CHAPTER 5

ENVIRONMENTAL IMPACTS OF STATION OPERATION

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5.0 ENVIRONMENTAL IMPACTS OF STATION OPERATION

Chapter 5 presents the potential environmental impacts of operation of the Bellefonte Nuclear Plant, Units 3 and 4 (BLN). In accordance with 10 CFR Part 51, impacts are analyzed and a single significance level of potential impact to each resource (i.e., SMALL, MODERATE, or LARGE) is assigned, consistent with the criteria that the Nuclear Regulatory Commission established in 10 CFR Part 51, Appendix B, Table B-1, Footnote 3. Unless the significance level is identified as beneficial, the impact is adverse, or in the case of "small," may be negligible. The definitions of significance are as follows:

SMALL - Environmental effects are not detectable or are so minor that they neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered small.

MODERATE - Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

LARGE - Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

This chapter is divided into 10 sections:

- Land-Use Impacts (Section 5.1).
- Water-Related Impacts (Section 5.2).
- Cooling System Impacts (Section 5.3).
- Radiological Impacts of Normal Operation (Section 5.4).
- Environmental Impacts of Waste (Section 5.5).
- Transmission System Impacts (Section 5.6).
- Uranium Fuel Cycle Impacts (Section 5.7).
- Socioeconomics Impacts (Section 5.8).
- Decommissioning (Section 5.9).
- Measures and Controls to Limit Adverse Impacts During Operation (Section 5.10).

These sections present potential ways to avoid, minimize, or mitigate adverse impacts of plant operation to the extent practical. For the purpose of this ER, the site vicinity, and region are defined in Section 2.0.

5.1 LAND-USE IMPACTS

This section describes the potential impacts of operating the Bellefonte Nuclear Plant, Units 3 and 4 (BLN). Subsection 5.1.1 describes impacts to the site and vicinity. Subsection 5.1.2 describes impacts that could occur along transmission lines and in off-site areas resulting from operation and maintenance activities. Subsection 5.1.3 describes potential impacts on historic properties in the site and vicinity, along transmission corridors, and at off-site areas.

5.1.1 THE SITE AND VICINITY

Adverse impacts to the BLN site and vicinity occur primarily during construction of the BLN, as documented in Section 4.1. It is anticipated that BLN operation has SMALL impacts on land use within the site boundary and in the vicinity of the BLN site.

5.1.1.1 The Site

Land use within and adjacent to the existing BLN site is discussed in Subsection 2.2.1 and Table 2.2-1. Figure 2.2-1 illustrates land use within the site. No new areas are expected to be disturbed after the construction phase ends, and no agricultural crop production is expected to occur on the BLN site. Therefore, operations at the BLN site are expected to have SMALL impacts on the pasture and developed land located within the site boundary.

As discussed in Subsection 2.2.1, 0.9 ac. of prime farmland are located within the BLN site plot plan but outside areas of previous construction. The prime farmland is currently forested and is located adjacent to the areas previously disturbed for commercial purposes. This small area of prime farmland is expected to be disturbed during construction of BLN and is discussed in Subsection 4.1.1. No new impacts on land use within the site are anticipated from the operation of the BLN.

Geologic features within the BLN site are discussed in Section 2.6.

Heat dissipation to the atmosphere from operation of the BLN cooling towers and the effects of the cooling tower plumes and drift are discussed in Subsection 5.3.3. The impacts of the cooling tower plumes, regarding salts, fogging, and icing on the BLN site, are also discussed in Subsection 5.3.3.2.

No land used for agricultural purposes exists within the BLN site. Therefore, operations at the BLN site are considered SMALL impacts on land use located within the site boundary.

5.1.1.2 The Vicinity

Land use within the vicinity of the BLN site is discussed in Subsection 2.2.1. Figure 2.2-2 illustrates land use within the vicinity. No new land is expected to be disturbed after the construction phase, and operational land-use impacts are confined to the BLN site. Therefore, operations at the BLN site are expected to have a SMALL impact on the developed and rural farmland in the vicinity of the site.

Geologic features in the vicinity of the BLN site are discussed in Section 2.6.

The location of roads and bridges within the vicinity of the BLN site is discussed in Subsection 2.5.2 and are shown on Figure 2.5-5. Housing is discussed in Subsection 2.5.2.6 and housing impacts related to plant operation are discussed in Subsection 5.8.2.3.2. Land-use impacts associated with plant operation that may have social and economical effects in the region are discussed in Section 5.8. The effects of the cooling tower plumes and drift associated with Units 3 and 4 in the vicinity of the BLN site are discussed in Subsection 5.3.3.1.3.

Units 3 and 4 generate waste that requires disposal in permitted facilities and landfills. Further discussion of radioactive waste disposal and non-radioactive wastes is contained in Sections 3.5 and 3.6. Impacts of radioactive waste disposal and non-radioactive wastes are discussed in Section 5.5. Because there is waste-minimization plan in place, there is a minimal amount of waste generated; therefore, the impacts to off-site land use due to disposal of wastes generated at BLN are considered SMALL and do not warrant mitigation.

5.1.2 TRANSMISSION CORRIDORS AND OFF-SITE AREAS

A description of the existing transmission corridors associated with the BLN site is provided in Section 3.7 and Subsection 2.2.2. No new transmission lines or off-site areas are planned. Land use within and adjacent to the existing BLN transmission corridors is discussed in Subsection 2.2.1 and 3.7.2. Figure 2.2-2 depicts land use within the site and the vicinity. Land use within the transmission corridors is shown in Figure 4.1-2.

Transmission lines off-site cross U.S. Highway 72, State Highway 117 and 275 and Norfolk Southern Railroad line. Although the transmission lines and corridors already exist, the impact to utility and road right-of-ways is considered SMALL.

Subsection 2.4.1 describes the vegetative cover within the existing transmission corridors associated with the BLN site, which is identified as an early successional stage, scrub-shrub. Although the transmission corridors already exist, impacts are anticipated from routine maintenance of the transmission corridors, including vegetation control such as mowing and access road maintenance per policy and procedure, and from operation (e.g., transmission system noise, electrical interface effects, and access road traffic). Such activities are not expected to result in land-use restrictions or changes. Therefore, impacts on land use associated with operation and maintenance of the transmission corridors and off-site areas are considered SMALL.

5.1.3 HISTORIC PROPERTIES

This subsection focuses on the effects of BLN operations on existing historic properties on the BLN site and within a 10-mi. radius of its center point. Aboveground historic properties and archaeological sites are among the entities that can be considered for listing on the National Register of Historic Places (NRHP). They are the principal historic properties of concern with regard to effects from operations at BLN, along with traditional cultural properties (TCPs) and cemeteries (also considered aboveground resources). For definitions of the terms historic properties, site integrity, and significance in relation to eligibility for the NRHP, and related concerns about effects, see Subsection 4.1.3. For the site numbers, locations, and NRHP status of relevant historic properties, see Subsection 2.5.3, Tables 2.5-19 and 2.5-20, and Figures 2.5-7 and 2.5-8.

5.1.3.1 Site and Vicinity

Direct effects from BLN site operations on existing historic properties are possible only within the archaeological area of potential effect (APE) for the BLN site. The archaeological APE was recommended by the Tennessee Valley Authority (TVA) in agreement with the Alabama SHPO and in consideration of BLN site construction and operations plans. It includes 606 ac. (see Figure 2.5-7). The archaeological APE lies entirely within the BLN site vicinity, located in U.S. Public Land Survey System Township 04S, Range 07E, Sections 5, 6, 7, 8, 12, and 18, of Jackson County, Alabama, with the majority of the area situated in Section 7. Indirect (noise-related and visual) effects from BLN site operations are possible on the BLN site or potentially within a 10-mi. radius of its center point (see Figure 2.5-18). The 10-mi. radius extends through portions of Jackson County, Alabama, and also includes a small area of DeKalb County, Alabama.

5.1.3.1.1 Prehistoric Archaeological Sites

For a detailed discussion of previous cultural resource surveys of the BLN site see Subsection 2.5.3.1 and for relevant prehistoric archaeological sites see Subsection 2.5.3.3. For a brief overview of prehistoric archaeological site assessments in relation to eligibility, planned site protection, and site integrity see Subsection 4.1.3.1.1. For a detailed discussion of the Alabama SHPO site determinations and preservation plans under the National Historic Preservation Act (NHPA) Section106 process review, see Subsection 4.1.3.1.1.

During the NHPA Section 106 process review, the Alabama SHPO concurred with the NRHP eligibility recommendations of the cultural resource survey and the TVA (see Subsection 4.1.3.1.1 and see Appendix A associated historic property consultation letters). As a result, one prehistoric site within the BLN site boundaries is considered potentially eligible for listing in the NRHP (1JA111). The SHPO agreed that the site must be protected by avoidance during BLN construction and operation. TVA subsequently drafted official correspondence (described initially in Subsection 2.5.3.2) assuring site protection and avoidance for site 1JA111. According to the letter, the protection measures are planned to include a 50-ft protective buffer established around the site with further protection by an obstructive barrier consisting of construction fencing or chain link fencing, and a sign posted informing personnel that an archaeological resource protected under the Archaeological Resource Protection Act is present (see Appendix A for this and other associated historic property consultation letters). These protections are planned to preclude operational impacts associated with the BLN site including operations associated with the nearby canal. Given the results of the NHPA Section 106 process consultation, it has been determined that BLN operations have no effects on this site. Furthermore, operations have no effects on any potentially eligible or eligible prehistoric archaeological sites within the BLN site APE. With regard to prehistoric sites located beyond the BLN site APE (but within 1 mi.) and the numerous prehistoric and multi-component archaeological sites within the 10-mi. radius, there are no effects from BLN site operations because operations are expected to be confined to the site, and because indirect (noise-related and visual) effects are extraneous considerations for archaeological sites. Therefore, the impacts of BLN site operations on prehistoric archaeological sites are considered SMALL. Mitigation is not warranted.

5.1.3.1.2 Historic Archaeological Sites

For a detailed discussion of previous cultural resource surveys of the BLN site see Subsection 2.5.3.1 and for relevant Historic Period archaeological sites see Subsection 2.5.3.4. For a brief overview of archaeological site assessments in relation to NRHP eligibility see Subsection 4.1.3.1.1.

One Historic Period site (1JA1103) was identified within the BLN site APE during the most recent cultural resource survey. During the NHPA Section 106 process review, the Alabama SHPO concurred with the recommendation that 1JA1103 was ineligible for inclusion in the NRHP. Sites determined to be ineligible for the NRHP do not require protection. Given the ineligible determination for site 1JA1103, no effects from BLN site operation are anticipated for eligible or potentially eligible Historic Period archaeological sites within the BLN site APE. Because 1JA1103 is the only Historic Period site within the BLN site APE and because indirect (noise-related or visual) effects are extraneous considerations for archaeological sites, no BLN site operation effects on Historic Period archaeological sites are anticipated. Therefore, operation impacts on Historic Period archaeological sites on the BLN site, in its vicinity, and within a 10-mi. radius of it are considered SMALL. No mitigation is warranted.

5.1.3.1.3 Historic Sites

This subsection refers to historic sites defined as aboveground historic properties. The NRHP eligibility requirements for such properties are discussed in Subsection 4.1.3, and detailed descriptions are provided in Subsection 2.5.3.5. No aboveground historic properties with intact standing structures were identified on the BLN site during any previous survey. Furthermore, the BLN railroad spur is not itself part of a historic site or district. Therefore, the BLN site has no aboveground historic properties that are potentially eligible for listing, eligible for listing, or listed on the NRHP. However, in Jackson County, within a 10-mi. radius of the BLN site center point; there are several aboveground historic properties. These properties are presented in Tables 2.5-19 and 2.5-20, and their locations are depicted in Figure 2.5-8. Because no historic sites exist within the BLN site APE, BLN site operations have no direct effects on historic sites. Unlike archaeological resources, indirect (noise-related or visual) effects are an intrinsic consideration in regard to the potential adverse effects of construction and operations on aboveground historic properties. However, none of the aboveground historic properties currently listed on the NRHP exist within a 1-mi. radius of the BLN site center point; the closest such property (the Townsend Farmhouse) is within approximately 5 mi., and the second closest (College Hill Historic District) is within approximately 6 mi. Both have intervening topographic formations that obscure visual and noise effects. These distances are beyond any noise-effect considerations for BLN site operations, as addressed in Subsection 2.5.5, and the BLN site is obscured from the viewshed of the historic properties currently listed on the NRHP within the 10- mi. radius of the BLN site center point. Four additional NRHP-eligible aboveground properties exist beyond the 606-ac. APE for the BLN site: two properties (Bellefonte Cemetery and African-American Bellefonte Cemetery) are located within the 1-mi. radius and two (Carter-Hansbrough Cemetery and Old Snodgrass Place) are located just beyond the 1-mi. radius of the extant BLN site cooling towers (Reference 2). These properties are currently pending NRHP listing. Although these properties have been determined eligible for the NRHP, it has also been determined by the same cultural resource survey, survey report, and TVA and SHPO consultation (References 3 and 4), that those resources will receive no adverse impacts from

BLN site operation. Therefore, BLN site operations have no effects on historic sites. The impacts of BLN site operations on aboveground historic sites are considered SMALL, and mitigation is not warranted.

5.1.3.1.4 Historic Cemeteries

No extant Euroamerican cemeteries have been identified within the TVA-recommended APE at the BLN site. The closest Euroamerican cemeteries and the general types of cemeteries located within a 10-mi. radius of the BLN site center point are discussed in Subsections 2.5.3.6 and 4.1.3.1.4. Because the cemetery that is archaeological site 1JA348 has not been assessed for NRHP status, was not relocated (found) during the 2008 aboveground historic properties survey (Reference 2), and is considered a belowground archaeological site, potential indirect effects related to noise or visual aesthetics are unsupported. For those cemeteries determined not eligible for the NRHP, there can be no adverse impacts as the concept of adverse impacts is only applicable to NRHP-eligible sites. The remaining three cemeteries determined eligible for the NRHP (Reference 2) were also determined by that survey, survey report, and TVA and SHPO consultation (References 3 and 4) to have no anticipated adverse impacts from BLN site operations (Reference 2). Therefore, BLN site operations should have no effects on historic cemeteries. The impacts of BLN site operations on historic cemeteries are considered SMALL. Mitigation is not warranted.

5.1.3.1.5 Traditional Cultural Properties

No traditional cultural properties (TCPs) are located on the BLN site, in its vicinity, or within a 10-mi. radius from the site (see Subsection 2.5.3.7). Therefore, BLN operations have no effect on TCPs in these areas. Therefore, the impacts of BLN site operations on TCPs are considered SMALL. Mitigation is not warranted.

5.1.3.2 Transmission Corridor

No effects on historic properties along the extant transmission line that is to service the BLN site are anticipated; therefore, no further historic property considerations or assessments along the transmission line corridor are deemed necessary (see Appendix A for TVA correspondence on this issue). One aboveground historic property (the Townsend Farmhouse) is located within 1.2 mi. of the transmission line corridor and beyond that area already assessed for BLN site operations (the 606-ac. BLN site APE and within 1-mi. of the cooling towers). The Townsend Farmhouse is located within 4800 ft. of the existing transmission line; however, that transmission line was extant when the property was listed on the NRHP (August 11, 2005), so its effects have already been assessed in regard to site integrity. Therefore, the Townsend Farmhouse situation is consistent with the determination that BLN operations have no effects on historic properties along the extant transmission line. The impacts of BLN site operations on historic properties associated with transmission line corridors are considered SMALL, and mitigation is not warranted. TVA’s procedure for reviewing the operations and maintenance of transmission lines is called a Sensitive Area Review (SAR). Under this review procedure all transmission line corridors, where routine operation and maintenance occur, are reviewed by TVA Cultural Resource staff for the potential to effect historic properties on or eligible for the NRHP. The regulatory guidance for the Sensitive Area Review concerning cultural resources is the same guidance for all cultural resource assessments: 36 CFR 800 (Reference 1). At the time of review, TVA would determine the need for consultation with the State SHPO and if needed, define an APE with the State SHPO. That requirement would range from no investigations (area already surveyed) to resurvey (if past surveys were not deemed sufficient) to site avoidance, data recovery, or monitoring if a previously or newly identified cultural resource within the APE was determined eligible or potentially eligible for inclusion in the NRHP. As TVA has already determined that no further historic property considerations or assessments along the extant transmission line corridor are deemed necessary, it is expected that the impacts of transmission line maintenance on historic properties are considered SMALL. Mitigation is not warranted.

5.1.4 REFERENCES

1. 36 CFR 800, “Protection of Historic Properties.”

2. TRC, Inc., Historic Resource Survey for the Bellefonte Nuclear Site in Jackson County, Alabama, Final Report, June 2008.

3. Letter from Thomas O. Maher, Ph.D., Tennessee Valley Authority, to Stacye Hathorn, Alabama Historical Commission, "AHC 2006-1221; Bellefonte NuStart Energy Development; Nuclear Regulatory Commission Application; Jackson County, Alabama," dated May 9, 2008.

4. Letter from Elizabeth A. Brown, Deputy State Historic Preservation Officer, State of Alabama, Alabama Historical Commission, to Thomas O. Maher, Ph.D., Tennessee Valley Authority, "AHC 2006-1211; Bellefont Nustart Energy Development; Historic Resource Survey; Jackson County," dated June 10, 2008.

5.2 WATER-RELATED IMPACTS

This section provides information that describes the hydrological alterations, plant water supply, and water-related impacts of plant operations. Water-use impacts from plant operations are addressed in the following subsections:

- Hydrologic Alterations and Plant Water Supply (5.2.1).
- Water-Use Impacts (5.2.2).

Based upon an evaluation of present and future water use, water withdrawal and discharge from the BLN are considered to be of SMALL direct, indirect and cumulative impact and mitigation is not warranted.

5.2.1 HYDROLOGIC ALTERATIONS AND PLANT WATER SUPPLY

BLN operations that could cause hydrological alterations include water that is withdrawn from the Guntersville Reservoir (an impoundment of the Tennessee River) for circulating water cooling tower make-up. The circulating water systems for the BLN require makeup water to replace that which is lost to evaporation, drift, and blowdown. The rate of withdrawal of reservoir water to replace water losses from the circulating water system is 48,118 gallons per minute (gpm) for two-unit operations (See Figure 3.3-1). Water withdrawn from the Guntersville Reservoir is 1) discharged back to the reservoir as blowdown (water released to purge solids), 2) lost as evaporation, or 3) lost as drift (entrained in water vapor). Water returned to the Guntersville Reservoir as blowdown is not lost to downstream users or downstream aquatic communities. Evaporative losses are not replaced and are considered “consumptive” losses. Drift losses are very small compared to evaporative losses and, therefore, were not considered in the analysis.

Stormwater discharged from the site to Town Creek and the Guntersville Reservoir could also potentially cause hydraulic alterations. To limit the potential of stormwater impacting surface water bodies the site maintains a stormwater pollution prevention plan and a National Pollutant Discharge Elimination System (NPDES) permit.

5.2.1.1 Physical Characteristics of Surface Water and Groundwater

The BLN location is a peninsula located between the west bank of the Guntersville Reservoir and Town Creek Embayment, a backwater extension of the Guntersville Reservoir. The Guntersville Reservoir extends 76 mi. up the Tennessee River between the Nickajack and Guntersville dams. The Guntersville Reservoir has a drainage area of 24,450 sq. mi. The drainage area of Town Creek at the site is approximately 6 sq. mi. Surface water features and impoundments are discussed in detail in Subsection 2.3.1.

The regional aquifer systems in the area of the BLN are the aquifers of the Sequatchie Valley, part of the Valley and Ridge Aquifer system of Alabama, Georgia, and Tennessee. The principal water bearing unit in and near the plant area is the Mississippian age Knox Dolomite, approximately 1000 ft. below the ground surface. The physical characteristics of the groundwater aquifers are discussed more completely in Subsections 2.3.1 of the ER and 2.4.12 of the FSAR.

5.2.1.2 Water Sources

The water source to be used for the BLN site is the Guntersville Reservoir (an impoundment of the Tennessee River). The Tennessee River is a navigable river and as such a certain water depth must be maintained; therefore the Guntersville Reservoir is one of the most stable TVA reservoirs, fluctuating only two ft. between its normal minimum pool in the winter and maximum pool in the summer.

The estimated daily average flow rate of the Tennessee River (in the Guntersville Reservoir) at the BLN site is 38,850 cfs. The calculated 7Q10 flow is defined as the lowest average flow over a period of 7 consecutive days that occurs once every 10 years, on average. The conservative 7Q10 flow rate for the Tennessee River (in the Guntersville Reservoir) for the Nickajack Dam discharge was approximately 5130 cfs. Average flows were considerably less than historical averages (drought of record) in 1986 for the Tennessee River (in the Guntersville Reservoir) as shown on Table 2.3-7. Low lake levels are documented for the Guntersville Reservoir in the FSAR Subsection 2.4.11.3. Estimates of frequency and duration of water-supply shortages are presented in the FSAR Subsection 2.4.11. The data presented in Table 2.4.11-203 of the FSAR show that a shortage of water supply is not expected. Additional flow rates are discussed in Subsection 5.2.2.1.1. Further information regarding flow data in the Guntersville Reservoir can be found in Subsection 2.3.1.2.3.

Groundwater is not used for operation of the BLN site. The groundwater characteristics are further discussed in FSAR Subsection 2.4.12.

5.2.1.3 Plant Withdrawals and Returns

The estimated water withdrawal for the circulating water system during normal plant operations for both Units 3 and 4 from the Guntersville Reservoir is 48,118 gpm or 69 Mgd (Table 2.3-32, Figure 3.3-1). The water discharge rate from the circulating water system during normal operations for both Units 3 and 4 is estimated at 15,828 gpm or 23 Mgd (Table 2.3-33). A minor amount of treated water, approximately 450 gpm or 0.65 Mgd (Table 2.3-33) during normal plant operations for both Units 3 and 4, is discharged to the Town Creek embayment from the Waste Water Retention Basin (WWRB). Additional information about water withdrawal, consumption, and returns including operational and shutdown modes is presented in Section 3.4 and Table 3.4-2. Groundwater is not used for operation of the BLN site. Additional information related to the BLN water use and discharge is presented in Sections 3.3 and 3.4.

5.2.1.4 Present and Future Surface Water Uses Potentially Affecting Available Water Supply

Water from the Tennessee River is used for cooling thermoelectric power plants, industrial use, public supply and irrigation (Reference 8). Most of the water withdrawn from the Tennessee River Basin Watershed is returned to the river. The forecast of total water withdrawals from the Tennessee River are for future thermoelectric, public supply, industrial and irrigation use. For the Tennessee River Watershed, return flow is estimated to be 95 percent of the water withdrawn. Total consumptive use accounts for the remaining 5 percent (Reference 12). Water use information, including monthly consumption rates by use, for the Guntersville watershed area is presented in Table 2.3-29. In addition, Table 2.3-31 provides information about water users within the area including locations of diversions, and maximum and monthly consumption rates. Water withdrawal for normal operations of the BLN is estimated to consume only 0.28 percent (107 cfs) with a blowdown return rate of 35 cfs for a net loss of 72 cfs, while the normal streamflow of the Tennessee River (in the Guntersville Reservoir) at the BLN site is 38,850 cfs (Tables 2.3-32 and 2.3-33). Thus, the water use at the BLN is considered to be of SMALL impact on downstream users including recreational, navigational, and water consumers and mitigation is not warranted. The current and future water use is discussed further in Subsections 5.2.2.4, 2.3.2.2 and 2.3.2.4.

In 2004, the U.S. Geological Survey (USGS) and TVA completed an estimated water-use forecast for total water usage in the Tennessee River basin projected out to the year 2030. The estimated water use forecast included projections of total water withdrawals for future thermoelectric, public supply, industrial, and irrigation uses (Table 2.3-34) (Reference 8). Although the potential operations of BLN was not included in the forecast study, the amount of water needed for the operation would be less than 4 percent of available water supply during drought conditions (Table 2.3-32).

Based upon an evaluation of present and future water use, water withdrawal and discharge at the BLN site are considered to be of SMALL direct, indirect, or cumulative impact and mitigation is not warranted.

5.2.1.5 Present and Future Groundwater Uses

Groundwater use in the vicinity of the BLN site appears to be limited to mainly individual residences. Groundwater is not used for operation of the BLN site. The present use and future use of groundwater is further discussed in Subsections 5.2.2.2.2, 2.3.2.3 and 2.3.2.4.

5.2.1.6 Operational Activities Causing Other Hydrologic Alterations

Periodic maintenance dredging for sediment removal may be required in the cooling water system intake channel as a result of operation of the raw water system. Maintenance dredging of the intake canal, as the term suggests, is a maintenance de-silting activity for sediment removal only. The intake canal design is not altered (modified) during this activity. A temporary increase in turbidity could occur in the Guntersville Reservoir near the intake structure during dredging activities. However, the additional turbidity (e.g. sediment) dissipates quickly due to the location of the dredging and streamflow rate of the Guntersville Reservoir near the BLN site. As discussed in Subsection 4.2.1.4 and Table 1.2-1, a USACE permit is not required prior to commencing maintenance dredging activities. Dredge spoils are planned to be disposed of in an upland, on-site spoils area above the 500-year flood elevation.

Discharge from the BLN could also cause hydrologic alterations; however, the current plan is to utilize the existing diffuser pipes installed for non-operating Bellefonte Units 1 and 2, which are designed to maximize thermal and chemical dissolution while minimizing bottom scour. In addition, the diffuser pipes are located downstream from the intake channel to prevent heated discharge water from recirculating back to the intake. Additional information related to the BLN discharge characteristics is presented in Subsections 5.2.2.2 and 5.2.2.8 as well as Section 3.4.

Dewatering activities that could affect groundwater flow and quality are not required during the operation of the BLN. Minimal dewatering may be needed during construction of BLN, as addressed in Section 4.2.

Operational activities at the BLN are considered to be of SMALL impact and mitigation is not warranted, based upon minimal impact from dredging discharge design, and no need for dewatering during operation.

5.2.1.7 Surface Water and Groundwater Users Affected by Hydrologic Alterations

No effects on any other water users, including surface water and groundwater resources used by municipalities and industrial facilities, in the vicinity of the BLN are anticipated from water usage during operational activities. Surface water withdrawn from the Guntersville Reservoir supplies the BLN's circulating and service water systems while potable water is supplied from Scottsboro's Municipal Water System. As stated in Subsection 5.2.1.5, groundwater is not used as a source of makeup or potable water for operation of the BLN.

The average withdrawal consumption is approximately 0.28 percent of the flow past the site, while at the low-flow rate (7Q10) of 5130 cfs average withdrawal creates a consumption rate of approximately 2 percent (See Table 2.3-32). Detailed information on water use for the area and the BLN is presented in Subsection 2.3.2 and Section 3.3.

Surface water quality in Guntersville Reservoir is good, and many municipalities use it for their sole or primary water supply (Reference 10). Additional information about municipality use and industrial use is provided in Subsection 2.3.2. Operational activities at the BLN are anticipated to have negligible, if any, effect on water quality or its current uses. Because groundwater is not used for the operation of the BLN, and the average surface water withdrawals are minimal compared to the total flow past the site, water use impacts are considered to be SMALL and mitigation is not warranted.

5.2.1.8 Legal Restrictions

The EPA has promulgated regulations that implement Section 316(b) of the Clean Water Act for new and existing electric power producing facilities. Additional information related to how the BLN meets the performance standards specified in the EPA regulations implementing Section 316(b) is provided in Subsection 5.3.1.1.1.

To limit the potential of stormwater impacting surface water bodies, TVA maintains a stormwater pollution prevention plan and a NPDES permit. In addition, any facility that discharges into waters of the United States is required to obtain a valid NPDES permit. The Bellefonte Units 1 and 2 NPDES permit (Reference 3) is further discussed in Subsections 5.2.2.2.1 and 5.2.2.3. A current NPDES permit is anticipated to be acquired prior to commencement of BLN plant operation.

The Alabama Department of Economic and Community Affairs (ADECA) Office of Water Resources is mandated to administer Alabama's Water Use Reporting Program. This program requires that major non-public and irrigation water users who have the capacity to withdraw at least 100,000 gallon per day (gpd) of surface and/or groundwater and all public water systems register the use with the ADECA (Reference 2).

As presented in Subsection 2.2.3, there are no Native American lands in the region based upon a review of the National Atlas information.

5.2.2 WATER-USE IMPACTS

The scope and review of this subsection includes 1) analysis of hydrologic alterations that could have impacts on water use, including availability, 2) analysis of water quality changes that could affect water use, 3) analysis and evaluation of direct, indirect and cumulative impacts resulting from these alterations and changes, 4) analysis and evaluation of practices to minimize or avoid potential impacts, and 5) evaluation of compliance with federal, state, regional, local, and affected Native American tribal regulations applicable to water use and water quality.

5.2.2.1 Plant Operational Activities Potentially Impacting Water Use

Guntersville Reservoir and the Town Creek embayment are the waters that could potentially be affected by operational activities. These activities include surface water withdrawal from the Guntersville Reservoir, discharge of BLN blowdown water to the Guntersville Reservoir and stormwater discharge effluents to Town Creek and Guntersville Reservoir (Table 2.3-27).

The NRC indicates that many nuclear plants using cooling towers are located on small rivers. These small rivers often supply alluvial aquifers and, therefore, large-scale withdrawals of makeup water to compensate for evaporative losses can impact alluvial aquifers during periods of low flow (Reference 1). Cooling and makeup water for the BLN is drawn from the Guntersville Reservoir which is a main stream impoundment of the Tennessee River, one of the largest river systems in the United States.

Preoperational baseline monitoring programs for surface water and groundwater are presented in Subsection 6.3.

5.2.2.1.1 Surface Water

A description of the Guntersville Reservoir, hydrologic alterations and their related operational activities, and physical effects of hydrologic alterations is presented in Subsection 5.2.1. Discharge records collected by the USGS for the Guntersville Reservoir were used to estimate the monthly, annual average, and low flows of the reservoir at the BLN site. Detailed reservoir flow and hydrology data are presented in Subsection 2.3.1.

The long-term, monthly average river-flow-discharge rates recorded by the USGS near the BLN site range from approximately 39,800 cfs at the former South Pittsburg gauge station (No. 03571850) (Table 2.3-7) to 39,500 cfs at the Guntersville gauge station (No. 3573500) (Table 2.3-12). Historical discharge-rate information is presented in Table 2.3-8 and Table 2.3-13.

Less than 1 percent (0.28 percent) of the monthly average river flow past the BLN is lost to water withdrawal and evaporation from the BLN cooling tower operations (Table 2.3-32) based on a conservative monthly average flow of 38,850 cfs (17.4 million gpm) at the BLN site. This monthly average flow rate was used for conservatism and is lower than the flow rates measured at the South Pittsburg and Guntersville gauge stations. Using the average withdrawal rate of approximately 48,118 gpm (or 107 cfs for comparison purposes) for the two units and the monthly 7Q10 low-flow rate of 5130 cfs, the net water lost from the river is approximately 2 percent. The relative amounts of water lost to evaporation as compared to river flow indicates consumptive use is expected to be highest in the summer and fall, and lowest in winter and spring (Table 5.2-1).

Consumptive losses of this magnitude are barely discernible under normal circumstances (typical flows). Combined with other consumptive losses discussed earlier in this chapter, the BLN withdrawals constitute only a small cumulative effect on water supply. Water availability downstream of the BLN site during low-flow periods of operation of the BLN units is considered to be of SMALL impact, because only about 1 percent of the river's flow is diverted and lost (Table 5.2-1). Daily water withdrawals for BLN operations represent approximately 0.03 percent of the total volume of the Guntersville Reservoir at the minimum operating pool level of 593 ft. msl. This corresponds to a negligible fluctuation (less than 1/100th foot per day) in reservoir level due to BLN operations. River-level associated with consumptive water losses resulting from two-unit operations does not affect recreational boating in summer, when river use is at its highest, even during extreme low-flow conditions. At this level of consumptive water use, impacts to river level is considered to be SMALL and mitigation is not warranted.

5.2.2.1.2 Groundwater

Groundwater is not used for safety-related or water supply purposes at BLN. Therefore, minimal impacts to groundwater are anticipated during normal operations.

The underlying aquifers at the BLN site lie within the Stones River Group (a poor water-bearing unit in the area of the BLN, which includes the Chickamauga Limestone) and Knox Dolomite formations; recharge is largely attributed to rainwater percolation, not from the river (Reference 11). Based on the information referenced above, surface-water-use impacts to groundwater are considered to be SMALL during normal operations and mitigation is not warranted. Additional groundwater characterization information is presented in Subsection 2.3.1 and Subsection 2.4.12 of the FSAR.

5.2.2.2 Potential Water-Use Impacts

Although cooling towers are considered to be closed-cycle cooling systems, concentrations of dissolved salts accumulate in the circulation system as a result of evaporative water loss. To maintain proper cooling, a certain percentage of the mineral-rich stream (blowdown) must be discharged and replaced with fresh water (makeup). The quantities of blowdown from closed-loop cooling systems are relatively small compared with the discharges from once-through systems (Reference 1). Water quality impacts could occur from the elevated blowdown water temperatures or from the concentration and discharge of chemicals added to the recirculating cooling water (to prevent corrosion and biofouling, regulate pH, etc.) (Reference 1). The BLN operates at three or four cycles of concentration in order to maintain circulating water concentrations within design parameters.

By maintaining cooling tower discharges within water quality criteria (e.g., NPDES permits), impacts are considered to be SMALL and mitigation is not warranted.

5.2.2.2.1 Chemical Impacts

Cooling tower water chemistry must be maintained with anti-scaling compounds and corrosion inhibitors because cooling towers concentrate solids (minerals and salts) and organics that enter the system in makeup water. Similarly, a biocide must be added to the system to prevent the growth of fouling bacteria and algae. Chemicals to be added to the liquid effluent streams are listed in Table 3.6-1. Water-treatment chemicals that are planned for use at the BLN include:

- Biocide – sodium hypochlorite
- Algaecide – quaternary amine
- pH adjuster – sulfuric acid
- Corrosion inhibitor – ortho/polyphosphate
- Antiscalant – phosphonate
- Silt dispersant – polyacrylate
- Molluskicide – quaternary amine

Water treatment for the circulating water system is provided by the turbine island chemical feed system.

The current BLN NPDES permit contains discharge limits (for discharges from the cooling towers) (Reference 3).

Operation of the cooling towers is based on three or four cycles of concentration, meaning that solids and chemical constituents in makeup water are concentrated three or four times before being discharged and replaced with fresh water from the Guntersville Reservoir. As a result, levels of solids and organics in the cooling tower blowdown are approximately three times higher than ambient concentrations. The projected blowdown flow for normal plant operations is 15,828 gpm. Average blowdown from the cooling towers and the service water system and effluent from other plant systems is discharged into the Guntersville Reservoir at a rate of approximately 15,858 gpm (Table 2.3-33). For maximum plant operations, the projected discharge flow is 15,978 gpm (Figure 3.3-1).

Based on an estimated average daily stream flow of 38,850 cfs, blowdown as percentage of average flow is approximately 0.1 percent of the average flow and 0.69 percent of the average 7Q10 flow calculated for the BLN site (two units). A comparison of reservoir streamflow and cooling tower blowdown flow rates is presented in Table 5.2-1. Concentrations of solids and residual water-treatment chemicals in the cooling tower blowdown quickly dissipate in the river, because the blowdown volume is insignificant relative to the river flow. As presented in the following subsections, the thermal plume is also expected to dissipate quickly within the modeled mixing zone.

