5.0 Operation Impacts at the Proposed Site

This chapter examines the environmental issues associated with operation of one or more additional nuclear units at the proposed Grand Gulf early site permit (ESP) site for an initial 40-year period as described in the application for an ESP submitted by System Energy Resources, Inc. (SERI). As part of this application, SERI submitted an environmental report (SERI 2005a) that provides the plant parameter envelope (PPE) (see Appendix I) as the basis for the environmental review.

Sections 5.1 through 5.10 of this chapter discuss the potential impacts on land use, air quality, water, ecosystems, socioeconomics, historic and cultural resources, and environmental justice, as well as nonradiological and radiological health effects and impacts of postulated accidents. In accordance with Title 10 of the Code of Federal Regulations (CFR) Part 51, the impacts have been analyzed, and, where possible, a significance level of potential impact – SMALL, MODERATE, or LARGE – has been assigned to each analysis. Measures and controls to limit adverse impacts of station operation during the initial 40 years are presented in Section 5.11. The staff's determination of significance levels is based on the assumption that the mitigative measures identified in the environmental report and in Section 5.11 of this environmental impact statement (EIS), or activities planned by various State and county governments as discussed throughout this chapter, such as infrastructure upgrades, are implemented. For issues that are considered to be resolved, the staff will verify the continued applicability of all assumptions used in its environmental analyses, should an applicant for a CP or COL reference the Grand Gulf ESP. These assumptions are listed in Appendix J.1. A summary of the operational impacts is presented in Section 5.12. The references cited in this chapter are listed in Section 5.13.

5.1 Land-Use Impacts

The land-use areas considered include those (such as the site, vicinity, area along transmission lines, and offsite areas) with the potential to be affected by operational activities. Operations of the ESP facility are not anticipated to require temporary or permanent changes of any current or planned land use.

5.1.1 Site and Vicinity

Operation of the proposed unit or units at the Grand Gulf ESP site would result in social and economic impacts that may translate into impacts on land use in the vicinity. These impacts are discussed in Section 5.5.2. A conservative estimate of the expected increase in population related to new personnel being employed at the ESP site would be 2320 persons. This assumes that all facility-related employment associated with the ESP site would relocate to the

impact region (within 80 km (50 mi)) of the ESP site. Section 5.5.2 presents potential population impacts within individual jurisdictions, assuming relocations occur in proportion to the current distribution of worker residences.

The staff analyzed recent mortgage finance data for Claiborne County (FFIEC 2001, 2002, 2003, 2004, 2005) to evaluate the potential need for new housing in the vicinity. The Federal Financial Institutions Examination Council (FFIEC) annually collects data on each mortgage finance transaction in the country from institutions required to report, including banks, mortgage companies, credit unions, and other finance companies. The detailed transaction data and borrower characteristics are provided to the census tract level. Table 5-1 provides a summary of such transactions reported in Claiborne County over the recent 5-year period. The data indicate that the 225 financed home purchases over the five years ending in 2004 have been evenly distributed across the county's three census tracts: the northern portion of the county, the Port Gibson area, and the southern portion of the county. Section 5.5.2 indicates that plant workers moving to the region would most likely locate in the Vicksburg area where housing and services are most available. The home purchase data summarized in Table 5-1 suggest that Claiborne County conservatively averages just 45 home sales annually, distributed somewhat evenly across the county.

Table 5-1. Mortgage Transactions in Claiborne County, Mississippi, 2000 to 2004

	2000	2001	2002	2003	2004
Home Purchase Mortgages	71	54	31	40	29
Average Loan Amount ($K)	43.2	52.3	47.5	55.3	62.4
Median Loan Amount ($K)	32.0	35.5	47.0	48.5	53.0
Average Annual Borrower Income ($K)	36.8	43.5	40.3	41.1	47.4
Median Annual Borrower Income ($K)	36	36	36	32	47

Source: FFIEC Home Mortgage Disclosure Act data (FFIEC 2001, 2002, 2003, 2004, 2005). These data include only mortgage transactions financed through Federally regulated institutions. Cash purchases are not included.

Based on this analysis and information presented in Section 5.5.2, the staff finds that relocating workers would tend to seek housing where it is currently most available and where the choice of homes is greatest, such as Vicksburg, Natchez, or Clinton. Relocation in proportion to the current distribution of worker residences is unlikely, given current housing availability in Claiborne County. It is not possible to know what real estate or land development might occur in Claiborne County as a result of siting and operating the ESP facility. Therefore, the staff concludes that land-use impacts from development of new housing would occur, but such

impacts would be widely disbursed and would not be concentrated in any one community. Such impacts might include land-cover alteration on private lands, new property access roads, or conversion from private agricultural to residential use.

Adding the Grand Gulf ESP facility to the Grand Gulf Nuclear Station (GGNS) site would introduce staggered refueling and maintenance outages. It is likely that outages would be scheduled for one facility at a time, increasing the frequency of the need for temporary outage workers and increasing the number by 100 to 200 workers (SERI 2005a). This increase in frequency would lead to increased impacts at local campgrounds and other local temporary housing facilities in the vicinity on a sustained basis. However, these impacts would not be expected to noticeably alter current land uses in the vicinity.

Another potential impact on land use includes the effects of salt drift on crops, timber, and other vegetation from operation of wet cooling towers (either natural or mechanical draft) that have been proposed for the Grand Gulf ESP facility. Forests both on the Grand Gulf site and offsite to the northwest of the ESP facility would be in the path of vapor plumes carried on southeasterly prevailing winds (SERI 2005a) and could thus be affected by salt drift. However, agricultural land occurs only offsite and largely to the southeast and east of the Grand Gulf ESP site, and thus would be less likely to be affected by salt drift, based on the direction of prevailing winds.

The staff assumed that new cooling towers would produce salt concentrations similar to cooling towers at existing nuclear power plants. New cooling towers would be located near the existing natural draft cooling tower at the Grand Gulf site and would be subject to the same meteorological conditions and, therefore, produce a similar plume footprint, potentially tripling the current salt deposition. A salt drift deposition study was conduced for GGNS Unit 1 from 1983 to 1988. The salt drift deposition rate was not significantly different between onsite and offsite locations. Consequently, a supplemental study was not undertaken to determine the biological effects of the salt at the Grand Gulf site (Entergy 1992). The impact of salt drift on crops, ornamental vegetation, and native plants was evaluated for existing nuclear power plants in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS) (NRC 1996) and was found to be of minor significance. This determination also included existing nuclear power plants with more than one cooling tower. Consequently, damage to timber or crops from the operation of cooling towers for the Grand Gulf ESP facility would be negligible.

Impacts on land use that would occur include minor land cover alterations because of the geographically disbursed construction of new housing for ESP facility workers. Therefore, the staff concludes that land-use impacts in the vicinity of the ESP facility due to operations would be SMALL, and additional mitigation would not be warranted.

5.1.2 Transmission Line Rights-of-Way and Offsite Areas

Section 4.1.2 indicates that although the current transmission system serving the GGNS site is likely to be inadequate under the bounding assumptions of the PPE, the full extent of changes to the transmission system cannot be known until an applicant for a CP or COL initiates the Federal Energy Regulatory Commission process for connecting new large generation to the grid. This process is discussed more specifically in Section 3.3. Whether that process results in findings that the existing rights-of-way can be upgraded, or that new rights-of-way must be acquired, maintenance of the transmission lines is expected to be accomplished using standard industry practices and following applicable laws and regulations. Impacts on land use would occur as a result of normal maintenance activities, such as right-of-way vegetation clearing, transmission line maintenance, and other normal access needs. Impacts on land use during the construction phase are discussed in Section 4.1.2, and the subsequent impacts of transmission line and right-of-way maintenance would be minimal. These may include access easements, building restrictions, temporary closures, and other activities as part of routine maintenance.

Based on information provided by SERI (2005a) and the U.S. Nuclear Regulatory Commission (NRC) staff's independent review, the staff concludes that land-use impacts in the transmission line rights-of-way and offsite areas from ESP facility operations would be SMALL, and additional mitigation would not be warranted.

5.2 Meteorological and Air Quality Impacts

Sections 2.3.1 and 2.3.2 describe the meteorological characteristics and air quality of the Grand Gulf ESP site. The primary impacts of operation of the Grand Gulf ESP facility on local meteorology and air quality would be from releases to the environment of heat and moisture from the primary cooling system (cooling towers), effluent from operation of auxiliary equipment (generators and boilers), and emissions from workers' vehicles. This section provides information on these factors and discusses the potential impacts of transmission line rights-of-way on air quality.

5.2.1 Cooling System

The proposed cooling system for the new nuclear unit or units at the Grand Gulf ESP site is wet cooling towers. Both natural draft and mechanical draft cooling towers are being considered. The most apparent impacts of wet cooling towers are the land use and aesthetic impacts associated with visible plumes. The air-quality impacts of wet cooling towers are associated with the drift from the cooling towers and possible interactions between the moist plumes and other pollutants. Wet cooling towers at existing nuclear power plants generally have drift eliminators to reduce drift.

Drift is composed of small water droplets that are carried out of the cooling tower. These droplets evaporate, leaving particles that contain residual salts and chemicals from the cooling water. Drift from mechanical draft cooling towers is deposited near the cooling tower, and drift from natural draft towers is deposited farther downwind. Based on a review of the measurements of deposition of drift from nuclear power plants, the GEIS (NRC 1996) states the "...measurements indicate that, beyond about 1.5 km (1 mi) from nuclear plant cooling towers, salt deposition is not significantly above natural background levels."

Based on the above considerations and the assumption that cooling towers associated with the new nuclear unit or units would be similar to cooling towers at existing nuclear plant sites, including the GGNS, the staff concludes that the impacts of the cooling towers on air quality would be SMALL and additional mitigation would not be warranted.

5.2.2 Routine Releases Other than Cooling System

Operation of auxiliary equipment, such as generators and boilers associated with a postulated facility at the Grand Gulf ESP site, would be intermittent. SERI provided bounding values for particulate sulfur and nitrogen oxides, carbon monoxide, and hydrocarbon emissions from auxiliary boilers, standby diesel generators, and standby power system gas turbines in the PPE. Auxiliary boilers are assumed to operate 30 days per year, and standby diesel generators and standby power system gas turbines are assumed to operate 4 hours per month. SERI (2005a) states that gaseous releases associated with the postulated units would comply with Federal, State, and local emission standards.

No major air pollution sources exist near the Grand Gulf ESP site. Diesel generators and boilers at the GGNS operate for limited periods. Generators and boilers associated with the new nuclear unit or units would also be operated for limited periods. Emissions from the generators and boilers would be minor compared to emissions from boilers and generators that run continuously. Interactions between pollutants emitted from these sources and the plumes from the new nuclear unit cooling towers would be intermittent and would not have a significant impact on air quality.

Because these systems are used on an infrequent basis and no significant industrial source exists within 16 km (10 mi) of the proposed site, the staff concludes the impacts of these releases would be SMALL.

5.2.3 Transmission Line Impacts

The impacts of existing transmission lines on air quality are reviewed in the GEIS (NRC 1996). Small amounts of ozone and smaller amounts of oxides of nitrogen are produced by transmission lines. The small amounts of these gases were found to be insignificant for

745-kV lines (the largest lines in operation) and for a prototype 1200-kV line. In addition, the staff determined that potential mitigation measures would be very costly and would not be warranted. The largest existing line in the transmission and distribution system serving the proposed Grand Gulf ESP site is a 500-kV line, well within the range of lines considered in NUREG-1437.

Based on the information provided by SERI, the staff's independent review, and the analyses discussed above, the staff concludes the potential transmission line impacts of operation of the Grand Gulf ESP facility would be SMALL, and additional mitigation would not be warranted.

5.3 Water-Related Impacts

Water-use and water-quality impacts involved in the operation of a nuclear power plant are similar to the impacts that would be associated with any large thermoelectric power generation facility. Accordingly, SERI would need to obtain similar water-related permits and certifications as any other large industrial facility. These would likely include

- Clean Water Act Section 401 certification. This certification would be issued by the Mississippi Department of Environmental Quality (MDEQ) and would ensure that the project does not conflict with State water quality management programs.

- Clean Water Act Sections 402(a) and 402(p) National Pollutant Discharge Elimination System (NPDES) discharge permit. These permits would be issued by MDEQ and would regulate point source and storm water discharges. The U.S. Environmental Protection Agency (EPA) has delegated the responsibility for administering the NPDES program in Mississippi to MDEQ.

- Clean Water Act Section 316(a). This section regulates heated and chlorinated cooling water discharges to protect the health of the aquatic habitat.

- Clean Water Act Section 316(b). This section regulates cooling water intake structures to minimize environmental impacts associated with location, design, construction, and capacity of those structures.

- Section 10 of the Rivers and Harbors Act of 1899. This section prohibits the obstruction or alteration of navigable waters of the United States without a permit. Appropriate U.S. Army Corps of Engineers (ACE) permits would need to be obtained for maintenance of the proposed intake and discharge structures on the shore of the Mississippi River.

- Section 1424(e) of the Safe Drinking Water Act of 1974. This section prohibits any commitment for Federal financial assistance (through a grant, contract, loan guarantee, or

otherwise) for any project which the EPA Administrator determines may contaminate an aquifer designated by the Administrator to be a sole-source aquifer. EPA has identified the Southern Hills Aquifer, which includes the Catahoula formation beneath the Grand Gulf ESP site, to be a sole-source aquifer (EPA 1998).

Managing water resources requires understanding and balancing the tradeoffs between various, often conflicting objectives. At the Grand Gulf ESP site, these include navigation, recreation, visual aesthetics, fishery, and a variety of beneficial consumptive domestic and industrial uses of water. The responsibility for regulating water use and water quality is delegated to ACE and MDEQ through Federal laws and laws of the state of Mississippi. This section discusses the estimated impacts on water use and water quality resulting from operation of a facility at the Grand Gulf ESP site bounded by the PPE.

5.3.1 Hydrological Alterations

The staff did not identify any significant changes to the local flow patterns or intensities that would occur at the site due to operation. The site drainage system would generally drain surface water runoff and storm flow in approximately the same levels to Stream A and Stream B. Any increase in runoff intensity resulting from the increase in the impervious surface area would be mitigated using standard engineering storm water management practices pursuant to the site's NPDES storm water management program. Given the small amount of water withdrawn for a new nuclear facility relative to the large flow of the Mississippi River, the intake and discharge would have minimal impact on the river's flow pattern adjacent to the shoreline.

Any dewatering systems active during operation would only impact the shallow aquifers. However, based on the character of the shallow groundwater system, the staff concluded that any impacts on the groundwater flow pattern would be localized and any change would unlikely extend beyond the site boundary.

Based on the above, the NRC staff concludes that the impact of hydrological alterations from operation would be SMALL, and additional mitigation would not be warranted.

5.3.2 Water-Use Impacts

Certain details concerning operation of a new nuclear facility at the Grand Gulf ESP site are not known at the ESP stage. Consequently, the staff's analysis is not to the depth warranted for actual operation. It is, however, sufficient for the purpose of comparing the proposed action to the alternatives.

Operation Impacts at the Proposed Site

A new nuclear facility would use surface water from the Mississippi River for cooling purposes and groundwater from the Catahoula formation for other facility water needs. By far, the largest single use of water for the proposed Grand Gulf ESP facility would be makeup for the normal heat sink. SERI stated that operation of the makeup water system for a new facility would have a negligible impact on the use and water supply of the Mississippi River (SERI 2005a). Normal makeup flow rate to a new nuclear facility would be approximately 3175 L/s (50,320 gpm), and the maximum expected makeup flow would be 5400 L/s (85,000 gpm). About 25 percent of this water would be returned to the Mississippi River as blowdown. The staff concludes that a new facility would withdraw only a small amount of water relative to the total river flow (about 0.2 percent) at even the lowest minimum river discharge conditions recorded for the area. Also, because of the proposed location and the small area of the river that would be affected by the proposed new facility, the staff concludes that the intake structure would not affect recreational or commercial fishing operations or otherwise restrict navigation on the Mississippi River. Because the withdrawal would be small relative to river flow (conservatively considering withdrawals for both the proposed ESP unit(s) and the existing GGNS Unit 1), the staff concludes that impacts would be small.

SERI stated that no water from Stream A or Stream B would be used by the proposed new nuclear facility (SERI 2005a). However, the alteration of the existing landscape would likely increase the impervious surfaces at the site, thereby increasing storm water flow. While this could possibly alter the timing and magnitude of runoff without significantly altering the overall water budget, the staff concludes that, by employing standard best management practices for storm water management, the impact of the ESP facility on water uses associated with Stream A and Stream B would be insignificant.

No new consumptive wells in the Holocene alluvial aquifer are proposed for operation of the new facility; therefore, the staff concludes no impacts would be anticipated on the alluvial aquifer.

SERI (2005a) stated that the use of the additional wells installed in the Catahoula formation for water needs other than for cooling makeup water would not significantly affect the groundwater water surface elevation in the vicinity. However, the staff concludes that the characterization of the Catahoula aquifer was inadequate to support such a conclusion, particularly given the significance of the aquifer to local domestic water supplies and its designation by EPA as a sole-source aquifer (EPA 1998). Because of the limited number of borings, hydraulic conductivity measurements, and long-term pump tests in this portion of the aquifer that are currently available, the staff was unable to assess reliably the impact of a significant increase in the groundwater withdrawal at the Grand Gulf ESP site. Given the information provided in the applicant's environmental report and the staff's independent review, impact on the Catahoula formation could be SMALL if the proposed withdrawal had little effect on the Catahoula formation or MODERATE if the proposed withdrawal were to adversely affect current water withdrawals elsewhere in the aquifer. An applicant for a CP or COL referencing an ESP for the

Grand Gulf ESP site would need to provide additional information on the ability of the Catahoula aquifer to sustain withdrawals in order for the staff to make a significance determination with respect to this resource. Use of wells that withdraw from the Catahoula formation would be in accordance with applicable standards published in the MDEQ groundwater use and protection regulations (MDEQ1994), and necessary permits would be obtained from the MDEQ. MDEQ regulations allow for permit denial or reduction of withdrawal rate if such a withdrawal is expected to interfere with existing permitted uses of if it conflicts with the public interest.

Based on its review, the staff concludes that the issue of water-use impacts resulting from operational activities on groundwater at the Grand Gulf ESP site is unresolved. Additional aquifer characterization would need to be provided by an applicant for a CP or COL referencing an ESP for the Grand Gulf ESP site.

5.3.3 Water-Quality Impacts

Certain details concerning operation of a new nuclear facility at the Grand Gulf ESP site are not known at the ESP stage. Consequently, the staff's analysis is not to the depth warranted for actual operation. It is, however, sufficient for the purpose of comparing the proposed action to the alternatives.

In Section 5.3.2 of its environmental report (SERI 2005a), SERI described the impact of effluent discharges from both the existing GGNS Unit 1 and the proposed ESP facility. While the specific design of the outfall, including the diffuser, has not yet been specified, parameters from the PPE were used to bound the impact of the outfall on the river environment. Environmental parameters, such as river discharge and receiving water temperature, were also varied in this analysis, using the historical record.

5.3.3.1 Mississippi River

SERI's environmental report (2005a) assumed the discharge outfall would enter the Mississippi River several hundred feet downstream of the intake screens and on the east bank (the same side as the Grand Gulf ESP site) of the river. The proposed discharge would enter perpendicular to the river via a shoreline-located discharge canal that would be rectangular in cross-section. The canal at the terminus was assumed to be 10 m (33 ft) wide by 0.5 m (1.6 ft) deep. Regardless of river environment, local river depth at the shoreline- located discharge exit would be 0.5 m (1.6 ft) deep, and the bank would slope 19.3 degrees. Based upon PPE values for the Grand Gulf ESP facility and the *Updated Final Safety Analysis Report* (UFSAR) (MP&L 1994) for GGNS Unit 1, the bounding discharge flow rate was assumed to be 3.34 m^3/s (52,900 gpm) at a temperature of 37.7°C (100°F).

Operation Impacts at the Proposed Site

For purposes of determining bounding conditions, the variable flow conditions of the river were examined. Mississippi River flows examined by SERI (SERI 2005a) were assumed to be either 15,860 m^3/s (560,000 cfs) for average river flow or 3653 m^3/s (129,000 cfs) for low river flow. The river was assumed to be rectangular in cross-section, with a constant width of 884 m (2900 ft) and a depth of either 9.44 m (31.0 ft) for the average river flow or 2.44 m (8.00 ft) for low river flow. These combinations of discharges and cross-sectional areas results in a mean ambient river velocity of 1.9 m/s (6.2 ft/s) for average flow and 1.69 m/s (5.54 ft/s) for low flow. Ambient winter river water temperatures examined were 1°C (34°F) and 4°C (39°F) and ambient summer river water temperatures were 27.8°C (82.0°F) and 30.6°C (87.1°F).

SERI estimated the length and width of the discharge plume using the Cornell Mixing Zone Expert System (CORMIX) version 3.2 (Jirka et al. 1996). Simulation parameters and summary of results are shown in the environmental report (SERI 2005a). The plume width and length were defined in the analysis as the location of the 2.8°C (5°F) isotherm. CORMIX version 3.2 results indicate the maximum width and length of the plume to have occurred with the higher discharge and colder river case. Under these conditions, the worst case (i.e., largest) surface extent of the plume was reported to be 187 m (614 ft) long and 16.3 m (53.5 ft) wide.

The NRC staff performed an independent analysis of the outfall plume using CORMIX version 4.3 (Jirka et al. 2004). This is the most recent version of the CORMIX model available and includes several revisions to the buoyant plume algorithms that are germane to the SERI application. The staff's evaluation assumed that the discharge plume would enter perpendicular to the river, several hundred feet downstream of the intake screens. The canal terminus was assumed to be 10 m (33 ft) wide by 0.5 m (1.6 ft), and the local river depth at the outfall location was assumed to be 0.5 m (1.6 ft). Based on the UFSAR (MP&L 1994), the slope of the protected river bank was assumed to be 14 degrees (approximately 4 ft horizontal for every vertical foot). Based upon PPE bounding values (SERI 2005a) and the UFSAR (MP&L 1994), the outfall discharge was assumed to be 3.34 m^3/s (52,900 gpm) at a temperature of 37.7°C (100°F).

The staff evaluated two assumed river discharges during their analysis. These discharges were based on monthly average Mississippi River streamflow data collected between 1931 and 1998 near Vicksburg by the U.S. Geological Survey (USGS 2004). From this dataset, the mean flow was approximately 17,040 m^3/s (601,800 cfs) and the low flow was 3115 m^3/s (110,000 cfs). Water temperature data maxima and minima were examined between 1962 and 1979 to determine bounding values. Based upon the UFSAR (MP&L 1994), the average winter water temperature is 5°C (41°F) with a minimum of approximately 1°C (34°F). The average summer river temperature is 27.8°C (82.0°F), with a maximum of 30.6°C (87.1°F).

The cross-sectional areas of the river at both the mean and the low flow were determined using ACE (2001), SERI's environmental report (SERI 2005a), and the UFSAR (MP&L 1994). For the mean flow scenarios, the river width was 1000 m (3281 ft) and the average water depth

was 13 m (43 ft), resulting in an ambient river water velocity of 1.31 m/s (4.30 ft/s). For the low-flow scenarios, the river width was 730 m (2400 ft) and the average water depth of 5.7 m (19 ft), resulting in an ambient river water velocity of 0.75 m/s (2.5 ft/s). Ambient water velocities match typical observed values at similar river discharges.

Plume dimensions computed using CORMIX version 4.3 are presented in Table 5-2 for the eight different scenarios. The plume is larger in winter because of the much larger difference between ambient and outfall temperatures. The winter low-flow scenario with the minimum ambient river temperature produced the largest plume, with a length of 387 m (1270 ft) and a width of 58 m (190 ft). The winter low-flow scenario results in a mixing zone of 2.2 ha (5.5 ac).

