water must be input into the plume model. The source of circulating water makeup for the NHS is the Mississippi River. Table 3.0-1 indicates that the cycles of concentration for the NHS circulating water is expected to be a maximum of 4, which will result in the concentrations in the circulating water being 4 times that of river water. Mississippi River water salt and dissolved solids concentrations used in the model are based on an average of the available data for the years 1983 through 1999 (latest available) from Reference 19. The river water concentrations and the equivalent NHS 4-cycle concentrations are as follows:

Parameter	River Water	4 Cycle Concentration
Dissolved Solids	234 mg/l	936 mg/l
Sodium Salt	18 mg/l	72 mg/l
Iron Salt	0.038 mg/l	0.15 mg/l

Four years of meteorological data from 1997 through 2000 for the Grand Gulf site and from Vicksburg, MS was used in the model.

Other inputs used in the analysis were (from Reference 16):

Parameter	NDCTs	LMDCTs
Number of Towers	4	4
Circulating Water Flow Rate	432,500 gpm per tower	432,500 gpm per tower
Drift Rate	22 gpm per tower	22 gpm per tower
Exit Air Flow	10,840 kg/sec per tower	10,840 kg/s per tower
Heat Rejection Rate	5.35 x 10^9 Btu/hr per tower	5.35 x 10^9 Btu/hr per tower
Tower Top Diameter	225 feet	31'-8" (each cell)
Number of Cells	N/A	20 per tower

Reference 16 gives specific information on assumptions and how the input data was utilized in the generation of the plume model.

5.3.3.1.1 Length and Frequency of Elevated Plumes

Table 5.3-3 describes the expected plume lengths by season and direction for the NDCT option. Each of the four individual NDCTs have less heat rejection than the existing operating GGNS Unit 1 NDCT, but the four plumes merge and carry farther than for an individual tower. The longest average plume lengths are predicted to occur during the winter months and the shortest are predicted to occur during the summer months. The model predicts a combined average length of approximately 2.32 miles in winter (Table 5.3-3). This can be compared to the approximate 0.9 mile average winter plume calculated for the combined operation of the existing GGNS single natural draft cooling tower and 20 cell mechanical draft auxiliary cooling tower modeled with the same SACTI plume modeling code (Table 2.3-164a of Reference 9), and to the originally modeled combined operation of a two-unit GGNS cooling tower plume length of approximately 3.4 miles in January (Table 2.3-164 of Reference 9). The shorter plumes predicted by the SACTI plume modeling code for a new facility compared to the original GGNS licensing prediction for two-unit two cooling tower operation (i.e., 2.32 miles versus 3.4 miles) is mainly attributable to more accurate modeling by the SACTI code.

Table 5.3-4 presents the plume lengths by season and direction for the LMDCT option. These lengths are typically shorter, but the plumes would be closer to the ground which increases salt deposition and the possibility of fogging. The combined average length in winter, from Table 5.3-4, for the LMDCT configuration is approximately 1.36 miles, which is bounded by the NDCT results.

Table 5.3-5 compares the plume lengths and direction by frequency for both the NDCT and LMDCT options.

5.3.3.1.2 Frequency and Extent of Ground Level Fogging and Icing In the Site Vicinity

*Studies conducted by Broehl (*Reference 20*), Zeller (*Reference 21*), and Hosler (*Reference 22*) indicate that surface fogging from natural draft towers does not present a significant problem. Broehl and Zeller found no cases of cooling tower plumes reaching the ground, while Hosler noted only one in a two year study at the Keystone Power Plant, near Shelcota, in western Pennsylvania.*

The plume study performed for the new facility on the GGNS ESP Site (Reference 16), showed no fogging would occur for the NDCTs option and, therefore, no resulting increase in icing would occur due to the operation of NDCTs.

The discharge of a LMDCT is closer to the ground than a NDCT (approximately 60 ft above grade for a LMDCT versus approximately 475 to 550 ft for a NDCT) and more susceptible to causing fogging, and, therefore, icing. Computer modeling of the LMDCTs (Reference 16), predicts very little fogging occurring (approximately 14 hours/yr) as a result of its operation (Table 5.3-6). Experience at other facilities using similar LMDCT configurations indicates that fogging does occur periodically even though computer modeling had predicted little or no fogging. However, the increased fogging at these facilities has been shown to be confined predominantly within close proximity of the towers with no adverse impact. (Reference 36) The SACTI model predicts that the majority of the fogging due to the operation of the LMDCTs will be confined to within about ½ mile (800 m) to the south to southeast of the towers with occasional fogging (approximately 2hrs/yr) up to about ¾ mile (1200 m) to the south to southeast of the towers (this area is entirely within the property boundary of the site). Therefore, it is predicted that the operation of the LMDCTs will result in limited increased fogging at the site; however, it is not anticipated to have any adverse operational or environmental impact at the site. Any impact should only be aesthetic in nature.

Icing, which is associated with fogging, can result during periods of sub-freezing temperatures. Icing can result in an adverse impact on plant operation if its duration is of sufficient length to cause significant accumulation of ice on plant components, for example on transmission lines. Since the LMDCTs would be located approximately ½ mile (800 m) or more north of the new and the existing facilities' power blocks and electrical transmission facilities (i.e., switchyard), and since fogging beyond this distance is predicted to be rare, no adverse impact on the plants' operation is anticipated even if icing were to occur. Temperature measurements at nearby Vicksburg recorded only 228.5 hours per year of less than 33°F (averaged for the years 1997 through 2000). The occurrence of icing conditions even in the vicinity of the LMDCTs is expected to be rare since the water deposition rate is small and prolonged periods with below-freezing temperatures are infrequent. Because any icing would be confined within the site property boundary, no adverse impact on surrounding public lands or roadways would occur.

5.3.3.1.3 Solids Deposition (i.e., Drift Deposition) in the Site Vicinity

The towers will use drift eliminators to minimize the amount of water lost from the towers via drift. Some droplets are, nevertheless, swept out of the tops of the cooling towers in the moving air stream. This drift essentially has the same concentrations of dissolved and suspended solids as the water in the cooling tower basin. The concentrations in the circulating water system are expected to be limited to 4 cycles of concentration of that present in Mississippi River Water. This is considered bounding and conservative, since some type of filtration or clarification of makeup water is anticipated (Section 3.3).

The drift droplets containing dissolved salt and particulates are swept out of the tops of the cooling towers. Initially, these droplets rise in the plume's updraft, but due to their high settling velocity, they eventually break away from the plume, and then evaporate, settle downward, and are dispersed by atmospheric turbulence.

The dispersion and deposition of the drift from cooling towers are influenced by the following factors:

- a. *Factors associated with the design and operation of the cooling tower*
  1. *Volume of water circulating in the tower per unit time (circulating water flow rate)*
  2. *Salt or particulates concentrations in the water*
  3. *Drift rate*
  4. *Mass size distribution of drift droplets*
  5. *Plume rise influenced by tower diameter, height and mass flux*
- b. *Factors related to atmospheric conditions*
  1. *Humidity*
  2. *Wind speed*
  3. *Wind direction*
  4. *Temperature*
  5. *Pasquill's stability class*

NUREG-1555 (Reference 12) Section 5.3.3.2, Terrestrial Ecosystems, provides the following guidance on analyzing operational impacts from salt drift:

- Deposition of salt drift (NaCl) at rates of 1 to 2 kg/ha/mo [89.2 to 178.4 lbm/100-acre-mo] is generally not damaging to plants.
- Deposition rates approaching or exceeding 10 kg/ha/mo [892 lbm/100-acre-mo] in any month during the growing season could cause leaf damage in many species.
- Deposition rates of hundreds or thousands of kg/ha/yr could cause damage sufficient to suggest the need for changes of tower-basin salinities or a re-evaluation of tower design, depending on the amount of land impacted and the uniqueness of the terrestrial ecosystems expected to be exposed to drift deposition.

The maximum predicted deposition rates are: 3.589 lbm/100-acre-month (4.02×10^{-2} kg/ha/mon or 4.02×10^{-3} g/m^2/mon) for total dissolved solids (TDS); 0.277 lbm/100-acre-month (3.10×10^{-3} kg/ha/mon or 3.10×10^{-4} g/m^2/mon) for sodium salt; and 5.4×10^{-4} lbm/100-acre-month (6.05×10^{-6} kg/ha/mon or 6.05×10^{-7} g/m^2/mon) for iron salt. These deposition rates are predicted to occur at approximately 1900 meters north of the NDCTs (Reference 16). Table 5.3-7 presents sodium salt deposition predictions for the NDCTs. Due to the high initial plumes of the NDCTs, no solids are deposited within 1800 meters of the center of the NDCTs.

The LMDCTs are lower to the ground than the NDCTs, therefore, solid deposition occurs closer to the tower. The maximum predicted deposition rates are: 104.2 lbm/100-acre-month (1.17 kg/ha/mon or 1.17×10^{-1} g/m^2/mon) for total dissolved solids (TDS); 8.01 lbm/100-acre-month (8.98×10^{-2} kg/ha/mon or 8.98×10^{-3} g/m^2/mon) for sodium salt, and 1.7×10^{-2} lbm/100-acre-month (1.91×10^{-4} kg/ha/mon or 1.91×10^{-5} g/m^2/mon) for iron salt. These deposition rates are predicted to occur at approximately 600 meters south of the LMDCTs (Reference 16). Table 5.3-8 presents sodium salt deposition predictions for the LMDCTs.

Estimates of the bounding salt and particulate ground level concentrations and deposition at the nearest homes and gardens in the vicinity of the new facility (Figure 2.3-1) are given in Table 5.3-9. The nearest garden is 0.46 mile (740 meters) and the nearest home is 0.31 mile (499 meters) from the proposed cooling tower location.

For the existing GGNS facility: *The salt and particulate ground level concentrations and deposition calculations were made at the nearest homes and gardens in the vicinity of the site. The results of these estimations are given in Table 5.1.23* of Reference 7*. The maximum predicted total dissolved solids (TDS), sodium salt, and iron salt are 4.7 x 10^{-2}, 2.4 x 10^{-3}, and 4.2 x 10^{-4} g/m^2-month, respectively.*

The Mississippi Air Pollution Control Regulations (APC-S-1, Section 3) specify that emissions or particulate fallout shall not exceed background levels by 5.25 g/m^2-month [4.68 x 10^3 lbm/100-acre-month]*, if such fallout occurs on property other than that from which the fallout originates.*

For the existing GGNS facility: …*the deposition of total dissolved solids and salts within a 5 km radius of the cooling towers is significantly less than the standard of 5.25 g/m^2-month. Based on the results…, it is apparent that the surrounding vegetation should not be affected.*

For a new facility, the deposition rates for the LMDCTs bound that of the NDCT. The maximum LMDCT sodium salt deposition rate of 8.01 lbm/100-acre-month (8.98 x 10^{-2} kg/ha/mon or 8.98 x 10^{-3} g/m^2/mon) is below the NUREG-1555 (Reference 12) Section 5.3.3.2 guidelines of maintaining deposition rates below 1 to 2 kg/ha/mon to prevent damage to vegetation and is well below the 10 kg/ha/mon deposition rate that could cause leaf damage to some species of plants during the growing season. As seen in Table 5.3-9, the maximum sodium salt deposit rate on a nearby residence or garden is 3.57 lbm/100-acre-month (4.00 x10^{-2} kg/ha/mon or 4.00 x 10^{-3} g/m^2/mon) which is well below the threshold of 1 to 2 kg/ha/mon for no damage to vegetation. Additionally, the bounding values for total dissolved solids (TDS), sodium salt and iron salt are well below the 5.25 g/m^2/mon guidelines used in the GGNS FER (Reference 7) Section 5.1.4.5.3.

For the existing GGNS facility, a Cooling Tower Drift Program was established as part of the Environmental Protection Plan (Reference 24 Section 4.2.2) to ascertain the impact of cooling tower drift on the surrounding areas. Seven sampling sites were utilized to measure cooling tower drift deposition. At least two of the sampling sites had duplicate sampling devices. Six of the seven sites were located in areas where maximum salt deposition was predicted. These areas were extrapolated from the Bechtel Salt Deposition Model developed for the GGNS Final Environmental Report (Reference 7). The seventh sampling site was a control site located south of Raymond, Mississippi. An eighth offsite control site was added in 1985 in Port Gibson, Mississippi. Fallout samples were collected on a quarterly basis and analyzed for ten specific constituents. The details of the sampling procedure and chemical analysis were submitted to the NRC's Environmental Engineering Branch for review and approval prior to GGNS Unit 1 operation above 5% power. An evaluation of the results of the Cooling Tower Drift Program indicated that the operation of the GGNS Unit 1 cooling tower produced no statistically significant effect upon the salt deposition rate for those chemical species evaluated. The cooling tower drift program was, therefore, terminated via Amendment 96 to the GGNS Facility Operating License (FOL) (Reference 25).

The evaluation performed for the NHS cooling towers for a new facility indicates that the solids deposition from the cooling towers is consistent with that predicted for the two-unit GGNS facility. The maximum TDS, sodium salt and iron salt deposition rates on homes or gardens for the GGNS site were predicted to be 4.7 x 10^{-2} g/m^2-month, 2.4 x 10^{-3} g/m^2-month and 4.2 x 10^{-4}

g/m^2-month respectively (Reference 7, Table 5.1.23), as compared to 5.21 x 10^{-2} g/m^2-month, 4.0 x 10^{-3} g/m^2-month, and 8.29 x 10^{-6} g/m^2-month respectively for a new facility (Table 5.3-9). Therefore, it is concluded that the impact of the operation of the NHS cooling towers for a new facility is comparable to the two-unit GGNS facility and the evaluations and testing performed for the two-unit GGNS facility would also apply to the new proposed facility.

Based on the results of the evaluation performed for this application, the guidance provided in NUREG-1555 (Reference 12), and the results of the Cooling Tower Drift Program performed for the existing GGNS facility (Reference 24), no adverse impact on the surrounding vegetation from salt deposition due to the operation of the NHS cooling towers for the new facility is anticipated.

5.3.3.1.4 Cloud Formation, Cloud Shadowing, and Additional Precipitation

The potential for cloud development and plume shadowing due to the operation of cooling towers exists. Natural-draft cooling tower plumes at several power plant sites have been observed to cause broken cloud decks to become overcast, make thin clouds thicker, and create separate cloud formations several thousand feet above ground (Reference 26). Although the plumes from natural draft cooling towers at several power plants have been observed to increase cloud cover several thousand feet above the ground, mechanical draft cooling towers are not known to produce such effects (Reference 11).

*Light drizzle and snow occasionally have been noted within a few hundred meters downwind from cooling towers (*Reference 27)*, but these phenomena are very localized and should have no effect outside the site boundary. Huff compared the flux of water vapor and air from natural draft cooling towers with those occurring in natural convective showers. His results indicate that some enhancement of small rain showers might be expected, as tower fluxes are within an order of magnitude of the shower fluxes. Large thunderstorms, with their much greater flux values, should not be significantly affected, except that formation may occur somewhat earlier in the day than would otherwise be expected, with the cooling tower plume possibly acting as a triggering mechanism.*

One of the potential environmental impacts resulting from the discharge of cooling tower moisture is the regional augmentation of natural precipitation. Estimates of the total contribution to surface precipitation from cooling towers, based on a 2,200-MWe station, would be only 0.4 inches annually (Reference 28). The analysis for a new facility (Reference 16) indicates that there would be maximum of only 0.04 in./year (83,915 lbm/100 acre-month) contribution to surface precipitation from operation of the LMDCTs (the impact of the LMDCT bounds that of the NDCT). This amount is inconsequential compared to the total annual rainfall (44.845 in.) experienced in this region (Table 2.7-6). Induced snowfall due to operating cooling towers has been observed. However, the accumulation was found to be less than 1 in of very light, fluffy snow. Other documented induced-snowfall occurrences generally preceded actual snowfall occurrences. An investigation into the climatic conditions conducive to induced snowfall indicated that a very cold, stable atmosphere with light winds optimized this situation (Reference 29). This type of meteorological condition occurs infrequently at the GGNS site; therefore, there is no reason to expect that a new facility's cooling towers would significantly alter local meteorology.

5.3.3.1.5 Interaction of Vapor Plume With Existing Pollutant Sources Located Within 1.25 Miles (2 km) of the Site

The existing NDCT for GGNS Unit 1 is located about 4000 ft (1200 m) to the south of the planned location for the NHS cooling towers for the new facility. The interaction between the plumes from the existing GGNS NDCT and that for a new facility's NHS cooling tower(s) is expected to be insignificant since usually the plumes will travel in parallel, non-intersecting directions. There are no other pollutant sources located within 1.25 miles (2 km) of the site.

5.3.3.1.6 Ground Level Humidity Increase in the Site Vicinity

In the vicinity of the vapor plumes, both the absolute and relative humidity aloft is increased as evidenced by calculated frequency of visible plume occurrence. Absolute humidity at the surface is increased only slightly. However, relative humidity near the towers may be increased during the colder months due to relatively low moisture-bearing capacities of cold air.

Ground level humidity resulting from the operation of cooling towers has not been reported.

5.3.3.2 Terrestrial Ecosystems

This section describes the potential impacts that the operation of the NHS cooling tower(s) of a new facility have on the terrestrial ecology in the vicinity of the GGNS site.

Cooling tower "drift" refers to the potential exposure of vegetation near nuclear power plants to salts, icing, or other effects (e.g., fogging and increased humidity) caused by operation of cooling towers. Refer to Section 5.3.3.1 for detailed discussions of the potential for these effects from a new facility and its cooling tower(s).

The potential impacts of cooling tower operation on native vegetation are similar to those for agricultural crops, including salt-induced leaf damage, growth and seed yield reduction, and ice-induced damage. In addition, native vegetation may suffer changes in community structure (Reference 5) in response to ice damage or differences in species tolerances to drift. Increased fogging and relative humidity near cooling towers have little potential to affect native vegetation, and no such impacts have been reported.

Monitoring results from a sample of nuclear plants, in conjunction with the literature review and information provided by the natural resource agency and agricultural agencies in all states with nuclear power plants, have revealed no instances where cooling tower operation has resulted in measurable degradation of the health of natural plant communities (Reference 1).

Cumulative impacts on natural plant communities are not a consideration because of the distance between the GGNS Unit 1 cooling tower and the proposed location of the cooling tower(s) for the new facility. Prevailing winds, for the most part, would preclude mixing of the plumes from the tower locations. There are no other facilities that have large cooling towers in the vicinity of the GGNS site.

Additionally, there are no chemical plants located within 5 miles of the GGNS site. Therefore, chemical interaction with existing pollutant sources need not be considered.

5.3.4 Impacts to Members of the Public

5.3.4.1 Thermophilic Organisms

The operation of the cooling towers for a new facility would lead to significant thermal discharges to the atmosphere and thermal discharges to the Mississippi River that could result in the increase of thermophilic microorganisms within the cooling towers themselves, and within aquatic and soil environments in the vicinity of the GGNS site. Thermophilic microorganisms identified in association with elevated temperatures in and around the cooling tower and discharge flume include: *Salmonella* sp., *Pseudomonas aeruginosa, Legionella* sp., free-living amoebae of the genera *Naegleria, Acanthamoeba*, and *N. fowleri,* and thermophilic fungi. Excessive exposure to these microorganisms can cause serious illness and, on rare occasions, death in humans.

Potential adverse health effects to the public resulting from increased thermophilic microbial populations is an issue for nuclear plants utilizing cooling ponds, lakes, or canals and those that discharge to "small rivers." Small rivers (as defined by NUREG-1437, Reference 1) are those with an average flow rate less than 100,000 cubic ft per second (cfs). This is approximately equal to the extreme low flow value of 99,400 cfs recorded for the Mississippi River in water-year 1940 (Table 2.3-7). From 1973 through 1999, river flow ranged from a low of 176,000 cfs to 1,930,000 cfs (Table 2.3-3), resulting in an average flow over this period of about 730,000 cfs. Both GGNS Unit 1 and a new facility would be discharging thermal effluents into a "large river." A review of the Centers for Disease Control documents from 1991 through 2000 indicates no outbreaks of waterborne diseases in Mississippi or Louisiana associated with the Mississippi River (References 30 through 34).

As discussed in Section 2.3, the nearest downstream user of Mississippi River water is Southeast Wood Fiber located at the Claiborne County Port facility, approximately 0.8 miles downstream of the Grand Gulf site property, and about 2 miles from the current barge slip location. The maximum intake requirement for this facility is estimated to be less than 0.9 million MGD for industrial purposes; but none of this intake is used as potable water. There are only three public water supply systems in the state of Mississippi that use surface water as a source, and none of these are located within 50 miles of the GGNS site. There are no downstream intakes within 100 miles of the GGNS site that use the Mississippi River as a potable water supply.

Therefore, the risk to public health from thermophilic microorganisms resulting from thermal discharges to the Mississippi River at the GGNS site would be minimal.

Potential adverse health effects on workers due to enhancement of microorganism populations are an issue for steam-electric plants that use cooling towers (Reference 1). Several reported cases of fatal *Naegleria* infections in association with cooling towers, have lead to extensive study of free-living amoebae in power plant environments. In response to these cases, several electric utilities require workers to utilize respiratory protection when cleaning cooling towers and condensers, and in the case of GGNS Unit 1, biocides are utilized to help reduce the levels of harmful microbial populations. Although no Occupational Safety and Health Administration (OSHA) standard presently exists for the exposure to microorganisms, a new facility would employ proven industrial hygiene principles to reduce worker exposure to the adverse impacts associated with microorganisms. There have been no reportable cases of legionnaires disease or any other diseases associated with the operation cooling towers at GGNS Unit 1 in the past 10 years (Reference 35). Potential impacts to workers at a new facility due to the operation of cooling towers would be expected to be minimal.

The operation of a new facility on the ESP Site would comply with all relevant OSHA regulations. Worker safety precautions, monitoring, and testing for microbial infections would be instituted, as required.

5.3.4.2 Noise Impacts

Two types of cooling systems will be considered for a new facility at the GGNS ESP Site: natural draft cooling towers and mechanical draft cooling towers. Natural and mechanical draft cooling towers emit broadband noise; therefore, the noise associated with the cooling towers is largely indistinguishable and non-obtrusive. The anticipated noise levels from either of the cooling tower options are not expected to be significantly greater than background levels. Noise levels below 60 to 65 dB are considered to be insignificant, because these levels are not sufficient to cause hearing loss off site (Reference 1).

Based on the PPE (Table 3.0-1) both natural and mechanical draft cooling towers have anticipated noise levels of 55 dB(A) at 1,000 feet. The proposed location of the cooling towers would place them approximately 1000 ft from the nearest site boundary on the north side of the site property. The resulting operational noise level from the addition of a new unit or units would not significantly increase the noise level at the property line. Therefore, the noise level at the property line is expected to remain below the limit of 65 dB(A) recommended in NUREG-1555. In general, power plant sites do not result in offsite noise level increases of more than 10 dB above background levels. The areas surrounding the GGNS site are rural with low population densities; therefore, background noise levels are expected to range from 45 to 55 dB.

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5.4 Radiological Impacts of Normal Operation

This section identifies the environmental pathways by which radiation and radiological effluents from a new facility can be transmitted to the living organisms in and around the GGNS site and the associated impacts. The scope of this section encompasses the transport pathways for gaseous and liquid radiological effluents to individual receptors as well as to biota, and includes an assessment of the operational exposure to living organisms in and around the station from plant effluents, as well as from increased ambient background radiation levels from the plant.

Occupational doses to workers that may be utilized in construction of a new facility on the GGNS ESP site are discussed and presented in Section 4.5. It is expected that the ESP site would be monitored during any new facility construction activities and appropriate actions taken as necessary to ensure that the construction workers are adequately protected and exposure is maintained ALARA.

5.4.1 Exposure Pathways

Radiological exposure due to operation of the new facility is highly dependent on the exposure pathway by which a receptor may become exposed to radiological releases from the facility. The major pathways of concern are those that could result in the highest calculated offsite radiological dose. These pathways are determined from the type and amount of radioactivity released, the environmental transport mechanism, and how the environs surrounding the site are used (e.g., residence, gardens, etc.). For gaseous effluents, the environmental transport mechanism is dependent on the meteorological characteristics of the area. However, the most important factor in evaluating the exposure pathway is the use of the environment by the residents in the area around the GGNS site. Factors such as location of homes in the area, use of cattle for milk, and gardens used for vegetable consumption, are considerations when evaluating exposure pathways.

Radioactive gaseous effluent exposure pathways include direct radiation, deposition on plants and soil, and inhalation by animals and humans. Radioactive liquid effluent exposure pathways include fish consumption and direct exposure from radionuclides that may be deposited in Mississippi River. An additional exposure pathway is the direct radiation from the facility during normal operation.

The radiation doses to man resulting from the release of radioactive materials have been evaluated for liquid effluents released into the Mississippi River and gaseous emissions released to the atmosphere. The critical pathways to man for routine releases at this site are radiation exposure from submersion in air, inhalation of contaminated air, drinking milk from a cow that feeds on open pasture near the site, eating vegetables from a garden near the site, and eating fish caught in the Mississippi River. Other less important pathways considered include: external irradiation from radionuclides deposited on the ground surface, eating animals and food crops, river shoreline activities, and direct radiation from the station. The relative importance of the potential pathways to man have been evaluated by calculating the doses from routine operations for each pathway. Calculation assumptions, methodology, results, and conclusions are presented in the following sections.

The description of the exposure pathways and the calculational methods utilized to estimate doses to the maximally exposed individual and to the population surrounding the GGNS site are based on USNRC Regulatory Guides 1.109 and 1.111. The source terms used in estimating exposure pathway doses are based on the values provided in Tables 3.0-7 and 3.0-8.

5.4.1.1 Liquid Pathways

The release of small amounts of radioactive liquid effluents is currently permitted at GGNS, and would be expected to be permitted for the new facility at the GGNS ESP Site, as long as releases comply with the requirements specified in 10 CFR 20. The important exposure pathways include:

- Internal exposure from ingestion of water or contaminated food chain components;
- External exposure from the surface of contaminated water or from shoreline sediment; and,
- External exposure from immersion in contaminated water.

As discussed in Section 2.3, the nearest downstream user of Mississippi River water is Southeast Wood Fiber located at the Claiborne County Port facility, approximately 0.8 mile downstream of the Grand Gulf site property, and about 2 miles from the barge slip location. The maximum intake requirement for this facility is estimated to be less than 0.9 million MGD for industrial purposes; but none of this intake is used as potable water. There are only three public water supply systems in the state of Mississippi that use surface water as a source, and none of these are located within 50 miles of the GGNS site. There are no downstream intakes within 100 miles of the GGNS site that use the Mississippi River as a potable water supply.

The LADTAP II computer program, as described in NUREG/CR-4013, and the liquid pathway parameters presented in Table 5.4-1 and Table 5.4-2 were used to calculate the maximally exposed individual dose from this pathway. This program implements the radiological exposure models described in Regulatory Guide 1.109, Revision 1, for radioactivity releases in liquid effluent.

5.4.1.2 Gaseous Pathways

The methodology contained in the GASPAR II program (described in NUREG/CR-4653) was used to determine the gaseous pathway doses. This program implements the radiological exposure models described in Regulatory Guide 1.109, Revision 1, for radioactivity releases in gaseous effluent. The code calculates the radiation exposure to man from:

- External exposure to airborne radioactivity;
- External exposure to deposited activity on the ground;
- Inhalation of airborne activity; and
- Ingestion of contaminated agricultural products.

Table 5.4-3 and Table 5.4-4 present the gaseous pathway parameters used by the code to calculate doses for both the maximally exposed individual and for the general population.

5.4.1.3 Direct Radiation from Station Operation

Radiation fields are produced around nuclear plants as a result of radioactivity within the reactor and its associated components, as well as a result of small amounts from radioactive effluent flow paths.

Radiation exposures at the nearest GGNS site boundary for GGNS Unit 1 and for the ESP Facility would arise from: a) onsite radioactive sources outside plant buildings, b) skyshine due to the presence of N-16 in the plant buildings (GGNS and new facility - if a BWR design), and c) release of gaseous effluents from the plant.

The only GGNS Unit 1 onsite source outside plant buildings that is significant in terms of direct radiation is the condensate water storage tank (CWST). Exposure due to direct radiation from this tank was evaluated in the GGNS Unit 1 licensing process using conservative assumptions and parameters, as documented in the GGNS UFSAR (Reference 4), and were found to be negligible.

Skyshine doses are due to air scattering of the high-energy gammas emitted by decaying N-16 present in reactor steam in the main steam lines, turbines, and moisture separators of BWRs (while operating). These doses were evaluated for GGNS Unit 1 using the program SKYSHINE. Estimated skyshine doses for two locations at the site boundary are given in Reference 4 Table 12.4-9. The dose point distances were measured from the intersection of the turbine-generator axis and the wall between the Unit 1 and Unit 2 turbine buildings. The dose calculated is negligible.

Estimates of skyshine dose rates in the various GGNS Unit 2 construction areas (for the scenario of Unit 1 operating and Unit 2 still under construction) and the total person-rem doses to construction workers are given in Reference 4 Table 12.4-10. The total dose to construction workers given in the table covers a period of two years. Again, the dose calculated is negligible.

Should a BWR be selected as the plant to license and build at the GGNS ESP Site as a result of this ESP application, bounding direct radiation doses could be expected to be similar to those from GGNS Unit 1. As noted above, the estimates of skyshine annual dose from GGNS Unit 1 at the two site boundary locations Reference 4 Table 12.4-9 are negligible (site boundary distances of 2450 ft and 3350 ft). Based on the proposed location of the power block at the new facility, the closest distance to the site boundary would be approximately 841 meters (2760 ft.) (Figure 2.2-1). Therefore, similar to that for GGNS Unit 1, negligible dose from direct radiation could be expected at the site boundary from the operation of a reactor or reactors at a new facility. And considering both the new facility and GGNS Unit 1 dose expectations (both negligible) at the site boundary, the combined dose from both facilities is expected to be negligible.