Although the volume of the cooling tower blowdown is anticipated to be small when compared to the river flow, and the treatment chemicals added are largely consumed leaving very small concentrations by the time they are discharged, the discharge is regulated by the existing NPDES permit and complies with applicable state water quality standards as discussed in Subsection 2.3.3. Therefore, impacts of residual chemicals (discharged in the permitted blowdown) on river water quality are considered to be SMALL and mitigation is not warranted.

5.2.2.2.2 Thermal Impacts

Discharges from the new units are permitted under the Alabama Department of Environmental Management (ADEM) NPDES program, which regulates the discharge of pollutants into waters of the state. Under NPDES regulations, waste heat is regarded as thermal pollution and is regulated in the same way as chemical pollutants. A computer program, CORMIX2 (Version 5.0), was used to simulate the thermal plume that is anticipated in the river by the discharge of the BLN cooling tower blowdown. CORMIX is an EPA-supported, mixing-zone model which emphasizes the role of boundary interactions to predict steady-state mixing behavior and plume geometry. CORMIX is widely used and recognized as a state-of-the-art tool for discharge mixing-zone analyses (Reference 4). The model has been validated in numerous applications (Reference 5).

River temperature data collected from 1974 to 1990 and from 2000 to 2006 (1991 to 1999 data not available) at Guntersville Reservoir, near the BLN site, were used to establish low, mean, and high ambient temperatures. Widows Creek Fossil Plant (WCF) records daily temperature readings at the H-6 intake, located at Tennessee River Mile (TRM) 407.0, at an approximate depth of 20 ft. below surface. As part of the Vital Signs monitoring program, TVA collects temperature data at various depths at three points on the Tennessee River in the Bellefonte region between the months of April and October. The nearest downstream location is at TRM 375.2, where temperature data are collected at depths between 1 ft. and approximately 36 ft. below the surface. These two long-term temperature monitoring stations (WCF and TRM 375.2) bracket the BLN site, which is situated at approximately TRM 391 (Figure 5.2-X1).

Intake temperatures from WCF (2000 through 2006) were compared to corresponding TRM 375.2 water temperature data collected at the 16 to 19-ft. depth interval during the seasonal data range. Results are presented in Table 5.2-X1. From January 2000 to August 2006, the differences between the WCF intake (TRM 407.0) water temperature and that at TRM 375.2 ranged from 5.00°F warmer to 2.61°F cooler, with 62 percent of temperature differences less than 2°F warmer (Table 5.2-X2). On average, the Tennessee River data showed an increase in temperature of 0.90°F, from the WCF intake to TRM 375.2. Given the approximate midpoint location of the BLN, this translates to an average increase in temperature of 0.45°F from the WCF intake to the BLN site.

Based on the minimal change in temperature observed between the WCF intake and TRM 375.2, and the near midpoint location of the BLN between these two sampling locations, the intake temperature at the WCF is considered representative of the Tennessee River temperature at the BLN site.

Long-term daily flow data were obtained from TVA simulation of flow at the BLN site developed from Nickajack Dam and Guntersville Dam discharge data. The flow records were used to synthesize a 30-year record of monthly low, mean, and high flows at the BLN site.

While in the normal intake/discharge mode, the cooling system operates at three to four cycles of concentration. When the reservoir water contains high levels of dissolved and suspended solids, the BLN may operate at three cycles of concentration in order to maintain circulating-water concentrations within design parameters. Blowdown-discharge flow rates were simulated in CORMIX at maximum flow for three-cycle operation. Results of these simulations show a small thermal plume that dissipates quickly. Therefore, temperature of the discharge from the BLN is considered to be of SMALL impact and mitigation is not warranted. Additional information about the simulation is provided in Subsections 5.2.2.8 and 5.3.2.1.

5.2.2.3 Operational Limitations

In the 2004 report for the TVA Vital Signs Monitoring Program, the river near the BLN site was classified as “good” (Reference 10). Details related to water quality of the Guntersville Reservoir is presented in Subsection 2.3.3. As mentioned in Subsection 5.2.2.2.1, the current BLN NPDES permit contains discharge limits (for discharges from the cooling towers) (Reference 3). Information from the Bellefonte Units 1 and 2 NPDES Permit is presented in Table 6.6-1. However, a current NPDES permit is anticipated to be acquired prior to commencement of BLN plant operation.

The Bellefonte Units 1 and 2 NPDES Permit requires that the discharge temperature cannot exceed a daily maximum temperature of 95°F or a monthly average of 92°F. ADEM water quality regulations limit ambient receiving waters temperature increases to less than 5°F. While specific size limits of mixing zones are not specified in the ADEM water quality regulations, the following is mentioned: “Mixing zones, i.e., that portion of the receiving waters where mixture of effluents and natural waters take place, shall not preclude passage of free-swimming and drifting aquatic organisms to the extent that their populations are significantly affected” (Reference 6).

5.2.2.4 Impacts on Current Water Use

For the Tennessee River Watershed existing water users, return flow is estimated to be 95 percent of the water withdrawn. Total consumptive use accounts for the remaining 5 percent (Reference 12). An intake channel currently exists for the BLN. No additional diversions of the Guntersville Reservoir are planned for the operation of the BLN. Information about existing water users is presented in Subsection 2.3.2. Table 2.3-29 provides information about current water users including maximum use and monthly consumption. Current surface water withdrawal volumes on the Guntersville Reservoir upstream of the BLN site only account for approximately 1093 Mgd or 33 million gallons per month (Table 2.3-29) (Reference 8). Based on this minimal use and the fact that the majority of this water is returned in the form of effluent, upstream water withdrawal is not affecting the available water for BLN operations.

Water withdrawal for normal operations of the BLN is estimated to consume only 0.28 percent of 107 cfs with a blowdown return rate of 35 cfs for a net loss of 72 cfs, while the normal streamflow of the Tennessee River (in the Guntersville Reservoir) at the BLN site is 38,850 cfs (Tables 2.3-32 and 2.3-33). Thus, the water use at the BLN is considered to be of SMALL impact on downstream users including recreational, navigational, and water consumers and mitigation is not warranted. Additional BLN water withdrawal volumes based on different BLN operational scenarios is presented on Table 3.4-2. Impacts from water consumption at the BLN site are considered to be of SMALL impact and mitigation is not warranted.

Groundwater is not used for operation of the BLN site. Past and current hydrogeologic information for the BLN site is presented in Subsection 2.3.1 and FSAR 2.4.12.

5.2.2.5 Estimated Future Water Use

As discussed in Subsection 5.2.1.4 in 2004, the USGS and TVA completed an estimated water-use forecast for total water usage in the Tennessee River basin projected out to the year 2030. From 2000 to 2030, total water withdrawals in the Tennessee River Watershed are projected to increase from 12,211 to 13,990 Mgd. This projected increase in water withdrawals of 1779 Mgd is presented in Table 2.3-34. Total consumptive use is projected to increase from 649 to 980 Mgd or about 51 percent (Reference 7). Per-capita use is estimated as approximately 2370 gpd in 2030, or about 13 percent less than in 2000 (Reference 8). Additional information related to future water use in the Tennessee River Basin is presented in Subsection 2.3.2.

The estimated water use forecast included projections of total water withdrawals for future thermoelectric, public supply, industrial, and irrigation uses (Table 2.3-34) (Reference 8). Although the potential operation of the BLN was not included in the forecast study, the amount of water needed for the operation would be less than 3.5 percent of available water supply during drought conditions (Table 2.3-32).

5.2.2.6 Potential Impacts From Hydraulic Alterations and Operational Activities

The operation of the BLN is not expected to cause hydraulic alterations to surface water bodies or groundwater resources, thus the operation of the BLN is considered to be of SMALL impact and mitigation is not warranted based upon the information provided in Subsection 5.2.1.6.

5.2.2.7 Operational Alterations to Terrestrial and Aquatic Ecosystems

Detailed discussions of possible intake and discharge processes that could alter the aquatic ecosystem near the BLN site are presented in Subsections 5.3.1.2 and 5.3.2.2. As presented in these two subsections, impacts to terrestrial and aquatic ecosystems from the intake of water from and discharge to the Guntersville Reservoir is considered to be of SMALL impact and mitigation is not warranted.

5.2.2.8 Discharge Design

An analysis of thermal plumes resulting from the BLN effluent discharges was done for these conditions:

- Low river temperature, 7Q10 downstream flow (Figure 5.3-3)
- High river temperature, 7Q10 downstream flow (Figure 5.3-4)

- Low river temperature, reversing river flow[1]
- High river temperature, reversing river flow[1]
- Low river temperature, maximum reverse river flow (Figure 5.3-5)
- High river temperature, maximum reverse river flow[1]
- Low river temperature, maximum downstream flow[1]
- High river temperature, maximum downstream flow[1]

The circulating water systems blowdown flow rate was assumed constant at 15,828 gpm. However, a conservative rate of 16,000 gpm was used for the CORMIX2 runs. This 16,000 gpm flow rate represents the total of maximum blowdown, plus other miscellaneous effluents, from the new facility. A plume model was developed for each case to determine the plume characteristics. Summaries of the predicted plume analysis data are provided in Table 5.3-2, and additional information is presented in Subsection 5.3.2.1.

Consistent with the existing diffuser design, the discharge design was modeled as a 120-ft. long multiport diffuser with 1920 openings (see Subsection 3.4.2.2 for additional model input details). The current, oblique diffuser pipes that were installed for the Bellefonte non-operating Units 1 and 2 are utilized for the BLN. To preclude bottom-scour problems, the discharge ports for these oblique diffusers are positioned to discharge at an angle of 22 degrees from the horizontal. Additional information about the oblique diffuser is presented in Section 3.4.

ADEM mixing-zone regulations limit the temperature increase at the edge of the near-field region of the thermal plume to less than 5°F greater than the ambient river temperature. The near-field region is a term used by CORMIX for describing the zone of strong initial mixing where the so-called near-field processes occur. It is the region of the receiving water where outfall design conditions are most likely to have an impact on in-stream concentrations (Reference 9). The CORMIX results for the low, mean, and high river temperatures show the temperature of the thermal plume at the edge of the near-field region to be1.742°F, 0.904°F, and 0.203°F above the ambient river temperature, respectively. Thus, the mixing-zone regulations are easily met for river temperatures with the worst-case river-flow and discharge characteristics. Temperature of the discharge from the BLN is, therefore, considered to be of SMALL impact and mitigation is not warranted. See Subsection 5.3.2 for further details regarding the thermal plume's mixing zone. Additional details related to the BLN discharge system are presented in Section 3.4.

1. No figures are provided for simulations without measurable plumes. In addition, no figures were provided for the transitional reversing river flow. The reversing condition is of such a short duration (less than 2 min.), that a fully developed plume could not be created.

5.2.2.9 Discharge Mixing Zone

As described previously (Subsection 5.2.2.3) the mixing zone is conservatively defined in terms of the 5°F maximum temperature increase above ambient and the 95°F maximum river temperature. For modeling, the river centerline temperature increase resulting from the discharge was added in each case to the ambient river temperature prior to simulating the discharge effects. The mixing-zone temperature excess for the discharge was then re-defined by decreasing the maximum allowable 5°F difference by the river temperature increase due to the discharge component; the discharge 95°F isotherm (only applicable for the max-T case) was defined based on the discharge-blowdown temperature and the ambient temperature incremented as described.

The three cycles of concentration, low-river-temperature modeling scenario results in the largest mixing zone. Even for this case, the mixing zone is demonstrably small. Allowing for 375 ft. between the river bank and the diffuser and adding the maximum cross-stream extent of 104 ft., less than 25 percent of the river width is impacted by the mixing zone and discharge structure. See Subsection 5.3.2 for further details regarding the thermal plume's mixing zone.

No reverse flows capable of returning effluent discharged from the diffusers have occurred since changing reservoir operation in 2004 (Subsection 2.3.1.2.3). As reverse flows in the range of this magnitude are rare, it is unlikely that the effluent discharged from the diffuser would cycle back to the plant intake or Town Creek during a reversal event. However, as operation of the dams has been shown capable of producing reverse flows that may return discharged effluent to the plant intake, administrative controls are expected be established to monitor the flow reversal phenomenon at the BLN to preclude discharging of radiological effluent during a large flow rate reversal.

5.2.2.10 Regulatory Compliance

EPA has promulgated regulations that implement Section 316(b) of the Clean Water Act for new and existing electric power producing facilities. Additional information describing how the BLN meets the performance standards specified in the EPA regulations implementing Section 316(b) is provided in Subsection 5.3.1.1.1.

The ADEM Water Division, Industrial Division, requires industrial facilities that discharge into waters of the United States to obtain a valid NPDES permit or secure coverage under a valid General NPDES permit. The current BLN NPDES permit is further discussed in Subsections 5.2.2.2.1 and 5.2.2.3. To limit the potential of stormwater impacting surface water bodies the site maintains a stormwater pollution prevention plan.

The ADECA Office of Water Resources is mandated to administer Alabama's Water Use Reporting Program. This program requires that major non-public and irrigation water users who have the capacity to withdraw at least 100,000 gpd of surface and/or groundwater and all public water systems register the use with the ADECA (Reference 2).

As mentioned in Subsection 2.2.3, there are no Native American lands in the region based upon a review of the National Atlas.

5.2.3 REFERENCES

1. U. S. Nuclear Regulatory Commission, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (NUREG-1437 Vol.1), Section 4 – Environmental Impacts of Operation, 1996.

2. Alabama Department of Economic and Community Affairs, Website http://www.adeca.state.al.us/C17/Water%20Use%20Reporting%20Forms/default.aspx, accessed April 15, 2007

3. Alabama Department of Environmental Management, "National Pollutant Discharge Elimination System Permit, Permit Number AL 0024635," November 2004.

4. CORMIX, CORMIX Mixing Zone Applications, Website, http://www.cormix.info/applications.php, accessed March 19, 2007.

5. CORMIX, Independent CORMIX Validation Studies, Website, http://www.cormix.info/validations.php, accessed March 19, 2007.

6. Alabama Department of Environmental Management, "Water Division – Water Quality Program", Volume I, Division 6, September 2006.

7. Tennessee Valley Authority, Tennessee Valley Water Supply Inventory & Needs Analysis, 2004, Website, http://www.tva.gov/river/watersupply/report.htm, accessed March 19, 2007.

8. U.S. Geological Survey, Estimated Use of Water in the Tennessee River Watershed in 2000 and Projections of Water Use to 2030, 2004.

9. CORMIX, CORMIX Mixing Zone Glossary, Website, http://www.cormix.info/glossary.php, accessed March 19, 2007.

10. Tennessee Valley Authority, Guntersville Reservoir Ecological Health Rating, 2004, Website, http://www.tva.com/environment/ecohealth/guntersville.htm, accessed June 7, 2007.

11. Tennessee Valley Authority, Bellefonte Nuclear Plant-Final Safety Analysis Report, 1988

12. U.S. Geological Survey, Estimated Use of Water in the Tennessee River Watershed in 2000 and Projections of Water Use to 2030, 2004, Website, http://pubs.usgs.gov/wri/wri034302/, accessed March 29, 2007.

TABLE 5.2-1
COMPARISON OF GUNTERSVILLE RESERVOIR FLOWS AND BLN COOLING WATER FLOWS

Month	Average Flow (cfs)	7Q10 Flow[a] (cfs)	Maximum Withdrawal for CT Makeup (2 units) (cfs)	Maximum CT Evaporation Rate (2 units) (cfs)	Percent of Average Flow Lost to Evaporation	Percent of 7Q10 Flow Lost to Evaporation	Blowdown Flow (cfs)	Blowdown as Percent of Average Flow	Blowdown as Percent of 7Q10 Flow
Jan-07	46,489	5,130	107.2	71.5	0.15	1.39	35.27	0.08	0.69
Feb-07	20,062	5,130	107.2	71.5	0.36	1.39	35.27	0.18	0.69
Mar-07	17,266	5,130	107.2	71.5	0.41	1.39	35.27	0.20	0.69
Apr-07	11,108	5,130	107.2	71.5	0.64	1.39	35.27	0.32	0.69
May-07	9,808	5,130	107.2	71.5	0.73	1.39	35.27	0.36	0.69
Jun-07	18,802	5,130	107.2	71.5	0.38	1.39	35.27	0.19	0.69
Jul-07	16,109	5,130	107.2	71.5	0.44	1.39	35.27	0.22	0.69
Aug-07	25,281	5,130	107.2	71.5	0.28	1.39	35.27	0.14	0.69
Sep-07	10,329	5,130	107.2	71.5	0.69	1.39	35.27	0.34	0.69
Oct-07	12,032	5,130	107.2	71.5	0.59	1.39	35.27	0.29	0.69
Nov-07	11,079	5,130	107.2	71.5	0.65	1.39	35.27	0.32	0.69
Dec-07	9,960	5,130	107.2	71.5	0.72	1.39	35.27	0.35	0.69

Notes: cfs - cubic feet per second

a) The 7Q10 flow is conservatively derived from the Nickajack Dam discharges from 1976 to 2007.

TABLE 5.2-X1 (Sheet 1 of 11)
TEMPERATURE COMPARISON TABLE
WIDOWS CREEK FOSSIL PLANT (WCF) TO TRM 375.2

Date	TRM 375.2		WCF Temp	Temperature Difference	Projected Temperature at BLN (TRM 391)
	Depth (ft.)	Temp (°F)	(°F)	(°F)	(°F)
4/17/2000	1.0	61.88			
4/17/2000	4.9	61.88			
4/17/2000	9.8	61.34			
4/17/2000	13.1	61.16			
4/17/2000	19.7	61.16	61.27	0.11	61.21
4/17/2000	26.2	61.16			
4/17/2000	33.8	61.16			
5/11/2000	1.0	76.28			
5/11/2000	4.9	73.94			
5/11/2000	9.8	73.58			
5/11/2000	13.1	73.58			
5/11/2000	19.7	73.04	73.96	0.92	73.50
5/11/2000	26.2	72.50			
5/11/2000	29.9	72.50			
5/11/2000	33.1	72.32			
6/16/2000	1.0	82.04			
6/16/2000	4.9	82.04			
6/16/2000	9.8	82.04			
6/16/2000	13.1	82.04			
6/16/2000	19.7	82.04	81.30	-0.74	81.67
6/16/2000	26.2	82.04			
6/16/2000	31.2	81.86			
6/16/2000	34.4	81.86			
7/18/2000	1.0	87.62			
7/18/2000	4.9	86.72			
7/18/2000	9.8	86.54			
7/18/2000	13.1	86.54			
7/18/2000	19.7	86.54	86.25	-0.29	86.40
7/18/2000	26.2	86.36			
7/18/2000	32.8	86.18			
7/18/2000	34.4	86.18			
8/17/2000	1.0	86.18			
8/17/2000	4.9	85.46			
8/17/2000	9.8	85.28			

TABLE 5.2-X1 (Sheet 2 of 11)
TEMPERATURE COMPARISON TABLE
WIDOWS CREEK FOSSIL PLANT (WCF) TO TRM 375.2

Date	TRM 375.2		WCF Temp	Temperature Difference	Projected Temperature at BLN (TRM 391)
	Depth (ft.)	Temp (°F)	(°F)	(°F)	(°F)
8/17/2000	13.1	85.28			
8/17/2000	19.7	85.28	83.70	-1.58	84.49
8/17/2000	26.2	85.28			
8/17/2000	32.8	85.28			
8/17/2000	34.4	85.28			
9/19/2000	1.0	78.98			
9/19/2000	4.9	78.26			
9/19/2000	9.8	78.08			
9/19/2000	13.1	78.08			
9/19/2000	19.7	78.08	78.37	0.29	78.22
9/19/2000	26.2	77.90			
9/19/2000	32.8	77.54			
9/19/2000	34.4	77.54			
4/16/2001	1.0	66.83			
4/16/2001	4.9	66.76			
4/16/2001	9.8	66.54			
4/16/2001	13.1	66.47			
4/16/2001	19.7	66.34	61.34	-5.00	63.86
4/16/2001	26.2	66.29			
4/16/2001	32.8	66.27			
4/16/2001	35.1	66.27			
5/14/2001	1.0	74.75			
5/14/2001	4.9	73.38			
5/14/2001	9.8	72.93			
5/14/2001	13.1	72.90			
5/14/2001	19.7	72.79	72.30	-0.49	72.55
5/14/2001	23.0	72.54			
5/14/2001	26.2	69.69			
5/14/2001	32.8	68.63			
5/14/2001	34.4	68.68			
6/18/2001	1.0	83.16			
6/18/2001	4.9	81.90			
6/18/2001	9.8	81.55			
6/18/2001	13.1	81.46			

TABLE 5.2-X1 (Sheet 3 of 11)
TEMPERATURE COMPARISON TABLE
WIDOWS CREEK FOSSIL PLANT (WCF) TO TRM 375.2

Date	TRM 375.2		WCF Temp	Temperature Difference	Projected Temperature at BLN (TRM 391)
	Depth (ft.)	Temp (°F)	(°F)	(°F)	(°F)
6/18/2001	19.7	81.34	81.05	-0.29	81.19
6/18/2001	26.2	81.25			
6/18/2001	32.8	80.94			
6/18/2001	35.4	80.83			
7/16/2001	1.0	84.02			
7/16/2001	4.9	82.71			
7/16/2001	9.8	82.45			
7/16/2001	13.1	82.40			
7/16/2001	19.7	82.38	83.43	1.04	82.90
7/16/2001	26.2	82.35			
7/16/2001	32.8	82.35			
7/16/2001	34.4	82.36			
8/22/2001	1.0	84.70			
8/22/2001	4.9	84.27			
8/22/2001	9.8	83.98			
8/22/2001	13.1	83.84			
8/22/2001	19.7	83.77	83.32	-0.45	83.54
8/22/2001	26.2	83.75			
8/22/2001	32.8	83.71			
8/22/2001	34.4	83.71			
9/19/2001	1.0	79.30			
9/19/2001	4.9	79.27			
9/19/2001	9.8	79.18			
9/19/2001	13.1	79.18			
9/19/2001	19.7	79.11	78.73	-0.38	78.92
9/19/2001	26.2	79.03			
9/19/2001	32.8	78.94			
9/19/2001	33.8	78.93			
10/18/2001	1.0	68.18			
10/18/2001	4.9	67.82			
10/18/2001	9.8	67.59			
10/18/2001	13.1	67.48			
10/18/2001	19.7	67.37	67.32	-0.05	67.34
10/18/2001	26.2	67.35			

TABLE 5.2-X1 (Sheet 4 of 11)
TEMPERATURE COMPARISON TABLE
WIDOWS CREEK FOSSIL PLANT (WCF) TO TRM 375.2

Date	TRM 375.2		WCF Temp	Temperature Difference	Projected Temperature at BLN (TRM 391)
	Depth (ft.)	Temp (°F)	(°F)	(°F)	(°F)
10/18/2001	32.8	67.33			
10/18/2001	34.4	67.32			
4/23/2002	1.0	70.97			
4/23/2002	4.9	70.57			
4/23/2002	9.8	70.30			
4/23/2002	16.4	70.16	69.31	-0.85	69.74
4/23/2002	26.2	70.14			
4/23/2002	29.5	70.12			
4/23/2002	35.1	70.11			
5/29/2002	1.0	75.96			
5/29/2002	4.9	74.50			
5/29/2002	9.8	73.29			
5/29/2002	19.7	71.89	74.50	2.61	73.18
5/29/2002	26.2	71.04			
5/29/2002	32.8	71.02			
5/29/2002	36.4	71.15			
6/25/2002	1.0	82.78			
6/25/2002	4.9	82.71			
6/25/2002	9.8	82.72			
6/25/2002	16.4	82.72	83.46	0.74	83.09
6/25/2002	23.0	82.71			
6/25/2002	29.5	82.69			
6/25/2002	36.1	82.69			
7/31/2002	1.0	86.97			
7/31/2002	4.9	86.92			
7/31/2002	9.8	86.88			
7/31/2002	16.4	86.67	86.56	-0.11	86.61
7/31/2002	23.0	86.63			
7/31/2002	29.5	86.61			
7/31/2002	34.1	86.61			
8/29/2002	1.0	86.88			
8/29/2002	1.3	86.88			
8/29/2002	4.9	85.19			
8/29/2002	5.2	85.19			

TABLE 5.2-X1 (Sheet 5 of 11)
TEMPERATURE COMPARISON TABLE
WIDOWS CREEK FOSSIL PLANT (WCF) TO TRM 375.2

Date	TRM 375.2 Depth (ft.)	TRM 375.2 Temp (°F)	WCF Temp (°F)	Temperature Difference (°F)	Projected Temperature at BLN (TRM 391) (°F)
8/29/2002	9.8	84.45			
8/29/2002	13.1	84.43			
8/29/2002	13.5	84.43			
8/29/2002	19.7	84.43	85.33	0.90	84.88
8/29/2002	25.9	84.42			
8/29/2002	26.2	84.42			
8/29/2002	32.8	84.42			
8/29/2002	35.8	84.40			
9/26/2002	1.0	78.73			
9/26/2002	4.9	78.69			
9/26/2002	9.8	78.73			
9/26/2002	16.4	78.66	78.06	-0.59	78.36
9/26/2002	23.0	78.62			
9/26/2002	29.5	78.62			
9/26/2002	33.8	78.53			
4/8/2003	1.0	63.68			
4/8/2003	4.9	63.54			
4/8/2003	9.8	63.34			
4/8/2003	13.1	62.67			
4/8/2003	19.7	62.58	58.15	-4.43	60.38
4/8/2003	26.2	62.51			
4/8/2003	32.8	62.51			
4/8/2003	35.1	62.51			
5/20/2003	1.0	68.54			
5/20/2003	4.9	68.52			
5/20/2003	9.8	68.54			
5/20/2003	13.1	68.56			
5/20/2003	16.4	68.58	65.59	-2.99	67.09
5/20/2003	23.0	68.56			
5/20/2003	29.5	68.58			
5/20/2003	32.8	68.54			
5/20/2003	35.1	68.50			
6/9/2003	1.0	76.64			
6/9/2003	4.9	74.66			

TABLE 5.2-X1 (Sheet 6 of 11)
TEMPERATURE COMPARISON TABLE
WIDOWS CREEK FOSSIL PLANT (WCF) TO TRM 375.2

Date	TRM 375.2		WCF Temp	Temperature Difference	Projected Temperature at BLN (TRM 391)
	Depth (ft.)	Temp (°F)	(°F)	(°F)	(°F)
6/9/2003	9.8	73.94			
6/9/2003	13.1	73.94			
6/9/2003	19.7	73.76	72.73	-1.03	73.25
6/9/2003	26.2	73.76			
6/9/2003	32.8	73.76			
6/9/2003	34.4	73.76			
7/7/2003	1.0	78.62			
7/7/2003	4.9	78.26			
7/7/2003	9.8	78.28			
7/7/2003	13.1	78.19			
7/7/2003	19.7	78.19	80.42	2.23	79.30
7/7/2003	26.2	78.19			
7/7/2003	32.8	78.19			
7/7/2003	36.4	78.19			
8/12/2003	1.0	82.90			
8/12/2003	4.9	82.40			
8/12/2003	9.8	82.15			
8/12/2003	13.1	82.15			
8/12/2003	19.7	82.09	79.74	-2.36	80.92
8/12/2003	26.2	82.09			
8/12/2003	32.8	82.08			
8/12/2003	35.4	82.11			
9/9/2003	1.0	83.14			
9/9/2003	4.9	82.20			
9/9/2003	9.8	82.11			
9/9/2003	13.1	82.06			
9/9/2003	19.7	81.90	79.83	-2.07	80.87
9/9/2003	26.2	81.79			
9/9/2003	32.8	81.77			
9/9/2003	35.4	81.77			
10/6/2003	1.0	71.69			
10/6/2003	4.9	71.67			
10/6/2003	9.8	71.60			
10/6/2003	13.1	71.56			

TABLE 5.2-X1 (Sheet 7 of 11)
TEMPERATURE COMPARISON TABLE
WIDOWS CREEK FOSSIL PLANT (WCF) TO TRM 375.2

Date	TRM 375.2 Depth (ft.)	TRM 375.2 Temp (°F)	WCF Temp (°F)	Temperature Difference (°F)	Projected Temperature at BLN (TRM 391) (°F)
10/6/2003	19.7	71.58	69.73	-1.85	70.66
10/6/2003	26.2	71.56			
10/6/2003	32.8	71.55			
10/6/2003	36.1	71.56			
4/5/2004	1.0	59.50			
4/5/2004	4.9	59.41			
4/5/2004	9.8	59.36			
4/5/2004	16.4	59.34	59.13	-0.22	59.23
4/5/2004	23.0	59.32			
4/5/2004	29.5	59.32			
4/5/2004	33.1	59.34			
5/3/2004	1.0	68.72			
5/3/2004	4.9	68.76			
5/3/2004	9.8	68.67			
5/3/2004	13.1	68.65			
5/3/2004	19.7	68.34	66.81	-1.53	67.58
5/3/2004	26.2	68.27			
5/3/2004	32.8	68.23			
5/3/2004	35.1	68.27			
6/7/2004	1.0	79.65			
6/7/2004	4.9	79.56			
6/7/2004	9.8	79.56			
6/7/2004	13.1	79.56			
6/7/2004	19.7	79.54	78.26	-1.28	78.90
6/7/2004	26.2	79.54			
6/7/2004	32.8	79.52			
6/7/2004	34.8	79.52			
7/15/2004	1.0	84.38			
7/15/2004	4.9	82.58			
7/15/2004	9.8	82.22			
7/15/2004	13.1	82.22			
7/15/2004	19.7	82.04	80.85	-1.19	81.45
7/15/2004	26.2	82.04			
7/15/2004	32.8	82.04			

TABLE 5.2-X1 (Sheet 8 of 11)
TEMPERATURE COMPARISON TABLE
WIDOWS CREEK FOSSIL PLANT (WCF) TO TRM 375.2

Date	TRM 375.2 Depth (ft.)	TRM 375.2 Temp (°F)	WCF Temp (°F)	Temperature Difference (°F)	Projected Temperature at BLN (TRM 391) (°F)
7/15/2004	35.4	82.04			
8/12/2004	1.0	82.54			
8/12/2004	4.9	82.58			
8/12/2004	9.8	82.58			
8/12/2004	13.1	82.56			
8/12/2004	19.7	82.56	80.55	-2.02	81.56
8/12/2004	26.2	82.53			
8/12/2004	32.8	82.51			
8/12/2004	33.8	82.51			
9/9/2004	1.0	80.51			
9/9/2004	4.9	80.01			
9/9/2004	9.8	79.86			
9/9/2004	13.1	79.75			
9/9/2004	19.7	79.66	78.48	-1.19	79.07
9/9/2004	26.2	79.63			
9/9/2004	32.8	79.63			
9/9/2004	35.4	79.63			
10/7/2004	1.0	73.22			
10/7/2004	4.9	73.22			
10/7/2004	9.8	73.24			
10/7/2004	16.4	73.22	71.53	-1.69	72.38
10/7/2004	23.0	73.20			
10/7/2004	29.5	73.22			
10/7/2004	33.5	73.20			
4/7/2005	1.0	60.57			
4/7/2005	4.9	60.40			
4/7/2005	9.8	60.33			
4/7/2005	16.4	60.22	58.08	-2.14	59.16
4/7/2005	23.0	60.19			
4/7/2005	29.5	60.19			
4/7/2005	35.1	60.19			
5/4/2005	1.0	64.78			
5/4/2005	4.9	64.76			
5/4/2005	9.8	64.67			

TABLE 5.2-X1 (Sheet 9 of 11)
TEMPERATURE COMPARISON TABLE
WIDOWS CREEK FOSSIL PLANT (WCF) TO TRM 375.2

Date	TRM 375.2 Depth (ft.)	TRM 375.2 Temp (°F)	WCF Temp (°F)	Temperature Difference (°F)	Projected Temperature at BLN (TRM 391) (°F)
5/4/2005	16.4	64.58	63.25	-1.33	63.92
5/4/2005	23.0	64.54			
5/4/2005	29.5	64.49			
5/4/2005	35.4	64.51			
6/2/2005	1.0	73.58			
6/2/2005	4.9	73.47			
6/2/2005	9.8	73.20			
6/2/2005	16.4	73.02	71.40	-1.62	72.22
6/2/2005	23.0	72.99			
6/2/2005	29.5	72.95			
6/2/2005	35.4	72.91			
7/7/2005	1.0	83.26			
7/7/2005	4.9	83.30			
7/7/2005	9.8	83.17			
7/7/2005	16.4	83.03	80.91	-2.12	81.97
7/7/2005	23.0	82.99			
7/7/2005	29.5	82.96			
7/7/2005	34.4	82.96			
8/4/2005	1.0	86.11			
8/4/2005	4.9	85.37			
8/4/2005	9.8	85.28			
8/4/2005	16.4	85.23	83.80	-1.42	84.52
8/4/2005	23.0	85.05			
8/4/2005	29.5	84.97			
8/4/2005	34.4	84.94			
9/8/2005	1.0	83.12			
9/8/2005	4.9	82.24			
9/8/2005	9.8	81.81			
9/8/2005	16.4	81.73	81.12	-0.61	81.43
9/8/2005	23.0	81.70			
9/8/2005	29.5	81.37			
9/8/2005	36.1	81.27			
10/13/2005	1.0	76.66			
10/13/2005	4.9	75.87			

TABLE 5.2-X1 (Sheet 10 of 11)
TEMPERATURE COMPARISON TABLE
WIDOWS CREEK FOSSIL PLANT (WCF) TO TRM 375.2

Date	TRM 375.2		WCF Temp	Temperature Difference	Projected Temperature at BLN (TRM 391)
	Depth (ft.)	Temp (°F)	(°F)	(°F)	(°F)
10/13/2005	9.8	75.63			
10/13/2005	16.4	75.58	74.28	-1.30	74.93
10/13/2005	23.0	75.52			
10/13/2005	29.5	75.49			
10/13/2005	34.8	75.45			
4/13/2006	1.0	65.86			
4/13/2006	4.9	63.25			
4/13/2006	9.8	62.85			
4/13/2006	13.1	62.82			
4/13/2006	19.7	62.78	63.70	0.92	63.24
4/13/2006	26.2	62.85			
4/13/2006	32.8	62.85			
4/13/2006	36.1	62.92			
5/15/2006	1.0	69.55			
5/15/2006	4.9	69.55			
5/15/2006	9.8	69.51			
5/15/2006	16.4	69.46	68.20	-1.26	68.83
5/15/2006	23.0	69.49			
5/15/2006	29.5	69.40			
5/15/2006	34.1	69.46			
6/13/2006	1.0	80.82			
6/13/2006	4.9	80.82			
6/13/2006	9.8	80.82			
6/13/2006	16.4	80.82	79.30	-1.51	80.06
6/13/2006	23.0	80.76			
6/13/2006	29.5	80.67			
6/13/2006	34.1	80.64			
7/18/2006	1.0	86.94			
7/18/2006	4.9	86.32			
7/18/2006	10.2	86.22			
7/18/2006	13.1	86.20			
7/18/2006	19.7	86.18	85.06	-1.12	85.63
7/18/2006	26.2	86.05			
7/18/2006	26.2	86.05			

TABLE 5.2-X1 (Sheet 11 of 11)
TEMPERATURE COMPARISON TABLE
WIDOWS CREEK FOSSIL PLANT (WCF) TO TRM 375.2

Date	TRM 375.2 Depth (ft.)	TRM 375.2 Temp (°F)	WCF Temp (°F)	Temperature Difference (°F)	Projected Temperature at BLN (TRM 391) (°F)
7/18/2006	32.8	86.02			
7/18/2006	36.1	86.00			
8/15/2006	1.0	87.13			
8/15/2006	4.9	86.94			
8/15/2006	9.8	86.86			
8/15/2006	16.4	86.83	85.75	-1.08	86.29
8/15/2006	23.0	86.70			
8/15/2006	29.5	86.59			
8/15/2006	35.1	86.41			
9/15/2006	1.0	79.90			
9/15/2006	4.9	79.88			
9/15/2006	9.8	79.79			
9/15/2006	16.4	79.66			
9/15/2006	23.0	79.59			
9/15/2006	29.5	79.25			
9/15/2006	33.8	79.16			
WCF - TRM 375.2 Average Difference:				-0.90	

TABLE 5.2-X2
TEMPERATURE DIFFERENCE (WCF - TRM 375.2) OCCURRENCE BY MONTH, 2000 TO 2006

By Number of Occurrences	Total	April	May	June	July	August	September	October
TRM 375.2 > 2^{o} Cooler	2	0	1	0	1	0	0	0
TRM 375.2 1 - 2^{o} Cooler	1	0	0	0	1	0	0	0
TRM 375.2 0 - 1^{o} Cooler	6	2	1	1	0	1	1	0
TRM 375.2 0 - 2^{o} Warmer	28	1	4	6	4	4	4	4
TRM 375.2 2 - 4^{o} Warmer	6	1	1	0	1	2	1	0
TRM 375.2 > 4^{o} Warmer	2	2	0	0	0	0	0	0
Total Readings	45	6	7	7	7	7	6	4

Percentage	Total	April	May	June	July	August	September	October
TRM 375.2 > 2^{o} Cooler	4.44%	--	50.00%	--	50.00%	--	--	--
TRM 375.2 1 - 2^{o} Cooler	2.22%	--	--	--	100.00%	--	--	--
TRM 375.2 0 - 1^{o} Cooler	13.33%	33.33%	16.67%	16.67%	--	16.67%	16.67%	--
TRM 375.2 0 - 2^{o} Warmer	62.22%	3.57%	14.29%	21.43%	14.29%	14.29%	14.29%	14.29%
TRM 375.2 2 - 4^{o} Warmer	13.33%	16.67%	16.67%	0.00%	16.67%	33.33%	16.67%	--
TRM 375.2 > 4^{o} Warmer	4.44%	100.00%	--	--	--	--	--	--

5.3 COOLING SYSTEM IMPACTS

The BLN is provided with two closed-cycle cooling water systems that transfer heat to the environment during normal modes of plant operation. These systems are the circulating water cooling system (CWS) and the service water cooling system (SWS) as described in Section 3.4. Subsection 5.3.1 presents the physical impacts of the intake system, as well as impacts on aquatic ecosystems. Subsection 5.3.2 presents the impacts of the discharge system, as well as impacts on aquatic ecosystems. Subsection 5.3.3 presents the aesthetic and physical impacts of the heat-discharge system, during station operation, on the atmosphere and terrestrial ecosystems.