Table 5-2. Dimensions of 2.8°C (5.0°F) Isotherm Plume in the Mississippi River Based on the Staff's CORMIX Simulations

			Low River Flow 3115 m^3/s		Average River Flow 17,040 m^3/s	
Case Studied	Ambient River Temperature[(a)]	Isotherm Above Ambient Considered[(a)]	Mixing Zone Length[(b)]	Mixing Zone Width[(b)]	Mixing Zone Length[(b)]	Mixing Zone Width[(b)]
Summer high temperature	30.6 (87)	2.8 (5.0)	72 (236)	36 (118)	8 (26)	10 (33)
Summer average temperature	27.8 (82)	2.8 (5.0)	75 (246)	34 (112)	8 (26)	9 (30)
Winter mean temperature	5 (41)	2.8 (5.0)	352 (1150)	53 (174)	254 (833)	21 (69)
Winter low temperature	1 (34)	2.8 (5.0)	387 (1270)	58 (190)	265 (869)	26 (85)

(a) °C (°F).
(b) meters (feet).

In addition to these scenarios, several submerged single-port diffuser outfalls were tested to determine if the size of the plume could be increased beyond those shown in the table above. As expected, by using a port diffuser located beneath the water surface, the buoyant jet entrained ambient water as it rose to the surface. It was therefore concluded that the shoreline diffuser discussed above is indeed the bounding case.

The maximum predicted size of the 2.8°C (5°F) above-ambient isotherm predicted by CORMIX version 4.3 is an approximately 400-m by 60-m (1300-ft by 200-ft) wedge-shaped region downstream of the outfall diffuser. By comparison, the Mississippi River is

approximately 1000 m (3281 ft) wide at this location. An approximate sketch of this plume in relation to the site is shown in Figure 5-1. The NRC staff concludes, therefore, that the impact of the thermal plume on the Mississippi River would be small and localized. The thermal discharge to the Mississippi River would be regulated by the MDEQ.

The staff extended its thermal impact assessment using the CORMIX model to consider the potential impacts of chemical pollutants in the discharge to the Mississippi River. The results presented in Table 5-2 can be used to derive mixing zone dilution factors for the cases considered in the thermal analysis. The dilution factor is the fractional concentration of a unit concentration in the discharge at the edge of the mixing zone. For instance, if the dilution factor were 10 percent and the discharge concentration were 20 ppm, then the concentration at the edge of the mixing zone would be 2 ppm. Table 5-3 presents dilution factors and the mixing zone (plume) dimensions for the four scenarios considered in the staff's thermal analysis.

For an 8-percent dilution factor, based on the low-flow condition, the mixing zone for the combined discharge from GGNS Unit 1 and the proposed ESP facility would be approximately 400 m long by 60 m wide (1300 ft by 200 ft). Again, this 60-m (200-ft) width is in comparison to the 1000-m (3281-ft) width of the Mississippi River at this location. The chemical discharge to the Mississippi River would be regulated by the MDEQ. The blowdown flow rate is expected to be more than 100 times greater than these other sources of non-radioactive liquid discharges. Any effluents from these other sources would be diluted by the blowdown effluent before entering the Mississippi River. However, SERI did not provide information in the PPE or environmental report defining the bounds of concentrations of chemical effluents to be discharged to the Mississippi River for sources other than the cooling water blowdown. Consequently, this issue is not considered to be resolved. Accordingly, impacts on Mississippi River water quality from chemical effluents (other than in blowdown) cannot now be determined. An applicant for a CP or COL referencing an ESP for the Grand Gulf ESP site would need to provide information on the concentrations of chemical effluents to the NRC.

5.3.3.2 Streams A and B

SERI stated that discharges to Streams A and B from the Grand Gulf ESP facility would include sanitary waste water, storm water, and sump drains. SERI did not provide information in the environmental report defining the bounds of concentrations of chemical effluents to be discharged to Streams A and B (SERI 2005a). Consequently, this issue is not considered to be resolved. An applicant for a CP or COL referencing an ESP for the Grand Gulf ESP site would need to provide information on the concentrations of chemicals in effluents to the NRC. The allowable concentrations and volumes of such effluents to Streams A and B would be regulated by the MDEQ.

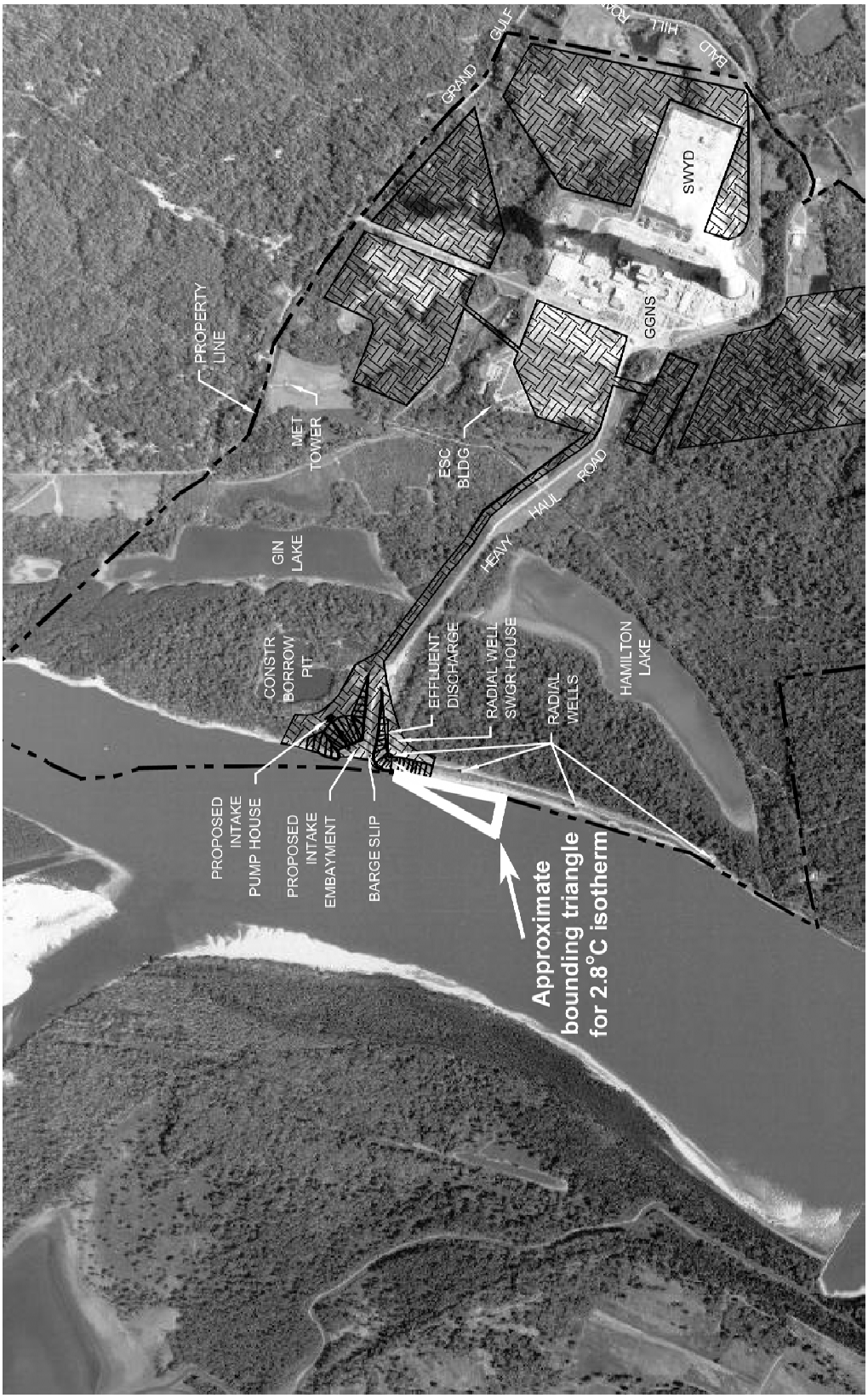

Figure 5-1. Bounding Triangle for the Location of the 2.8°C Above-Ambient Isotherm Based upon the Winter Extreme Temperature Difference, Low-Discharge Scenario

Table 5-3. Dilution Factors for Chemical Discharge to the Mississippi River Based on the Staff's CORMIX Simulations

Case Studied	Dilution Factor
Summer high temperature	28%
Summer average temperature	39%
Winter mean temperature	9%
Winter low temperature	8%

5.3.3.3 Groundwater

If very deep groundwater drawdowns were to occur resulting from high groundwater withdrawal rates during operation of the Grand Gulf ESP facility, it is conceivable that lower quality groundwater from deeper aquifers would be induced to flow upward into the Catahoula formation and possibly degrade the quality of water in the Catahoula formation. Given the information provided in the applicant's environmental report and the staff's independent review, impacts on the Catahoula formation could be SMALL if the proposed withdrawal had little effect on the Catahoula formation or LARGE if the proposed withdrawal were to induce degradation of the water quality of the sole source aquifer. Further aquifer characterization is needed to determine the impacts of additional groundwater withdrawals from the Catahoula formation. Therefore, the issue of impacts to groundwater quality resulting from operational activities at the Grand Gulf ESP facility is not resolved. An applicant for a CP or COL that references the ESP for the Grand Gulf ESP site would need to provide such additional information for the staff to make a significance determination with respect to impacts on groundwater quality.

5.3.3.4 Summary

SERI did not provide PPE values for non-radioactive liquid discharges other than the blowdown. Although the impact to surface water quality would be SMALL if discharges were within the limits of the existing GGNS NPDES permit, the staff cannot rely on assumed compliance with a permit in order to reach a conclusion regarding the magnitude of impact. Additional information regarding the constituents and associated concentrations for all liquid effluent sources is needed in order to determine the impacts of operation on surface water quality to the Mississippi River and Streams A and B. Therefore, the issue of impacts to surface water quality resulting from operational activities at the Grand Gulf ESP facility is not resolved. An applicant for a CP or COL that references the ESP for the Grand Gulf ESP site would need to provide such additional information for the staff to make a significance determination with respect to impacts on surface water quality.

Water quality impacts to the groundwater resources would be SMALL if the proposed groundwater withdrawal had little impact on the Catahoula formation or LARGE if the proposed groundwater withdrawal were to induce degradation of the water quality of the sole source Catahoula aquifer. The staff concludes that further aquifer characterization is needed to determine the impacts of additional groundwater withdrawals from the Catahoula formation. Therefore, the issue of impacts to groundwater quality resulting from operational activities at the Grand Gulf ESP facility is unresolved. An applicant for a CP or COL that references the ESP for the Grand Gulf ESP site would need to provide such additional information for the staff to make a significance determination with respect to impacts on groundwater quality.

5.4 Ecological Impacts

This section describes the potential impacts from operation of the Grand Gulf ESP facility, including transmission lines and associated right-of-way maintenance, to terrestrial ecosystems, aquatic ecosystems, and threatened and endangered species.

5.4.1 Terrestrial Ecosystems

The proposed cooling system for the Grand Gulf ESP facility is closed-cycle that would employ either natural or mechanical draft cooling towers. The rejected heat would be manifest in the form of water vapor plumes. Impacts associated with vapor plumes include those resulting from salt drift, fogging, and icing. Vapor plumes may affect crops, ornamental vegetation, and native plants, and water losses could affect shoreline habitat. In addition, bird collisions and noise-related impacts are possible with wet cooling towers. Each of these topics is discussed in the following paragraphs.

Electric transmission systems have the potential to affect terrestrial ecological resources through right-of-way maintenance, bird collisions with power lines, and electromagnetic fields (EMFs). The transmission and distribution system existing at the time of startup and operation of the proposed Grand Gulf ESP facility would be relied upon to distribute the power generated. A study conducted by SERI concluded that the existing system is adequate for an additional 1311 MW(e) generating capacity, assuming that modifications and upgrades are made to equipment in the switchyard of GGNS Unit 1. However, the maximum generating capacity is approximately 3000 MW(e) (SERI 2005a). If 3000-MW(e) generating capacity were installed, the existing transmission lines would have to be upgraded or additional transmission lines would be required.

Should the Grand Gulf ESP facility be constructed, the actual need for and nature of any transmission system improvements would be determined definitively prior to or during the CP or COL phase by the transmission and distribution system owner and operator (currently Entergy

| Mississippi, Inc.) under Federal Energy Regulatory Commission Order No. 2003
| (18 CFR Part 35). The magnitude of the environmental impacts associated with any transmission system improvements would also be established by the transmission and distribution system owner and operator at that time.

5.4.1.1 Impacts on Crops, Ornamental Vegetation, and Native Plants

Impacts on crops, ornamental vegetation, and native plants may result from cooling tower salt drift, icing, fogging, or increased humidity. No agricultural land exists on the Grand Gulf site. Offsite and in the immediate vicinity of the location of the Grand Gulf ESP facility, there is agricultural land only to the southeast and east, and winds originate most frequently in the
| southeast (SERI 2005a). Based solely on the direction of prevailing winds, it appears unlikely that cooling tower impacts on crops and ornamental vegetation would result. However, forests and forested wetlands both onsite and offsite to the northwest of the Grand Gulf ESP facility could be in the path of vapor plumes carried on southeasterly prevailing winds and could thus be affected.

It is assumed that new cooling towers would produce salt concentrations similar to cooling towers at existing nuclear power plants. New cooling towers would be located near the existing natural draft cooling tower at the Grand Gulf site and be subject to the same meteorological conditions and hence produce a similar plume footprint, potentially tripling the current salt deposition. A salt drift deposition study was conducted for GGNS Unit 1 from 1983 to 1988. The salt drift deposition rate was not significantly different between onsite and offsite locations. Consequently, a supplemental study was not undertaken to determine the biological effects of salt drift at the Grand Gulf site (Entergy 1992). The impact of salt drift on crops, ornamental vegetation, and native plants was evaluated for existing nuclear power plants in the GEIS
| (NRC 1996) and was found to be of minor significance. This determination also included existing nuclear power plants with more than one cooling tower. Information from the GEIS for license renewal is useful for this analysis. Therefore, the potential impact on crops, ornamental vegetation, and native plants from the operation of cooling towers for the Grand Gulf ESP
| facility would be minimal and mitigation would not be warranted.

5.4.1.2 Bird Collisions with Cooling Towers

Although the Grand Gulf ESP site is located adjacent to the Mississippi River and thus along the Mississippi flyway (Bird Nature 2004), no bird collisions have been reported for the existing
| 159-m (522-ft) GGNS Unit 1 natural draft cooling tower (SERI 2005a). However, there is no plan in place to monitor and report avian fatalities. The conclusion presented in the GEIS (NRC 1996) is that bird collisions with natural draft cooling towers are of small significance at all operating nuclear power plants, including those with multiple cooling towers. Mechanical draft cooling towers are known to cause only negligible avian mortality and were thus not addressed in the GEIS (NRC 1996). Consequently, the incremental number of bird collisions, if any,

associated with the operation of one or more wet cooling towers for the proposed Grand Gulf ESP facility, regardless of the type of cooling tower (natural or mechanical draft) employed, would be minimal and mitigation would not be warranted.

5.4.1.3 Noise

For both natural and mechanical draft cooling towers, the noise levels from cooling tower operation is anticipated to be 55 decibels (dBA) at 300 m (1000 ft) (SERI 2005a). This noise level is well below the 80- to 85-dBA threshold at which birds and small mammals are startled or frightened (Golden et al. 1980). Thus, noise from operating natural or mechanical draft cooling towers would not be likely to disturb wildlife beyond the Grand Gulf site perimeter fence, which is over 300 m (1000 ft) from the source. Consequently, the potential impact on wildlife posed by the incremental noise resulting from the operation of one or more wet cooling towers for the Grand Gulf ESP facility would be minimal and additional mitigation would not be warranted.

5.4.1.4 Shoreline Habitat

Because of the small quantity of water withdrawn and discharged during operation relative to the flow in the Mississippi River, adverse impacts on the river shoreline are unlikely. SERI has estimated the water use for the Grand Gulf ESP facility and the areal extent of the thermal plume (SERI 2005a). The staff's independent assessment is presented in Section 5.3.2. The amount of water to be withdrawn from the Mississippi River represents about 0.2 percent of the total lowest minimum flow. The discharge plume, based on the 2.8°C (5°F) above-background isotherm, would range from 8 to 400 m (26 to 1300 ft) in length and 9 to 60 m (30 to 200 ft) in width, depending on season and flow (Section 5.3.2). No additional shoreline habitat would be exposed from the water removal, and evaporative loss for the proposed facility would be undetectable and not likely to affect shoreline plants or wildlife. Consequently, the potential effects on terrestrial ecology from the drawdown of the Mississippi River resulting from operation of one or more wet cooling towers for the Grand Gulf ESP facility would be negligible and mitigation would not be warranted.

5.4.1.5 Transmission Line Right-of-Way Management (Cutting and Herbicide Application)

It is currently anticipated that if the maximum generating capacity for the Grand Gulf ESP facility (approximately 3000 MW(e)) (SERI 2005a) were installed, the existing transmission lines would have to be upgraded or additional transmission lines would be required. It is assumed that any transmission line improvements, such as the addition of new lines and pole support structures, for example, would be sited within the existing transmission line rights-of-way to the greatest extent possible and that no new rights-of-way would be required (Section 4.4.1.2).

| However, it is possible that the width of the existing rights-of-way would need to be increased
| (Section 4.4.1.2). Existing roads providing access to the current transmission line rights-of-way
| likely would be sufficient for use in any expanded right-of-way and no new roads would
be required.

| The staff assumes that the same vegetation management practices currently employed by
| Entergy Mississippi, Inc. for the existing GGNS Unit 1 facility transmission line rights-of-way
(such as, bushhogging on an as-needed basis as discussed in Section 2.7.1.1) would be
| applied to any expanded rights-of-way associated with the Grand Gulf ESP facility. Thus, for
| the Grand Gulf ESP facility, vegetation management would simply occur along the same rights-
| of-way, but potentially over twice the area. Transmission line right-of-way maintenance was
evaluated in the GEIS (NRC 1996), and the impact was found to be of small significance at
| operating nuclear power plants with associated transmission line rights-of-way of variable
| widths. Consequently, the incremental effects of transmission line right-of-way maintenance
| posed by increasing the width of the existing rights-of-way for the Grand Gulf ESP facility would
| be minimal. Entergy Mississippi, Inc. would follow best management practices and coordinate
| with Federal and State agencies; thus, no other mitigation would be warranted.

5.4.1.6 Bird Collisions with Transmission Lines

| Transmission line and right-of-way maintenance personnel have not reported dead birds from
collisions with the GGNS Unit 1 plant transmission lines. However, there is no plan in place to
monitor and report avian fatalities under transmission lines. The conclusion presented in the
| GEIS (NRC 1996) is that bird collisions with transmission lines are of small significance at
| operating nuclear power plants, including transmission line rights-of-way with variable numbers
of power lines.

Thus, although additional transmission lines could be required for the Grand Gulf ESP facility
(see Section 4.4.1.2), these would likely present few new opportunities for bird collisions. The
additional number of bird collisions, if any, would not be expected to cause a measurable
reduction in local bird populations. Consequently, the incremental number of bird collisions
posed by possible addition of new transmission lines for the Grand Gulf ESP facility would be
| negligible and mitigation would not be warranted.

5.4.1.7 Impact of Electromagnetic Fields on Flora and Fauna (Plants, Agricultural Crops, Honeybees, Wildlife, Livestock)

| EMFs are unlike other agents that have an adverse impact (e.g., toxic chemicals and ionizing
| radiation) in that dramatic acute effects cannot be demonstrated and long-term effects, if they
| exist, are subtle (NRC 1996). As discussed in the GEIS (NRC 1996), a careful review of
| biological and physical studies of EMFs did not reveal consistent evidence linking harmful
| effects with field exposures. Thus, the conclusion presented in the GEIS (NRC 1996) was that

the impacts of EMFs on terrestrial flora and fauna were of small significance at operating nuclear power plants, including transmission systems with variable numbers of power lines. Since 1997, over a dozen studies have been published that looked at cancer in animals that were exposed to EMF for all or most of their lives (Moulder 2005). These studies have found no evidence that EMFs cause any specific types of cancer in rats or mice (Moulder 2005). Therefore, the staff concludes that the incremental EMF impact posed by possible addition of new power lines for a new nuclear unit or units at the Grand Gulf ESP site would be minimal and mitigation would not be warranted.

5.4.1.8 Floodplains and Wetlands on Transmission Line Rights-of-Way

As noted earlier, the existing transmission lines would have to be upgraded or additional transmission lines would be required to support the full PPE. These upgrades likely would be sited within the existing rights-of-way to the greatest extent possible. However, these upgrades could potentially increase the width of the existing rights-of-way. It is assumed existing roads providing access to the current transmission line rights-of-way would be sufficient for use in any expanded right-of-way and that no new roads would be required.

The effects of transmission line right-of-way maintenance on floodplains and wetlands was evaluated previously in the GEIS (NRC 1996). The impacts were found to be of small significance at operating nuclear power plants, and these included transmission line rights-of-way of variable widths. The incremental effects of transmission line right-of-way maintenance on floodplains and wetlands posed by increasing the width of the existing rights-of-way for the Grand Gulf ESP facility would be negligible and mitigation beyond use of best management practices would not be warranted.

5.4.1.9 State-Listed Species

Animal Species

The endangered wood stork *(Mycteria americana)* was observed in the summertime on Gin and/or Hamilton lakes 18 years prior to construction of GGNS Unit 1 (AEC 1973). The wood stork should be considered a possible non-breeding transient to the Grand Gulf site and vicinity (SERI 2005a; MNHP 2004a, 2004b). Consequently, the potential impacts from collisions of the wood stork with cooling towers and/or any additional transmission lines associated with the Grand Gulf ESP facility are considered minimal.

Plant Species

The critically imperiled hairy waterclover (*Marsilea vestita*) and jug orchid (*Platythelys querceticola*), and the imperiled glade fern (*Diplazium pycnocarpon*) and American bittersweet (*Celastrus scandens*), are known to occur beyond 3.2 km (2 mi) but within 16 km (10 mi) of the

Grand Gulf site (MNHP 2004b). The critically imperiled/imperiled Allegheny monkeyflower (*Mimulus ringens*) is known to occur about 17.6 km (11 mi) from the Grand Gulf site (SERI 2005a). Although the known locations of these five species occur at some distance from the Grand Gulf site, they could yet occur onsite. However, potential impacts on these five species from the effects of cooling tower operation (salt drift), transmission line operation, and right-of-way maintenance, as described above, are considered negligible.

5.4.1.10 Summary of Terrestrial Ecosystem Impacts

The potential impacts of operating wet cooling towers for the Grand Gulf ESP facility on crops, ornamental vegetation, native plants, birds, shoreline habitat, and any related impacts on State-listed species are considered negligible. The potential impacts of transmission line right-of-way maintenance (cutting and herbicide application) and similar impacts on floodplains and wetlands, birds, and biota due to EMFs and any related impacts on State-listed species are considered negligible.

The staff reviewed the potential terrestrial ecological impacts of a new generation facility at the Grand Gulf ESP site including the associated heat-dissipation system, transmission lines, and associated right-of-way maintenance. The staff concludes the impacts from operation of the Grand Gulf ESP facility would be SMALL, and additional mitigation beyond that mentioned in the text would not be warranted.

5.4.2 Aquatic Ecosystems

The potential impacts on the aquatic ecosystem from operation of a Grand Gulf ESP facility, including water intake, discharge of heated effluents, physical changes to aquatic systems from storm water collection, and transmission line right-of-way maintenance activities were evaluated.

5.4.2.1 Intake System

For aquatic resources, the primary concerns of water intake are the location of the cooling water intake structure and the potential for organisms to be impinged on the intake screens or entrained into the cooling-water system. Impingement occurs when organisms are trapped against intake screens by the force of the water passing through the cooling-water intake structure (66 FR 65256). Impingement can result in starvation and exhaustion, asphyxiation (water velocity forces may prevent proper gill movement or organisms may be removed from the water for prolonged periods of time), and descaling (66 FR 65256). Entrainment occurs when organisms are drawn through the cooling water intake structure into the cooling system. Organisms that become entrained are relatively small benthic, planktonic, and nektonic (organisms in the water column) forms, including early life stages of fish and shellfish, and

which often serve as prey for larger organisms (66 FR 65256). As entrained organisms pass through a plant's cooling system, they are subject to mechanical, thermal, and toxic stress.