As noted above this type of radiation is a characteristic of the BWR. Direct radiation from non-BWR technologies would expected to be less that associated with BWR designs and, in any case, negligible with no impact to workers or members of the public.

Radiological impacts to construction workers at the new facility, from the operation of GGNS Unit 1 and from a second reactor at the new facility, are discussed in Section 4.5, and doses to construction workers at the second unit are considered to be negligible.

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

5.4.2 Radiation Doses to Members of the Public

5.4.2.1 Liquid Pathways Doses

GGNS Unit 1 liquid radioactive effluent is mixed with cooling tower blowdown in a discharge basin, and is subsequently discharged into the Mississippi River at the barge slip. As discussed in Sections 3.4.2 and 5.3.2, discharge from the new facility would be combined with the discharge from GGNS Unit 1 before discharging either to the Mississippi River. The expected cooling tower blowdown from the new facility is estimated at about 12,800 gpm from the normal heat sink cooling tower(s). Other discharges may be combined with this, but they are small in comparison and are ignored as a source of dilution. The GGNS UFSAR indicates a cooling tower blowdown flow rate for Unit 1 operation of 11,200 gpm. This combined with that of the new facility results in about 24,000 gpm blowdown flow.

Mixing of the diluted radioactive effluent with the Mississippi River water is analyzed for the mean river level of 54 feet msl, corresponding to a discharge of 560,000 cfs. (Reference 1) The isotopic releases in the liquid effluent are given in Table 3.0-8. The outflow from the combined discharge mixes with the Mississippi River water, resulting in additional dilution of the effluent.

Maximum dose rate estimates to man due to liquid effluent releases were determined in the following ways:

- Eating fish or invertebrates caught near the point of discharge;
- Using the shoreline for activities, such as sunbathing or fishing; and
- Swimming and boating on the Mississippi River near the point of discharge.

The estimates for whole-body and critical organ doses from each of these interactions are presented in Table 5.4-8. These doses are within the limits given in 10 CFR 50, Appendix I and would only occur under conditions that maximize the resultant dose. It is unlikely that any individual would receive doses of the magnitude calculated because of little or no shoreline activities at or near the GGNS site, and very limited swimming (if any) in the river downstream of the site.

Estimated occupational dose to workers involved in construction of a new facility is provided in Section 4.5.

5.4.2.2 Gaseous Pathways Doses

Dose rate estimates were calculated for hypothetical individuals of various ages exposed to gaseous radioactive effluents through the following pathways:

- Direct radiation from immersion in the gaseous effluent cloud and from particulates deposited on the ground;
- Inhalation of gases and particulates;
- Ingestion of milk contaminated through the grass-cow-milk pathway; and
- Ingestion of foods contaminated by gases and particulates.

Table 5.4-11A provides the estimated whole-body and critical organ doses for the identified gaseous effluent pathways. These doses are within the 10 CFR 50, Appendix I criteria and would only occur under conditions that maximize the resultant dose.

Estimated occupational dose to workers involved in construction of a new facility are provided in Section 4.5.

5.4.3 Impacts to Members of the Public

5.4.3.1 Impacts From Liquid Pathway

Release of radioactive materials in liquid effluents to the discharge, from where they mix with the Mississippi River water, results in minimal radiological exposure to individuals and the general public. Since irrigation has not been found necessary or observed in the area around the Grand Gulf site (average rainfall for Vicksburg 50 inches), this pathway has not been considered in the evaluation of doses. Likewise, the dose due to drinking water has not been considered since there is no downstream user of potable water from the river within 100 miles of the site. Since there is no record of consumption of aquatic vegetation in the area surrounding the GGNS site this pathway is not evaluated. Shoreline use is very limited with essentially no swimming, sunbathing, or fishing from the bank, and consequently is expected to be an insignificant pathway in comparison with the pathway of aquatic foods. Nevertheless, for purposes of conservatism, this pathway has been included in the evaluation of doses for the maximum exposed individual.

Annual radiation exposures to the maximum exposed individual via the pathways of aquatic foods and shoreline deposits, and to the population within a 50-mile radius of the Grand Gulf site via the pathway of aquatic foods are given in Tables 5.4-8 and 5.4-10, respectively. These doses have been evaluated using the models and the values for the required parameters given in NRC Regulatory Guide 1.109. A single dilution factor was conservatively chosen for all points of exposure or harvest of aquatic food. For shore width, the value of 0.2 given in Regulatory Guide 1.109 for river shoreline was chosen. Expected population distribution by sectors and distances in the year 2070, given in Section 2.5, and the commercial aquatic food catch data, provided in Table 5.4-1, were used to evaluate population exposures.

As can be seen from Table 5.4-8, the maximum exposed individual annual doses from the discharge of radioactive materials in liquid effluents from the new facility meets the guidelines of Appendix I to 10 CFR Part 50. Since the guidelines for the maximum individual exposure via hydrospheric pathways are much more restrictive (at least by a factor of 160) than the standards of 10 CFR Part 20, it can be inferred that radioactive releases in liquid effluents from the new facility meet the standards for concentrations of released radioactive materials in water (accessible to a maximum exposed individual of the general public), as specified in Column 2 of Table 2 of 10 CFR Part 20. The maximally exposed individual dose calculated was also compared to 40 CFR 190 criteria (Table 5.4-9).

5.4.3.2 Impacts from the Gaseous Pathway

Release of radioactive materials in gaseous effluents from a new facility to the environment results in minimal radiological impact. Annual radiation exposures to the maximum exposed individual, and the population within a 50-mile radius of the Grand Gulf site, via the pathways of submersion, ground contamination, inhalation and ingestion are given in Tables 5.4-11A and 5.4-13, respectively. These doses have been evaluated using the release data given in Table 3.0-7 and atmospheric dilution and deposition factors (*X*/Q and D/Q) given in Table 2.7-117. For models and values of required parameters, Regulatory Guide 1.109 was used. Annual production rates of milk, meat, and vegetables are given in Tables 5.4-5, 5.4-6, and 5.4-7, respectively. The estimated population distribution in the year 2070 within a 50-mile radius of the Grand Gulf site, given in Section 2.5, were used to evaluate the population exposures. As can be seen from Table 5.4-11B, annual doses to the maximum exposed individual due to release of radioactive materials in gaseous effluents from a new facility meet the guidelines of Appendix I to 10 CFR Part 50. Since the guidelines of Appendix I to 10 CFR Part 50 for maximum individual exposures via atmospheric pathways are much more restrictive (by a factor of ≈100) than the standards of 10 CFR Part 20, it can be inferred that radioactive releases via gaseous effluents from the new facility meet the standards for concentrations of released radioactive materials in air (at the locations of maximum annual dose to an individual and hence, at all locations accessible to the general public), as specified in Column 1 of Table 2 of 10 CFR Part 20. In addition, the maximally exposed individual dose calculated was also compared to 40 CFR 190 criteria (Table 5.4-12).

As stated in Section 5.2.1 of the GGNS FER (Reference 1), the whole body dose to individuals living in the site region from existing radiation sources is expected to average about 130 mrem/yr. Comparison of the calculated doses listed in Table 5.4-11B shows that there is no significant impact to members of the public due to operation of a new facility at the GGNS ESP Site.

5.4.3.3 Direct Radiation Doses from the GGNS ESP Facility

Refer to the discussion in Section 5.4.1.3.

5.4.4 Impacts to Biota Other than Members of the Public

Radiation exposure pathways to biota other than members of the public were examined to determine if the pathways could result in doses to biota greater than those predicted for humans. This assessment uses surrogate species that provide representative information on the various dose pathways potentially affecting broader classes of living organisms. Surrogates are used since important attributes are well defined and are accepted as a method for judging doses to biota. Surrogate biota used includes algae (surrogate for aquatic plants), invertebrates (surrogate for fresh water mollusks and crayfish), fish, muskrat, raccoon, duck, and heron.

This assessment uses dose pathway models adopted from Regulatory Guide 1.109. Pathways included are:

- Ingestion of aquatic foods including fish, invertebrates, and aquatic plants;
- Ingestion of water;
- External exposure by water immersion, or by surface effect;
- External exposure to shoreline residence;
- Inhalation of airborne nuclides;
- External exposure to immersion in gaseous effluent plumes; and
- Surface exposure from deposition of iodine and particulates from gaseous effluents.

Internal exposures to biota from the accumulation of radionuclides from aquatic food pathways are determined using element-dependent bioaccumulation factors. The terrestrial doses are calculated as total body doses resulting from the consumption of aquatic plants, fish, and invertebrates. The terrestrial doses are the result of the amount of food ingested, and the previous uptake of radioisotopes by the “living” food organism. The total body doses are calculated using the bioaccumulation factors corresponding to the “living” food organisms and dose conversion factors for adult man, modified for terrestrial animal body mass and size.

The use of the adult factors is conservative since the full 50-year dose commitment predicted by the adult ingestion factors would not be received by biota due to their shorter life spans. These models show that the largest contributions to biota doses are from liquid effluents via the food pathway.

5.4.4.1 Liquid Effluents

The model used for estimating nuclide concentrations is similar to that used in the analysis for doses to man described in Section 5.4.2. Table 5.4-1 summarizes parameters used in the calculation of nuclide concentrations in the Mississippi River. The calculation of biota doses was performed using LADTAP II (USNRC, 1986). Doses to biota are estimated at the discharge to the Mississippi River.

Food consumption, body mass, and effective body radii used in the dose calculations are shown in Table 5.4-14. Residence times for the surrogate species are shown in Table 5.4-15. Surrogate biota doses from liquid effluents are shown in Table 5.4-16.

5.4.4.2 Gaseous Effluents

Doses from gaseous effluents also contribute to terrestrial total body doses. External doses occur due to immersion in a plume of noble gases, and deposition of radionuclides on the ground. The inhalation of radionuclides followed by the subsequent transfer from the lung to the rest of the body also contributes to total body doses. Inhaled noble gases are poorly absorbed into the blood and do not contribute significantly to the total body dose. The noble gases do contribute to a lung organ dose but do not make a contribution via this path to the total body dose.

Immersion and ground deposition doses are largely independent of organism size and the doses for the maximally exposed individual described in Section 5.4.2 can be applied. The external ground doses described in Section 5.4.2 calculated by GASPAR II are increased to account for the closer proximity to the ground of terrestrials. This approach is similar to the adjustments made for biota exposures to shoreline sediment performed in LADTAP II. The inhalation pathway doses for biota are the internal total body doses calculated by GASPAR II as described in Section 5.4.2 for man. The total body inhalation dose (rather than organ specific doses) is used since the biota doses are assessed on a total body basis.

5.4.4.3 Biota Doses

Doses to biota from liquid and gaseous effluents are shown in Table 5.4-16. Table 5.4-17 compares the biota doses to the criterion given in 40 CFR 190. These dose criteria are applicable to man, and are considered conservative when applied to biota. The criteria in 40 CFR 190 for thyroid and next highest organ doses are not used in this analysis since doses are based on total body doses. The total body dose is taken as the sum of the internal and external dose. In man, the internal dose from individual organs is weighted by factors less than unity to arrive at the whole body dose equivalent. Thus, a unity factor is assumed for the entire internal dose. Table 5.4-17 shows that annual doses to two of the seven surrogates can meet the requirements of 40 CFR 190.

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

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

An international consensus has been developing with respect to permissible dose exposures to biota. The International Atomic Energy Agency (IAEA, 1992) evaluated available evidence including the *Recommendations of the International Commission on Radiological Protection* (ICRP, 1977). The IAEA found that appreciable effects in aquatic populations would not be expected at doses lower than 1 unit of absorbed dose (100 ergs/gm) per day (rad/day) and that limiting the dose to the maximally exposed individual organisms to less than 1 rad/day would provide adequate protection of the population. The IAEA also concluded that chronic dose rates of 0.1 rad/day or less do not appear to cause observable changes in terrestrial animal populations. The assumed lower threshold occurs for terrestrials rather than for aquatic animals primarily because some species of mammals and reptiles are considered more radiosensitive than aquatic organisms. The permissible dose rates are considered screening levels and higher species-specific dose rates could be acceptable with additional study or data.

5.4.5 References

1. Mississippi Power and Light Company, Grand Gulf Nuclear Station Units 1 and 2 Final Environmental Report (FER), as amended through Amendment No. 8.
2. NUREG/CR-4013, LADTAP II - Technical Reference and User Guide, PNL-5270, April 1986.
3. NUREG/CR-4653, GASPAR II - Technical Reference and User Guide, PNL-5907, March 1987.
4. Grand Gulf Nuclear Station Updated Final Safety Analysis Report (UFSAR).
5. USNRC Regulatory Guide 1.109, Rev. 1, 1977, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50 Appendix I.
6. USNRC Regulatory Guide 1.111, Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors, Revision 1, July 1977.
7. 10 CFR 50, Appendix I, Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low As Is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents.
8. 10 CFR 20, Standards for Protection from Radiation.
9. 10 CFR 20.1301, Dose Limits for Individual Members of the Public.
10. 40 CFR 190, Environmental Radiation Protection Standards for Nuclear Power Operations.
11. International Atomic Energy Agency (IAEA), Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards, Report Series No. 332,1992.
12. International Council on Radiation Protection (ICRP), Recommendations of the International Commission on Radiological Protection, ICRP Publication 26, 1977.

5.5 Environmental Impacts of Waste

5.5.1 Non-Radioactive Waste-System Impacts

This section describes the potential environmental impacts of non-radioactive waste systems (i.e. non-radioactive solid, liquid, and gaseous waste effluents) associated with a new facility at the GGNS ESP Site. Information provided within this section was obtained from the review of the GGNS Unit 1 FER (Reference 8), analysis of recent water quality data (Section 2.3), and estimates of possible chemical discharges provided within the PPE (Table 3.0-2). A description of the non-radioactive waste systems is provided in Section 3.6 of this report. Estimates of non-radioactive liquid and gaseous effluents, and solid waste discharges are provided in the PPE Tables 3.0-2, and 3.0-4 through 3.0-6.

5.5.1.1 Non-radioactive Solid Waste

Solid non-radioactive waste may include typical office waste, aluminum cans, glass, metals, paper, etc. Solid waste generated at the site would not be burned, buried, or deposited on site. Therefore, increased solid waste generation would not impact terrestrial ecology, soils, or groundwater at the GGNS site. Solid wastes would be collected on a routine basis by a contracted vendor. Disposal of non-radioactive solid wastes would meet the requirements of any federal, state, or local regulations in effect at the time of facility operation.

Water withdrawn from the Mississippi River may have to be treated before it can be used in a new facility. This treatment may include clarifiers to remove suspended solids. The solids generated from the treatment of the raw river water would either be returned to the river or collected by a contracted vendor and disposed of at an approved landfill. Disposal would comply with the requirements of any Federal, State, or local regulations in effect at the time of facility operation.

5.5.1.2 Non-radioactive Liquid Effluents

Non-radioactive liquid waste from nuclear power plants may include (but are not limited to) cooling tower blowdown, auxiliary boiler blowdown, water treatment waste, floor and equipment drains, storm water runoff, and laboratory waste. A description of potential waste streams from a new facility operation is included in Section 3.6 of this report.

5.5.1.2.1 Liquid Effluents Containing Biocides or Chemicals

Description of the anticipated non-radioactive liquid waste streams and estimates of chemical and biocide discharges are provided in Section 3.6 and PPE Table 3.0-2. Chemical and biocide usage and discharge information was based upon the PPE and upon information compiled for permitting of GGNS Unit 1 (Reference 8). Water quality information for the Mississippi River is discussed in Section 2.3 of this report.

The various liquid waste streams resulting from operation of a new facility would be discharged to the Mississippi River through the discharge outfall as described in Section 3.4.2.2. The dominant component of the discharge is cooling tower blowdown; therefore, estimates of the constituent concentrations within the blowdown can be utilized as an estimation of the chemical concentrations in the liquid discharge from the GGNS site (Table 3.0-2).

The habitat most likely to be impacted by the chemical and biocide discharge is the river bank area at and downstream of the barge slip. Revetments (concrete mats) were installed, along with riprap above the revetment, by the U.S. Army Corp of Engineer (USACE) shoreline modification program to stabilize the river bank. Stabilization of the river bank fronting the

GGNS site was completed in the mid-1970s to the early 1980s. As discussed in the GGNS FER (Reference 8), benthic fauna were historically depauperate from the shoreline and bottom of the river downstream of the discharge. In addition, the area likely to be impacted by operation of a new facility represents a small portion of available shoreline in the region of the station. Therefore, the potential for and extent of further impact to these biological communities over and above the impacts caused by the operation of GGNS Unit 1would be expected to be minimal.

As is the case with GGNS Unit 1, biocide usage at a new facility would be intermittent and limited. The choice of biocides for a new facility has not been made. However, if the biocide is chlorine, as it is with GGNS Unit 1, the low concentrations of chlorine in the effluent would further dissipate or be consumed by the Mississippi River water so that beyond the immediate vicinity of the discharge the effect of the biocide on the environment would be negligible. At GGNS Unit 1, free available chlorine in the main circulating water system is allowed to dissipate prior to discharge; similarly the GGNS Unit 1 service water, when chlorinated, is discharged to the circulating water system to promote dissipation (Reference 8). A similar arrangement could be utilized at a new facility to minimize the amount of free chlorine in the effluent.

Through monitoring of water quality, chemical and biocide use in the operation of a new facility would be reduced as much as possible. The discharge of these chemicals would be minimized through in-plant chemical and/or physical treatment. Chemicals utilized within the current GGNS Unit 1 plant, and thus those utilized at a new facility, may change. Reformulated biocides may contain no chlorine, or reduced chlorine concentrations, while at the same time introducing alternative chemicals that were not considered during the preparation of this document.

Chemicals utilized in general operations and water treatment at the GGNS site are subject to review and approval by the Mississippi Department of Environmental Quality (MDEQ), the agency authorized to administer the NPDES program for the State of Mississippi. Therefore, waste discharges from a new facility at GGNS would be subject to limits established by the MDEQ through the NPDES permitting process. Effluents released to the Mississippi River would comply with local, state, and federal limits, and would be protective of the water quality of the Mississippi River.

In that appropriate Federal, State, and local standards regarding discharges will be met, the use of chemicals and biocides are expected to result in no adverse impacts (i.e., minimal impacts) to river biota. As noted in Section 5.2.2, there are no downstream intakes within 100 miles of the GGNS site that use the Mississippi River as a potable water supply. Given the distance downstream of potential users and compliance with appropriate standards, no impacts to downstream potable water users would be expected from chemical or biocides in the (combined ESP Facility and GGNS Unit 1) discharge to the river.

5.5.1.2.2 Demineralized Water Treatment Wastes

The system to demineralize water prior to its use in the various systems in a new facility would likely consist of activated carbon filters and layered resin bed demineralizers (Section 3.6.1.4). During demineralization, it is anticipated that chemicals such as sulfuric acid and caustic soda would be used to regenerate resins. The typical waste products from this system would be wastewater and spent carbon and resin beds. The waste water would be adjusted to a pH value of between 6 and 9 and released to the Mississippi River through a designated outfall. Spent resin beds would most likely be collected by a contracted vendor and disposed of in an offsite licensed land fill. Thus, potential environmental impacts would be expected to be minimal.

5.5.1.2.3 Sanitary Waste Effluent

A sanitary waste system would be provided for the operations phase of a new facility. A tertiary treatment process would be conducted on site, and the effluent would be tested and discharged to the Mississippi River. The chosen sanitary waste system design would incorporate state of the art sewage treatment and disposal technologies and would comply with an approved NPDES permit. Estimated flow rates and raw water requirements for the potable water/sanitary waste system are provided in the PPE Table 3.0-1.

Effluent discharges are regulated under the provisions of the Clean Water Act and the conditions of discharge for the plant will be specified in the NPDES permit. The pollution discharge limits established for the sanitary waste effluents would be protective of the water quality of the Mississippi River. As discussed above regarding the impact of chemical and biocide discharges, based on the lack of proximity of users downstream and conformance with applicable standards, minimal or no localized effects in the river are expected in the river.

5.5.1.2.4 Floor Drain Systems

Discharges from floor drains would be monitored, treated, and released in accordance with applicable federal, state, and local standards in place at the time of operation of a new facility. The final design of building structures and drainage systems would accommodate oil and other chemical disposal for potential waste streams. The treated effluent would be combined with the cooling tower blowdown and released to the Mississippi River as permitted by the NPDES in place at the time. Restrictions placed on the quality of the effluent by the future NPDES permit requirements would be protective of the river; thus, impacts to the river water quality and to downstream users of river water would be expected to be minimal.

5.5.1.3 Surface Drainage and Roof Drains

During and following precipitation events, water from roof drains would flow overland or via a storm drain system, combining with general site runoff, to either Stream A or Stream B, the two drainage features for the GGNS site. The water would flow through the sediment retention basins, continue down the streams to Hamilton Lake and eventually the Mississippi River. GGNS Unit 1 currently has a Storm Water Pollution Prevention Plan that regulates the discharge of storm water and is designed to be protective of the Mississippi River. This plan would be updated, or a new plan formulated for the operation of a new facility, and would serve to minimize potential impacts from storm water runoff.

5.5.1.4 Gaseous Effluents

Non-radioactive gaseous effluents result primarily from operation of auxiliary boilers and testing and operation of the standby power system. The fuel for the auxiliary boilers and standby power system may be either diesel or natural gas. The constituents of the gaseous effluents from these systems would not be determined until a technology for a new facility is chosen. Refer to Section 3.6.3.1 for more information regarding the sources of gaseous effluents.

Yearly emissions for auxiliary boilers are provided in Table 3.0-4. Yearly emissions from standby diesel generators are provided in Table 3.0-5, and for gas turbines in Table 3.0-6.

Gaseous effluent releases would comply with future federal, state, and local emissions standards that would be protective of the air quality in the region of the GGNS site. Thus, impacts would be minimal.

5.5.1.5 Miscellaneous Non-Radioactive Wastes

5.5.1.5.1 Chemical Wastes

Chemical wastes from laboratories and other sources at a new facility would be collected and disposed of off site at licensed disposal facilities. These wastes would not be released to the environment, thus no impacts would be expected.

5.5.1.5.2 Petroleum Wastes

Waste petroleum products may include fuels, such as gasoline and diesel oil, and lubricating oils and greases. Waste petroleum products would be collected and stored on site in accordance with applicable federal, state, and local regulations in effect when a new facility would be operating. Waste petroleum products would be sent to an offsite licensed facility for recycling or disposal. These wastes would not be released to the environment, thus no impacts would be expected.

5.5.2 Mixed Waste Management and Impacts

In October of 1992, Congress enacted the Federal Facilities Compliance Act (FFCA) which, among other things, added a definition of mixed waste to the Resource Conservation and Recovery Act of 1976 (RCRA). Mixed waste is waste that contains both hazardous waste and source, special nuclear, or byproduct material as defined in the Atomic Energy Act (AEA) of 1954 (42 U.S.C. 2011 et seq.) (Reference 1).

The management of mixed waste at nuclear power plants is jointly regulated by NRC under the AEA, and by the Environmental Protection Agency (EPA) or authorized states under RCRA. Nuclear power plants managing mixed waste must meet the NRC requirements for general radiation protection (10 CFR 20) and emission control requirements and for low level waste (LLW) specified in 10 CFR 61, and EPA's requirements for hazardous waste in 40 CFR Parts 261, 264, and 265 (DOE/RW-0006) before final transfer off site for disposal [assuming off site disposal is an option]. (Reference 2)

This section addresses onsite storage of operational mixed LLW for a new facility. Radiological and nonradiological impacts are addressed. And radiological impacts to members of the public and workers are considered.

5.5.2.1 Mixed Waste Generation, Handling, Storage and Disposal

Mixed waste is not a parameter in the Plant Parameters Envelope, which defines the bounding facility evaluated for this ESP application. Currently there is no source of reliable information regarding the specific types and quantities of mixed waste that could be generated by operating nuclear power facilities. Reference 2 provides some general information regarding commercial generation of mixed wastes, and information from a number of nuclear facilities, which is used in this evaluation to determine potential impacts.

Mixed waste is generated during routine maintenance activities, refueling outages, health physics activities, and radiochemical laboratory activities. Nuclear power plants, in general, are not significant generators of mixed waste. The vast majority of mixed waste that is [currently] stored at nuclear power plants is chlorinated fluorocarbons (CFCs) and waste oil. Other sources include liquid scintillation fluids, other types of organic materials, and metals, including lead and chromium, and aqueous corrosives (References 1 and 2).

Mixed LLW generation is highly variable but projected to be about 5 m^3/year per plant, which is less than 3 percent of the LLW volumes (Reference 2, Section 2.3.7.3). Mixed waste is subject to additional regulatory requirements on containment. For example, RCRA hazardous waste regulations require maintenance of container integrity, berms, and other catchment means for capturing leaks to prevent or minimize releases of hazardous materials to the environment.

Mixed waste is commonly stored on site due to the lack of treatment and disposal sites. However, nuclear power plant operators emphasize to their staffs the need to recognize opportunities to avoid and/or minimize the creation of mixed wastes, due to interests in minimizing environmental impact and occupational dose, as well as because of the significantly high cost of treatment and/or disposal. Continued progress is expected in reducing mixed-waste generation through improved training, procedures, and technology. Therefore, future nuclear plant operations are not expected to generate significant volumes of mixed waste. (References 1 and 2) Note: Envirocare in Utah is licensed to receive mixed waste. There has been some controversy over the years about the facility, but, based on a DOE website, they are still receiving mixed wastes.

Despite the current lack of mixed-waste treatment and disposal capacity, new mixed-waste treatment and disposal capacity may occur prior to operation of a new facility at the ESP Site. DOE generates large quantities of mixed waste per year and currently has significant mixed waste in storage, dwarfing the mixed-waste management requirements of other commercial generators (DOE/LLW-180). (Reference 2) A mixed-waste inventory conducted by NRC and EPA revealed that the characteristics of commercial mixed wastes are, for the most part, very similar to those produced by DOE. (Reference 2) DOE's need to develop extensive new mixed-waste treatment capabilities should benefit new facilities requiring additional offsite treatment capabilities. The development by DOE of new mixed-waste technologies and/or its willingness to accept nuclear power facilities low-level mixed waste for treatment and disposal could, as anticipated for license renewal, dramatically reduce onsite waste inventories for a new facility.

5.5.2.2 Mixed Waste Minimization Plan

Under RCRA regulations, each facility owner/operator is required to develop a waste-minimization plan that identifies process changes that can be made to reduce or eliminate mixed wastes, methods to minimize the volume of regulated wastes through better segregation of materials, and the substitution of nonhazardous materials. The plan must include a schedule for implementation, projections of volume reductions to be achieved, and assumptions that are critical to the accomplishment of the projected volume reductions. (Reference 2)

Pursuing environmentally responsible management of mixed wastes is critical to minimizing occupational exposures as well as preventing waste from entering the accessible environment through various air and groundwater pathways. Specifically, records must be maintained identifying each physical location or unit where mixed waste is stored and identifying the method of storage [40 CFR 264.73(b) and 265.73(b)]. An inspection of these storage areas for compliance with applicable RCRA standards for storage methods, including an assessment of compliance with storage facility standards of 40 CFR 264 or 265 (interim status) would be performed regularly as described in 40 CFR 264.15 and 265.15. (Reference 2)

Pursuant to the regulations regarding mixed waste and the issuance of a license to operate a new nuclear power facility at the GGNS ESP Site, the ESP Applicant would develop a mixed-waste minimization plan encompassing the elements of the regulations as discussed above to ensure impacts from mixed wastes are truly minimized. The plan would address elements such as: inventory identification and control, work planning to reduce mixed waste generation, mixed waste reduction methods and processes and key assumptions critical to successful waste reduction, waste segregation, waste storage and inspection requirements, and material substitution opportunities. Implementation of such a plan would be scheduled consistent with commencement of operation of a new facility.

5.5.2.3 Mixed Waste Impacts

As stated above, nuclear power plant operations are not expected to generate significant volumes of mixed waste because of continued progress in reducing mixed-waste generation. Because nuclear power plant operations are conducted in compliance with applicable NRC and EPA regulations governing the storage and disposal of mixed wastes (10 CFR 20; 10 CFR 61; 40 CFR 264 and 268), exposures will be minimized. (Reference 2)

5.5.2.3.1 Radiological

Concern has been expressed that the limited progress that has been made in developing disposal capacity for mixed waste could result in extended storage of mixed waste at nuclear power reactors. Occupational exposures from onsite storage have been shown to be reduced by the application of waste-minimization technologies and procedures (Rogers 1990). In addition, the potential for exposure can be reduced by remote sampling methods. Remote evaluation methods include classifying waste streams as mixed through the application of knowledge about processes that generate waste streams and substituting closed-circuit television using high-resolution monitors for weekly inspections by facility personnel (Rogers 1990). The latter method can determine if sufficient deterioration of a container has occurred to warrant proximate visual inspections. (Reference 2)

Off site disposal impacts, as well as the impacts of limited and extended onsite storage of mixed waste that would be generated have been evaluated by the NRC in Reference 2, for the license renewal period discussed in the LRGEIS, and found to be small.