5.3.1 INTAKE SYSTEM

This section describes the impact of the intake system on the aquatic ecology and the physical impacts such as scouring, silt build up and shoreline erosion caused by the flow field induced by the intake system during station operation. Overall, per the following discussion, the impacts of operation of the intake system on the environment are considered SMALL.

The CWS and SWS systems are supplied with water from the raw water system (RWS) intake to the cooling towers in order to makeup for cooling tower losses due to evaporation, drift and blowdown, as well as provide intake screen washing flow and strainer backwash flow.

5.3.1.1 Hydrodynamic Descriptions and Physical Impacts

This section describes the intake hydrodynamics and the predicted spatial and temporal alterations in the ambient flow field and physical hydrological effects (e.g., bottom scouring, induced turbidity, silt buildup) induced by the intake system operation. In addition, design considerations and descriptions of practices or procedures to mitigate or minimize predicted adverse impacts are identified and evaluated.

5.3.1.1.1 Intake-Hydrodynamic Description

The existing intake channel is located about 32 mi. downstream of Nickajack Dam and 43 mi. upstream of the Guntersville Dam. It is constructed along a line approximately perpendicular to the river flow with the bottom of the channel at sufficient depth to provide direct flow from the main river channel to the intake pumping station (IPS) during all low water levels.

The intake structure with respect to the water surface, bottom geometry and shoreline is illustrated in Figures 3.4-2 and 5.3-1. The intake channel is centered in a natural draw and excavated to rock to create a 200 ft. wide channel from the reservoir to the intake pumping structure, a distance of approximately 1960 ft. The intake channel is riprapped between elevation 590 ft. and 600 ft. In addition, a 25 ft. wide trench is excavated into the rock along the centerline of the channel and extends to the bottom of the main river channel (elevation 569 ft.). This trench slopes toward the IPS from elevation 566.5 ft. at the main river channel to elevation 565.5 ft. near the intake pumping station. Parallel to the IPS wall, and running its full length, is a 75 ft. wide trench excavated down to elevation 557 ft. This provides sufficient submergence for the cooling water pumps under all expected water level conditions. A floating pontoon type structure is provided, across the intake channel at the shoreline, to serve as a barrier against milfoil and other floating debris, and also to discourage direct approach to the IPS from the reservoir. As the river water enters the IPS, it is filtered as described in Section 3.4.2.1.

Section 3.4 discusses the maximum amount of water introduced into the system from the Guntersville Reservoir for both units in operation. The 7Q10 flow rate for the Tennessee River (in the Guntersville Reservoir) based on the Nickajack Dam discharges was approximately 5130 cfs. (Subsection 5.2.1.2). Based on the maximum intake flow for both units in operation, the intake withdraws less than 3 percent of the minimum low flow, as shown in FSAR Subsection 2.4.11.5. Temporal and spatial variations in the intake channel flow field vary based on operation requirements of the BLN. Maximum flow velocities, and therefore maximum flow field change, are present at the minimum normal water level and maximum operation of the intake pumps, as discussed in Section 3.4.2.1.

Section 3.4.2.1 indicates the intake channel maximum flow velocity of the cross section for minimum normal water elevation. This section also describes the intake pumping station as well as the velocities through each of the openings at maximum normal water elevation. The openings are followed by traveling screens which are described in Section 3.4.2.1. This section also estimates the maximum velocities through clean screens based on minimum normal water elevation. This intake screen velocity is less than 0.5 fps, as required by 40 CFR 125.84, to limit organism mortality from impingement and entrainment.

EPA has promulgated regulations that implement Section 316 (b) of the Clean Water Act for new and existing electric power producing facilities. 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. As discussed in Section 3.4.1.1, BLN uses mechanical draft and natural draft cooling systems in a closed-cycle cooling system configuration. BLN meets the performance standards specified in the EPA regulations implementing Section 316 (b). In addition, Regulation 40 CFR 125.94(a)(1)(i) indicates that if a facility's flow is commensurate with a closed-cycle recirculation system, the facility has met the applicable performance standards and is not required to demonstrate that it meets impingement mortality and entrainment performance standards.

The above evaluation indicates that the design of BLN intake cooling water system has the following features:

a. The intake channel is approximately perpendicular to the river and its flow.

b. Withdrawal of the intake cooling water is less than 5 percent of the river's flow during minimum river flow conditions.

c. Extremely low current velocities exist along the length of the intake channel.

d. A closed-cycle cooling water system is employed in compliance with Section 316 (b) of the Clean Water Act.

Based on the above assessment, the induced flow fields by the intake system operation result in insignificant impacts on aquatic biota.

5.3.1.1.2 Physical Impacts of Intake

The existing intake channel floor is excavated to rock and a trench excavation into rock is made throughout the length of the channel to provide a water intake below water surface assuming loss of the downstream dam. The channel in the rock is protected from earth slides either from the cut channel slopes in overburden or sliding of the sides of the draw along the rock surface dipping toward the channel. Overburden was excavated down to rock a maximum of 100 ft. on each side of the channel centerline and then on the side slope of 3:1 (horizontal to vertical). The intake channel slopes are designed to maintain their stability during plant operating conditions (Reference 2). To minimize erosion by river currents and to protect the integrity of the intake channel, the slopes of the intake channel are covered by riprap between elevation 590 and 600 ft. as shown in Figure 3.4-2. Riprap stabilizes the banks of the intake channel and the river shoreline. Field water sample data, shown in Table 2.3-38, indicates that the turbidity of water at the nearby entrance of the intake channel is 5.0 to 8.2 Nephelometric Turbidity Units. These data indicate relatively clear and clean water. Because the intake channel withdraws less than 5 percent of river water flow with relatively low-intake velocities, the operation of the intake system is not expected to cause any significant changes in shoreline erosion, bottom scouring, induced turbidity, or silt buildup. However, the intake channel is periodically monitored and dredged, as a maintenance activity, as required to prevent the buildup of sediment deposits and littoral debris to maintain free access to the river.

5.3.1.2 Aquatic Ecosystems

In considering the effects of the intake structure for closed-cycle cooling systems on aquatic ecology, the U.S. Nuclear Regulatory Commission (NRC) evaluates (1) impingement or trapping of fish and shellfish on the intake structure screens, (2) entrainment, or drawing into the cooling water stream, of fish (eggs and larvae) and veligers (mollusk larvae), and (3) entrainment of phytoplankton and zooplankton. Studies of intake effects of closed-cycle cooling systems have generally judged these impacts to be not significant because a closed-cycle, re-circulating cooling system decreases water use by up to 98 percent from a once-through cooling system (References 3 and 4).

5.3.1.2.1 Fish Impingement and Entrainment

Utilizing closed-cycle technology and cooling towers rather than a once through system reduces entrainment and impingement losses of fish primarily because of the relatively small volumes of makeup water needed for the evaporative loss of water from the cooling towers (Reference 3). However, even low rates of entrainment and impingement may be of concern when an unusually important resource is affected. Important aquatic resources include threatened, endangered, and other species of special interest, and critical habitat for these and other species. Table 2.4-7 lists fishes identified in Guntersville Reservoir over time. Species collected are common and community structure uniform for all sampling locations. Because species composition is similar for intrareservoir sampling and habitat near the intake and discharge structures are not rare or unique to the reservoir, additional sampling at the intake and discharge structures was not warranted.

Based on review of literature and operational monitoring reports, Subsection 5.3.1.1.1 concludes that less than 3 percent of the Guntersville Reservoir water is removed under both mean and 7Q10 low-flow conditions. Using this relatively small volume of water for a new facility at BLN has minimal impact on the resident population of fish. Section 3.4.2.1 indicates water velocity through the screens during operational mode, which is well under 0.5 fps flow requirements of Section 316(b) of the Clean Water Act. Impingement of organisms on the intake screens is not likely to be a problem due to minimal water use and low intake velocities.

The current intake structure is at the terminal end of a canal that extends perpendicularly from the Guntersville Reservoir. Substrate material in the canal consists of silt deposited from the water column over bedrock. Maximum flow rate through the canal is in Section 3.4.2.1. This type of habitat is not conducive to developing a diverse aquatic community. The habitat is not degraded by operational water intake.

Only two federal- and state-listed protected species (Tables 2.4-5 and 2.4-6) identified through agency contacts (Section 2.4.2) possibly occur on or near the BLN site. The pink mucket mussel (*Lampsilis abrupta*) and Anthony's river snail (*Athearnia anthonyi*) have been found in the northern reaches of the Guntersville Reservoir. However, a 1995 survey adjacent to BLN revealed neither species (Section 2.4). A mussel survey performed in April, 2007 identified only common mussels in low densities (0.08 – 0.48 mussels/square meter) adjacent to the BLN site. Densities are too low to support commercial or recreational uses. Because few mussels exist adjacent to BLN, impacts from the intake system to resident mussel populations are expected to be SMALL.

Although protected species have not been located within the Guntersville Reservoir adjacent to the BLN site, the reservoir does support an active sport fishery. In the mid-1990s, estimations concerning sport fishing dollars funneled into the local economy from the Guntersville Reservoir was approximately 15 million. Two thirds of anglers visiting the Guntersville Reservoir fish predominantly for largemouth bass, although sunfish, sauger, crappie, and catfish also receive attention from anglers. To prevent over harvesting of young quickly growing bass, the minimum length limit was increased to 15 in. on October 1, 1993 (Reference 5). Although fish growth is largely dependent upon water temperature and food availability, on average largemouth bass in Alabama reach harvestable size at four years of age (Reference 6). Given the percentage of reservoir water necessary to cool the BLN, negative impacts to the fishery on Guntersville Reservoir are considered SMALL.

Entrainment of ichthyoplankton carries a 100% mortality rate. A study of ichthyoplankton and larval fish in the Guntersville Reservoir from 1977 – 1983 did not result in the collection of any species of special interest. The overwhelming majority (95 percent) of entrained ichthyoplankton were from freshwater drum (*Aplodinotus grunniens*), which are one of the only pelagic spawning fish species (Reference 7). However, egg characteristics of many fish species are such that they would not be entrained. Some Catostomidae species lay heavy eggs in open water, which sink to the bottom leaving them less vulnerable to current patterns (Reference 18). Species from families Catostomidae, Clupeidae, Cyprinidae and Percidae (sauger) lay eggs with adhesive properties that stick to substrate such as logs or emergent vegetation and are not susceptible to directional flow (References 18 and 19). Some species of families Centrarchidae (sunfish, crappie, bass), Ictaluridae (catfish), and Cyprinidae display parental care by laying eggs in nests and guarding them until they hatch. (References 19, 20 and 21)

Entrainment estimates presented in a 1977 TVA report (Reference 23) are based on predictions of intake design and hydraulic flow characteristics, where it is assumed that biotic entrainment is equal to hydraulic entrainment (percent of river flow withdrawn by the intake). This report concludes that this comparison is conservative and overestimates biotic entrainment due to a variety of factors such as (1) the assumption of a temporally and spatially homogeneous distribution of ichthyoplankton, (2) the behavior of larval fish in association with shelter or substrate, and (3) the ability of larval fish to withstand and escape from low-velocity water currents. During this study the percent entrainment of larval fish and eggs ranged from 0.47 to 1.37 and 0.14 to 0.26, respectively. The total number of larval fish and eggs entrained during both years of monitoring ranged from 3.314×10^7 to 8.046×10^7 and 1.068×10^7 to 6.983×10^7, respectively. These estimates were based on the intake demand of 3.675×10^5 m^3/d for original design of Bellefonte Units 1 and 2.

The intake system description for the currently considered AP1000 reactor systems states that the daily average flow of Guntersville Reservoir past the site is 38,850 cfs or 9.50×10^7 m^3/d (Subsection 2.3.1.2.2). The intake makeup water during normal operation is reported to be 110 cfs or 2.70×10^5 m^3/d (Subsection 3.4.2.1). Therefore, the hydraulic entrainment is 0.28 percent.

Larval fish densities, expressed as numbers per 1000 m^3 of water sampled, collected in reservoir transects adjacent to Bellefonte Nuclear Plant site from 1975 through 1983 ranged from 19,480 to 197,402/1000 m^3 and averaged a total of 54,783 fish larvae over the nine years of sampling (Reference 24). If the biotic entrainment is equal to hydraulic entrainment, albeit a conservative assumption, then 0.28 percent of the annual average larval fish density would represent the level of entrainment of fish larvae at the BLN site. This yields an estimated 15,339.2/1000 m^3 of fish larvae entrained.

TVA owns and operates Widows Creek Fossil Plant (WCF), which is also located on Guntersville Reservoir between Tennessee River mile 406 and 408, approximately 15 mi. upstream of the BLN site. The eight coal-fired units at WCF are divided into two groups; WCF Plant A is comprised of Units 1 through 6, and WCF Plant B is comprised of Units 7 and 8. The intake canal and intake structure for WCF Plant A are similar in length and design to those for BLN. The BLN intake canal is 1200 ft. long, and the intake canal at WCF is 1100 ft. in length. Both intake structures are equipped with trash racks and traveling screens and have a trash boom located at the intake canal entrance to protect the channel from floating debris. Plant operating maximum intake water velocity at the intake structure for WCF is 1.55 fps, whereas the BLN intake water velocity is estimated to be less than 0.5 fps.

Annual impingement information was collected from 2005 to 2007 for both intake structures associated with WCF. Because the intake structure for WCF Plant A is similar to that for BLN, the years of impingement monitoring at Plant A, along with species sample data taken at TRMs 350.0, 375.2, 450.0, 410.0, and 424.0 (Table 2.4-X5), provide surrogate species composition information for BLN. Study data indicate threadfin shad is the species most susceptible to impingement. Threadfin shad comprised 72 percent of fish impinged during the 2005 – 2006 study and 93 percent during the 2006 – 2007 study. Bluegill and freshwater drum comprised a distant second-highest percentage (6 percent each) of fish impinged during

2005 – 2006, and yellow bass comprised a distant second-highest percentage (4 percent) of fish impinged during 2006 – 2007 (Table 5.3-X1).

Although threadfin shad is the species most vulnerable to impingement, other species present within Guntersville Reservoir appear able to largely avoid impingement and entrainment. However, threadfin shad and freshwater drum have consistently been collected in population surveys indicating the operation of the WCF cooling system through the existing intake structure has not dramatically reduced populations of these fishes. Due to the difference in water velocity at the BLN intake compared to WCF, impingement at the BLN intake structure is expected to be of a similar composition but reduced magnitude from that shown for WCF. Population impacts stemming from impingement and entrainment of fish are, therefore, considered to be SMALL.

5.3.2 DISCHARGE SYSTEM

This section describes the impact of the discharge system on the aquatic ecology and the physical impacts such as scouring, silt build up and shore line erosion caused by the flow field induced by the discharge system during station operation.

The CWS and SWS, as described in Section 3.4, discharge into a common blowdown pipe, which discharges to the Guntersville River.

Subsection 5.3.2.1 describes the physical impacts associated with thermal discharges to the Guntersville Reservoir. Subsection 5.3.2.2 describes the impacts of the thermal discharges on the aquatic ecosystems. Overall, as discussed in the following subsections, the impacts associated with the operation of the discharge system are SMALL.

5.3.2.1 Thermal Description and Physical Impacts

The effluent discharge from the new facility is installed directly in the Guntersville Reservoir (Tennessee River), and is located downstream of the intake to avoid recirculation of effluents into the plant intake. The effluent outfall is located approximately 6000 ft. downstream of the intake screens. Due to the distance of the intake from the station discharge the plume dissipates before ever reaching the plant intake in the event of a reverse river flow. The station discharge has been analyzed using CORMIX2, version 5.0 as discussed in the next paragraphs. Data used for input to CORMIX was collected using portable temperature probes and flow meters in random transects and measured distances from the discharge.

The mathematical modeling tool CORMIX is a computer code for the analysis, prediction, and design of aqueous toxic or conventional pollutant discharges into diverse water bodies. It is an EPA recommended analysis tool for the permitting of industrial, municipal, thermal, and other point source discharges to receiving waters. The CORMIX2 system, which is used for prediction of subsurface multi-port discharges, was used exclusively for this analysis (Reference 17).

CORMIX2 analyzes unidirectional, staged, and alternation designs of multi-port diffusers and allows for arbitrary alignment of the diffuser structure within the ambient water body, and for arbitrary arrangement and orientation of the individual ports. For complex hydrodynamic cases, CORMIX2 uses the “equivalent slot diffuser” concept and thus neglects the details of the individual jets issuing from each diffuser port and their merging process, but rather assumes that the flow arises from a long slot discharge with equivalent dynamic characteristics (Reference 17).

Dilution and distribution of the discharge heat as well as other effluent constituents are affected by both the design of the discharge structure and the flow characteristics of the receiving water. Table 5.3-1 shows the projected average discharge parameters and the maximum expected discharge rates for a new facility. BLN is using an existing blowdown discharge for the new units. This discharge system consists of a submerged multiport diffuser, which discharges at an angle of 60 degrees from the north river bank. The diffuser system consists of two diffuser sections with a combined length of 120 ft. situated approximately 375 ft. from the right bank. Simulation runs for the 45 ft. and the 75 ft. diffusers were also made and were found to be bounded by the 120 ft. diffuser. Results of all simulations can be found in Table 5.3-2.

The temperature of the blowdown from the natural draft cooling towers may vary from below the river temperature in October to above the river temperature in December, depending upon the relative magnitude of wet bulb temperatures and river temperatures. The latter case is expected to result in the maximum mixed temperature rise after diffuser mixing. The maximum temperature is expected in July and August, when river temperatures are the highest.

An analysis of thermal plumes resulting from plant effluent discharges was conducted for conditions:

- Low river temperature, 7Q10 downstream flow (Figure 5.3-3).
- High river temperature, 7Q10 downstream flow (Figure 5.3-4).
- Low river temperature, reversing river flow.[1]
- High river temperature, reversing river flow.[1]
- Low river temperature, maximum reverse river flow (Figure 5.3-5).
- High river temperature, maximum reverse river flow.[1]
- Low river temperature, maximum downstream flow.[1]
- High river temperature, maximum downstream flow.[1]

The effluent blowdown flow rate of 16,000 gpm was conservatively used for the CORMIX2 runs, the actual blowdown flow for two cooling towers is approximately 15,828 gpm.

1. No figures are provided for simulations without measurable plumes. In addition, no figures were provided for the transitional reversing river flow. The reversing condition is of such a short duration (less than 2 min.), that a fully developed plume could not be created.

Summaries of the predicted plume analysis data are provided in Table 5.3-2. For the maximum delta-T conditions, low river temperature 7Q10 downstream flow, the surface area within a 5°F temperature isotherm is estimated to be 25,213 sq ft. These isotherms extend approximately 36 ft. from the discharge diffuser. The maximum width of the 5°F isotherm is approximately 379 ft., or about 23 percent of the width of the river, which is approximately 1640 ft. at normal reservoir pool condition (Reference 9). Therefore, the formation of a thermal barrier is precluded. During a low temperature discharge, the diffusion of the low temperature plume is bounded by the conditions as seen in the diffusion of a high temperature plume. If the discharge is non-buoyant, or weakly buoyant, and the ambient is unstratified, there is no buoyant spreading region in the far-field, only a passive diffusion region. The high temperature plumes have all dissipated in the near field mixing zone region, therefore the low temperature plumes should follow this same pattern.

The combined blowdown flow rate of approximately 15,828 gpm for the site is less than 0.10 percent of the normal minimum flow for the Guntersville Reservoir (Tennessee River) near the site given as 3.8 million gpm. Under low temperature operating conditions, the greatest temperature difference (delta-T) of approximately 56°F exists between the river water at 39.2°F and the effluent discharge, which is conservatively assumed to be at a temperature of 95°F for this analysis. Actual mixed effluent discharge temperatures are lower than 95°F.

The predicted thermal plume resulting from the proposed discharge system was modeled for the combined discharge using the CORMIX2. Thermal predictions for the low temperature conditions assumed plant discharge conditions as above, and an ambient river flow velocity of 0.5 fps. Results of this model show a small thermal plume that dissipates quickly. The plumes have no attachment or interface with a river bank and do not adversely affect river temperature. Dimensions of the predicted plume are provided in Table 5.3-2.

5.3.2.2 Aquatic Ecosystems

Potential effects of discharging heated water are effectively minimized by using a closed-loop cooling system and cooling towers. The majority of waste heat is discharged to the atmosphere through evaporation and not to Guntersville Reservoir. In using a closed-loop system, increased evaporation from the cooling towers causes a buildup of minerals in the water. By discharging some effluent and bringing in makeup water, the total dissolved solids are kept within design parameters. However, limited thermal effects have been shown at other facilities associated with the discharge of heated blowdown water to the river.

NRC studies evaluated the potential impacts of discharging heated water to an aquatic system including (1) thermal discharge effects, (2) cold shock, (3) effects on movement and distribution of aquatic biota, (4) premature emergence of aquatic insects, (5) stimulation of nuisance organisms, (6) losses from predation, (7) parasitism and disease, (8) gas supersaturation of low dissolved oxygen in the discharge, and (9) accumulation of contaminants in sediments or biota. In general, for plants employing cooling tower systems, the impacts were found to be minor (Reference 4). The thermal plume discharged by the BLN in particular is so small that adverse impacts to biota are not expected.

Based on directional flow of reservoir water toward the Guntersville Dam, the thermal plume would have the potential to cause minor impacts to aquatic habitat at and southwest of the discharge area toward the dam. The maximum discharge rate for any mode of operation is 7,989 gpm per unit. The highest temperature discharge allowed by NPDES permit AL 0024635 is 95ºF (Reference 10). A mixing plume of maximum volume occurs in winter when the reservoir temperatures are colder.

The CORMIX model (Subsection 5.3.1.1) assumes worst case conditions when ambient water temperature in the Guntersville Reservoir is 39.2ºF and the discharge temperature is 95ºF. The plume is then 35 ft. in length and 232 ft. wide (Table 5.3-2). In summer months, when ambient reservoir temperatures can reach 88.5ºF, thermal discharge mixes immediately, reducing the plume to 0.72 ft. in length and 124 ft. wide, at which point effects to biota, including important species outlined in Subsection 2.4.2, are expected to be negligible. Under all temperatures and water volume scenarios modeled, the plume is maintained well within 25 percent of the width of the reservoir.

In the winter, some fish may be attracted by the elevated temperature of the plume with some species possibly residing in the plume for extended periods. This, in turn, could result in accelerated spawning, possibly leading to increased larval mortality from asynchrony with food source development or cold shock of migrant larvae. Because the heated water plume is small in comparison to the reservoir size, these impacts are expected to be SMALL, having a negligible effect on total reservoir populations.

During the breeding season, many fish migrate to spawning grounds in rivers and reservoirs. In the Tennessee River system a number of dams and locks divide the river into a series of reservoirs. Sauger (*Sander canadensis)* are known to traverse the lock system to migrate to preferred breeding grounds. Although the actual spawning grounds within the Tennessee River system are not known for any species, the Nickajack Dam tailwater area is considered a staging area where sauger congregate prior to breeding. Due to the discharge plume size and location it is not expected to interfere with migration or breeding areas of fish within the Guntersville Reservoir.

Populations of drifting benthos, plankton, and larval fish are more dense in spring and summer months. However, because the temperature differential from the thermal plume to ambient reservoir temperature is greater in the winter, individuals passing through the thermal plume at the site may be influenced to a greater extent in winter months. Calculated plume in the winter is also 35 ft. Given the plume's small size within the reservoir, any impacts to drifting organisms is SMALL.

Physical impacts associated with discharging water into Guntersville Reservoir are expected to be SMALL for several reasons. The discharge pipes total 120 ft. in length and are situated 300 ft. from the river bank. Water is diffused out of several ports within the discharge pipe and at an angle which was designed to minimize bottom scouring of the river. Because the plume width is less than 300 ft. in width, river banks are not affected by discharge. Thermal blowdown associated with BLN is diffused directly into Guntersville Reservoir and not to any wetlands in the floodplain. Therefore, no impacts to wetlands or the bottomland floodplain are expected. The additional flow during a flood event minimizes the time for mixing of the effluent with reservoir water. This further reduces the possibility of significant impact.

Second to thermal impacts to aquatic organisms in potential significance are chemical effects due to chemicals present in blowdown water from the cooling towers. Common to industrial cooling water systems are chemicals to prevent the buildup of bacteria, algae, scale and mollusks at some point from intake to discharge. Chemical additives intended to disperse silt, inhibit corrosion, and adjust pH to acceptable discharge levels are also frequently used. NPDES permit AL 0024635 limits priority pollutants and chlorine within blowdown water. Sodium hypochlorite, intended as a biocide within the blowdown system, contains chlorine. Total chlorine is limited to a maximum of 0.5 ppm, which is too low to cause negative impacts to resident biota. (Reference 10) Although NPDES permit AL 0024635 applies to Bellefonte Units 1 and 2, it is reasonable to expect similar restrictions for Units 3 and 4.

Perhaps more important than limitations on chemical concentrations within blowdown water is performing toxicity tests using live organisms. Toxicity can only be tested using live organisms as a gauge. One seven day chronic toxicity test is mandated by the current NPDES permit annually. Emissions of unregulated toxic chemicals in toxic amounts would cause the BLN to fail the lethal concentration 25 percent (LC25) limitation. Because a mandatory chronic assay using effluent would be performed annually, chemical impacts from effluent are expected to be SMALL.

5.3.3 HEAT-DISCHARGE SYSTEM

This section describes the impact of the heat-discharge system on the aquatic ecology and the physical impacts such as scouring, silt build up and shore line erosion caused by the flow field induced by the discharge system during station operation.

The CWS and SWS, as described in Section 3.4, use cooling towers to dissipate heat to the atmosphere.

Subsection 5.3.3.1 describes the impacts associated with heat dissipation to the atmosphere. Subsection 5.3.3.2 describes the impacts of the operation of heat dissipation systems on terrestrial ecosystems. Overall, as discussed in the following subsections, the impacts associated with the heat dissipation system on the atmosphere and terrestrial ecosystems is SMALL

5.3.3.1 Heat Dissipation to the Atmosphere

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

Two natural draft cooling towers (NDCTs) are normal plant heat sink(s) (NHS) for the AP1000 units existing on the site as a result of the past nuclear construction. The existing cooling towers were selected on the basis of cost and their ability to meet the plant's heat load requirements. The cooling tower dimensions, layout, and airflow rates, are provided in Table 5.3-3. Typical drift rates for cooling towers of this type, and average Guntersville Reservoir water's dissolved solids and salt concentrations were used to support deposition calculations. See Figure 2.1-1 for the location of the cooling towers with respect to the BLN facility.

In addition, the service water cooling towers (SWCT) are used when the NHS is not in service. The heat dissipated by the SWCT during plant shutdown/cooldown are orders of magnitude less than the heat dissipated by the NHS cooling towers, and the heat dissipated by the NHS cooling towers decreases as the plant shuts down and is zero when the plant is shutdown; therefore, the environmental impact that is associated with SWCT operation is bounded by the NHS cooling tower analysis.

A model discussed in NUREG-1555, Environmental Standard Review Plan, was Carhart and Policastro. In NUREG-1555, the NRC accepted Carhart and Policastro's conclusion that their code predicts the plume rise within a factor of two about 75 percent of the time and visible plume length within a factor of 2.5 about 70 percent of the time. This model was embedded into the Electric Power Research Institute's Seasonal/Annual Cooling Tower Impact Prediction Code (SACTI) in 1991. ENERCON uses SACTI to evaluate the cooling tower plumes impact on the environment. The temperature of the water into and out of the cooling tower, temperature of the air, and the amount of heat released are all inputs to Electric Power Research Institute's SACTI code. Cooling tower performance curves are located in Section 3.4.

As discussed earlier, the heat dissipation system for the NHS for the new facility uses the existing NDCTs. The base of the cooling towers is located at 630 ft. msl and has a height at the discharge of 1104 ft. msl. This value was used in the SACTI model.

The mixing height data for the model was taken from Table 5.3-4. This table contains average mixing heights for the morning and afternoon by season for Nashville, TN.

In order to determine the potential impact of solids deposition due to the cooling tower plumes, the concentrations of salts and dissolved solids in the NHS circulating water must be input into the plume model. The source of circulating water makeup for the NHS is the Guntersville Reservoir. Table 5.3-3 indicates that the cycles of concentration for the NHS circulating water is expected to be a maximum of four, which results in the concentrations being four times that of the reservoir. The Guntersville Reservoir water salt and dissolved solids concentrations used in the model are based on an average of the available information from Subsection 2.3.3. The river water concentrations and the equivalent NHS four-cycles of concentration are as follows:

Parameter	River Water	Four Cycles of Concentration
Dissolved Solids	<2.0 mg/l	<2.0 mg/l
Sodium Salt	10.0 mg/l	40.0 mg/l
Iron Salt	<0.01 mg/l	<0.01 mg/l

Four years of meteorological data from 1979 through 1982 for the BLN site and from Huntsville, AL were used in the model.

Parameter	BLN NDCT Values
Number of Towers	two
Circulating Water Flow Rate	531,100[(a)] gpm per tower
Flow Rate	531,100[(a)] gpm per tower
Maximum Drift Rate	106 gpm per tower
Exit Air Flow	34,650 lb per second, per tower
Heat Rejection Rate	7660 MBtu/hr per tower (actual 7540 MBtu/hr)
Tower Top Diameter	350 ft.
Hot Water Temperature	121ºF
Cold Water Temperature	91ºF
Exit Air Temperature	110.8ºF

a) Includes Turbine Component Cooling and Condenser Vacuum pump cooler flows.

5.3.3.1.1 Length and Frequency of Elevated Plumes

Table 5.3-5 describes the expected plume lengths by season and direction for the two NDCT. The longest average plume lengths are predicted to occur during the winter months and the shortest are predicted to occur during the summer months. The model predicts a combined average length of approximately 2.8 mi. in winter.

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

A study conducted by Central Hudson Gas & Electric, 1977 (Reference 11) indicates that surface fogging from natural draft towers does not present a significant problem. The height of the cooling towers and their calculated plume make it unlikely that fogging could occur at the site. Icing, which is associated with fogging, can result during periods of sub-freezing temperatures. Because the NDCTs are located approximately 0.5 mi. or more south of the new power blocks and electrical transmission facilities (i.e., switchyard), and because fogging from NDCTs is predicted to be rare, no adverse impact on the plants' operation is anticipated.

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

The towers use drift eliminators to minimize the amount of water lost from the towers via drift. Some droplets are, nevertheless, swept out of the tops of the cooling towers in the moving air stream (See Table 5.3-6). This drift essentially has the same concentrations of dissolved and suspended solids as the water in the cooling tower basin. The concentrations in the CWS are expected to be limited to four cycles of concentration of that present in the Guntersville Reservoir water.

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

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

a. Factors associated with the design and operation of the cooling tower include:

   1. Volume of water circulating in the tower per unit time (circulating water flow rate).

   2. Salt or particulates concentrations in the water.

   3. Drift rate.

   4. Mass size distribution of drift droplets.

   5. Plume rise influenced by tower diameter, height and mass flux.

b. Factors related to atmospheric conditions include:

   1. Humidity.

   2. Wind speed.

   3. Wind direction.

   4. Temperature.

   5. Pasquill’s stability class.

Sodium salt from the natural draft cooling towers (NDCT) is predicted to deposit at a maximum rate of 0.089 pounds per 100-acre-month at a distance of 7542 ft. southwest of the NDCT. NUREG-1555 Subsection 5.3.3.2 indicates maintaining a deposition rate below 89.2 to 178.4 pounds per 100-acre-month is generally not damaging to vegetation. The nearest garden is 0.71 mi. WNW of the cooling tower locations therefore, operations at the BLN site are anticipated to have SMALL impacts on land use in the vicinity of the site. The maximum predicted deposition rate for sodium salt is 0.089 lb per 100-ac-mo (Subsection 5.3.3.2.1). These deposition rates are predicted to occur at approximately 7500 ft. southwest of the NDCTs. Table 5.3-7 presents sodium salt deposition predictions for the NDCTs. The nearest garden is 0.71 mi. WNW and the nearest home is 0.69 mi. NW from the proposed cooling tower location.