EPA has promulgated regulations that implement Section 316(b) of the Clean Water Act for new and existing electric power producing facilities (66 FR 65256; 69 FR 41576). The Phase II regulations apply to facilities that employ a cooling water intake structure and withdraw 50 million gallons per day or more of water from waters of the United States for cooling purposes. New nuclear unit or units at the Grand Gulf ESP site would be subject to these regulations. The regulations state that if the facility employs a closed-cycle cooling system, then the facility is deemed to have met the performance standards to reduce impingement mortality and entrainment. SERI has not yet finalized a detailed design of the cooling water system; however, the PPE identifies cooling system designs that employ the use of mechanical draft or natural draft cooling systems, both of which are considered a closed-cycle cooling system. Therefore, the staff believes that the ESP facilities would meet the performance standards specified in the EPA regulations implementing Section 316(b).

The Grand Gulf ESP facility would, as the existing GGNS Unit 1 does, use cooling towers. Losses of fish from impingement and entrainment are significantly less with systems that have cooling towers because relatively small volumes of makeup water are needed for the evaporative loss of water in comparison to systems with once-through cooling. GGNS Unit 1 uses radial wells located along the shoreline of the Mississippi River to collect makeup water through the influx of river and groundwater into the well system. The ESP facility would require more water than can be generated through the radial well network. An intake structure designed to collect water from the river itself is proposed to supply the makeup water for the proposed plant (SERI 2005a).

The proposed intake structure for the Grand Gulf ESP facility and the designs of the other portions of the cooling water system have not been finalized. The flow for makeup water from the Mississippi River is estimated to average 3175 L/s (50,320 gpm), with a maximum peak flow of 5400 L/s (85,000 gpm). The maximum peak flow would equal about 0.2 percent of the river flow at the Grand Gulf site under extreme low-flow conditions in the river—3653 m^3/s (129,000 cfs). The intake structure for the proposed Grand Gulf ESP facility would be of a different design than the existing radial well system currently used at the GGNS. The intake structure would be located along the upstream shoreline of the existing barge slip. The intake would consist of screened suction pipes supplying the makeup water pumps. The intake screens would be sized so that the average intake velocity through the screen would be less than or equal to 0.12 m/s (0.5 ft/s). The depth of the intake screens would be such that the removal of water would minimize the uptake of aquatic biota and river debris. The plans for the intake screen are based on a design that is currently being employed at the River Bend Station intake (SERI 2005a). Located on the Mississippi River at River Mile (RM) 262, the River Bend Station is a 2894 MW(t) nuclear power plant that uses closed-cycle cooling dissipating heat using mechanical draft cooling towers.

Operation Impacts at the Proposed Site

In correspondence with resource agencies associated with the Grand Gulf ESP facility, eight aquatic species that could be affected by operation of a new ESP facility (SERI 2005a) were identified as being of special interest. Four of these species are Federal or State-listed threatened or endangered species, and are discussed in Section 5.4.3: gulf sturgeon (*Acipenser oxyrinchus desotoi*), pallid sturgeon (*Scaphirhynchus albus*), bayou darter (*Etheostoma rubrum*) and crystal darter (*Crystallaria asprella*). Of the remaining fish species, chestnut lamprey (*Ichthyomyzon castaneus*), paddlefish (*Polyodon spathula*), and blue sucker (*Cycleptus elongatus*) were found in the Mississippi River and lakes on the Grand Gulf site in GGNS pre-construction surveys (MP&L 1973). The black buffalo (*Ictiobus niger*) has been reported from the Mississippi River in the vicinity of the Grand Gulf site (Ross 2001). The black buffalo is a species of "special concern" to the state of Mississippi (MNHP 2004a, 2004b). No biologically important areas (e.g., critical habitats) were identified by the resource agencies as being in the immediate vicinity of the Grand Gulf ESP site (SERI 2005a).

As adults, the fish of special interest described above would be able to avoid the proposed intake structure and not be impinged. Also, the design for the proposed intake structure would create a low-intake velocity that would not be likely to affect fish. Larval stages of fish and eggs of fish that are released into the water column travel at the speed of the current of the river. These organisms are susceptible to entrainment if they are trapped in the flow of an intake structure. A study conducted as part of the GGNS pre-construction surveys in 1972 to 1973 found that the numbers of fish larvae in the Mississippi River at Grand Gulf were low (MP&L 1973). No fish of special interest were collected. The amount of water that would be removed by the intake structure is about 0.2 percent of the overall flow in the river under extreme low-flow conditions.

Impingement and entrainment can be evaluated by comparing the proposed intake structure for a new ESP facility to the performance of the similarly designed structure at the once-through River Bend Nuclear Station. The intake structure at the River Bend Nuclear Station has an intake water velocity of 0.12 m/s (0.5 ft/s) or lower through the screens. The structure is located within an embayment so as not to block the passage of fish, similar to that proposed for the Grand Gulf ESP facility. The final environmental impact statement for the River Bend Nuclear Station (NRC 1985) concluded that impingement of organisms on the intake screens was not likely to be a problem because of low-intake velocities. Also, entrained plankton and other non-swimming species would be limited because the highest density of organisms was located on the far side of the river, away from the intake structure (NRC 1985). The staff is not aware of any recent studies of impingement or entrainment conducted at the River Bend Nuclear Station that indicate the impact on aquatic organisms has changed. Thus, the use of a similar intake structure at the Grand Gulf ESP facility would likely also pose a minimal impact from impingement and entrainment of aquatic organisms in the Mississippi River (SERI 2005a).

5.4.2.2 Aquatic Thermal Impacts

The effluent discharge from the Grand Gulf ESP 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. While the design of the structure has not been finalized, it was assumed that the shoreline discharge would be located several hundred feet downstream of the intake screens. The proposed shoreline discharge would be a concrete structure 10 m (33 ft) wide by 0.5 m (1.6 ft) deep. The location is thought to be outside the influence of the intake structure and any currents created by the intake embayment and barge slip (SERI 2005a).

SERI and the staff have used the CORMIX model (Section 5.3.2) to estimate the size and temperature of the thermal plume from the existing Unit 1 and one or more new ESP nuclear units. The staff estimated plumes varying from 8 to 387 m (26 to 1270 ft) in length and 9 to 58 m (30 to 190 ft) in width (Figure 5-1). The size of the plume varied with the summer and winter conditions. The model defines the plume as a 2.8°C (5°F) degree difference in temperature from the ambient water temperature, thus the smaller size of the plume occurred during the summer.

Impacts on the aquatic organisms in the Mississippi River would be minimized by the proposed design of a closed loop cooling system with cooling towers for the Grand Gulf ESP facility. With this design, the majority of the waste heat would be discharged to the atmosphere and not the Mississippi River (SERI 2005a).

The size of the thermal plume from the proposed effluent discharge (defined as 2.8°C (5°F) or higher than the ambient temperature of the river) was determined to be small in comparison to the width of the Mississippi River at the Grand Gulf ESP site. Fish and other organisms in the river would move through the plume unencumbered by any structures or physical features that would retain them in the plume. Furthermore, fish will avoid elevated temperatures that are potentially harmful, if possible. The increase in temperature expected at the discharge could be disorienting to organisms moving through the plume, but the temperature is unlikely to be lethal (NRC 1981a; Fry 1971; Dean 1973; Beitinger et al. 2000).

Cold shock occurs when aquatic organisms that have been acclimated to warm water, such as fish in a power plant's discharge canal, are exposed to a sudden temperature decrease. This sometimes occurs when single-unit power plants shut down suddenly in winter. Cold shock mortalities at U.S. nuclear power plants are "relatively rare" and typically involve small numbers of fish (NRC 1996). It is less likely to occur at a multiple-unit plant, because the temperature decrease from shutting down one unit is moderated by the heated discharge from the unit or units that continue to operate. At the Grand Gulf ESP site, the volume of the discharge in

comparison to the flow of the river is very small. Furthermore, there is no confined area like a discharge canal that will attract the fish to the thermal plume and concentrate the organisms (SERI 2005a).

The thermal plume could affect the movement and distribution of the aquatic biota. The warmer water could attract some organisms during the colder months. Fish could avoid the plume if the temperature were too high. The location and design of the discharge would not impede fish passage. During normal and minimal flows of the river, the thermal discharge would be along the river bank. During the flood season, the discharge structure would be below the river level. The amount of water and swift current would quickly mix the effluent with the river water, thus minimizing any potential impact (SERI 2005a).

The location of the discharge along the bank of the Mississippi River, the buoyant nature of the plume, the large flow of the river, and the stabilization of the river shoreline by concrete mats and riprap would minimize other potential impacts on aquatic organisms from the thermal discharge of the proposed ESP facility. Aquatic insects and benthic macrofauna are not in great abundance along the shore of the Mississippi River, based on MP&L pre-construction surveys in 1972 to 1973, and the conditions are not thought to have changed over time. Nuisance organisms are not likely to be encouraged since the discharge is into the river flow and the substrate is not suitable for colonization by most of these organisms. The plume in the river would not be in a confined area for aquatic organisms and the flow of the river would not be encumbered by the proposed design such that predation, parasitism and disease, changes in dissolved gases, or accumulation of contaminants would become an issue (MP&L 1973; NRC 1981a; SERI 2005a).

5.4.2.3 Shoreline Erosion and Other Physical Impacts

As mentioned above, the shoreline of the Mississippi River at the GGNS has been stabilized by concrete mats and riprap. SERI has stated that any disruption of the stabilized banks would be addressed during operation of the Grand Gulf ESP facility. Periodic dredging of the intake embayment to remove sediment deposits and littoral debris carried into the embayment would be necessary. Dredging may lead to temporary increase in turbidity in river. These activities would require a permit from the ACE and could be timed and conducted to have a minimal impact on the existing aquatic resources in the vicinity (MP&L 1973; NRC 1981a; SERI 2005a).

5.4.2.4 Transmission Line Right-of-Way Maintenance Activities

Maintenance activities along the Baxter-Wilson and Franklin transmission line rights-of-way could lead to temporary impacts in the waterways being crossed. Plans for maintenance procedures of the widened rights-of-way have not been developed. The impacts on aquatic resources would vary depending on whether physical or chemical means for controlling vegetation in the rights-of-way are used. The maintenance procedures currently being used

(primarily bushhogging performed on an as-needed basis) would likely continue (41 FR 24062). If widening the existing rights-of-way is needed, NRC expects that an applicant for a CP or COL referencing the Grand Gulf ESP would work with the appropriate Federal and State agencies and the transmission line owner, Entergy Mississippi, Inc., to develop and implement the plans for rights-of-way maintenance that would have minimal impacts on the aquatic ecosystems.

5.4.2.5 State-Listed Species

Animal Species

The endangered crystal darter (*Crystallaria asprella*) is found in Bayou Pierre and its tributaries, which flow as close as 3 km (1.9 mi) east of the Grand Gulf site (Ross 2001; MNHP 2004b; Katula 2004). Operation of the Grand Gulf ESP facility would not affect the regions where the crystal darter is found. The Franklin transmission line right-of-way crosses Bayou Pierre approximately 5.5 km (3.4 mi) to the south of the Grand Gulf site. NRC expects that SERI would work with the appropriate State agencies and the transmission line owner, Entergy Mississippi, Inc., to develop and implement plans for maintenance of the transmission line rights-of-way that would have minimal impacts on Bayou Pierre and the crystal darter.

Plant Species

No State-listed aquatic plant species are known to occur within 16 km (10 mi) of the Grand Gulf site (MNHP 2004a, 2004b).

5.4.2.6 Summary of Aquatic Ecosystem Impacts

The final design of the proposed intake and discharge systems for the Grand Gulf ESP facility would consider potential impacts on aquatic organisms under EPA regulations implementing Section 316(b) of the Clean Water Act. The use of cooling towers is a mitigative measure for reducing impacts from impingement and entrainment. The characteristics of the thermal discharge into the river would be reduced through the use of a cooling tower system. The NRC staff therefore concludes that the impact from operations would be SMALL, and additional mitigation would not be warranted. The NRC staff will verify that any necessary aquatic ecology monitoring (see Section 2.7.2.3) would be performed.

5.4.3 Threatened and Endangered Species

The potential impacts of operation of the ESP facility, including transmission lines and associated right-of-way maintenance, on terrestrial and aquatic Federally listed threatened and endangered species were evaluated. These species were identified through correspondence

with the U.S. Fish and Wildlife Service (FWS) (FWS 2004a, 2004b), review of FWS county listings of such species for the state of Mississippi (FWS 2000), and correspondence with the National Oceanic and Atmospheric Administration (NOAA) Fisheries (NMFS 2004).

5.4.3.1 Federally Listed Animal Species

Florida Panther - Endangered

Currently no viable populations of the Florida panther *(Puma concolor coryi*) occur outside of Florida (SERI 2005a). Therefore, potential impacts on Florida panthers from facility and transmission line operation and right-of-way maintenance, as discussed in Section 5.4.1, would be minimal.

Bald Eagle - Threatened

Bald eagle (*Haliaeetus leucocephalus*) occurrences have not been reported within 16 km (10 mi) of the Grand Gulf site (MNHP 2004b) or within several miles of transmission line rights-of-way (Section 4.4.3.1). Therefore, potential impacts on bald eagles from facility and transmission line operation and right-of-way maintenance, as discussed in Section 5.4.1, would be minimal.

Interior Least Tern - Endangered

The nearest areas occupied by least terns (*Sterna antillarum*) upstream and downstream from the Grand Gulf site (RM 405) (SERI 2005a) were at Yucatan Dikes (RM 409.8), Togo Island Dikes (RM 413.6), and Below Bondurant Towhead Dikes (RM 393.0) (ACE 2004). The areas occupied by least terns that are closest to the transmission line rights-of-way are about 3.2 km (2 mi) distant (Section 4.4.3.1). Therefore, potential impacts on interior least terns from facility and transmission line operation and right-of-way maintenance, as discussed in Section 5.4.1, would be minimal.

American Alligator - Threatened

The only Federally listed animal species known to inhabit the Grand Gulf site is the threatened American alligator (*Alligator mississippiensis*). However, the alligator is listed only because of its similarity of appearance to the American crocodile (*Crocodylus acutus*). American alligator populations are considered disjunct, limited to available habitat but stable (52 FR 21059). Although the alligator is present in wetland habitats onsite, potential impacts on the species from the effects of facility and transmission line operation and right-of-way maintenance, as discussed in Section 5.4.1, would be minimal.

Red-Cockaded Woodpecker - Endangered

The red-cockaded woodpecker (*Picoides borealis*) is not known from Claiborne County (Costa and Walker 1995) and would thus not be affected by facility operation. The species may occur in the vicinity of the Franklin transmission lines, but would not be expected to be adversely affected by operation of the lines and may be positively affected by right-of-way maintenance. Transmission line right-of-way maintenance practices that favor development of an herbaceous understory may foster use of restored old-age long leaf pine (*Pinus palustris*) stands (Section 2.7.1.2) by red-cockaded woodpeckers by providing nearby foraging habitat (USFS 2005). In 2003, Entergy Corporation entered into a partnership with the National Wild Turkey Federation to maintain utility rights-of-way on the Homochitto National Forest using low-toxicity herbicides for the express purpose of producing a more open, grassy habitat (USFS 2003). Consequently, right-of-way maintenance would be expected to benefit the red-cockaded woodpecker.

Louisiana Black Bear - Threatened

It is likely that the Louisiana black bear *(Ursus americanus luteolus)* occurs on and in the vicinity of the Grand Gulf site and potentially could be initially affected by noise from cooling tower operation. However, if present, the bear likely has become accustomed to noise produced by the existing GGNS Unit 1 cooling tower. Thus, this potential effect from operation of the Grand Gulf ESP facility would be expected to be negligible. The Louisiana black bear may occur in the vicinity of transmission line rights-of-way (Section 4.4.3.1) but would not be expected to be affected by transmission line operation and right-of-way maintenance. Consequently, the potential impacts on the subspecies from facility and transmission line operation and right-of-way maintenance, as discussed in Section 5.4.1, would be negligible.

Gulf Sturgeon - Threatened

The gulf sturgeon *(Acipenser oxyrinchus desotoi)* has not been collected in the region of the Grand Gulf site; however, the Mississippi River is considered part of the historical range for the gulf sturgeon. Therefore, the reach of the river at the Grand Gulf site is likely to be used by the sturgeon as it migrates up and down the river. No known spawning areas for the gulf sturgeon exist near the Grand Gulf site, and thus it is unlikely that this area of the river is used by larval stages of the gulf sturgeon (68 FR 13370; FWS & GSMFC 1995; Ross 2001; NMFS 2004).

The end of the Baxter-Wilson transmission line right-of-way is no closer then 0.6 km (0.4 mi) to the Mississippi River. Thus, the potential impacts from transmission line operation and right-of-way maintenance of the transmission line rights-of-way would have no effect on the Mississippi River and Gulf Sturgeon.

Operation Impacts at the Proposed Site

The operational activities of the Grand Gulf ESP facility that could influence the juvenile and adult gulf sturgeon as they migrate through the area would include water removal from the Mississippi River via a water intake structure and discharge of water downstream. The proposed intake structure is estimated to have a through-screen velocity of less than 0.2 m/s (0.5 ft/s) (SERI 2005a). Juvenile and adult sturgeon could easily escape the planned through-screen velocity at the plant's intake structure and would not become impinged on the screens. The thermal plume created from the discharge of blowdown water from the proposed plant would not likely influence the migration of the sturgeon. The plume is estimated to have a width of 8 to 387 m (26 to 1270 ft), which varies based on the season. The impacts on sturgeon from such elevated temperatures are not known (Beitinger et al. 2000). However, the juvenile and adult stages of the sturgeon could easily avoid the thermal plume if the temperature were too high. Consequently, impacts on gulf sturgeon from operation of the Grand Gulf ESP facility would be unlikely.

Bayou Darter - Threatened

The bayou darter (*Etheostoma rubrum*) is endemic to Bayou Pierre and its tributaries, which flow as close as 3 km (1.9 mi) east of the Grand Gulf site (40 FR 44149; FWS 1990, 2000; 2004a, Ross 2001). The operation of a Grand Gulf ESP facility would not affect the regions where the bayou darter is found. The Franklin transmission line right-of-way crosses Bayou Pierre. The NRC expects that an applicant for a CP or COL referencing the Grand Gulf ESP would work with the appropriate Federal and State agencies and the transmission line owner, Entergy Mississippi, Inc., to develop and implement plans for maintenance of the transmission line rights-of-way that would have minimal impacts on the Mississippi River and bayou darter.

Fat Pocketbook Mussel - Endangered

The fat pocketbook mussel *(Potamilus capax)* was historically found throughout the Mississippi River drainage from Minnesota to Louisiana. In 2003, the mussel was found near Vicksburg in the Mississippi River, as well as south of the Grand Gulf Site (41 FR 24062; FWS 1989, 2000, 2004a, 2004b, 2004c; MNHP 2004c). The adult mussels are found in sand and mud as well as in stable substrates of fast flowing rivers. Little information is available on the reproduction of the fat pocketbook mussel; however, they are thought to be similar to other freshwater mussels. When the mussels reproduce, the sperm are released into the water column and the sperm are taken in by the female through siphoning. Fertilized embryos then develop inside the female mussel into a parasitic stage (glochidia). Upon release from the female, the glochidia attach to a fish host and, after a period of time, metamorphose into a free-living juvenile. As the mussel matures, it settles into the sand and mud or onto a stable substrate to grow into an adult. The fat pocketbook mussel population is thought to be a long-period breeder, spawning in summer, retaining glochidia through fall and winter, and releasing them in late spring and early summer. Gravid females have been found from June through October (CMI 1996).

The end of the Baxter-Wilson transmission line right-of-way is no closer than 0.6 km (0.4 mi) to the Mississippi River. Thus, the potential impacts from transmission line operation and right-of-way maintenance of the transmission line rights-of-way would have no effect on the Mississippi River and fat pocketbook mussel.

Operation of the Grand Gulf ESP facility would include water removal from the Mississippi River via a water intake structure and discharge of water downstream. While the intake screens would be sized so that the through-screen velocity is less than 0.2 m/s (0.5 ft/s) (SERI 2005a), the sperm and free-living juvenile stage of the mussel could be entrained by the water intake system of the proposed plant. The area influenced by the flow into the intake structure is not great in comparison to the entire region of the Mississippi River where the mussel might occur. Not enough is known about the mussel's life history to determine if the increased temperature within the discharge plume of the proposed plant would have any impact; however, it would be highly unlikely. The area that would be affected by the increased temperature from the discharge plume is small and the warmer water is buoyant and would not normally impinge on the river bottom. It is likely that the impact of a thermal discharge from a new nuclear facility would be minimal because the region of the shoreline habitat in the Mississippi River that would change with operation is small compared to the entire shoreline habitat available for this species.

Pallid Sturgeon - Endangered

Pallid sturgeon *(Scaphirhynchus albus)* have been collected in the region of the Grand Gulf ESP site. Adult pallid sturgeon have been caught in regions with moderate to strong currents and a sand or sand/gravel substrate, similar to the main channel of the Mississippi River as it passes by the Grand Gulf site. Little is known about the use of the Mississippi River in the area of the Grand Gulf ESP site for spawning by the pallid sturgeon. Spawning habitat may exist within 16 km (10 mi) of the Grand Gulf ESP site. There also is little information about the use of the reach by larvae or juvenile pallid sturgeon (55 FR 36641; FWS 1993, 2000, 2004a; Ross 2001; Hartfield 2003; LDOTD 2003; SERI 2005a).

The end of the Baxter-Wilson transmission line right-of-way is no closer than 0.6 km (0.4 mi) to the Mississippi River. Thus, the potential impacts from transmission line operation and right-of-way maintenance of the transmission line rights-of-way would have no effect on the Mississippi River and pallid sturgeon.

The operation of the Grand Gulf ESP facility in the vicinity of the pallid sturgeon's habitat would include water removal from the Mississippi River with a water intake structure and discharge of water downstream. The adult and juvenile sturgeon would likely not be impinged on the

screens of the intake structure because they would easily be able to avoid impingement from the anticipated through-screen velocity of water (less than 0.2 m/s (0.5 ft/s)). Larval sturgeon (less than 3 cm (1.2 in.) in size) are thought to drift along the bottom of the river (less than 0.5 m (1.6 ft) from the bottom) at the velocity of the river (Braaten and Fuller 2005).

Discharge at the downstream structure would create a thermal plume that might affect the passage of pallid sturgeon on the eastern shore of the Mississippi River. If the sturgeon, at any life stage, were to drift through the thermal plume at the average velocity of the river, the individual would spend from 13 seconds to 15 minutes at temperatures 2.8°C (5°F) or more above ambient temperature. The estimate of residence time in the plume is based on a river velocity of 0.4 to 0.6 m/s (1.3 to 2 ft/s) (SERI 2005a) and a thermal plume estimated by staff to have a length of 8 to 387 m (26 to 1270 ft), which varies with the season. The impact on sturgeon from such elevated temperatures is not known (Beitinger et al. 2000). However, the juvenile and adult stages of the sturgeon could easily swim and avoid the thermal plume if the temperature were too high. There are no known spawning areas in the reach of the Mississippi River that would be influenced by the thermal plume, and thus the number of larval pallid sturgeon in this area of the Mississippi is likely to be low. If the higher temperatures are detrimental, the larval stages of the pallid sturgeon that are drifting with the river current could become disoriented, but the temperature increase would not likely be lethal (Beitinger et al. 2000). Furthermore, based on the staff's analysis, the thermal plume is buoyant and does not extend more than 1 m (3 ft) below the water surface. Drifting pallid sturgeon larvae would, if present, be found near the bottom of the river (Braaten and Fuller 2005) and would not be affected by the thermal plume. Therefore, the impacts on pallid sturgeon from the discharges at the Grand Gulf ESP plant would likely be minimal.

5.4.3.2 Federally Listed Plant Species

No impacts on Federally listed or proposed threatened or endangered plant species–either terrestrial or aquatic–are anticipated from operation of the Grand Gulf ESP facility because no such plant species are known to occur on or within 16 km (10 mi) of the Grand Gulf site (MNHP 2004b; FWS 2004a).

5.4.3.3 Summary of Threatened and Endangered Species Impacts

Because SERI is not planning any preconstruction ground disturbing activities as a result of the ESP, no Section 7 consultation with FWS or NOAA Fisheries is required at this time. However, the issuance of a CP or COL is a separate action requiring a consultation with the appropriate agency, pursuant to Section 7 of the Endangered Species Act.