The NRC provided the following assessment in Reference 2: “Given the technical feasibility of mixed-waste disposal, the states' responsibilities for providing LLW (and thus mixed-waste) disposal capacity and DOE's obligations under the FFCA to develop treatment and disposal capacity for its mixed waste, NRC believes that there will eventually be sufficient economic incentives to overcome nontechnical obstacles and to find cost effective ways to dispose of mixed waste. While the NRC understands that there have been some delays and that uncertainties exist, the (NRC) staff concludes that there is reasonable assurance that sufficient mixed-LLW-disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements. Thus, in summary, mixed LLW will result in only a small environmental impact, taking into account both storage at a reactor site and disposal at an appropriate disposal site.” This conclusion regarding mixed waste for license renewal is equally valid for any new facility which may be constructed and operated on the GGNS ESP Site.

While mixed waste generated might be stored on site for the life of the new facility operating license, if adequate treatment and disposal capacities or DOE acceptance of commercial mixed waste are delayed, as for license renewal the accumulated volumes of mixed waste would be small when compared to overall LLW volumes. Incremental effluents and doses to members of the public should be minimal and would be subject to the same regulatory limits and enforcement as LLW.

5.5.2.3.2 Occupational

As indicated above, mixed waste is commonly stored on site due to the lack of treatment and disposal sites available at present. For this reason, impacts resulting from the chemical hazards and occupational exposures to radioactive material may be somewhat higher than would otherwise be expected. In addition, occupational chemical and radiological exposures may occur during the testing of mixed wastes (particularly decontamination wastes and ion exchange resins) to determine if the constituents are chemically hazardous. A second occupational exposure impact of mixed waste is from onsite storage and handling. It has been estimated that the largest single exposures result from samples being collected when lead blankets have not been used to shield pipes and valves. (References 1 and 2)

Estimates of incremental occupational exposures from short-term and extended storage of mixed LLW have been made (Rogers 1990). The estimates were developed to evaluate ALARA problems for radiation exposures from compliance with RCRA sampling and inspecting requirements. When mixed LLW can be shipped immediately, doses from inspections were estimated to be about 3 man-rem per plant. With five years of accumulated mixed wastes, inspection exposures could rise to 100 man-rem/year per plant. Mitigating measures, including remote inspection, were considered essential to meet ALARA requirements. The doses in these estimates were based on assumed volumes and activities that should bound potential doses, since "these inventories are believed to represent conservatively high estimates of reactor-generated mixed wastes." (Rogers 1990). While sampling and handling were estimated to potentially result in significant doses in the 1990 study, absent ALARA mitigation such as use of lead blankets on contaminated piping with high exposure rates, they are included in current baseline exposures. The NRC concluded that ALARA mitigating measures will continue to be developed and implemented by the utilities and RCRA regulatory authorities and that, even with the contribution of incremental occupational doses from extended storage, total individual occupational doses will continue to be well within regulatory limits and thus will be small. (Reference 2)

5.5.2.3.3 Nonradiological

As noted in Section 5.5.2.1, the volumes of mixed waste currently represent 3 percent or less of total LLW volumes. Due to the small mixed waste volume and because no significant emissions or releases of hazardous materials are expected due to control and containment requirements, the NRC concluded that the findings for LLW remain valid when both LLW and mixed-LLW impacts are considered.

Based on the arguments presented in Reference 2 and the regulatory requirements for handling, storage and disposal of mixed wastes the NRC concluded the following in Reference 2: “The storage and disposal of mixed waste will continue to be accomplished well within regulatory limits. The comprehensive regulatory controls and the facilities and procedures that are in place ensure proper handling and storage, as well as negligible doses and exposure to toxic materials for the public and the environment at all plants. License renewal will not increase the small, continuing risk to human health and the environment posed by mixed waste at all plants. The radiological and nonradiological environmental impacts of long-term disposal of mixed waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient mixed-waste-disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements. The environmental impacts of mixed-waste storage and disposal will continue to be small during the license renewal period. ….”

The NRC also concluded in Reference 2 that regulatory requirements already in place provide adequate mitigation incentives for onsite storage of mixed waste; and therefore, there is no need for consideration of additional mitigation alternatives within the context of renewal of a power reactor license.

Given that the handling, storage and disposal issues and requirements for mixed waste are the same, either for license renewal of an existing facility or for operation of a new nuclear power facility which may be constructed in the future, the above conclusions are also valid for the new facility for the GGNS ESP Site proposed in this ESP application.

5.5.3 References

1. U.S. Nuclear Regulatory Commission (USNRC), 1999, Environmental Standard Review Plan (NUREG-1555), Office of Nuclear Reactor Regulation, Washington, DC.
2. U.S. Nuclear Regulatory Commission (USNRC), 1996, Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG-1437, Volume 1, Section 6.4.5), Office of Nuclear Reactor Regulation, Washington, DC.
3. Rogers and Associates Engineering Corporation, The Management of Mixed Low-Level Radioactive Waste in the Nuclear Power Industry, National Environmental Studies Project, Nuclear Management and Resources Council, Washington, D.C., January 1990.
4. DOE/LLW-180, Analysis of the Legal, Regulatory, and Technical Issues Associated with DOE Accepting Commercial Mixed Waste, National Low-Level Waste Management Program, U.S. Department of Energy, Washington, D.C., July 1993.
5. NUREG/CR 5938/ORNL-6731, National Profile on Commercially Generated Low-Level Radioactive Mixed Waste, Oak Ridge National Laboratory, Oak Ridge, Tenn., December 1992.
6. DOE/RW-0006, Integrated Data Base for 1994: Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics, Rev. 9, U.S. Department of Energy, Washington, D.C., March 1994.
7. L-S/488364, Policy Statement on the Extension of the Policy on the Enforcement of RCRA Section 3004 (J) Storage Prohibition at Facilities Generating Mixed Radioactive Hazardous Waste, Federal Register Official Summary, 59 FR 18813, Apr. 20, 1994.
8. Mississippi Power and Light Company, Grand Gulf Nuclear Station Units 1 and2, Final Environmental Report (FER), as amended through Amendment No. 8.

5.6 Transmission System Impacts

As indicated in Section 3.7, the power transmission system to which GGNS is connected at the time of a new facility startup and operation would be utilized for up to at least an additional 1311 MWe generation capacity. When the specific facility design, the expected electrical output, the need for power, and primary market location(s) are established, the adequacy of the existing (at that time) T&D system would be determined. If, at that time, additional changes to the T&D system were warranted, the associated environmental impacts would be evaluated. Impacts of operation and maintenance of the existing transmission lines and corridors to which GGNS Unit 1 is currently connected are addressed in Reference 1.

5.6.1 References

1. Mississippi Power and Light Company, Grand Gulf Nuclear Station Units 1 and 2 Final Environmental Report (FER), as amended through Amendment No. 8.

5.7 Uranium Fuel Cycle Impacts

10 CFR 51.51(a) states that "Every environmental report prepared for the construction permit stage of a light-water-cooled nuclear power reactor, and submitted on or after September 4, 1979 shall take Table S-3, Table of Uranium Fuel Cycle Environmental Data, as the basis for evaluating the contribution of the environmental effects of uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials and management of low level waste and high level wastes related to uranium fuel cycle activities to the environmental costs of licensing the nuclear power plant. Table S-3 shall be included in the environmental report and may be supplemented by a discussion of the environmental significance of the data set forth in the table as weighed in the analysis for a new facility."

This section addresses the uranium fuel cycle environmental impacts and is divided into two main sections. The first section addresses the light-water-cooled reactor (LWR) designs presently being considered. The second section addresses the gas-cooled reactor designs also being considered. This split addresses the regulatory distinction made in 10 CFR 51.51 for light-water-cooled reactors.

5.7.1 Light-Water-Cooled Reactor Designs

10 CFR 51.51(a) states that "Every environmental report prepared for the construction permit stage of a light-water-cooled nuclear power reactor, and submitted on or after September 4, 1979 shall take Table S-3, Table of Uranium Fuel Cycle Environmental Data, as the basis for evaluating the contribution of the environmental effects of uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials and management of low level waste and high level wastes related to uranium fuel cycle activities to the environmental costs of licensing the nuclear power plant. Table S-3 shall be included in the environmental report and may be supplemented by a discussion of the environmental significance of the data set forth in the table as weighed in the analysis for a new facility."

Table S-3 of 10 CFR 51.51 is reproduced in its entirety herein as Table 5.7-3. Specific categories of natural-resource use included in the table relate to land use, water consumption and thermal effluents, radioactive releases, burial of transuranic and high- and low-level wastes, and radiation doses from transportation and occupational exposures. The contributions in the table for reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no recycle); that is, the cycle that results in the greater impact is used.

Descriptions of the environmental impact assessment of the uranium fuel cycle as related to the operation of light-water-cooled reactors are well documented by the USNRC. The environmental impact of a light-water-cooled reactor on the U.S. population from radioactive gaseous and liquid releases (including radon and technetium) due to the uranium fuel cycle is small when compared with the impact of natural background radiation. In addition, the nonradiological impacts of the uranium fuel cycle are acceptable.

The light-water-cooled reactor technologies being considered are identified in Section 1.3 of the Site Safety Analysis Report, Part 2 of this application. These LWR designs include the ABWR (Advanced Boiling Water Reactor), the ESBWR (Economic Simplified Boiling Water Reactor), the AP-1000 (Advanced Passive PWR), the IRIS (International Reactor Innovative and Secure), and the ACR-700 (Advanced light-water-cooled version of the CANDU Reactor). The standard configuration for each of these reactor technologies is as follows. The ABWR is a single unit, 4,300 MWt, nominal 1,500 MWe reactor. The ESBWR is a similar BWR: single unit, 4,000 MWt, nominal 1,390 MWe. The AP-1000 is a single unit, 3,400 MWt, nominal 1,117-1,150 MWe pressurized water reactor. The IRIS is a three module pressurized water reactor configuration for a total of 3,000 MWt and nominal 1,005 MWe. And the ACR-700 is a twin unit, 3,964 MWt, nominal 1,462 MWe, light-water-cooled CANDU reactor.

These reactor technologies are light-water-cooled nuclear power reactors with uranium dioxide fuel and therefore Table S-3 of paragraph (b) of 10 CFR 51.51 provides the environmental effects from the uranium fuel cycle for these reactor technologies.

5.7.2 Gas-Cooled Reactor Designs

5.7.2.1 Introduction and Background

This section provides an assessment of the environmental impacts of the fuel cycle, as related to the operation of the gas-cooled reactor technologies, based on a comparison of the key parameters that were used to generate the impacts listed in 10 CFR 51.51 Table S-3 (and repeated in Table 5.7-3). The key parameters are energy usage, material involved, number of shipments, etc. associated with the major fuel cycle activities. These activities are mining and milling, uranium hexafluoride conversion, enrichment, fuel fabrication, and radioactive waste disposal. Basically, the premise is that if less energy is needed, if fewer shipments are required, and if less material is involved in the process, then with all other things being equal, the overall impacts are less.

There are two gas-cooled reactor technologies being considered at this time. The GT-MHR is a four module, 2,400 MWt, nominal 1,140 MWe reactor that operates at a unit capacity of 88%. The PBMR is an eight module, 3,200 MWt, nominal 1,320 MWe reactor operating at a 95% unit capacity.

A key reference is NUREG-1437, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, May 1996, which provides a very detailed look at the impacts to the environment from the nuclear fuel cycle. The document also looks at the sensitivity of the changes to the nuclear fuel cycle on the impacts to the environment. As these changes are much more representative of the current and future situation than what was considered in the WASH-1248 Environmental Survey of the Uranium Fuel Cycle report, the conclusions of NUREG-1437 will be used in the following discussion.

Table 5.7-1 was prepared to succinctly capture the major features of the reference LWR fuel cycle that were used to develop Table S-3 and compare these same features with the gas-cooled reactor technologies being considered. This comparison can then help to demonstrate that the previously accepted environmental impacts identified in Table S-3 are comparable to the impacts for these gas-cooled technologies. The premise being that if the values of the major contributors to the health and environmental impacts that were used for the reference LWR fuel cycle are greater than those comparable values for the gas-cooled reactor technologies then the published, previously accepted impacts would also be greater than the impacts from the new reactor technologies. It is important to point out that even though we are looking at the contributors individually, it is the overall impact that is of concern. As such, there can be increases in individual contributors, yet the total impacts can still be bounded, if offset by decreases in other contributors.

The information to conduct the comparison was taken from 10 CFR 51.51 Table S-3 "Uranium Fuel Cycle Environmental Data," WASH-1248 Environmental Survey of the Uranium Fuel Cycle, and Supplement 1 to WASH-1248 (also known as NUREG-0116) Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle. The “reference LWR” refers to the model 1000 MWe light-water-cooled nuclear reactor used as a basis for studying annual fuel related requirements as described in WASH-1248. For the gas-cooled reactor technologies, information was gathered from the reactor vendors, United States Enrichment Corporation (USEC) and ConverDyn.

5.7.2.2 Analytic Approach

The major activities of the reference LWR fuel cycle that were considered in the WASH-1248 report were uranium mining, uranium milling, uranium hexafluoride production, uranium enrichment, fuel fabrication, irradiated fuel reprocessing, radioactive waste management which includes decontamination and decommissioning, and transportation. Three comments pertinent to this analysis are: 1) the WASH-1248 report and this evaluation only address the uranium fuel cycle (other fuel cycles such as thorium and plutonium are not part of this effort), 2) irradiated fuel reprocessing is not being considered by any of the new reactor technologies and is not included in this analysis, and 3) the transportation impacts are addressed based on the following premise - if the quantity of material required by the new gas-cooled reactor technologies at each major step of the fuel cycle is less than the reference plant, then the transportation impacts are also less. Comparing only the number of shipments of material is appropriate since there is little if any radioactivity in the fuel cycle shipments considered by Table S-3.

The main features of the major activities of the reference LWR fuel cycle that were identified as being the primary contributors to the health and environmental impacts are as follows. For the mining operation, annual ore supply is the major determinant of environmental and health impacts. Less ore will necessitate less energy, fewer emissions, less water usage, and less land disturbed. Secondarily, the mining technique can play a significant role in any impacts. Open pit mining has by far the most environment impact, followed by underground mining, with in situ leaching being the most environmentally benign.

For the milling operation, annual yellowcake (U_3O_8) production is the metric of interest. If a plant requires less U_3O_8 than the reference plant, then there will be less energy needed, fewer emissions, and less water usage. This is especially true if in situ leaching was used to obtain the ore, because the major milling steps of crushing and grinding are not required.

For the uranium conversion process, annual uranium hexafluoride (UF_6) production is the primary determinant of environmental impacts. If the new technology requires less UF_6 than the reference plant, then there will be less energy required, fewer emissions and less water used. As with the mining step, the conversion process (wet versus dry) is also a consideration. However, NUREG 1437 states that in either case “the environmental releases are so small that changing from 100 percent use of one process to 100 percent of the other would make no significant difference in the totals given in Tables S-3 or S-4.”

For the enrichment operation, there are two quantities of interest. The first quantity is the separative work units (SWU) needed to enrich the fuel, and the second quantity is the amount of enriched UF_6. The SWU is a measure of energy required to enrich the fuel. More SWUs would by itself indicate not only more energy required but also more emissions associated with the production of the energy needed and with that more water usage. However, this assumes the same technology is used to achieve the enrichment. As discussed in NUREG 1437, the centrifuge process uses 90 percent less energy than the gaseous diffusion process. Since the major environmental impacts for the entire fuel cycle are from the emissions from the fossil fueled plants needed to supply the energy demands of the gaseous diffusion plant, this reduction in energy requirements results in a fuel cycle with much less environmental impact. With regard to the amount of enriched UF_6 produced, the major effect would be the number of shipments. More UF_6 would necessitate more shipments, while less UF_6 would require fewer shipments. Slight increases or decreases would probably result in the same number of shipments.

For the fuel fabrication process, the quantity of UO_2 produced is the value of interest. This is really equivalent to the annual fuel loading in MTU, which will also be evaluated. Here again, the production of more UO_2 would require more energy, greater emissions, and increased water usage. New reactor technologies with an annual fuel loading less than the reference LWR plant would have less environmental impact, requiring less energy, fewer emissions and less water usage.

The last activity to be addressed is radioactive waste management. There are two aspects of radioactive waste that are considered as part of Table S-3: operations and reactor decontamination and decommissioning (D&D). For these activities, curies (Ci) of low-level waste (LLW) from annual operations and Ci of LLW from reactor (D&D) are the measures to consider. Curies by themselves are not a direct indicator of the potential environmental impacts. The radionuclide, its half-life and type of emission, and its physical and chemical form are the main contributors to risk. While we recognize this distinction, for this bounding analysis we will use curies as was done in the WASH-1248. More curies generally indicate the potential for greater impacts, while fewer curies indicate lesser impacts.

One of the clearest ways to conduct this comparison between the reference LWR and the gas-cooled reactor technologies is to start with the annual fuel loading in MTU for each of the reactor technologies. The other activities more accurately originate from the need for a certain amount of fuel. Using annual fuel loading as the starting point, the analysis will proceed in the reverse direction for the fuel cycle until the mining has been addressed, then the radioactive waste will be addressed. Before beginning this comparison, it is important to recognize that the plants being considered are a different size, have a different electrical rating and have a different capacity factor from the reference LWR. The reference LWR is a 1000 MWe plant with a capacity factor of 80%. In order to make a proper comparison, we need to evaluate the activities based on the same criterion. In this case, electrical generation is the metric of choice. Electrical generation is why the plants are being built and we want to know if these new reactor technologies, for the same electrical output, have a greater or lesser impact on human health and environment. Based on this, the reactor technologies will be normalized to 800 MWe using plant specific electrical rating and capacity factor.

5.7.2.3 Analysis and Discussion

5.7.2.3.1 Fuel Fabrication / Operations

The reference LWR required 35 MTU on an annual basis. This is equivalent to 40 MT of enriched UO_2, the annual output needed from the fuel fabrication plant. In comparison, the normalized annual fuel needs for the new gas-cooled reactor technologies ranged from 4.3 MTU to 5.3 MTU, approximately 88% to 85% lower than the reference plant. Similarly, the annual output needed from the fuel fabrication plant range from a low of 4.89 MT of UO_2 to 6.0 MT of UO_2, again approximately 88% to 85% lower than the reference plant. The specific breakdowns are shown on Table 5.7-1. One important distinction is that the fuel form for the gas-cooled reactors is also different. For the GT-MHR, the fuel is a two-phase mixture of enriched UO_2 and UC_2, usually referred to as UCO. For the PBMR the fuel kernel is UO_2. Both fuels are then

TRISO coated. For the GT-MHR these TRISO fuel particles are blended and bonded together with a carbonaceous binder. These fuel compacts are then stacked within a graphite block. For the PMBR, the fuel unit is a 6 cm diameter graphite sphere containing approximately 15000 fuel particles.

Before concluding the potential impacts from the fuel fabrication process are less, the gas-cooled reactors require a different fuel fabrication process altogether. The TRISO coated fuel kernel is quite different from the UO_2 sintered fuel pellet and as such would require a different type of facility. Ideally, to verify the environmental impacts of this change in fabrication process are bounded by the reference LWR fuel fabrication plant, a comparison of the land use, energy demand, effluents, etc., is in order. However, because there are no planned or currently operating plants in the United States, a direct comparison cannot be made at this time. Therefore, we have provided information on the reference fuel fabrication plant along with conceptual design information for a TRISO fabrication plant that was planned for the New Production Reactor and conceptual design information received from one of the gas-cooled reactor vendors.

From WASH-1248, the reference LWR fuel fabrication plant produced fuel for 26 plants (~910 MTU), was located on a site of about 100 acres, required 5.2 million gallons of water per annual fuel requirement of 35 MTU, and required 1,700 MW-hours of electricity per 35 MTU. The WASH-1248 report also states that nearly all of the airborne chemical effluents resulted from the combustion of fossil fuels to produce electricity to operate the fabrication plant. These numbers represented a very small portion of the overall fuel cycle. For example, the electrical usage represented less than 0.5% of that needed for the enrichment process, and the water use was less than 2% of the overall fuel cycle.

The fuel fabrication facility for the New Production Reactor was for a modular high temperature gas reactor (MHTGR) design and was sized for just one plant, so any comparisons with the much larger reference LWR fuel fabrication plant are problematic. The dimensions for the fuel fabrication building were 230 ft x 150 ft. The annual production was about 2 MTU. The plant required 960 kW of electrical power and 45 liters per minute of water. Effluents consisted of 60 m^3/yr of miscellaneous non-combustible solids and filters; 50 m^3/yr of combustible solids; 50 m^3/yr of process off-gas and HVAC filters; 2.0 m^3/yr of tools and failed equipment; and process off-gases of 900,000 m^3/yr. The process off-gases consisted of 74 % N_2, 12% O_2, 7.2% Ar, 6.4% CO_2, 0.2% CO, and 0.02% CH_3CCl_3. The activity associated with this off-gas: 0.01 pCi alpha/m^3, and 0.01 pCi beta/m^3.

The information gathered from one of the current reactor vendors was for a plant producing 6.3 MTU, about 19% more than the annual reload of 5.31 MTU for its reactor. Again this plant was sized for just one reactor. This plant would require 10 MW of electrical power with an annual electrical usage of 35,000 MW-hr. The gaseous emissions consist of 80 MT of nitrogen, 52 MT of argon, 22.4 MT of CO, 22 MT of hydrogen and 3.7 MT of CO_2. The solid waste totals about 84 m^3 of LLW, 3 m^3 of intermediate level waste, and the remainder sanitary/industrial wastes. The liquid processing system would generate an additional 3.8 m^3 of LLW, would discharge about 3700 m^3 of low activity aqueous effluent, and would discharge about 45,000 m^3 of industrial cooling water.

Because of the differences in scale and the state of design of the facilities, it is not possible or appropriate to make a direct comparison of the impacts. Obviously, there are economies of scale and design improvements that will occur for a plant comparable in size to the reference plant. Regardless, the projected impacts of a TRISO fuel plant based on the two conceptual designs are not inconsistent with the reference plant and would be operated within existing air, water, and solid waste regulations. Further; like the impacts associated with the sintered UO_2 pellet plant, the impacts from a TRISO fuel plant would still be a minor contributor to the overall fuel cycle impacts. By characterizing the impacts as “not inconsistent,” we mean that while certain parameters such as electrical usage for fuel fabrication might be higher for the gas-cooled plants on an annual fuel loading basis, the environmental impacts from the TRISO plants as conceptualized would still be bounded by the overall LWR fuel cycle impacts.

5.7.2.3.2 Uranium Enrichment

In order to produce the 40 MT of enriched UO_2 for the reference LWR, the enrichment plant needed to produce 52 MT of UF_6, which required 127 MT of SWU. The normalized enriched UF_6 needs for the new gas-cooled reactor technologies ranged from 6.38 MT of UF_6 to 7.9 MT of UF_6, approximately 88% to 85% lower. To produce these quantities of UF_6 requires from 124 MT of SWU to 163 MT of SWU, slightly lower to 28% higher. The enrichment SWU calculation for the new reactor technologies was performed using the USEC SWU calculator and assumes a 0.30% tails assay, the same value as for the NUREG-0116 reference plant. Using this calculator for the reference LWR plant yielded 126 MT of SWU versus the NUREG value of 127. This is very close indicating that this latest version of the USEC SWU calculator is appropriate for use in this computation. Table 5.7-2 gives the details of the computations.

The 28% increase in the MTU of SWU would by itself indicate greater environmental impacts. However, a close look at the original WASH 1248 analysis shows that the environmental impacts are almost totally from the electrical generation needed for the gaseous diffusion process. These impacts result from the emissions from the electrical generation that is assumed to be from coal plants and from the associated water to cool the plants. Today, and in the future, the enrichment process is and will be different. A significant fraction of the enrichment services to US utilities today is provided from European facilities using centrifuge technology rather than the fifty-year-old gaseous diffusion technology. For the future, two private companies, United States Enrichment Corporation and Louisiana Energy Services, are planning to develop centrifuge technology in the US. In fact, NRC has just recently accepted United States Enrichment Corporation’s centrifuge license application for technical review. Centrifuge technology requires less than 10% of the energy needed for the gaseous diffusion process and as such the environmental impacts associated with the electrical generation will be correspondingly less. This tremendous reduction in energy and the associated environmental impacts more than offsets a 28% increase in SWU.

5.7.2.3.3 Uranium Hexafluoride Production

In order to provide the feed needed for the reference LWR to the enrichment plant, the uranium hexafluoride plant needed to produce 360 MT of UF_6. The normalized feed needed for the new gas-cooled reactor technologies, the output from the uranium hexafluoride plant, ranged from 241 to 303 MT of UF_6, well below the reference plant. The feed calculations were performed using the USEC SWU calculator. Using this calculator for the reference LWR yielded 353 MT of UF_6 versus the NUREG value of 360. Again this value is very close (<2%) to the published value.

5.7.2.3.4 Uranium Milling

To produce the 360 MT of UF_6 for the reference LWR, 293 MT of yellowcake (U_3O_8) from the mill was required. The normalized new gas-cooled reactor technologies needs ranged from 193 MT of U_3O_8 to 243 U_3O_8, well below the reference plant. These yellowcake numbers were generated using the relationship 2.61285 lbs of U_3O_8 to 1 kg of UF_6. This conversion factor was obtained from ConverDyn.

5.7.2.3.5 Uranium Mining

The raw ore needed to produce the 293 MT of yellowcake (U_3O_8) for the reference LWR was 272,000 MT. Now assuming a 0.1% ore body and a 90% recovery efficiency, the normalized new gas-cooled reactor technologies ore requirements ranged from 215,000 to 270,000 MT of ore, both below the reference plant. Of note, the NUREG table value of 272,000 should be about 325,600 using the same assumptions. It is not clear why this number is different, but in any case, the gas-cooled reactor technologies are below the published reference plant value.

Uranium mining completes the front end of the fuel cycle. However, there are two areas on the down stream cycle to be considered. These are the LLW generated by operations and the LLW generated as part of the D&D process. As mentioned earlier, spent fuel reprocessing is not germane to this analysis, and therefore, not discussed.

5.7.2.3.6 Solid Low-Level Radioactive Waste - Operations

For the reference LWR, 10 CFR 51.51, Table S-3, Table of Uranium Fuel Cycle Environmental Data, states that there are 9,100 Ci of LLW generated annually from operations. The range of activity of LLW generated annually projected by the new gas-cooled reactor technologies is 65.4 Ci to 1,100 Ci, far below the reference LLW. This decrease would also suggest many fewer shipments to the disposal facility and less worker exposure.

5.7.2.3.7 Solid Low-Level Radioactive Waste – Decontamination and Decommissioning

10 CFR 51.51, Table S-3, states 1,500 Ci per Reactor Reference Year (RRY) “comes from reactor decontamination and decommissioning – buried at land burial facilities.” Based on this small quantity and the modifying phrase “buried at land burial facilities” it is clear that only waste suitable for shallow land burial was considered as a basis for the Table S-3 line item. At this time, only general conclusions can be drawn to indicate these gas-cooled reactor technologies would generate less D&D LLW than the reference plant. The new plants will operate much cleaner than the reference LWR as evidenced by the annual generation of much less LLW. Improvements in fuel integrity and differences in fuel form as well as the use of the chemically and radiologically inert helium as the coolant are responsible for this reduction and also should contribute to both a lower level and less overall contamination to be managed during the D&D process. The plants higher thermal efficiency and higher fuel burnup would produce less heavy metal radioactive waste. Lastly, the plants are typically more compact than the reference LWR contributing to less D&D waste. For these reasons it is expected that the D&D LLW generation from the gas-cooled reactor designs would be comparable or less than that associated with the reference LWR.

The key areas of impact from D&D LLW for the gas-cooled reactor are expected to be identical to those of the reference LWR, namely, transportation and land use supporting waste disposal. As discussed in WASH-1248, the largest portion of D&D LLW transportation and land use is associated with the mining, milling, and enrichment steps. D&D contributions are relatively quite small. WASH-1248 also points out that other areas of impact are quite dominated by the these “front-end” phases of the nuclear fuel cycle, e.g., land use and power consumption to support enrichment, related water usage, and power plant emissions.

As noted above, the D&D LLW impacts related to the gas-cooled reactor designs are expected to be comparable or less than that of the reference LLW. However, even if the gas-cooled reactor D&D LLW activities and/or volumes were larger, the overall reference LWR fuel cycle impacts would continue to be bounding.

5.7.2.3.8 Waste Products from Reprocessing

10 CFR 51.51, Table S-3 includes an entry for waste products resulting from reprocessing of fuel associated with the reference LWR (i.e., 1.1 E7 Ci for transuranic and other high level waste). As noted earlier in Section 5.7.2.2, reprocessing is not being considered in this analysis; therefore, no comparison with this Table S-3 entry is provided. See Table 5.7-1.

5.7.2.4 Summary and Conclusion

To recap, there are only two instances where any part of the uranium fuel cycle is/might be exceeded by the new gas-cooled reactor technologies. These fuel cycle steps are enrichment, a 28% increase and possibly D&D. As discussed above, the enrichment requirement for SWU, while slightly larger, can be conducted in a much more environmentally benign manner, centrifuge versus gaseous diffusion, from current overseas sources or expected new domestic facilities. The net effect will be that the environmental and health impacts will be less than those identified in Table S-3. The second area, decontamination and decommissioning, is a minor contributor to the fuel cycle impacts. While definitive D&D LLW information was not readily available for the gas-cooled reactor technologies, for numerous qualitative reasons, the impacts are expected to be comparable or less than the reference LLW. However, while not expected, an increase in the D&D LLW impacts would be more than offset by the significant decreases in the impacts due to reduction in fuel needs and changes in the enrichment process and mining technique.