Therefore, it is concluded that the impact of the operation of the NHS cooling towers for the new facility does not affect the normal area crops or the growing season in the area.

5.3.3.1.4 Cloud Formation, Cloud Shadowing, and Additional Precipitation

The potential for cloud development and plume shadowing due to the operation of cooling towers exists (See Table 5.3-8). Natural-draft cooling tower plumes at several power plant sites have been observed to cause broken cloud decks to become overcast, make thin clouds thicker, and create separate cloud formations several thousand feet above ground.

Light drizzle and snow occasionally have been noted within a few hundred meters downwind from cooling towers, but these phenomena are very localized and should have no effect outside the site boundary (Reference 12). Studies indicate that some enhancement of small rain showers might be expected, as tower fluxes are within an order of magnitude of the shower fluxes (Reference 12). Large thunderstorms, with their much greater flux values, should not be significantly affected, except that formation may occur somewhat earlier in the day than would otherwise be expected, with the cooling tower plume possibly acting as a triggering mechanism.

One of the potential environmental impacts resulting from the discharge of cooling tower moisture is the regional augmentation of natural precipitation. Estimates of the total contribution to surface precipitation from cooling towers, based on a 2200-MWe (7507 MBTU per hour) station, would be only 0.4 in. annually (Reference 13). This amount is inconsequential compared to the total annual rainfall (56.8 in.) experienced in this region, Subsection 2.3.1.5.7. Induced snowfall due to operating cooling towers has been observed. However, the accumulation was found to be less than 1 in of very light, fluffy snow. Other documented induced-snowfall occurrences generally preceded actual snowfall occurrences. An investigation into the climatic conditions conducive to induced snowfall indicated that a very cold temperatures (less than 11ºF), high plume height (4900 ft.), and stable atmosphere with moderate winds (15 fps) optimized this situation (Reference 14). This type of meteorological condition occurs infrequently at the BLN site; therefore, there is no reason to expect that the new facility's cooling towers would significantly alter local meteorology.

5.3.3.1.5 Interaction of Vapor Plume with Existing Pollutant Sources Located Within 1.25 Mi. of the Site

There are no pollutant sources located within 1.25 mi. of BLN.

5.3.3.1.6 Ground Level Humidity Increase in the Site Vicinity

In the vicinity of the vapor plumes, both the absolute and relative humidity aloft is increased as evidenced by calculated frequency of visible plume occurrence. Absolute humidity at the surface is increased only slightly. However, relative humidity near the towers may be increased during the colder months due to relatively low moisture-bearing capacities of cold air. Ground level humidity resulting from the operation of cooling towers has not been reported.

5.3.3.2 Terrestrial Ecosystems

The cooling system for the BLN is a closed-cycle that would employ NDCTs. Rejected heat is manifested in the form of atmospheric water vapor plumes. This section describes the potential impacts that the cooling tower plume drift has regarding exposure of the vegetation near nuclear power plants to salts, icing, or other effects (e.g., fogging and increased humidity) caused by standard operation of cooling towers.

A significant benefit behind closed-cycle systems is that water is recycled through the plant leading to less overall water removed from the reservoir when compared to a once-through system. However, because cooling water is cycled through the system several times and evaporation rates are high, dissolved and suspended solids evident in cooling water are concentrated up to four times that found in intake water. For BLN, cooling water is drawn from the Guntersville Reservoir from a canal perpendicular to the reservoir. Given the concentrations of dissolved solids, sodium salts, and iron salt within the Guntersville Reservoir, four cycles of concentration would bring the levels to < 2.0 ppm, 40 ppm, and < 0.01 ppm, respectively (Subsection 5.3.3.1).

5.3.3.2.1 Salt Drift

Although the cooling towers are equipped with drift eliminators to reduce the amount of liquid particle loss, some droplets containing dissolved particles are ejected from the cooling tower. Potential impacts of salt exposure due to cooling tower operation on native vegetation are similar to those for agricultural crops, including salt-induced leaf damage, growth, and seed yield reduction. It is not expected that species other than those located on the site would be susceptible to salt deposition. No land used for agricultural purposes exists within the BLN boundary and the nearest garden is 0.71 mi. WNW of the cooling tower locations. A winter 2007 habitat survey for endangered vegetation within the BLN site indicates appropriate habitat for Price’s potato bean and Morefield’s leather flower is located on-site (Section 2.4.1). However, salt deposition rates are calculated to be too low to induce damage to vegetation.

NUREG-1555, Subsection 5.3.3.2 indicates maintaining a deposition rate below 89.2 lb per 100-ac-mo is generally not damaging to vegetation. The maximum NDCT sodium salt deposition rate of 0.089 lb per 100-ac-mo is predicted to occur at 7542 ft. southwest of the NDCTs. NUREG-1555, Subsection 5.3.3.2 indicates maintaining a deposition rate below two kilogram per ha per month (178.4 lb per 100-ac-mo), preventing damage to vegetation. Therefore, impacts associated with salt deposition stemming from cooling tower operation both on-site and outside the BLN site are SMALL.

5.3.3.2.2 Increased Precipitation

Increases in precipitation within the drift field are expected. One of the potential environmental impacts resulting from the discharge of cooling tower moisture is the regional augmentation of natural precipitation. Estimates of the total contribution to surface precipitation from cooling towers, based on a 2200-MWe station, is only 0.4 in. annually and predominantly southwest of the cooling towers within 1.5 mi. (Table 5.3-6) (Subsection 5.3.3.1). This amount is inconsequential compared to the total annual rainfall (56.8 in.) experienced in this region and is expected to have a SMALL impact on resident species. (Subsection 2.3.1.5.7).

Induced snowfall due to operating cooling towers has also been observed. However, the accumulation was found to be less than 1 in. of very light, fluffy snow. Other documented induced-snowfall occurrences generally preceded actual snowfall occurrences. An investigation into the climatic conditions conducive to induced snowfall indicated that a very cold air temperature (less than -11ºF), plume height (4900 ft.), and stable atmosphere with moderate winds (15 fps) optimized this situation (Subsection 5.3.3.1). This type of meteorological condition occurs infrequently at BLN; therefore, it is expected that impacts to area weather are SMALL.

5.3.3.2.3 Fogging and Icing

Subsection 5.3.3.1 indicates surface fogging at the BLN site is expected to be rare. The height of the cooling towers and their evaluated plume make it unlikely that fogging could occur. Icing, which is associated with fogging, can result during periods of sub-freezing temperatures. However, because fogging is not expected, icing events would also be rare, thus having SMALL impacts on terrestrial ecology and not warrant mitigation.

5.3.3.2.4 On-Site Ponds

Several pond areas exist on the BLN site. Over time, on site ponds have developed communities of fish, amphibians, invertebrates, beavers, and vegetation kept in check by grass carp (Subsection 2.4.2). The WWRB (Figure 2.4-4) is the wastewater retention pond and functions as a settling pond. The WWRB cascades into Pond A, which functions as a stormwater retention pond. Pond A cascades into the construction holding pond, which subsequently discharges to Town Creek. Toxic wastes are not disposed of in the WWRB and solids are expected to settle in either the WWRB or Pond A.

5.3.3.2.5 Noise

Noise stemming from the operation of existing cooling towers is expected to be similar to background at the site boundary, as noted in Subsection 5.8.1.4. Resident species quickly adapt to constant background noise or relocate to adjacent habitats. Therefore, noise is expected to have a SMALL impact on terrestrial ecology.

5.3.4 IMPACTS TO MEMBERS OF THE PUBLIC

This section describes the potential health impacts associated with the cooling system for Units 3 and 4. Specifically, impacts to human health from thermophilic microorganisms and from noise resulting from operation of the cooling system are addressed.

5.3.4.1 Thermophilic Microorganisms

Recreational swimming in Alabama is generally considered a safe activity with regard to pathogen exposure. The TVA measures bacteria levels in common swimming areas along the Tennessee River including the Guntersville Reservoir. In 2006, no state swimming advisories were issued for the Guntersville Reservoir. Furthermore, Alabama reported zero waterborne disease outbreaks for U.S. surveillance reports in 1997–1998, 2001–2002, and 2003–2004 (References 15 and 16).

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

Units 3 and 4 utilize two natural draft cooling towers to employ a closed-cycle cooling system and reduce heated discharge to the Guntersville Reservoir. Discharged blowdown and wastewater is expected to be released directly into the Guntersville Reservoir in accordance with the facility's NDPES permit. The facility's main wastewater discharge point is located approximately 6000 ft. downstream of the intake structure (Subsection 5.3.2.1).

The Guntersville Reservoir is a large reservoir in the Tennessee River system. Flow throughout the reservoir is approximately 39,800 cfs. The reservoir is considered a run of the river reservoir because retention time is short and winter drawdown is slight. The sheer size and flow of this reservoir are conducive to discharges of heated water because the mixing plumes are very small. The calculated mixing zone for releasing BLN blowdown under a worst case scenario (winter during low flow conditions) was 35 ft. in length. In summer months when the reservoir is warm, no thermal plume exists. Although bacterial analysis for thermophilic microorganisms have not been performed, by discharging into a large and flowing reservoir, concentrations of detrimental thermophilic bacteria are expected to remain low.

Section 5.2.3 details the thermal plume expected from cooling tower blowdown to the Guntersville Reservoir. Theoretically, thermal additions to the Guntersville Reservoir could support thermophilic microorganisms. However, thermal plume has maximum temperatures in the range of 91ºF with a very small mixing zone thus limiting the conditions necessary for optimal growth. Impacts to public health from thermophilic microorganisms are SMALL and do not warrant mitigation.

5.3.4.2 Noise

The BLN units produce noise from the operation of pumps, cooling towers, transformers, turbines, generators, switchyard equipment, and loudspeakers. NUREG-1555 notes that the principal sources of noise include natural draft cooling towers and pumps that supply the cooling water. Nearest off-site residences are within 1.2 mi. and distance and vegetation are expected to attenuate any noise.

Most equipment is located inside structures, reducing the outdoor noise level. The cooling towers have noise emissions as high as 55 dBA at distances of 1000 ft. (Section 5.8). The closest distance from a cooling tower to a point on the property boundary is over 1500 ft. Day-night noise levels that are anticipated from the plant's cooling tower are less than 65 dBA at the site boundary, which is considered to be of SMALL significance to the public. Thus, no mitigation alternatives are necessary. Therefore, the noise impact at the nearest residence is SMALL and no mitigation measures are expected.

5.3.5 REFERENCES

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TABLE 5.3-1
SUMMARY OF FACILITY DISCHARGE PLUME CASES ANALYZED

Case	Ambient River Temperature (ºF)	Discharge Rate[a] (gpm)	Discharge Temperature[b] (ºF)
High River Temperature	90	16,000	95
Low River Temperature	39.2	16,000	95

a) Actual plant discharge rates vary; maximum flows are shown. As discussed in Subsection 5.3.2, this discharge flow represents the total of the maximum expected blowdown from Units 3 and 4.

b) The analysis was done using a temperature of 95ºF for all discharges.

TABLE 5.3-2 (Sheet 1 of 3)
SUMMARY OF THERMAL PLUME ANALYSIS

120-Ft. Diffuser, 100% Discharge Flow

		Maximum Downstream Flow		Maximum Reverse Flow		7Q10 Flow		Reversing River Flow	
Case Studied	Isotherm Considered (ºF)	Plume Length (ft.)	Max. Plume Width (ft.)	Plume Length (ft.)	Max. Plume Width (ft.)	Plume Length (ft.)	Max. Plume Width (ft.)	Plume Length (ft.)	Max. Plume Width (ft.)
High River Temperature	5	0.00	120.01	0.00	120.01	132.38	141.80	219.72	491.08
Low River Temperature	5	0.98	119.88	8.66	119.03	133.07	378.94	22.74	125.85

75-Ft. Diffuser, 1/2 Discharge Flow

		Maximum Downstream Flow		Maximum Reverse Flow		7Q10 Flow		Reversing River Flow	
Case Studied	Isotherm Considered (ºF)	Plume Length (ft.)	Max. Plume Width (ft.)	Plume Length (ft.)	Max. Plume Width (ft.)	Plume Length (ft.)	Max. Plume Width (ft.)	Plume Length (ft.)	Max. Plume Width (ft.)
High River Temperature	5	0.00	75.00	0.00	75.00	91.99	92.19	132.94	255.97
Low River Temperature	5	0.85	74.93	4.95	74.61	76.05	195.08	24.74	81.04

TABLE 5.3-2 (Sheet 2 of 3)
SUMMARY OF THERMAL PLUME ANALYSIS

45-Ft. Diffuser, 1/2 Discharge Flow

		Maximum Downstream Flow		Maximum Reverse Flow		7Q10 Flow		Reversing River Flow	
Case Studied	Isotherm Considered (ºF)	Plume Length (ft.)	Max. Plume Width (ft.)	Plume Length (ft.)	Max. Plume Width (ft.)	Plume Length (ft.)	Max. Plume Width (ft.)	Plume Length (ft.)	Max. Plume Width (ft.)
High River Temperature	5	0.00	45.01	0.00	45.01	129.43	67.72	170.90	233.60
Low River Temperature	5	1.64	44.95	12.66	44.36	54.53	157.81	141.93	1122.70

75-Ft. Diffuser, 100% Discharge Flow

		Maximum Downstream Flow		Maximum Reverse Flow		7Q10 Flow		Reversing River Flow	
Case Studied	Isotherm Considered (ºF)	Plume Length (ft.)	Max. Plume Width (ft.)	Plume Length (ft.)	Max. Plume Width (ft.)	Plume Length (ft.)	Max. Plume Width (ft.)	Plume Length (ft.)	Max. Plume Width (ft.)
High River Temperature	5	0.00	75.00	0.00	75.00	138.25	102.95	223.20	442.78
Low River Temperature	5	0.89	74.93	19.88	73.56	98.95	335.24	294.69	2138.85

TABLE 5.3-2 (Sheet 3 of 3)
SUMMARY OF THERMAL PLUME ANALYSIS

45-Ft. Diffuser, 100% Discharge Flow

		Maximum Downstream Flow		Maximum Reverse Flow		7Q10 Flow		Reversing River Flow	
Case Studied	Isotherm Considered (ºF)	Plume Length (ft.)	Max. Plume Width (ft.)	Plume Length (ft.)	Max. Plume Width (ft.)	Plume Length (ft.)	Max. Plume Width (ft.)	Plume Length (ft.)	Max. Plume Width (ft.)
High River Temperature	5	0.00	45.01	0.00	45.01	132.41	79.66	223.13	442.52
Low River Temperature	5	0.82	44.95	51.87	43.04	425.43	738.71	654.33	3046.00

TABLE 5.3-3
COOLING TOWER AND CIRCULATING WATER DATA

Tower type	Natural draft.
Number of towers	2
Tower arrangement	Hyperbolic
Tower height above plant grade	474 ft.
Tower basin diameter	412 ft.
Number of cells/tower	N/A
Exit diameter	350 ft.
Heat dissipation rate per tower	7630 MBtu/hr
Air mass flow rate per tower	34,650 lb/s
Circulating water flow/tower	531,100 gpm
Drift rate per tower	106 gpm
Cooling water salt concentration	40 mg/l
Cycles of concentration	Maximum 4

TABLE 5.3-4
MIXING HEIGHTS AT NASHVILLE, TENNESSEE

	Morning (ft.)	Afternoon (ft.)
Winter	1880	2638
Spring	1778	5010
Summer	1329	5712
Fall	1362	4039
Average	1588	4347

TABLE 5.3-5
AVERAGE PLUME LENGTHS IN MILES

	Winter	Spring	Summer	Fall	Annual
Plume from NDCT moving in the indicated direction					
S	3.08	1.87	1.07	2.15	2.2
SSW	3.11	2.07	1.63	2.39	2.32
SW	2.66	1.71	1.62	2.19	2.03
WSW	2.05	1.49	1.49	1.5	1.58
W	1.88	1.73	1.12	1.34	1.44
WNW	2.03	1.13	0.8	1.33	1.19
NW	2.06	1.57	0.98	2.08	1.6
NNW	2.28	1.24	0.86	1.6	1.45
N	2.47	1.21	0.92	1.3	1.37
NNE	3.06	1.85	1.43	2.07	2.11
NE	2.57	1.83	0.96	2.19	1.86
ENE	2.91	1.46	0.83	1.94	1.72
E	3	1.72	0.74	1.79	1.9
ESE	3.06	1.73	0.78	1.55	1.93
SE	2.85	1.68	0.63	1.44	1.75
SSE	2.93	1.73	0.64	1.65	1.93
All	2.8	1.65	1.17	1.93	1.88

TABLE 5.3-6
ANNUAL WATER DEPOSITION IN LB/(100-AC-MO)

Directions are directions that the plume is headed.

(mi)	(m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE
1.24	2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.3	2100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.37	2200	464	455	447	223	232	51	250	116	313	429	313	223	223	87	125	205
1.43	2300	1072	1072	1072	518	536	98	464	268	723	982	723	509	518	161	223	473
1.49	2400	393	384	375	188	196	37	179	98	268	357	268	188	188	63	88	170
1.55	2500	393	384	375	188	196	37	179	98	268	357	268	188	188	63	88	170
1.62	2600	393	384	375	188	196	37	179	98	268	357	268	188	188	63	88	170
1.68	2700	143	143	143	71	74	13	67	38	98	134	98	71	71	23	33	65
1.74	2800	143	143	143	71	74	13	67	38	98	134	98	71	71	23	33	65
1.8	2900	143	143	143	71	74	13	67	38	98	134	98	71	71	23	33	65
1.86	3000	143	143	143	71	74	13	67	38	98	134	98	71	71	23	33	65
1.93	3100	134	134	125	64	67	13	60	34	89	125	89	63	64	21	29	58
1.99	3200	5	1	1	3	3	0	0	1	3	1	0	3	3	0	0	2
2.05	3300	5	1	1	3	3	0	0	1	3	1	0	3	3	0	0	2
2.11	3400	5	1	1	3	3	0	0	1	3	1	0	3	3	0	0	2
2.17	3500	5	1	1	3	3	0	0	1	3	1	0	3	3	0	0	2
2.24	3600	5	1	1	3	3	0	0	1	3	1	0	3	3	0	0	2
2.3	3700	5	1	1	3	3	0	0	1	4	1	0	3	3	0	0	2
2.36	3800	5	1	1	3	3	0	0	1	3	1	0	3	3	0	0	2
2.42	3900	5	1	1	3	3	0	0	1	3	1	0	3	3	0	0	2
2.49	4000	5	1	1	3	3	0	0	1	3	1	0	3	3	0	0	2
2.55	4100	11	1	1	3	3	2	16	5	12	1	0	3	3	0	0	4
2.61	4200	57	1	1	10	10	10	77	38	85	1	0	3	3	0	0	24
2.67	4300	57	27	32	10	10	7	54	38	85	32	9	3	3	0	0	24
2.73	4400	35	134	161	7	7	4	33	22	50	161	42	3	3	0	0	15
2.8	4500	32	107	134	6	7	4	33	21	46	134	35	3	3	0	0	14
2.86	4600	28	61	72	4	4	4	33	20	43	72	20	0	0	0	0	12
2.92	4700	28	61	72	4	4	4	30	20	43	72	20	0	0	0	0	12
2.98	4800	24	61	72	3	3	3	27	17	38	72	20	0	0	0	0	11
3.04	4900	48	60	71	14	11	3	27	23	116	71	19	25	19	0	0	30
3.11	5000	268	48	57	107	79	3	27	86	848	57	15	250	188	0	0	214
3.42	5500	196	40	47	79	57	44	152	63	607	47	13	179	134	88	67	152
3.73	6000	81	39	46	32	23	12	46	28	250	46	13	71	53	22	17	63
4.04	6500	81	116	143	32	23	12	45	28	250	87	52	71	53	22	17	63
4.35	7000	76	107	125	31	22	12	40	24	241	74	48	71	53	22	17	61
4.66	7500	5	223	277	1	1	11	37	3	8	152	107	0	0	22	17	2
4.97	8000	241	500	598	152	50	14	36	52	152	313	232	84	70	25	28	98
5.28	8500	134	500	598	82	28	12	26	29	83	313	232	46	38	19	23	53
5.59	9000	107	179	196	68	22	9	20	22	66	85	63	38	31	15	19	43
5.9	9500	107	179	196	68	22	9	20	22	66	80	62	38	31	15	19	43
6.21	1e4	78	134	143	49	16	7	15	17	48	61	46	27	22	12	14	31

TABLE 5.3-7
ANNUAL SODIUM SALT DEPOSITION IN LB/(100-AC-MO)

Directions are directions that the plume is headed. Cutoff is 0.009 lb/(100-ac-mo). No deposition occurs in the first 2000m due to the high discharge of the plume.

(mi)	(m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE
1.24	2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.3	2100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.37	2200	0.036	0.036	0.036	0.018	0.018	0	0.018	0.009	0.027	0.036	0.027	0.018	0.018	0.009	0.009	0.018
1.43	2300	0.089	0.089	0.089	0.045	0.045	0.009	0.036	0.027	0.063	0.080	0.063	0.045	0.045	0.018	0.018	0.036
1.49	2400	0.036	0.036	0.036	0.018	0.018	0	0.018	0.009	0.027	0.036	0.027	0.018	0.018	0.009	0.009	0.018
1.55	2500	0.036	0.036	0.036	0.018	0.018	0	0.018	0.009	0.027	0.036	0.027	0.018	0.018	0.009	0.009	0.018
1.62	2600	0.036	0.036	0.036	0.018	0.018	0	0.018	0.009	0.027	0.036	0.027	0.018	0.018	0.009	0.009	0.018
1.68	2700	0.027	0.027	0.027	0.009	0.009	0	0.009	0.009	0.018	0.018	0.018	0.009	0.009	0	0.009	0.009
1.74	2800	0.027	0.027	0.027	0.009	0.009	0	0.009	0.009	0.018	0.018	0.018	0.009	0.009	0	0.009	0.009
1.8	2900	0.027	0.027	0.027	0.009	0.009	0	0.009	0.009	0.018	0.018	0.018	0.009	0.009	0	0.009	0.009
1.86	3000	0.027	0.027	0.027	0.009	0.009	0	0.009	0.009	0.018	0.018	0.018	0.009	0.009	0	0.009	0.009
1.93	3100	0.018	0.018	0.018	0.009	0.009	0	0.009	0.009	0.018	0.018	0.018	0.009	0.009	0	0.009	0.009
1.99	3200	0.009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.05	3300	0.009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.11	3400	0.009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.17	3500	0.009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.24	3600	0.009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.3	3700	0.054	0	0	0.027	0.018	0.009	0.027	0.018	0.045	0	0	0.027	0.027	0.018	0.018	0.027
2.36	3800	0.027	0	0	0.018	0.009	0	0	0.009	0.027	0	0	0.018	0.009	0	0	0.018
2.42	3900	0.009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.49	4000	0.009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.55	4100	0.009	0	0	0	0	0	0	0	0.009	0	0	0	0	0	0	0
2.61	4200	0.009	0	0	0	0	0	0	0	0.009	0	0	0	0	0	0	0
2.67	4300	0.009	0	0	0	0	0	0	0	0.009	0	0	0	0	0	0	0
2.73	4400	0.009	0.009	0.009	0	0	0	0	0	0.009	0.009	0	0	0	0	0	0
2.8	4500	0.009	0.009	0.009	0	0	0	0	0	0.009	0.009	0	0	0	0	0	0
2.86	4600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.92	4700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.98	4800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.04	4900	0	0	0	0	0	0	0	0	0.009	0	0	0	0	0	0	0
3.11	5000	0.009	0	0	0	0	0	0	0	0.036	0	0	0.009	0.009	0	0	0.009
3.42	5500	0.009	0	0	0	0	0	0.009	0	0.027	0	0	0.009	0.009	0	0	0.009
3.73	6000	0	0	0	0	0	0	0	0	0.009	0	0	0	0	0	0	0
4.04	6500	0	0.009	0.009	0	0	0	0	0	0.009	0	0	0	0	0	0	0
4.35	7000	0	0.009	0.009	0	0	0	0	0	0.009	0	0	0	0	0	0	0
4.66	7500	0	0.009	0.009	0	0	0	0	0	0	0.009	0.009	0	0	0	0	0
4.97	8000	0.009	0.018	0.027	0.009	0	0	0	0	0.009	0.009	0.009	0	0	0	0	0
5.28	8500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.59	9000	0.009	0.009	0.009	0	0	0	0	0	0	0	0	0	0	0	0	0
5.9	9500	0.009	0.009	0.009	0	0	0	0	0	0	0	0	0	0	0	0	0
6.21	10000	0.027	0.009	0.009	0.009	0	0	0	0	0.018	0	0	0.009	0.009	0	0	0.009

TABLE 5.3-8 (Sheet 1 of 2)
ANNUAL HOURS/YR OF PLUME SHADOW

Directions are directions from the tower.

(mi)	(m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE
0.12	200	657.2	876.3	1615.0	2262.0	2625.0	2582.0	2545.0	2360.0	2344.0	2300.0	2224.0	2033.0	1551.0	1034.0	768.7	649.2
0.25	400	355.9	487.3	1004.0	2193.0	2550.0	1945.0	1456.0	1191.0	1261.0	1461.0	1563.0	1430.0	1195.0	641.9	385.6	339.3
0.37	600	286.1	408.0	882.3	1967.0	1822.0	1272.0	781.9	692.2	779.5	858.3	906.0	969.9	833.9	507.0	289.2	249.4
0.5	800	250.5	378.3	826.1	1741.0	1342.0	884.6	471.3	538.3	592.3	645.3	624.4	713.8	675.8	437.7	265.7	216.2
0.62	1000	233.1	354.2	796.3	1558.0	1091.0	649.3	393.7	468.3	483.6	536.7	505.8	582.7	555.4	411.6	235.6	196.2
0.75	1200	219.6	343.1	756.6	1398.0	920.7	544.6	331.1	408.9	435.5	458.8	419.5	488.5	429.0	381.3	208.5	166.6
0.87	1400	208.3	328.1	728.1	1256.0	807.1	425.5	284.3	373.7	400.3	416.4	362.5	411.8	352.2	339.1	193.1	166.1
0.99	1600	192.5	317.7	695.1	1147.0	723.6	359.3	258.0	331.5	377.1	385.4	322.2	364.7	285.4	288.0	177.5	156.4
1.12	1800	184.3	306.4	671.1	1043.0	626.9	298.7	247.3	315.0	350.1	365.4	298.6	315.2	273.3	248.7	164.0	147.5
1.24	2000	172.3	292.1	647.6	945.5	560.5	264.2	230.9	288.7	330.1	340.4	275.9	292.8	245.0	223.4	157.6	142.4
1.37	2200	163.1	283.0	623.0	879.8	493.7	244.2	219.9	274.2	313.0	318.4	267.1	264.9	235.7	201.9	147.6	133.9
1.49	2400	160.4	277.3	600.7	817.5	458.0	225.8	212.7	254.9	298.0	300.4	255.4	250.8	215.2	197.5	143.1	127.1
1.62	2600	158.4	273.1	576.8	774.3	421.1	201.3	204.3	237.6	285.8	286.5	252.0	240.9	204.7	186.4	142.9	125.8
1.74	2800	156.2	268.2	559.8	735.2	391.7	191.1	195.8	227.4	270.8	276.8	238.9	227.2	190.9	175.3	137.0	124.1
1.86	3000	150.9	263.8	547.3	696.9	371.4	181.4	191.0	217.4	263.8	268.0	227.6	218.6	182.0	170.6	132.2	120.8
1.99	3200	150.8	257.5	530.3	654.6	348.5	171.3	188.1	207.7	255.6	250.0	215.7	215.4	171.2	160.0	129.5	120.7
2.11	3400	146.1	255.5	515.9	609.0	327.5	167.3	182.5	196.0	242.4	245.1	210.1	206.3	162.8	151.1	127.8	124.6
2.24	3600	147.5	252.5	498.8	576.9	304.3	161.4	169.3	187.6	232.3	236.1	205.0	199.9	149.7	146.8	124.2	121.6
2.36	3800	144.1	251.5	493.2	555.8	289.5	150.1	169.2	181.6	225.3	225.5	198.3	194.0	143.3	139.4	122.1	118.6
2.49	4000	140.4	251.4	490.5	529.5	265.3	140.1	164.0	177.6	211.1	215.5	188.1	189.1	135.6	133.9	118.5	116.5
2.61	4200	136.4	248.4	482.1	509.9	252.1	132.0	156.1	169.7	196.1	208.3	182.1	181.0	127.3	126.1	117.5	115.5
2.73	4400	131.4	243.4	477.9	494.6	236.3	126.7	150.1	163.8	184.1	196.3	172.2	175.2	120.8	122.1	113.4	114.5
2.86	4600	127.4	240.4	468.9	475.5	230.9	120.3	145.8	153.8	179.1	188.9	166.1	170.3	115.9	119.3	107.3	111.2
2.98	4800	126.4	236.4	457.9	461.1	221.1	117.3	140.8	148.4	172.1	182.8	164.7	162.6	112.3	116.4	107.5	108.2
3.11	5000	123.1	230.4	448.1	443.6	215.8	109.3	137.6	144.2	171.1	176.8	160.2	153.4	109.8	111.0	106.5	98.2
3.23	5200	118.1	221.4	430.7	420.8	201.6	106.1	135.5	144.6	169.1	169.5	157.2	144.3	110.8	110.8	107.7	96.2
3.36	5400	116.1	214.6	418.7	408.2	187.4	101.0	130.6	140.7	165.7	165.5	152.2	142.3	107.5	110.8	105.7	93.6
3.48	5600	108.1	208.8	408.9	399.3	183.3	98.9	128.4	132.7	162.4	157.2	148.9	137.3	107.0	106.5	97.7	87.6

TABLE 5.3-8 (Sheet 2 of 2)
ANNUAL HOURS/YR OF PLUME SHADOW

Directions are directions from the tower.

(mi)	(m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE
3.6	5800	106.3	204.1	397.4	389.3	175.6	94.0	124.0	128.7	159.4	148.4	147.6	134.2	102.8	102.6	95.7	84.4
3.73	6000	104.3	200.4	389.3	379.5	170.7	92.0	122.0	124.6	156.4	144.4	142.8	129.1	96.7	101.5	91.6	84.4
3.85	6200	102.6	197.0	379.1	367.6	162.9	89.8	120.0	122.4	154.4	143.4	140.8	126.6	93.4	98.2	88.2	83.1
3.98	6400	99.4	188.8	372.5	360.3	153.0	89.0	117.8	116.2	151.6	139.4	136.8	117.5	91.7	96.2	86.2	81.1
4.1	6600	96.3	183.7	365.5	351.3	145.9	86.0	117.8	113.0	148.9	136.4	134.8	115.9	88.7	90.0	78.4	79.1
4.23	6800	94.1	182.7	357.1	340.7	137.2	84.2	113.1	108.0	145.8	134.2	128.8	110.9	86.7	87.9	77.4	75.9
4.35	7000	91.1	174.7	351.1	334.0	134.6	82.0	110.7	105.2	141.8	128.2	126.5	107.3	84.1	80.9	78.1	71.6
4.47	7200	85.7	171.7	346.8	324.2	130.9	81.9	110.2	104.2	139.8	122.5	126.2	102.8	79.4	74.5	76.0	69.6
4.6	7400	84.5	167.3	341.3	316.6	127.5	81.2	108.2	99.2	137.7	119.5	121.8	99.0	76.1	69.3	71.7	65.5
4.72	7600	82.5	160.0	337.8	306.2	126.4	80.2	105.9	97.2	129.5	115.5	119.1	96.0	76.1	69.3	67.7	61.4
4.85	7800	72.5	156.7	332.7	302.6	126.4	79.4	105.9	95.2	122.6	111.9	117.1	88.8	73.5	67.3	64.6	57.6
4.97	8000	66.5	151.3	320.0	292.0	122.8	77.6	103.3	95.2	117.8	104.6	109.1	88.8	70.5	62.6	62.5	55.6

TABLE 5.3-X1
SPECIES PERCENTAGE OF TOTAL NUMBER OF FISH IMPINGED
WIDOWS CREEK IMPINGEMENT STUDY 2005 – 2007

Species	June 2005 – 2006	June 2006 – 2007
Threadfin shad	72	93
Bluegill	6	1
Unidentified sunfish	5	1
Gizzard shad	2	–
Channel catfish	4	–
Freshwater drum	6	1
Largemouth bass	2	–
Yellow bass	3	4

Dash denotes this was not a major species (i.e., <1%) that year.

5.4 RADIOLOGICAL IMPACTS OF NORMAL OPERATION

This section identifies the environmental pathways by which radiation and radiological effluents from the facility can be transmitted to the living organisms in and around the Bellefonte Nuclear Plant, Units 3 and 4 (BLN) site and the associated impacts. The scope of this section encompasses the transport pathways for gaseous and liquid radiological effluents to individual receptors as well as to biota, and includes an assessment of the operational exposure to living organisms in and around the station from plant effluents, as well as from increased ambient background radiation levels from the plant.

Consuming vegetables irrigated by public drinking water contributes less than 10 percent to the overall total body dose due to routine liquid effluents and is negligible compared to the doses due to routine gaseous effluents; therefore, this pathway is not included in the liquid doses due to routine liquid effluents.

The AP1000 is designed to operate within the occupational dose limits specified in 10 CFR 20.1201. The anticipated occupational radiation exposure due to normal operation and anticipated inspection and maintenance of the AP1000 units is provided in the AP1000 Design Control Document (DCD), Section 12.4, Dose Assessment.

5.4.1 EXPOSURE PATHWAYS

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

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

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

The description of the exposure pathways and the calculational methods utilized to estimate doses to the maximally exposed individual and to the population surrounding the BLN site are based on USNRC Regulatory Guides 1.109 and 1.111. The exposure pathway data are given in Tables 5.4-1 and 5.4-2 for the liquid pathways and Tables 5.4-3, 5.4-5, and 5.4-6 for the gaseous pathway. The 2057 population distribution within 50 mi. of the BLN site is given in Table 5.4-4. The source terms used in estimating exposure pathway doses are based on the values provided in DCD Tables 11.2-7 and 11.3-3. There are no unusual animals, plants, agricultural practices, game harvests, or food processing operations that require special consideration.

5.4.1.1 Liquid Pathways

The release of small amounts of radioactive liquid effluents is permitted, as long as releases comply with the requirements specified in 10 CFR Part 20 and 40 CFR Part 190. Liquid effluent releases at BLN would result in doses to the public that are within the ALARA design objectives of 10 CFR 50, Appendix I. The important exposure pathways include:

- Internal exposure from drinking water.
- External exposure from the surface of contaminated water or from shoreline sediment.
- External exposure from immersion in contaminated water.

The nearest drinking water takeoff downstream of the BLN site is approximately 4 mi. on the far shore of Guntersville Reservoir. This location is used as the extraction point for drinking water.

5.4.1.2 Gaseous Pathways

The normal release of gaseous effluents is also permitted if the releases comply with the requirements specified in 10 CFR Part 20 and 40 CFR Part 190. Gaseous effluent releases at BLN result in doses to the public that are within the ALARA design objectives of 10 CFR Part 50, Appendix I. The exposure pathways for gaseous releases that were considered are:

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

Exposures from these pathways were considered for the important receptors considering the effluent release points, dilution factors, and transit times at each appropriate receptor location.