The staff concludes the impacts on terrestrial and aquatic Federally listed threatened and endangered species from operation of the Grand Gulf ESP facility would be SMALL, and additional mitigation would not be warranted. The conclusion of SMALL impacts by the NRC

staff is predicated on certain assumptions made by the staff. These include the current occurrence of Federally listed threatened and endangered species and critical habitat in the project area, the current listing status of such species, and the current designation of critical habitat.

5.5 Socioeconomic Impacts

The socioeconomic impacts from operating the Grand Gulf ESP facility and from the activities and demands of the operating workforce on the surrounding region include the potential impacts on individual communities, the surrounding region, and minority and low-income populations. To assess the potential impacts of operations, the staff evaluated the physical impacts, population impacts, and impacts on community characteristics.

5.5.1 Physical Impacts

The potential physical impacts on the nearby communities resulting from operation of the new unit or units includes noise, odors, exhaust, thermal emissions, and visual intrusions.

5.5.1.1 Workers and Local Public

The town of Port Gibson, located about 10 km (6 mi) southeast of the Grand Gulf site, is a small rural community that includes small businesses, houses, and farm buildings and has a population of 1840, according to the 2000 U.S. Census (USCB 2004c). Because of Port Gibson's distance from the Grand Gulf ESP site, its residents would not experience any physical impact from operation of the new unit or units.

The new unit or units would produce noise from the operation of pumps, transformers, turbines, generators, and switchyard equipment. The noise levels would be controlled in accordance with applicable local regulations. Most equipment would be located inside structures, reducing the outdoor noise level.

Two types of cooling systems will be considered for a new facility at the Grand Gulf ESP site: natural draft cooling towers and mechanical draft cooling towers (SERI 2005a). Natural and mechanical draft cooling towers emit broadband noise. Therefore, the noise associated with the cooling towers would be largely indistinguishable and nonobtrusive. 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 dBA are not considered to be significant because these levels are not sufficient to cause hearing loss (NRC 1996).

Based on the PPE (see Appendix I), both natural and mechanical draft cooling towers have anticipated noise levels of 55 dBA at 300 m (1000 ft). The proposed location of the cooling

towers would place them approximately 300 m (1000 ft) from the nearest site boundary on the north side of the 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 dBA recommended in NUREG-1555 (NRC 2000a). In general, power plant sites do not result in offsite noise level increases of more than 10 dBA above background levels. Therefore, background noise levels are expected to range from 45 to 55 dBA at the nearest site boundary.

Noise levels below 60 to 65 dBA are considered to be of SMALL significance (NRC 1996). Therefore, the noise impact at the nearest residence would be SMALL and no mitigation would be warranted.

Ambient noise heard by recreational users of Grand Gulf Military Park under normal conditions includes some noise from the GGNS Unit 1 plant. The noise level generated by the operation of the new unit or units would not affect the recreational use of Grand Gulf Military Park.

In Section 2.7 of NRC Regulatory Guide 4.2 (NRC 1976), the staff states that an assessment should be made of the ambient noise level within 8 km (5 mi) of any proposed nuclear facility. Particular attention is directed toward obtaining acoustic levels associated with high voltage transmission lines. An assessment of the impact from the transmission system would be studied at a suitable time within future planning work and after a decision has been made to proceed with the new additional capacity.

The new unit or units would have standby diesel generators and auxiliary power systems. Air permits acquired for these generators would ensure that air emissions comply with regulations. In addition, standby diesel generators would be operated on a limited short-term basis.

5.5.1.2 Buildings

Operations activities would not affect any offsite buildings. Onsite buildings have been constructed to safely withstand any possible impact, including shock and vibration, from operations activities associated with the proposed activity. Except for GGNS Unit 1 structures, no other industrial, commercial, or residential structures would be directly affected by the operation of a new ESP facility.

5.5.1.3 Roads

Commuter traffic would be controlled by speed limits. The access roads to the Grand Gulf ESP site would be paved. Good road conditions and appropriate speed limits would minimize the noise level generated by the workforce commuting to the Grand Gulf site.

5.5.1.4 Aesthetics

The nearest residential area is about 500 m (1650 ft) from the Grand Gulf ESP site and is shielded by woods. Given this distance, residents near the site would not have a clear view of the new unit or units. Some structures of the new facility may be visible from the Mississippi River (for example, intake structure, cooling towers) and from Grand Gulf Military Park. Bluffs on the site east of the Mississippi River are about 20 m (65 ft) above the average river level (Entergy 2003c), and dense forest throughout the vicinity would help conceal the new structures.

The reactor design and ancillary facilities (cooling water system) have not yet been selected. The natural draft cooling towers, if used, would be up to 168 m (550 ft) tall, so some visual impact would result. However, the existing cooling tower at GGNS is similar in height and is difficult to see from most vantage points offsite. Mechanical draft cooling towers would be considerably shorter: 18 m (60 ft). Either type of tower would generate a visible water vapor plume. Longest visible plumes would occur in the winter with an estimated average length of 3.71 km (2.32 mi) for natural draft cooling towers and 2.18 km (1.36 mi) for mechanical draft cooling towers (SERI 2005a). Because the Grand Gulf ESP site is already aesthetically altered by the presence of an existing nuclear power plant (GGNS Unit 1) with a natural draft cooling tower along with its visual plume, only slight adverse impacts on visual aesthetics of the site and vicinity are expected from the operation of a new facility.

As stated in Section 5.4.2, the full extent of the changes in the transmission system cannot be known until SERI initiates the Federal Energy Regulatory Commission process for connecting new large generation plants to the grid. If, as assumed in Section 4.4.1, existing transmission line rights-of-way are used, even significant widening of these rights-of-way and building of new transmission towers is unlikely to have more than a minor effect on visual aesthetics.

During normal plant operation, the new unit or units would not use a large amount of chemicals that would generate odors exceeding the odor threshold value.

5.5.1.5 Summary of Physical Impacts

Based on the information provided by SERI, staff interviews with local public officials, and its own independent review, the staff concludes that the physical impacts of operation of the new unit or units at the Grand Gulf ESP site would be SMALL, and additional mitigation measures beyond those identified by SERI would not be warranted.

The conclusion of SMALL impacts by the NRC staff is predicated on certain assumptions made by the staff. These include mitigative actions identified to reduce physical impacts such as: cooling tower plume control; compliance measures to control noise, dust, and other air pollutants; and traffic management identified by SERI are undertaken.

5.5.2 Demography

The demographic impacts from the operation of a new unit or units at the Grand Gulf ESP site would be associated with employment related to the daily operation of the new unit(s) and with resulting effects on the surrounding region.

According to the SERI environmental report, approximately 1160 workers (SERI 2005a) would be required for the operation of the new unit or units, about 50 percent more than are currently required for the existing GGNS Unit 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, 2320 people could be expected to move to the region from other areas and would represent both a source of income to the community and a potential demand on community services, such as schools and police protection.

The expected number of permanent workers needed to operate the new unit or units and their families generally would be a small fraction of the total projected population growth in the region. Assuming that the geographic distribution of new employees would be the same as for the existing unit, Table 5-4 shows the potential geographic distribution of new employees and the potential percentage increase for each jurisdiction's population represented by facility-related population if facility operations started today. Proportionally more new migrants, however, are expected to reside in the Vicksburg area rather than in Port Gibson because of the wider availability of housing and services in Vicksburg (SERI 2005a).

Table 5-4. Potential Increase in Resident Population Resulting from Operations at the Grand Gulf Early Site Permit Site

Jurisdiction	Percent of Current GGNS Workforce by Location	ESP Facility-Related Increase in Population	Year 2000 U.S. Census Population	Percentage Increase in Resident Population	ESP Facility-Related Households	Year 2000 Vacant Housing Units
Vicksburg	46.4	1,076	26,407	4.1	269	1,290
Port Gibson	14.6	339	1,840	18.4	85	95
Other locations						
Clinton	7.3	169	23,347	0.7	42	571
Fayette	3.9	90	2,242	4.0	22	68
Natchez	3.3	77	18,464	0.4	19	888
Brookhaven	2.7	63	9,861	0.6	16	430
Jackson	2.7	63	184,256	0.0	16	7,837
Wesson	2.3	53	1,693	3.1	13	41
Hazelhurst	1.7	39	4,400	0.9	10	158
All Other	15.1	350	NA	NA	88	NA
Total	**100.0**	**2,319**[(a)]			**580**	

(a) Difference between total of 2319 and SERI (2005a) assumption of 2320 is due to rounding.
ESP = early site permit
GGNS = Grand Gulf Nuclear Station
NA = not available
Source of resident locations: SERI 2004a
Source of Year 2000 U.S. Census Population: USCB 2004c

Based on the information provided by SERI, staff interviews with local public officials, and their own independent review, the staff concludes that the demographic impacts of operation of the new unit or units at the Grand Gulf ESP site on most of the region would be SMALL. However, if Port Gibson, Mississippi, were to attract new in-migrating population in the same proportion as existing facility employees, the town would experience an 18 percent population increase, which would be a LARGE demographic impact.

The conclusion regarding the range of impacts by the NRC staff is predicated on certain assumptions made by the staff. These include not more than 1160 new operations workers at the Grand Gulf ESP site, not less than 50 percent of the operations workers would come from the region within 80 km (50 mi) of the Grand Gulf site, and most of the new workers would choose to live in the larger cities of the region.

5.5.3 Social and Economic Impacts

The social and economic impacts on the surrounding region as a result of operating the Grand Gulf ESP facility were evaluated, assuming a 40-year operating license term.

5.5.3.1 Economy

The main economic impacts resulting from new workers and their families on the area would be related to taxes, housing, and requirements for goods and services. Economic impacts related to the operation of the new unit or units would be associated mainly with payment of the plant property taxes.

A detailed description of local and regional employment trends is provided in Section 2.8. Annual 2004 county labor force data indicate that Claiborne County has an unemployment rate of 10.1 percent (Section 2.8.2.1). General trends for Claiborne and the contiguous counties indicate the total number of jobs across many of the surveyed industries have decreased from 1990 to 2000 (USCB 2004a, 2004b). Operation of a new ESP facility could generate jobs for the residents of the area. The addition of 1160 permanent workers traveling into the area would also increase demand for commercial retail establishments, which would provide some additional employment. The overall impact on the economy of the region (including Claiborne County and surrounding counties–especially Vicksburg and Warren County) would be positive.

5.5.3.2 Taxes

The assessed value of the new unit or units would exceed that of the existing GGNS unit, which has depreciated with time. It is not possible at this time to estimate the actual taxes that would be paid to the regional governments or the expenditures regional governments would incur to accommodate the workforce. The expenditures by the regional governments would, in part, be related to the size and age distribution of the families of the new employees. Based on the

assumption that the new employees would come from outside the region, the regional governments would experience both outflows and inflows of monies as a result of the operation of the new unit or units. Expenditures would be related to the impact on the local and regional infrastructure because of the increased use of the school, recreational, medical, fire and police, and transportation systems. The types of taxes and their bases can be addressed and are presented below.

Sales, Use, and Income Taxes

Sales, use, and income taxes would be generated by retail expenditures (restaurants, hotels, and merchant sales) of operations workers. Although there is a small local sales and use tax, the State would collect most of these, both from individual workers and from corporate entities in the general region of the site. No estimate is available of the day-to-day expenditures during operations that would occur in the region.

Property Taxes

The jurisdictions shown in Table 5-4 would benefit from additional property tax revenues from two sources associated with the Grand Gulf ESP facility: property tax on the new unit or units and property tax on land owned by the new employees. Because of the manner in which Mississippi treats the tax base of nuclear power facilities, local property taxes might or might not be levied for the increase in value of the Grand Gulf site because of the new unit or units. The property tax payments to Claiborne County are discussed in Sections 2.8 and 4.5, and are identified as a potential beneficial impact for the state of Mississippi or for Claiborne County, depending on tax treatment of the new plant. The addition of the new unit or units to the Grand Gulf site would substantially increase the property tax payments in the State.

The existing GGNS unit has contributed 83 percent of the property taxes paid to Claiborne County over the past decade. The construction and operation of a new nuclear unit or units are expected to maintain the very high percentage of the property taxes in Claiborne County paid by Entergy.

The potential effect of future electric utility deregulation within Mississippi is not known. However, if Mississippi were not to regulate the Grand Gulf ESP facility as a public utility, it is reasonable to conclude the facility could be treated as an ordinary corporate asset subject to normal local property taxation. If so, the new unit or units would result in a substantial increase in property tax payments to Claiborne County.

If the final capital cost were in the range of $1000 per installed kilowatt, the maximum capacity 3000 MW(e) facility would (at completion) have an approximate capital value of $3 billion. At Claiborne County's current property tax rate of 65.01 mills and 15 percent assessment ratio for nonresidential property (SERI 2004a), the tax yield would be about $29 million per year, a very

significant positive impact. Even if the new nuclear facility were taxed and the funds distributed as with the existing GGNS, the payment in lieu of taxes to Claiborne County would be about $7.8 million per year, increasing county revenues by about 83 percent, still a LARGE effect. Other nearby counties would see much smaller benefits from other taxes. The expected impacts on the economy and tax revenues in Claiborne County would be LARGE and beneficial.

The conclusion of LARGE beneficial impacts in Claiborne County is predicated on certain assumptions made by the staff. These include not more than 1160 new operations workers would be employed at the Grand Gulf ESP site, not less than 50 percent of the operations workers would come from the region within 80 km (50 mi) of the Grand Gulf site, most of the new workers would choose to live in the larger cities of the region, and there are no significant changes in the terms and conditions for taxability of real property under Mississippi tax law.

5.5.3.3 Summary of Social and Economic Impacts

Based on the information provided by SERI, staff interviews with local public officials, and its own independent review of data on the regional economy and taxes, the staff concludes that the impacts on the regional economy of operating the new unit or units at the Grand Gulf ESP site on most of the region would be SMALL, with a possible MODERATE beneficial impact in Warren County. Under current Mississippi tax law, it appears that Claiborne County would receive annual property taxes or payments in lieu of taxes equal at least to an increase of $7.8 million (83 percent of the current county budget) and perhaps much more, depending how the new plant would be treated for tax purposes. Taken together with the jobs created in the region, this would be a LARGE beneficial impact in Claiborne County.

The conclusion of LARGE beneficial impacts by the NRC was predicated on certain assumptions made by the staff; these include: that there would be no more than 1160 new operations workers at the Grand Gulf ESP site; that no less than 50 percent of these workers would come from the 80-km (50-mi) region surrounding the site; that new workers would tend to live in the larger communities in the region; and that there are no significant changes in Mississippi tax law, especially the terms and conditions for taxability of real property. The NRC staff would have to confirm these assumptions at the CP or COL stage and determine whether there would be any new and significant information that would change this conclusion.

5.5.4 Infrastructure and Community Services

Infrastructure and community services include transportation, recreation, housing, public services, and education.

5.5.4.1 Transportation

Roads within the vicinity of the Grand Gulf ESP site would experience a temporary increase in traffic at the beginning and the end of the workday period. However, the current road network has sufficient capacity to accommodate the increase, as discussed in Section 4.5.4.1. Section 4.5.4.1 shows a number of permanent changes to the regional and local transportation network that would reduce any potential adverse impacts generated by the influx of 3150 construction workers during construction of one or more new units. These permanent changes would also reduce or eliminate any potential adverse impacts that could be generated by the operating workforce of 1160 for the new unit or units, 50 percent of whom are expected to have relocated with their families into the region.

5.5.4.2 Recreation

The facility-related population increase in the potentially affected counties is expected to be about 2320 people. To accommodate normal increases in population, which are expected to be much larger, the surrounding counties would need to address and fund new recreational areas as they update their comprehensive plans. The GEIS (NRC 1996) concludes the impacts of existing employees and their families on parks and other recreational areas within a typical region are small. This conclusion likely would also apply to the employees of the new ESP unit or units and their families who would relocate to the area because they represent a small fraction of the projected population growth for the area.

A detailed description of local tourism and recreation is provided in Section 2.8. Because of the proximity of the Grand Gulf Military Park to the north of the Grand Gulf ESP 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, and that there would be minor effects on noise and visual aesthetics in the park. However, the majority of tourists visit the park on the weekends when fewer people report for work at the Grand Gulf ESP site (SERI 2004a, Attachment 14). In addition, the traffic associated with the Grand Gulf site is limited to specific times of the day, during shift changes, which would minimize the impact of potential Grand Gulf ESP site traffic on the Grand Gulf Military Park. Case studies conducted during operation of several nuclear power facilities indicated no adverse impacts on local tourism and recreation as a result of the operation of existing nuclear power plants (NRC 1996).

5.5.4.3 Housing

The number of housing units required to support the expected permanent workforce migrating into the area would be 580, half of the 1160 new employees (see Table 5-4). In Port Gibson, plant-related migration would absorb a substantial portion of the vacant housing stock, if today's residence pattern of GGNS workers were the same for new workers and if the population increase were to happen today. There is no accurate way to estimate the number of housing

units that would be available in the region in the year 2030, the year a new ESP facility would be expected to begin operations (SERI 2005a). However, the counties in the vicinity of the Grand Gulf ESP site and within the region are addressing the needs of the projected increases in population and an adequate number of units likely would be available, especially in the larger towns. Little new housing seems to have been recently added in Claiborne County, as discussed in Section 5.1.1, although nearby larger communities are keeping pace with housing demand (Scott 2004). Because the new workforce incomes would be high relative to other incomes in the region, it can be expected that the housing purchases would be on the high end of the price range. The new workers and their families would be about 9.4 percent of the population growth SERI (2005a) has projected for the area within 80 km (50 mi) over the next 30 years (Table H-2 in Appendix H). Therefore, the impact of the property taxes paid for housing by these families overall would be a small benefit to the region, but possibly locally more important in Port Gibson and Vicksburg, Mississippi, if they concentrate in those cities.

Currently, 100 to 200 additional outage workers conducting refueling of the GGNS Unit 1 reactor are onsite for a period of 30 to 40 days per outage (SERI 2005a). It is expected the planned outages for the new unit or units would be scheduled so that multiple units would not be worked on simultaneously. This would also reduce the potential for exceeding the availability of short-term housing in the immediate vicinity of the Grand Gulf ESP site. The temporary outage staff for the existing GGNS typically stays in area hotels or manufactured home and recreational vehicle parks 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 affect the region.

5.5.4.4 Public Services

Water Supply and Waste Treatment

Detailed information regarding the current sewer and water services available at the Grand Gulf site is provided in Section 2.8.2.6. SERI currently operates an onsite water and sewer system for treatment of sanitary waste from GGNS Unit 1. Additional water and sewage 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 ESP facility have not been selected. Because a new facility would use onsite water and sewer services, the operation of a new facility at the Grand Gulf site would not burden public utilities in surrounding communities. In general, case studies indicate minimal impact on public utilities resulting from plant operation (NRC 1996).

The in-migration of additional 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 these workers would reside in or around the more populous areas such as Vicksburg, Mississippi, because of the public utilities and other services

available. The water and sewer services in Vicksburg are currently at 70 percent of total capacity (SERI 2004a). Therefore, the addition of plant personnel to this or other comparable communities would not be expected to overburden public utilities. The possible exception would be Port Gibson where, if population increased by 18.4 percent (Table 5-4), water use could increase to close to the maximum capacity of the system. Because operational staff in-migrating to the region for a new facility would likely settle in numerous surrounding communities, the potential impacts on 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 at least partially offset costs associated with any upgrades a community may find necessary. The impacts of relocated families on these water and sewer systems would not be significant.

Police, Fire, and Medical

The police and fire departments within 16 km (10 mi) of the Grand Gulf ESP site are part of the existing emergency response plan for the existing GGNS Unit 1. The Claiborne County Sheriff and other local police departments are responsible for the proper evacuation of the area in the event of an emergency at the Grand Gulf site. This would continue to be the case should the new unit or units become operational. Despite the transfer of funds from the State government to Claiborne County, there is substantial local concern about the adequacy of emergency resources to implement the current evacuation plan and the ability of local officials to carry it out (Scott 2004).

The nearest medical facilities generally consist of local physicians' offices and the 32-bed hospital in Port Gibson, Mississippi. However, major medical facilities are available in Vicksburg, Natchez, and Jackson, Mississippi. These facilities are readily accessible to county residents and have held successful emergency drills with the GGNS. The surrounding counties assess the need for additional medical, fire, and police facilities and add new facilities or expand existing facilities as needed. For example, the Warren County hospitals and medical facilities recently have accommodated economic and population growth from 1800 new jobs at two Japanese-owned companies (Scott 2004). The increase of 580 (half of the total 1160) new resident employees and their families would represent a small fraction of the expected population growth in the multi-county region around the Grand Gulf ESP site. However if new residents were to concentrate in Claiborne County, the increase in Claiborne County population might be quite significant relative to the current population. Therefore, while in general no unforeseen demands on medical facilities would result from the operation of the new unit or units, there may be increased demands for beds in Port Gibson's hospital as well as increased hours of operation. Financing the potential hospital upgrades would require additional revenue (Scott 2004).

Detailed information concerning the capacity of the hospitals in Claiborne County and the adjacent Mississippi counties is provided in Section 2.8.2.6. It is expected that a majority of the

future employees will reside in more populous areas located in neighboring counties (for example, Vicksburg, Warren County). Therefore, the influx of plant workers is not expected to overburden Claiborne County health or social services. Case studies of several nuclear power plants show only a small impact on local social services associated with the influx of plant workers (NRC 1996).

5.5.4.5 Education

Table 2-18 shows the number of schools within the Mississippi counties surrounding Claiborne in the Grand Gulf ESP site area. As was the case with GGNS Unit 1, new workers would likely move to the more populous areas in the surrounding communities where they would have access to more developed public services. Workers with school-aged children would be interested in communities with good school districts. The largest school district near the Grand Gulf ESP site is in Vicksburg, Mississippi. The current student population at Vicksburg is 9180 (NCES 2002). Given sufficient lead times, school officials in Warren County are not concerned about absorbing the potential increase in students (Scott 2004). The impact on Vicksburg schools would likely be small.

Port Gibson has only 2011 students (Section 2.8.2.7). If 14.6 percent of new workers moving to the area located in Port Gibson and their family size is assumed to be four (two of whom are students), the impact in Port Gibson would be 169 students, an 8.4 percent increase. This would be a moderate impact (assuming some impact assistance from the State) on Port Gibson schools were it to happen. Part of this increase could be absorbed by private schools located in the area. Any adverse impact on local school districts because of the influx of plant workers into a community would likely be at least partially offset by increased sales, personal property, and income tax revenues paid by facility personnel. Overall, the impacts on education in Claiborne County would be moderate.

5.5.4.6 Summary of Infrastructure and Community Services

Based on information supplied by SERI, staff interviews conducted with public officials in Claiborne, Jefferson, and Warren counties, and staff review of data concerning the current availability of services and current state and community planning efforts, the staff concludes that the operation impacts on the regional infrastructure and community services would be SMALL in most of the region. The estimated workforce of 1160 persons would have a SMALL effect on the transportation network in the vicinity and region because several permanent transportation mitigation measures are being implemented that will remove most remaining bottlenecks. The site is relatively isolated, industrial in nature, and well masked by forest in most directions so the impacts on aesthetics would be SMALL, as would the impacts on

recreation. The impacts on public services and infrastructure would be SMALL throughout the region, unless Claiborne County draws a substantial share of the in-migrating operations workforce, which is not expected. In that case, the impacts on housing and education in Claiborne County could be MODERATE.

The conclusion of MODERATE impacts by the NRC was predicated on certain assumptions made by the staff; these include: that there would be no more than 1160 new operations workers at the Grand Gulf ESP site; that no less than 50 percent of these workers would come from the 80-km (50-mi) region surrounding the site; that new workers would tend to live in the larger communities in the region (but could still result in a significant relative increase of population in Claiborne County); and that the state would provide some financial help if the school system were seriously affected by in-migration. The NRC staff would have to confirm these assumptions at the CP or COL stage and determine whether there is any new and significant information that would change this conclusion.