In conclusion, the assessment of environmental impacts indicates that the impacts of the fuel cycle for a gas-cooled reactor are considered low. These impacts would be similar to those of a light-water reactor, as compared to the data in 10 CFR 51.51, Table S-3. This detailed comparison of the underpinnings of Table S-3 show qualitatively that the existing WASH-1248 environmental and health effects are conservative and appropriate for use by these new gas-cooled reactor technologies. Collectively, improvements in both past practices as well as changes in technology have resulted in a fuel cycle with lower environmental impact.

5.7.3 Methodology Assessment

As indicated in Section 3.0, the selection of a reactor design to be used for the ESP Facility is still under consideration. Selection of a reactor to be used at the ESP Site may not be limited to those considered above. However, the methodology utilized above is appropriate to evaluate the final selected reactor. Further, should the selected design be shown to be bounded by the above evaluation, then the selected design would be considered to be within the acceptable fuel cycle environmental impacts considered for this ESP.

5.7.4 References

1. 10 CFR 51.51, Table S-3, Table of Uranium Fuel Cycle Environmental Data.
2. NUREG-1437, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, May 1996.
3. WASH-1248, Environmental Survey of the Uranium Fuel Cycle, April 1974.
4. Supplement 1 to WASH-1248, also known as NUREG-0116, Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle, October 1976.

5. EGG-NPR-8522, Rev. B, NPR-MHTGR Generic Reactor Plant Description and Source Terms, March 1991.

5.8 Socioeconomic Impacts

The discussion of socioeconomic impacts is divided into three subsections. First, direct physical effects of station operation on the community are considered. Second, the social and economic impacts of station operation on the surrounding region are considered. Finally, considerations of environmental justice are presented.

5.8.1 Physical Impacts of Station Operation

Sections 2.1 and 2.2.1 provide a detailed description of the proposed new facility location and surrounding community characteristics. As explained in these sections, the proposed new facility site is located in a rural area, relatively remote from population centers and communities. Therefore, the potential for direct physical impacts to the community from facility operation is minimal.

In terms of direct physical impacts, operation of a nuclear power plant can contribute noise, odors, exhausts, thermal emissions and a visual intrusion to the surrounding environment. These potential impacts are addressed in the following sections.

5.8.1.1 Noise

The most audible noise sources associated with normal station operation are the switchyard and transformers, waterfall from within a natural draft cooling tower, or fan noise from a mechanical draft cooling tower. No changes are proposed to the existing switchyard which would alter the existing GGNS switchyard noise levels.

As discussed in Section 3.4, the cooling systems for a new facility at the GGNS ESP Site have not yet been selected. However, a closed cooling system with cooling towers will likely be utilized for the normal heat sink. On the basis of the literature identified in References 1 through 5, operating experience from other nuclear facilities (Reference 6), and PPE Table 3.0-1, the following sound levels for cooling towers have been considered in determining potential noise impacts due to operation of a new facility.

Type of Cooling Tower	Noise Level	Data Source
Linear mechanical draft cooling tower operation (LMDCT)	55 dB(A) at 1,000 ft	PPE Table 3.0-1
Natural draft cooling tower operation (NDCT)	45 to 55 dB(A) at 1,000 ft	References 1, 2, and 3, and PPE Table 3.0-1

The proposed location for the cooling towers is approximately 1,000 feet from the nearest site property line (Figure 2.3-1) on the north side of the site (near the north access road). From Figure 2.3-1 it is seen that either four NDCTs or four LMDCTs are assumed to be required for the cooling system. Reference 30, indicates that combined sound sources are not added algebraically since logarithmic ratios are involved. Using Figure 19.1 of Reference 30 to determine the combined sound level for the four towers results in a final combined sound level of about 61 dB(A) from the four tower assembly, at 1000 ft. Assuming a background noise at this location (the same as at FER survey point no. 5 (Figure 2.8-1) of 59 dB(A) given in FER Section 5.6.1) results in a combined sound level of about 63 dB(A) at the north property boundary location. This is within the regulatory guidance of 65 dB(A). Considering the approximate 4000 (+) ft. distance to the GGNS Unit 1 transformers and cooling towers, no significant increase in sound level at the north access road is expected.

The proposed location for the new facility cooling towers is about 4,700 ft from survey point no. 5 on the eastern property line (Figure 2.8-1). Using the equation presented in Section 4.1.4 and ignoring the excess attenuation factor, the expected noise level at survey point no. 5 from operation of a new facility's cooling towers would be approximately 48 dB(A).

Switchyard operational noise from Reference 1 is 90 to 92 dB(A) at 6 ft from transformers. Assuming two transformers at the center of the proposed power block location, and using the methodology of Section 4.1.4, results in a sound level at the north property line location (about 3400 ft distance) of 40 dB(A), and at the location of survey point no. 5 (about 4100 ft distance) of 38 dB(A). Combining this transformer noise with the new facility cooling towers at the north property line results in a sound level of about 63 dB(A), no discernable increase over that from the cooling towers combined with background at this location.

FER Section 5.6.1 discussed noise impacts for GGNS Unit 1, and indicated that at survey point no. 5 on Figure 2.8-1 the maximum sound levels from the Unit 1 NDCT and switchyard would be 47 dB(A) and 50 dB(A), respectively. FER Section 5.6.1 also indicated background noise levels at survey point no. 5 to be a maximum of 59 dB(A). Using the methodology in Reference 30, the noise level at survey point no. 5 considering the maximum background condition combined with the sound levels from GGNS Unit 1 equipment above and the new facility cooling towers and transformers is about 60 dB(A). This would increase slightly with the addition of noise from the newly installed GGNS Unit 1 Auxiliary Cooling Tower (mechanical draft cooling tower near the Unit 1 NDCT). Again, this is within the regulatory guidance of 65 dB(A).

The operational noise level from the addition of a new unit or units on the GGNS ESP Site would not significantly increase the noise level at the property lines. The noise level at the property line is expected to remain below the regulatory guidance of 65 dB(A) during normal operations.

The distance to the residence nearest the proposed location of the new cooling tower(s) is about 1650 ft., further reducing the noise levels at that location.

Point 8 (Figure 2.8-1) from the pre-construction noise surveys, considered representative of nearby sensitive land use at that time, is well beyond the plant property line. There are no new sensitive receptors, such as schools or churches, nearer the GGNS site than that located at point 8 of the original survey. Therefore, it is unlikely that any noise generated by operation of a new reactor unit or units would annoy or even be audible to the nearby populace. This is consistent with the findings of Reference 6.

5.8.1.2 Air

Bounding parameters for non-radioactive gaseous emissions from the equipment under consideration for a new facility are presented in PPE Tables 3.0-4, 3.0-5 and 3.0-6, and are discussed in Section 3.6.3. Gaseous emissions will be within regulatory guidelines set by Federal and State agencies. Nuclear power plants generally do not produce gaseous effluents; therefore, the impact on air quality is expected to be minimal (Reference 7).

5.8.1.3 Visual Aesthetics

The most visually obtrusive structures at a new facility would be the natural draft cooling towers and their associated plumes. The bounding cooling tower(s) height would be approximately 550 feet. A 522 ft tall natural draft cooling tower currently exists at the site (Reference 27); therefore, the addition and operation of similar structures would cause only minimal additional aesthetic impacts to the site vicinity. The areas around the GGNS site are generally rural and heavily wooded, which would tend to mitigate the visual impact of many structures proposed for the new facility. Some structures of the new facility may be visible from the Mississippi River (e.g., intake structure, cooling towers), and from Grand Gulf Military Park. There are bluffs on the site east of the Mississippi River that are about 65 ft above the average river level (Reference 27), and dense forest throughout the vicinity that would help conceal the new structures.

Visibility issues related to the natural draft cooling towers are associated with potential meteorological phenomena, such as cloud formation, fogging, shadowing, and additional precipitation, that may result from operation of the towers. A detailed discussion of these potential impacts is presented in Section 5.3.3, which concludes that these phenomena would be very localized and would have no effect outside the GGNS site boundary.

Because the GGNS site is already aesthetically altered by the presence of an existing nuclear power plant with a natural draft cooling tower along with its visual plume, adverse impacts to visual aesthetics of the site and vicinity are not expected from the operation of a new facility.

5.8.2 Social and Economic Impacts of Station Operation

Section 2.5 provides a detailed description of the social and economic characteristics of the region surrounding the proposed ESP Site. The area within the boundaries of the Emergency Planning Zone is a rural setting with a low population density. Four towns with higher population densities are located within the 50-mile radius of the GGNS site. Vicksburg, Mississippi, located 25 miles to the north-northeast, had a 2000 U.S. Census population of 26,407. Clinton, Mississippi located to the northeast and Natchez, Mississippi, located to the southwest had 2000 U.S. Census populations of 23,347 and 18,464, respectively. Jackson, Mississippi, the largest nearby metropolitan area, located about 55 miles northeast of the site had a 2000 U.S. Census population of 184,256. Most of the skilled labor workforce would likely commute from these areas, as is the case with the GGNS Unit 1 workers.

The current workforce at the GGNS site commutes from a number of local communities including: Clinton, Fayette, Hazelhurst, Natchez, Port Gibson, Vicksburg, and Jackson (Reference 31). The largest concentration of these workers (46 percent) commute from Vicksburg, 14 percent commute from the Port Gibson area, and much smaller proportions of the population (generally less than 5 percent at any one location) are spread throughout the surrounding communities (Reference 31). Although a number of skilled workers for the new facility would in-migrate to the area, a variety of positions would be available for local residents who already live in local and surrounding communities. It is estimated that the operation of a new facility would require 1,160 workers (Table 3.0-1). A conservative estimate of 50 percent of these would be expected to in-migrate to the region, accompanied by their families. Assuming an average family size of four (4), 2,380 people could be expected to move to the region from other areas.

As is the case with the current operational staff at GGNS Unit 1, the operational workforce would likely commute from surrounding Mississippi Counties, but would concentrate in larger population centers, where public and private services are available. In-migrants to the area would be expected to evaluate the acceptability and attractiveness of local (and surrounding) communities based on their own needs in relation to the availability of housing, public utilities, education, and other services.

The majority of in-migrants and their families would be expected to settle in developed, more populous areas, or their suburbs, such as Vicksburg (Warren County), Natchez (Adams County), and Clinton/Jackson (Hinds County), which have a combined year 2000 population of over 300,000 people. The total anticipated number of operational workers and their families expected to move to the region (2,380) represent less than 1 percent of the year 2000 combined population of Warren, Adams, and Hinds Counties. If 50 percent of the in-migrant workers settled in Vicksburg, this would amount to less than 5 percent of the total population of Vicksburg, a minimal increase.

It is expected that the number of personnel required for an outage at a new facility would be similar to the outage staff required for GGNS Unit 1. Outages at Unit 1 would likely not coincide with outages planned for a new facility. Therefore, although the frequency of the outages would increase, the total number of people working at GGNS during a plant outage effectively would not increase. The temporary outage staff typically stays in area hotels or trailer courts dispersed throughout the region; therefore, no single community would be overburdened by the influx of temporary workers. It is expected that the increased frequency of the temporary outage staff would not significantly impact the region. Increased sales tax and consumption of goods would offset any minor temporary impacts caused by the influx of outage staff to area communities.

Issues related to socioeconomic impacts from operation of a new facility include local housing, tax payments, local public services, local land use, local employment, and historic resources. These issues are discussed in the following sections.

5.8.2.1 Local Housing

As stated above, the bounding number of employees for operation of a new facility is 1,160, 50 percent, or approximately 580, of which would be conservatively expected to in-migrate to the region with their families. It is anticipated that, similar to the employees of GGNS Unit 1, the majority of in-migrant personnel would reside in or around Vicksburg, Mississippi. As noted above, workers would also take up residences in other counties contiguous to Claiborne County that have communities with well-developed public and private services. This would include the metropolitan Jackson area (Hinds County) and Natchez, Mississippi (Adams County).

Warren County, where Vicksburg is located, had over 2,000 vacant housing units in the year 2000 (Table 2.5-14). In Claiborne County and surrounding counties (Warren, Copiah, and Jefferson) there were over 4,000 vacant housing units in year 2000. Including Adams County and Hinds County, the total number of vacant housing units increases to about over 14,800. There is no way of accurately estimate of the number of housing units that would be available in the region in the year 2030, the year a new facility would be expected to begin operations. However, based on the year 2000 census data, and the assumed in-migrant workforce, the number of housing units available for personnel moving into the region would be expected to be adequate. Thus, no significant burden on local housing resources would be expected.

Empirical case studies of seven operating nuclear power plants indicated in all instances that the in-migration of plant personnel had small impacts on housing (Reference 8). In addition, the workers would not move exclusively to one community but rather would be expected to make residences in the relatively large area formed by surrounding communities. Therefore, the increase in employees in the general area would not adversely impact the housing market in any one community.

5.8.2.2 Tax Payments

Section 2.5.2.2 describes the distribution of tax revenues from GGNS Unit 1. Recipients of the revenues include the town of Port Gibson, Claiborne County and a number of other counties where electricity generated at GGNS is used, as well as the state of Mississippi. Depending on the type of plant (merchant plant which would be unregulated, or a regulated – by the Public Service Commissions (PSC) of Mississippi and Louisiana - plant) the tax structure may be similar to the above for GGNS Unit 1 (for a regulated plant), or be some mutually agreeable amount for an unregulated merchant plant. In any case, increased tax payments from the operation of a new facility would be expected to have a beneficial impact upon the receiving jurisdictions.

Further benefit to some or all of these jurisdictions would be expected from sales, personal property, and income tax revenues paid by the employees of a new facility. This benefit would generally be distributed (proportionally) over the larger area where the workforce resides.

5.8.2.3 Local Public Services

Local public services that would be affected by operation of a new facility at the GGNS site include education, transportation, public safety, social services, public utilities, tourism and recreation. In general, impacts to each of these services from plant operation are expected to be minimal (Reference 9). As stated above, the operational staff for a new facility and their families would be expected to concentrate in population centers with well developed public services. As such, the workers would be distributed throughout the surrounding region thus minimizing the likelihood of overburdening the public services in any one community.

5.8.2.3.1 Education

Table 2.5-16 shows the number of schools within the Mississippi counties surrounding Claiborne in the GGNS site region, and in Hinds County. As was the case with GGNS Unit 1, new workers would likely move to the more populous areas in the surrounding communities, having access to the more developed public services. Workers with school-aged children would be interested in communities with good school districts, for example. The largest school district near the GGNS site is in Vicksburg, MS. The current student population at Vicksburg is 9,180, but the district's capacity is significantly higher. The system has had as many as 10,000 students and has recently added two new schools, indicating the capacity exists for additional students (Reference 10).

There are a number of private schools located in the area that further increase educational options for in-migrating workers and their families. Based upon the likelihood that plant workers would choose to live in the more populous communities, the anticipated number of workers and their families is not expected to significantly impact the educational institutions in the area. In addition, access to the large capacity school districts available in Hinds County (i.e., southwest portion of the greater Jackson metropolitan area) further minimizes any localized stress on area school districts. Any small adverse impacts to local school districts due to the influx of plant workers into a community would likely be proportionally offset by increased sales, personal property and income tax revenues paid by facility personnel.

5.8.2.3.2 Transportation

The GGNS site is accessible by both river and road. U.S. Highway 61 and State Highway 18 connect Port Gibson (5 miles southeast of the site) with Natchez, Jackson, and Vicksburg. U.S. Highway 61 parallels the Mississippi River from New Orleans, Louisiana to St. Louis, Missouri, and is approximately 4.5 miles from the site at the closest point. From the town of Port Gibson the highway goes north to Vicksburg, MS, and runs southwest to Natchez Mississippi. The Natchez Trace Parkway runs between Clinton, MS, and Port Gibson, providing access from the Clinton/Jackson area to the site. Refer to Figure 2.5-3 and Figure 2.5-4 for maps of major highways in Claiborne County and in the surrounding counties. A detailed description of the current transportation routes around the GGNS site is provided in Section 2.5.2.10. A highway construction plan to extend the present path of Highway 18 is in the early planning stages. This proposed extension would connect Highway 18 from Port Gibson to Grand Gulf Road near the site, providing additional access to the GGNS site (Reference 13). The section of U.S. Highway 61 from Natchez Trace Parkway south through Claiborne and Jefferson Counties to the Jefferson/Adams county line is currently being widened from two to four lanes (References 14 and 15). The sections of U.S. Highway 61 to the north and to the south of this construction are already four-lanes. Therefore, Highway 61 is expected to accommodate the increased traffic created by commuters to the GGNS ESP Site.

An increase in the workforce would increase traffic volumes commuting to and from the GGNS site, which may increase the potential for traffic accidents on Grand Gulf Road and along major commuter routes including U.S. Highways 18 and 61. The on-going and planned improvements to the highways described above would increase the capacity of the major commuter routes and therefore mitigate the impact of the additional employee population. In addition 10 to 15 percent of the plant personnel would work at night reducing the concentration of drivers during heavy traffic times, and decreasing the risk of accidents.

The estimated work force for operation of a new facility is 1,160 (Table 3.0-1). Taking into account the night shift and assuming 20% of employees would car pool, the estimated increase in vehicular traffic in and out of the GGNS site at shift change is approximately 800 vehicles. Table 4.4-1 shows current daily traffic counts and estimated hourly capacity of the primary roads in Claiborne County. The information clearly shows that the primary access routes, including Grand Gulf Road, have sufficient capacity to handle the projected increase in traffic due to the operational work force for a new facility. Therefore, impacts to transportation in the region of the GGNS site would not be expected to be significant.

5.8.2.3.3 Public Safety

A new facility at the GGNS ESP Site would have a fire protection system and onsite emergency response personnel. As is the case with GGNS Unit 1, it is expected that local fire and police departments would provide aid in the event of an emergency at a new facility. Currently, Claiborne County and the City of Port Gibson receive GGNS tax revenues earmarked for offsite emergency planning. Claiborne County receives $500,000 on an annual basis and Port Gibson receives $50,000 annually, which is intended to maintain offsite emergency preparedness to deal with potential emergency situations at the GGNS site (Reference 18). As stated in Section 2.5.2.2, depending on the type plant built the basis for tax payments may vary from that for GGNS Unit 1; however, it is expected that participating agencies would be appropriately compensated for support of an Emergency Plan for a new facility on the GGNS ESP Site.

Emergency planning and preparedness responsibilities are assigned to a number of departments and agencies. Federal, state and local officials implement appropriate protective actions in case of an emergency (References 19 and 20). A new Emergency Plan would be prepared for the new facility at the GGNS ESP Site. It is anticipated this plan would be similar to the present Emergency Plan in scope and in service arrangements with local public-safety departments. Detailed information regarding the overlapping police and fire jurisdictions and onsite security personnel is provided in Section 2.5.2.9 and Part 4 of this ESP Application.

A case study conducted at the Arkansas Nuclear One facility (Reference 29), showed no serious disruptions of public safety services occurred during operations of the facility. It is expected that existing public safety services in the region of the GGNS site would be adequate to handle the increase in staff at the site. Previous case studies indicate there would be little or no need for additional police or fire personnel. However, if the new facility at the GGNS ESP Site increased the demands on local police and fire departments, the additional burden could be mitigated through the addition of police or fire staff, addition of vehicles, and building new facilities or improvements and additions to existing facilities (Reference 17). Costs incurred by local fire and police departments would likely be offset by the additional tax revenues generated by plant personnel living in the affected community, and through tax revenues generated by the operation of a new facility.

5.8.2.3.4 Social Services

Detailed information concerning the capacity of the hospitals in Claiborne County and the adjacent Mississippi Counties is provided in Section 2.5.2.9. It is expected that a majority of the future employees will reside in more populous areas located in neighboring counties (e.g., Vicksburg, Warren County); therefore, the influx of plant workers is not expected to overburden Claiborne County health or social services. Empirical data based on case studies conducted at several nuclear power plants, indicate only small impacts to local social services associated with the influx of plant workers. (Reference 21)

5.8.2.3.5 Public Utilities

Detailed information regarding the current sewer and water services available at GGNS is provided in Section 2.5.2.9. GGNS Unit 1 currently operates an onsite water and sewer system for treatment of sanitary wastes. Additional water and sewer treatment facilities would be constructed as part of a new facility to support future operations. However, the designs for water and sewer treatment facilities for the site have not been selected. Bounding parameters for the water and sewer treatment systems under consideration are included in Table 3.0-1.

Because a new facility would utilize onsite water and sewer services, the operation of a new facility at the GGNS ESP Site would not burden public utilities in surrounding communities. In general, case studies indicate minimal impacts to public utilities resulting from plant operation (Reference 22).

The in-migration of additional GGNS employees and their families would increase the demand for public utilities in the communities where these employees reside. As was the case with the construction of GGNS Unit 1, it is expected that these workers would reside in or around the more populous areas such as Vicksburg, Mississippi, in part due to the public utilities and other services available. The water and sewer services in Vicksburg are currently 70 percent of total capacity (Reference 19). Therefore, the addition of plant personnel to this or other comparable communities would not be expected to overburden public utilities.

Because operational staff in-migrating to the region for a new facility would likely settle in numerous surrounding communities, potential impacts to public utilities of any one community would be expected to be minimal. Increases in sales, property, and income taxes generated by the population in-migrating to specific communities would offset costs associated with any upgrades a community may find necessary.

5.8.2.3.6 Tourism and Recreation

A detailed description of local tourism and recreation is provided in Section 2.5.2.7. Due to the proximity of the Grand Gulf Military Park to the north of the GGNS site, it is possible that increased traffic resulting from the influx of site workers would indirectly affect the traffic flow to Grand Gulf Military Park. However, the majority of tourists visit the park on the weekends when fewer numbers of people report for work at GGNS. (Reference 23) In addition, the traffic associated with GGNS is limited to specific times of the day, during shift changes, which minimizes the potential impact of GGNS traffic on the Grand Gulf Military Park.

Case studies conducted during operation of several nuclear power facilities indicated no adverse impacts to the local tourism and recreation as a result of the operation of existing nuclear power plants (Reference 24).

5.8.2.4 Land Use

A detailed description of regional land use is discussed in Section 2.2.3. Case studies documenting offsite land use changes indicate that in most instances moderate offsite land use changes occurred in areas surrounding operating nuclear power plants. Large offsite land use changes may occur, for example, if tax revenues generated by plant operations are utilized to enhance local public services in order to attract industrial development. (Reference 25) In contrast to operations at nuclear power plants analyzed for the above referenced case study, the operation of GGNS Unit 1 did not significantly impact the offsite land use in the region surrounding the GGNS site. Based on experience from the operation of the existing GGNS Unit 1, the operation of a new facility would not be expected to significantly impact land use in the region surrounding the GGNS site.

As previously mentioned the region surrounding the site has a low population density with local land use primarily devoted to commercial forests and agricultural production (Reference 26). The lack of a local workforce, limited availability of public water and sewer utilities, and the current usage of a majority of land area for forest and agricultural production likely hampered additional industrial development in the immediate area after the construction of the existing GGNS facility.

It is possible that the influx of site workers would increase demand for and stimulate the development of some commercial businesses (e.g. gasoline and automotive service stations, restaurants, etc). However, these services would likely be confined to existing commuter routes, and would not represent a major land use change for the region.

5.8.2.5 Local Employment

A detailed description of local and regional employment trends is provided in Section 2.5.2.1. December 2002 area labor force data indicates that Claiborne County has an unemployment rate of 12.4 percent (Reference 19). General trends for Claiborne and the contiguous counties indicate the total number of jobs across the surveyed industries have decreased 9 percent from 1990 to 2000 (Reference 28). Operation of the new facility would generate jobs for the residents of the area. The addition of 1,160 permanent workers traveling into the area may also increase demand for commercial retail establishments, which would provide some additional employment.

5.8.2.6 Historic Resources

A detailed description of the historic features identified in Claiborne County is included in Section 2.5.3. Claiborne County has 35 sites listed on the National Register of Historic Places

(Table 2.5-17). The increase in the operational workforce at the GGNS site with the addition of a new facility may result in increased visitation of these historic resources. This would result in additional monies for locations that charge an admission fee.

5.8.3 Environmental Justice Impacts

Executive Order 12898 (59 FR 7629) directs federal executive agencies to consider environmental justice under the National Environmental Policy Act. This Executive Order ensures that minority and/or low-income groups do not bear a disproportionate share of adverse health or environmental consequences of a proposed project.

This environmental justice review is an assessment of the potential disproportionate environmental (including socioeconomic) and human health impacts on low-income and/or minority populations attributable to the operation of a new facility at the GGNS ESP Site. Low-income is defined as a household living at or below the national poverty level.

5.8.3.1 Demographics

The characteristics of the population within the region, a 50 mile radius around the GGNS site, was determined by examining 2000 Census data (Reference 28). Section 2.5 provides detailed discussion regarding demographics of this region which were used in this review of environmental justice related impacts. In particular, see Section 2.5.4, which provides the criteria and screening results regarding the presence and distribution of minority and low-income population groups within a 50 miles radius of the GGNS site.

5.8.3.2 Potential Impacts

5.8.3.2.1 Potential Environmental Impacts

For the purposes of this environmental justice assessment, environmental impacts considered included potential impact to the air, surface water, ground water, and terrestrial and aquatic ecosystems. Table 5.10-1 summarizes the potential adverse impacts from operation of a new facility. None of these potential impacts are judged to be significant.

5.8.3.2.2 Potential Human Health Impacts

Operation of the new facility would result in slight contributions to radiation dose to members of the public living in the vicinity of the site, comparable to that associated with natural radiation background levels.

As presented in Section 5.4, the critical pathways to man for routine radiation releases from facilities at the GGNS ESP Site are exposure from submersion in air, inhalation of contaminated air, drinking milk from a cow that feeds on open pasture near the site, eating vegetables from a garden near the site, and eating fish caught in the Mississippi River. The results of the normal operation dose assessments indicate that the maximum individual dose for these pathways was found to be insignificant, well below the regulatory guidelines in Appendix I to 10 CFR Part 50 and the regulatory standards of 10 CFR Part 20.

The evaluation of postulated accidents is provided in Section 7.1 and demonstrated that radiological consequences of these accidents would meet the site acceptance criteria of 10 CFR 50.34 and 10 CFR 100 for the exclusion area boundary and low population zone boundary. In demonstrating compliance with these criteria, an adequate level of protection would be provided. Therefore, there would be no significant adverse health impacts to the public.

5.8.3.2.3 Potential Socioeconomic Impacts

Potential adverse socioeconomic impacts during operation of a new facility are included in Table 5.10-1. These include potential adverse impacts on air quality, aesthetics, schools, transportation, public safety, social services, public utilities, and recreational resources. However, none of the potential impacts attributable to operation of a new facility were judged to be significant.

Several positive socioeconomic impacts, principally applicable to Mississippi areas surrounding the site, would be realized by operation of a new facility at the GGNS ESP Site (Sections 5.8.1 and 5.8.2). These include increased employment opportunities, both directly and indirectly related to facility operation for workers within the region of the GGNS site, and increased tax revenues. See Section 2.5.2.2 for additional discussion of special provisions for GGNS Unit 1 tax payments made directly to Claiborne County in recognition of its role as host county to the site.

5.8.3.3 Conclusion

Based on the information gathered for this Environmental Justice review it is concluded that, while there are substantial minority populations and a few localized low income populations in the region of the GGNS site, there are no significant adverse impacts from facility operation that would disproportionately affect these populations.

5.8.4 References

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5.9 Decommissioning

Decommissioning is defined as permanently removing a nuclear facility from service and reducing radioactive materials on the licensed site to levels that would permit termination of the NRC operating license (10 CFR 50.2). The NRC evaluated the environmental impacts for the typical decommissioning methods in its Final Generic Environmental Impact Statement (FGEIS) on decommissioning nuclear facilities (Reference 1). Studies of social and environmental effects of decommissioning large commercial power generating units have not identified any significant impacts beyond those identified in the NRC FGEIS on decommissioning (References 1 and 5).

Site-specific considerations of impacts related to decommissioning were discussed in Section 5.9 of the GGNS Final Environmental Report (FER) (Reference 2), concluding that no significant environmental effects would be expected from plant decommissioning. Radiation doses to the public related to decommissioning of the existing GGNS facility were considered by the NRC to be very small, resulting primarily from the transportation of decommissioning waste. Occupational doses from these activities were expected to be well within occupational exposure limits imposed by regulatory requirements (Reference 3). Based on the NRC's FGEIS, it is expected that these conclusions would also apply to decommissioning of the new facility proposed in this ESP application.

Per NRC regulations, no detailed decommissioning plans are required at this time. Such plans would not be required until the holder of the operating license decides to permanently cease operations. Pursuant to 10 CFR 50.82, environmental impacts associated with site-specific decommissioning activities would be documented in the site's Post-Shutdown Decommissioning Activities Report. It is expected that technologies and guidance related to decommissioning will continue to mature and improve to further reduce environmental impacts related to decommissioning. For example, the NRC has recently published a supplement (Reference 4) to its decommissioning FGEIS, which goes beyond the above referenced 1988 FGEIS by explicitly considering high-temperature gas-cooled reactors and fast breeder reactors. This guidance would be used to evaluate environmental impacts during decommissioning, as required.

As noted by the NRC in NUREG-1555 (Reference 5), the 10 CFR 50.33(k) certification regarding financial capability to successfully decommission the facility is not required for ESP applications but would apply to the application for the combined license per 10 CFR 52.77. Decommissioning cost impacts and financial capabilities are, therefore, not discussed in this report.

5.9.1 References

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5.10 Measures and Controls to Limit Adverse Impacts During Operation

Potential adverse environmental impacts caused by the operation of a new facility at the GGNS ESP Site have been described in Sections 5.1 through 5.9. In this section the potential adverse environmental impacts are summarized and potential mitigation measures to reduce adverse impacts are presented. Because technology may change between the time an Early Site Permit is issued and a new facility commences operation, there are no commitments implied in this presentation of potential mitigation measures. The mitigation techniques presented herein represent best management practices or standard industrial practices at the time of ESP application submittal.