5.4.2 Radiation Doses to Members of the Public

This section describes the methodology, data, and results of the dose evaluations for members of the public.

5.4.2.1 Liquid Pathways Doses

Liquid radioactive effluents from BLN are mixed with cooling tower blowdown and subsequently discharged into the Tennessee River. Other non-radioactive discharges may be combined with the cooling tower blowdown, but they are small in comparison and are ignored as a source of dilution.

Release of radioactive materials in liquid effluents to the discharge, from where they mix with the Tennessee River water, results in minimal radiological exposure to individuals and the general public. The nearest drinking water takeoff downstream of the BLN site is approximately 4 mi. on the far shore. This location is used as the extraction point for drinking water. There is no record of crop or pasture irrigation downstream of the BLN site, therefore this pathway is not evaluated. The parameters used to determine the dilution factor and the dilution factors used are given in Table 5.4-1. There is no record of consumption of aquatic vegetation in the area surrounding the BLN site, therefore this pathway is not evaluated.

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

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

- Eating fish caught near the point of discharge.
- Using the shoreline for activities, such as sunbathing or fishing.
- Internal exposure from drinking water.
- Swimming and boating on the Tennessee River.

A single dilution factor was conservatively chosen for points of exposure or extraction of drinking water. For towns with more than one water intake, it is assumed that the entire population uses water from the intake nearest to the BLN plant discharge. Because the plant discharge is 27 ft. under water, it is assumed that the effluent discharge will not reach the water surface until it is 300 ft. downstream. The population distribution by sectors and distances and the commercial and/or sport fishing aquatic food catch data, provided in Table 5.4-2, were used to evaluate population exposures.

The estimates for whole-body and critical organ doses from each of these interactions are presented in Table 5.4-7. These doses are within the design objectives of 10 CFR Part 50, Appendix I and are based on hypothetical conditions that maximize the resultant dose.

5.4.2.2 Gaseous Pathways Doses

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

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

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

Table 5.4-3 presents the gaseous pathway consumption factors used by the computer program to calculate doses for both the maximally exposed individual and for the general population.

The gaseous effluent release doses have been evaluated using the gaseous effluent release data given in FSAR Section 11.3 and atmospheric dilution and deposition factors (χ/Q and D/Q) given in Section 2.7. For models and values of required parameters, Regulatory Guide 1.109 was used. Annual production rates of milk, meat, and vegetables are given in Table 5.4-5. The estimated population distribution within a 50-mi. radius of the BLN site (Table 5.4-4) was used to evaluate the population exposures.

Table 5.4-10 provides the estimated whole-body and critical organ doses for the identified gaseous effluent pathways. These doses are within the 10 CFR Part 50, Appendix I criteria and are based on hypothetical conditions that maximize the resultant dose.

5.4.2.3 Direct Radiation Doses

The radiation exposure at the site boundary was considered in DCD Section 12.4.2. Direct radiation from the containment and other plant buildings is negligible. Additionally, there is no contribution from refueling water because the refueling water is stored inside the containment instead of in an outside storage tank. In addition, there is no outside storage of solid radwaste. There are no radiation sources outside of the permanent plant structures.

5.4.3 IMPACTS TO MEMBERS OF THE PUBLIC

5.4.3.1 Impacts From Liquid Pathway

Annual radiation exposures to the maximum exposed individual via the pathways of sport and commercial fishing, drinking water, and shoreline deposits, and to the population within a 50-mi. radius of the BLN site via the liquid pathway are given in Tables 5.4-7 and 5.4-8, respectively. These doses have been evaluated using the models and the values for the required parameters given in NRC Regulatory Guide 1.109.

As can be seen from Table 5.4-7, the maximum exposed individual annual doses from the discharge of radioactive materials in liquid effluents from the new facility meets the guidelines of Appendix I to 10 CFR Part 50. Because the guidelines for the maximum individual exposure via liquid pathways are much more restrictive (at least by a factor of 160) than the standards of 10 CFR Part 20, it can be inferred that radioactive releases in liquid effluents meet the standards for concentrations of released radioactive materials in water (accessible to a maximum exposed individual of the general public), as specified in Column 2 of Table 2 of 10 CFR Part 20. The maximally exposed individual dose calculated was also compared to 40 CFR Part 190 criteria (Table 5.4-9). Because the doses due to operation of BLN are within the applicable regulatory limits of 40 CFR 190 and the goals of 10 CFR Part 50, Appendix I there are no observable health impacts and the impact to members of the public is considered to be SMALL and does not require mitigation.

5.4.3.2 Impacts from the Gaseous Pathway

Release of radioactive materials in gaseous effluents from a new facility to the environment results in minimal radiological impact. Annual radiation exposures to the maximum exposed individual and the population within a 50-mi. radius of the BLN site via the pathways of submersion, ground contamination, inhalation and ingestion are given in Tables 5.4-10 and 5.4-13, respectively.

As can be seen from Table 5.4-11, annual doses to the maximum exposed individual due to release of radioactive materials in gaseous effluents meet the guidelines of Appendix I to 10 CFR Part 50. Because the guidelines of Appendix I to 10 CFR Part 50 for maximum individual exposures via atmospheric pathways are much more restrictive (by a factor of approximately 100) than the standards of 10 CFR Part 20, it can be inferred that radioactive releases via gaseous effluents from each BLN unit meet the standards for concentrations of released radioactive materials in air (at the locations of maximum annual dose to an individual and hence, at all locations accessible to the general public), as specified in Column 1 of Table 2 of 10 CFR Part 20. In addition, the maximally exposed individual dose calculated was also compared to 40 CFR Part 190 criteria (Table 5.4-12). Because the doses due to operation of BLN are within the applicable regulatory limits of 40 CFR 190 and the goals of 10 CFR Part 50, Appendix I there are no observable health impacts and the impact to members of the public is considered to be SMALL and does not require mitigation.

5.4.3.3 Direct Radiation Doses from the BLN Facility

The most limiting location at the site boundary was used to determine the direct radiation dose to a member of the public. The doses were determined to be negligible.

Implementation of a Radiological Environmental Monitoring Program (REMP), compliance with requirements for maintaining dose As Low As Reasonably Achievable (ALARA), and attention to design of plant shielding to ensure dose is ALARA, would result in doses to the public due to direct radiation being minimal.

In the United States, the average person is exposed to an effective dose equivalent of approximately 360 millirems (mrem) (whole body exposure) per year from all sources (Reference 3). Comparison of the calculated maximum individual doses listed in Table 5.4-11 with the background radiation dose shows that there is no significant impact to members of the public due to operation of BLN. Because the doses due to operation of BLN are within the applicable design objective of 10 CFR Part 50, Appendix I and the criteria of 40 CFR 190 there are no observable health impacts and the impact to members of the public is considered to be SMALL.

5.4.3.4 Total Site Dose

The total site dose compared with the 40 CFR Part 190 criteria is provided in Table 5.4-17. As seen in this table, the total site dose is bounded by the dose limit of 40 CFR Part 190. Because the doses due to operation of BLN are within the applicable regulatory limits of 40 CFR 190 the impact to members of the public is considered to be SMALL.

The AP1000 is designed to operate within the occupational dose limits specified in 10 CFR 20. The anticipated occupational radiation exposure due to normal operation and anticipated inspection and maintenance of the AP1000 units is provided in the AP1000 Design Control Document (DCD), Section 12.4, Dose Assessment. The estimated annual doses associated with all evaluated plant activities are presented in DCD Section 12.4. The estimated annual collective dose is 67.1 man-rem based on normal operation with an 18-month fuel cycle.

5.4.4 IMPACTS TO BIOTA OTHER THAN MEMBERS OF THE PUBLIC

Radiation exposure pathways to biota other than members of the public were examined to determine if the pathways could result in doses to biota greater than those predicted for humans. This assessment uses surrogate species that provide representative information on the various dose pathways potentially affecting broader classes of living organisms. Surrogates are used because important attributes are well defined and are accepted as a method for judging doses to biota. Surrogate biota used includes algae (surrogate for aquatic plants), invertebrates (surrogate for fresh water mollusks and crayfish), fish, muskrat, raccoon, duck, and heron. There are no unusual animals or pathways identified in the vicinity of the site that would require specific evaluation.

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

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

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

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

5.4.4.1 Liquid Effluents

The model used for estimating nuclide concentrations is similar to that used in the analysis for doses to humans described in Subsection 5.4.2. Table 5.4-1 summarizes parameters used in the calculation of nuclide concentrations in the Tennessee River. The calculation of biota doses was performed using LADTAP II (Reference 2).

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

5.4.4.2 Gaseous Effluents

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

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

5.4.4.3 Biota Doses

Doses to biota from liquid and gaseous effluents are shown in Table 5.4-16. These dose criteria are applicable to humans, and are considered conservative when applied to biota. The criteria in 40 CFR Part 190 for thyroid and next highest organ doses are not used in this analysis because doses are based on total body doses. The total body dose is taken as the sum of the internal and external dose. In humans, the internal dose from individual organs is weighted by factors less than unity to arrive at the whole body dose equivalent. Thus, a unity factor is assumed for the entire internal dose.

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

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

An international consensus has been developing with respect to permissible dose exposures to biota. As stated in NUREG-1555, Environmental Standard Review Plan 5.4.4, the National Academy of Sciences Committee on the Biological Effects of Ionizing Radiation (BEIR) Report concludes that the evidence indicates that no other living organisms have been identified that are likely to be significantly more radiosensitive than members of the public. The NUREG also states that the International Atomic Energy Agency concludes that there is no convincing evidence from scientific literature that chronic radiation dose rates below 1 mGy/day (100 mrad/day) harm animal or plant populations. Environmental Standard Review Plan 5.4.4 also states that limiting exposure in humans to 1 mSv/yr (100 mrem/day) leads to dose rates to plants and animals in the same area of less than 1 mGy/day (less than 100 mrad/day). The NUREG also states that the National Council on Radiation Protection and Measurements (NCRP) also concludes that the 1977 ICRP statement, "if man is adequately protected, then other living things are also likely to be sufficiently protected," is appropriate. The assumed lower threshold occurs for terrestrials rather than for aquatic animals primarily because some species of mammals and reptiles are considered more radiosensitive than aquatic organisms. The permissible dose rates given in 40 CFR Part 190 are considered screening levels and higher species-specific dose rates could be acceptable with additional study or data. Because the biota doses in Table 5.4-16 are below the 40 CFR Part 190 limits, no impacts are expected. The doses are well below those specified by IAEA and well below any dose expected to have any noticeable acute effects. Based on the postulated biota doses presented in Table 5.4-16, the impact due to operation of BLN is considered to be SMALL.

5.4.5 REFERENCES

1. U.S. Nuclear Regulatory Commission, "GASPAR II - Technical Reference and User Guide", NUREG/CR-4653 (PNL-5907), March 1987. (Part of NRCDose 2.3.2)

2. U.S. Nuclear Regulatory Commission, "LADTAP II – Technical Reference and User Guide", NUREG/CR-4013 (PNL-5270), April 1986. (Part of NRCDose 2.3.2)

3. U.S. Environmental Protection Agency, Ionizing Radiation Fact Sheets Series: No. 2 (from NCRP Report No. 93), Website, http://www.epa.gov/radiation/docs/ionize/402-f-98-010.htm, accessed May 21, 2007

TABLE 5.4-1
DILUTION FACTOR PARAMETERS AND DILUTION FACTORS

Parameter	Average Annual Condition
Average Width of River (ft.)	3400
Average Depth of Guntersville Reservoir (ft.)	15
Average Depth of River (ft.)	11[a]
River Volumetric Flowrate (cfs)	38,850
Stream Velocity in Guntersville Reservoir (ft/s)	0.76
Stream Velocity of Tennessee River below Guntersville Reservoir (ft/sec)	1.04
Distance from Near Shore for Source (ft.)	0
Distance to Drinking Water Extraction (mi.)	4.5
Average Distance to Where Fish are Caught (mi.)	21.25
Dilution Factor for Drinking Water Beyond Guntersville Reservoir	2907
Downstream Distance Used to Determine Dilution Factor for Commercial Fishing (mi.)	21.25
Average Residential Water Usage (gal/day/person)	170
Downstream Distance Used to Determine Dilution Factor for Shoreline Activities (mi.)	21.25
Downstream Distance Used to Determine Dilution Factor for Sport Fishing (mi.)	21.25

a) Conservatively low depth assumed for dilution factor determination.

TABLE 5.4-2
LADTAP II INPUT FOR INDIVIDUAL DOSE RATES [(a)] [(b)]

Input Parameter	Value
Discharge Flowrate (cfs)	13.37
Cooling tower Blowdown (gal/min)	6,000 [(c)]
50-mile Population	1,782,393
50-mile Population Using Downstream Drinking Water	970,571
Source Term	DCD Table 11.2-7
Reconcentration Model [(d)]	None
Shore Width Factor	0.3 [(e)]
Dilution Factors	Table 5.4-1
Transit Time - Nearest Drinking Water (hr.)	8.7
Transit Time - Mid Point of Guntersville Reservoir (hr.)	41
Transit Time - Radwaste Discharge to Unrestricted Area (hr.)	0
Shoreline Usage (person-hrs/yr)	292,027,269
Swimming Exposure (person-hrs/yr)	292,027,269
Boating Exposure (person-hrs/yr)	292,027,269
Length of Guntersville Reservoir (river mi.)	42.5

Production Rate Using Contaminated Water	Value
Sport Fish Annual Harvest (kg/yr)	309,134
Commercial Fish Harvest (kg/yr)	761,931

a) Input parameters not specified use default LADTAP II values.

b) Input parameters not specified use default LADTAP II values.

c) Conservatively low blowdown assumed for dilution factor determination. See ER Section 3.4.2.2 for normal cooling tower blowdown.

d) Reconcentration Model not applicable because the discharge is to the surface water body with no impoundment.

e) The portion of the Tennessee River on which the BLN site is located is considered the northern end of the Guntersville Reservoir. The shore width factor for a lake was selected for this reason.

TABLE 5.4-3
GASEOUS PATHWAY CONSUMPTION FACTORS

Maximum Individual Consumption Factors [a]

Age Group	Vegetables (kg/yr)	Leafy Vegetables (kg/yr)	Milk (L/yr)	Meat (kg/yr)
Adult	520	64	310	110
Teen	630	42	400	65
Child	520	26	330	41
Infant	0	0	330	0

Average Consumption Factors[a]

Age Group	Vegetables (kg/yr)	Leafy Vegetables (kg/yr)	Milk (L/yr)	Meat (kg/yr)
Adult	190	30	110	95
Teen	240	20	200	59
Child	200	10	170	37

a) Consumption factors from USNRC Regulatory Guide 1.109, Tables E-4 and E-5 and NUREG/CR-4653, the GASPAR II - Technical Reference and User Guide, Table 2.16.

TABLE 5.4-4
POPULATION DISTRIBUTION

	DISTANCE (miles)									
Direction	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
N	5	58	77	52	21	266	574	4,765	9,177	6,981
NNE	0	47	117	173	183	825	6,419	7,783	8,151	11,697
NE	0	30	33	17	28	254	6,887	9,524	29,319	91,976
ENE	0	3	9	16	26	214	5,902	16,297	79,290	250,397
E	0	5	25	77	175	1,463	4,264	8,575	13,575	17,399
ESE	0	5	20	97	302	1,566	5,218	12,458	18,212	13,543
SE	0	4	11	20	34	1,301	10,948	10,537	8,973	19,181
SSE	0	4	9	19	44	866	11,572	12,556	10,824	15,461
S	0	1	4	29	103	2,103	6,340	9,632	19,713	47,054
SSW	0	0	10	191	723	861	3,529	19,894	38,054	34,127
SW	0	3	51	160	337	5,524	5,964	12,583	21,301	29,876
WSW	0	24	94	293	737	13,759	2,920	9,515	16,780	16,889
W	5	51	135	207	198	707	2,088	40,264	111,023	187,497
WNW	20	75	157	242	284	447	1,397	8,045	20,143	34,014
NW	13	56	58	32	27	198	1,056	3,273	7,893	15,181
NNW	12	58	57	22	12	257	368	6,910	20,169	37,006

Notes:

2027 population distribution

TABLE 5.4-5
COMMODITY PRODUCTION

Commodity	Value
Milk Production (L/yr)	61,128,558
Meat Production (kg/yr)	20,644,713
Vegetable Production (kg/yr)	144,009,482

Notes:

A uniform distribution is assumed instead of using distribution data by compass direction and distance.

TABLE 5.4-6

GASPAR INPUT DATA [(a)]

Parameter	Value
Distance (in mi.) from site to the northeast corner of the U.S.	1262
Fraction of year leafy vegetables are grown [(b)]	0.42
Fraction of year milk cows are on pasture [(b)]	0.67
Fraction of individual's vegetable intake from own garden [(c)]	0.76
Fraction of milk-cow feed intake from pasture while on pasture [(c)]	1
Average relative humidity over the growing season [(d)]	75.6%
Average temperature over growing season [(c)]	71.7 °F
Fraction of year milk goats are on pasture [(b)]	0.75
Fraction of milk goat feed intake from pasture while on pasture [(c)]	1
Fraction of year beef cattle are on pasture [(b)]	0.67
Fraction of beef-cattle feed intake from pasture while on pasture [(c)]	1
Nearest Garden [(e)]	SW, 1817 m
Nearest Site Boundary [(f)]	NNE, 1244 m
Maximum Point of Concentration [(g)]	S, 2800 m
Production data	Table 5.4-5
Source term multiplier	1
Source term data	DCD Table 11.3-3
Meteorological data	Tables 2.7-120, 2.7-121, 2.7-122, 2.7-123, 2.7-124, and 2.7-125

a) There were no revisions to the GASPAR II block data module.

b) Estimated based on Figure 2.2 of the GASPAR II Technical Reference and User Guide.

c) Conservative GASPAR II default value.

d) Using a conservative growing season of May through October, the average relative humidity and temperature were determined based on historical data from Huntsville, AL and Scottsboro, AL, respectively.

e) "Nearest" refers to the receptor location at which the highest radiation dose to an individual from the applicable pathways has been estimated. The nearest garden results in the highest χ/Q and D/Q values of the offsite receptor locations identified in Table 2.7-119. For conservatism, all dose pathways, with the exception of doses due to immersion in the plume, are evaluated at the nearest garden.

f) "Nearest" refers to that site boundary location at which the highest radiation doses due to gaseous effluents have been estimated to occur.

g) "Maximum Point of Concentration" refers to the location beyond the site boundary with the highest χ/Q values and is not associated with the location of any particular receptor or the site boundary. The maximum point of concentration is a "peak" χ/Q value within three miles of the site created as a result of aerodynamic downwash due to terrain effects and recirculation. No peaks occur beyond the locations of the nearest receptors given in Table 2.7-119 within 3 miles of the site.

TABLE 5.4-7
COMPARISON OF MAXIMUM INDIVIDUAL DOSE TO 10 CFR PART 50, APPENDIX I OBJECTIVES

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

Annual Dose Total Body[a]	Maximum Organ[b] (Liver)	Maximum Thyroid Dose[c]	TEDE Dose	Dose Limit[d]
2.06E-01	2.65E-01	4.96E-02	2.07E-01	Total Body: 3 Any organ: 10

a) The maximum individual total body dose would be received by an adult.

b) The maximum individual organ dose would be received by a teenager.

c) The maximum individual thyroid dose would be received by a child.

d) 10 CFR Part 50, Appendix I.

TABLE 5.4-8
ESTIMATED POPULATION DOSE FROM LIQUID EFFLUENTS VIA THE AQUATIC FOOD PATHWAY

Annual Dose (person-rem) per Unit

Item	Annual Dose (person-rem)
Total Body	1.60
Liver (Max. organ)	1.90
Thyroid	1.41

TABLE 5.4-9
LIQUID PATHWAY COMPARISON OF MAXIMUM INDIVIDUAL DOSE TO
40 CFR PART 190 LIMIT

Type of Dose (Annual)	Design Limit [(a)] (mrem/yr)	Calculated Dose [(b)] (mrem/yr)
Whole body dose equivalent (adult)	25	5.34
Thyroid dose (child)	75	0.94
Dose to another organ (teen liver)	25	6.58

a) Source 40 CFR Part 190.

b) Total for two units.

TABLE 5.4-10 (Sheet 1 of 2)
ANNUAL DOSE TO A MAXIMALLY EXPOSED INDIVIDUAL FROM GASEOUS EFFLUENTS (PER UNIT)

Dose Rate (mrem/yr)

Adult				**Organ**				
Pathway	Whole Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Plume	1.58E-01	1.58E-01	1.58E-01	1.58E-01	1.58E-01	1.58E-01	1.72E-01	9.57E-01
Ground	4.20E-02	4.20E-02	4.20E-02	4.20E-02	4.20E-02	4.20E-02	4.20E-02	4.93E-02
Vegetable	6.17E-02	6.34E-02	3.60E-01	6.18E-02	5.77E-02	8.66E-01	5.15E-02	5.06E-02
Meat	1.93E-02	2.39E-02	8.80E-02	1.94E-02	1.89E-02	4.87E-02	1.85E-02	1.84E-02
Goat Milk	4.26E-02	2.69E-02	1.24E-01	4.96E-02	3.81E-02	1.17E+00	2.72E-02	2.48E-02
Inhalation	9.04E-03	9.15E-03	1.42E-03	9.25E-03	9.41E-03	8.50E-02	1.18E-02	8.77E-03
Total	3.33E-01	3.23E-01	7.73E-01	3.40E-01	3.24E-01	2.37E+00	3.23E-01	1.11E+00

Teen				**Organ**				
Pathway	Whole Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Plume	1.58E-01	1.58E-01	1.58E-01	1.58E-01	1.58E-01	1.58E-01	1.72E-01	9.57E-01
Ground	4.20E-02	4.20E-02	4.20E-02	4.20E-02	4.20E-02	4.20E-02	4.20E-02	4.93E-02
Vegetable	9.35E-02	9.55E-02	5.63E-01	9.86E-02	9.20E-02	1.19E+00	8.27E-02	8.10E-02
Meat	1.57E-02	1.83E-02	7.40E-02	1.60E-02	1.56E-02	3.71E-02	1.53E-02	1.52E-02
Goat Milk	6.11E-02	4.52E-02	2.24E-01	8.58E-02	6.57E-02	1.86E+00	4.72E-02	4.25E-02
Inhalation	9.15E-03	9.24E-03	1.73E-03	9.50E-03	9.73E-03	1.06E-01	1.34E-02	8.85E-03
Total	3.79E-01	3.68E-01	1.06E+00	4.10E-01	3.83E-01	3.39E+00	3.73E-01	1.15E+00

TABLE 5.4-10 (Sheet 2 of 2)
ANNUAL DOSE TO A MAXIMALLY EXPOSED INDIVIDUAL FROM GASEOUS EFFLUENTS (PER UNIT)

Dose Rate (mrem/yr)

Child				**Organ**				
Pathway	Whole Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Plume	1.58E-01	1.58E-01	1.58E-01	1.58E-01	1.58E-01	1.58E-01	1.72E-01	9.57E-01
Ground	4.20E-02	4.20E-02	4.20E-02	4.20E-02	4.20E-02	4.20E-02	4.20E-02	4.93E-02
Vegetable	2.07E-01	1.99E-01	1.30E+00	2.18E-01	2.07E-01	2.33E+00	1.91E-01	1.89E-01
Meat	2.86E-02	2.98E-02	1.39E-01	2.91E-02	2.86E-02	6.12E-02	2.82E-02	2.81E-02
Goat Milk	1.16E-01	9.96E-02	5.39E-01	1.70E-01	1.35E-01	3.71E+00	1.04E-01	9.74E-02
Inhalation	8.10E-03	7.99E-03	2.09E-03	8.45E-03	8.64E-03	1.24E-01	1.16E-02	7.81E-03
Total	5.60E-01	5.36E-01	2.18E+00	6.26E-01	5.79E-01	6.43E+00	5.49E-01	1.33E+00

Infant				**Organ**				
Pathway	Whole Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Plume	1.58E-01	1.58E-01	1.58E-01	1.58E-01	1.58E-01	1.58E-01	1.72E-01	9.57E-01
Ground	4.20E-02	4.20E-02	4.20E-02	4.20E-02	4.20E-02	4.20E-02	4.20E-02	4.93E-02
Vegetable	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Meat	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Goat Milk	2.19E-01	1.98E-01	9.98E-01	3.41E-01	2.59E-01	8.96E+00	2.09E-01	1.96E-01
Inhalation	4.68E-03	4.56E-03	1.05E-03	5.05E-03	5.03E-03	1.11E-01	7.10E-03	4.49E-03
Total	4.24E-01	4.03E-01	1.20E+00	5.46E-01	4.64E-01	9.27E+00	4.30E-01	1.21E+00

Notes:

(a) The doses via the plume pathway correspond to the maximum point of concentration, 2800 m south of the site. Other pathways are conservatively evaluated at the nearest garden as defined in Table 5.4-6.

TABLE 5.4-11
COMPARISON OF MAXIMUM INDIVIDUAL DOSE TO 10 CFR PART 50, APPENDIX I OBJECTIVES - GASEOUS PATHWAY (PER UNIT)

Radionuclide Releases/ Type of Dose	Point of Evaluation	Calculated Dose	Design Objective [a]
Noble Gas Releases			
Gamma air dose	Maximum Point of Concentration [b]	2.65E-01 mrad	10 mrad
Beta air dose	Maximum Point of Concentration [b]	1.39E+00 mrad	20 mrad
Total body dose	Maximum Point of Concentration [b]	1.58E-01 mrem	5 mrem
Skin dose	Maximum Point of Concentration [b]	9.57E-01 mrem	15 mrem
Iodine and Particulate Releases			
Organ dose (infant, thyroid) [c]	Nearest Garden [d]	9.11E+00 mrem	15 mrem

a) Source 10 CFR Part 50, Appendix I.

b) "Maximum Point of Concentration" refers to the location with the highest χ/Q values and is not associated with the location of any particular receptor or the site boundary. The maximum point of concentration is a "peak" χ/Q value within three miles of the site created as a result of aerodynamic downwash due to terrain effects and recirculation. No peaks occur beyond the locations of the nearest receptors given in Table 2.7-119 within 3 miles of the site.

c) The maximum organ dose includes the doses due to radioiodines and particulates only. All other doses provided in this table are due to noble gases only.

d) The "Nearest Garden" is the offsite receptor location at which the highest radiation dose to an individual has been estimated. The nearest garden results in the highest χ/Q and D/Q values of the offsite receptor locations identified in Table 2.7-119. For conservatism, all dose pathways, with the exception of doses due to immersion in the plume, are evaluated at the nearest garden.

TABLE 5.4-12
COMPARISON OF MAXIMUM INDIVIDUAL DOSE TO 40 CFR PART 190 LIMIT - GASEOUS PATHWAY

Type of Dose (Annual)	Dose Limit [(a)]	Calculated Dose [(b), (c)]
Whole body dose equivalent	25 mrem	1.12 mrem
Dose to thyroid	75 mrem	18.5 mrem
Dose to skin	25 mrem	4.36 mrem

a) Source 40 CFR Part 190.

b) The calculated dose includes the plume dose evaluated at the Maximum Point of Concentration and all other gaseous dose pathways evaluated at the Nearest Garden.

c) Total for two units.

TABLE 5.4-13
ANNUAL POPULATION DOSES - GASEOUS PATHWAY

	Estimated Doses (Person rem)	
Pathway	Whole Body	Bone (worst case organ)
Plume	1.15E+00	1.15E+00
Ground	1.50E-01	1.50E-01
Inhalation	3.96E-01	5.63E-02
Vegetable Ingestion	2.72E+00	1.16E+01
Cow Milk Ingestion	3.12E-01	1.30E+00
Meat Ingestion	1.20E+00	5.39E+00
Total	5.93E+00	1.97E+01

Notes:

a) Per Unit

TABLE 5.4-14
TERRESTRIAL BIOTA PARAMETERS[(a)]

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

a) Source NUREG/CR-4013.

TABLE 5.4-15
BIOTA RESIDENCE TIMES[(a)]

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

a) Source NUREG/CR-4013.

b) Data not available.

TABLE 5.4-16
DOSE TO BIOTA FROM LIQUID AND GASEOUS EFFLUENTS [(a)]

Organism	Liquid Effluents [(b)]		Gaseous Effluents	
	Internal Dose (mrad/yr)	External Dose (mrad/yr)	Internal Dose [(c)] (mrad/yr)	External Dose [(d)] (mrad/yr)
Fish	1.06	1.09	N/A	N/A
Invertebrate	3.24	2.18	N/A	N/A
Algae	1.42E+01	4.96E-03	N/A	N/A
Muskrat	6.22	0.72	1.19E-02	1.24
Raccoon	2.28	0.54	1.19E-02	0.90
Heron	3.38E+01	0.72	1.19E-02	0.87
Duck	5.42	1.09	1.19E-02	1.13

a) Total for two units.

b) Based on conservative dilution factor of 1.

c) Whole Body inhalation dose for infant at the site boundary as a surrogate for biota dose.

d) Whole Body dose due to ground and plume exposure at the site boundary. Ground exposure increased by a ratio of the height used in GASPAR for dose due to ground deposition (1 meter) to the approximate height of the biota. This adjustment accounts for ground proximity.

TABLE 5.4-17
COMPARISON OF MAXIMUM SITE INDIVIDUAL DOSE TO 40 CFR PART 190 LIMITS

Type of Dose (Annual)	Dose [(a)] Per Unit (mrem)	Total Site Dose [(b)] (mrem)	Dose Limit [(c)] (mrem)
Whole body dose equivalent	0.77	1.53	25
Dose to thyroid	9.30	18.6	75
Dose to max organ [(d)]	2.45	4.89	25

a) Includes gaseous and liquid effluent pathways and direct radiation sources. Direct radiation has been shown to be negligible per Subsection 5.4.2.3.

b) Includes gaseous and liquid effluent pathways and direct radiation sources for all units at the site. Direct radiation has been shown to be negligible per Subsection 5.4.2.3.

c) Source 40 CFR Part 190.

d) Conservatively includes the maximum dose to any organ due to liquid effluents and the maximum dose to any organ due to gaseous effluents, which do not necessarily apply to the same organ.

5.5 ENVIRONMENTAL IMPACTS OF WASTE

Construction and operation of the BLN results in the generation of several identifiable waste streams. The facility wastes are regulated during generation, storage, and disposal. The State of Alabama is authorized to regulate water, air, solid waste, and hazardous wastes (Reference 1). Plant industrial, nonhazardous wastes are disposed at a permitted landfill or are recycled whenever possible. The City of Scottsboro, Alabama, owns and operates a landfill located near the BLN that is permitted under the Resource Conservation and Recovery Act (RCRA) (Reference 2) to accept construction/demolition debris and approved industrial wastes. Construction/demolition and industrial wastes generated at the BLN site may be disposed of at the City of Scottsboro's landfill or a similarly permitted facility.

Used oil, hazardous and mixed wastes are regulated under RCRA both for managed storage and disposal. A facility generating these wastes is required to obtain a U.S. Environmental Protection Agency (EPA) RCRA identification number which is site-specific. The EPA has authorized the Alabama Department of Environmental Management (ADEM) to oversee the RCRA program in that state. The BLN has been assigned EPA RCRA Identification Number AL5640090002. This EPA RCRA Identification Number carries-over to the construction and operation of the BLN. Wastes generated at the BLN that fall under RCRA regulations are either recycled or disposed of at RCRA-permitted treatment, storage, and disposal facilities (TSDs).

Aqueous discharges are regulated through the National Pollutant Discharge Elimination System (NPDES) program both for stormwater and wastewater. ADEM is authorized to oversee the NPDES program in Alabama, and incorporates chemical monitoring requirements for wastewater and stormwater in NPDES discharge permits. The BLN site has a current NPDES permit, Permit Number AL0024635 (covering process water generated from operation of the BLN and stormwater discharges). Within the permit, point-source discharge outfalls are assigned a discharge serial number (DSN), constituents to be monitored or sampled, and associated limits. The DSN outfalls are shown in Figure 2.3-26 and Table 6.6-1 lists the surface water quality parameters that are included in the current NPDES permit. This permit is amended as new wastewater streams are identified.

Air emissions are regulated through the Clean Air Act (CAA) (Reference 3) by the EPA or authorized state agency. ADEM has been granted authorization to implement provisions of the CAA in Alabama. The facility currently possesses two synthetic operating source permits. Permit number 705-0021-X002 addresses emissions from the auxiliary boilers. However, the boilers have been sold and are to be removed from the site, and a request be sent to ADEM to cancel this permit. The second synthetic operating source permit number is 705-0021-X004 and addresses emissions from two 7000-kW diesel generators. TVA plans to sell the two diesel generators and cancel the permit as well.

The Nuclear Regulatory Commission (NRC), in the Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG-1437, Volume 1 (Reference 5), has assembled several years of data from operating stations and their effects on the environment. Station operations, and the regulatory requirements for protection of the environment, show that the impact of discharges from operations is considered to be SMALL. The effects of biocides, sanitary, and metal containing wastes are in this category.

Descriptions of some nonradioactive and mixed waste streams generated, and subject to the regulations, noted above are discussed in the following sections.

5.5.1 NONRADIOACTIVE WASTE-SYSTEM IMPACTS

This section describes the potential environmental impacts of nonradioactive solid, liquid, and gaseous waste streams associated with the construction and operation of Units 3 and 4. Information provided within this section was obtained from a review of historic site documents and experiences from currently operating plants. A description of possible chemical discharges and effluents is provided, based on the AP1000 reactor. A description of the nonradioactive waste systems and chemicals is provided in Section 3.6. The wastes generated and the chemicals present and their projected concentrations are provided in Tables 3.6-1 and 3.6-2 for the water and air effluents respectively.

The concentration of chemicals at the main discharge is dependent on their concentration in their respective waste stream and the stream flow in relation to the main discharge flow that it is combined with. Concentration changes in the outfall plume can be estimated in the same manner as the thermal plume description generated by the CORMIX model discussed in Section 5.3.

Chemical waste minimization procedures are used to reduce or eliminate effects from their use and discharge. An inventory of hazardous chemicals is maintained and, where possible and effective, nonhazardous chemicals are substituted. Chemical waste minimization processes are the same as those used for mixed waste and discussed in Subsection 5.5.2.1.

Based upon discussions in the following subsections, the impact from nonradiological waste management is considered to be SMALL. Facilities and procedures are put in place to ensure proper handling and disposal at all plants (see Chapter 9 of NUREG-1437) (Reference 5).

5.5.1.1 Impacts of Discharges to Water

Nonradioactive liquid wastewater from nuclear power plants may include, but is not limited to, cooling water blowdown, auxiliary-boiler blowdown, water-treatment waste, floor and equipment drains, and stormwater runoff. Many of these wastewater streams have their own NPDES-designated outfall number for monitoring purposes. The NPDES permit establishes criteria that are protective of water quality for the receiving stream. In this case, the criteria are established to protect Guntersville Reservoir water quality for its designated uses as a drinking water source, recreation, and industrial use such as cooling.