5.5.5 Summary of Socioeconomic Impacts

Based on information supplied by SERI, staff interviews conducted with public officials in Claiborne, Jefferson, and Warren counties concerning the current availability of services, and additional taxes that would likely compensate the need for additional services, the staff concludes that the operations impacts on the local economy would be beneficial and SMALL in most of the region and probably MODERATE and beneficial in Warren County (Vicksburg). The estimated workforce of 1160 would have a SMALL effect on the transportation network in the vicinity and region because permanent transportation mitigation measures proposed for the construction of the new unit or units would also result in much reduced transportation-related impacts during operation of the new unit or units. The effect on tax revenues would be beneficial and SMALL except for property tax receipts in Claiborne County, which could be beneficial and LARGE. The site is relatively isolated, industrial in nature, and well masked by forest in most directions so the impacts on aesthetics would be SMALL, as would the impacts on recreation. The impacts on public services and infrastructure would be SMALL throughout the region, unless Claiborne County draws a substantial share of the in-migrating construction workforce, which is not expected. In that case, the impacts on housing and education in Claiborne County could be MODERATE and adverse, but more than likely would be more than offset by LARGE tax receipts.

The conclusion of LARGE to SMALL beneficial impacts and SMALL to MODERATE adverse impacts by the NRC staff is predicated on certain assumptions made by the staff. These include not more than 1160 new operations workers would be employed at the Grand Gulf ESP site, not less than 50 percent of the operation workers would come from the region within 80 km (50 mi) of the Grand Gulf site, most of the new workers would choose to live in the larger cities of the region, and there are no significant changes in Mississippi tax law, especially the terms and conditions for taxability of real property.

5.6 Historic and Cultural Resources Impacts

The National Environmental Policy Act of 1969 (NEPA) requires Federal agencies to take into account the potential effects of their undertakings on the cultural environment, which includes archaeological sites, historic buildings, and traditional places important to local populations. The National Historic Preservation Act of 1966 (NHPA), as amended through 1992, also requires Federal agencies to consider impacts on those resources if they are eligible for listing on the National Register of Historic Places (such resources are referred to as "Historic Properties" in NHPA). As outlined in "Coordination with the National Environmental Policy Act," 36 CFR 800.8, the NRC is coordinating compliance with Section 106 of the NHPA in meeting the requirements of NEPA.

Because all ground-disturbing activities that could have an impact on historic or archaeological resources would probably occur during the construction phase, there would be limited potential for impacts during operation of one or more additional units at the Grand Gulf ESP site. The NRC staff therefore concludes that the potential impacts on historic and cultural resources would be SMALL. The conclusion of SMALL impacts by the NRC staff is predicated on the assumption that SERI will develop procedures regarding protection of historic and cultural resources that would be incorporated into the site-wide Excavation and Backfill Work Procedures, which will involve an immediate stop work order should archaeological, historical, or other cultural resources be uncovered during excavation. The construction supervisor would be responsible for ensuring the work stoppage and for notifying the Environmental Compliance Coordinator of an inadvertent discovery. If such a discovery is made, site personnel would be instructed to notify the State Historic Preservation Officer and would consult with him or her in conducting an assessment of the discovery to determine if additional work is needed. If an applicant submits a CP or COL application referencing this ESP, the NRC staff's review of such an application would be a separate undertaking requiring further consultation pursuant to Section 106 of the NHPA.

5.7 Environmental Justice Impacts

Environmental justice refers to a Federal policy under which each Federal agency identifies and addresses, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority or low-income populations. On August 24, 2004, the Commission issued its policy statement on the treatment of environmental justice matters in licensing actions (69 FR 52040). Section 2.10 discusses the locations of minority and low-income populations around the Grand Gulf ESP site and within the 80-km (50-mi) radius.

As discussed in Section 4.7, the staff examined the geographic distribution of minority and low-income populations recorded during the 2000 U.S. Census (USCB 2004b, 2004c) within

80 km (50 mi) of the Grand Gulf ESP site, encompassing 25 counties and parishes. The analysis was also supplemented by field inquiries and outreach to the planning department and social service agencies in Claiborne, Warren, and Jefferson counties.

Specifically, in the case of the Grand Gulf ESP, announcements of public meetings were made in the Port Gibson Reveille and Jackson Clarion-Ledger. Press releases announcing the meetings were forwarded to the Arkansas Democrat, the Columbus (MS) Telegram, Jackson (MS) Clarion-Ledger, Port Gibson (MS) Reveille, and Vicksburg (MS) Post newspapers, and to WJTV (Jackson) and WVUE-TV (New Orleans). In addition to public meetings, at the request of staff, the local county governments invited a number of local government and social services officials to additional meetings that were held in Port Gibson, Fayetteville, and Vicksburg.

Minority and low-income areas identified from the census block group data are shown graphically in Figures 2-12 and 2-13, respectively. However, it is also clear from examining census block group data that most of the counties and parishes within 32 km (20 mi) of the Grand Gulf ESP site have large African-American populations, whether or not they meet the usual plus-20 or -50 percent criteria.

The scope of the review as defined in NRC guidance (NRC 2001, 2004b; 69 FR 52040) should include an analysis of the impacts on minority and low-income populations, the location and significance of any environmental impacts during operations on populations that are particularly sensitive, and any additional information pertaining to mitigation. The descriptions to be provided by this review should state whether the impacts are likely to be disproportionately high and adverse. The review should also evaluate the significance of such impacts.

With the locations of minority and low-income populations identified, the staff proceeded to evaluate whether the environmental impacts of the proposed action could affect these populations in a disproportionate manner. Based on staff guidance (NRC 2001, 2004b; 69 FR 52040), air, land, and water resources within about 80 km (50 mi) of the Grand Gulf ESP site were examined. Within that area, potential environmental impacts could affect human populations. All physical environmental impacts would be SMALL, and the socioeconomic impacts would vary from LARGE beneficial to MODERATE adverse.

5.7.1 Environmental Impacts

The pathways through which the environmental impacts associated with the new unit or units could affect human populations are discussed in Sections 5.7.2 and 5.7.3. The staff evaluated whether minority and low-income populations could be disproportionately affected by these impacts. The staff found no unusual health conditions or resource dependencies or practices, such as subsistence agriculture, hunting, or fishing, through which the populations could be disproportionately affected (see Section 2.10). In addition, the staff did not identify any location-dependent disproportionate impacts affecting these minority and low-income

populations. The staff concludes that offsite impacts on minority and low-income populations from operating one or more new units at the Grand Gulf ESP site would be minor, and no additional mitigation would not be warranted.

The conclusion of SMALL impacts by the NRC staff is predicated on certain assumptions made by the staff. These include there will not be any significant demographic changes before additional units are added to the Grand Gulf site and there are no significant resource dependencies or pre-existing conditions among the minority and low-income population that have not been identified.

5.7.2 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, far below that associated with natural radiation background levels.

As presented in Section 5.9, the critical pathways to humans for routine radiation releases from facilities at the Grand Gulf ESP site are exposure from 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 of 10 CFR Part 50 and the regulatory standards of 10 CFR Part 20.

The evaluation of postulated accidents is provided in Section 5.10 and demonstrates that radiological consequences of these accidents would meet the site acceptance criteria of 10 CFR 50.34 and 10 CFR Part 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. There would be no significant adverse health impacts on members of the public, and, therefore, there would be only minimal negative and disproportionate health impacts on minority and low-income members of the public.

The conclusion of SMALL impacts by the NRC staff is predicated on certain assumptions made by the staff. These include there will not be any significant demographic changes before any additional units are added to the Grand Gulf site, regional populations of minority and low-income populations will remain in the same geographic locations, and there are no significant resource dependencies or pre-existing conditions among the minority and low-income population that have not been identified.

5.7.3 Socioeconomic Impacts

Potential adverse socioeconomic impacts during operations include potential adverse impacts on air quality, aesthetics, schools, transportation, public safety, social services, public utilities, and recreational resources. None of the potential physical impacts attributable to operation of a new facility were judged to be significant to most of the region. SERI would provide some additional revenues to support emergency services in Claiborne County and Port Gibson (see Section 5.1.1). However, depending on where new in-migrating employees decide to live, Claiborne County might have to upgrade several components of its social services and public utilities infrastructure. It is not clear how the new nuclear facility would be treated for property tax purposes, so it is not clear whether Claiborne County would receive property taxes, sales, and use taxes, or other taxes and public monies commensurate with the costs of its additional emergency management and public services obligations. However, under current Mississippi tax law, it appears that Claiborne County would receive at least $7.8 million per year if the new nuclear facility were treated the same as the existing GGNS, and considerably more if it were treated as an ordinary industrial asset. A LARGE net financial benefit would be realized by local residents and taxpayers, most of whom are minority and low-income persons.

The conclusion of LARGE beneficial impacts is predicated on certain assumptions made by the NRC staff. These include: not more than 1160 new operations workers would be employed at the Grand Gulf ESP site; not less than 50 percent of the operations workers would come from the region within 80 km (50 mi) of the Grand Gulf site; most of the new workers would choose to live in the larger cities of the region; there are no significant changes in the terms and conditions for taxability of real property under Mississippi tax law; and regional populations of minority and low-income populations will remain in the same geographic locations.

5.7.4 Summary of Environmental Justice Impacts

Taken together, the impacts of plant operations on environmental justice would be SMALL for environmental and human health impacts because no environmental pathways or health and other preconditions of the minority and low-income population were found that would lead to adverse and disproportionate impacts. The socioeconomic impacts would be LARGE and beneficial because local tax burdens and access to public services in Claiborne County would likely greatly improve, depending on the level of public sector obligations imposed by new residents and the level of tax revenues provided by the new units.

The conclusion of LARGE beneficial impacts is predicated on certain assumptions made by the NRC staff. These include not more than 1160 new operations workers would be employed at the Grand Gulf ESP site, not less than 50 percent of the operation workers would come from the region within 80 km (50 mi) of the Grand Gulf site, most of the new workers would choose to live in the larger cities of the region, there are no significant changes in the terms and conditions for taxability of real property under Mississippi tax law, and regional populations of

minority and low-income populations will remain in the same geographic locations. The NRC staff would have to confirm these assumptions at the CP or COL stage and determine whether there is any new and significant information that would change this conclusion.

5.8 Nonradiological Health Impacts

This section discusses the nonradiological health impacts of operating the proposed new unit(s) at the Grand Gulf ESP site. Health impacts on the public from the cooling system, noise generated by unit operations, and EMFs are discussed. Health impacts from the same sources are also evaluated for workers at the new unit. The health impacts from radiological sources during operations are discussed in Section 5.9.

5.8.1 Thermophilic Microorganisms

The SERI environmental report (SERI 2005a) noted thermal discharges to the Mississippi River would result from the use of cooling towers. Such discharges have the potential to increase the growth of thermophilic microorganisms both in the cooling tower and river. The types of thermophilic microorganisms sometimes found where elevated moist temperatures exist are *Salmonella* sp., *Psudomonas aeruginosa*, *Legionella* sp., and free-living amoebae of the genera *Naegleria* and *Acanthamoeba*. Serious illness and even death can occur when there is high exposure to these microorganisms.

As described in the GEIS (NRC 1996), nuclear power plants that use cooling ponds, lakes, or canals and those that discharge to "small rivers" have the greatest chance of affecting the public from increases in thermophilic microbial populations. A small river is defined as one with an average flow rate of less than 2830 m^3/s (100,000 ft^3/s). The average flow of the Mississippi River between the years 1973 and 1999 was about 20,700 m^3/s (730,000 ft^3/s) (SERI 2005a) and, therefore, does not meet the criterion of a small river. GGNS Unit 1 and one or more new units would be discharging thermal effluent into the river. SERI reviewed data from the Center of Disease Control for the years 1991 through 2000 and found no incidences of waterborne diseases in Mississippi that were associated with the Mississippi River (SERI 2005a).

5.8.2 Noise

In the GEIS (NRC 1996), the staff discusses the environmental impacts of noise at existing nuclear power plants. Common sources of noise from plant operation include cooling towers, transformers, and loud speakers with intermittent contributions from auxiliary equipment. These noise sources are generally sufficiently distant from the plant boundaries that the noise generated by the plant is attenuated to near ambient levels before reaching critical receptors outside the plant boundary.

Operation Impacts at the Proposed Site

GGNS Unit 1 has a closed-cycle cooling system that uses a natural draft cooling tower. This system does not contribute significantly to noise at the plant site or at the plant boundary.
| SERI's environmental report (SERI 2005a) specifies that additional units at the proposed Grand Gulf ESP site would be cooled by wet cooling towers. If the ESP is approved and cooling towers are used at the site, the towers would be the primary noise source on the site in addition to the existing cooling tower for GGNS Unit 1.

| Sound surveys made prior to startup of GGNS Unit 1 showed that ambient noise levels at the
| site generally varied from about 40 to 60 dBA during the course of a day (SERI 2005a).
| SERI (2005a) does not indicate any more recent sound surveys. Based on the PPE cooling
| tower noise level of 55 dBA at 300 m (1000 ft) for the existing cooling tower, the staff estimates that the background noise level at the exclusion area boundary closest to the postulated
| location for new cooling towers has increased by less than 1 dBA, an increase in the background noise level that would not be perceptible.

At its closest point of approach, the site fence line is approximately 300 m (1000 ft) from the
| postulated location of the cooling towers at the Grand Gulf ESP site. Using this distance, the
| PPE cooling tower noise specification and four linear mechanical draft cooling tower units, the
| noise level at the closest point on the fence line is expected to increase to about 62 dBA. The
| noise level at 500 m (1650 ft), the closest residence, would be less than 60 dBA, and the noise level at 800 m (0.5 mi) from the cooling towers is expected to be about 55 dBA. For context,
| Tipler (1982) lists the sound intensity of a quiet office as 50 dBA, normal conversation as
| 60 dBA, busy traffic as 70 dBA, and a noisy office with machines or an average factory as
| 80 dBA. Construction noise (at 3 m (10 ft)) is listed as 110 dBA, and the pain threshold is 120 dBA .

| According to the GEIS (NRC 1996), noise levels below 60 to 65 dBA are considered to be of small significance. More recently, the impact of noise was considered in the *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*, *Supplement 1 Regarding the Decommissioning of Nuclear Power Reactors* (NRC 2002a). In that document, the criterion for assessing the level of significance was not expressed in terms of sound levels. Rather, the level of significance was based on the effect of noise on human activities and
| threatened or endangered species. The criterion in NUREG-0586 Supplement 1 (NRC 2002a) is stated as follows:

> The noise impacts of... are considered detectable if sound levels are sufficiently high to disrupt normal human activities on a regular basis. The noise impacts ... are considered destabilizing if sound levels are sufficiently high that the affected area is essentially unsuitable for normal human activities, or if the behavior or breeding of a threatened or endangered species is affected.

In addition, the U.S. Department of Housing and Urban Development, as set forth in 24 CFR 51.101(a)(8), considers day-night average exterior noise levels 65 dBA and below to be acceptable for residential areas.

On these bases, the staff concludes that the potential impacts of noise resulting from operation of additional nuclear power plants with cooling systems meeting the noise criteria of the PPE (see Appendix I) would be minor at the Grand Gulf ESP site.

5.8.3 Acute Effects of Electromagnetic Fields

EMFs are produced by electrical devices including transmission lines. Two issues related to the health effects of EMFs are addressed in some detail in the GEIS (NRC 1996). Those issues are acute effects (shock hazard) and chronic effects (effects of long-term exposures to EMF).

Acute effects can result from direct contact with transmission lines. Transmission line construction practices minimize public access to the lines. Acute effects can also be caused by induced currents. The 1981 revision of National Electric Safety Code (NESC) added criteria related to construction of transmission lines to minimize potential impacts associated with induced currents. Section 3.7 of SERI's environmental report (2005a) states that the existing transmission and distribution system serving GGNS Unit 1 is adequate for at least an additional 1311 MW(e) generating capacity. Should a new plant with capacity greater than 1311 MW(e) be proposed, SERI would conduct a study to determine the adequacy of the transmission and distribution system existing at that time.

SERI (2005a) has not asserted that the existing transmission and distribution system meets NESC criteria for induced currents or that modifications to the existing system would comply with the relevant local, State, and industry standards including NESC and various American National Standards Institute/Institute of Electrical and Electronics Engineers standards. As a result, the staff cannot come to a conclusion on potential acute impacts of EMFs and this issue is not considered to be resolved.

5.8.4 Chronic Effects of Electromagnetic Fields

Research on the potential for chronic effects from 60-Hz EMFs from energized transmission lines was reviewed in the GEIS (NRC 1996). At that time, research results were not conclusive. The potential for chronic effects from these fields continues to be studied and consensus results are still outstanding. The National Institute of Environmental Health Sciences (NIEHS) directs related research through the DOE. An NIEHS report (NIEHS 1999) contains the following conclusion:

> The NIEHS concludes that ELF-EMF [extremely low frequency-EMF] exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may

> pose a leukemia hazard. In our opinion, this finding is insufficient to warrant aggressive regulatory concern. However, because virtually everyone in the United States uses electricity and, therefore, is routinely exposed to ELF-EMF, passive regulatory action is warranted such as a continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. The NIEHS does not believe that other cancers or non-cancer health outcomes provide sufficient evidence of a risk to currently warrant concern.

This statement is not sufficient to cause the staff to consider the potential impact as significant to the public. However, because conclusive information is not available, this issue is not considered to be resolved.

5.8.5 Occupational Health

In general, human health risks for the operation of new nuclear units are expected to be dominated by occupational injuries (for example, falls, electric shock, asphyxiation) to workers engaged in activities such as maintenance, testing, and facilities modifications. Historically, actual injury and fatality rates at nuclear reactor facilities have been lower than the average U.S. industrial rates. Occupational injury and fatality risks are reduced by adherence to NRC and Occupational Safety and Health Administration (OSHA) safety standards, practices, and procedures. Appropriate State and local statutes must also be considered when assessing the occupational hazards and health risks for operation of new nuclear units. The staff assumes adherence to NRC, OSHA, and State safety standards, practices, and procedures for operation of new nuclear units.

Occupational health impacts from thermophilic microorganisms would be the same as those discussed in Section 5.8.1. Health impacts on workers from noise and EMFs would be monitored and controlled in accordance with applicable OSHA regulations.

5.8.6 Summary of Nonradiological Health Impacts

The staff evaluated health impacts on the public and the workers. Health risks to workers are expected to be dominated by occupational injuries at rates below the average U.S. industrial rates. Health impacts on the public and workers from thermophilic microorganisms and noise generated by operations would be minimal. Based on information provided by SERI and the NRC staff's independent review, the staff concludes that the potential impacts of nonradiological effects resulting from the operation of one or more new nuclear units as defined in the environmental report (SERI 2005a) would be SMALL, and additional mitigation would not be warranted. The staff does not come to conclusions on acute and chronic impacts of EMFs; consequently, these issues are not resolved.

5.9 Radiological Impacts of Normal Operations

This section addresses the radiological impacts of normal operations of the new unit(s), including a discussion of the estimated radiation dose to a member of the public and to the biota inhabiting the area around the new unit(s). Estimated doses to workers at the new unit(s) are also discussed. Radiological impacts were determined using the PPE approach where the bounding direct radiation and liquid and gaseous effluent were used in the evaluation (see discussion in Section 3.2.3).

5.9.1 Exposure Pathways

Using the PPE, SERI's environmental report provided a list of fission and activation products that may be released in gaseous emissions and liquid effluents from the new unit(s) (see SERI 2005a, Tables 3.0-7 and 3.0-8). The impacts from releases and direct radiation were evaluated by considering the probable pathways to individuals, populations, and biota near the additional unit(s). The highest dose from the major exposure pathways were evaluated for a given receptor. The exposure pathways, described in Regulatory Guides 1.109 and 1.111 (NRC 1977a, 1977b), are illustrated in Figures 5-2 and 5-3.

The new unit(s) at the Grand Gulf ESP site would release liquid effluents mixed with the GGNS Unit 1 radiological effluents and cooling tower blowdown to a discharge basin that is then released into the Mississippi River. The liquid pathways considered are ingestion of aquatic food, ingestion of drinking water, exposure to shoreline sediment, and external exposure from the surface of contaminated water or from shoreline sediment and from immersion in contaminated water (SERI 2005a).

The gaseous pathways discussed in the SERI environmental report (SERI 2005a) were external exposure to the airborne radioactivity, external exposure to contaminated ground, inhalation of airborne activity, and ingestion of contaminated agricultural products.

SERI (2005a) stated that the primary contribution to direct radiation exposure from new reactor designs would be from skyshine doses resulting from air scattering of high-energy gamma radiation emitted by decaying nitrogen-16 in the reactor steam lines, turbines, and moisture separators of the operating boiling water reactor. These doses were estimated and determined to be bounded by the doses produced from GGNS Unit 1 (SERI 2005a).

5.9.2 Radiation Doses to Members of the Public

The dose to a maximally exposed individual was calculated from both the liquid and gaseous effluent release pathways (SERI 2005a), and a collective whole body dose was calculated for the population within 80 km (50 mi) of the Grand Gulf ESP site.