Table 5.10-1 summarizes the potential impacts identified in Sections 5.1 through 5.9 and potential measures to mitigate these impacts.

TABLE 5.3-1

SUMMARY OF FACILITY DISCHARGE PLUME CASES ANALYZED

Case	Ambient River Temperature °F (°C)	Discharge Rate [3] gpm (m^3/s)	Discharge Temperature [2] °F (°C)
Summer Mean	82 (27.8)	52,900 (3.3)	99.3 (37.4)
Summer Extreme	87 (30.6)	52,900 (3.3)	99.3 (37.4)
Winter Mean	41 (5)	52,900 (3.3)	98.2 (36.8)
Winter Extreme	34 (1.1)	52,900 (3.3)	98.2 (36.8)

NOTES:

1. All cases listed were analyzed for both average river flow, and 7-day, 10-year low flow condition.

2. The analysis was done using 100°F temperature for all discharge. The predicted temperature of the mixed discharge is provided, i.e., GGNS Unit 1 plus that of the proposed new facility.

3. Actual plant discharge rates will vary; maximum flows are shown. As discussed in Section 5.3.2, this discharge flow represents the total of the maximum expected blowdown from the proposed facility plus the normal cooling tower blowdown flow from GGNS Unit 1.

TABLE 5.3-2

SUMMARY OF THERMAL PLUME ANALYSIS

		Low River Flow Plume Dimensions			Mean River Flow Plume Dimensions		
Case Studied	Isotherm Considered ^oF (^oC)	Plume Length ft (m)	Max. Plume Width, ft (m)	Area Sq ft (m^2)	Plume Length ft (m)	Max. Plume Width, ft (m)	Area Sq ft (m^2)
Summer Mean	5 (2.8)	242 (73.8)	17 (5.2)	2057 (191)	197 (60)	11.1 (3.4)	1093 (102)
Summer Extreme	5 (2.8)	160 (48.8)	10.8 (3.3)	864 (80.3)	105 (32)	3.3 (1.0)	173 (16)
Winter Mean	5 (2.8)	462 (140.8)	47.7 (14.5)	11,019 (1024)	541 (165)	47.5 (14.5)	12,848 (1194)
Winter Extreme	5 (2.8)	525 (160)	53.7 (16.4)	14,096 (1310)	614 (187)	53.5 (16.3)	16,424 (1526)

TABLE 5.3-3

AVERAGE PLUME LENGTHS DURING 4 NDCT OPERATION

	Winter		Spring		Summer		Fall	
Direction	Miles	km	Miles	km	Miles	km	Miles	km
S	2.97	4.78	1.40	2.25	0.76	1.22	1.14	1.83
SSW	2.58	4.15	1.40	2.25	0.97	1.56	1.20	1.93
SW	2.52	4.05	1.40	2.25	0.94	1.51	1.47	2.37
WSW	2.92	4.70	1.94	3.12	1.33	2.14	1.78	2.86
W	3.60	5.79	2.51	4.04	1.56	2.51	2.19	3.52
WNW	2.93	4.71	2.49	4.01	1.25	2.01	2.32	3.73
NW	2.29	3.68	1.62	2.61	1.66	2.67	1.70	2.74
NNW	1.86	2.99	1.42	2.28	1.40	2.25	0.94	1.51
N	1.91	3.07	1.23	1.98	1.26	2.03	1.12	1.80
NNE	2.03	3.27	1.16	1.87	0.80	1.29	0.99	1.59
NE	1.78	2.86	1.06	1.71	0.66	1.06	1.07	1.72
ENE	1.84	2.96	1.13	1.82	0.76	1.22	1.09	1.75
E	1.65	2.65	1.16	1.87	0.80	1.29	0.96	1.54
ESE	1.55	2.49	1.10	1.77	0.73	1.17	1.05	1.69
SE	2.40	3.86	1.35	2.17	0.80	1.29	1.22	1.96
SSE	2.61	4.20	1.38	2.22	0.95	1.53	1.11	1.79
All	2.32	3.73	1.36	2.19	0.94	1.51	1.24	2.00

NOTES:

1. Plume from 4 NDCTs moving in the indicated direction.
2. Information in Table from Reference 16, Table 7.

TABLE 5.3-4

AVERAGE PLUME LENGTHS DURING 4 LMDCT UNIT OPERATION

	Winter		Spring		Summer		Fall	
Direction [1]	Miles	km	Miles	km	Miles	km	Miles	km
S	1.57	2.53	0.83	1.34	0.43	0.69	0.58	0.93
SSW	1.44	2.32	0.80	1.29	0.64	1.03	0.69	1.11
SW	1.50	2.41	0.87	1.40	0.64	1.03	0.92	1.48
WSW	1.81	2.91	1.20	1.93	0.81	1.30	0.92	1.48
W	2.32	3.73	1.86	2.99	1.07	1.72	1.25	2.01
WNW	1.71	2.75	1.86	2.99	0.77	1.24	1.89	3.04
NW	1.24	2.00	0.97	1.56	1.29	2.08	1.10	1.77
NNW	1.12	1.80	0.84	1.35	0.89	1.43	0.58	0.93
N	1.10	1.77	0.71	1.14	0.74	1.19	0.63	1.01
NNE	1.23	1.98	0.86	1.38	0.50	0.80	0.46	0.74
NE	1.16	1.87	0.66	1.06	0.39	0.63	0.61	0.98
ENE	1.00	1.61	0.63	1.01	0.48	0.77	0.53	0.85
E	0.91	1.46	0.65	1.05	0.48	0.77	0.46	0.74
ESE	0.82	1.32	0.65	1.05	0.47	0.76	0.57	0.92
SE	1.44	2.32	0.76	1.22	0.44	0.71	0.62	1.00
SSE	1.61	2.59	0.77	1.24	0.57	0.92	0.62	1.00
All	1.36	2.19	0.82	1.32	0.58	0.93	0.68	1.09

NOTES:

1. Plume from 4 LMDCTs moving in the indicated direction.
2. Information in Table from Reference 16, Table 18.

TABLE 5.3-5

VISIBLE PLUME LENGTH SUMMARY

	Winter		Spring		Summer		Fall	
Most Frequent Plume Heading Directions	S, N, SSE		N, S		N, NNE, NE		S, SSW, SW	
	NDCT	LMDCT	NDCT	LMDCT	NDCT	LMDCT	NDCT	LMDCT
Percent of Plumes < 0.25 miles (0.4 km)	19.8	37.3	37.5	62.1	52.4	76.1	40.9	65.4
Percent of Plumes > 0.25 to 0.75 mile (0.4 to 1.2 km)	30.0	28.2	34.4	16.8	28.9	10.3	33.1	15.9
Percent of Plumes > 0.75 to 2 miles (1.2 to 3.2 km)	16.5	16.1	10.8	11.0	8.3	7.3	10.7	11.1
Percent of Plumes > 2 Miles (3.2 km)	33.7	18.4	17.3	10.1	10.4	6.3	15.3	7.6

NOTES:

1. Information in Table from Reference 16, Table 34.

TABLE 5.3-6

HOURS/YR OF FOGGING (4 LMDCT)

Distance		Direction [1]															
(FT)	(M)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE
328	100	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0.4
656	200	0.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0.4	1
984	300	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	1
1,312	400	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	1
1,641	500	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	1
1,969	600	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	1
2,297	700	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	1
2,625	800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2,953	900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.9
3,281	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5
3,609	1100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5
3,937	1200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
4,265	1300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4,593	1400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4,922	1500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5,250	1600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		2.3	0	0	0	0	0	0	0	0	0	0	0	0	0	2.3	9.4

NOTES:

1. Direction Is from the Towers.
2. Information in Table from Reference 16, Table 28.

TABLE 5.3-7

ANNUAL SODIUM SALT DEPOSITION IN LBM/(100-ACRE-MONTH) - 4 NDCT

Distance [1]		Direction [2]															
(mi)	(m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE
1.12	1800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.18	1900	0.250	0.187	0.241	0.214	0.196	0.054	0.062	0.143	0.277	0.134	0.134	0.116	0.143	0.089	0.143	0.205
1.24	2000	0.152	0.116	0.143	0.134	0.116	0.036	0.036	0.080	0.170	0.080	0.080	0.071	0.089	0.054	0.089	0.125
1.30	2100	0.134	0.098	0.125	0.116	0.107	0.027	0.036	0.071	0.152	0.071	0.071	0.062	0.080	0.045	0.080	0.116
1.37	2200	0.116	0.089	0.107	0.098	0.089	0.027	0.027	0.062	0.125	0.062	0.062	0.054	0.062	0.045	0.062	0.098
1.43	2300	0.107	0.089	0.107	0.098	0.089	0.027	0.027	0.062	0.116	0.062	0.062	0.054	0.062	0.036	0.062	0.098
1.49	2400	0.098	0.071	0.098	0.089	0.080	0.018	0.027	0.054	0.107	0.054	0.054	0.045	0.062	0.036	0.062	0.080
1.55	2500	0.098	0.062	0.080	0.071	0.071	0.018	0.018	0.045	0.098	0.045	0.045	0.036	0.054	0.027	0.054	0.062
1.62	2600	0.214	0.125	0.134	0.152	0.116	0.027	0.036	0.089	0.179	0.080	0.080	0.080	0.098	0.054	0.107	0.143
1.68	2700	0.205	0.125	0.125	0.143	0.107	0.027	0.027	0.089	0.170	0.080	0.071	0.071	0.089	0.045	0.098	0.143
1.74	2800	0.089	0.054	0.062	0.062	0.054	0.009	0.018	0.036	0.080	0.036	0.036	0.036	0.045	0.027	0.045	0.062
1.80	2900	0.089	0.054	0.062	0.062	0.054	0.009	0.018	0.036	0.080	0.036	0.036	0.036	0.045	0.027	0.045	0.062
1.86	3000	0.089	0.054	0.062	0.062	0.054	0.009	0.018	0.036	0.080	0.036	0.036	0.036	0.045	0.027	0.045	0.062
1.93	3100	0.107	0.062	0.071	0.071	0.054	0.018	0.018	0.045	0.098	0.045	0.045	0.036	0.045	0.027	0.054	0.071
1.99	3200	0.089	0.045	0.054	0.054	0.045	0.009	0.009	0.036	0.080	0.036	0.036	0.027	0.036	0.018	0.045	0.054
2.05	3300	0.045	0.027	0.027	0.027	0.018	0.009	0.009	0.018	0.045	0.018	0.018	0.009	0.018	0.009	0.018	0.027
2.11	3400	0.045	0.027	0.027	0.027	0.018	0.009	0.009	0.018	0.045	0.018	0.018	0.009	0.018	0.009	0.018	0.027
2.17	3500	0.045	0.027	0.027	0.027	0.018	0.009	0.009	0.018	0.045	0.018	0.018	0.009	0.018	0.009	0.018	0.027
2.24	3600	0.045	0.027	0.027	0.027	0.018	0.009	0.009	0.018	0.045	0.018	0.018	0.009	0.018	0.009	0.018	0.027
2.30	3700	0.045	0.027	0.027	0.027	0.018	0.009	0.009	0.018	0.045	0.018	0.018	0.009	0.018	0.009	0.018	0.027
2.36	3800	0.045	0.027	0.027	0.027	0.018	0.009	0.009	0.018	0.045	0.018	0.018	0.009	0.018	0.009	0.018	0.027
2.42	3900	0.027	0.018	0.009	0.018	0.009	0	0	0.009	0.018	0.009	0.009	0.009	0.009	0.009	0.009	0.018
2.49	4000	0.009	0.009	0	0.018	0	0	0	0.009	0.009	0.009	0	0.009	0	0.009	0	0.018
2.55	4100	0.009	0.009	0	0.009	0	0	0	0.009	0.009	0.009	0	0	0	0	0	0.009
2.61	4200	0.009	0	0	0	0	0	0	0	0.009	0	0	0	0	0	0	0
2.67	4300	0.009	0	0	0	0	0	0	0	0.009	0	0	0	0	0	0	0
2.73	4400	0.009	0	0	0	0	0	0	0	0.009	0	0	0	0	0	0	0

TABLE 5.3-7 (Continued)

Distance [1]		Direction [2]															
(mi)	(m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE
2.80	4500	0.009	0	0	0	0	0	0	0	0.009	0	0	0	0	0	0	0
2.86	4600	0.009	0	0	0	0	0	0	0	0.009	0	0	0	0	0	0	0
2.92	4700	0.009	0	0	0	0	0	0	0	0.009	0	0	0	0	0	0	0
2.98	4800	0.009	0	0	0	0	0	0	0	0.009	0	0	0	0	0	0	0
3.04	4900	0.009	0	0	0	0	0	0	0	0.009	0	0	0	0	0	0	0
3.11	5000	0.009	0	0	0	0	0	0	0	0.009	0	0	0	0	0	0	0
3.17	5100	0.009	0	0	0	0	0	0	0	0.009	0	0	0	0	0	0	0
3.23	5200	0.009	0	0	0	0	0	0	0	0.009	0	0	0	0	0	0	0
3.29	5300	0.009	0	0	0	0	0	0	0	0.009	0	0	0	0	0	0	0
3.36	5400	0.009	0	0	0	0	0	0	0	0.009	0	0	0	0	0	0	0
3.42	5500	0.009	0	0	0	0	0	0	0	0.009	0	0	0	0	0	0	0
3.48	5600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

NOTES:

1. Due to high initial plumes, no salt is deposited within 1800 m of the NDCT tower center.
2. Directions are directions that the plume is headed.
3. Information in Table from Reference 16, Table 12.

TABLE 5.3-8

ANNUAL SODIUM SALT DEPOSITION IN LBM/(100-ACRE-MONTH) - 4 LMDCT

Distance [2]		Direction [1]															
(mi)	(m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE
0.06	100	2.40	2.19	1.96	1.43	0.72	0.19	0.29	1.30	2.35	1.30	1.11	0.80	1.04	0.63	0.87	1.48
0.12	200	3.29	2.59	2.50	1.99	0.99	0.24	0.39	1.76	3.18	1.50	1.38	1.09	1.40	0.83	1.11	2.04
0.19	300	3.14	2.50	2.47	1.77	0.91	0.24	0.39	1.73	3.10	1.43	1.36	1.06	1.37	0.83	1.10	1.90
0.25	400	3.37	2.80	2.86	2.00	1.13	0.30	0.46	1.87	3.38	1.65	1.55	1.17	1.53	0.91	1.20	2.04
0.31	500	5.62	5.24	5.28	3.32	1.76	0.45	0.71	3.20	5.76	3.03	2.85	1.96	2.55	1.39	1.78	3.40
0.37	600	8.01	6.21	6.17	4.52	2.43	0.67	1.06	4.42	7.88	3.57	3.36	2.70	3.48	2.16	2.84	4.81
0.43	700	7.54	5.08	5.00	4.26	2.36	0.68	1.04	4.13	7.32	2.96	2.79	2.51	3.24	2.09	2.83	4.53
0.50	800	3.69	1.41	1.58	2.24	1.53	0.52	0.72	1.86	3.36	0.92	0.84	1.23	1.57	1.42	2.00	2.23
0.56	900	2.09	1.07	1.29	1.53	1.13	0.32	0.39	1.08	1.96	0.77	0.67	0.74	0.97	0.65	0.97	1.29
0.62	1000	1.84	0.99	1.18	1.37	1.04	0.28	0.34	0.94	1.71	0.71	0.62	0.65	0.85	0.50	0.72	1.13
0.68	1100	1.65	0.87	1.02	1.17	0.87	0.21	0.26	0.82	1.48	0.61	0.54	0.56	0.74	0.40	0.61	1.01
0.75	1200	1.65	0.87	1.02	1.17	0.87	0.21	0.26	0.82	1.48	0.61	0.54	0.56	0.74	0.40	0.61	1.01
0.81	1300	1.65	0.87	1.02	1.17	0.87	0.21	0.26	0.82	1.48	0.61	0.54	0.56	0.74	0.40	0.61	1.01
0.87	1400	1.65	0.87	1.02	1.17	0.87	0.21	0.26	0.82	1.48	0.61	0.54	0.56	0.74	0.40	0.61	1.01
0.93	1500	1.14	0.54	0.62	0.80	0.59	0.20	0.24	0.60	1.06	0.36	0.32	0.39	0.52	0.38	0.58	0.71
0.99	1600	0.54	0.17	0.19	0.27	0.15	0.04	0.05	0.29	0.47	0.10	0.10	0.16	0.21	0.15	0.23	0.34
1.06	1700	0.54	0.17	0.19	0.27	0.15	0.03	0.04	0.29	0.47	0.10	0.10	0.16	0.21	0.11	0.12	0.34
1.12	1800	0.54	0.17	0.19	0.27	0.15	0.03	0.04	0.29	0.47	0.10	0.10	0.16	0.21	0.11	0.12	0.34
1.18	1900	0.54	0.17	0.19	0.27	0.15	0.03	0.04	0.29	0.47	0.10	0.10	0.16	0.21	0.11	0.12	0.34
1.24	2000	0.54	0.17	0.19	0.27	0.15	0.03	0.04	0.29	0.47	0.10	0.10	0.16	0.21	0.11	0.12	0.34
1.30	2100	0.54	0.17	0.19	0.27	0.15	0.03	0.04	0.29	0.47	0.10	0.10	0.16	0.21	0.11	0.12	0.34
1.37	2200	0.44	0.17	0.19	0.21	0.12	0.03	0.04	0.21	0.37	0.10	0.10	0.13	0.16	0.11	0.12	0.27
1.43	2300	0.28	0.17	0.19	0.13	0.08	0.03	0.04	0.12	0.22	0.10	0.10	0.08	0.10	0.11	0.12	0.17
1.49	2400	0.13	0.14	0.16	0.06	0.04	0.03	0.04	0.06	0.11	0.08	0.08	0.04	0.04	0.11	0.12	0.08
1.55	2500	0.08	0.04	0.04	0.04	0.03	0.02	0.03	0.04	0.06	0.03	0.03	0.03	0.03	0.07	0.08	0.04
1.62	2600	0.08	0.04	0.04	0.04	0.03	0.00	0.01	0.04	0.06	0.03	0.03	0.03	0.03	0.01	0.02	0.04
1.68	2700	0.08	0.04	0.04	0.04	0.03	0.00	0.01	0.04	0.06	0.03	0.03	0.03	0.03	0.01	0.02	0.04

TABLE 5.3-8 (Continued)

Distance [2]		Direction [1]															
(mi)	(m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE
1.74	2800	0.08	0.04	0.04	0.04	0.03	0.00	0.01	0.04	0.06	0.03	0.03	0.03	0.03	0.01	0.02	0.04
1.80	2900	0.08	0.04	0.04	0.04	0.03	0.00	0.01	0.04	0.06	0.03	0.03	0.03	0.03	0.01	0.02	0.04
1.86	3000	0.08	0.04	0.04	0.04	0.03	0.00	0.01	0.04	0.06	0.03	0.03	0.03	0.03	0.01	0.02	0.04
1.93	3100	0.09	0.04	0.04	0.04	0.04	0.01	0.01	0.04	0.07	0.03	0.04	0.03	0.03	0.01	0.03	0.05
1.99	3200	0.09	0.04	0.04	0.04	0.04	0.01	0.01	0.04	0.07	0.03	0.04	0.03	0.03	0.01	0.02	0.05
2.05	3300	0.09	0.05	0.04	0.04	0.04	0.01	0.01	0.04	0.07	0.03	0.04	0.03	0.03	0.01	0.03	0.05
2.11	3400	0.09	0.05	0.05	0.04	0.04	0.01	0.01	0.04	0.07	0.03	0.04	0.03	0.03	0.01	0.03	0.05
2.17	3500	0.09	0.05	0.05	0.04	0.04	0.01	0.01	0.04	0.07	0.03	0.04	0.03	0.03	0.01	0.03	0.05
2.24	3600	0.09	0.05	0.05	0.04	0.04	0.01	0.01	0.04	0.07	0.03	0.04	0.03	0.03	0.01	0.03	0.05
2.30	3700	0.09	0.05	0.05	0.04	0.04	0.01	0.01	0.04	0.07	0.03	0.04	0.03	0.03	0.01	0.03	0.05
2.36	3800	0.09	0.05	0.05	0.04	0.04	0.01	0.01	0.04	0.07	0.03	0.04	0.03	0.03	0.01	0.03	0.05
2.42	3900	0.09	0.05	0.05	0.04	0.04	0.01	0.01	0.04	0.07	0.03	0.04	0.03	0.03	0.01	0.03	0.05

NOTES:

1. Direction is the direction the plume is heading.
2. Trace amounts extend out to 10,000 meters.
3. Information in Table from Reference 16, Table 23.

TABLE 5.3-9

DEPOSITION RATE ON NEAREST HOMES AND GARDENS

Nearest Homes

			Deposition Rates [2]					
	Distance [1]		TDS		NaCl		Fe+	
Direction	(miles)	(meters)	(lbm/100-acre-mon)	(kg/ha-mon) [4]	(lbm/100-acre-mon)	(kg/ha-mon) [4]	(lbm/100-acre-mon)	(kg/ha-mon) [4]
N-NE	0.38	611	46.50	$5.21x10^{-1}$	3.57	$4.00x10^{-2}$	7.4×10^{-3}	$8.29x10^{-5}$
NE	0.31	499	37.21	$3.05x10^{-1}$	2.85	$3.19x10^{-2}$	5.9×10^{-3}	$6.61x10^{-5}$
E-NE	2.34	3,765	1.07	$1.2x10^{-2}$	0.03	$3.36x10^{-4}$	0	0
E	0.46	740	42.14	$4.72x10^{-1}$	3.24	$3.63x10^{-2}$	6.7×10^{-3}	$7.51x10^{-5}$
E-SE	1.06	1,706	1.26	$1.41x10^{-2}$	0.11	$1.23x10^{-3}$	0	0
	2.44	3,926	1.06	$1.19x10^{-2}$	0.01	$1.12x10^{-4}$	0	0
SE	2.51	4,039	<1.46	$<1.64x10^{-1}$	<0.03	$<3.36x10^{-4}$	0	0
S-SE	1.65	2,655	2.40	$2.69x10^{-2}$	* 0.14	*$1.57 x10^{-3}$	* 2.7×10^{-4}	*$3.03x10^{-6}$
S	3.74	6,018	<3.21	$<3.60x10^{-2}$	<0.09	$<1.01 x10^{-3}$	$<8.9 \times 10^{-5}$	$<9.98x10^{-7}$
S-SW	1.36	2,188	4.55	$5.10x10^{-2}$	0.17	$1.91 x10^{-3}$	2.7×10^{-4}	$3.03x10^{-6}$
	2.79	4,489	<2.25	$<2.52x10^{-2}$	<0.05	$5.6 x10^{-4}$	0	0
N-NW	0.56	901	12.86	$1.44 x10^{-1}$	1.08	$1.21 x10^{-2}$	1.8×10^{-3}	$2.02x10^{-5}$

TABLE 5.3-9 (Continued)

Nearest Gardens

	Distance [1]		Deposition Rates [2]					
			TDS		NaCl		Fe+	
Direction	(miles)	(meters)	(lbm/100-acre-mon)	(kg/ha-mon) [4]	(lbm/100-acre-mon)	(kg/ha-mon) [4]	(lbm/100-acre-mon)	(kg/ha-mon) [4]
E	0.46	740	42.14	$4.72x10^{-1}$	3.24	$3.63x10^{-2}$	$6.7 x 10^{-3}$	$7.51x10^{-5}$
	2.53	4,071	<1.42	$<1.59x10^{-2}$	<0.03	$<3.36 x10^{-4}$	0	0
E-SE	1.04	1,673	1.71	$1.91x10^{-2}$	0.15	$1.68x10^{-3}$	$8.9 x 10^{-5}$	$<9.98x10^{-7}$
	2.44	3,926	<1.06	$1.19x10^{-2}$	<0.01	$1.12x10^{-4}$	0	0
SE	4.27	6,870	<1.46	$<1.64x10^{-2}$	<0.03	$<3.36x10^{-4}$	0	0
S-SE	4.92	7,916	<2.03	$<2.28x10^{-2}$	<0.05	$<5.60x10^{-4}$	0	0
S	3.74	6,018	<3.21	$<3.60x10^{-2}$	<0.09	$<1.01x10^{-3}$	$<8.9 x 10^{-5}$	$<9.98x10^{-7}$
S-SW	2.79	4,489	<2.25	$<2.52x10^{-2}$	<0.05	$<5.60 x10^{-4}$	0	0
	1.36	2,188	4.55	$5.10x10^{-2}$	0.17	$1.91x10^{-3}$	$6.2 x 10^{-4}$	$6.96x10^{-6}$
N-NW	1.21	1,947	3.03	$3.40x10^{-2}$	0.29	$3.25x10^{-3}$	* $2.7 x 10^{-4}$	*$3.03x10^{-6}$

NOTES:

1. Distances were estimated using the locations given in the GGNS 2001 Annual Radiological Environmental Operating Report (Reference 23) and the identified location of the new cooling tower area for the new facility (Mississippi West Grid coordinates: N 551,952.40, E 278,367.24, see Figure 2.3-1).
2. Deposition Rates from Reference 16.
3. *Indicates that bounding value is based on NDCT bounding value; all other values are based on LMDCT bounding values.
4. To convert from kg/ha-mon to g/m^2-mon divide by 10.

TABLE 5.4-1

LIQUID PATHWAY PARAMETERS

Description	Parameter
Effluent Discharge [1]	12,800 gpm
Source Term [2]	Isotope Maximum Composite Release
Commercial Fish Catch [3]	446,467 kg
Invertebrate Harvest [3]	3,511 kg

NOTES:
1. Source Table 3.0-1.
2. Source Table 3.0-8.
3. GGNS FER (Reference 1).

TABLE 5.4-2

LIQUID PATHWAY CONSUMPTION FACTORS

	Usage/Consumption Factors [1]						
Age Group	Fish (kg/yr)	Invertebrates (kg/yr)	Aquatic Plants	Drinking Water	Shoreline (hr/yr)	Swimming (hr/yr)	Boating (hr/yr)
Adult	21	5.0	0.0	0.0	12	0.0	0.0
Teen	16	3.8	0.0	0.0	67	0.0	0.0
Child	6.9	1.7	0.0	0.0	14	0.0	0.0
Infant	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NOTES:

1. Consumption Factors from USNRC Regulatory Guide 1.109, Table E-5.

TABLE 5.4-3

GASEOUS PATHWAY PARAMETERS

Input Description	Location of Data
Source Term	Table 3.0-7
Population Data	Section 2.5
Meteorological Data	Section 2.7
Consumption Factors	Table 5.4-4
Milk Production	Table 5.4-5
Meat Production	Table 5.4-6
Vegetable Production	Table 5.4-7

TABLE 5.4-4

GASEOUS PATHWAY CONSUMPTION FACTORS

	Maximum Individual Consumption Factors [1]			
Maximum Individual	Vegetables (kg/yr)	Leafy Vegetables (kg/yr)	Milk (L/yr)	Meat (kg/yr)
Adult	520	64	310	110
Teen	630	42	400	65
Child	520	26	330	41
Infant	0	0	330	0

NOTES:
1. Consumption Factors from USNRC Regulatory Guide 1.109, Table E-5.