The BLN site-specific NPDES permit (Permit Number AL0024635) became effective on December 1, 2004, and expires on November 30, 2009. Table 6.6-1 lists the discharge streams (systems) to be sampled, location of sampling stations (outfall DSNs), constituents to be monitored or sampled, frequency of sampling, type (method) of sample collection (e.g., surface grab or depth composite), and time period for required monitoring (monitoring frequency) under the permit. Discharge locations are shown on Figure 2.3-26. (Note: The routing of laboratory waste for Units 3 and 4 differs from that proposed for Units 1 and 2. Units 3 and 4 laboratory wastewater is treated as liquid radioactive wastewater and is not discharged through DSN007.) Table 3.6-1 lists the anticipated chemicals used and residual concentrations within the waste streams discharged from the facility that are used in establishing the NPDES monitoring requirements.

Because Bellefonte Units 1 and 2 were not completed and never operated, no operating process wastewaters were generated or discharged; therefore the existing permit limits have not been assessed with anticipated discharges; however, discharges from Bellefonte Units 1 and 2 are directed to the desilting pond, which discharges through outfall DSN003 to the Tennessee River.

Two discharge points are anticipated for the BLN design and include: (1) the cooling tower blowdown (including sampled desilting pond discharges), discharged to the Tennessee River through the existing outfall and diffuser system (DSN003), and (2) the nonradioactive plant discharge that is discharged to the wastewater retention basin (WWRB), and then cascades in sequence through Pond A and the construction holding pond, finally discharging from the construction holding pond to Town Creek (DSN002). Chemicals that are added for cooling-water treatment are effective at low concentrations and are mostly consumed as they react with the fouling organisms. The diffuser discharge, consisting of cooling tower blowdown and other wastewater resulting from electric power generation, is currently designated as outfall DSN003.

5.5.1.1.1 Liquid Effluents Containing Biocides or Chemicals

A description of the anticipated nonradioactive, liquid-waste chemical and biocide discharge concentrations is provided in Section 3.6. Biocides are added in parts per million concentrations and are consumed leaving very small concentrations by the time they are discharged. The NPDES permit issued by ADEM imposes monitoring and concentration limits on outfall DSN003d (cooling tower blowdown). The current NPDES permit takes biocide and chlorine concentrations into account and the associated discharge limits are established to protect receiving waters. Because biocides and chemicals used for water treatment are added in parts per million concentrations and are largely consumed serving their purposes, and the NPDES permit takes the potential for these substances being in the discharge into consideration by establishing requirements for appropriate chemical parameter monitoring and acceptable limits the impact from these discharges is considered to be SMALL (Reference 5).

5.5.1.1.2 Demineralized Water-Treatment Wastes

The system to demineralize water prior to its use in various applications at the BLN facility typically consists of a reverse osmosis (RO) system. During demineralization or regeneration, the waste stream from the process may contain chemicals, such as sulfuric acid and caustic soda, added to adjust the pH to between 6 and 9 for release to the WWRB, and consist of liquid waste and condensate demineralizer regeneration wastes (in this case the wastewater effluent from the RO system). Subsection 3.6.1 identifies and quantifies each chemical and biocide added to the receiving water by the discharge stream. Table 3.6-1 shows the chemicals used in the demineralized water system, the amount used per year, the frequency of use and the concentration anticipated in the waste stream discharged from two units. These waste streams are monitored during discharges from the construction holding pond at DSN002. The spent RO system filters are disposed of in accordance with applicable industrial solid-waste regulations. See Subsection 5.5.1.2 for additional details on solid-waste management. The impact from this stream is like that for biocides and metals and is considered to be SMALL.

5.5.1.1.3 Floor Drain Systems

As stated previously, discharges from Bellefonte Units 1 and 2 are directed to the desilting pond, which discharges through outfall DSN003 to the Tennessee River.

Discharges from floor drains are components of wastewater discharged to the WWRB and composed of building sumps and floor drains, and other miscellaneous low-volume wastewaters. Floor drain discharges are also made from outfall DSN007, consisting of Simulator Training Facility sanitary wastewaters and equipment room floor drains. Laboratory floor drains will be routed to the liquid radioactive waste management system and eventually discharged to Guntersville Reservoir from outfall DSN003.

Because the NPDES permit requires monitoring of floor drain systems contributing to discharges made through the WWRB and desilting pond, the impact from floor drains is considered to be SMALL. If monitoring indicates any need for treatment for oil and grease or the presence of radionuclides prior to discharge the stream is directed to a treatment system to meet regulatory limits before discharge.

5.5.1.1.4 Surface Drainage and Roof Drains

During and after precipitation events, water from roof drains and impervious surfaces, such as parking lots and sidewalks, sheet-flows to drainage ways to Pond A. General wash activities (including vehicles, buildings, equipment, etc.) are conducted on-site and create a limited quantity of wash water discharge. The construction holding pond discharge, including the WWRB and Pond A, is monitored under the NPDES permit as outfall DSN002 in accordance with the facility's Stormwater Pollution Prevention Plan (SWPPP) and is discharged to Town Creek embayment. Additional stormwater discharges are made through outfalls DSN004 (consisting of the BLN facility's east culvert impoundment stormwater runoff) and DSN009 - 015 (consisting of uncontaminated stormwater runoff). Discharges through outfall DSN004 are monitored for flow, pH, total suspended solids, and oil and grease. Discharges through outfall DSN009 - 015 do not have any monitoring requirements.

Because surface drainage and roof drain system discharges (including discharges made through DSN009 – 015) are made in accordance with the facility’s SWPPP and the NPDES permit requires monitoring the discharges made through DSN002 and DSN004 surface and roof drain discharge impact is considered to be SMALL.

All of the above described outfalls are projected to be part of the revised NPDES permit for Units 3 and 4 operation. Some of the outfall designations and streams may change. Table 6.6-1 is an example of most of the outfalls that may be part of the revised permit. The requirement for monitoring the various streams is based upon water quality criteria, knowledge of the chemicals stored and used on-site, and their concentrations. Good operating procedure is to use, or substitute for, environmentally friendly chemicals that are equally effective in protecting equipment and function.

5.5.1.2 Impacts of Discharges to Land

5.5.1.2.1 Nonradioactive Solid Waste

Solid nonradioactive waste includes, but is not limited to, typical office waste, aluminum cans, glass, metals, paper, etc. These solid wastes are not burned or disposed of on-site. Licensed or permitted municipal or county solid-waste haulers collect this waste for recycling or disposal in an appropriately permitted landfill. The waste does not affect site terrestrial ecology, soil, or groundwater.

Water-treatment and purification-waste filters from the RO unit are containerized and disposed of at a permitted industrial-waste landfill. Construction/demolition and industrial wastes generated at the BLN site are also be disposed of at a similarly permitted facility.

Site construction and demolition wastes, such as asbestos, concrete, scrap steel, etc. are disposed of off-site in a properly permitted industrial waste landfill.

5.5.1.2.2 Hazardous Wastes

Solid hazardous waste is managed and disposed of in accordance with federal and state regulations under RCRA regulations and permits. The generation of hazardous waste at the BLN is small, and the facility is considered a Conditionally Exempt Small-Quantity Generator (CESQG) or a Small Quantity Generator (SQG).

RCRA hazardous wastes generated through BLN operations, and hazardous chemical wastes from laboratories and other sources at the facility, are collected and disposed of off-site at RCRA-permitted TSDs, using the site-specific assigned EPA RCRA Identification Number AL5640090002. Hazardous waste is transported by specifically licensed and permitted haulers in accordance with EPA RCRA regulations. These wastes are not released to the environment and do not present an impact potential to the environment.

5.5.1.2.3 Petroleum Waste

Petroleum wastes may include fuels, such as gasoline and diesel oil, and used oil and greases. These materials are collected and stored on-site in accordance with federal, state and local regulations. These materials are either recycled or disposed at RCRA-permitted TSD facilities and recyclers.

5.5.1.2.4 Assessment of Impacts of Discharges to Land

Because nonradioactive solid wastes water-treatment and purification-waste filters from the RO unit, construction/demolition and industrial wastes, solid hazardous waste, and petroleum wastes (including fuels, such as gasoline and diesel oil, and used oil and greases) are handled per the methods described above in Subsections 5.5.1.2.1 through 5.5.1.2.3, the impact from discharges to land is considered to be SMALL.

5.5.1.3 Impacts of Discharges to Air

Nonradioactive gaseous effluents are generated by the routine testing and operation of the standby diesel generators and the diesel-driven fire pumps. Constituents of the gaseous effluents from these systems are typical of releases from the combustion of the fuel. Projected constituents and quantities are discussed in Section 3.6.

Annual emissions for the standby diesel generators and the diesel-driven fire pumps are provided in Table 3.6-2. Minor emissions are generated from the storage tanks used to supply diesel fuel to this equipment. Annual storage-tank emissions are provided in Table 3.6-2. The emissions should comply with applicable federal, state, and local regulations, and the existing BLN site-specific minor-source operation permit. Because this equipment is designated for off-normal use, a routine operational schedule is not provided.

Because limited air emissions are created from the operation of the BLN, as described above, the impact from discharges to air is considered to be SMALL.

5.5.1.4 Sanitary Waste

Sanitary waste is discharged to and treated at the nearby municipal sewage treatment plant in Scottsboro, Alabama. The discharge to the Scottsboro, Alabama's municipal sewage treatment plant is made under the Regulation of Sewer Use, and not under a specific permit.

Because sanitary waste is discharged to and treated at the Scottsboro, Alabama’s municipal sewage treatment plant, as described above, the impact from sanitary waste discharges is considered to be SMALL.

5.5.2 MIXED-WASTE IMPACTS

In October of 1992, Congress enacted the Federal Facilities Compliance Act (FFCA) (Reference 4) which, among other things, added a definition of mixed waste to RCRA. Mixed waste is waste that contains both hazardous waste and source, special nuclear, or byproduct material.

The management of mixed waste at nuclear power plants is jointly regulated by the NRC under the AEA, and the EPA or authorized states under RCRA. Nuclear power plants managing mixed waste must meet NRC requirements for general radiation protection (10 CFR Part 20), emission control requirements for low-level waste (LLW) specified in 10 CFR Part 61, and EPA requirements for hazardous waste (40 CFR Parts 261, 264, and 265 DOE/RW-0006) before final transfer off-site for disposal (Reference 5).

Mixed-waste generation is highly variable but is projected to be approximately 177 cu ft/year, which is less than 3 percent of typical LLW volumes (see Section 2.3.7.3 of NUREG-1437) (Reference 5). Management of this waste is in accordance with NRC and EPA regulations, and is subject to maintenance and containment criteria described in the RCRA regulations that require containers to be free of corrosion and stored in a bermed catchment area to contain leaks and spills. Chemical exposure is minimized through proper training and procedures, the use of protective clothing and equipment, and the use of chemically compatible containers. Workers are exposed to low levels of radiation while performing radioactive waste storage, handling, testing, and storage inspection activities. However, this source of exposure is small compared with other sources of exposure at operating nuclear plants (Reference 5).

Typical mixed wastes include solutions collected in containment building sumps, auxiliary building sumps and drains, laboratory drains, sample station drains, and other miscellaneous drains. Other mixed wastes are generated from laundry facilities (detergent wastes) and wastes generated from personnel and protective equipment decontamination activities. These mixed waste sources have low radioactivity or radionuclide concentrations with short half-lives that allow for storage until decayed. Lubricating oils are another source of radionuclide containing mixed waste requiring proper separation and management for disposal (Reference 5).

Nuclear power plants are not expected to generate significant volumes of mixed waste because of continued progress in reducing mixed-waste generation. Conformance with mixed-waste storage requirements, in conjunction with the As Low As Reasonably Achievable (ALARA) and chemical awareness training programs, minimizes radiological and chemical exposures. Regular inspections are conducted and documented, and preventive maintenance measures are taken when needed. An inventory of the mixed waste is maintained, and material safety data sheets for the chemicals present are readily available to identify the proper protection to be taken. The storage area is placarded with appropriate hazard warning signs, and access is restricted.

In the absence of a licensed off-site disposal site, mixed waste is containerized, segregated and stored on-site in a remote, monitored structure to minimize the potential of chemical and radiological exposure to employees and the public. Only authorized individuals are given access to the storage area to inspect for container integrity and leakage.

5.5.2.1 Waste-Minimization Plan

Inventory management and control techniques are used to limit the generation of chemical and mixed wastes or out-of-date (past shelf-life) hazardous chemicals. The inventory and assessment of chemicals and alternatives is a critical step in minimizing both chemical and mixed waste generation.

Pursuant to the regulations regarding mixed-waste management and the issuance of a license to operate Units 3 and 4, a mixed-waste minimization plan is developed and put into effect to address storage and management oversight requirements. Elements of the waste minimization plan include, as a minimum, 1) inventory identification and control, 2) work planning to reduce mixed waste generation, 3) mixed-waste reduction methods and processes, and 4) key assumptions critical to successful implementation of waste management. These requirements are part of the EPA RCRA hazardous waste regulations codified in 40 CFR Parts 260 - 265 implementing the RCRA Act (Reference 2).

Mixed waste is stored on-site in a monitored area until an off-site repository is approved and licensed. The mixed-waste minimization plan provides for conduct of activities in a manner intended to reduce the potential for generation. The storage area is monitored for radiation level and inspected for container integrity.

As noted in Section 5.5.2, the volume of mixed waste produced at nuclear power plants is typically a small fraction of the overall waste stream, accounting for less than 3 percent by volume of the annual LLW discharged (Reference 5). Due to this projected small volume of mixed waste, and because no significant emissions or releases of hazardous materials are expected as a result of control and containment requirements, the NRC generically concluded that the findings for both LLW and mixed-LLW impacts are considered to be SMALL (Reference 5).

5.5.2.2 Assessment of Mixed-Waste Impacts

The NRC's generic conclusions as related to LLW and mixed-LLW are applicable to BLN because it is anticipated that the volume of mixed waste produced at the facility typically accounts for less than 3 percent by volume of the annual LLW discharged and, due to this projected small volume of mixed waste, no significant emissions or releases of hazardous materials are expected as a result of control and containment requirements

Because NRC regulations, ALARA chemical awareness training, and the waste minimization plan are used and followed at the BLN for managing (handling, storage, transportation and treatment) of mixed-wastes, as described above in Subsections 5.5.2 and 5.5.2.1, the impact from mixed-wastes is considered to be SMALL.

5.5.3 REFERENCES

1. Alabama Department of Environmental Management, Environmental Regulations: Land Division – Solid Waste Program, Division 13, ADEM Admin Code R. 335-13-x-.xx; Water Division - Water Quality Program, Volume 1, Division 6, ADEM Admin Code R. 335-6-x-.xx; Air Division, Division 335-3, ADEM Admin Code R. 335-3-x-.xx; Land Division – Hazardous Waste Program, Division 14, ADEM Admin Code R. 335-14-x-.xx.

2. Resource Conservation and Recovery Act, 42 USC 6901 et seq.

3. Clean Air Act, 42 USC 7401 et seq.

4. Federal Facilities Compliance Act, Public Law 102-386.

5. U. S. Nuclear Regulatory Commission, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants,* NUREG-1437, Vol. 1, Washington, DC, 1996.

5.6 TRANSMISSION SYSTEM IMPACTS

This section describes the impacts of transmission system operation for the BLN. As discussed in Section 3.7 all the transmission infrastructure, including corridors and switchyards, to support operation of a two-unit nuclear plant at the BLN site was identified, reviewed, and evaluated in the earlier environmental review documents of the Tennessee Valley Authority (TVA) and Atomic Energy Commission (predecessor to the Nuclear Regulatory Commission) for the original facility encompassing Bellefonte Units 1 and 2. The Atomic Energy Commission subsequently approved and issued a construction license for the BLN facility and its supporting transmission infrastructure into and at the site. As part of the current proposal TVA plans to use the existing transmission lines and switchyards at the BLN to convey power generated from two new Westinghouse AP1000 reactors. No new transmission lines are proposed.

Subsections 5.6.1 and 5.6.2 discuss potential environmental impacts of routine maintenance to terrestrial and aquatic ecosystems. Subsection 5.6.3 addresses potential impacts of the existing transmission lines to members of the public.

As described in greater detail in Section 3.7, two separate transmission lines are located on the BLN site. The actual lines are suspended from self-supporting steel towers which eliminate the need for guy wires. A 500-kV transmission line extends in a southeasterly and northwesterly direction from the site and crosses both Town Creek embayment and Guntersville Reservoir. A 161-kV line runs concurrently with the 500-kV line southeastward onto the BLN but terminates on site (Figure 1.1-5). The right-of-way (ROW) ranges from 300 to 350 ft. and has been maintained as grass fields where the 161- and 500-kV lines coincide. Areas where 500-kV lines are not running with 161-kV lines have not been maintained and have experienced re-growth of scrub-shrub vegetation. A second smaller tap-line extends northeast from the plant before turning northwest at a right angle and crossing Town Creek embayment. The ROW for this smaller 46-kV tap-line is 50 ft. wide and is well maintained as is evident by vegetation characterized as native grass field underneath the transmission line.

TVA's procedure for reviewing the operations and maintenance of transmission lines is called a Sensitive Area Review. Under this review procedure all transmission line corridors, where routine operation and maintenance occur, are reviewed by TVA Cultural Resource staff for the potential to effect historic properties on or eligible for the NRHP. No effects on historic properties along the extant transmission line that is to service the BLN site are anticipated; therefore, no further historic property considerations or assessments along the transmission line corridor are deemed necessary (see Appendix A for TVA correspondence on this issue). One above ground historic property (Townsend Farmhouse) is located within 4800 ft. of the existing transmission line; however, that transmission line was extant when the property was listed on the National Register of Historical Properties (NRHP) (August 11, 2005), so its effects have already been assessed in regard to site integrity. Therefore, the Townsend Farmhouse situation is consistent with the determination that BLN operations have no effects on historic properties along the extant transmission line. The impacts of BLN site operations on historic properties associated with transmission line corridors are considered SMALL, and mitigation is not warranted. The regulatory guidance for the Sensitive Area Review concerning cultural resources is the same guidance for all cultural resource assessments: 36 CFR 800 (Reference 1). At the time of review TVA would determine the need for consultation with the State SHPO, and if needed, define an APE with the State SHPO. That requirement would range from no investigations (area already surveyed) to resurvey (if past surveys were not deemed sufficient) to site avoidance, data recovery, or monitoring if a previously or newly identified cultural resource within the area of potential effect was determined eligible or potentially eligible for inclusion in the NRHP. As TVA has already determined that no further historic property considerations or assessments along the extant transmission line corridor are deemed necessary, it is expected that the impacts of transmission line maintenance on historic properties are considered SMALL, and mitigation is not anticipated.

5.6.1 TERRESTRIAL ECOSYSTEMS

Transmission corridors are managed to prevent woody growth from encroaching on energized transmission lines and potentially causing disruption in service or becoming a general safety hazard. ROW clearing on working transmission corridors is conducted on a 3- to 5-year maintenance cycle by the TVA.

The 161-kV transmission lines built under a portion of the 500-kV lines and the 46-kV tap-line on the BLN site are maintained and require minimal clearing. These segments of 500-kV line were previously energized, but as described in Section 3.7, have subsequently been de-energized. Actions necessary to re-energize the existing 500-kV lines and switchyard at BLN are described in Section 3.7. More extensive re-clearing than would occur with a normal maintenance cycle is needed. However, the types of activities, techniques and equipment used is consistent with those identified in Subsection 3.7.2, as occasionally needed for even regular maintenance.

Federal and state agencies were contacted regarding the BLN project (Section 2.4). The U.S. Fish and Wildlife Service (FWS) was specifically interested in endangered aquatic organisms and plants. Plants of concern in northern Alabama are the green pitcher plant, Morefield's leather flower, Price's potato bean and the fringeless orchid. Only Price's Potato Bean is a concern along ROWs (Section 2.4).

As part of the maintenance cycle, technical specialists in the TVA Regional Natural Heritage Program conduct a Sensitive Area Review to identify any natural resource issues that may occur along the ROWs. Aerial photographs, U.S. Geological Survey topographical maps and low-altitude flyovers are used to detect the presence of sensitive areas that meet habitat requirements for rare plants or animals. Noise from low-altitude flyovers may cause temporary displacement of local fauna. However, impacts are temporary and localized. If sensitive habitat is present, field surveys may be conducted, or the presence of protected species may be assumed. In the latter case, staff proceeds in a manner to minimize impacts to rare species.

TVA's Natural Heritage staff regularly receives requests to review ROW areas scheduled for vegetation management or other minor maintenance or modification activities (e.g. single pole replacements and installation of lightning mitigation measures). Major construction projects, including rebuilds and most major upgrade projects are field surveyed and specific resource features are identified and mapped. Regular maintenance activities, however, typically involve a Sensitive Area Review prior to initiation of work.

There are approximately 19,000 ROW mi. in the TVA system and requests are received involving approximately one-third of these miles every year. Such a large workload means that it is not possible to field survey ROWs where maintenance occurs. Instead, TVA utilizes the best tools available to determine the likelihood of any listed plant or animal inhabiting the section of line under review. Heritage staffers examine the transmission line corridors (using video available to them on TVA InsideNet computer files) to “see” the kinds of habitats present in the project area. Aerial photographs, U.S. Geological Survey topographical maps and low-altitude flyovers are used to detect the presence of sensitive areas that meet habitat requirements for rare species of plants or animals. TVA staff then overlay the ROW with records of sensitive plants and animals from the Heritage database, National Wetland Inventory (NWI) maps, county soil surveys, and other available data in order to identify areas that may require alternative maintenance practices. The standard TVA criteria and guidelines are then applied to make conservative vegetation and/ or land management recommendations to the Power System Operations-Transmission Operations and Maintenance project managers.

In general, the listed species are assumed to be present, and the recommendations are conservatively made with the objective of protecting the species. Vegetation management recommendations can involve restrictions on use of aerial or other herbicide sprays, and restrictions on the type of clearing equipment used. Some particularly sensitive areas are designated as “hand-clearing only” and no herbicide application (backpack, broadcast or aerial) or heavy equipment use is recommended. If there is ground-disturbing work to be done (e.g., pole replacement, lightning arrester installation, etc.), and the Sensitive Area Review indicates likely habitat for a listed plant or animal, field visits are made to those project areas to check for the presence of listed species.

The criteria and guidelines used by TVA’s Natural Heritage staff for protection of listed species potentially affected by power line work activities were shared with the FWS when they were first developed, and again in a February 2005 demonstration session for visiting FWS personnel. In both reviews, FWS personnel agreed that these were reasonable methods to perform this work. TVA managers responsible for transmission and power supply maintenance and new construction were also present at the February 2005 demonstration.

No areas designated by the FWS as “critical habitat” for endangered species exists on or adjacent to existing BLN transmission lines (Subsection 2.4.1). However, transmission lines do cross at least one management area after leaving BLN property (Figure 5.6-1). When management areas are encountered, the TVA uses Environmental Systems Research Institute’s ArcMap GIS software to draw boundaries of potentially affected areas including a 0.5-mi. buffer. After reviewing available data and consulting the area specialist or resource manager, potentially affected management areas are assigned a color and corresponding restriction class. Four levels of restriction exist for managed areas. Examples of restrictions include hand-clearing only and selective spraying of herbicides to shrubs or tree saplings less than 12 ft. in height.

Effects of transmission line maintenance and vegetation management on floodplains and wetlands were evaluated in NUREG-1437 and impacts were found to be small. Wetlands delineated on the NWI map are plotted on the TVA ROW maps with a 1-mi. buffer, while potential wetlands not delineated on NWI maps are plotted without a buffer. Best management practices are observed in wetland and potential wetland areas to avoid and minimize potential impacts. Potential terrestrial impacts associated with ROW maintenance are expected to be SMALL because the TVA has approved methods in place to protect terrestrial habitat from maintenance activities.

5.6.2 AQUATIC ECOSYSTEMS

No new transmission lines associated with the BLN are proposed because existing transmission lines are utilized for the BLN site. Routine maintenance activities on existing transmission line ROWs are performed on a 3- to 5-year cycle by the TVA. Transmission lines within the vicinity of the BLN cross aquatic habitats including reservoirs, creeks, and streams at several locations. Immediately adjacent to the BLN, Town Creek is crossed twice, while Guntersville Reservoir is traversed in a single location (Figure 1.1-5). TVA is responsible for many miles of transmission lines that cross aquatic habitat, and therefore has procedures in place for ROW maintenance to protect them.

Aquatic biologists review county lists and the TVA Natural Heritage database for protected animals. Once an occurrence or likely occurrence is identified based on presence of habitat, the area is delineated on TVA maps and assigned a color and corresponding restriction class. Biologists make recommendations specific to the situation. Transmission line maintenance activities are conducted using best management practices.

Streamside management zone widths are defined depending on the slope of the surrounding area, the type of stream, and the particular resource that may be present in the stream. Hand-clearing or backpack herbicide application of approved herbicides reduce impacts to streams and potential resources within. If impact avoidance is not possible, heritage specialists consult, as appropriate, with the FWS. Because care and time are taken when working near aquatic environments, adverse effects regarding aquatic biota are minimized.

No threatened or endangered species occur in the aquatic habitat adjacent to the BLN site. However, as stated in Subsection 2.4.2, Guntersville Reservoir supports a thriving recreational fishery and is used by waterfowl and other birds throughout the year. Given the measures taken by the TVA to avoid affecting aquatic habitat and the fact no new transmission lines are proposed, any impacts associated with routine maintenance or re-clearing of existing transmission corridors are expected to be SMALL.

5.6.3 IMPACTS TO MEMBERS OF THE PUBLIC

This subsection is included to analyze the impacts of a proposed transmission system to the public. Existing transmission lines currently connect the BLN to the energy distribution grid. However, no new transmission lines associated with the BLN are proposed. Existing line characteristics indicate the highest voltage line associated with the BLN is 500 kV (Section 5.6.1). Transmission lines designed for voltage levels less than 765 kV reduce adverse impacts from ozone formation. Other potential adverse impacts include: electric shock, electromagnetic field effects, corona discharges, and visual impacts.

5.6.3.1 Electric Shock

Objects located near transmission lines can become electrically charged due to their immersion in the lines' electric field. This charge results in a current that flows through the object to the ground. The current is called induced because there is no direct connection between the line and the object. The induced currents can also flow to the ground through the body of a person who touches the object. An object that is insulated from the ground can actually store an electrical charge, becoming what is called “capacitively charged.” A person standing on the ground touching a vehicle or a fence receives an electrical shock due to the sudden discharge of the capacitive charge through the person’s body to the ground. After the initial surge, a steady-state current can develop.

Minimum vertical clearances have been established by the National Electrical Safety Code for electric lines exceeding 98 kV. Clearance must limit the induced current due to electrostatic effects to five milliamps. A 500-kV transmission line requires a minimum of 45-ft. clearance at which induced currents are below five milliamps even for tall vehicles such as tractor trailers and busses. The transmission lines that were constructed to connect BLN to the transmission system conform to the NESC provisions for preventing electric shock from induced current. There are a few spans on the Widows Creek – Madison 500-kV loop into BLN for which the calculated short circuit current would exceed the 5 mA limit. However, this 500-kV loop is de-energized and would remain so until new generation is established at BLN. Physical adjustments to these few spans may be necessary to comply with the 5 mA limit. Additional information on this issue is provided in Subsection 3.7.1.

Induced current can be prevented by grounding metal objects that are in the transmission line ROWs. Grounding chains can easily be installed on tractors. Metal fences can be connected to a simple ground rod with an insulated lead and wire clamp. Grounding of objects within the ROWs are in accordance with the Institute of Electrical and Electronics Engineers Recommended Practices for Grounding of Industrial and Commercial Power Systems (IEEE-142). Impacts due to electric shock as a result of induced current are potentially adverse but can be easily mitigated; therefore, impacts are considered to be SMALL.

5.6.3.2 Electromagnetic Field Exposure

TVA recognizes there is public concern about whether any adverse health effects are caused by electric and magnetic fields (EMF) that result from generation, transmission, distribution, and use of electricity. Many scientific research efforts and other studies examining the potential health and other effects of EMF have been and are currently being conducted. TVA maintains an awareness of published research study results and directly supports some of the research and study efforts.

TVA's standard location practice has the effect of minimizing public exposures to transmission line EMF. The transmission line route selection team uses a constraint model that places a 300-ft. radius buffer around occupied buildings. For schools, a 1200-ft. buffer is used. The purpose of these buffers is to reduce potential land use conflicts with yard trees, outbuildings and ancillary facilities, and to reduce potential visual impacts and possible EMF related controversy. Because EMF diminishes with distance, routing transmission lines using constraint buffers reduces potential public exposure to EMF. Because TVA uses conservative location practices to minimize public exposure to EMF, impacts resulting from public exposure to EMF are considered SMALL.

5.6.3.3 Noise

High-voltage transmission lines can emit noise when the electric field strength surrounding the lines is greater than the breakdown threshold of the encapsulating air, creating an energy discharge. This discharge is known as corona discharge, and is affected by ambient weather conditions such as wind, precipitation, air density, humidity, etc., and energized surface irregularities. The corona discharge can create a noise which can be observed near the base of the transmission lines. Noise from corona discharge along the transmission line is low (well below the 60 – 65 dBA thresholds) and does not pose a noise induced risk to the surrounding community or habitat. Electric field effects on terrestrial biota need not be considered for lines energized at less than 765 Kv. For voltages of 765 kV or above, consideration of the possible effects of electric fields and corona discharge, including resulting noise on terrestrial biota, may be warranted. As stated in NUREG 1437, the term "corona" generally refers to the electrical discharges occurring in air subjected to the strong electric fields adjacent to phase conductors. Corona generally is not a problem at voltages below 765 kV. Corona results in audible noise, radio and TV interference, energy losses, and the production of ozone and oxides of nitrogen (Section 5.8). Increased noise is anticipated during periods of transmission line maintenance. Low altitude fly overs and the use of tractors and power tools generate noise temporarily while maintenance activities are performed.

Because corona generally is not a problem at voltages below 765 kV, and TVA's transmission lines to BLN are at 500 kV and temporary noise from transmission line maintenance is infrequent, impacts to the public from transmission line noise are considered SMALL.

5.6.3.4 Radio and Television Interference

Electromagnetic interference with television and radio is usually the result of defective insulators or hardware. As discussed in Subsection 5.6.3.3, interference stemming from a 500-kV transmission line is minimal. Therefore, impacts associated with radio and television interference from transmission lines are SMALL.

5.6.3.5 Visual Impacts

The TVA attempts to maintain important viewsheds. Natural vegetation is retained at road crossings to help minimize visual impacts where possible. Because no new transmission lines are proposed, viewscapes are not further impacted by the BLN transmission system.

5.6.4 REFERENCES

1. 36 CFR 800, "Protection of Historic Properties."

5.7 URANIUM FUEL CYCLE EFFECTS

This section discusses the effects to the environment associated with the uranium fuel cycle (UFC). The UFC is defined as the total of those options and processes associated with the provision, utilization, and ultimate disposition of fuel for nuclear power reactors.

Table S-3 of 10 CFR 51.51 provides estimates of the environmental effects due to the UFC. The effects are calculated for a reference 1000-MWe light water reactor (LWR) operating at an annual capacity factor of 80 percent for an effective electric output of 800 MWe. This is referred to as the reference plant throughout this section. Data are calculated and presented in tables for land use, water consumption, thermal effluents, radioactive releases, waste burial, and radiation doses. Nuclear Regulatory Commission regulation 10 CFR 51.51 requires that the data in Table S-3 be used as the basis for evaluation of the proposed project.

Two Westinghouse AP1000 pressurized water reactors are proposed for the BLN. Each unit's net electrical power to the grid is 1117 MWe. For conservatism in this evaluation, a margin is added to that power level, giving a total of 1150 megawatts electrical (MWe). A capacity factor of 93 percent, higher than the American nuclear fleet average, is applied. These two reactors operating at 1150 MWe, with an annual capacity factor of 93 percent, yield an effective electric output of 2140 MWe. A ratio of the generation values of 2140 MWe and 800 MWe provides a scale factor of 2.675 to convert reference plant values to BLN specific values (Table 5.7-1). BLN values are presented in the text and tables of this section.

In developing the reference plant data, the NRC staff considered two UFC options. The first, no recycle, and the second, uranium-only recycle, that differ only in the treatment of spent fuel removed from a reactor. No recycle treats all spent fuel as waste to be stored at a Federal waste repository. Uranium-only recycle involves reprocessing spent fuel to recover unused uranium and return it to the UFC. The reference plant values provided for reprocessing, waste management and transportation are from the UFC option resulting in the larger environmental effect.

The Nuclear Nonproliferation Act of 1978 (Reference 3) effectively banned any reprocessing or recycling of spent fuel from U.S. commercial nuclear power. The ban on reprocessing spent fuel was lifted in 1981 but the combination of economics, uranium ore stockpiles, and nuclear industry stagnation provided little incentive for the industry to resume reprocessing. The Energy Policy Act of 2005 (Reference 4) authorized DOE to research and develop proliferation-resistant fuel recycling and transmutation technologies that minimize environmental or public health and safety effects. Federal policy does not now prohibit reprocessing but additional efforts are required before commercial reprocessing and recycling of spent fuel produced in the U.S. commercial nuclear power plants could commence.

The stages of the UFC include:

- Mining.
- Conversion.
- Enrichment of uranium.

- Fabrication of nuclear fuel.
- Use of this fuel.
- Disposal of the used (spent) fuel.

Figure 5.7-1 illustrates this process.

Natural uranium is extracted from the earth through either open-pit or underground mines or by an in situ leaching (ISL) process. ISL involves injecting a solvent solution into the underground uranium ore to dissolve uranium, and then pumping the solution to the surface for further processing. The ore or leaching solution is moved to mills where it is processed to produce uranium oxide (U_3O_8). The uranium oxide is then converted to uranium hexafluoride (UF_6) in preparation for the enrichment process.

The UF_6 is then transported to an enrichment facility. The process of enrichment increases the percentage of the more fissile isotope uranium-235 (U-235) and decreases the percentage of isotope uranium-238 (U-238). Natural uranium is approximately 0.7 percent U-235.

The enrichment process exploits the slight differences in atomic weights of the two isotopes. A feature common to large-scale enrichment schemes is that they employ a number of identical stages, which use a cascading process to produce successively higher concentrations of U-235. Each stage concentrates the product of the previous stage further before being sent to the next stage. Similarly, the tailings from each stage are returned to the previous stage for further processing.

At a fuel-fabrication facility, the enriched uranium is then converted from UF_6 to uranium dioxide (UO_2). The UO_2 is formed into pellets, inserted into tubes, and loaded into fuel assemblies. The fuel assemblies are placed in the reactor to produce power. After most of the U-235 has fissioned, the concentration reaches a point where the nuclear fission process becomes inefficient. The fuel assemblies are then withdrawn from the reactor. After onsite storage for sufficient time to allow for short-lived fission product decay and to reduce the heat generation rate, the fuel assemblies are transferred to a waste repository for interment. Storing the spent fuel elements in a repository constitutes the final step in the no-recycle option.

Next, the environmental effects of the UFC due to the operation of BLN are assessed. This assessment is based on the BLN values calculated in Table 5.7-2, and an analysis of the radiological effect from radon-222 (Rn-222) and technetium-99 (Tc-99). In NUREG-1437, Generic Environmental Impact Statement for License Renewal of Nuclear Plants (Reference 5), the NRC staff provides a detailed analysis of the environmental effects from the UFC. Although NUREG-1437 is specific to license renewal, the information is relevant because the LWR design considered here uses the same type of fuel. The analyses in Section 6.2.3 of NUREG-1437, “Sensitivity to Recent Changes in the Fuel Cycle,” are summarized and presented in this section.