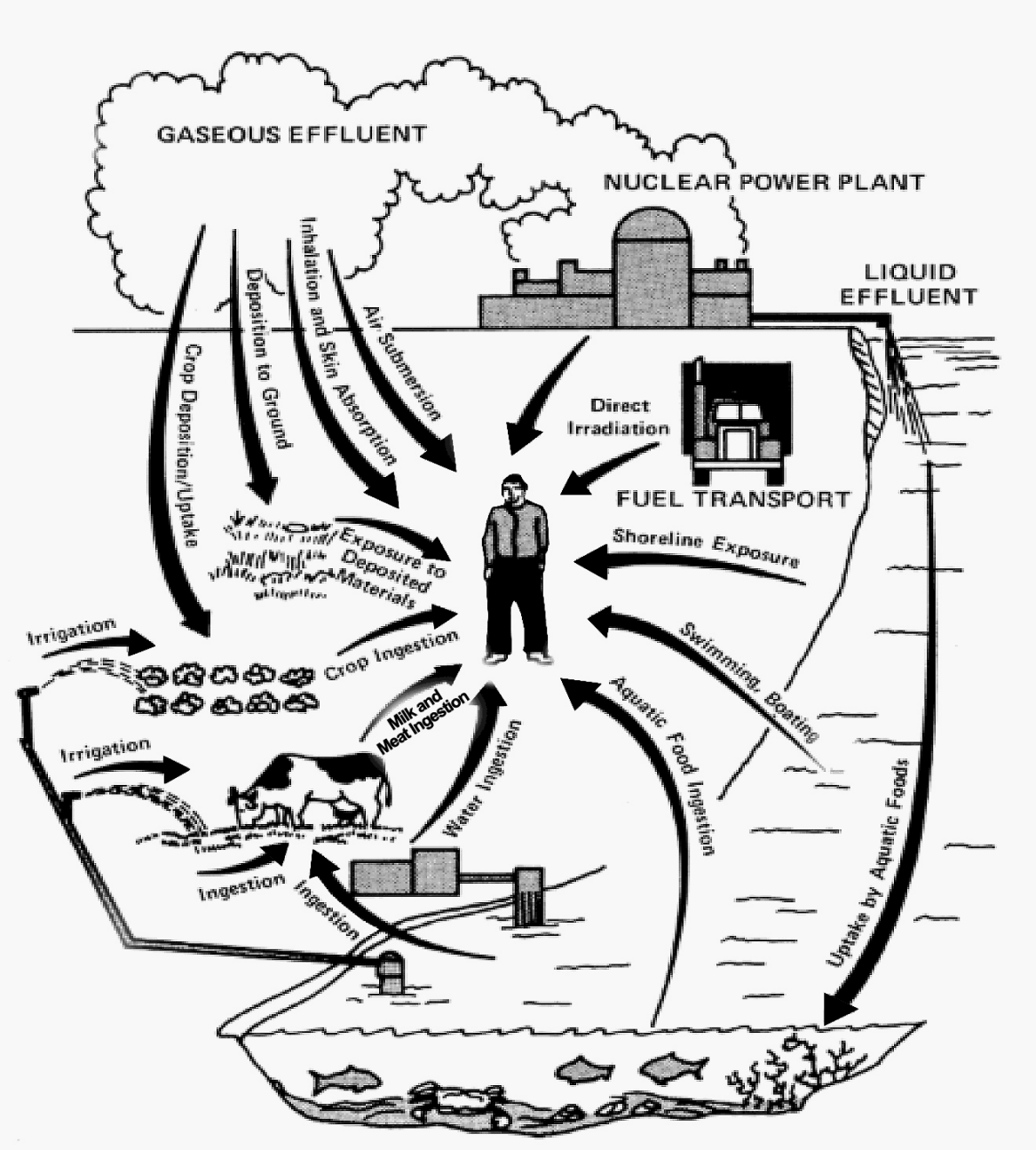

Figure 5-2. Exposure Pathways to Humans

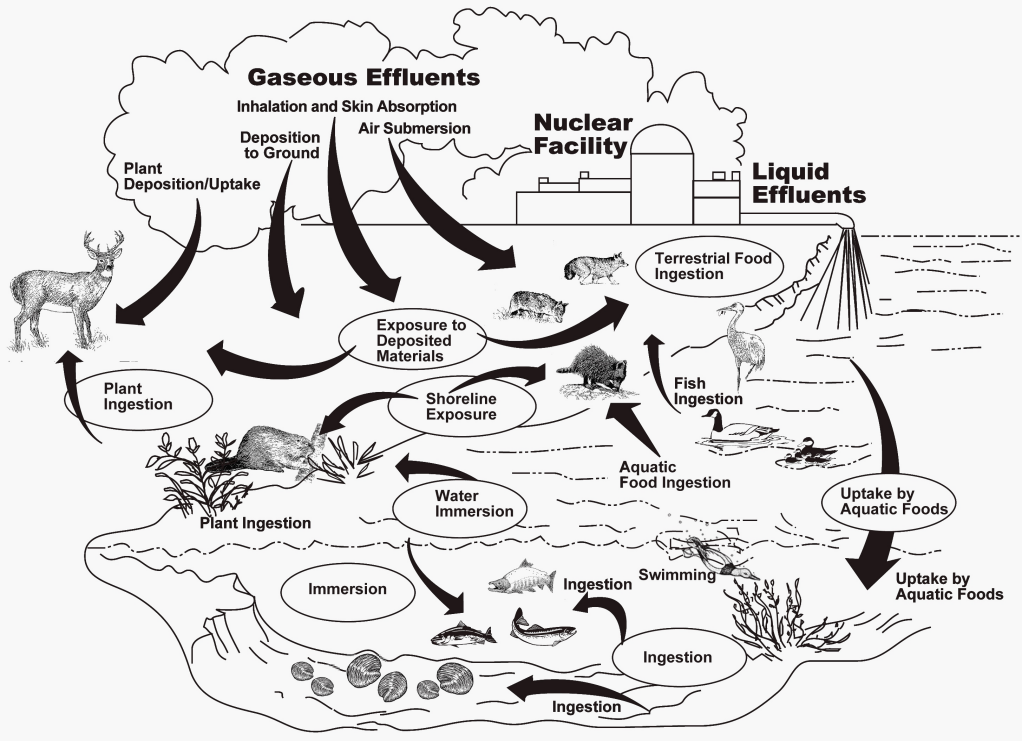

Figure 5-3. Exposure Pathways to Biota Other than Humans

5.9.2.1 Liquid Effluent Pathway

Liquid pathway doses were calculated by SERI using the LADTAP II computer program (Strenge et al. 1986) for the following activities: eating commercially caught fish and invertebrates caught in the river and using the shoreline for recreational purposes. SERI's environmental report (SERI 2005a) shows no use of the Mississippi River for drinking water within 160 km (100 mi) downstream from the Grand Gulf ESP site. Therefore, drinking water was not calculated in the assessment. The liquid effluent releases for one ESP unit used in the estimate of dose to a maximally exposed individual are given in Table 3.0-8 of the SERI environment report (SERI 2005a). These releases were based on a composite release that bounds the potential release from two Advanced Boiling Water Reactor (ABWR) units, two surrogate Advanced Pressurized Water Reactor (AP1000) units, and four Advanced CANDU (CANada Deuterium Uranium) Reactor ACR-700 units. Annual average liquid releases for each of these designs were compared. The most limiting isotopic releases were identified and then included in the composite release (SERI 2005b). This resulted in a slight increase in release rate for those isotopes where the ABWR design was the bounding condition. Other parameters

used as input to the LADTAP II program including effluent discharge rate, amount of commercial fish catch, invertebrate harvest, and usage consumption factors are found in Tables 5.4-1 and 5.4-2 of the SERI environment report (SERI 2005a).

Liquid pathway doses to the maximally exposed individuals calculated by SERI are presented in Table 5-5. The maximum annual dose to the total body of an adult was 0.022 mSv (2.2 mrem) for one unit. The maximum annual dose to the bone of a child was 0.041 mSv (4.1 mrem) (SERI 2005a). The staff performed an independent evaluation of liquid pathway doses and found similar results.

Table 5-5. Liquid Pathway Doses for Maximally Exposed Individual at the Grand Gulf Early Site Permit Site from Operation of One New Nuclear Unit

Pathway	Total Body Dose (adult) (mSv/yr)[(a)]	Maximum Organ (bone, child) (mSv/yr)[(a)]
Aquatic Foods	0.022	0.041
Shoreline Use	3.1×10^{-5}	3.6×10^{-5}
Total	**0.022**	**0.041**

(a) Multiply mSv/yr by 100 to obtain mrem/yr.
Source: SERI 2005a. Doses were estimated for one unit.

5.9.2.2 Gaseous Effluent Pathway

Gaseous pathway doses to the maximally exposed individual were calculated by SERI using the GASPAR II computer program (Strenge et al. 1987) at the following locations: the nearest site boundary, nearest vegetable garden, nearest residence, nearest milk cow, and nearest meat cow. The gaseous effluents used in the estimate of dose to the maximally exposed individual are given in Table 3.0-7 of the SERI environmental report (SERI 2005a). These releases, which were estimated for one ESP unit, were based on a composite of the releases for each evaluated design type. The designs include two ABWR units, two surrogate AP1000 units, eight Gas Turbine Modular Helium Reactor (GT-MHR) modules, four ACR-700 units, and six International Reactor Innovative and Secure (IRIS) units. For each radionuclide, the highest release for any proposed design was used for the source term. Other parameters used as input to the GASPAR II program (including milk, meat, and vegetable production rates, meteorological data, population data, and consumption factors) are found in Tables 5.4-3 through 5.4-7 of the SERI environmental report (SERI 2005a).

Gaseous pathway doses to the maximally exposed individuals calculated by SERI are presented in Table 5-6. The dose calculations in Table 5-6 are based on dispersion factors from meteorological data from 2002 to 2003. The staff performed an independent evaluation of gaseous pathway doses and found similar results.

5.9.3 Impacts on Members of the Public

The staff evaluated the impacts on members of the public from the operation of the proposed Grand Gulf ESP facility by identifying the maximally exposed individual and population dose.

5.9.3.1 Maximally Exposed Individual

SERI (2005a) stated that whole body and organ dose estimates to the maximally exposed individual from liquid effluent and gaseous emissions for one unit were within the design objectives of 10 CFR Part 50, Appendix I. The design objectives of 10 CFR Part 50, Appendix I are applicable to each reactor unit. Doses to whole body and maximum organ (bone) from liquid effluent were well within the 0.03 mSv/yr (3 mrem/yr) and 0.1 mSv/yr (10 mrem/yr) 10 CFR Part 50, Appendix I design objectives, respectively. Doses at the exclusion area boundary from gaseous effluents were well within the 10 CFR Part 50, Appendix I design objectives of 0.1 mGy/yr (10 mrad/yr) gamma in air, 0.2 mGy/yr (20 mrad/yr) beta in air, 0.05 mSv/yr (5 mrem/yr) dose to the whole body, and 0.15 mSv/yr (15 mrem/yr) dose to the skin. In addition, dose to the thyroid was within the 0.15 mSv/yr (15 mrem/yr) 10 CFR Part 50, Appendix I design objectives (SERI 2005a). A comparison of dose estimates for one ESP unit to the 10 CFR Part 50, Appendix I design objectives is presented in Table 5-7.

SERI (2005a) stated that doses from liquid and gaseous effluents to the maximally exposed individual at the site boundary from the existing GGNS Unit 1 and the proposed new nuclear unit or units combined were within the regulatory standards of 40 CFR Part 190. The dose standards from 40 CFR Part 190 are 0.25 mSv/yr (25 mrem/yr) to the whole body, 0.75 mSv/yr (75 mrem/yr) to the thyroid, and 0.25 mSv/yr (25 mrem/yr) to any other organ. The combined doses from the existing unit and the ESP units were 0.089 mSv/yr (8.9 mrem/yr) to the whole body, 0.17 mSv/yr (17 mrem/yr) to the thyroid, and 0.21 mSv/yr (21 mrem/yr) to the bone for the maximally exposed member of the public (SERI 2005a, Table 5.4-18). These data are summarized in Table 5-8. Therefore, the combined dose to the maximally exposed individual from GGNS and the new units would be within the 40 CFR Part 190 standards, 10 CFR Part 20 standards, and 10 CFR Part 50, Appendix I design objectives.

5.9.3.2 Population Dose

SERI (2005a) estimated a collective whole body dose within 80 km (50 mi) of each Grand Gulf ESP unit to be 0.032 person-Sv/yr (3.2 person-rem/yr). Collective dose was estimated using the LADTAP II and GASPAR II computer codes (SERI 2005a, Tables 5.4-10 and 5.4-13, respectively). Collective dose from the liquid effluent pathways was calculated for the aquatic food pathway, but not drinking water since the Mississippi River is not used for drinking water within 160 km (100 mi). The staff independently evaluated the population doses and found

Table 5-6. Gaseous Pathway Doses for Maximally Exposed Individual from Operation of One New Nuclear Unit[a]

Location	Pathway	Dose Rate (mSv/yr)[b]		
		Total Body	Skin[c]	Thyroid
Nearest Residence[d] (NNE, 1.02 km (0.64 mi))	Plume Exposure	0.0063	0.021	0.0063
	Inhalation			
	Adult	0.0017		0.0069
	Teen	0.0017		0.0085
	Child	0.0015		0.0099
	Infant	0.00088		0.0086
Nearest Garden[d] (ENE, 1.01 km (0.63 mi))	Vegetable Consumption			
	Adult	0.0039		0.029
	Teen	0.0049		0.036
	Child	0.009		0.067
Nearest Site Boundary[e] (N, 0.93 km (0.58 mi))	Plume Exposure	0.012	0.039	0.012
	Inhalation			
	Adult	0.0032		0.013
	Teen	0.0032		0.016
	Child	0.0028		0.018
Nearest Milk Cow[d] (SSW, 16 km (10 mi))	Cow Milk			
	Adult	0.000056		0.00055
	Teen	0.000083		0.00086
	Child	0.00016		0.0017
	Infant	0.00029		0.0041
Nearest Meat Cow[d] (S, 6.4 km (4.0 mi))	Meat Consumption			
	Adult	0.000065		0.00014
	Teen	0.000047		0.0001
	Child	0.000076		0.00016

(a) Data provided in SERI 2005a was for one unit.
(b) mSv = millisievert; multiply mSv/yr by 100 to obtain mrem/yr.
(c) Skin dose is only applicable to plume exposure.
(d) "Nearest" refers to the location at which the highest radiation dose to an individual from the applicable pathways has been estimated.
(e) "Nearest" refers to that site boundary location at which the highest radiation doses from gaseous emissions have been estimated to occur.

Table 5-7. Comparison of Maximum Individual Dose to 10 CFR Part 50, Appendix I Design Objective per Unit

Type of Dose	Design Objective[(a)]	Point of Evaluation	Calculated Dose[(a)]
		Gaseous Effluents	
Gamma air dose	0.1 mGy/yr (10 mrad/yr)	Exclusion Area Boundary	0.018 mGy/yr (1.8 mrad/yr)
Beta air dose	0.2 mGy/yr (20 mrad/yr)	Exclusion Area Boundary	0.035 mGy/yr (3.5 mrad/yr)
Total body dose	0.05 mSv/yr (5 mrem/yr)	Exclusion Area Boundary	0.016 mSv/yr (1.6 mrem/yr)
Skin dose	0.15 mSv/yr (15 mrem/yr)	Exclusion Area Boundary	0.044 mSv/yr (4.4 mrem/yr)
		Radioiodines and Particulates	
Vegetable Consumption	0.15 mSv/yr (15 mrem/yr)	Nearest Garden	0.067 mSv/yr (6.7 mrem/yr) (thyroid, child)

(a) mGy = milligray, mrad = millirad, mSv = millisievert, mrem = millirem
Sources: 10 CFR Part 50, Appendix I; SERI 2005a

Table 5-8. Comparison of Maximally Exposed Individual Dose Estimates from Liquid and Gaseous Effluents from Operation of GGNS Unit 1 and Two New Nuclear Units to 40 CFR Part 190 Standards

Dose	SERI Estimate[(a)(b)]	40 CFR Part 190 Standards[(b)]
Whole body dose equivalent	0.089 mSv/yr	0.25 mSv/yr
Thyroid dose	0.17 mSv/yr	0.75 mSv/yr
Dose to organ (bone)	0.21 mSv/yr	0.25 mSv/yr

(a) Doses were estimated for GGNS Unit 1 and two ESP units (SERI 2005a, Table 5.4-18).
(b) mSv = millisievert; multiply mSv/yr by 100 to obtain mrem/yr.

similar results. For comparative purposes, the estimated collective dose from natural background radiation to the population within 80 km (50 mi) of the proposed Grand Gulf ESP site is 1020 person-Sv/yr (102,000 person-rem/yr).

Although radiation may cause cancers at high doses and high dose rates, currently there are no data that unequivocally establish the occurrence of cancer following exposure to low doses

below about 100 mSv (10,000 mrem) and at low dose rates. However, radiation protection experts conservatively assume that any amount of radiation may pose some risk of causing cancer or a severe hereditary effect and that the risk is higher for higher radiation exposures. Therefore, a linear, no-threshold dose response relationship is used to describe the relationship between radiation dose and detriments such as cancer induction. A recent report by the National Research Council (2006), BEIR VII report, supports the linear, no threshold dose response. Simply put, this theory states that any increase in dose, no matter how small, results in an incremental increase in health risk. This theory is accepted by the NRC as a conservative model for estimating health risks from radiation exposure, recognizing that the model probably overestimates those risks.

Based on this model, the staff estimated the risk to the public from radiation exposure using the nominal probability coefficient for total detriment (730 fatal cancers, nonfatal cancers, and severe hereditary effects per 10,000 person-Sv (1,000,000 person-rem)) from International Commission on Radiological Protection (ICRP) Publication 60 (ICRP 1991). This coefficient was multiplied by the estimated collective whole body population dose of 0.032 person-Sv/yr (3.2 person-rem/yr) to calculate that the population living within 80 km (50 mi) of the Grand Gulf ESP site would incur a total of approximately 0.002 fatal cancers, nonfatal cancers, and severe hereditary effects annually. The risks from the cumulative radiation exposure from GGNS and the proposed ESP units would be only slightly higher. This risk is very small compared to the estimated 75 fatal cancers, nonfatal cancers, and severe hereditary effects that the same population would incur annually from exposure to natural sources of radiation.

In addition, at the request of the U.S. Congress, the National Cancer Institute conducted a study and published “Cancer in Populations Living Near Nuclear Facilities” in 1990. This report included an evaluation of health statistics around all nuclear power plants, as well as several other nuclear fuel cycle facilities, in operation in the United States in 1981 and found “no evidence that an excess occurrence of cancer has resulted from living near nuclear facilities” (NCI 1990).

5.9.3.3 Summary of Radiological Impacts on Members of the Public

The NRC staff evaluated the health impacts from routine gaseous and liquid radiological effluent releases from new nuclear units at the Grand Gulf ESP site. Based on the information provided by SERI and the NRC staff’s independent review, the NRC staff concludes there would be no observable health impacts on the public from normal operation of new nuclear units, and the health impacts would be SMALL.

5.9.4 Occupational Doses to Workers

On the basis of information contained in NUREG-0713 (NRC 2002b), the average annual collective dose per operating reactor was 1.72 person-Sv/yr (172 person-rem yr) for the time

period from 1992 to 2001. Limited information is available on occupational dose estimates from the advanced reactor designs, and SERI did not provide such information. However, Dominion Energy, Inc., in a study regarding potential sites for new nuclear power plants, reported annual occupational dose estimates of 1.5 person-Sv (150 person-rem) for the AP1000 reactor, IRIS, and GT-MHR designs (Dominion and Bechtel 2002). The estimated occupational doses for the advanced reactor designs were slightly less than annual occupational doses for current light water reactors (LWRs). The staff reviewed this information and concluded (1) that the information was generically applicable to SERI's application and (2) that the annual dose estimates are reasonable. Moreover, the environmental impact from this occupational dose is considered small because the dose to any individual worker is maintained within the limits of 10 CFR Part 20 (0.05 Sv/yr (5 rem/yr)).

5.9.5 Impacts on Biota Other than Members of the Public

SERI (2005a) estimated doses to surrogate species (fish, invertebrates, algae, muskrat, raccoon, heron, and duck). Fish, invertebrates, and algae are referred to as aquatic species. Muskrats, racoons, herons, and ducks are referred to as terrestrial species. Important biota species for the Grand Gulf ESP site and the corresponding surrogate species are bald eagle and woodstork (heron), pallid sturgeon (fish), and fat pocketbook mussel (invertebrate). Surrogate species are well defined and provide an acceptable method for judging doses to the biota (SERI 2005a). Exposure pathways considered in evaluating dose to the biota are discussed in Section 5.9.1 and shown in Figure 5-3.

5.9.5.1 Liquid Effluent Pathways

SERI (2005a) used the LADTAP II computer code to calculate doses to the biota from liquid effluent pathways. The following exposure pathways (illustrated in Figure 5-3) were evaluated for the different surrogate biota:

- Fish and invertebrates – internal exposure from bioaccumulation of radionuclides and external exposure from swimming and shoreline activities
- Algae – internal exposure from bioaccumulation of radionuclides and external exposure from immersion in water
- Muskrat and duck – internal exposure from ingestion of aquatic plants and external exposure from swimming and shoreline activities
- Raccoon – internal exposure from ingestion of invertebrates and external exposure from shoreline activities

- Heron – internal exposure from ingestion of fish and external exposure from swimming and shoreline activities.

Input parameters used in the dose calculation included food consumption rates, body masses, and effective body radii. These parameters were taken from NUREG/CR-4013 (Strenge et al. 1986). These parameters are shown in Tables 5.4-14 and 5.4-15 of the SERI environmental report (SERI 2005a). The LADTAP II program has an adjustment factor because the biota would be closer to any potential shoreline contamination than humans.

5.9.5.2 Gaseous Effluent Pathways

SERI used the doses calculated for the maximally exposed individual from the gaseous effluent pathways (described earlier in this section) as a basis for the doses to the biota. External doses from ground deposition were increased to account for the terrestrial organisms being closer to the ground (SERI 2005a).

5.9.5.3 Impacts of Estimated Biota Doses

Table 5-9 compares the estimated whole body dose to the biota from the liquid and gaseous effluent pathways calculated by SERI (2005a) from one proposed new unit at the Grand Gulf ESP site to the regulatory standard for humans in 40 CFR Part 190. The biota doses for all surrogate species exceed the regulatory standard in 40 CFR Part 190 of 0.25 mSv/yr (25 mrem/yr) to the total body. This assumes mrem and mrad are approximately equivalent. The staff performed an independent evaluation of biota doses and found similar results.

The ICRP (1977, 1991) states that if man is adequately protected, then other living things are also likely to be sufficiently protected. The International Atomic Energy Agency (IAEA 1992) and the National Council on Radiation Protection and Measurements (NCRP 1991) reported that a chronic dose rate of no greater than 10 mGy/day (1 rad/day) to the maximally exposed individual in a population of aquatic organisms would ensure protection for the population. IAEA (1992) also concluded that chronic dose rates of 1 mG/day (0.1 rad/day) or less do not appear to cause observable changes in terrestrial animal populations. Table 5-9 compares the estimated whole body dose to the biota for the proposed unit or units to the IAEA chronic dose rate values for aquatic organisms and terrestrial animals. The cumulative effects of current operating units and proposed unit or units would result in dose rates significantly less than the NCRP and IAEA studies.

The staff performed an independent evaluation of doses to biota and found similar results.

Table 5-9. Comparison of Biota Dose Estimates from Liquid and Gaseous Effluents from Operation of New Nuclear Units to 40 CFR Part 190 Standards and Relevant Guidelines for Biota Protection

Biota	Dose from Liquid Effluents/Unit (mGy/yr)[a]	Dose from Gaseous Effluents/Unit (mGy/yr)[a]	Total Dose/Unit (mGy/yr)[a]	Total Dose for Two Units (mGy/yr)[a]	40 CFR Part 190 Total Body Dose Limit (mSv/yr)[b]	IAEA/NCRP Guideline for Protection of Biota Populations (mGy/yr)[a]
Fish	0.25	0	0.25	0.51	0.25	3650
Invertebrate	1.65	0	1.65	3.31	0.25	3650
Algae	1.48	0	1.48	2.96	0.25	3650
Muskrat	0.81	0.022	0.83	1.67	0.25	365
Raccoon	0.19	0.02	0.21	0.42	0.25	365
Heron	1.93	0.018	1.95	3.91	0.25	365
Duck	0.81	0.023	0.83	1.67	0.25	365

(a) mGy = milligray; multiply mGy/yr by 100 to obtain mrad/yr.
(b) mSv = millisievert; multiply mSv/yr by 100 to obtain mrem/yr.
IAEA = International Atomic Energy Agency
NCRP = National Council on Radiation Protection and Measurements
Sources: SERI 2005a, Tables 5.4-16 and 5.4-17; IAEA 1992; NCRP 1991

In conclusion, the staff reviewed the available information related to the radiological impact on biota from the routine operation of the proposed Grand Gulf ESP unit(s) and concluded that the impact would be SMALL, and mitigation would not be warranted.

5.9.6 Radiological Monitoring

A radiological environmental monitoring program (REMP) (10 CFR 50.34a(a); 10 CFR 50.36a(a); SEC IV, B.2 of Appendix I in 10 CFR Part 50) has been performed around the Grand Gulf site since 1978. The REMP includes monitoring of the airborne exposure pathway, direct exposure pathway, water exposure pathway, aquatic exposure pathway with control and indicator locations within a 29 km (18 mi) radius of the site. Milk is sampled when there is commercial milk production within 8 km (5 mi) of the site. The pre-operational REMP sampled various media in the environment to determine a baseline from which to observe the magnitude and fluctuation of radioactivity in the environment once the unit began operation (Entergy 2003b). The pre-operational program included collection and analysis of samples of air particulates, precipitation, milk, crops, soil, well water, surface water, fish, and silt as well as measurement of ambient gamma radiation. After operation of GGNS Unit 1 plant began in 1985, the monitoring program continued to assess the radiological impacts on workers, the public, and the environment. Radiological releases are summarized in the two annual reports: the *Annual Radiological Environmental Operating Report* (Entergy 2003b) and *Annual Radioactive Effluent Release Report* (Entergy 2003a). The limits for all radiological releases

| are specified in the *Grand Gulf Offsite Dose Calculation Manual* (Entergy 2004). No additional monitoring program has been established for the new unit(s). The staff reviewed the
| documentation for the REMP, the Grand Gulf Offsite Dose Calculation Manual, and recent
| monitoring reports from SERI and the state of Mississippi (MDH 2004) and determined that the current operational monitoring program is adequate to establish the radiological baseline for
| comparison with the expected impacts on the environment related to the construction and operation of proposed new unit(s) at the Grand Gulf ESP site.

5.10 Environmental Impacts of Postulated Accidents

The staff considered the radiological consequences on the human environment of potential
| accidents at one or more new nuclear units at the Grand Gulf ESP site. Consequence estimates are based on the General Electric ABWR standard reactor design, which has been
| certified by the NRC (10 CFR Part 52, Appendix A), and the surrogate Westinghouse AP1000. The term "accident," as used in this section, refers to any off-normal event not addressed in Section 5.9 that results in the release of radioactive materials into the environment. The focus of this review is on events that could lead to releases substantially in excess of permissible limits for normal operations. Normal release limits are specified in 10 CFR Part 20, Appendix B, Table 2.

Numerous features combine to reduce the risk associated with accidents at nuclear power plants. Safety features in the design, construction, and operation of the plants, which compose the first line of defense, are intended to prevent the release of radioactive materials from the plant. The design objectives and the measures for keeping levels of radioactive materials in
| effluents to unrestricted areas as low as is reasonably achievable (ALARA) are specified in 10 CFR Part 50, Appendix I. There are additional measures that are designed to mitigate the consequences of failures in the first line of defense. These include the NRC's reactor site criteria in 10 CFR Part 100, which require the site to have certain characteristics that reduce the risk to the public and the potential impact of an accident, and emergency preparedness plans and protective action measures for the site and environs as set forth in 10 CFR 50.47;
| 10 CFR Part 50, Appendix E; and NUREG-0654/FEMA-REP-1 (NRC and FEMA 1980). All of these safety features, measures, and plans make up the defense-in-depth philosophy to protect the health and safety of the public and the environment.