TABLE 5.4-5

MILK PRODUCTION FROM 10 TO 50 MILES FROM GGNS SITE

	Milk Production (Liters/yr)			
SECTOR	10-20	20-30	30-40	40-50
N-NE	0	0	0	0
NE	0	336,480	336,480	336,480
E-NE	0	336,480	672,959	672,959
E	0	854,659	854,659	854,659
E-SE	0	1,722,775	1,722,775	1,722,775
SE	0	343,209	1,009,439	11,776,790
S-SE	0	0	672,959	672,959
S	336,480	336,480	1,009,439	0
S-SW	1,682,399	336,480	336,480	336,480
SW	0	0	0	0
W-SW	0	0	403,776	975,792
W	0	1,514,159	1,514,159	1,514,159
W-NW	0	0	1,514,159	2,691,838
NW	0	0	0	2,691,838
N-NW	0	0	0	672,959
N	0	0	0	0

TABLE 5.4-6

TOTAL MEAT PRODUCTION BETWEEN 0 AND 50 MILES BY SECTOR

	Meat Production (Kg/yr)									
SECTOR	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
N-NE	0	0	0	0	0	2,814	16,738	39,418	71,871	88,427
NE	0	0	0	0	1,925	5,464	193,395	719,571	1,216,263	1,453,516
E-NE	0	0	0	0	9,603	8,278	331,128	1,052,352	2,045,736	2,045,736
E	0	0	0	0	8,278	11,093	408,240	813,829	1,310,521	1,310,521
E-SE	0	0	0	0	16,556	11,093	408,240	949,909	839,478	977,393
SE	0	0	0	0	0	0	331,128	44,090	60,962	1,118,557
S-SE	0	0	0	0	12,633	77,112	450,336	339,905	220,697	697,843
S	0	0	0	0	8,278	0	450,336	339,905	559,762	27,649
S-SW	0	0	0	0	0	0	450,336	339,905	691,740	597,865
SW	0	0	0	0	0	0	130,135	36,426	220,697	171,461
W-SW	0	0	0	0	0	0	211,425	111,066	326,299	475,942
W	0	0	0	0	2,152	0	43,544	172,232	308,491	314,756
W-NW	0	0	0	0	11,093	0	106,458	243,308	281,007	597,412
NW	0	0	0	0	0	11,093	75,000	75,978	87,794	468,322
N-NW	0	0	0	0	0	0	137,915	120,183	175,316	661,555
N	0	0	0	0	2,814	0	41,391	64,885	110,431	116,101
TOTAL	0	0	0	0	73,332	126,947	3,785,745	5,462,962	8,527,065	11,123,056

TABLE 5.4-7

TOTAL VEGETABLE PRODUCTION BETWEEN 0 AND 50 MILES BY SECTOR

	Total Vegetable Production (kg/yr)									
SECTOR	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
N-NE	0	0	0	0	0	10,623	27,549	34,568	75,896	84,986
NE	0	0	0	0	0	0	218,838	76,487	648,016	1,202,548
E-NE	0	0	0	0	0	0	276,204	297,450	1,062,322	1,062,322
E	0	0	42,493	84,986	0	127,479	448,572	67,223	84,986	1,064,989
E-SE	0	0	0	42,493	0	0	342,248	84,986	389,732	2,318,642
SE	0	0	0	0	0	6,350	193,523	0	241,112	858,459
S-SE	0	0	0	0	0	15,501	0	106,232	107,259	104,160
S	0	0	0	0	0	1,270	21,247	59,490	42,493	194,374
S-SW	0	0	0	0	0	3,171	21,247	63,739	127,479	63,739
SW	0	0	0	0	0	0	42,493	63,739	0	89,235
W-SW	0	0	0	0	0	0	25,496	212,465	127,479	169,971
W	0	0	0	0	0	25,496	0	169,971	254,957	254,957
W-NW	0	0	0	0	0	0	0	169,971	637,390	212,465
NW	0	0	0	0	0	0	0	0	169,971	37,165
N-NW	0	0	0	0	0	0	84,986	0	0	844,167
N	10,623	0	0	0	0	0	424,929	424,929	254,954	0
TOTAL	10,623	0	42,493	127,479	0	189,890	2,127,332	1,831,250	4,224,046	8,562,179

TABLE 5.4-8

LIQUID PATHWAY
COMPARISON OF MAXIMUM INDIVIDUAL DOSE TO
10 CFR 50, APPENDIX I CRITERIA

Estimated Maximum Individual Dose from Liquid Effluents
(mrem/yr, Per Unit)

Pathway	Annual Dose Total Body [2]	Maximum Organ (bone) [3]	Dose Limit [1]
Aquatic Foods	2.17	4.09	Total Body: 3
Shoreline Use	3.06E-03	3.56E-03	Any organ: 10
Total	2.17	4.10	

NOTES:

1. 10CFR50 Appendix I Limits.
2. An adult was found to receive the maximum individual total body dose.
3. A child was found to receive the maximum individual organ dose.

TABLE 5.4-9

LIQUID PATHWAY
COMPARISON OF MAXIMUM INDIVIDUAL DOSE TO
40 CFR 190 CRITERIA

Type of Dose (Annual)	Design Objective [1] (mrem/yr)	Calculated Dose (mrem/yr)
Whole body dose equivalent	25	4.34
Thyroid dose	75	5.40E-01
Dose to another organ	25	8.19 (bone)

NOTES:
1. Source 40 CFR 190.

TABLE 5.4-10

ESTIMATED POPULATION DOSE FROM LIQUID EFFLUENTS VIA THE AQUATIC FOOD PATHWAY

Item	Annual Dose (man-rem/yr, per unit)
Whole Body	2.06
Maximum organ (Liver)	3.32

TABLE 5.4-11A

ANNUAL DOSE TO A MAXIMALLY EXPOSED INDIVIDUAL FROM GASEOUS EFFLUENTS (Per Unit)

Location	Pathway	Dose Rate (mrem/yr) Total Body	Skin	Thyroid
Nearest Residence [1, 3] (N-NE, 0.64 mile)	Plume Exposure	6.30E-01	2.09E+00	6.30E-01
	Inhalation			
	Adult	1.71E-01	1.69E-01	6.90E-01
	Teen	1.73E-01	1.71E-01	8.50E-01
	Child	1.53E-01	1.51E-01	9.95E-01
	Infant	8.81E-02	8.65E-02	8.55E-01
Nearest Garden [1, 3] (E-NE, 0.63 miles)	Vegetable Consumption			
	Adult	3.87E-01	3.55E-01	2.87E+00
	Teen	4.90E-01	4.57E-01	3.60E+00
	Child	9.01E-01	8.55E-01	6.70E+00
Nearest Site Boundary [2, 3] (N, 0.58 miles)	Plume Exposure	1.18E+00	3.88E+00	1.18E+00
	Inhalation			
	Adult	3.18E-01	3.14E-01	1.28E+00
	Teen	3.21E-01	3.17E-01	1.58E+00
	Child	2.85E-01	2.80E-01	1.84E+00
Nearest Milk Cow [1] (S-SW, 10.0 miles)	Cow Milk			
	Adult	5.65E-03	5.25E-03	5.50E-02
	Teen	8.33E-03	7.80E-03	8.65E-02
	Child	1.59E-02	1.52E-02	1.72E-01
	Infant	2.87E-02	2.77E-02	4.09E-01
Nearest Meat Cow [1] (S, 4.0 miles)	Meat Consumption			
	Adult	6.53E-03	6.25E-03	1.44E-02
	Teen	4.72E-03	4.55E-03	1.04E-02
	Child	7.58E-03	7.40E-03	1.63E-02

NOTES:

1. "Nearest" refers to the location at which the highest radiation dose to an individual from the applicable pathways has been estimated.
2. "Nearest" refers to that site boundary location at which the highest radiation doses due to gaseous effluents have been estimated to occur.
3. Distances are corrected for the approximate difference between GGNS Unit 1 location and the ESP facility location. For example, dose analyses were done using a distance of 0.63 miles for the nearest garden, rather than the distance of 0.67 miles given in ER Section 2.7 Reference 29 for this receptor location. The GGNS 2001 Land Use Census results show the nearest residence and garden at a distance of 0.67 miles; however, the ESP analysis conservatively considered the nearest home in the N-NE Sector at a distance of 0.64 miles since this location has the highest D/Q value.

TABLE 5.4-11B

COMPARISON OF MAXIMUM INDIVIDUAL DOSE TO 10 CFR 50, APPENDIX I CRITERIA – GASEOUS PATHWAY
(Per Unit)

Type of Dose	Design Objective [1]	Point of Evaluation	Calculated Dose
Gaseous Effluents			
Gamma air dose	10 mrad	Exclusion Area Boundary	1.80 mrad
Beta air dose	20 mrad	Exclusion Area Boundary	3.48 mrad
Total body dose (Teen)	5 mrem	Exclusion Area Boundary	1.62 mrem
Skin dose (Teen)	15 mrem	Exclusion Area Boundary	4.42 mrem
Vegetable Consumption (Child, thyroid)	15 mrem	Exclusion Area Boundary	6.70 mrem

NOTES:
1. Source 10 CFR 50, Appendix I.

TABLE 5.4-12

COMPARISON OF MAXIMUM INDIVIDUAL DOSE TO
40 CFR 190 CRITERIA - GASEOUS PATHWAY

Type of Dose (Annual)	Design Objective [1]	Calculated Dose [2]
Whole body dose equivalent	25 mrem	1.62 mrem
Dose to thyroid	75 mrem	3.21 mrem
Dose to skin	25 mrem	4.42 mrem

NOTES:
1. Source 40 CFR 190.
2. Plume + inhalation dose at EAB, based on one unit.
3. See Table 5.4-18 for total site dose comparisons to 40 CFR 190 criteria.

TABLE 5.4-13

ANNUAL POPULATION DOSES - GASEOUS PATHWAY

Pathway	Estimated Doses (Person rem)	
	Whole Body	Thyroid (Worst Case Organ)
Plume	1.57E-01	1.57E-01
Ground	5.46E-02	5.46E-02
Inhalation	4.18E-01	1.23E+00
Vegetable Ingestion	1.52E-01	1.54E-01
Cow Milk Ingestion	2.15E-01	8.90E-01
Meat Ingestion	1.84E-01	2.48E-01
Total	1.18E+00	2.73E+00

TABLE 5.4-14

TERRESTRIAL BIOTA PARAMETERS [1]

Terrestrial Biota	Food Intake (gm/day)	Body Mass (gm)	Effective Body Radius (cm)
Muskrat	100	1,000	6
Raccoon	200	12,000	14
Heron	600	4,600	11
Duck	100	1,000	5

NOTES:
1. Source NUREG/CR-4013.

TABLE 5.4-15

BIOTA RESIDENCE TIMES [1]

Biota	Shoreline Exposure (hr/yr)	Swimming Exposure (hr/yr)
Fish	4380	8760
Invertebrates	8760	8760
Algae	Note 2	8760
Muskrat	2922	2922
Raccoon	2191	Note 2
Heron	2922	2920
Duck	4383	4383

NOTES:
1. Source NUREG/CR-4013.
2. Data not available.

TABLE 5.4-16

DOSE TO BIOTA FROM LIQUID AND GASEOUS EFFLUENTS

Organism	Liquid Effluents Internal Dose (mrem/yr)	Liquid Effluents External Dose (mrem/yr)	Gaseous Effluents Internal Dose (mrem/yr)	Gaseous Effluents External Dose (mrem/yr)
Fish	14.20	11.20	N/A	N/A
Invertebrate	143.00	22.30	N/A	N/A
Algae	148.00	0.05	N/A	N/A
Muskrat	73.80	7.45	1.64E-01	2.03
Raccoon	13.40	5.57	1.64E-01	1.82
Heron	186.00	7.44	1.64E-01	1.69
Duck	69.90	11.20	1.64E-01	2.14

TABLE 5.4-17

BIOTA DOSES COMPARED TO 40 CFR 190
WHOLE BODY DOSE EQUIVALENT OF 25 MREM/YR

Biota meeting 40 CFR 190	Biota Exceeding 40 CFR 190
Fish	Invertebrate
Raccoon	Algae
	Muskrat
	Heron
	Duck

TABLE 5.4-18

TOTAL SITE DOSE
COMPARISON OF MAXIMUM SITE INDIVIDUAL DOSE TO 40 CFR 190 CRITERIA

Type of Dose (Annual)	ESP Facility (2-Units) Dose [2] (mrem)	GGNS Unit 1 Dose [2] (mrem)	Total Site Dose [1] (mrem)	Design Objective [3] (mrem)
Whole Body Dose Equivalent	7.58	1.33	8.91	25
Thyroid Dose	6.96	9.65	16.61	75
Dose to Another Organ	10.97 (bone)	9.65 [4] (bone)	20.62 (bone)	25
	8.84 (skin)	2.16 (skin)	11.00 (skin)	

NOTES:

1. Includes all pathways for all effluents and direct radiation sources for all units at the site. Direct radiation has been shown to be negligible per Section 5.4.1.3.

2. Includes all pathways for all effluents and direct radiation sources. Direct radiation has been shown to be negligible. Source for GGNS Unit 1 data is GGNS UFSAR Tables 11.2-11 and 11.3-12.

3. Source 40 CFR 190.

4. Dose to other organs are less than the dose to the thyroid.

TABLE 5.7-1

GAS-COOLED FUEL CYCLE WORKSHEET

Reactor Technology	Reference LWR[12] (Single Unit) (1000 MWe) 80% Capacity	GT-MHR (4 Modules) (2400 MWt Total) (1,140 MWe Total) 88% Capacity	PBMR (8 Modules) (3200 MWt Total) (1,340 MWe Total) 95% Capacity
Facility/Activity			
Mining Operations			
Annual ore supply MT	272,000	337,140	337,140
Normalized annual ore supply MT	272,000	269,712	214,739
% of reference LWR	1	0.99	0.79
Recalculated number	314,011	269,712	214,739
Milling Operations			
Annual yellowcake MT	293	303	303
Normalized annual yellowcake MT	293	243	193
% of reference LWR	1	0.83	0.66
Recalculated number	283	243	193
UF_6 Production			
Annual UF_6 MT	360	379	379
Normalized annual UF_6 MT	360	303	241
Fraction of reference LWR	1	0.84	0.67
Calculated number	353	303	241
Enrichment Operations			
Enriched UF_6 MT	52	8.0	12.3
Normalized enriched UF_6 MT	52	6.38	7.9
Fraction of reference LWR	1	0.12	0.15
Calculated number	52	6.38	7.9
Annual SWU MT	127	204	194
Normalized annual SWU MT	127	163	124
Fraction of reference LWR	1	1.29	0.97
Calculated number	126	163	124

TABLE 5.7-1 (Continued)

Reactor Technology	Reference LWR[12] (Single Unit) (1000 MWe) 80% Capacity	GT-MHR (4 Modules) (2400 MWt Total) (1,140 MWe Total) 88% Capacity	PBMR (8 Modules) (3200 MWt Total) (1,340 MWe Total) 95% Capacity
Facility/Activity			
Fuel Fabrication Plant Operations			
Enriched UO_2 MT	40	6.11	9.5
Normalized enriched UO_2 MT	40	4.89	6.0
Fraction of reference LWR	1	0.12	0.15
Calculated number	40	4.89	6.0
Annual Fuel Loading MTU	35	5.39	8.34
Normalized annual fuel loading MTU	35	4.3	5.31
Fraction of reference LWR	1	0.12	0.15
Reprocessing Plant Operations			
Annual spent fuel reprocessing MTU	35	0	0
Solid Radioactive Waste			
Annual LLW from reactor operations Ci	9,100	1100 Ci; 98 m^3	65.4 Ci; 800 drums
Fraction of reference LWR	1	0.12	0.01
LLW from Reactor Decontamination & Decommissioning Ci per RRY	1,500	Data not available.	$2.2x10^4$ ($5.30x10^5$ Ci after 24 years operation and 2 years decay)
TRU and HLW Ci	$1.1x10^7$	Reprocessing not considered.	Reprocessing not considered.

TABLE 5.7-1 (Continued)

NOTES:

1. The enrichment separative work units (SWU) calculation was performed using the USEC SWU calculator and assumes a 0.30% tails assay.
2. The information on the reference reactor (mining, milling, UF6, enrichment, fuel fabrication values) taken from NUREG-0116, Table 3.2, no recycling.
3. The information on the reference reactor (solid radioactive waste) taken from 10CFR51.51, Table S-3.
4. The calculated information on the reference reactor uses the same methodology as for the reactor technologies.
5. The normalized information is based on 1000 MWe and the reactor vendor supplied unit capacity factor.
6. For the new reactor technologies, the annual fuel loading was provided by the reactor vendor.
7. The USEC SWU calculator also calculated the kgs of U feed. This number was multiplied by 1.48 to get the necessary amount of UF_6.
8. The annual yellowcake number was generated using the relationship 2.61285 lbs of U_3O_8 to 1 kg U of $UF_{6;}$ 1.185 kgs of U_3O_8 to 1.48 kg of UF_6.
9. The annual ore supply was generated assuming an 0.1% ore body and a 90% recovery efficiency.
10. Co-60 with a 5.26 year half-life and Fe-55 with a 2.73 year half-life are the main nuclides listed for the PBMR D&D waste.
11. Highlight indicates a value larger than Table S-3 of Reference 1 below, or data not provided by vendors.
12. The "Reference LWR" refers to the model 1000 MWe light-water-cooled nuclear reactor used a basis for studying annual fuel related requirements as described in WASH-1248.

SOURCE:

10 CFR 51.51, Table S-3 Table of Uranium Fuel Cycle Environmental Data.

TABLE 5.7-2

GAS-COOLED REACTOR SWU AND FEED CALCULATION RESULTS

Reactor Technology	Uranium Product (kgs)	Weight Percent U235	SWU Quantity	U Feed Required (kgs)	Tails Assay
GT-MHR	5,394	19.80%	204,373	255,918	0.30%
PBMR	8,340	12.90%	194,414	255,679	0.30%
NUREG-0116	35,000	3.10%	126,175	238,455	0.30%
WASH-1248	35,000	3.20%	147,280	223,965	0.25%

NOTES:

1. The reactor vendor supplied the kgs uranium product and weight percent U235.
2. The tails assay was assumed to be 0.3% to match NUREG-0116 with the exception of WASH-1248 which used a tail assay of 0.25%.
3. The separative work units (SWU) Quantity and kgs Feed Required were calculated using the USEC SWU Calculator.
4. The results have not been normalized to equivalent electrical generation.

TABLE 5.7-3

TABLE S-3 - TABLE OF URANIUM FUEL CYCLE ENVIRONMENTAL DATA[1]

[Normalized to model LWR annual fuel requirement (WASH-1248)
or reference reactor year (NUREG-0116)]

Environmental Considerations	Total	Maximum effect per annual fuel requirement or reference reactor year of model 1,000 MWe LWR.
Natural Resource Use		
Land (acres)		
Temporarily committed[2]	100	
Undisturbed area	79	
Disturbed area	22	Equivalent to a 110 MWe coal-fired power plant.
Permanently committed	13	
Overburden moved (millions of MT)	2.8	Equivalent to 95 MWe coal-fired power plant.
Water (millions of gallons)		
Discharged to air	160	=2 percent of model 1,000 MWe LWR with cooling tower.
Discharged to water bodies	11,090	
Discharged to ground	127	
Total	11,377	<4 percent of model 1,000 MWe LWR with once through cooling.
Fossil Fuel:		
Electrical energy (thousands of MW-hour)	323	<5 percent of model 1,000 MWe output.
Equivalent coal (thousands of MT)	118	Equivalent to the consumption of a 45 MWe coal-fired power plant.
Natural gas (millions of scf)	135	<0.4 percent of model 1,000 MWe energy output.
Effluents-Chemical (MT)		
Gases (including entrainment):[3]		
SO_x	4,400	
NO_x[4]	1,190	Equivalent to emissions from 45 MWe coal-fired plant for a year.
Hydrocarbons	14	
CO	29.6	
Particulates	1,154	

TABLE 5.7-3 (Continued)

Environmental Considerations	Total	Maximum effect per annual fuel requirement or reference reactor year of model 1,000 MWe LWR.
Other gases		
F	.67	Principally from UF_6, production, enrichment, and reprocessing. Concentration within range of state standards- below level that has effects on human health.
HCl	.014	
Liquids:		
SO-$_4$	9.9	From enrichment, fuel fabrication, and reprocessing steps. Components that constitute a potential for adverse environmental effect are present in dilute concentrations and receive additional dilution by receiving bodies of water to levels below permissible standards. The constituents that require dilution and the flow of dilution water are: NH_3-600cfs., NO_3-20cfs., Fluoride-70cfs.
NO-$_3$	25.8	
Fluoride	12.9	
CA^{++}	5.4	
$C1^{-}$	8.5	
Na^{+}	12.1	
NH_3	10.0	
Fe	.4	
Tailings Solutions (thousands of MT)	240	From mills only-- no significant effluents to environment.
Solids	91,000	Principally from mills-- no significant effluents to environment.
Effluents-- Radiological (curies)		
Gases (including entrainment):		
Rn-222		Presently under reconsideration by the Commission.
Ra-226	.02	
Th-230	.02	
Uranium	.034	
Tritium (thousands)	18.1	
C-14	24	
Kr-85(thousands)	400	
Ru-106	.14	Principally from fuel reprocessing plants.
I-129	1.3	
I-131	.83	

TABLE 5.7-3 (Continued)

Environmental Considerations	Total	Maximum effect per annual fuel requirement or reference reactor year of model 1,000 MWe LWR.
Tc-99		Presently under consideration by the Commission.
Fission products and transuranics	.203	
Liquids:		
Uranium and daughters	2.1	Principally from milling-- included tailings liquor and returned to ground -- no effluents; therefore, no effect on the environment.
Ra-226	.0034	From UF_6 production.
Th-230	.0015	
Th-234	.01	From fuel fabrication plants-- concentration 10 percent of 10 CFR 20 for total processing 26 annual fuel requirements for model LWR.
Fission and activation products	5.9×10^{-6}	
Solids (buried on site):		
Other than high level (shallow)	11,300	9,100 Ci comes from low level reactor wastes and 1,5000 Ci comes from reactor decontamination and decommissioning -- buried at land burial facilities. 600 Ci comes from mills -- included in tailing returned to ground. Approximately 60 Ci comes from conversion and spent fuel storage. No significant effluent to the environment.
TRU and HLW (deep)	1.1×10^{7}	Buried at Federal Repository.
Effluents-- thermal (billions of British thermal units)	4,063	<5 percent of model 1,000 MWe LWR.
Transportation (person-rem):		
Exposure of workers and general public	2.5	
Occupational exposure	22.6	From reprocessing and waste management.

[49 FR 9381, Mar. 12, 1984; 49 FR 10922, Mar. 23, 1984]

TABLE 5.7-3 (Continued)

NOTES:

1. In some cases where no entry appears it is clear from the background documents that the matter was addressed and that, in effect, the Table should be read as if a specific zero entry had been made. However, there are other areas that are not addressed at all in the Table. Table S-3 does not include health effects from the effluents described in the Table, or estimates of releases of Radon-222 from the uranium fuel cycle, or estimates of Technetium-99 released from waste management or reprocessing activities. These issues may be the subject of litigation in the individual licensing proceedings.

   Data supporting this table are given in the Environmental Survey of the Uranium Fuel Cycle," WASH-1248, April 1974; the "Environmental Survey of Reprocessing and Waste Management Portion of the LWR Fuel Cycle," NUREG-0116 (Supp. 1 to WASH-1248); the "Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," NUREG-0216 (Supp.2 to WASH-1248): and in the record of final rulemaking pertaining to Uranium Fuel Cycle Impacts from Spent Fuel Reprocessing and Radioactive Waste Management, Docket RM-50-3. The contributions from reprocessing, waste management and transportation of wastes are maximized for either of the two fuel cycles (uranium only and fuel recycle). The contribution from transportation excludes transportation of cold fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor which are considered in Table S-4 of §51.20(g). The contributions from the other steps of the fuel cycle are given in columns A-E of Table S-3A of WASH-1248.

2. The contributions to temporarily committed land from reprocessing are not prorated over 30 years, since the complete temporary impact accrues regardless of whether the plant services one reactor for one year or 57 reactors for 30 years.

3. Estimated effluents based upon combustion of equivalent coal for power generation.

4. 1.2 percent from natural gas use and process.

TABLE 5.10-1

MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING OPERATION OF THE PROPOSED NEW FACILITY AT THE GGNS SITE

Impact Category	Description of Impact	Explanation and Potential Mitigation Measures
5.1 Land Use Impacts		
5.1.1 The Site and Vicinity	Minimal or no impacts expected to land use, primarily forestry and agriculture, in the vicinity of the GGNS site.	None necessary.
	Recreation facilities in the region may experience an increase in usage because of the increase in the operational work force at the GGNS site. No adverse impacts to recreational facilities would be expected.	None necessary.
	Vehicular traffic on highways and access roads to the GGNS site would increase with the 155% increase in total staffing at GGNS site. This would result in a concomitant increase in vehicular accidents.	Transportation routes in the region were adequate for the larger construction work force for the existing GGNS Unit 1 facility. There are several on-going and planned upgrades to highways in the region that would likely be completed prior to the start of operation of the proposed new facility. These upgrades would help minimize traffic impacts and accidents.
	The bounding estimate of salt deposition from the operation of cooling towers would be approximately 8 lbm/100-acre-month. This amount would not be expected to cause damage to vegetation in the vicinity of the GGNS site. Thus, impacts would be expected to be minimal.	Drift eliminators would be incorporated into design of cooling towers to minimize the potential for salt deposition.
5.2 Water Related Impacts		
5.2.1 Hydrologic Alterations and Plant Water Supply	A new facility would require a maximum of 85,000 gpm of water from the Mississippi River. No adverse impact on the river hydraulic characteristics would be expected.	85,000 gpm is approximately 0.2% of the minimum historical flow in the river. Operation of the intake pumping station would not impact the flow of water across the floodplain. No mitigation necessary.

TABLE 5.10-1 (Continued)

Impact Category	Description of Impact	Explanation and Potential Mitigation Measures
	Operation of the proposed new facility would require 180 gpm (240 gpm maximum peak usage) of water from the Catahoula formation. No significant impact on the water level of the Catahoula formation would be expected.	There has been no significant lowering of the ground water table around the plant structures during operation of GGNS Unit 1. The new well required for construction of the proposed new facility could be used for operation as well.
	Dewatering of portions of the site for the proposed facility may be necessary during facility operations. This would cause a local depression in the perched water table. The impact of this dewatering on ground water supply would be expected to be minimal.	Dewatering during operations, if required, would be only from the perched water table, not the Catahoula aquifer. The GGNS Unit 1 potable water wells draw from the Catahoula aquifer. There should be no effect on this aquifer due to dewatering during operations.
	Portions of Stream A and Stream B may be rerouted to accommodate new facility structures. These streams have been previously impacted by GGNS Unit 1. Additional impacts would not be expected to be significant.	Natural drainage patterns would be maintained as much as is practicable. Appropriate permits would be obtained for work in waters of the U.S.
	No significant alterations to Hamilton Lake would be expected as a result of operation of the proposed new facility.	Sedimentation Basins A and B would be maintained to continue to minimize the increase in the sedimentation rate to Hamilton Lake. Discharges to Hamilton Lake would be maintained at levels acceptable under future NPDES permit requirements.
	No significant impacts to Stream A and Stream B would be expected from increased discharges or runoff during the operation of the proposed new facility.	Discharges to Stream A and Stream B from the proposed new facility would likely be similar to that from the existing GGNS facility, and may include increased discharge from the waste-water treatment plant, building drains, and storm water. Discharges to these streams would be controlled in accordance with future NPDES permit requirements.

TABLE 5.10-1 (Continued)

Impact Category	Description of Impact	Explanation and Potential Mitigation Measures
5.2.2 Water Use Impacts		
	Operation of the makeup water system for the proposed new facility would have a negligible impact on the use and water supply of the river.	The proposed new facility would require only a small amount of water withdrawal relative to the total river flow, even at minimum river discharge conditions recorded for the area.
	A temporary increase in turbidity would occur in the Mississippi River during dredging activities required to maintain embayment bottom clearance. No long-term effects on water quality would be expected.	The intake embayment would be periodically dredged during plant operation. Dredge spoils would be disposed of in a manner acceptable to the USACE and the Mississippi DEQ. The turbidity from this maintenance activity, if dredge spoils are returned to the river, would likely quickly dissipate due to the relatively high flow velocity and the large volume of water in the river.
	Due to the proposed location, the embayment and intake structure should not impact recreational or commercial fishing operations or otherwise restrict navigation on the Mississippi River.	This area of the Mississippi River is not used for recreational purposes. Commercial fishing is done on the Mississippi River, Big Black and Bayou Pierre Rivers. The small area of the river affected by the new facility, minimal or no impact to commercial fishing is expected. No mitigation required.
	No significant impacts to downstream users would be expected as a result of discharges from the proposed new facility.	The nearest downstream user of Mississippi River water is Southeast Wood Fiber located at the Claiborne County Port facility, approximately 2 miles downstream of the existing barge slip. The maximum intake requirement for the Port Claiborne facility is estimated to be less than 0.9 million gallons/day (mgd), for industrial purposes. None of this intake is used as potable water.

TABLE 5.10-1 (Continued)

Impact Category	Description of Impact	Explanation and Potential Mitigation Measures
	There would be minimal or no impact on the water quality of Gin Lake due to operation of the proposed new facility.	Gin Lake is located to the north and west of the plant operation areas. Stream A and Stream B have no active connection to Gin Lake, so any changes in water quality of these streams should not impact Gin Lake.
	There would minimal impact on the water quality of Hamilton Lake due to operation of the proposed new facility.	The sedimentation basins would continue to prevent runoff of increased sediments to the lake from Streams A and B. Continued NPDES monitoring would ensure that water discharged by the proposed new facility meets future applicable water quality standards.
	Operation of the proposed new facility would require 180 gpm (240 gpm maximum peak usage) of water from the Catahoula formation. Impact on the water quality of the Catahoula formation would be expected to be minimal.	The water quality in the Catahoula aquifer has not changed significantly since the initial sampling was conducted in 1972.
5.3 Cooling System Impacts		
5.3.1 Intake System	Minimal impacts to aquatic community in the Mississippi River by impingement or entrainment of organisms.	Intake pipes/screens would be designed to minimize the potential for impingement or entrainment of organisms. The intake velocity at the screens would be 0.5 fps or lower, which meets the requirements of Section 316(b) of the Clean Water Act.
	No impacts to critical habitats would be expected.	No critical habitats have been identified on or in the vicinity of the GGNS site.
	Minimal impact to fish species of special interest expected.	Intake screens would preclude impingement or entrainment of fish such as the pallid sturgeon, lamprey, and paddlefish. The Mississippi River at the GGNS site is not suitable habitat for several of the special interest species.

TABLE 5.10-1 (Continued)

Impact Category	Description of Impact	Explanation and Potential Mitigation Measures
	Operation of the intake would have minimal impact on larval fish in the vicinity of the GGNS site.	In general, numbers of fish larvae in the area of GGNS were low. The amount of water that would be withdrawn from the river, about 0.2% at extreme low flow conditions. This along with the low flow velocities at the intake screens in the embayment would result in a minimal impact on the numbers of fish larvae in the GGNS area. The majority of the larvae in the river channel would likely be carried past the intake embayment by the current.
5.3.2 Discharge System	The potential for scouring of the river bank caused by operational discharges is expected to be minimal.	The river banks in the immediate vicinity of the GGNS site have been revetted by the USACE to stabilize the course of the river. Bank stabilization measures would be restored and preserved following any construction on the river shore.
	Minimal impact to aquatic community of the Mississippi River would be expected from the release of the heated effluent.	Combined blowdown from the existing Unit 1 and the proposed new facility would be approximately 52,900 gpm. The thermal plume would be relatively small compared to the breadth of the river at the GGNS site.
	In winter, fish may be attracted to the thermal plume causing early spawning that may result in increased larval mortality due to cold shock. Impact is expected to be minimal.	Minimal impact to fish population on river is expected due to small size of the thermal plume and the large quantity of water flowing past GGNS.
	Potential impact to fish larvae and drifting benthos passing through the thermal plume in winter expected to be minimal.	The thermal plume is small compared to the width of the river at the GGNS site, and compared to the total volume of water passing the site.
	No impacts to wetlands or bottomlands from thermal discharge expected.	Heated effluent would be release directly to river, not to any flood plains and wetlands on the site.