Recent changes in the UFC may have some bearing on environmental effects. The TVA concludes that the effects of the current UFC are less than those identified for the reference plant, as discussed below. The reference plant values were calculated from industry averages for each type of facility or operation within the UFC. Recognizing that this approach results in a range of values for each estimate, the NRC staff chose the assumptions or factors to be applied so the calculated values are not underestimated. This approach was intended to ensure that the actual environmental effects are less than the quantities shown for the reference plant and envelope the widest range of operating conditions for light water reactors.

Some UFC parameters and interactions were recognized by the NRC staff as being less precise than the estimates and were not considered or were considered but had no effect on the reference plant calculations. To determine the annual fuel requirement, the NRC staff defined the model reactor as a 1000-MWe light water cooled reactor. They assumed an 80 percent capacity factor, a 12-month fuel reloading cycle, and an average fuel burnup of 33,000 megawatt-days (MWd) per metric ton (t) of uranium. This is referred to here as a “reference reactor year” (RRY). The current expected lifetime of a new nuclear plant is 60 years (the 40-year initial licensing plus one 20-year license renewal term). The sum of the initial fuel loading and all of the expected reloads for the lifetime of the reactor are divided by the 60-year expected lifetime to obtain an average annual fuel requirement. This quantity of fuel was determined for both boiling water reactors (BWRs) and pressurized water reactors; the higher annual requirement, a BWR using 35 t of uranium, was chosen in NUREG-1437 as the basis for the RRY.

A number of fuel management improvements have been adopted by nuclear power plants to achieve higher performance, and to reduce fuel and enrichment requirements. Since the reference plant data was promulgated, these improvements have resulted in an overall reduction of the annual fuel requirement.

Another factor is the elimination of the U.S. restrictions on importation of foreign uranium. The economic conditions of the uranium market have, until recently, favored utilization of foreign uranium rather than domestic uranium. These market conditions had led to the closing of most domestic uranium mines and mills, and had substantially reduced the environmental effects in the U.S. from these activities. However, because of the increasing cost of uranium, and the anticipated increase due to demand from new plants now involved in licensing and construction, U.S. uranium production has begun to increase again, and is expected to continue to do so. These changes to the UFC suggest that the environmental effects of mining and milling could temporarily drop levels below those given for the reference plant, but would probably creep upward again, making the reference numbers accurate. For the purposes of this analysis, the reference plant estimates have not been reduced.

Section 6.2 of NUREG-1437 discusses the sensitivity to recent changes in the UFC on the environmental effects in detail.

Where relevant in discussions below, a single significance level of the potential effect (i.e., SMALL, MODERATE, or LARGE) is assigned to each analysis. This is consistent with the criteria that the NRC established in 10 CFR 51, Appendix B, Table B 1, Footnote 3, as follows:

> SMALL Environmental effects are not detectable or are so minor that they neither destabilize nor noticeably alter any important attribute of the resource.
>
> MODERATE Environmental effects are sufficient to alter noticeably, but not to destabilize, any important attribute of the resource.

LARGE Environmental effects are clearly noticeable and are sufficient to destabilize any important attributes of the resource.

5.7.1 LAND USE

The total annual land requirement for the UFC supporting BLN is presented in Table 5.7-2. This includes values for both permanently and temporarily committed land. A “temporary” land commitment is a commitment for the life of the specific UFC plant (e.g., a mill, enrichment plant, or succeeding plants). Following completion of decommissioning, such land can be released for unrestricted use. “Permanent” commitments represent land that may not be released for use after plant shutdown and/or decommissioning. This is because decommissioning activities on the pertinent land cannot remove sufficient radioactive material to meet the limits in 10 CFR 20, Subpart E, for release of land for unrestricted use. The division of temporarily committed land into undisturbed and disturbed land is presented in Table 5.7-2, and compared to the land disturbed to provide fuel for a coal-fired power plant using strip-mined coal with power generation equivalent to the BLN value. The BLN fuel cycle requires only 15 percent of the temporarily committed land and 13 percent of the permanently committed land that would be required by replacement with coal-fired capacity. If the quality and opportunity cost of the land is equivalent, then it is reasonable to say that land requirements are SMALL. Therefore, it is concluded that the impact on land use to support BLN is considered SMALL.

5.7.2 WATER USE

Power stations supply electrical energy to the enrichment stage of the UFC. The primary water requirement of the UFC is waste heat removal from these power stations. For the UFC supporting the BLN, over 97 percent of the annual water requirement is used in this manner. Values for the various water uses required are presented in Table 5.7-2.

On a thermal effluent basis, annual discharges from the UFC are equal to about 4 percent of the thermal effluent from the reference plant using once-through cooling. The consumptive water use is about 2 percent of the consumptive water use of the reference plant using cooling towers. The expected thermal effluent values for BLN are presented in Table 5.7-2. The amount of water withdrawn from surface and ground water and discharged to air by BLN activities within the fuel cycle represents only 5.4 percent of the annual discharges to air of a LWR with cooling towers. The fuel cycle discharges are spread among facilities involved in the various stages of the fuel cycle; thus, the water discharge to air from any one of these facilities are less than the 5.4 percent. The amount of water withdrawn from surface and ground water and discharged to water bodies and to the ground represents only 11 percent of the annual discharges to water bodies and the ground of a LWR with once-through cooling. The fuel cycle discharges are spread among facilities involved in the various stages of the fuel cycle; thus, the water discharges from any one of these facilities are less than the 11 percent. Given that the water discharged to water bodies and to the ground from other fuel cycle facilities for an RRY is only a small fraction of the discharge from a LWR, it is concluded that the impact to support BLN is considered to be SMALL.

5.7.3 FOSSIL FUEL EFFECTS

Electrical energy and process heat are required during various phases of the UFC process. The electrical energy is usually produced by combustion of fossil fuels at power plants. BLN electrical energy needs associated with the UFC represents about 13.4 percent of the annual electrical power production of the reference plant. Process heat is primarily generated by the combustion of natural gas. This gas consumption, if used to generate electricity, is less than 1.1 percent of the electrical output from the reference plant. Electrical energy needs for BLN associated with the UFC are presented in Table 5.7-2. It is concluded that the fossil fuel impacts from the consumption of electrical energy for UFC operations is considered to be SMALL relative to the net power production of BLN.

5.7.4 CHEMICAL EFFLUENTS

The quantities of chemical, gaseous, and particulate effluents due to UFC processes to support BLN are presented in Table 5.7-2. The principal effluents are oxides of sulfur (SO_x), oxides of nitrogen (NO_x), and particulates. The volume of effluent is equivalent to that of a quite small [120-MW(e)] coal-fired plant; thus it is concluded that the impact to the degradation of air quality is SMALL. Based on data in “The 1997 Annual Report of the Council on Environmental Quality” (Reference 6), these emissions constitute a small additional atmospheric loading in comparison with these emissions from the stationary fuel combustion and transportation sectors in the United States (i.e., about 0.06 percent maximum of the annual national releases for each of these species).

Liquid chemical effluents produced in the UFC processes are related to the ISL process, fuel enrichment and fabrication, and may be released to receiving waters. These effluents are usually present in such small concentrations that only small amounts of dilution water are required to reach levels of concentration that are within established standards. Table 5.7-2 presents the amount of dilution water required for specific constituents. Additionally, any liquid discharges into the navigable waters of the United States from plants associated with UFC operations are subject to requirements and limitations set in an NPDES permit issued by an appropriate Federal, State, regional, local, or affected Native American tribal regulatory agency.

Tailings solutions and solids are generated during the milling process. These materials are not released in quantities sufficient to have a significant effect on the environment. It is concluded that the impact of these chemical effluents is considered to be SMALL.

5.7.5 RADIOACTIVE EFFLUENTS

The estimates of radioactive effluent releases to the environment are presented in Table 5.7-2. These are from the ISL process, waste management activities and certain other phases of the UFC process. The 100-year involuntary environmental dose commitment to the U.S. population is calculated in several parts.

The portion of dose commitment from radioactive gaseous effluents during reactor operation is 10.7 person-Sv (1070 person-rem) per Table 5.7-4 per year of operation of the BLN. This estimate excludes reactor releases and any dose commitment from Rn-222.

The portion of dose commitment from radioactive liquid effluents due to all UFC operations other than reactor operation is 5.4 person-Sv (535 person-rem) per Table 5.7-4 per year of operation of the BLN.

Thus, the total 100-year environmental dose commitment to the U.S. population from radioactive gaseous and liquid releases resulting from these portions of the UFC is 16.1 person-Sv (1605 person-rem) per Table 5.7-4 per year of operation of the BLN. Using risk estimators of 500 cancer deaths per 10,000 person-Sv (1 million man-rem) (Reference 1), the estimated cancer risk is 0.8 per RRY (16.1 x 500 x 10^{-4}).

Currently, the radiological effects associated with Rn-222 and Tc-99 release are not addressed in the reference plant data. Principal Rn-222 releases occur during mining and milling operations and as emissions from mill tailings, whereas principal Tc-99 releases occur from gaseous diffusion enrichment facilities.

In Section 6.2.2.1 of NUREG-1437, the NRC staff estimated the Rn-222 releases from the mining and milling operation and from mill tailings required to support each year of operations of the reference plant. Of this total, about 77 percent are from mining, 15 percent from milling operations, and 7 percent from inactive tailings prior to stabilization.

The major risks from Rn-222 are bone and lung exposure, although there is a small risk from whole body exposure. The organ-specific dose weighting factors from 10 CFR Part 20 are applied to the bone and lung doses to estimate the 100-year dose commitment from Rn-222 to the whole body. The estimated population dose commitment from mining, milling, and tailings before stabilization for each year of operation of BLN is presented in Table 5.7-3. From stabilized tailings piles, the estimated 100-year environmental dose commitment is presented in Table 5.7-3.

The NRC staff also considered the potential health effects associated with the release of Tc-99. It was found that the release of Tc-99 per year of BLN operation are from chemical reprocessing of recycled UF6 before it enters the isotope enrichment cascade, and are released into the groundwater from a federal repository. These values are presented in Table 5.7-3.

The major risks from Tc-99 are from gastrointestinal tract and kidney exposure, although there is a small risk from whole-body exposure. Using organ-specific risk estimators, these individual organ risks can be converted to a whole-body 100-year dose commitment per year of BLN operation. This value is presented in Table 5.7-3.

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 and dose rates, below a lifetime dose of 100 mSv (10,000 mrem). 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 model is used to describe the relationship between radiation dose and risk such as cancer induction. A report by the National Research Council (Reference 2) supports the linear, no-threshold dose response model. Simply stated, any increase in dose, no matter how small, results in an incremental increase in health risk. This theory is accepted by the NRC as a conservative model for estimating health risks from radiation exposure, recognizing that the model probably overestimates those risks.

Based on this model, the NRC staff estimated the risk to the public from radiation exposure. The sum of the estimated whole body population doses from gaseous effluents, liquid effluents, Rn-222, and Tc-99 discussed above can be used to estimate the number of fatal cancers, nonfatal cancers, and severe hereditary effects that the U.S. population would incur annually. This risk is quite small compared to the number of fatal cancers, nonfatal cancers, and severe hereditary effects that are estimated to occur in the U.S. population annually from exposure to natural sources of radiation using the same risk estimation method.

The radiation levels from Rn-222 released from tailings piles are indistinguishable from background radiation levels at a few kilometers from the tailings pile (at less than 1 km in some cases). The public dose limit specified by U.S. Environmental Protection Agency's (EPA) regulation in 40 CFR Part 190, is 0.25 mSv/yr (25 mrem/yr) to the whole body from the entire UFC, but most NRC licensees have airborne effluents resulting in doses of less than 0.01 mSv/yr (1 mrem/yr). (Reference 5)

In addition, at the request of the U.S. Congress, the National Cancer Institute (NCI) conducted a study and published "Cancer in Populations Living Near Nuclear Facilities. A Survey of Mortality Nationwide and Incidence in Two States" in 1990 (Reference 9). The report concluded that if any excess cancer risk was present in US counties with nuclear facilities, it was too small to be detected with the methods employed. The contribution to the annual average dose received by an individual from the UFC-related radiation and other sources is presented in Table 5.7-5.

Based on the analyses presented above, it is concluded that the environmental impact of radioactive effluents from the UFC is considered to be SMALL.

5.7.6 RADIOACTIVE WASTES

The quantities of buried radioactive waste material (low-level, high-level, and transuranic wastes) are specified in Table 5.7-2. For low-level waste disposal at land burial facilities, the NRC notes in the reference plant data that there are to be no significant radioactive releases to the environment. For high-level and transuranic wastes, the NRC notes that these are expected to be buried at a repository and that no release to the environment is expected to be associated with such disposal. The gaseous and volatile radionuclides contained in the spent fuel would have been released and monitored before disposal.

On July 9th, 2002, the U.S. Senate cast the final legislative vote to approve the Yucca Mountain site for the development of a repository for the geologic disposal of spent nuclear fuel and high-level nuclear waste. This was then approved by the President on July 23rd, 2002, allowing the DOE to continue work on this repository (Reference 12).

The EPA developed Yucca Mountain-specific repository standards, which were subsequently adopted by the NRC in 10 CFR Part 63. In an opinion issued on July 9, 2004, the U.S. Court of Appeals for the District of Columbia Circuit Court vacated EPA's radiation protection standards for the candidate repository, which required compliance with certain dose limits over a 10,000-year period (Reference 13). The Court's decision also vacated the compliance period in NRC's licensing criteria for the candidate repository in 10 CFR Part 63. In response to the Court's decision, EPA issued proposed revised standards on August 22, 2005. The proposed standard would revise the radiation protection standards for the candidate repository (Reference 14). As required by the Nuclear Waste Policy Act of 1982 (Reference 7), and in order to be consistent with EPA's revised standards, NRC proposed revisions to 10 CFR Part 63 on September 8, 2005.

The proposed standards are 0.15 mSv/yr (15 mrem/yr) for 10,000 years following disposal and 3.5 mSv/yr (350 mrem/yr), after 10,000 years through 1 million years after disposal.

It is concluded that this impact is acceptable, because the impact is not sufficiently great to require the conclusion of the NEPA analysis to be that the construction and operation of BLN should be denied. For the reasons stated above, it is concluded that the environmental impact of radioactive waste disposal from the UFC is considered to be SMALL.

5.7.7 OCCUPATIONAL DOSE

In the review and evaluation of the environmental effects of the UFC, the annual occupational dose attributable to all phases of the UFC for BLN is about 16.1 person-Sv (1605 person-rem). Occupational doses is maintained to meet the dose limits in 10 CFR Part 20, which is 0.05 Sv/yr (5 rem/yr). On this basis, it is concluded that environmental effects from this occupational dose is considered to be SMALL.

5.7.8 TRANSPORTATION

The transportation dose to workers and the public totals about 0.067 person-Sv (6.7 person-rem) annually per Table 5.7-2 for the BLN. For comparative purposes, the estimated collective dose from natural background radiation to the population within 50 mi. of BLN is 1440 person-Sv/yr (144,000 person-rem/yr) (Reference 11). On this basis, it is concluded that the environmental impact of transportation is considered to be SMALL.

5.7.9 CONCLUSION

Using an evaluation process as provided by NUREG-1437 (Reference 5), this evaluation has examined the environmental impact of the UFC, considered the impact of Rn-222 and Tc-99, and appropriately scaled the data for the BLN. Based on this comparison, it is concluded that the environmental impact of the UFC is considered to be SMALL, and mitigation is not warranted.

5.7.10 REFERENCES

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13. United States Court of Appeals for the District of Columbia Circuit, January 14, 2004, No. 01-1258, Nuclear Energy Institute, Inc., Petitioner, v. Environmental Protection Agency, Respondent.

14. U.S. Environmental Protection Agency (EPA), Office of Air and Radiation, “EPA's Proposed Public Health and Environmental Radiation Protection Standards for Yucca Mountain,” 2005.

TABLE 5.7-1
SCALING FACTOR - REFERENCE PLANT AND BLN

	10 CFR 51.51 Reference Plant (1000 MWe LWR)	BLN (Two AP1000 Units)
Net Electric Output	1000 MWe	2 units * 1150 MWe per unit = 2300 MWe
Capacity Factor	80 percent	93 percent
Effective Electric Output	1000 MWe * 80 percent = 800 MWe	2300 MWe * 93 percent = 2140 MWe
Ratio of Effective Electric Output Values	2140 MWe / 800 MWe = 2.675	

This scale factor is used to calculate the BLN values in the remaining tables.

TABLE 5.7-2 (Sheet 1 of 7)

URANIUM FUEL CYCLE ENVIRONMENTAL DATA – REFERENCE PLANT AND BLN[(a)]

10 CFR 51.51 Table S-3[(b)] (Normalized to model LWR annual fuel requirement [WASH-1248] or RRY [NUREG-0116])			AP1000 Data (2 units at BLN)	
Environmental Considerations	Reference Reactor Data (10 CFR 51.51 values are shown in bold text[(c)])	Maximum effect per annual fuel requirement or RRY	Reference Reactor Data multiplied by scale factor[(c)]	Maximum effect per annual fuel requirement or RRY multiplied by scale factor[(c)]
Natural Resource Use				
Land, ha (acres [ac.])				
Total	46 ha. (113 ac.)	———————	46 ha * 2.675 scale factor = 122 ha (302 ac.)	———————
Temporarily committed[(d)]	40 (**100**)	———————	108 (268)	———————
Undisturbed area	32 (**79**)	———————	86 (211)	———————
Disturbed area	9 (**22**)	This is equivalent to a 110 MWe coal-fired power plant.	24 (59)	This is equivalent to a 294 MWe coal-fired power plant.
Permanently committed	5 (**13**)	———————	14 (35)	———————
Overburden moved, million t (millions of tons [T])	**2.8 million t** (3.1 million T)	This is equivalent to a 95 MWe coal-fired power plant	7.5 (8.3)	This is equivalent to a 254 MWe coal-fired power plant
Water, million l (million gal)				
Discharged to air	606 million l (**160 million gal**)	This equals 2 percent of the model 1000 MWe LWR with cooling tower.	1620 (428)	This equals 5.4 percent of the model 1000 MWe LWR with cooling tower.
Discharged to water bodies	41,980 (**11,090**)		112,297 (29,666)	
Discharged to ground	481 (**127**)		1286(340)	

TABLE 5.7-2 (Sheet 2 of 7)

URANIUM FUEL CYCLE ENVIRONMENTAL DATA – REFERENCE PLANT AND BLN[(a)]

10 CFR 51.51 Table S-3[(b)] (Normalized to model LWR annual fuel requirement [WASH-1248] or RRY [NUREG-0116])			AP1000 Data (2 units at BLN)	
Environmental Considerations	Reference Reactor Data (10 CFR 51.51 values are shown in bold text[(c)])	Maximum effect per annual fuel requirement or RRY	Reference Reactor Data multiplied by scale factor[(c)]	Maximum effect per annual fuel requirement or RRY multiplied by scale factor[(c)]
Total	43,067 (**11,377**)	This is less than 4 percent of the model 1000 MWe LWR with once through cooling.	115,203 (30,433)	This is less than 11 percent of the model 1000 MWe LWR with once through cooling.
Fossil fuel				
Electrical energy, MW hour (MWh)	**323,000 MWh**	This is less than 5 percent of the model 1000 MWe LWR output	864,000	This is less than 13.4 percent of the model 1000 MWe LWR output
Equivalent coal, thousand t (thousand T)	**118,000 t** (130,000 T)	This is equivalent to the consumption of a 45 MWe coal-fired power plant.	316,000 (348,000)	This is equivalent to the consumption of a 120 MWe coal-fired power plant.
Natural gas, millions of cubic meters (m^3) (millions of standard cubic feet [scf])	3.82 million m^3 (**135 million scf**)	This is less than 0.4 percent of the model 1000 MWe energy output.	10 (361)	This is less than 1.1 percent of the model 1000 MWe energy output.
Chemical Effluents, t (T)				
Gases, incl. entrainment[(e)]				
SOx	**4400 t** (4851 T)	These values are equivalent to the emissions from a 45 MWe coal-fired plant for a year.	11,770 (12,976)	These values are equivalent to the emissions from a 120 MWe coal-fired plant for a year.
NOx[(f)]	**1190** (1312)		3183 (3509)	
Hydrocarbons	**14** (15)		37 (41)	
CO	**29.6** (32.6)		79.2 (87.3)	
Particulates	**1154** (1272)		3087 (3403)	

TABLE 5.7-2 (Sheet 3 of 7)
URANIUM FUEL CYCLE ENVIRONMENTAL DATA – REFERENCE PLANT AND BLN[(a)]

10 CFR 51.51 Table S-3[(b)] (Normalized to model LWR annual fuel requirement [WASH-1248] or RRY [NUREG-0116])			AP1000 Data (2 units at BLN)	
Environmental Considerations	Reference Reactor Data (10 CFR 51.51 values are shown in bold text[(c)])	Maximum effect per annual fuel requirement or RRY	Reference Reactor Data multiplied by scale factor[(c)]	Maximum effect per annual fuel requirement or RRY multiplied by scale factor[(c)]
Other gases				
F	**0.67 t** (0.74 T)	This is principally from UF6 production, enrichment, and reprocessing. The concentration is within range of state standards below the level that has effects on human health.	1.79 (1.98)	This is principally from UF6 production, enrichment, and reprocessing. The concentration is within range of state standards below the level that has effects on human health.
HCl[(g)]	**0.014** (0.015)	————	0.037 (0.041)	————
Liquids				
SO4-	**9.9 t** (10.9 T)	This is from enrichment, fuel fabrication, and reprocessing steps. Components that constitute a potential for adverse environmental effect are present in dilute concentrations, and receive additional dilution by receiving bodies of water to levels below permissible standards. The constituents that require dilution and the flow of dilution water are: NH_3, 17 m^3/s (600 cubic feet per second [cfs]); NO_3, 0.57 m^3/s (20 cfs); Fluoride, 2.0 m^3/s (70 cfs)	26.5 (29.2)	This is from enrichment, fuel fabrication, and reprocessing steps. Components that constitute a potential for adverse environmental effect are present in dilute concentrations, and receive additional dilution by receiving bodies of water to levels below permissible standards. The constituents that require dilution and the flow of dilution water are: NH_3, 45 m^3/s (1600 cubic feet per second [cfs]); NO_3, 1.5 m^3/s (54 cfs); Fluoride, 5.4 m^3/s (190 cfs)
NO3-	**25.8** (28.4)		69 (76.1)	
Fluoride	**12.9** (14.2)		34.5 (38.0)	
Ca++	**5.4** (6.0)		14.4 (15.9)	
Cl-	**8.5** (9.4)		22.7 (25.1)	
Na+	**12.1** (13.3)		32.4 (35.7)	
NH3	**10** (11)		27 (29)	
Fe	0.4 t (0.4 T)	————	1.1 (1.2)	————
Tailings solutions	240,000 t (265,000 T)	From mills only - no significant effluents to environment.	642,000 (708,000)	From mills only - no significant effluents to environment.

TABLE 5.7-2 (Sheet 4 of 7)

URANIUM FUEL CYCLE ENVIRONMENTAL DATA – REFERENCE PLANT AND BLN[a]

10 CFR 51.51 Table S-3[b] (Normalized to model LWR annual fuel requirement [WASH-1248] or RRY [NUREG-0116])			AP1000 Data (2 units at BLN)	
Environmental Considerations	Reference Reactor Data (10 CFR 51.51 values are shown in bold text[c])	Maximum effect per annual fuel requirement or RRY	Reference Reactor Data multiplied by scale factor[c]	Maximum effect per annual fuel requirement or RRY multiplied by scale factor[c]
Solids	**91,000 t** (100,328 T)	Principally from mills - no significant effluents to environment.	243,425 (268,376)	Principally from mills - no significant effluents to environment.
Radiological Effluents, Ci				
Gases, incl. entrainment[e]				
Rn-222		This is presently under reconsideration by the NRC		This is presently under reconsideration by the NRC
Ra-226	**0.02 Ci**	————	0.05	————
Th-230	**0.02**	————	0.05	————
U	**0.034**	————	0.091	————
H-3 (thousands)	**18.1**	————	48.4	————
C-14	**24**	————	64	————
Kr-85 (thousands)	**400 Ci**	————	1070	————
Ru-106	**0.14**	This is principally from fuel reprocessing plants.	0.37	This is principally from fuel reprocessing plants.
I-129	**1.3**	————	3.5	————
I-131	**0.83**	————	2.22	————
Tc-99		This is presently under consideration by the NRC		This is presently under consideration by the NRC

TABLE 5.7-2 (Sheet 5 of 7)
URANIUM FUEL CYCLE ENVIRONMENTAL DATA – REFERENCE PLANT AND BLN[(a)]

10 CFR 51.51 Table S-3[(b)] (Normalized to model LWR annual fuel requirement [WASH-1248] or RRY [NUREG-0116])			AP1000 Data (2 units at BLN)	
Environmental Considerations	Reference Reactor Data (10 CFR 51.51 values are shown in bold text[(c)])	Maximum effect per annual fuel requirement or RRY	Reference Reactor Data multiplied by scale factor[(c)]	Maximum effect per annual fuel requirement or RRY multiplied by scale factor[(c)]
Fission products and transuranics (TRU)	**0.203**	——————	0.543	——————
Liquids				
Uranium and daughters	**2.1 Ci**	Principally from milling - included tailings liquor and returned to ground - no effluents; therefore, no effect on the environment.	5.6	Principally from milling - included tailings liquor and returned to ground - no effluents; therefore, no effect on the environment.
Ra-226	**0.0034**	This is from UF6 production.	0.0091	This is from UF6 production.
Th-230	**0.0015**	——————	0.0040	——————
Th-234	**0.01**	From fuel fabrication plants — concentration 10 percent of 10 CFR 20 for total processing 26 annual fuel requirements for the model LWR.	0.03	From fuel fabrication plants — concentration 27 percent of 10 CFR 20 for total processing 26 annual fuel requirements for the model LWR.
Fission and Activation	**0.0000059**	——————	0.000016	——————

TABLE 5.7-2 (Sheet 6 of 7)
URANIUM FUEL CYCLE ENVIRONMENTAL DATA – REFERENCE PLANT AND BLN[(a)]

10 CFR 51.51 Table S-3[(b)] (Normalized to model LWR annual fuel requirement [WASH-1248] or RRY [NUREG-0116])			AP1000 Data (2 units at BLN)	
Environmental Considerations	Reference Reactor Data (10 CFR 51.51 values are shown in bold text[(c)])	Maximum effect per annual fuel requirement or RRY	Reference Reactor Data multiplied by scale factor[(c)]	Maximum effect per annual fuel requirement or RRY multiplied by scale factor[(c)]
Solids buried				
Other than high level (HLW) (shallow)	**11,300 Ci**	9100 Ci comes from low-level reactor wastes and 1,500 Ci from reactor decontamination and decommissioning - buried at land burial facilities. 600 Ci comes from mills, included in tailing returned to ground. Approximately 60 Ci comes from conversion and spent fuel storage. There is no significant effluent to the environment.	30,228	24,300 Ci comes from low-level reactor wastes and 4,000 Ci from reactor decontamination and decommissioning - buried at land burial facilities. 1600 Ci comes from mills, included in tailing returned to ground. Approximately 160 Ci comes from conversion and spent fuel storage. There is no significant effluent to the environment.
TRU and HLW (deep)	**11,000,000**	Buried at Federal Repository	29,000,000	Buried at Federal Repository
Thermal Effluents, Gigawatt hours (GWh) (Billions of British thermal units [Btu])	1190 GWh **(4063 billion Btu)**	This is less than 5 percent of the model 1000 MWe LWR.	3184 (10,869)	This is less than 14 percent of the model 1000 MWe LWR.
Transportation, person-Sv (person-rem)				
Exposure of workers and the general public	0.025 person-Sv **(2.5 person-rem)**	————	0.067 (6.7)	————
Occupational exposure	0.226 (**22.6**)	From reprocessing and waste management	0.605 (60.5)	From reprocessing and waste management

TABLE 5.7-2 (Sheet 7 of 7)

URANIUM FUEL CYCLE ENVIRONMENTAL DATA – REFERENCE PLANT AND BLN[a]

10 CFR 51.51 Table S-3[b] (Normalized to model LWR annual fuel requirement [WASH-1248] or RRY [NUREG-0116])			AP1000 Data (2 units at BLN)	
Environmental Considerations	Reference Reactor Data (10 CFR 51.51 values are shown in bold text[c])	Maximum effect per annual fuel requirement or RRY	Reference Reactor Data multiplied by scale factor[c]	Maximum effect per annual fuel requirement or RRY multiplied by scale factor[c]

a) In some cases where no entry appears it is clear from the background documents that the matter was addressed and that, in effect, the Table should be read as if a specific zero entry had been made. However, other areas are not addressed at all in the Table. Table S-3 does not include health effects from the effluents described in the Table, or estimates of releases of Radon-222 from the UFC or estimates of Technetium-99 released from waste management or reprocessing activities. These issues may be the subject of litigation in the individual licensing proceedings.
Data supporting this table are given in the “Environmental Survey of the UFC," WASH-1248, April 1974; the "Environmental Survey of Reprocessing and Waste Management Portion of the LWR Fuel Cycle," NUREG-0116 (Supp. 1 to WASH-1248); the "Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," NUREG-0216 (Sup. 2 to WASH-1248): and in the record of final rulemaking pertaining to UFC Effects from Spent Fuel Reprocessing and Radioactive Waste Management, Docket RM-50-3. The contributions from reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and fuel recycle). The contribution from transportation excludes transportation of cold fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor which are considered in Table S-4 of § 51.20(g). The contributions from the other steps of the fuel cycle are given in columns A-E of Table S-3A of WASH-1248.

b) All data from 10 CFR 51.51 is for a single reference reactor year. For plant lifetime values, multiply table values by the plant’s lifetime, in years.

c) Differences may exist due to rounding. All calculated values have been abbreviated to the number of significant figures present in the Reference Reactor Data. Values outside of parenthesis are expressed in metric measurements, values inside of parenthesis are values in US Standard measurements.

d) The contributions to temporarily committed land from reprocessing are not prorated over 30 years, because the complete temporary impact accrues regardless of whether the plant services 1 reactor for 1 year or 57 reactors for 30 years.

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

f) 1.2% from natural gas use and process.

g) NUREG 1555 shows the HCl value as 0.14 t.

TABLE 5.7-3
WHOLE BODY 100-YEAR DOSE COMMITMENT ESTIMATE OF RN-222 AND TC-99

Values for Rn-222	Release, Ci per RRY (Reference 5)	Percent of total (with stabilized tailings)	Whole body 100 year dose commitment, 100 year person Sv per RRY (100 year person rem per RRY) (Reference 5)	Release, Ci per BNP operation year	Whole-body 100-year dose commitment (100-year person-rem per BNP year)
Mining	4060 Ci	77%	1.1 person-Sv/100 years (110 person-rem/100 years)	4060 Ci * 2.675 scale factor = 10,861 Ci	2.93 person-Sv/100 years (293 person-rem/100 years)
Milling	780	15	0.21 (21)	2087	0.56 (56)
Tailings	350	7	0.09 (9)	936	0.25 (25)
Stabilized tailings	1	<1	0.00027 (0.027)	3	0.00072 (0.072)
Total for Rn-222	**5191**	**100**	**1.4 (140)**	**13,886**	**3.75 (375)**
Values for Tc-99	(Reference 5)				
Chemical reprocess	0.007 Ci	58%	0.58 person-Sv/100 years (58 person-rem/100 years)	0.019	1.56 person-Sv/100 years (156person-rem/100 years)
Groundwater	0.005	42	0.42 (42)	0.013	1.11 (111)
Total for Tc-99	**0.012**	**100**	**1.0 (100)**	**0.032**	**2.68 (268)**

TABLE 5.7-4
WHOLE BODY 100-YEAR DOSE COMMITMENT ESTIMATE

100-year overall involuntary whole-body dose commitment to the U.S. population from the uranium fuel cycle, excluding Rn-222 or Tc-99, person-Sv (person-rem)	Reference Reactor, per RRY	BLN, per BLN operation year
From radioactive gaseous effluents (excluding reactor releases and the dose commitment due to Rn-222) (Reference 5)	4.0 person-Sv/100 years (400 person-rem/100 years)	4.0 * 2.675 scale factor = 10.7 (1070)
From radioactive liquid effluents (all fuel-cycle operations excluding reactor operation) (Reference 5)	2.0 (200)	5.4 (535)
Subtotal	**6.0 (600)**	**16.1 (1605)**
Total Rn-222 (Table 5.7-3)	1.4 (140)	3.7 (375)
Total Tc-99 (Table 5.7-3)	1.0 (100)	2.7 (268)
Total with Rn-222 and Tc-99	**8.4 (840)**	**22.5 (2247)**

TABLE 5.7-5
RADIATION EXPOSURE TO THE U.S. POPULATION

Exposure Source		Average Dose Equivalent to U.S. Population mSv/yr (mrem/yr)
Natural		
	Radon	2 mSv/yr(200 mrem/yr)
	Other	1 (100)
Occupational		.009 (0.9)
Nuclear Fuel Cycle[a]		0.0005 (0.05)
Consumer Products:		
	Tobacco[b]	- - -
	Other	0.05 – 0.13 (5 – 13)
Medical:		
	Diagnostic X-rays[c]	0.39 (39)
	Nuclear medicine[d]	0.14 (14)
Approximate Total		3.6 (360)

a) Collective dose to regional population within 50 mi. of each facility.

b) Difficult to determine a whole body dose equivalent. However, the dose to a portion of the lungs is estimated to be 16,000 mrem/yr.

c) Number of persons unknown. However, 180 million examinations performed with an average dose of 50 mrem per examination.

d) Number of persons unknown. However, 7.4 million examinations performed with an average dose of 430 mrem per examination.

(Reference 10)

5.8 SOCIOECONOMIC IMPACTS

The following subsections describe the potential socioeconomic impacts from operating the BLN. Subsection 5.8.1 describes physical impacts of BLN operation to the site and vicinity. Subsection 5.8.2 describes social and economic impacts on the region. Subsection 5.8.3 describes environmental justice impacts as a result of BLN operation.

5.8.1 PHYSICAL IMPACTS OF STATION OPERATION

This subsection assesses the potential physical impact due to operation of the new units on the nearby communities or residences. Potential impacts include noise, odors, exhausts, thermal emissions, and visual intrusions. These physical impacts comply with applicable federal, state, and local environmental regulations and do not significantly affect the BLN site and its vicinity.

There are no residential units located within the site boundary. The area surrounding the BLN site is predominately rural and characterized by farmland and wooded tracts. The Creeks Edge residential area with 110 lots is located northwest of the BLN site on the shoreline of Town Creek. The nearest community to the BLN site is Hollywood, Alabama located approximately 3 mi. from the site. However, the nearest large community is Scottsboro, Alabama located approximately 7 mi. to the southwest. Because of this distance from the BLN site, the residents of Scottsboro, Alabama would not experience any physical impact from operation of the new units. The locations of surrounding communities within the vicinity are described in Section 2.1. Population distribution is described in Section 2.5.

An estimated 1000 operations workers are needed for operation of the BLN. The impacts from these workers on the local and regional area are discussed in Subsection 5.8.2.