This section discusses (1) the types of radioactive materials, (2) the paths to the environment, (3) the relationship between radiation dose and health effects, and (4) the environmental
| impacts of postulated reactor accidents, both design basis accidents (DBAs) and severe accidents. The environmental impacts of postulated accidents during transportation of spent fuel are discussed in Chapter 6.

The potential for dispersion of radioactive materials in the environment depends on the mechanical forces that physically transport the materials and on the physical and chemical forms of the materials. Radioactive material exists in a variety of physical and chemical forms. The majority of the material in the fuel is in the form of nonvolatile solids. However, there is a significant amount of material that is in the form of volatile solids or gases. Gaseous radioactive materials include the chemically inert noble gases krypton and xenon, which have a high potential for release. Radioactive forms of iodine, which are created in substantial quantities in the fuel by fission, are volatile. Other radioactive materials formed during the routine operation of a nuclear power plant have lower volatilities and, therefore, have lower tendencies to escape from the fuel than the noble gases and iodines.

Radiation exposure to individuals is determined by their proximity to radioactive material, the duration of their exposure, and the extent to which they are shielded from the radiation. Pathways that lead to radiation exposure include external radiation from radioactive material in the air, on the ground, and in the water; the inhalation of radioactive material; and ingestion of food or water containing material initially deposited on the ground and in water.

The risks of health effects from radiation exposure below 0.1 Sv (10 rem) are either too small to be observed or are non-existent (HPS 2004). After exposure to higher levels of radiation, incidences of cancer in the exposed general population may begin to develop after a lapse of 2 to 15 years (latent period) and then level off over a period of about 30 years (plateau period). In the case of radiation exposure of fetuses, cancer may begin to develop as early as at birth (no latent period) to the age of 10.

Physiological effects are clinically detectable should individuals receive radiation exposure resulting in a dose greater than about 0.25 Sv (25 rem) over a short period of time (hours). Doses of about 2.5 to 5.0 Sv (250 to 500 rem) received over a relatively short period (hours to a few days) can be expected to cause some fatalities.

5.10.1 Design Basis Accidents

SERI evaluated the potential consequences of postulated accidents to demonstrate that new unit(s) could be constructed and operated at the Grand Gulf ESP site without undue risk to the health and safety of the public. These evaluations use a set of surrogate DBAs that are representative for the range of reactor designs being considered for the ESP site and site-specific meteorological data. The set of accidents covers events that range from relatively high probability of occurrence with relatively low consequences to relatively low probability with high consequences.

The DBA review focuses on two light water reactor designs: the ABWR and the surrogate AP1000. The bases for analyses of postulated accidents for these designs are well established because they have been considered as part of the NRC's advanced reactor design certification

process. Accidents for the other reactor designs listed in SERI's ESP are not as well defined as those for the ABWR and the surrogate AP1000; acceptable assumptions and methodologies for the evaluation of postulated accidents have not been fully established. Consequently, design basis accidents for reactor designs other than light-water designs are not resolved. Because the source terms for accident analyses are generally proportional to the power level, for the purposes of this environmental impact evaluation, the potential consequences of accidents for the other reactor designs are expected to be bounded by those for the ABWR and surrogate AP1000 designs. For example, preliminary information on source terms for the IRIS and ACR-700 reactor designs indicates that the source terms for the surrogate AP1000 loss-of-coolant accident (LOCA) would bound the worst-case accident release for these advanced reactor designs. Similarly, the ABWR source terms are expected to bound the source terms for the Economic Simplified Boiling Water Reactor (ESBWR) design. The advanced gas reactor designs (GT-MHR and Pebble Bed Modular Reactor) postulate relatively small releases to the environment compared to water reactor technologies (SERI 2005a).

Should an application for a CP or COL that references an ESP at the Grand Gulf ESP site reference one of the designs other than an ABWR or surrogate AP1000, the applicant would be required to show – and the staff would verify – that the radiological consequences of DBAs for the proposed reactor(s) are bounded by the consequences of DBAs evaluated in this EIS.

Potential consequences of DBAs are evaluated following procedures outlined in regulatory guides and standard review plans. The potential consequences of accidental releases depend on the specific radionuclides released, the amount of each radionuclide released, and meteorological conditions. The source terms for the ABWR design are based on TID-14844 (AEC 1962) guidance, and guidance on methods for evaluating potential accidents for the ABWR are set forth in NUREG-0800 (NRC 1987), Regulatory Guide 1.3 (NRC 1974a), and Regulatory Guide 1.25 (NRC 1974b). The source terms for the surrogate AP1000 reactor and methods for evaluating potential accidents are based on guidance in Regulatory Guide 1.183 (NRC 2000b).

For environmental reviews, consequences are evaluated assuming realistic meteorological conditions. Meteorological conditions are represented in these consequence analyses by an atmospheric dispersion factor, which is also referred to as X/Q. Acceptable methods of calculating X/Q for DBAs from meteorological data are set forth in Regulatory Guide 1.145 (NRC 1983).

SERI provided the staff with meteorological data for the Grand Gulf ESP site for 2002 and 2003 (SERI 2004b). These data have been reviewed by the staff and found to be representative of the meteorological conditions at the site. The meteorological instrumentation and its maintenance are consistent with staff guidance, and the data quality is consistent with

standards set forth in that guidance. Therefore, the data are considered acceptable for use in evaluation of the consequences of DBAs. The staff also reviewed SERI's procedures for calculating site-specific X/Qs and found them to be consistent with staff guidance.

Table 5-10 lists X/Q values pertinent to the evaluation of the suitability of the Grand Gulf ESP site. The first column lists the time periods and boundaries for which X/Q values and dose estimates are needed. For the EAB, the postulated DBA dose and its atmospheric dispersion factor are calculated for a short-term, i.e., 2 hours, and for the low population zone (LPZ), they are calculated for the course of the accident, i.e., 30 days (720 hours) composed of four time periods. The second column lists the X/Q values calculated by SERI using the site meteorological information discussed in environmental report Section 2.7.5 (SERI 2005a) and the EAB and LPZ distances from Section 2.7.6 of the environmental report. No credit was taken for building wake. These X/Q values are expected to be exceeded no more than five percent of the time.

Table 5-10. Atmospheric Dispersion Factors (X/Q, s/m^3) for the Grand Gulf Early Site Permit Site Design Basis Accident Calculations

Time Period[(a)] and Boundary	Site	
	Adverse	Typical
0 to 2 hr, Exclusion Area Boundary	5.95×10^{-4}	8.82×10^{-5}
0 to 8 hr, Low Population Zone	8.83×10^{-5}	2.83×10^{-5}
8 to 24 hr, Low Population Zone	6.16×10^{-5}	2.21×10^{-5}
1 to 4 day, Low Population Zone	2.82×10^{-5}	1.29×10^{-5}
4 to 30 day, Low Population Zone	9.15×10^{-6}	5.95×10^{-6}

(a) Times are relative to the beginning of the release to the environment.

In its independent assessment, the staff evaluated SERI's process for deriving the site X/Q values from site-specific information. The staff determined the process is consistent with NRC guidance (NRC 1983), but the X/Q values are not acceptable for use in environmental reviews because they are for adverse meteorological conditions rather than typical conditions.

Using information provided by SERI and the procedure described in Regulatory Guide 1.145, the staff estimated site X/Q values for typical meteorological conditions using the EAB and LPZ distances given in the ESP application. The staff's estimates of X/Q values for typical meteorological conditions are listed in the last column of Table 5-10. These values indicate the atmospheric dilution capability in the vicinity of the site. Small X/Q values are associated with greater dilution capability. Thus, if a design X/Q value for a specific reactor design identified as part of the CP or COL were greater than or equal to the site-specific X/Q value, then atmospheric dispersion at the site is sufficient such that the doses predicted for postulated DBAs for the design would likely be below regulatory limits.

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The staff concludes that the atmospheric dispersion characteristics of the Grand Gulf ESP site are acceptable with respect to the potential environmental consequences of postulated DBAs for reactor designs with design X/Q values falling within the bounds set by the staff's site X/Q values. At the CP or COL stage, the staff would need to verify that the X/Q values for reactor designs proposed at the CP/COL stage are bounded by the site X/Q values used in this analysis. Additional evaluation will be needed if reactor design X/Q values do not meet this criterion.

Tables 5-11 and 5-12 list the set of surrogate DBAs considered by SERI and present the staff's estimate of the environmental consequences of each DBA in terms of total effective dose equivalent (TEDE). TEDE is the sum of the committed effective dose equivalent (CEDE) from inhalation and the deep dose equivalent from external exposure. Dose conversion factors from Federal Guidance Report 11 (Eckerman et al. 1988) were used to calculate the CEDE. Similarly, dose conversion factors from Federal Guidance Report 12 (Eckerman and Ryman 1993) were used to calculate the deep dose equivalent.

TEDE values were estimated for the ABWR by multiplying the thyroid dose by a factor of 0.03 (the organ weighting factor for the thyroid in the TEDE methodology) and adding the product to the whole body dose. The review criteria used in the staff's safety review of DBA doses are included in Tables 5-11 and 5-12 to illustrate how small the calculated environmental consequences (TEDE doses) are.

In addition to the evaluation of the DBAs for the ABWR and surrogate AP1000 designs described above, SERI evaluated the consequences of a postulated LOCA for the ACR-700 reactor design. The staff's estimate of the 0 to 2 hr TEDE at the EAB is 8.8×10^{-3} Sv (0.88 rem), and the estimate for TEDE for the LPZ is 1.7×10^{-2} Sv (1.7 rem). These TEDE values for the ACR-700 are well below the review criteria used in the staff's safety review of DBA doses (0.25 Sv (25 rem) for EAB and LPZ). These comparisons are included to illustrate how small the calculated environmental consequences (TEDE doses) are.

In all cases, the calculated TEDE values are small – considerably smaller that the TEDE doses used as safety review criteria. The environmental impacts of DBAs have not been explicitly evaluated for gas-cooled reactors because necessary design information is lacking. The staff expects, however, that releases to the environment under accident conditions would be small

for such designs. Should an applicant for a CP or COL reference an LWR design, the staff would need to verify that the doses for postulated DBAs for the actual reactor design remain bounded by the environmental impacts from the surrogate reactor designs considered in this EIS. Because impacts of DBAs for gas-cooled designs are not resolved at the ESP stage, the applicant would need to provide an evaluation of the impacts of DBAs.

Table 5-11. Design Basis Accident Doses for an Advanced Boiling Water Reactor

Accident	Standard Review Plan Section[b]	TEDE in Sv[a] EAB	LPZ	Review Criterion
Main Steam Line Break	15.6.4			
Pre-Existing Iodine Spike		1.4×10^{-3}	4.8×10^{-4}	2.5×10^{-1}[c]
Accident-Initiated Iodine Spike		7.0×10^{-5}	2.4×10^{-5}	2.5×10^{-2}[d]
Loss-of-Coolant Accident	15.6.5	5.9×10^{-3}	5.4×10^{-2}	2.5×10^{-1}[c]
Failure of Small Lines Carrying Primary Coolant Outside Containment	15.6.2	1.2×10^{-4}	4.2×10^{-5}	2.5×10^{-2}[d]
Fuel Handling	15.7.4	9.8×10^{-4}	3.3×10^{-4}	6.25×10^{-2}[d]

(a) To convert Sv to rem, multiply by 100.
(b) NUREG-0800 (NRC 1987)
(c) 10 CFR 50.34(a)(1); 10 CFR 100.11; 10 CFR 100.21
(d) Standard Review Plan criterion
EAB = exclusion area boundary
LPZ = low population zone
TEDE = total effective dose equivalent

Although SERI chose to use the PPE approach in its ESP application, it based its evaluation of the environmental impact of DBAs on characteristics of the ABWR and the surrogate AP1000 reactor designs with the explicit assumption that the impact would bound the impact of other advanced LWR designs (SERI 2005a). The NRC staff reviewed the analysis in the environmental report, which is based on analyses performed for design certification of these reactor designs and found it appropriate for safety analyses, but overly conservative for environmental reviews. Therefore, the staff adjusted the results of the SERI analysis to reflect typical meteorological conditions. The results of both the SERI and the staff analyses indicate that the environmental risks associated with DBAs, should an advanced LWR be located at the Grand Gulf ESP site, would be small compared to the TEDE doses used as safety review criteria. On this basis, the staff concludes that the consequences of DBAs at the Grand Gulf ESP site are of SMALL significance for advanced LWRs. The environmental impacts of DBAs have not been explicitly evaluated for gas-cooled reactors and are, therefore, unresolved. These impacts would need to be evaluated at the CP or COL stage if such a design were selected. For the evaluation in this EIS to bound the reactor design selected at the CP or COL stage, an applicant referencing the Grand Gulf ESP would need to demonstrate that the environmental impacts of a DBA at the proposed Grand Gulf ESP site remain bounded by the environmental impacts for the surrogate designs considered in this EIS.

Table 5-12. Design Basis Accident Doses for a Surrogate AP1000 Reactor

Accident	Standard Review Plan Section[b]	TEDE in Sv[a] EAB	LPZ	Review Criterion
Main Steam Line Break	15.1.5			
Pre-Existing Iodine Spike		9.6×10^{-4}	1.0×10^{-3}	2.5×10^{-1}(c)
Accident-Initiated Iodine Spike		1.1×10^{-3}	3.8×10^{-3}	2.5×10^{-2}(d)
Steam Generator Rupture	15.6.3			
Pre-Existing Iodine Spike		4.1×10^{-3}	7.5×10^{-4}	2.5×10^{-1}(c)
Accident-Initiated Iodine Spike		2.1×10^{-3}	5.3×10^{-4}	2.5×10^{-2}(d)
Loss-of-Coolant Accident	15.6.5	3.4×10^{-2}	2.2×10^{-2}	2.5×10^{-1}(c)
Rod Ejection	15.4.8	4.1×10^{-3}	3.7×10^{-3}	6.25×10^{-2}(d)
Reactor Coolant Pump Rotor Seizure (Locked Rotor)	15.3.3	3.5×10^{-3}	1.3×10^{-3}	2.5×10^{-2}(d)
Failure of Small Lines Carrying Primary Coolant Outside Containment	15.6.2	1.8×10^{-3}	6.4×10^{-4}	2.5×10^{-2}(d)
Fuel Handling	15.7.4	3.3×10^{-3}	1.3×10^{-3}	6.25×10^{-2}(d)

(a) To convert Sv to rem, multiply by 100.
(b) NUREG-0800 (NRC 1987)
(c) 10 CFR 50.34(a)(1); 10 CFR 100.21
(d) Standard Review Plan criterion
EAB = exclusion area boundary
LPZ = low population zone
TEDE = total effective dose equivalent

5.10.2 Severe Accidents

In its environmental report, SERI (2005a) bases its evaluation of the potential environmental consequences of severe accidents on the evaluation of potential consequences of severe accidents for current generation reactors presented in the GEIS (NRC 1996). Three pathways were considered: the atmospheric pathway in which radioactive material is released to the air, the surface water pathway in which airborne radioactive material falls out on open bodies of water, and the groundwater pathway in which groundwater is contaminated by a basemat melt-through with subsequent contamination of surface water by the groundwater.

In response to an NRC request for additional information dated May 19, 2004 (NRC 2004a), SERI performed a site-specific analysis of the potential environmental consequences of postulated severe accidents at the Grand Gulf ESP site. Because the PPE does not include source terms for severe accidents, SERI used the source terms for the ABWR and surrogate AP1000 reactors. SERI used the MACCS2 computer code (Chanin et al. 1990; Jow et al.

1990) for the analysis. Input to the MACCS2 computer code and summary results of the analysis were submitted to the NRC in a letter dated August 10, 2004 (SERI 2004g). |

The MACCS computer code was developed to evaluate the potential offsite consequences of severe accidents for the sites covered by NUREG-1150 (NRC 1990). MACCS2 (Chanin and Young 1997) is the current version of MACCS. The MACCS and MACCS2 codes evaluate the consequences of atmospheric releases of radioactive material following a severe accident. The pathways modeled include external exposure to the passing plume, exposure to material deposited on the ground and skin, inhalation of material in the passing plume and resuspended from the ground, and ingestion of contaminated food and surface water. The primary enhancements in MACCS2 are that MACCS2 has (1) a more flexible emergency response model, (2) an expanded library of radionuclides, and (3) a semidynamic food-chain model (Chanin and Young 1997).

Three types of severe accident consequences were assessed: (1) human health, (2) economic costs, and (3) land area affected by contamination. Human-health effects are expressed in terms of the number of cancers that might be expected if a severe accident were to occur. These effects are directly related to the cumulative radiation dose received by the general population. MACCS2 estimates both early cancer fatalities and latent fatalities. Early fatalities are related to high doses or dose rates and can be expected to occur within a year of exposure (Jow et al. 1990). Latent fatalities are related to exposure of a large number of people to low doses and dose rates and can be expected to occur after a latent period of several (2 to 15) years. Population health-risk estimates (latent and early cancers) are based on the population distribution within an 80-km (50-mi) radius of the plant, although early fatalities would be expected only in the population near the site. MACCS2 also calculates average individual health risks (early and latent fatalities) for individuals near the site. The risk of an early cancer fatality is calculated for individuals within 1.6 km (1 mi) and the risk of a latent cancer fatality is calculated for individuals within 16 km (10 mi). Economic costs of a severe accident include the costs associated with short-term relocation of people, decontamination of property and equipment, interdiction of food supplies, land and equipment use, and condemnation of property. The affected land area is a measure of the areal extent of the residual contamination following a severe accident.

Risk is the product of the frequency of an accident and the consequences of the accident. For example, the probability of a severe accident without loss of containment for an ABWR is estimated to be 1.34×10^{-7} per reactor year (Ryr^{-1}); and the cumulative population dose associated with a severe accident without loss of containment at the Grand Gulf ESP site is calculated to be 7.11×10^{1} person-Sv (7.11×10^{3} person-rem). The population dose risk for this class of accidents is the product of 1.34×10^{-7} Ryr^{-1} and 7.11×10^{1} person-Sv, or 9.53×10^{-6} person-Sv Ryr^{-1} (9.53×10^{-4} person-rem Ryr^{-1}). The following sections discuss the estimated risks associated with each pathway.

The risk presented in the tables that follow is risk per year of reactor operation. SERI has indicated the Grand Gulf ESP site could support reactors producing a total of 8600 MW(t). Based on this limit, the site could hold two ABWR or AP1000 reactors. The consequences of a severe accident would be the same regardless of whether one or two reactors were built. However, if two reactors were built, the risk would apply to each reactor, and the total risk for new reactors at the site would be twice the risk for a single reactor. Even if the risk values were doubled, the risks would still be significantly smaller than the risks associated with current-generation reactors.

5.10.2.1 Air Pathway

The MACCS2 code directly estimates consequences associated with releases to the air pathway. For the purposes of this analysis, the power levels of the ABWR and surrogate AP1000 reactors were scaled to 4300 MW(t) and 3415 MW(t), respectively (SERI 2004g). The results of the MACCS2 runs are presented in Tables 5-13 and 5-14. The core damage frequencies given in these tables are for internally initiated accident sequences while the plant is at power. Internally initiated accident sequences include sequences initiated by equipment failures, loss of offsite power, and human error. Based on insights from the review of the advanced LWR probabilistic risk assessments, the core damage frequencies for externally initiated events and during shutdown would be comparable to or lower than those for internally initiated events.

Tables 5-13 and 5-14 show that the probability weighted consequences, i.e., the risks, of severe accidents for an ABWR or a surrogate AP1000 reactor located on the Grand Gulf ESP site are small for all risk categories considered. For perspective, Tables 5-15 and 5-16 compare the health risks from severe accidents for the ABWR or surrogate AP1000 reactors at the Grand Gulf ESP site with the risks for current-generation reactors at various sites.

In Table 5-15, the health risks estimated for the ABWR and surrogate AP1000 reactors at the Grand Gulf ESP site are compared with health risk estimates for the five reactors considered in NUREG-1150 (NRC 1990). Although risks associated with both internally and externally initiated events were considered for the Peach Bottom and Surry reactors in NUREG-1150, only risks associated with internally initiated events are presented in Table 5-16. The health risks shown for the ABWR and surrogate AP1000 reactors at the Grand Gulf ESP site are significantly lower than the risks associated with current-generation operating reactors presented in NUREG-1150 (NRC 1990).

In addition, the last two columns of Table 5-15 provide average individual fatality risk estimates for comparison to the Commission's safety goals. The Commission has set safety goals for

Table 5-13. Mean Environmental Risk from Advanced Boiling Water Reactor Severe Accidents at the Grand Gulf Early Site Permit Site

Release Category Description (Accident Class)		Core Damage Frequency (Ryr^{-1})	Environmental Risk					
			Population Dose (person-Sv Ryr^{-1})[a]	Fatalities (Ryr^{-1})		Cost[d] ($ Ryr^{-1})	Land Requiring Decontamination[e] (ha Ryr^{-1})	Population Dose from Water Ingestion (person-Sv Ryr^{-1})[a]
				Early[b]	Latent[c]			
0	No loss of containment	1.34×10^{-7}	9.53×10^{-6}	0	4.12×10^{-7}	3.05×10^{-2}	1.10×10^{-6}	3.52×10^{-8}
1	Transients followed by failure of high-pressure coolant makeup water and failure to depressurize in timely fashion	2.08×10^{-8}	1.27×10^{-6}	0	6.91×10^{-8}	6.98×10^{-3}	1.60×10^{-7}	5.55×10^{-9}
2	Short-term station blackout with reactor core isolation cooling (RCIC) failure, onsite power recovery in 8 hr	1.00×10^{-10}	2.43×10^{-9}	0	1.04×10^{-10}	1.79×10^{-6}	8.31×10^{-11}	5.69×10^{-12}
3	Station blackout with RCIC available for about 8 hr	1.00×10^{-10}	1.86×10^{-7}	0	8.61×10^{-9}	1.02×10^{-2}	5.79×10^{-7}	2.51×10^{-9}
4	Station blackout (more than 8 hr) with RCIC failure	1.00×10^{-10}	1.18×10^{-7}	0	5.25×10^{-9}	7.39×10^{-3}	4.11×10^{-7}	1.82×10^{-9}
5	Transients followed by failure of high pressure coolant makeup water, successful depressurization of reactor, failure of low-pressure coolant makeup water	1.00×10^{-10}	4.88×10^{-8}	0	2.00×10^{-9}	$6.4\ 1x\ 10^{-3}$	1.12×10^{-7}	6.03×10^{-10}

Table 5-13. (contd)

	Release Category Description (Accident Class)	Core Damage Frequency (Ryr^{-1})	Population Dose (person-Sv Ryr^{-1})[a]	Fatalities (Ryr^{-1})		Cost[d] ($ Ryr^{-1})	Land Requiring Decontamination[e] (ha Ryr^{-1})	Population Dose from Water Ingestion (person-Sv Ryr^{-1})[a]
				Early[b]	Latent[c]			
6	Transient, loss-of-coolant accident (LOCA), and anticipated transient without scram (ATWS) events with successful coolant makeup water, but potential prior failure of containment	1.00×10^{-10}	5.72×10^{-7}	0	2.61×10^{-8}	1.53×10^{-1}	1.06×10^{-5}	8.77×10^{-8}
7	Small/medium LOCA followed by failure of high-pressure coolant makeup water and failure to depressurize	3.91×10^{-10}	2.56×10^{-6}	0	1.15×10^{-7}	6.62×10^{-1}	4.34×10^{-5}	4.42×10^{-7}
8	LOCA followed by failure of high-pressure coolant makeup water	4.05×10^{-10}	4.24×10^{-6}	9.46×10^{-13}	1.93×10^{-7}	$1.10 \times 10^{+0}$	5.24×10^{-5}	1.08×10^{-6}
9	ATWS followed by boron injection failure and successful high-pressure coolant makeup water	1.70×10^{-10}	2.29×10^{-6}	5.91×10^{-14}	1.13×10^{-7}	5.15×10^{-1}	2.18×10^{-5}	7.28×10^{-7}
Total		**1.56×10^{-7}**	**2.08×10^{-5}**	**1.00×10^{-12}**	**9.45×10^{-7}**	**$2.49 \times 10^{+0}$**	**1.31×10^{-4}**	**2.39×10^{-6}**

(a) To convert person-Sv to person-rem, multiply by 100.
(b) Early fatalities are fatalities related to high doses or dose rates that generally can be expected to occur within a year of the exposure (Jow et al. 1990).
(c) Latent fatalities are fatalities related to low doses or dose rates that could occur after a latent period of several (2 to 15) years.
(d) Cost risk includes costs associated with short-term relocation of people, decontamination, interdiction, and condemnation. It does not include costs associated with health effects (Jow et al. 1990).
(e) Land risk is farm land requiring decontamination prior to resumption of agricultural usage. To convert hectares (ha) to acres, multiply by 2.47.