TABLE 5.10-1 (Continued)

Impact Category	Description of Impact	Explanation and Potential Mitigation Measures
5.3.3 Heat-Discharge System	Incidences of local fogging and icing caused by operation of cooling towers would be minimal. Thus, any impact would be minimal.	Modeling results show no incidences of local fogging from natural draft cooling tower, and that the operation of mechanical draft cooling towers would result in only approximately 14 hours per year of fog, all within the boundary of the GGNS site. Icing is associated with fogging when air temperatures are below freezing. Occurrences of icing conditions at the GGNS site are rare.
	The bounding estimate of salt deposition from the operation of cooling towers would be approximately 8 lbm/100-acre-month. This amount would not be expected to cause damage to vegetation in the vicinity of the GGNS site. Thus impacts would be expected to be minimal.	Drift eliminators would be incorporated into design of cooling towers to minimize the potential for salt deposition.
	Operation of cooling towers would not significantly alter local meteorology.	The contribution to local precipitation from cooling towers of the proposed new facility is estimated to be 0.4 inches annually. This amount is inconsequential compared to the total annual rainfall (~45 in./yr) experienced in this region.
	The interaction between the plumes from the existing GGNS natural draft cooling tower and the cooling towers for the proposed new facility would be expected to be insignificant.	The plumes would normally travel in parallel, non-intersecting directions.

TABLE 5.10-1 (Continued)

Impact Category	Description of Impact	Explanation and Potential Mitigation Measures
5.3.4 Impacts to Members of the Public	The risk of exposure of plant workers to thermophyllic organisms associated with the cooling towers would be minimal.	The proposed new facility would employ proven industrial hygiene principles to reduce worker exposure to the adverse impacts associated with microorganisms.
	The risk to public health from thermophyllic microorganisms resulting from thermal discharges at GGNS would be minimal.	Discharge of thermophyllic organisms to large rivers is generally not a problem, primarily due to the amount of water. The Mississippi River at the GGNS site is not used for recreational swimming.

TABLE 5.10-1 (Continued)

Impact Category	Description of Impact	Explanation and Potential Mitigation Measures
5.4 Radiological Impacts of Normal Operations		
5.4.1 Exposure Pathways – Direct Radiation Exposure Impacts	The only GGNS Unit 1 onsite source outside plant buildings that is significant in terms of direct radiation is the condensate water storage tank (CWST). Exposures due to direct radiation from this tank were evaluated using conservative assumptions and parameters as documented in the GGNS UFSAR (Reference 4), and were found to be negligible. Estimates of skyshine dose rates in the various GGNS Unit 2 construction areas (for the scenario of GGNS Unit 1 operating and GGNS Unit 2 still under construction) and the total person-rem doses to construction workers were determined to be negligible (Reference 4). At the proposed location of the power block at the new facility, the closest distance to the site boundary would be approximately 841 meters (2760 ft.). Therefore, similar to that for GGNS Unit 1, negligible dose from direct radiation could be expected at the site boundary from the operation of a reactor or reactors at the new facility. Skyshine radiation is a characteristic of the BWR. Direct radiation from non-BWR technologies would expected to be less that associated with BWR designs and, in any case, negligible with no impact to workers or members of the public.	Implementation of a radiological environmental monitoring program for the new facility, compliance with requirements for maintaining dose ALARA, and attention to design of plant shielding to ensure dose is ALARA, will result in doses to the public due to direct radiation being maintained within limits.
5.4.3 Impacts to Members of the Public	The maximum exposed individual annual doses from the discharge of radioactive materials in liquid effluents from the new facility meets the guidelines of Appendix I to 10 CFR Part 50. Since the guidelines for the maximum individual exposure via hydrospheric pathways are	Implementation of a radiological environmental monitoring program for the new facility, compliance with requirements for maintaining dose ALARA, and attention to design of plant systems to minimize off-site releases, will result in doses to the public from liquid

TABLE 5.10-1 (Continued)

Impact Category	Description of Impact	Explanation and Potential Mitigation Measures
	much more restrictive (at least by a factor of 160) than the standards of 10 CFR Part 20, it can be inferred that radioactive releases in liquid effluents from the new facility meet the standards for concentrations of released radioactive materials in water (accessible to a maximum exposed individual of the general public), as specified in Column 2 of Table 2 of 10 CFR Part 20. The maximally exposed individual dose calculated was also compared to 40 CFR 190 criteria (Table 5.4-9). Therefore, no adverse impact is expected. Annual doses to the maximum exposed individual due to release of radioactive materials in gaseous effluents from the proposed new facility meet the guidelines of Appendix I to 10 CFR Part 50. Since the guidelines of Appendix I to 10 CFR Part 50 for maximum individual exposures via atmospheric pathways are much more restrictive (by a factor of ≈100) than the standards of 10 CFR Part 20, it can be inferred that radioactive releases via gaseous effluents from the new facility meets the standards for concentrations of released radioactive materials in air (at the locations of maximum annual dose to an individual and hence, at all locations accessible to the general public), as specified in Column 1 of Table 2 of 10 CFR Part 20. As stated in Section 5.2.1 of the GGNS FER, the whole body dose to individuals living in the site region from existing radiation sources is expected to average about 130 mrem/yr. Comparison of the calculated doses for a new facility at the proposed location on the GGNS Site shows that there is no significant impact to members of the public due to operation of a new facility at the GGNS site.	and gaseous releases being maintained within limits.

TABLE 5.10-1 (Continued)

Impact Category	Description of Impact	Explanation and Potential Mitigation Measures
5.4.4 Impacts to Biota Other than Members of the Public	Doses to biota from liquid and gaseous effluents are shown in Table 5.4-16. Table 5.4-17 compares the biota doses to the criterion given in 40 CFR 190. These dose criteria are applicable to man, and are considered conservative when applied to biota. Table 5.4-17 shows that annual doses to two of the seven surrogates can meet the requirements of 40 CFR 190. Although doses may exceed the criteria of 40 CFR 190, no adverse consequences are expected.	Use of exposure guidelines, such as 40 CFR 190, which apply to members of the public in unrestricted areas, is considered very conservative when evaluating calculated doses to biota. The International Council on Radiation Protection states that "...if man is adequately protected then other living things are also likely to be sufficiently protected" and uses human protection to infer environmental protection from the effects of ionizing radiation. Conversely, it is also known that biota with the same environment and exposure pathways as man can experience higher doses without adverse effects. Species in most ecosystems experience dramatically higher mortality rates from natural causes than man. From an ecological viewpoint, population stability is considered more important to the survival of the species than the survival of individual organisms. Thus, higher dose limits could be permitted. In addition, no biota have been discovered that show significant changes in morbidity or mortality to radiation exposures predicted for nuclear power plants. None necessary.
5.5 Environmental Impacts of Waste		
5.5.1 Nonradioactive-Waste-System Impacts	Minimal environmental impacts from the release of non-radioactive liquid effluents are expected.	Water quality would be closely monitored and the use of biocides and chemical treatments would be minimized through process optimization. Effluents containing biocides or other chemicals would be treated to be protective of the Mississippi River and to meet future NPDES permit requirements.

TABLE 5.10-1 (Continued)

Impact Category	Description of Impact	Explanation and Potential Mitigation Measures
	Minimal environmental impacts from the release of non-radioactive gaseous effluents are expected.	Gaseous effluents would be monitored as necessary to ensure future applicable regulations are met.
	Minimal environmental impacts from the release of sanitary waste effluents are expected.	All liquid effluents released from the proposed facility would be treated to meet future NPDES permit requirements and to be protective of the local streams, lakes and the Mississippi River.
	Potential environmental impacts from the disposal of filter material and resin beds from raw water demineralization system would be expected to be minimal.	Spent resin beds would most likely be collected by a third party vendor and disposed of in an offsite licensed land fill.
	Potential environmental impacts from the release of waste water from the raw water demineralization system (if necessary) would be expected to be minimal.	Chemicals such as sulfuric acid and caustic soda could be used to regenerate demineralization system resins. The waste water would be adjusted to a pH between 6 and 9. All liquid effluents released from the proposed facility would be treated to meet future NPDES permit requirements and to be protective of the local streams, lakes and the Mississippi River.
	Potential environmental impacts from the release of effluents from the sanitary waste treatment system to the Mississippi River would be expected to be minimal.	The onsite sanitary waste treatment system would include tertiary treatment. All liquid effluents released from the proposed facility would be treated to meet future NPDES permit requirements and to be protective of the local streams, lakes and the Mississippi River. The effluent release would be subject to NPDES permit that would be protective of the quality of the receiving body water.
	Potential impacts to the river water quality and to downstream users of river water from the release of effluents from floor drains would be expected to be minimal.	Discharges from floor drains, including chemical drainage systems, would be monitored, treated and released as permitted by the NPDES permit in place at the time.

TABLE 5.10-1 (Continued)

Impact Category	Description of Impact	Explanation and Potential Mitigation Measures
	Potential impacts to the river water quality and to downstream users of river water from the runoff from the GGNS site, including roof drains, would be expected to be minimal.	Water from roof drains would flow overland or via a storm drain system, combining with general site runoff, to either Stream A or Stream B. The water would flow through the sediment retention basins, to Hamilton Lake and eventually to the Mississippi River. Site runoff would be regulated by the Storm Water Pollution Prevention Plan.
	Potential environmental impacts from the release of gaseous effluents from diesel engines or gas turbines would be expected to be minimal.	Gaseous effluent releases would comply with future federal, state, and local emissions standards that would be protective of the air quality in the region of the GGNS site.
	Chemical wastes from laboratories and other sources at the proposed new facility would not be released to the environment at the GGNS site, thus no impacts would be expected.	Chemical wastes from laboratories and other sources would be collected and stored, or disposed of offsite at licensed disposal facilities.
	Waste petroleum products would not be released to the environment at the GGNS site, thus no impacts would be expected.	Waste petroleum products would be sent to an offsite licensed facility for recycling or disposal.
5.5.2 Mixed Waste Impacts	Nuclear power plant operations are not expected to generate significant volumes of mixed waste because of continued progress in reducing mixed-waste generation. Because nuclear power plant operations are conducted in compliance with applicable NRC and EPA regulations governing the storage and disposal of mixed wastes (10 CFR 20; 10 CFR 61; 40 CFR 264 and 268), exposures will be minimal.	None necessary.

TABLE 5.10-1 (Continued)

Impact Category	Description of Impact	Explanation and Potential Mitigation Measures
	All mixed waste generated might be stored on site for the life of the new facility operating license, if adequate treatment and disposal capacities or DOE acceptance of commercial mixed waste are delayed. However, as for license renewal the accumulated volumes of mixed waste would be small when compared to overall LLW volumes. Incremental effluents and doses to members of the public should be minimal and would be subject to the same regulatory limits and enforcement as LLW.	None necessary.
	Estimates of incremental occupational exposures from short-term and extended storage of mixed LLW have been made (Rogers 1990). When mixed LLW can be shipped immediately, doses from inspections were estimated to be about 3 man-rem per plant. With five years of accumulated mixed wastes, inspection exposures could rise to 100 man-rem/year per plant.	Mitigating measures, including remote inspection, were considered essential to meet ALARA requirements. While sampling and handling were estimated to potentially result in significant doses in the 1990 study, absent ALARA mitigation such as use of lead blankets on contaminated piping with high exposure rates, they are included in current baseline exposures. The NRC concluded in NUREG-1437 that ALARA mitigating measures will continue to be developed and implemented by the utilities and RCRA regulatory authorities and that, even with the contribution of incremental occupational doses from extended storage, total individual occupational doses will continue to be well within regulatory limits and thus will be small.

TABLE 5.10-1 (Continued)

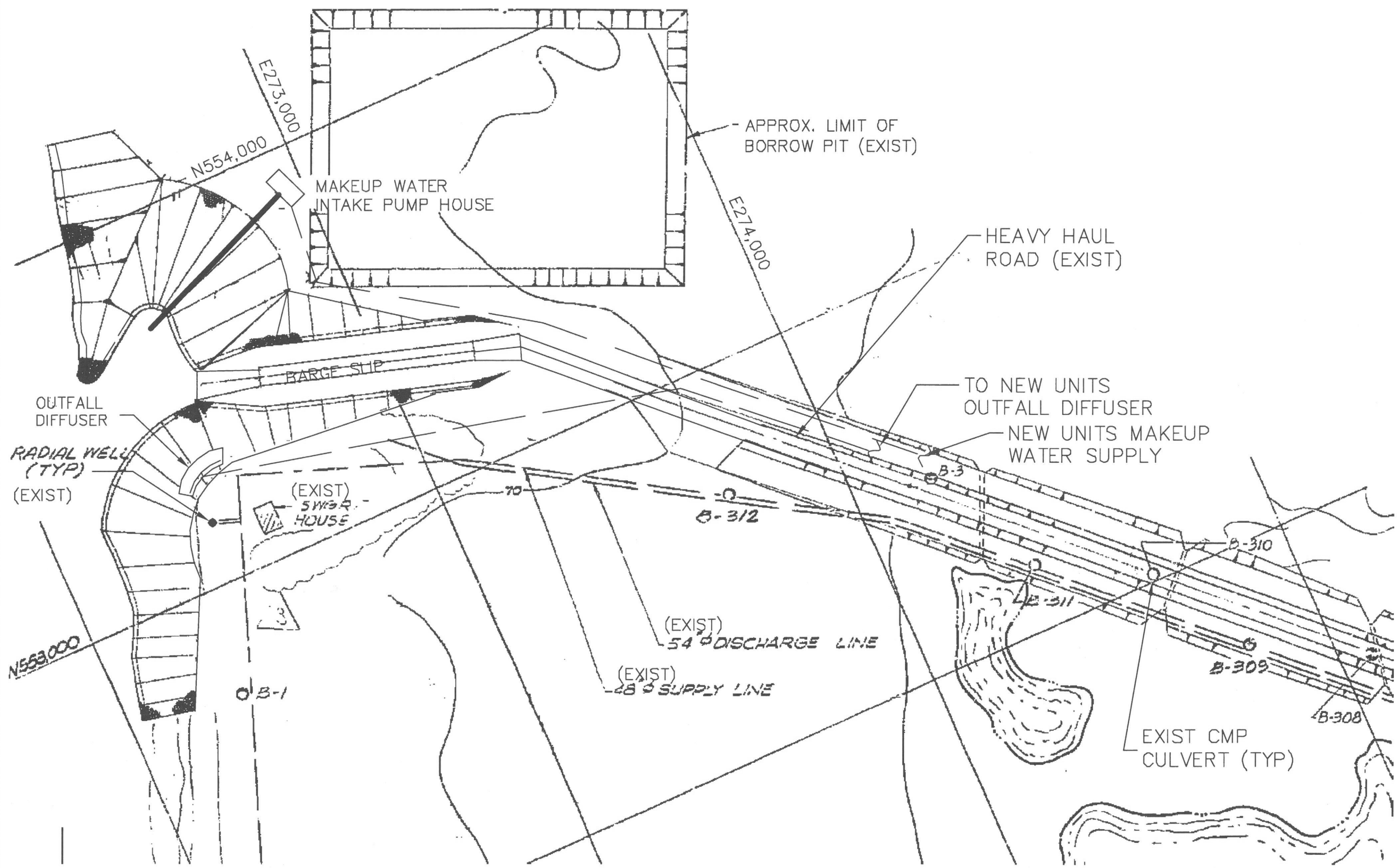
Impact Category	Description of Impact	Explanation and Potential Mitigation Measures
	The volumes of mixed waste currently represent 3 percent or less of total LLW volumes. Due to the small mixed waste volume and because no significant emissions or releases of hazardous materials are expected due to control and containment requirements, impacts are expected to be small.	The NRC concluded in NUREG-1437 that regulatory requirements already in place provide adequate mitigation incentives for onsite storage of mixed waste; and therefore, there is no need for consideration of additional mitigation alternatives within the context of renewal of a power reactor license. Given that the handling, storage and disposal issues and requirements for mixed waste are the same, either for license renewal of an existing facility or for operation of a new nuclear power facility which may be constructed in the future, the NRC's conclusions are also valid for the new facility for the GGNS site proposed in this ESP application.
5.7 Uranium Fuel Cycle Impacts	Refer to 10 CFR 51.51, Table S-3 for fuel cycle impacts for LWR technologies.	None necessary.
	There are two instances where any part of the uranium fuel cycle impacts for the reference LWR plant is/might be exceeded by that for the gas-cooled reactor technologies. These fuel cycle steps are enrichment, a 28% increase, and possibly decontamination and decommissioning (D&D).	The enrichment, while slightly larger, will likely be conducted in a much more environmentally benign manner, centrifuge versus gaseous diffusion, and may be procured from an overseas source. The net effect will be that the environmental impacts will be much less. The second area, decontamination and decommissioning, is a minor contributor to the fuel cycle impact. A slight increase in the D&D step is more than offset by the significant decreases in the impacts due to reduction in fuel needs and changes in the enrichment process and mining technique. Collectively, improvements in both past practices as well as changes in technology have resulted in a more environmentally benign fuel cycle.

TABLE 5.10-1 (Continued)

Impact Category	Description of Impact	Explanation and Potential Mitigation Measures
5.8 Socioeconomic Impacts		
5.8.1 Physical Impacts of Station Operation	Noise level at the GGNS property boundary from operation of cooling towers and transformers would be less than the guidance in NUREG-1555 of 65 dB(A).	None necessary.
	All air emissions would be within regulatory limits in effect at the time of operation.	None necessary.
	Structures such as the cooling tower(s), and the plumes from the towers, would likely be visible from the Mississippi River and Grand Gulf Military Park. The visual impact would be expected to be minimal, as the GGNS is an industrial site, and is surrounded by forests.	None necessary.
5.8.2 Social and Economic Impacts of Station Operation	Local highways and access routes to the GGNS site are adequate to handle the 1,160 operating personnel for the proposed new facility, The number of traffic accidents on the primary access roads may increase over current levels.	Several road improvement and construction projects are already planned for the GGNS area. These projects will help ameliorate traffic problems associated with the proposed facility. In addition, flexible work hours and additional road improvements, such as traffic lights or turn lanes, could be instituted.
	Public safety organizations in the region of the GGNS site would not be overburdened by the influx of operating personnel for the proposed facility.	Claiborne County and the City of Port Gibson currently receive revenue from the GGNS to support emergency services. This would continue and most likely be increased to support the operation of the proposed new facility.
	The availability of social services, including hospital care, would be minimally impacted by the influx of operation personnel for the proposed facility.	None necessary

TABLE 5.10-1 (Continued)

Impact Category	Description of Impact	Explanation and Potential Mitigation Measures
	Minimal impacts to public utilities in the region of the GGNS site would be expected, as the proposed facility would have a dedicated water supply and sewage treatment facility. It is expected that the influx of workers for the proposed facility would have minimal impacts on the public utilities in the communities in the region.	None necessary. Increased tax revenue from the proposed facility could be used to upgrade public utilities if necessary.
	Local tourism and recreation may be impacted slightly due to increased traffic volumes on access roads to the Grand Gulf Military Part.	None necessary. Visitation to local tourist and recreation attractions would be expected to increase because of the increase in operational personnel for the proposed facility.



REF: GGNS DWG.
C–0003 FOR
LOCATION COORDINATES

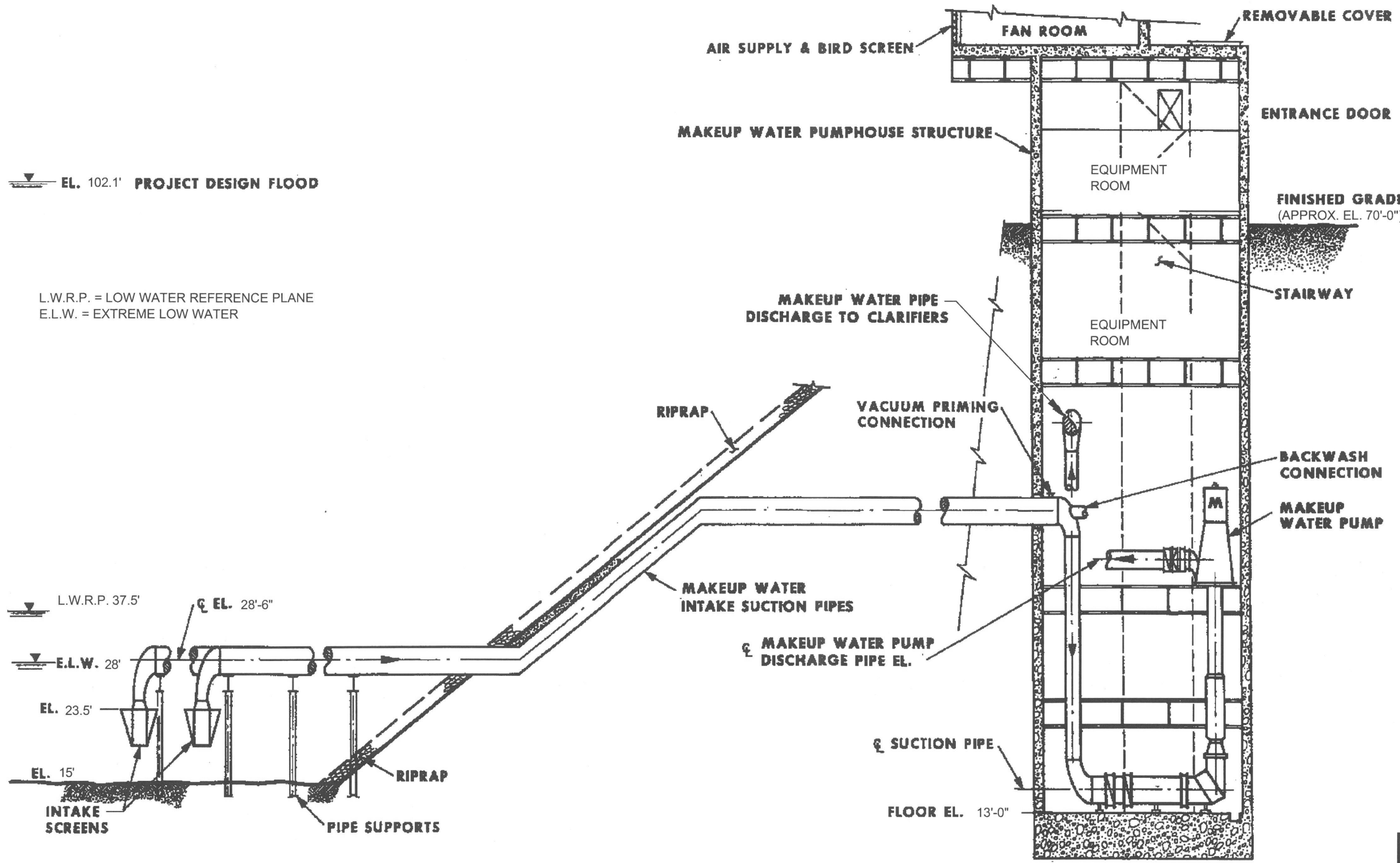
NOTES:

1. GRID COORDINATES SHOWN ARE MS WEST ZONE COORDINATES.

SERI
GRAND GULF NUCLEAR STATION SITE
EARLY SITE PERMIT APPLICATION
ENVIRONMENTAL REPORT

MAKEUP WATER
EMBAYMENT LAYOUT

FIGURE 5.3-1 REV. 1



NOTES:

1. ELEVATIONS GIVEN ARE IN FT ABOVE MSL.
2. EQUIPMENT LOCATIONS AND ELEVATIONS SHOWN ARE FOR INFORMATION ONLY.
3. RIVER LEVEL ELEVATIONS ARE BASED ON US ARMY CORPS OF ENGINEERS DATA FOR THIS SECTION OF THE RIVER.

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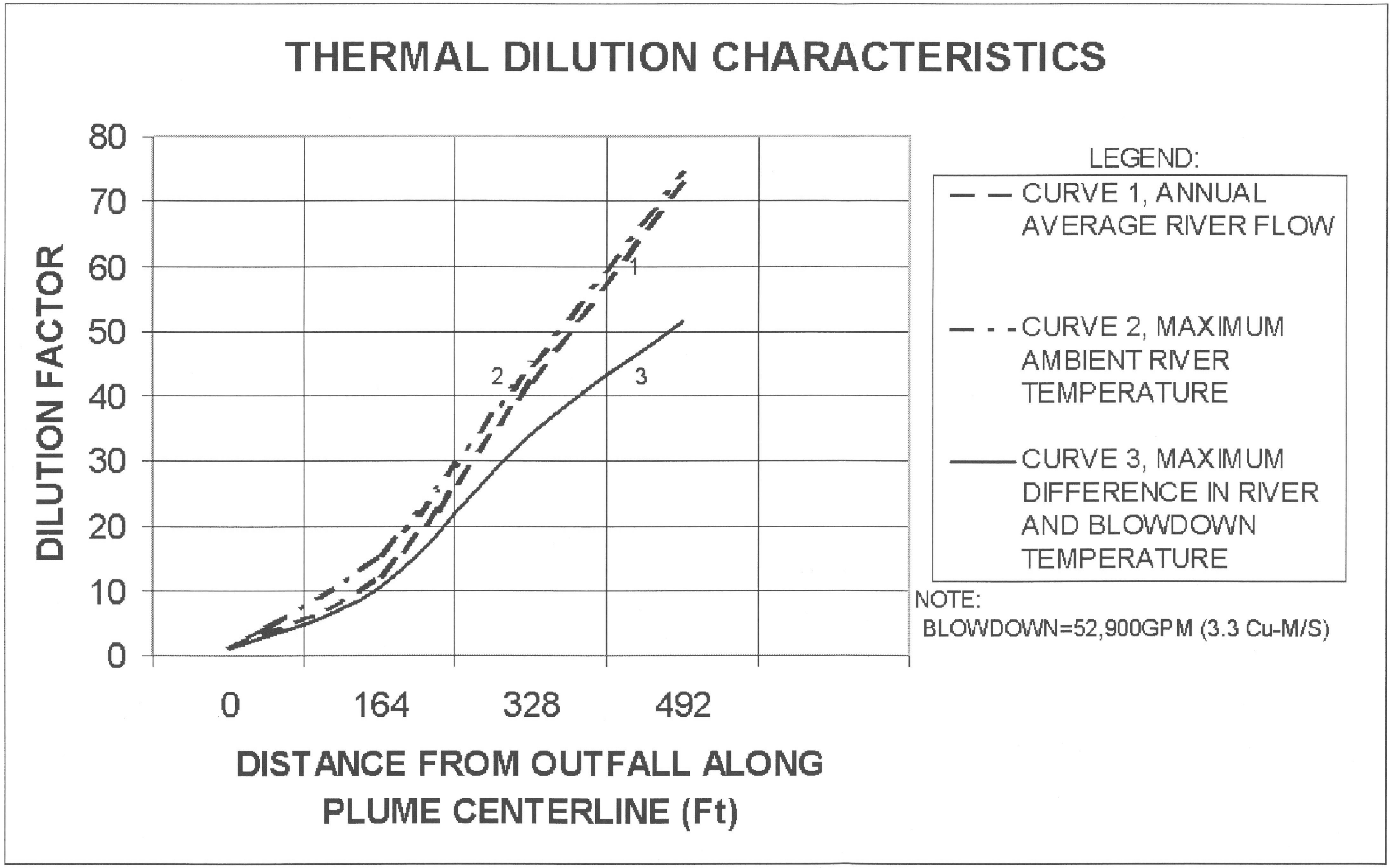
MAKEUP WATER INTAKE
STRUCTURE PROFILE