Table 5-14. Mean Environmental Risk from the Surrogate AP1000 Severe Accidents at the Grand Gulf Early Site Permit Site

Release Category Description (Accident Class)		Core Damage Frequency (Ryr^{-1})	Environmental Risk					
			Population Dose (person-Sv Ryr^{-1})[a]	Fatalities (Ryr^{-1})		Cost[d] ($ Ryr^{-1})	Land Requiring Decontamination[e] (ha Ryr^{-1})	Population Dose from Water Ingestion (person-Sv Ryr^{-1})[a]
				Early[b]	Latent[c]			
CFI	Intermediate containment failure, after core relocation but before 24 hr	1.89×10^{-10}	7.49×10^{-7}	0	3.73×10^{-7}	1.27×10^{-1}	1.03×10^{-5}	8.18×10^{-8}
CFE	Early containment failure, after onset of core damage but before core relocation	7.47×10^{-9}	3.07×10^{-5}	0	1.46×10^{-6}	$5.81 \times 10^{+0}$	3.75×10^{-4}	6.08×10^{-6}
IC	Intact containment	2.21×10^{-7}	7.98×10^{-6}	0	3.98×10^{-7}	3.66×10^{-2}	2.48×10^{-6}	7.55×10^{-8}
BP	Containment bypass, fission products released directly to environment	1.05×10^{-8}	9.91×10^{-5}	0	4.72×10^{-6}	$1.93 \times 10^{+1}$	1.08×10^{-3}	3.86×10^{-5}
CI	Containment isolation failure occurs prior to onset of core damage	1.33×10^{-9}	4.90×10^{-6}	0	2.63×10^{-7}	8.66×10^{-1}	5.51×10^{-5}	8.47×10^{-7}
CFL	Late containment failure occurring after 24 hr	3.45×10^{-13}	1.83×10^{-9}	0	8.21×10^{-11}	3.81×10^{-4}	3.07×10^{-8}	1.69×10^{-11}
Total		**2.40×10^{-7}**	**1.43×10^{-4}**	**$<1.00 \times 10^{-12}$**	**6.87×10^{-6}**	**$2.61 \times 10^{+1}$**	**1.53×10^{-3}**	**4.57×10^{-5}**

(a) To convert person-Sv to person-rem, multiply by 100.
(b) Early fatalities are fatalities related to high doses or dose rates that generally can be expected to occur within a year of the exposure (Jow et al. 1990).
(c) Latent fatalities are fatalities related to low doses or dose rates that could occur after a latent period of several (2 to 15) years.
(d) Cost risk includes costs associated with short-term relocation of people, decontamination, interdiction, and condemnation. It does not include costs associated with health effects (Jow et al. 1990).
(e) Land risk is farm land requiring decontamination prior to resumption of agricultural usage. To convert hectares (ha) to acres, multiply by 2.47.

Table 5-15. Comparison of Environmental Risk for an Advanced Boiling Water Reactor or a Surrogate AP1000 at the Grand Gulf Early Site Permit Site with Risk for Five Sites Evaluated in NUREG-1150

Reactor Site	Core Damage Frequency (Ryr^{-1})	50-mi (80-km) Population Dose Risk (person-Sv Ryr^{-1})[a]	Fatalities (Ryr^{-1})		Average Individual Fatality Risk (Ryr^{-1})	
			Early	Latent	Early	Latent Cancer
Grand Gulf[b]	4.0×10^{-6}	5×10^{-1}	8×10^{-9}	9×10^{-4}	3×10^{-11}	3×10^{-10}
Peach Bottom[b]	4.5×10^{-6}	$7 \times 10^{+0}$	2×10^{-8}	5×10^{-3}	5×10^{-11}	4×10^{-10}
Sequoyah[b]	5.7×10^{-5}	$1 \times 10^{+1}$	3×10^{-5}	1×10^{-2}	1×10^{-8}	1×10^{-8}
Surry[b]	4.0×10^{-5}	$5 \times 10^{+0}$	2×10^{-6}	5×10^{-3}	2×10^{-8}	2×10^{-9}
Zion[b]	3.4×10^{-4}	$5 \times 10^{+1}$	1×10^{-4}	2×10^{-2}	9×10^{-9}	8×10^{-9}
ABWR[c]	1.6×10^{-7}	2×10^{-5}	1×10^{-12}	9×10^{-7}	2×10^{-14}	3×10^{-12}
AP1000[c]	2.4×10^{-7}	1×10^{-4}	$<1 \times 10^{-12}$	7×10^{-6}	$< 1 \times 10^{-14}$	2×10^{-11}

(a) To convert person-Sv to person-rem, multiply by 100.
(b) Risks were calculated using the MACCS code and presented in NUREG-1150 (NRC 1990).
(c) Calculated with MACCS2 code using Grand Gulf site-specific input.

Table 5-16. Comparison of Environmental Risk from Severe Accidents Initiated by Internal Events for an Advanced Boiling Water Reactor and a Surrogate AP1000 at the Grand Gulf Early Site Permit Site with Risks for Current Reactors

Reactor Site	Core Damage Frequency (yr^{-1})	50-mi (80-km) Population Dose Risk (person-Sv Ryr^{-1})[a]
Current Reactor Maximum[b]	2.4×10^{-4}	6.9×10^{-1}
Current Reactor Mean[b]	3.6×10^{-5}	1.5×10^{-1}
Current Reactor Median[b]	2.8×10^{-5}	1.4×10^{-1}
Current Reactor Minimum[b]	1.9×10^{-6}	5.5×10^{-3}
ABWR[c]	1.6×10^{-7}	2.1×10^{-5}
AP1000[c]	2.4×10^{-7}	1.4×10^{-4}

(a) To convert person-Sv to person-rem, multiply by 100.
(b) Based on MACCS and MACCS2 calculations for current plants undergoing operating license renewal.
(c) Calculated with MACCS2 code using Grand Gulf site-specific input.

average individual early fatality and cancer fatality risks from reactor accidents in the safety goal policy statement (51 FR 30028). The policy statement expressed the Commission's policy regarding the acceptance level of radiological risk from nuclear power plant operation as follows:

- Individual members of the public should be provided a level of protection from the consequences of nuclear power plant operation such that individuals bear no significant additional risk to life and health.

- Societal risks to life and health from nuclear power plant operation should be comparable to or less than the risks of generating electricity by viable competing technologies and should not be a significant addition to other societal risks.

The following quantitative health objectives are used in determining achievement of the safety goals:

- The risk to an average individual in the vicinity of a nuclear power plant of prompt fatalities that might result from reactor accidents should not exceed one-tenth of 1 percent (0.1 percent) of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population are generally exposed.

- The risk to the population in the area near a nuclear power plant of cancer fatalities that might result from nuclear power plant operation should not exceed one-tenth of 1 percent (0.1 percent) of the sum of cancer fatality risks resulting from all other causes.

These quantitative health objectives are translated into two numerical objectives as follows:

- The individual risk of a prompt fatality from all "other accidents to which members of the U.S. population are generally exposed," such as fatal automobile accidents, is about 5×10^{-4} per year. One-tenth of one percent of this figure implies that the individual risk of prompt fatality from a reactor accident should be less than 5×10^{-7} per reactor year.

- "The sum of cancer fatality risks resulting from all other causes" for an individual is taken to be the cancer fatality rate in the United States, which is about 1 in 500 or 2×10^{-3} per year. One-tenth of 1 percent of this implies that the risk of cancer to the population in the area near a nuclear power plant because of its operation should be limited to 2×10^{-6} per reactor year.

MACCS2 calculates average individual early and latent cancer fatality risks. The average individual early fatality risk is calculated using the population distribution within 1.6 km (1 mi) of the plant boundary. The average individual latent cancer fatality risk is calculated using the population distribution within 16 km (10 mi) of the plant. For the plants considered in NUREG-1150, these risks were well below the Commission's safety goals. Risks calculated for the ABWR and surrogate AP1000 designs at the Grand Gulf ESP site are lower than the risks associated with the current-generation reactors considered in NUREG-1150, and are well below the Commission's safety goals.

The staff compared the core damage frequencies and population dose risk estimates for the ABWR and surrogate AP1000 reactors at the Grand Gulf ESP site with statistics summarizing the results of contemporary severe accident analyses performed for 28 current-generation operating reactors at 23 sites. The results of these analyses are included in the final site-specific Supplements 1 through 20 to the GEIS (NRC 1996), and in the environmental reports included with license renewal applications for those plants for which supplements to the GEIS have not been published. All of the analyses were completed after publication of NUREG-1150, and 23 of the analyses used MACCS2, which was released in 1997. Table 5-16 shows that the core damage frequencies estimated for the ABWR and surrogate AP1000 reactors are significantly lower than those of current-generation reactors. Similarly, the population doses estimated for the advanced reactors at the Grand Gulf ESP site are well below the mean and median values for current generation reactors undergoing license renewal.

The population dose estimates and risks for the Grand Gulf ESP site in Tables 5-13 through 5-16 are based on the 2002 population for the region. Growth estimates in the environmental

report indicate that the population in the region is expected to grow by a factor of 1.18 from 2002 to 2070 (SERI 2005a). The population risks for the ESP site may be multiplied by this factor to account for population growth. Even with this increase, the risks associated with either the ABWR or surrogate AP1000 reactors are low.

The staff compared the risk estimates given in Tables 5-13 and 5-14, the air pathway risks in Tables 5-15 and 5-16, and the average individual early fatality and average individual latent cancer fatality risks in Table 5-15 with the Commission's safety goals. Preliminary information on the IRIS and the ACR-700 reactor designs indicates that the surrogate AP1000 will likely bound the risk for these advanced reactor designs. Similarly, the ESBWR risk is expected to be bounded by the risk for the ABWR. Based on these comparisons, the staff concludes that the impacts for the proposed Grand Gulf ESP site for the air pathway releases for severe accidents would be small for operation of advanced LWRs.

For the evaluation in this EIS to bound a non-LWR reactor design selected at the CP or COL stage, an applicant referencing the Grand Gulf ESP would need to demonstrate that the environmental impacts of the air pathway releases for severe accidents at the Grand Gulf ESP site remain bounded by the environmental impacts from the surrogate designs.

5.10.2.2 Surface Water Pathways

Surface water pathways are an extension of the air pathway. These pathways cover the effects of radioactive material deposited on open bodies of water. The surface water pathways of interest include exposure to external radiation from submersion in water and activities near the water, ingestion of water, and ingestion of fish and other aquatic creatures. Of these pathways, the MACCS2 code only evaluates the ingestion of contaminated water. The risks associated with this surface water pathway calculated for the Grand Gulf ESP site are included in the last columns of Tables 5-13 and 5-14.

For each accident class, the population dose risk from ingestion of water is a small fraction of the dose risk from the air pathway. These dose estimates are conservative because there are no known downstream intakes within 160 km (100 mi) of the Grand Gulf ESP site that use the Mississippi River as a potable water supply. None of the public water supply systems in Mississippi that use surface water as a source are within 80 km (50 mi) of the ESP site (SERI 2005a), and there are only five public water supply systems in Louisiana within 80 km (50 mi) of the site that use surface water as a source (LDEQ 2001). Four of these withdraw water from Lake Bruin, which is about 13 km (8 mi) west-southwest of the site. The other water supply system that uses surface water is about 64 km (40 mi) to the south-southwest.

The Mississippi River is used for recreational activities including swimming and fishing. Doses from these surface water pathways are not modeled in MACCS or MACCS2. The GEIS (NRC 1996) considered typical population exposure risk for the aquatic food pathway for plants

located on large rivers. For plants on large rivers, the population dose from the food pathway was well below the population dose from the air pathway. The proposed Grand Gulf ESP site is classified as being on a large river. Analysis of water-related exposure pathways at the Fermi reactor (NRC 1981b) suggests that population exposures from swimming are significantly lower than exposures from the aquatic ingestion pathway.

After considering the water ingestion dose estimates and the GEIS (NRC 1996), the staff concludes that the impacts for the proposed Grand Gulf ESP site from surface water pathway releases for severe accidents are small for operation of ABWR and surrogate AP1000 reactors.

In a similar fashion to the air pathway, the environmental impacts of the surface water pathways for other advanced LWRs are expected to be bounded by the ABWR and the surrogate AP1000. For the evaluation in this EIS to bound a non-LWR reactor design selected at the CP or COL stage, an applicant referencing the Grand Gulf ESP would need to demonstrate that the environmental impacts of the surface water pathway releases for severe accidents at the Grand Gulf ESP site remain bounded by the environmental impacts from the surrogate designs.

5.10.2.3 Groundwater Pathway

Neither MACCS nor MACCS2 evaluates the environmental risks associated with severe accident releases of radioactive material to groundwater. However, this pathway has been addressed in the GEIS in the context of renewal of operating licenses for the current generation reactors (NRC 1996). The GEIS assumes a 1×10^{-4} Ryr^{-1} probability of occurrence of a severe accident with a basemat melt-through leading to potential groundwater contamination, and the staff concluded that groundwater generally contributed a small fraction of the risk attributable to the atmospheric pathway. Although the staff assumed that the probability of occurrence of a release via the groundwater pathway is significantly larger than a release via the atmospheric pathway for either the ABWR or the surrogate AP1000, the groundwater pathway is more tortuous and affords a greater time for implementing protective actions and, therefore, results in a lower risk to the public. As a result, the staff concludes that the risks associated with releases to groundwater are small for the proposed Grand Gulf ESP site.

5.10.2.4 Summary of Severe Accident Impacts

Although SERI chose the PPE approach in the overall ESP application, it based its evaluation of the environmental impact of severe accidents on characteristics of the ABWR and the surrogate AP1000 reactor designs (SERI 2005a). The NRC staff reviewed the analysis in the environmental report and conducted its own confirmatory analysis using the MACCS2 code. The results of both the SERI analysis and the NRC analysis indicate that the environmental risks associated with severe accidents if an advanced LWR were to be located at the Grand Gulf ESP site would be small compared to risks associated with operation of current-generation reactors at the Grand Gulf site and other sites. These risks are well below the Commission's

safety goals. On these bases, the staff concludes that the probability weighted consequences of severe accidents at the Grand Gulf ESP site are of SMALL significance for an advanced LWR. The environmental impacts of severe accidents for designs not evaluated in this EIS, including gas-cooled designs, are not resolved because necessary design information is lacking. Consequently, these impacts would need to be evaluated at the CP or COL stage. For the evaluation in this EIS to bound an LWR reactor design selected at the CP or COL stage, the staff would need to verify that the environmental impacts of severe accidents at the Grand Gulf ESP site remain bounded by the environmental impacts discussed herein.

5.10.3 Summary of Postulated Accident Impacts

The staff evaluated the environmental impacts from DBAs and severe accidents using the ABWR and the surrogate AP1000 to characterize the environmental impacts from advanced LWRs. As described previously, preliminary information on the IRIS and the ACR-700 reactor designs indicates that the surrogate AP1000 would likely bound the source terms for the design basis and severe accidents. Consequently, the staff considers it likely that doses from surrogate AP1000 DBAs would bound the doses from DBAs for the IRIS and ACR-700 designs, and that the probability weighted consequences of severe accidents for the surrogate AP1000 would bound the probability weighted consequences for IRIS and ACR-700 severe accidents. Similarly, the accident source terms, DBA doses, and probability weighted consequences of severe accidents for an ESBWR are expected to be bounded by those for an ABWR.

Based on the information provided by SERI and the NRC staff's independent review, the staff concludes that the potential environmental impacts from a postulated accident from the operation of one or more additional nuclear power units would be SMALL for the operation of advanced LWRs. The staff did not explicitly evaluate the design basis or severe accident impacts for gas-cooled reactors because of the lack of necessary design information. Consequently, the impacts involving gas-cooled reactor designs are not resolved.

5.11 Measures and Controls to Limit Adverse Impacts During Operation

The following general measures and controls on which the staff relied in their evaluation of environmental impact during operation of the proposed new unit or units at the Grand Gulf ESP

site include those for which SERI would be required by applicable permits (Federal, State, and local) and authorizations as well as the feasible measures and controls contained in Table 5.10-1 of the environmental report (SERI 2005a):

- Compliance with the applicable Federal, State, and local laws, ordinances, and regulations that prevent or minimize adverse environmental impact (for example, solid waste management, erosion and sediment control, air emission control, noise control, storm water management, spill response and cleanup, hazardous material management)

- Compliance with applicable requirements of permits and licenses required for operation (for example, NPDES permit and operating license).

Some of these permits or approvals include:

- Compliance with NPDES permit requirements imposed on water discharges from the new unit(s) (environmental report, Section 5.2)

- Compliance with MDEQ permit limits and regulations for installing and operating air emission sources (environmental report, Section 5.3)

- Compliance with SERI and Entergy procedures applicable to environmental control and management.

SERI specifically identified the following general plans or specific mitigation measures in its environmental report on which the staff relied in its evaluation:

- Incorporating drift eliminators into design of cooling towers to minimize potential for salt deposition (environmental report, Sections 5.1.1, 5.3.3)

- Maintaining natural drainage patterns as much as practicable (environmental report, Section 5.2.1)

- Maintaining sedimentation basins to minimize sedimentation to Hamilton Lake (environmental report, Sections 5.2.1, 5.2.2)

- Disposing dredge spoils as required by ACE and MDEQ (environmental report, Section 5.2.2)

- Designing intake pipes/screens to minimize potential for impingement and entrainment (environmental report, Section 5.3.1)

- Maintaining/restoring bank stabilization following any construction on the river shore (environmental report, Section 5.3.2)

- Using proven industrial hygiene principles to reduce worker exposure to microorganisms (environmental report, Section 5.3.4)

- Treating effluents containing biocides or other chemicals prior to discharge, in compliance with NPDES permit requirements. Onsite sanitary waste treatment would include tertiary treatment. SERI would also develop and implement a Storm Water Pollution Prevention Plan to manage runoff (environmental report, Section 5.5.1)

- Collecting and storing chemical wastes and waste petroleum products; disposing or recycling offsite at licensed facilities (environmental report, Section 5.5.1)

- Developing and implementing ALARA requirements to mitigate occupational exposures to radioactive and mixed wastes (environmental report, Section 5.5.2)

- Instituting flexible work hours and additional road improvements, such as traffic lights or turn lanes, as needed to mitigate effects on local traffic (environmental report, Section 5.8.2)

- Increasing revenue to Claiborne County and the town of Port Gibson to support emergency services (environmental report, Section 5.8.2).

SERI evaluated the measures and controls shown in Table 5.10-1 of its environmental report (SERI 2005a) and considered them feasible from both a technical and economic standpoint. In addition, SERI expects that these measures and controls would be adequate for avoiding or mitigating potential adverse impact associated with operation of the new unit(s). The staff considered these measures and controls in its evaluation of station operation impact.

5.12 Summary of Operational Impacts

Table 5-17 shows impact level categories as SMALL, MODERATE, or LARGE as a measure of their expected adverse impacts, if any. A brief statement in the “comments” column explains the basis for the impact level. Some impacts, such as the addition of tax revenue for the local economies, are likely to be beneficial. The beneficial aspect is also reflected in the “comments” column. Impacts related to water use and water quality were estimated for the purposes of comparison to alternatives, but are not resolved because significant information on the proposed action is lacking at the ESP stage. Other issues (effects of EMF, accident impacts for other-than-LWR designs) are not resolved, because of the lack of information on source terms

or impacts. An applicant for a CP or COL that references the Grand Gulf ESP would need to provide this information to enable analysis at that time.

Table 5-17. Characterization of Operational Impacts at the Grand Gulf Early Site Permit Site

Category	Comments	Impact Level
Land-use impacts		–
Site and vicinity	Operation of new unit(s) within existing site. Minimal impacts from cooling tower drift.	SMALL
Transmission line rights-of-way and offsite areas	Upgrade of existing transmission line rights-of-way would be needed.	SMALL
Air quality impacts	Air quality impacts would be small because the emission sources would be operated intermittently and emissions would be within Federal, State, and local air quality limits.	SMALL
Water-related impacts		–
Hydrological alterations	No significant changes in surface hydrology would result from plant operation.	SMALL
Water use	Water use from the Mississippi River would be a small fraction of even the lowest flows.	Unresolved, likely to be SMALL
Water quality	Impact on water quality would be small and would be regulated by the Mississippi Department of Environmental Quality.	Unresolved, likely to be SMALL
Ecological impacts		–
Terrestrial ecosystems	No detectable impacts are expected.	SMALL
Aquatic ecosystems	Impact would be minimal because of the use of cooling towers.	SMALL
Threatened and endangered species	No impacts on Federally or State-listed species are likely to be detectable.	SMALL
Socioeconomic impacts		–
Physical impacts		SMALL
Workers/public	Workers would use protective equipment and receive training to mitigate any possible impact. The Grand Gulf location is relatively remote, so the public would not be affected.	–
Buildings	No impacts on onsite or offsite buildings.	–
Roads	Upgrades before or during construction would cover the lesser impact of operational workforces.	–
Aesthetics	Visual impacts would be minimal because of the remote location.	–

Table 5-17. (contd)

Category	Comments	Impact Level
Socioeconomic impacts (contd)		–
Demography	Number of new employees would be small in proportion to population base in the region. If in-migrating population settles according to current patterns for Grand Gulf Unit 1, the impact on Port Gibson could be moderate to large.	LARGE
Social and economic		LARGE Beneficial
Economy	Increased jobs would benefit the area economically, up to a moderate beneficial impact (Warren County) is possible.	–
Taxes	Degree of impact depends on distribution of revenues to county or state; generally impact is beneficial, especially for property taxes. Under current tax law, beneficial impact of additional taxes would be large for Claiborne County.	–
Infrastructure and community services		MODERATE
Transportation	Improvements made for construction would be sufficient to cover any adverse impact from additional operational workers.	–
Recreation	Overall impacts on recreation would be minimal because of the remote location and fact that the proposed ESP facility would be operating in an area with an existing nuclear power facility.	–
Housing	Adequate housing is available in the region to handle operational workers.	–
Public services	Adequate in region for any population increase resulting from operation workforce. Claiborne County may be more affected by demands on police, fire, and medical resources.	–
Education	Current schools and planned additions would handle additional students. Claiborne County could be more affected if worker distribution is similar to that for existing Grand Gulf Unit 1.	–
Historic and cultural resources	A cultural resource procedure would be implemented for minimizing impacts from routine land disturbances.	SMALL

Table 5-17. (contd)

Category	Comments	Impact Level
Environmental justice	Physical impacts would be small. Economic impacts would be large beneficial under existing tax law.	LARGE Beneficial
Nonradiological health impacts	Health impacts would be monitored and controlled in accordance with Occupational Safety and Health Administration regulations.	SMALL, Unresolved for EMF
Radiological health impacts	Doses to public and occupational workers would be monitored and controlled in accordance with NRC limits.	SMALL
Impacts of postulated accidents		–
Design basis accidents (DBAs)	Doses for advanced LWRs are expected to be a small fraction of the regulatory dose limits. CP or COL applicant would demonstrate that doses for postulated DBAs on chosen gas-cooled reactor designs are within regulatory limits.	SMALL for LWR, Unresolved for gas-cooled designs
Severe accidents	Risks for advanced LWRs would be small. If a gas-cooled reactor is selected at the CP or COL stage, then applicant would analyze the severe accident impact for gas-cooled reactors.	SMALL for LWR, Unresolved for gas-cooled designs

5.13 References

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