FIGURE 5.3-2 REV. 1



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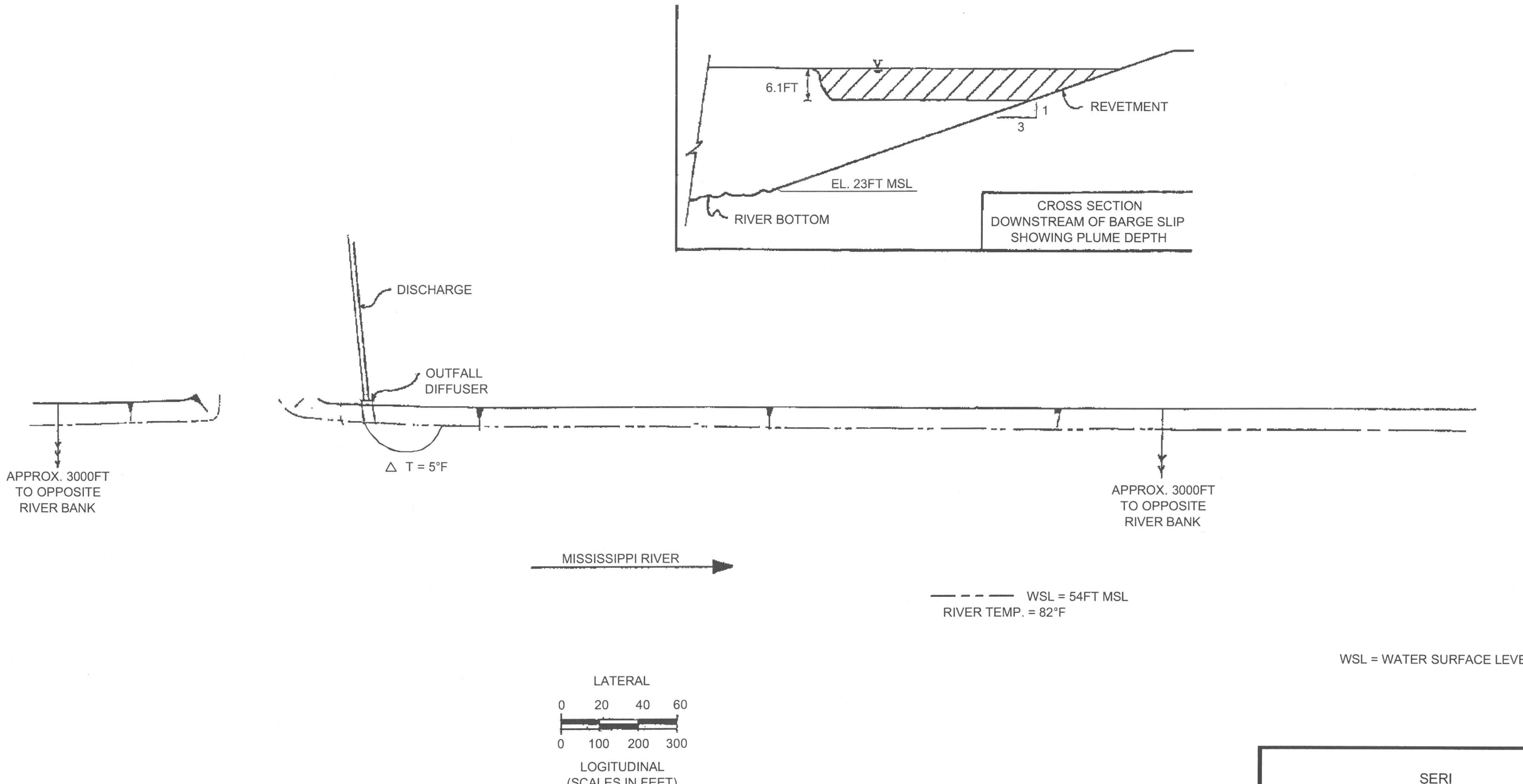
PREDICTED THERMAL DILUTION CHARACTERISTICS FROM CORMIX

FIGURE 5.3-3 REV. 1



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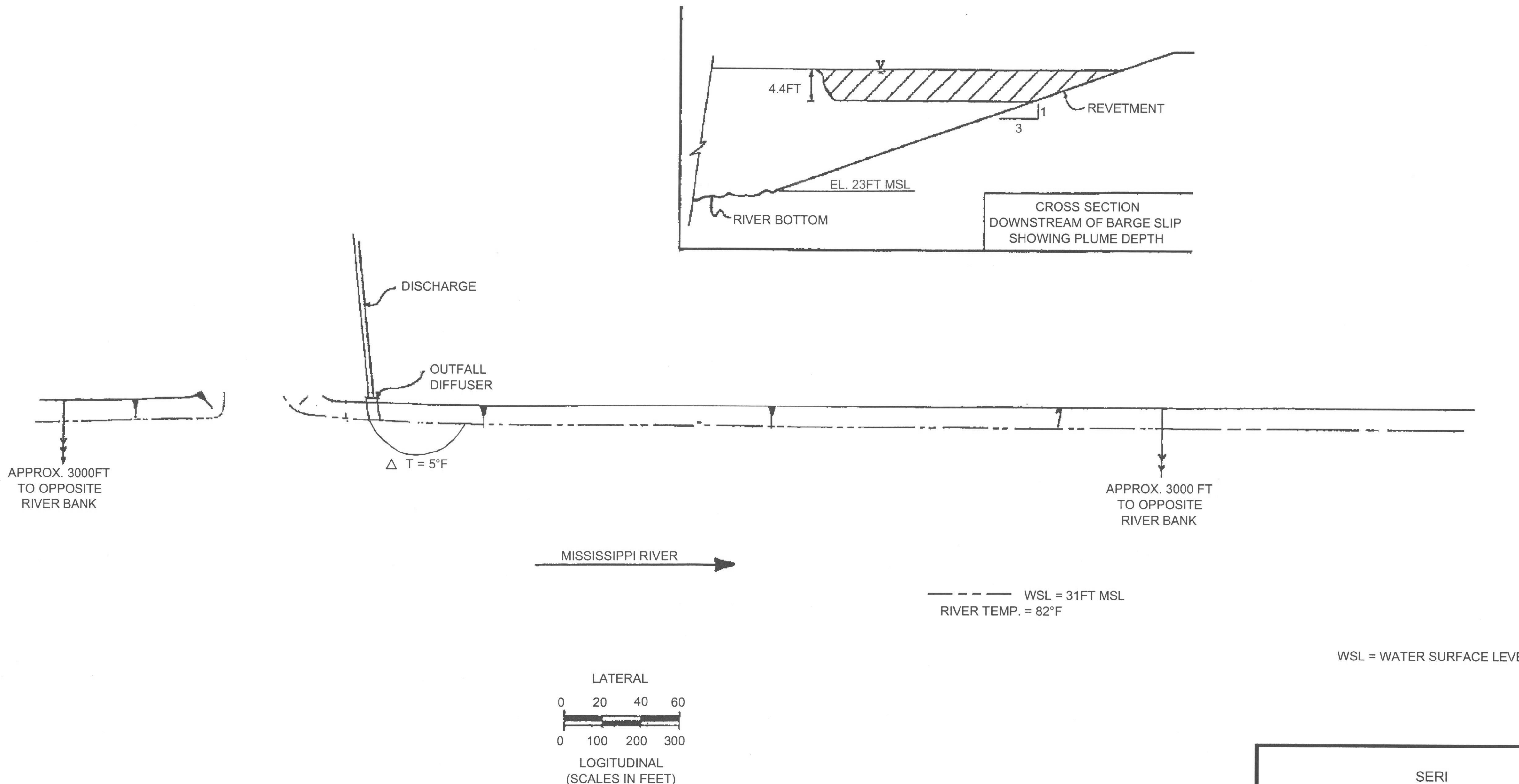
SUMMER MEAN
5°F ISOTHERM PLUME

FIGURE 5.3-4

REV. 1



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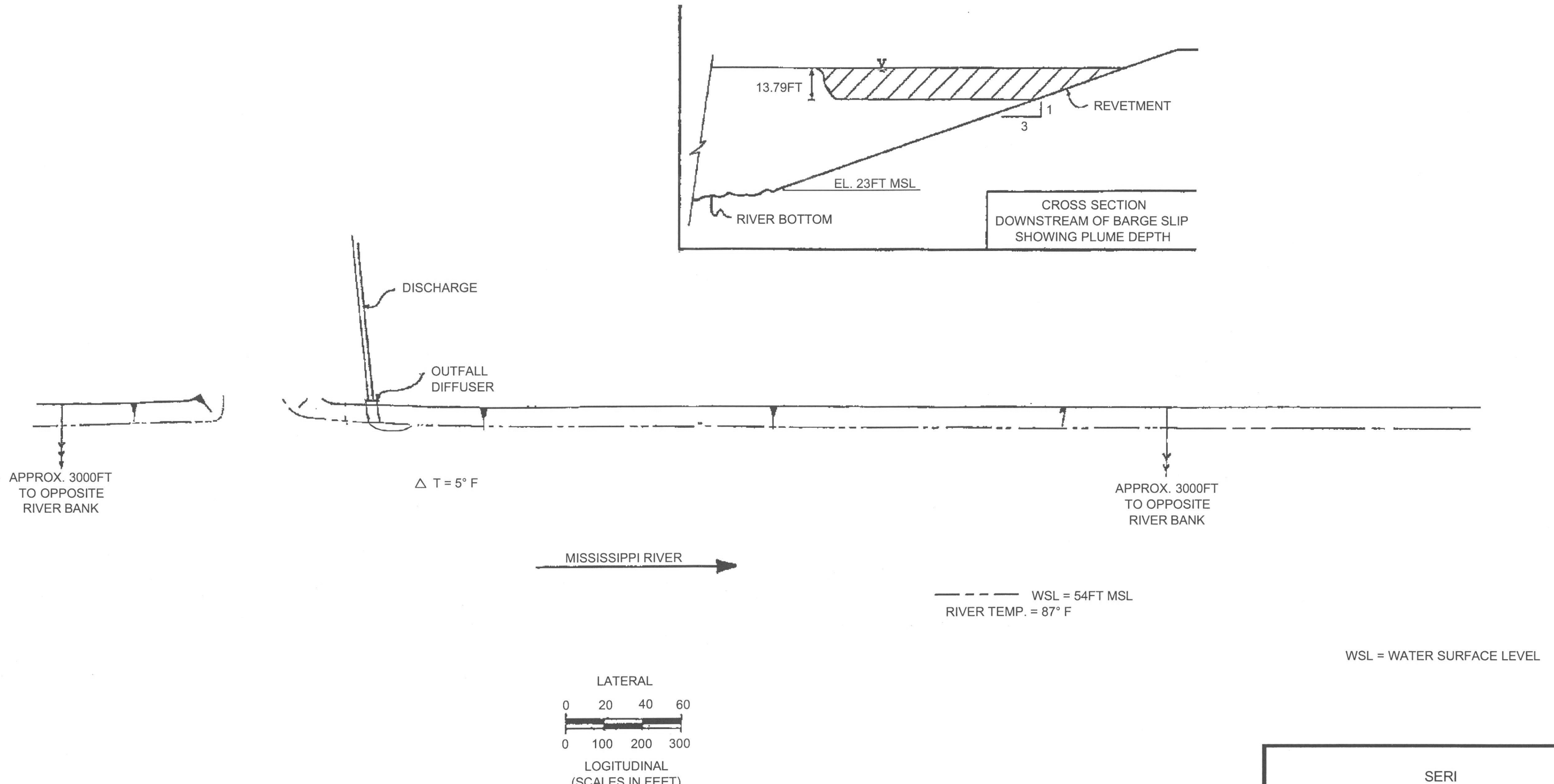
SUMMER MEAN LOW
5°F ISOTHERM PLUME

FIGURE 5.3-5 REV. 1



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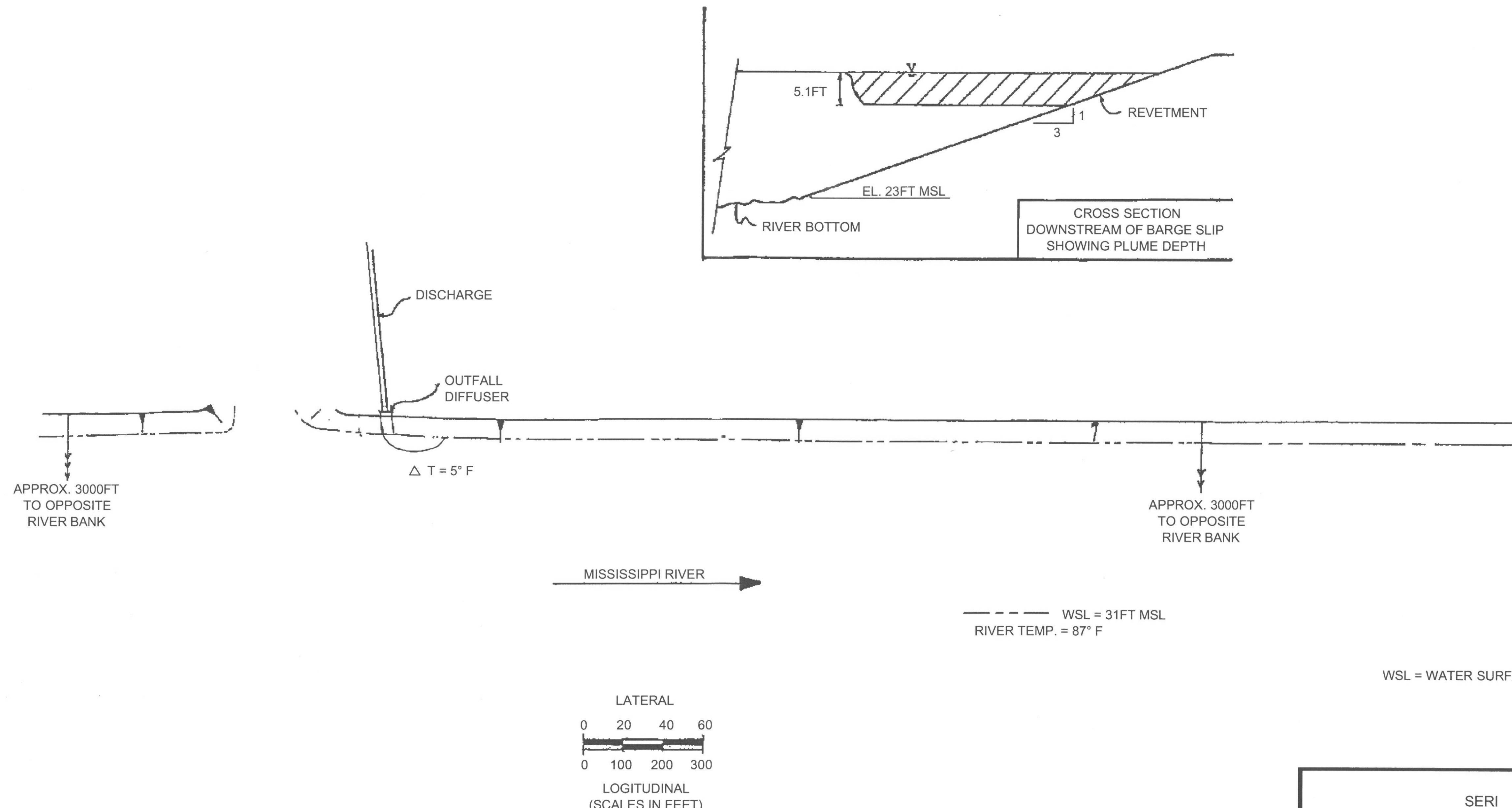
SUMMER EXTREME
5°F ISOTHERM PLUME

FIGURE 5.3-6 REV. 1



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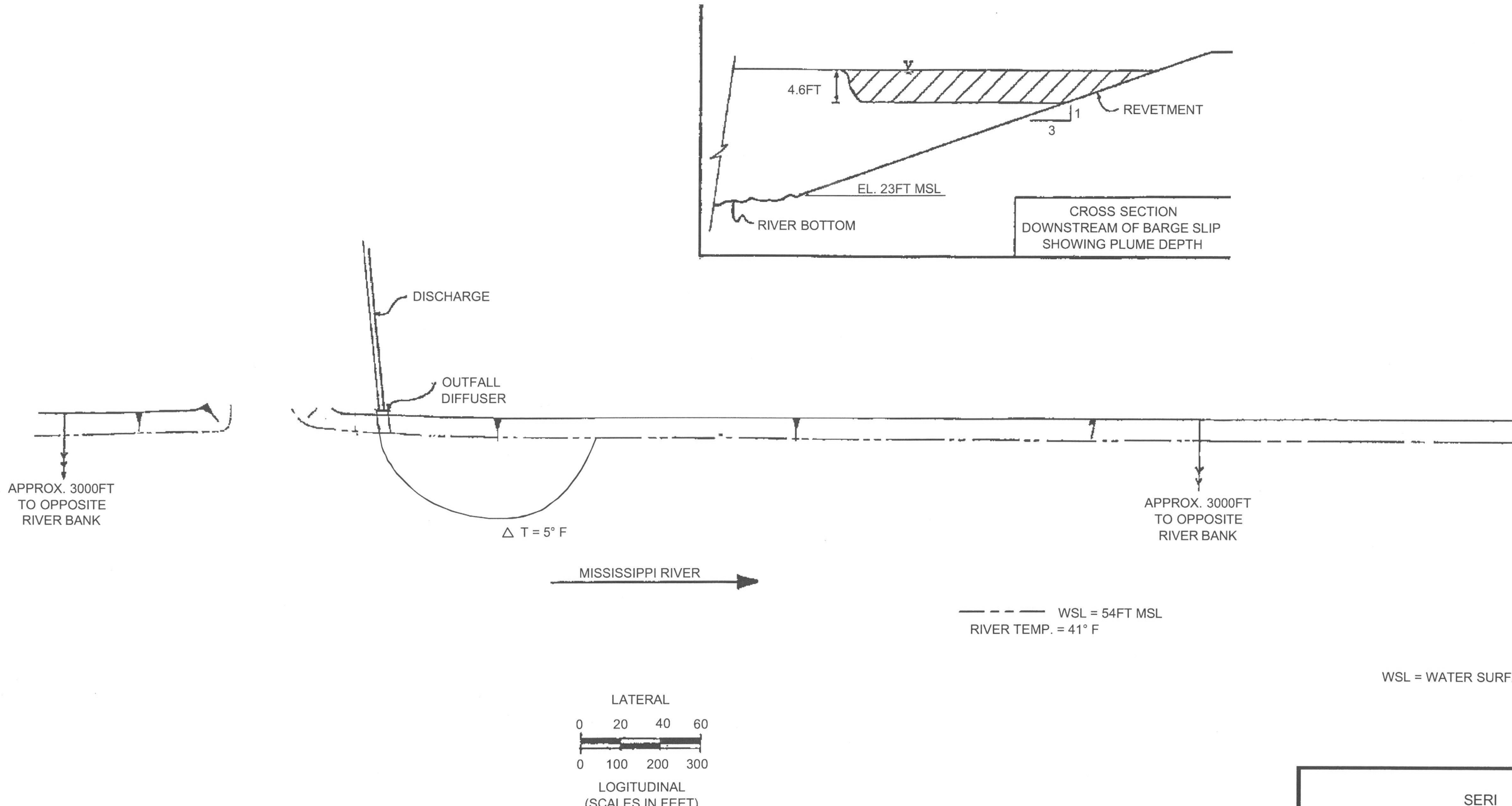
SUMMER EXTREME LOW
5°F ISOTHERM PLUME

FIGURE 5.3-7 REV. 1



WSL = WATER SURFACE LEVEL

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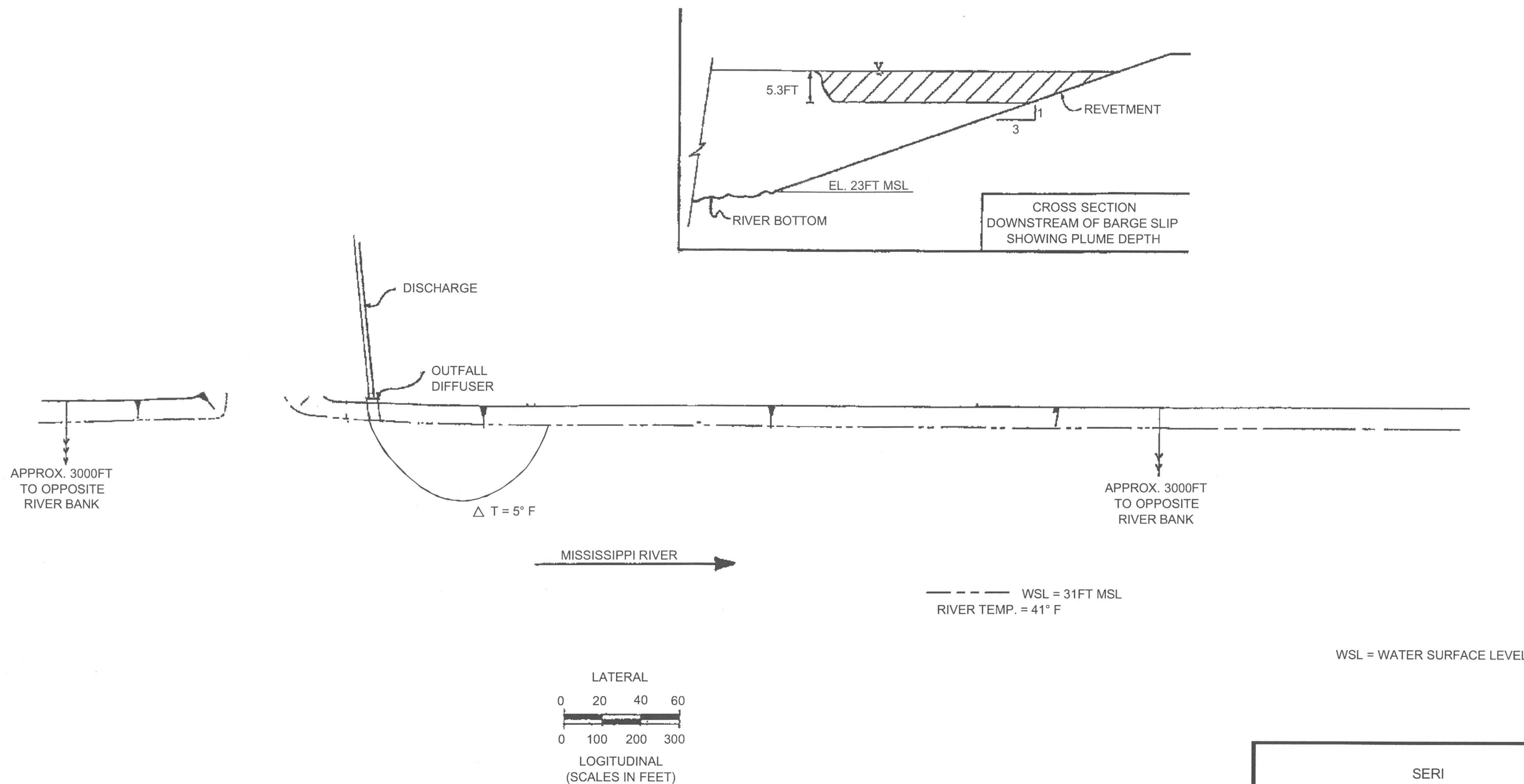
WINTER MEAN
5°F ISOTHERM PLUME

FIGURE 5.3-8 REV. 1



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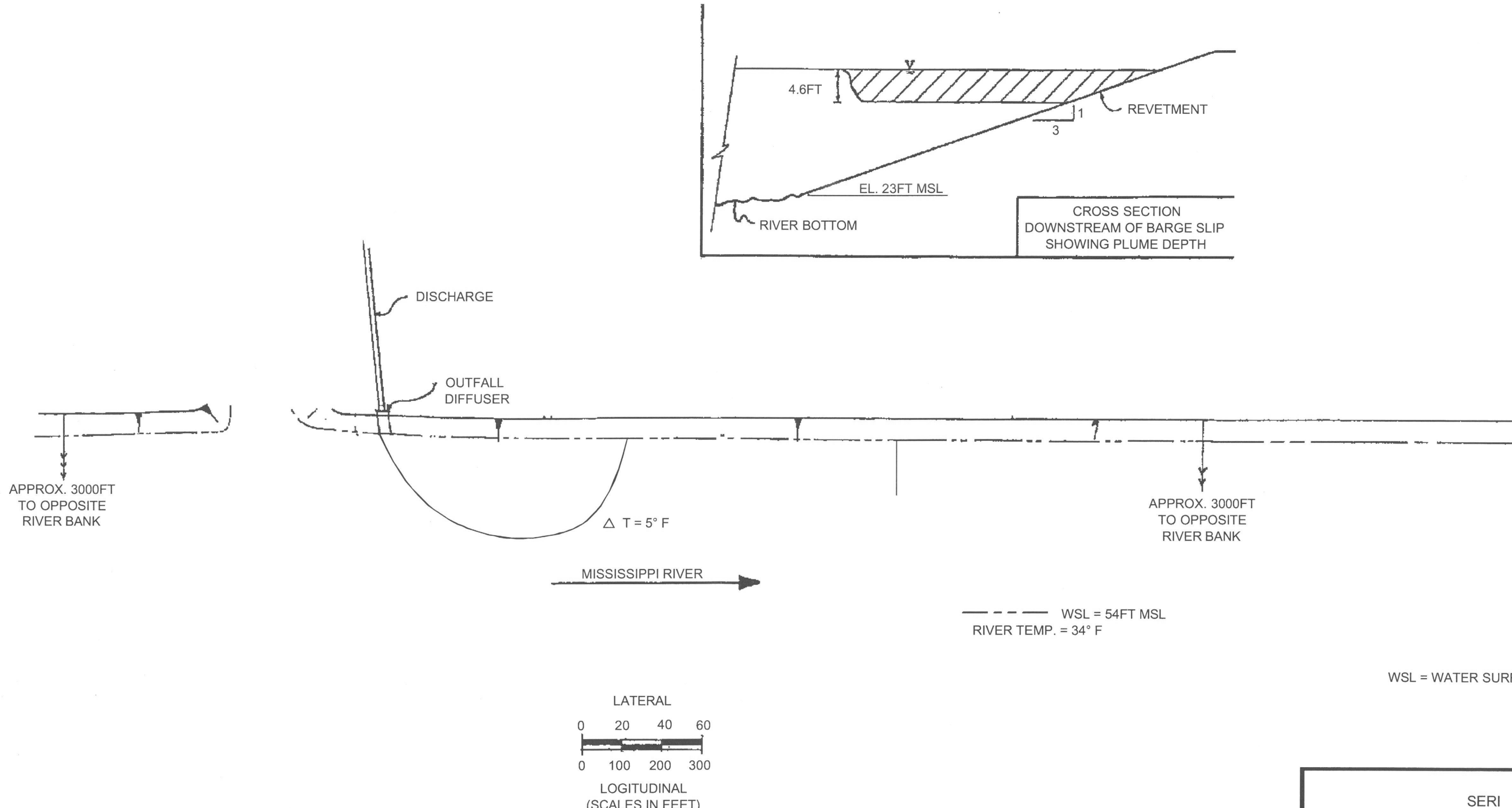
WINTER MEAN LOW
5°F ISOTHERM PLUME

FIGURE 5.3-9 REV. 1



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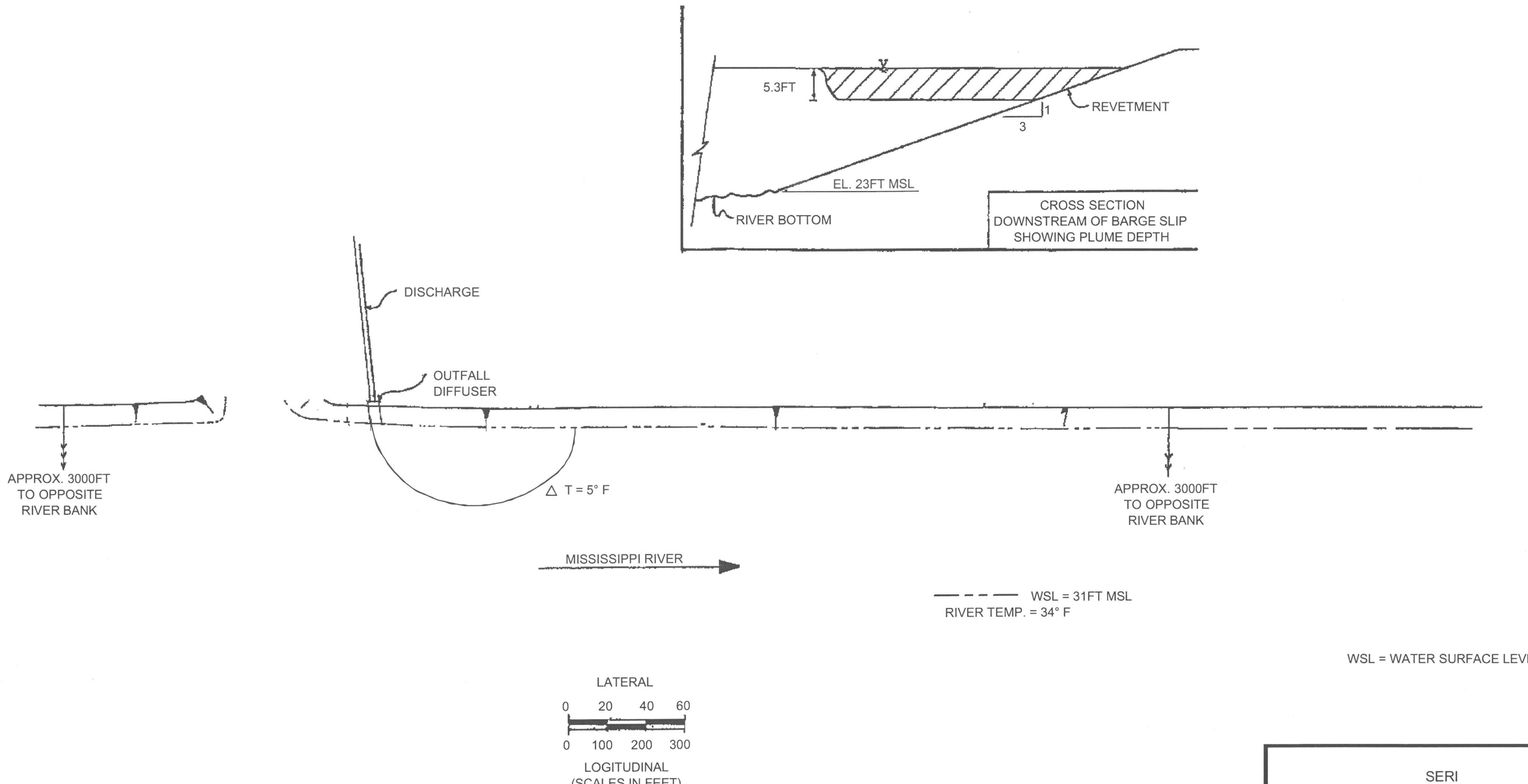
WINTER EXTREME
5°F ISOTHERM PLUME

FIGURE 5.3-10 REV. 1



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WINTER EXTREME LOW
5°F ISOTHERM PLUME

FIGURE 5.3-11 REV. 1