5.8.1.1 Buildings

The nearest industrial park to the BLN site is Jackson County Industrial Park, the boundary of which is located within 2.0 mi. of the BLN site boundary. Figure 2.5-28 and Subsection 2.5.5 indicate that the nearest residence is approximately 0.5 mi. from the nearest cooling tower.

On-site buildings are constructed within safety standards and requirements to withstand any possible impact, including shock and vibration, from operation activities.

Based on the distance from the nearest residences to on-site buildings and the safety standards to which the buildings are constructed, operational activities are considered to have a SMALL impact on on-site and nearby residential areas, and mitigation is not warranted.

5.8.1.2 Roads

Impacts of the new units’ operations on transportation and traffic are greatest on the rural roads of Jackson County. Impacts on traffic are determined by four elements:

- The number of operations workers and their vehicles on the roads.
- The number of shift changes for the operations workforce.

- The projected population growth rate in the region.
- The capacity of the roads.

The impacts to roads are greatest during shift changes.

For plant operations, it was assumed that the BLN site would operate in three shifts. The day shift would be composed of 60 percent of the workers, the night shift would be composed of 30 percent of the workers, and the midnight (graveyard) shift would be composed of 10 percent of the workers. The BLN site expects to employ approximately 1000 operations workers at the new units. Therefore, the 1000 workers needed for operation of the new facility would add approximately 1000 additional vehicles on the roadway. Of these, approximately 600 are associated with the day shift, 300 are associated with the night shift, and 100 are associated with the midnight (graveyard) shift. Assuming most of the vehicles are on the roadway at the end of the day shift and the start of the night shift (shift change), there is a maximum of 900 additional vehicles entering and leaving the site at that time. Additional impacts may be present during outages and during refueling periods when more workers are present. Additional information on transportation, including current traffic counts, is discussed in Subsection 2.5.2.

Given the current volume of traffic, as indicated by Annual Average Daily Traffic (AADT) counts in Subsection 2.5.2, on the road network, the impact due to the addition of 900 vehicles is considered SMALL, and potential mitigation measures include staggering outage shifts opposite traditional high-traffic periods, mandatory carpooling, and busing in employees, if necessary. Additionally, because 650 operation workers and their vehicles are anticipated to be phased into the BLN site during the construction stage (see Subsection 4.4.1.2), the initial impact during operation is anticipated to be lessened due to the temporal phasing.

5.8.1.3 Aesthetics

As shown in Figure 1.1-4, the BLN site is located along the Tennessee River which borders the site boundary from approximately river mile marker 390 to river mile marker 393. Areas adjacent to the site boundary primarily consist of farmland, pastureland, and undeveloped woodland.

The tallest structures at the BLN site are the existing natural draft cooling towers. TVA works to minimize the visual impact of the structures through use of topography, design, materials and color. As stated in Section 4.4, the cooling towers for the new units were constructed in the 1970s and any effect on local viewsheds has already occurred. The cooling towers are most visible from the Creeks Edge community located northwest of the BLN site across Town Creek, Guntersville Reservoir, and its associated parks. Because the visual effects are inversely proportional to distance, the effects of the towers on most of the other parks in the region are minimal.

Following construction and throughout the operations phase, the BLN cooling towers discharge two plumes, which are visible to the surrounding communities. These plumes are most visible in the winter, during which the average seasonal plume length has been calculated to not exceed 3.11 miles as indicated in Table 5.3-5. In addition, maximum plume lengths are estimated to occur only 16.9 percent of the time annually according to the information provided in FSAR Table 2.3-305. The plumes are similar in size and scale to plumes generated by other nuclear plants. The length of the visible plumes depends on the ambient temperature and humidity.

Colder and more humid weather is more conducive to longer plumes. Most of the time, the visible plumes are anticipated to extend only a short distance from the towers and then disappear by evaporation. Because the visual impact from the two steam plumes is similar to lines of cumulus clouds and the maximum plumes for the BLN cooling system occur infrequently, this visual impact is considered to be SMALL. Furthermore, because the surrounding land is primarily less developed and heavily wooded, the plume is blocked from view by dense trees and is not visible from nearby roads in many areas. The effects of the steam plumes on the watershed are described in Subsection 5.3.3.

Most of the parks in the region are located more than 18.6 mi. from the site. Although the towers and plumes may be visible at that distance, the two cooling towers occupy less that one-half of a degree of vision as detailed in Section 4.4.

Because the transmission service lines are already present, the impact on visual aesthetics is considered SMALL and mitigation is not warranted.

Further discussion on the impacts of recreational activities is discussed in Subsection 5.8.2.3.4.

5.8.1.4 Noise

The potential effects of noise from BLN site operation have been analyzed by projecting noise levels at the site and vicinity from various facility sources as presented in Table 5.8-1. Projected levels are compared to ambient measurements described in Section 2.5, as well as to federal noise level guidelines. The results of these comparisons are then used to determine the magnitude of noise impacts at the various receptors identified in Section 2.5.

The U.S. Department of Housing and Urban Development (HUD) has established noise impact guidelines for residential areas based on day-night average sound levels (Ldn) (Reference 10). Although some states and municipalities have established noise control regulations or zoning ordinances that specify acceptable noise levels, neither the State of Alabama nor Jackson County have developed such regulations or ordinances.

A special version of equivalent sound levels (Leq), and the most common measure of environmental noise levels is the day-night average level (Ldn). The Ldn is valid for a 24-hour period and is computed the same as a 24-hour Leq except that the prevailing sound level in the calculation has a 10-dB penalty added between the hours of 2000 and 0700. For the purpose of this document, noise impacts are assessed using the Ldn of 60 - 65 dBA as the level below which noise levels would be considered acceptable for residential and outdoor recreational uses. Also, noise levels below 60–65 dBA are considered to be of small significance (Reference 12).

Noise sources from BLN plant operation are expected to include heating, ventilation and air-conditioning systems, vents, transformers and electrical equipment, transmission lines, water pumps, material-handling equipment, motors, public address systems, cooling towers, trucks and vehicular traffic. Testing of emergency warning sirens is expected to be conducted periodically, with advance notification to the public. Many of the noise sources are confined indoors, underground or are used infrequently. The main source of continuous noise is the water falling at the natural draft cooling towers. Cooling towers generate approximately 85 dBA (Reference 13) in close proximity and approximately 55 dBA at a distance of 1000 ft. during operation

(Reference 11). As shown in Table 5.8-1 and Figure 2.5-29, background noise levels plus projected operational noise level impacts at the nearby receptor sites are similar to the original background noise level range.

To assess the noise impacts on the surrounding environment, receptor sites were selected including: the fence line, nearest residences, churches, and businesses, a heron rookery, and the Sand Mountain area. Recreation locations were also selected. None of the identified sensitive receptors (nearest residences, churches, and businesses, a heron rookery, and the Sand Mountain area) is located within the fence line of the facility; therefore, none would be significantly impacted by operational noise.

Nearby residences (Creeks' Edge addition) are located across Town Creek from the northwestern fence line. Noise across water does not attenuate (reduce) with distance as well as by ground cover, earthen berms, grass, trees with foliage, etc. Ground cover and foliage are considered to be soft site conditions that reduce noise levels better than water or concrete, which are considered to be hard site conditions. Since operational noise sources are located more than 1000 ft. from the northwestern fence line across soft site conditions, noise levels are attenuated to ambient levels at the fence line. Therefore, the residences of Creeks Edge should not be impacted by operational noise above the acceptable 60 - 65 dBA and background levels. Other receptors are also located at distances greater than 1000 ft. that would be comparable to background levels and would not be impacted by on-site operational noise. New home construction located across Town Creek and to the northeast of the existing residences was noted during the ambient noise survey. Off-site new home construction can add to the noise at the BLN site.

The day-night noise levels that are anticipated from the plants' cooling towers at the site boundary are expected to be below the limit of 65 dBA recommended in NUREG-1555. In NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS) (Reference 12) the staff discusses the environmental impacts of noise at existing nuclear power plants and common noise sources (cooling towers, transformers, loud speakers and intermittent noise from auxiliary equipment). As noted in the GEIS, at most sites employing cooling towers, transformer noise is masked by the broadband cooling tower noise. The GEIS also notes these noise sources are generally sufficiently distant from the plant boundaries that the noise generated by the plant is attenuated to near ambient noise levels at the site boundaries. Therefore, noise would also be attenuated to ambient noise levels beyond the site boundaries at critical receptors. Personal communication devices should be used instead of loud speakers when possible. If loud speakers need to be utilized, they should only be utilized during emergencies and day light hours. Because significant noise sources are located a substantial distance from the BLN site boundary, plant operational noise is attenuated to near ambient levels beyond the site boundary; therefore noise impact is considered to be SMALL and mitigation is not warranted.

5.8.1.4.1 Transmission Line Noise due to Operation

High-voltage transmission lines can emit noise when the electric field strength surrounding the lines is greater than the breakdown threshold of the encapsulating air, creating an energy discharge. This discharge is known as corona discharge, and is affected by ambient weather conditions such as wind, precipitation, air density, humidity, etc., and energized surface irregularities. As stated in the GEIS, the term "corona" generally refers to the electrical discharges occurring in air subjected to the strong electric fields adjacent to phase conductors. Corona results in audible noise, radio and television interference, energy losses, and the production of ozone and oxides of nitrogen (Reference 12). The noise created from corona discharge can create a noise which can be observed near the base of the transmission lines. Noise from corona discharge along the transmission line is low (well below the 60 – 65 dBA threshold) and does not pose a noise induced risk to the surrounding community or habitat. As mentioned in NUREG 1555, electric field effects on terrestrial biota need not be considered for lines energized at less than 765 kV. Also, experience has shown that for transmission lines energized at 765 kV or less, there are no known adverse impacts resulting from ozone formation. At voltages of 765 kV or above, consideration of the possible effects of electric fields and corona discharge, including resulting noise on terrestrial biota, may be warranted. Although additional transmission lines are not installed at the BLN site, the existing 500-kV transmission lines are re-energized to carry power generated by the plant.

Because the electric transmission lines are expected to be energized at 500 kV or less and receptors are located a substantial distance from the transmission lines, noise impact created by corona discharge from the transmission lines is considered to be SMALL and mitigation is not warranted.

5.8.1.4.2 Traffic Noise due to Operation

Noise analysis was conducted related to traffic noise along the access road to BLN site and the connecting U.S. Highway 72 (U.S. 72). Traffic noise was based on the Highway Traffic Noise Analysis and Abatement Policy and Guidance and compared with traffic analysis conducted by the US Department of Energy FEIS, 1999. Operational workforce traffic, especially the occasional delivery of heavy equipment, impose noise impacts to receptors along the access road between U.S. 72 and the BLN entrance. Because U.S. 72 is already utilized by tractor trailers and other heavy trucking equipment, additional noise impacts along this highway are expected to increase only slightly. Noise from traffic should result in an increase of less than 4 dBA along U.S. Highway 72, and could be noticeable at nearby residences.

Traffic noise levels along the access road have been fairly quiet because construction of BLN was deferred. Much of the traffic during the operation of BLN would be at the beginning and end of each work shift. Traffic noise along the access road would increase to a day-night average of about 57 dBA during operation. Peak hour traffic would result in an increase in traffic noise levels along the access road from about 51 dBA at 100 ft. to about 58 dBA. Heavy truck traffic would be the most bothersome and could approach levels of 70-90 dBA at 50 ft. from the road.

Because traffic increases during shift changes, peak traffic noise should have a SMALL to MODERATE impact on approximately 10 homes located along the access road. Noise can be minimized by enforcing low speed limits, good road conditions, controlling the time of day that peak traffic occurs, minimizing Jake-braking, equipment with noise reduction devices (mufflers), and utilizing barge traffic for large equipment. Because off-peak traffic should not increase significantly, off-peak traffic noise impact is considered to be SMALL and no mitigation is warranted.

5.8.1.5 Air Quality

Regional air quality is discussed in Section 2.7. Operation activities would be conducted in accordance with the accepted management practices available during the time of operation. Air emissions would be controlled as necessary, to meet the requirements of applicable air regulations and permits in place at the time of operation.

Because air emissions from nuclear power plants are minimal, physical impacts to the surrounding population as a result of operation of the new units are considered SMALL and mitigation is not warranted.

5.8.2 SOCIAL AND ECONOMIC IMPACTS OF STATION OPERATION

This section evaluates the demographic, economic, infrastructure, and community impact to the region as a result of plant operations at the BLN site. The evaluation assesses impacts of operation and of demands placed by workforce on the region. It is estimated that regional procurement of various consumables and out-sourced services in support of BLN operation will be at least $550,000 per year.

5.8.2.1 Demography

The 2007 estimated permanent population within the 50-mi. BLN region is 1,158,869. Population projections are discussed in Subsection 2.5.1. Acknowledging that 650 operation workers (including security personnel) have been accounted for in Subsection 4.4.2.1, the impact analysis is based on the remaining 350 operation workers. Based on preliminary estimates, and to provide a maximum impact scenario, it is assumed that 50 percent of the new units' employees migrate into the region, and that each operations worker brings their family. The assumed family size of four is based on U.S. Census Bureau 2000 data (Reference 2), which states that the average family size in the United States is 3.14 persons. For estimating family size, the value of 3.14 persons per family was rounded up to bound the U.S. Census Bureau value. Expectations are that the worker family size would be typical of the U.S. Census Bureau data. The U.S. Census Bureau data is used instead of Jackson County family size, because the in-migrating construction workers are expected to come from outside Jackson County. As stated previously, the remaining workforce of 350 increases the population in the 50-mi. region by approximately 700 people. Of the operations workers who migrate into the region, it is assumed that all settle in Jackson County. In 2015, the Jackson County estimated population is 61,249. Based on these estimates, the influx of operations workers and families in-migrating at this time would likely represent a 1 percent increase in population in Jackson County. The operations workers and their families represent a very small percent increase in the existing population.

Within the communities in the vicinity, the influx of operational workers during outages helps reduce the effect of population decline caused by the departure of construction workers at the end of construction ramp down. At the current rate of population growth, it would take approximately 15 years for the population in the vicinity to reach the population peak experienced during construction. However, the approximate 600 to 800 temporary employees required for the scheduled refueling outage every 18 months per unit act to offset this impact. These workers are expected to work at the plant for a 30-day period. The impact of plant operations on local and regional demography is considered to be SMALL, as the percent increase in population is below 4 percent for Jackson County, and mitigation is not warranted.

5.8.2.2 Economy

The impacts of the new facility's operation on the local and regional economy depend on the region's current and projected economy and population. The U. S. Department of Commerce Bureau of Economic Analysis, Economics and Statistics Division provide multipliers for industry jobs, earnings and expenditures. The economic model they use is called RIMS II. This model incorporates buying and selling linkages among regional industries creating multipliers for both jobs and monetary expenditures. Additional jobs in the region result from the multiplier effect attributable to the new operations workforce. In the multiplier effect, each dollar spent on goods and services by an operations worker becomes income to the recipient who saves some and spends the rest. The recipients spending becomes income to someone else, who in turn saves part and spends the rest. The number of times the final increase in consumption exceeds the initial dollar spent is called the "multiplier." The U.S. Department of Commerce Bureau of Economic Analysis Economics and Statistics Division provide multipliers for industry jobs and earnings (Reference 1). The RIMS II economic model was used to estimate the impact of the new nuclear plant-related expenditure of money in the region of interest. The wages and salaries of the operation workforce have a multiplier effect that could result in an increase in business activity, particularly in the retail and service industries. For every dollar of income for operational plant employees, an additional 0.331 dollars are added to the regional economy.

For every plant operations employee, an estimated additional 0.759 jobs are created in the 50-mi. region. Acknowledging that 650 operation workers have been accounted for in Subsection 4.4.2, the impact associated with the remaining 350 operation workers means that 350 direct operations jobs resulted in 260 indirect jobs for a total of approximately 610 new jobs in the region. For the operations phase, it is assumed that the operations workforce is in place, having in-migrated during or near the end of the construction phase. Because most indirect jobs are service-related and not highly specialized, it is likely that most, if not all, indirect jobs are filled by the existing population, including both unemployed workers and persons not currently in the workforce within the 50-mi. region. This is a positive impact on the economy by providing new business and job opportunities for local residents. In addition, these businesses and employees generate additional profits, wages, and salaries, upon which taxes are paid.

The impacts of operation employees on the economy of the region are considered SMALL beneficial impacts due to the creation of jobs, employee purchasing, and increased tax revenues. The impact from plant operation employees in Jackson County are considered MODERATE beneficial impacts due to the higher concentration of operation employees within Jackson County and the coinciding benefits.

5.8.2.2.1 Regional Taxes and Political Structure

Regional taxes and the political structure within the BLN site region are discussed in Subsection 2.5.2. TVA is directed by Section 13 of the TVA Act to pay 5 percent of its gross proceeds from the sale of power (minus sales to government agencies) to state and counties where its power operations are carried on. A comparison plant for the BLN is Brown's Ferry Nuclear Plant, a two-unit nuclear plant owned by TVA in Limestone County, Alabama. Tax equivalent payments to the county resulting from the presence of Brown's Ferry Nuclear Plant amounted to 8 percent of the county's general fund revenue (Reference 8). The impact of increased revenue related to plant operation is larger in Jackson County than that in the surrounding counties with large municipal areas.

TVA makes tax-equivalent payments to eight states, including Alabama. The State of Alabama then allocates its tax-equivalent payments from TVA in accordance with Title 40 "Revenue and Taxation," Chapter 28 "Distribution of Payments Made In Lieu of Taxes," Sections 40-28-1 through 40-28-4. Alabama distributes 78 percent of the TVA tax-equivalent payments to the 16 TVA-served counties based on a formula from TVA's book value of power property and sales in each of these counties. These counties then may share a portion of their payment with cities, the school systems, hospitals, etc., within their boundaries. The remainder of the tax equivalent payments is either retained for the state's general fund or is distributed to counties not served by TVA (Reference 7).

Based on the tax calculation procedures described in Subsection 2.5.2.3 and the property value of BLN (i.e., Units 3 and 4), tax-equivalent payments to Jackson County from the State of Alabama are estimated at $13.6 million, an increase of $3.2 million over FY 2007 estimates. This includes the assumption that tax-equivalent payments based on Bellefonte Units 1 and 2 will no longer be made by the time that BLN (i.e., Units 3 and 4) is operational. Based on DOE/EIS-0288 data, 40 percent of the annual allocation to Jackson County, approximately $5.4 million, is paid to the city and county school systems, while the remaining 60 percent, approximately $8.2 million, funds public services within the county (Reference 18).

The state of Alabama has a general sales tax rate of 4 percent that applies to most purchases of goods and services. In addition, Jackson County has a 2 percent general sales tax rate. Towns and cities also have their own sales taxes at varying rates. The county rate of 2 percent would yield to Jackson County about 0.75 percent of total wages in sales tax, or about $7,500 for every $1 million in wages. All of the county sales tax is allocated to the Jackson County School System.

Additional tax revenues are to be generated by BLN operation. Such revenues (e.g., property taxes, income taxes, real estate transfer fees, and motor vehicle taxes) are collected by or on behalf of the state government and then distributed to the jurisdictions, including schools and public services.

At the beginning of the new units' operation, population in the area is expected to decrease due to the departure of the construction workforce. At the same time, the total amount of tax-equivalent payments is estimated to be greater at the end of BLN Units 3 and 4 construction than at the beginning.

The impacts of plant operation on tax revenue in the region are considered SMALL and beneficial because of the distribution system of the revenues. The tax revenue is given to all areas that are powered by TVA, rather than just the county in which the plant is located. Also, 17 percent of the revenue is allocated to the Alabama general fund and is used for services and improvements anywhere in the state, while in Tennessee almost 50 percent is given to the state (References 7 and 9). The estimated annual state sales tax revenue from regional expenditures on goods and services is expected to be less than $27,000 for Alabama, Georgia, and Tennessee, combined.

Therefore, the annual sales tax resulting from these regional expenditures is beneficial, but is not expected to affect the impact significance associated with the plant's tax-equivalent payments.

The impacts of the plant operation on tax revenue in Jackson County are expected to be MODERATE and beneficial due to the increased revenues from the TVA property in the county.

5.8.2.3 Infrastructure and Public Services

Local public infrastructure and community services affected by plant operation include: education, social and public services, housing, land use, and recreation. These are described individually in Section 2.5. It is likely that operation workers and their families would tend to locate in several large communities with well-developed public services. Diversification of settlement would minimize the likelihood of any one community’s services being overburdened.

Impacts on highways and transportation is discussed in Subsection 5.8.1.2.

5.8.2.3.1 Social and Public Services

Water Supply Facilities

Subsection 2.5.2 describes the public water supply systems in the area, their capacities, and current demands. Subsection 4.4.2.3 describes the public water supply system usage during construction. The BLN site is not anticipating the use of groundwater as a safety-related water source, and it does not plan to use groundwater as its primary water supply resource for any purpose. Potable water is supplied by the Scottsboro Municipal Water System, operated by the city of Scottsboro, Alabama.

The demand on potable water utilities is anticipated to decrease during operations at the BLN site. Acknowledging that 650 operation workers have been accounted for in Subsection 4.4.2.3, the impacts are associated with the remaining 350 and, taking into consideration the estimated number of operational workers with families moving into Jackson County, the population is expected to decrease by 7100 people (estimated construction population increase [7800], minus the result of multiplying one-half of the anticipated operational workers by the estimated family size of four [700]). During operation, the Scottsboro Municipal Water System would use approximately 77.2 percent (6.2 Mgd) of its normal capacity of 8 Mgd. It is anticipated that the average per capita amount of water consumed per day is 90 gal. (Reference 3). Based on these values, an overall decrease in consumption is anticipated at approximately 522,000 gal., from the construction phase to the operational phase. This represents a reduction of 6.6 percent usage of system capacity.

The current maximum capacities for the potable water supplies would not be reached during the peak construction phase, the period of highest use of service. Because the Scottsboro Municipal Water System is expected to be capable of handling the additional water use for construction, capacity is not expected to be reached during operation, when water demand decreases and approaches preconstruction levels.

Impacts to municipal water suppliers from the operations-related population increase are considered SMALL and mitigation is not warranted.

Wastewater

Wastewater treatment is provided by the city of Scottsboro, Alabama. Currently, there are five wastewater treatment systems in the county, the largest of which is operated by the city of Scottsboro, Alabama. This plant has a maximum capacity of 5 mgd. Estimated wastewater amounts for operations are based on expected water supply usage. With the understanding that some water is lost before it reaches the wastewater treatment facility due to watering lawns, evaporation, etc., the values for wastewater are conservative.

During the construction phase, the wastewater treatment facility operated by the city of Scottsboro is expected to operate at 94 percent of its capacity or 4.7 Mgd. Following construction, during reactor operation, facility use is anticipated to drop to 83.6 percent or approximately 4.2 Mgd, which is approximately 3.6 percent more than the wastewater system's current, preconstruction use of 4 Mgd (80 percent of capacity).

The current maximum capacity for the wastewater treatment facility is not expected to be surpassed during the peak construction phase, the period of greatest use of services. Because this facility is expected to process the increased wastewater produced during construction without a change in capacity, no anticipated capacity increases are expected during operation. Indeed, wastewater production during operation is anticipated to approach preconstruction levels.

Based on system capacity and expected utilization, impacts to wastewater treatment facilities from an operations-related population increase are considered SMALL and mitigation is not warranted.

Police and Fire Protection Services

Assuming the number of police officers in Jackson County does not increase during construction or operation, the police officer-to-resident ratio is anticipated to be 1:670 during operations, a decrease of 57 persons per officer from the construction period. According to the U.S. military, the recommended police officer-to-resident ratios should be between 1 and 4 officers per 1000 citizens, or 1 police officer for every 250 to 1000 persons (Reference 14). Police officer-to-resident ratios in Jackson County during construction and operations fall within this recommended range.

Assuming the number of firefighters is not expected to increase during construction or operation, the firefighter-to-resident ratio is anticipated to be 1:146 during operation, an increase from 1:159 ratio during the peak construction period. The derived firefighter-to-resident ratio for the United States in 2006 was 1:262 (References 15 and 16). Firefighter-to-resident ratios in Jackson County during construction and operations are greater than the national average.

Even with the anticipated increase and decrease of population in Jackson County due to construction and operations, the predicted ratios for police officers and firefighters per resident fall within the recommended ratios or cited national values. Potential impacts of the BLN operations on police protection and firefighting are considered SMALL, and mitigation is not warranted.

Medical Services

In Jackson County, the ratio of primary-care-physicians-to-persons ratio is 6.2 doctors per 10,000 people; however, the state ratio for rural areas is 5.74 doctors per 10,000 people. Jackson County is considered to be an area with a physician shortage. Alabama's shortage of physicians is a state-wide problem (Reference 17).

The construction and operation of the BLN station is expected to stimulate the local economy and make the area more attractive to physicians and medical investors. Because the county is currently experiencing a shortage, an excess of physicians is not anticipated during the transition from the construction phase to the operational phase of the BLN. Minor injuries to operations workers are assessed and treated by on-site medical personnel. Other injuries are treated at Highland Medical Center (Subsection 2.5.2).

Based on these factors, the impact of plant operations on medical services is considered SMALL and mitigation is not warranted.

5.8.2.3.2 Housing

The estimated number of available housing units at the commencement of operations is not available. Further discussion of housing availability within the region in the year 2000 is discussed in Subsection 2.5.2.

In 2000, there were 620 vacant rental units and 274 vacant housing units for sale in Jackson County. According to the U.S. Census Bureau, the remainder of vacant housing units was classified as one of four other categories: rented or sold but not occupied; for seasonal recreational, or occasional use; for migratory workers; or listed as “other vacant” (Reference 2).

Additional workers are required during refueling outages, but they most likely stay in temporary housing in the form of extended hotels, trailers, or rented rooms in homes.

Acknowledging that 650 operation workers have been accounted for in Subsection 4.4.2.4, the impacts are associated with the remaining 350 operation workers. As stated previously, based on an assumption that 50 percent of the workers in-migrate to Jackson County, a conservative estimate of 175 housing units are needed for the new workers. Jackson County has a total of 2553 vacant housing units, with 894 available for sale or rent.

Based on the availability of housing units and rental units in Jackson County in relation to the number of operations workers, the impacts of plant operation on housing are considered SMALL and mitigation is not warranted.

Land use planning and zoning laws within the BLN site and vicinity are described in Section 2.2. Land use impacts from operation of the BLN site are described in Subsection 5.1.1.

5.8.2.3.3 Education

As a maximum likely impact scenario, it is assumed that the new workforce moving to the area relocates to Jackson County with their families, increasing the population in Jackson County by approximately 2000 people.

According to the U.S. Census Bureau estimate for 2005, 17 percent of Jackson County's population was between the ages of 5 and 18 (Reference 19). Based on this number, it is estimated that the number of school-age children added to the Jackson County schools due to the BLN project would be 340. For the 2004 – 2005 school year, the total number of students in Jackson County, including Scottsboro City, was 8734 (References 4 and 5). These additional 340 students represent an approximate 4 percent increase over the 2004 – 2005 student population.

In 2017, assuming normal growth of the current population, the total estimated number of school-age students (BLN-related population increase plus projected baseline population), in Jackson County is approximately 10,820. With no increase in the number of teachers, the overall student-to-teacher ratio would be 15.9:1. To maintain the 2004 – 2005 ratio of 12.8:1, a total of approximately 845 teachers (or approximately 165 additional teachers) would be needed during BLN operations.

The impacts of plant operation on the educational system of Jackson County, Alabama are considered SMALL to MODERATE and do not require mitigation as the increase in students are offset by the increase in local government revenues paid to the school district. Any MODERATE impact is temporary and offset by the tax factors that allow the district to expand and/or update the current infrastructure and hire additional teachers.

5.8.2.3.4 Recreation

There are numerous facilities within the 10-mi. radius that host outdoor activities. These include Lake Guntersville Park, Goose Pond Colony, and Buck’s Pocket State Park. The northern extent of Guntersville Reservoir includes an area immediately adjacent to the BLN.

Golf courses, the closest of which is Goose Pond Colony, host many golfing events throughout the year. Two major events held at Goose Pond Colony are the Spring Fling Junior College Golf Tournament (typically held the second week of March) and the National Junior College Golf Championship (typically held the third week of May).

There are three parks operated by the Georgia State Park Division located within the region: James H. “Sloppy” Floyd State Park, Cloudland Canyon State Park, and New Echota Historic Site.

Hunting, fishing, and wildlife-watching in the portions of Alabama, Georgia, and Tennessee included within the BLN region are an important recreational pastime.

Additional information on recreational opportunities in the BLN region is located in Section 2.5.

Many of the recreational opportunities within the BLN region are outdoors and it is not possible to ascertain capacities. Based on aesthetic impacts discussed in Subsection 5.8.1.4, noise impacts discussed in Subsection 5.8.1.5, and the potential use of mitigation measures to control air quality; the impacts on recreational opportunities due to plant operation are discussed in Subsection 5.8.1.4 and are considered SMALL; mitigation efforts are not warranted.

5.8.3 ENVIRONMENTAL JUSTICE IMPACTS

Executive Order 12898 (59 FR 7629) directs federal executive agencies to consider environmental justice under the National Environmental Policy Act. The underlying purpose of this Executive Order ensures that minority and/or low-income populations do not bear a disproportionate share of adverse health or environmental consequences of a proposed project, such as BLN. The TVA is an Equal Opportunity Employer and expects the BLN work force to reflect the surrounding demographic characteristics.

Subsection 2.5.4 describes the evaluation process used to identify minority and low-income populations living within the region that meet the conditions associated with the NRC guidance. Tables 2.5-22 and 2.5-23 and Figures 2.5-9 through 2.5-28 identify census blocks, block groups, and relative distances and spatial distributions of minorities and low-income populations around BLN.

In this document, potential operations impacts were analyzed for the following resource areas: land use, water, air, socioeconomic, ecological, health and safety, waste, and cultural resources. These analyses were conducted to identify any disproportionate adverse impacts for minority or low-income populations. The summaries of these analyses are presented in Subsection 5.8.3.1.

In general, the spatial distribution of minority populations in the region is random, with clusters occurring in urban areas. Locally, there are two minority populations identified in census blocks on the opposite side of Town Creek, which could be considered adjacent to the BLN site. Although the impacts of operation are expected to occur primarily to the site and adjacent properties, it is anticipated that there are no disproportionate impacts to minority populations.

The nearest low-income population to the site is in Scottsboro, Alabama, 6 mi. away from the BLN site. The identified low-income populations are located within or near urban areas with the exception of one block group near Huntsville, Alabama. Because of their distance from the site and geographic location, it is anticipated that any impacts to low-income populations are SMALL.

5.8.3.1 Operational Impacts

For the purposes of this environmental justice assessment, environmental impacts under consideration due to BLN plant operation include potential impacts due to land-use, water, and ecology. As discussed in Sections 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, and 7.1, impacts resulting from the operation of BLN are SMALL with respect to the following resources:

- Land Use.
- Water Use.

- Aquatic and Terrestrial Ecology.
- Human Populations.

Because these impacts were determined to be SMALL, and given the distribution of minority and low-income populations, the potential for disproportionate impacts to those populations is considered to be SMALL. Specifically, the TVA did not identify any location-dependent, disproportionate high and adverse impact to minority and low income populations.

Based on the analysis in Subsection 2.5.4, no significant natural resource dependencies in any population have been identified in the region.

5.8.3.2 Socioeconomic Impacts

For the purposes of this environmental justice assessment, socioeconomic impacts due to plant operation include potential impacts due to transportation, housing, infrastructure and public services, education, and recreation. As previously discussed in Section 5.8, impacts resulting from the operation of BLN are SMALL with respect to the following resources:

- Housing.
- Recreation.
- Transportation.
- Infrastructure and Public Services.

Impacts resulting from the operation of the BLN are SMALL to MODERATE with respect to the following resource:

- Education

Because the impact was determined to be SMALL to MODERATE, and given the distribution of minority and low-income populations, the potential for disproportionate impacts to those populations is considered to be SMALL. Specifically, the TVA did not identify any location-dependent, disproportionate high and adverse impacts to minority and low-income populations.

5.8.3.3 Benefits of Operation

Several beneficial impacts due to BLN operations are expected in the surrounding vicinity and region. These include local economic impacts, including the addition of new jobs, revenues paid by TVA, and taxes paid by BLN workers, which benefit local public services and the local education systems. However, such benefits would not be disproportionate to minority and low-income populations in the vicinity and region.

5.8.3.4 Mitigative Measures

Because the potential impacts of BLN operations on minority and low-income populations are expected to be SMALL, no mitigation efforts are required.

5.8.4 REFERENCES

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TABLE 5.8-1
PREDICTED NOISE LEVELS ALONG FENCE LINE DUE TO PLANT OPERATIONS

Receptor Position[a]	Approximate Distance from nearest Cooling Tower (ft.)	Recorded Ambient Leq dB(A) Day – Night average 2006	Predicted Bellefonte Units 1 and 2 Noise Emissions dBA	Projected Noise Level[b]
1 - Approximate north fence line along access road.	3268	47-55	46	50 – 55
0 - Approximate northwest fence line between northwest cooling tower and residential property located across Town Creek.	2307	51-54	48	52- 55
2 and 3 - Approximate southeast fence line along the river (near dock and water outlet).	3233	47-50	45	48-51
7- Approximate north fence line near north gate entrance	8903	53-55	36	53-55
5- Approximate southwest fence line near south gate entrance.	2416	49-52	47	53

a) See Measurement Position Map

b) Calculations were made using a noise level of 55 dBA at 1000 ft. The combination of cooling towers 1 and 2 would not have a significant impact due to distance and shielding from each cooling tower and other structures.

5.9 DECOMMISSIONING

The NRC defines decommissioning as the safe removal of a nuclear facility from service and the reduction of residual radioactivity to a level that permits release of the property and termination of the license. NRC regulation 10 CFR 50.82 specifies the regulatory actions that the NRC and a licensee must take to decommission a nuclear power facility. NRC regulation 10 CFR Part 20, Subpart E identifies the radiological criteria that must be met for license termination.

Regulatory Requirements

Pursuant to the requirements of 10 CFR 50.33(k)(1), an application for a combined license for a production or utilization facility must include a report that indicates how reasonable assurance will be provided that sufficient funds will be available to decommission the facility. The requirements for the specific contents of the report are contained in 10 CFR 50.75. 10 CFR 50.75(b) specifies that the decommissioning report must contain a certification that financial assurance for decommissioning will be provided no later than 30 days after the Commission publishes notice in the Federal Register under 10 CFR 50.103(a). The amount of the financial assurance may be more, but not less, than the amount stated in the table in 10 CFR 50.75(c)(1). The amount must be covered by one or more of the methods described in 10 CFR 50.75(e) as acceptable to the NRC. As part of the certification, a copy of the financial instrument obtained to satisfy the requirements of 10 CFR 50.75(e) must be submitted to the NRC; however, an applicant for a combined license need not obtain such financial instrument or submit a copy to the Commission except as provided in 10 CFR 50.75(e)(3).

The BLN plant is a two-unit Westinghouse AP1000 pressurized water reactor (PWR) that is being licensed based upon the referenced DCD. This design has a thermal power rating of 3400 MWt. The minimum decommissioning funding, as calculated in accordance with 10 CFR 50.75(c) and using NUREG-1307, Revision 12, is summarized in Part 1, Administrative and Financial Information, of this combined license application. Part 1 of this application also includes a discussion of the proposed decommissioning funding mechanism for BLN.

5.10 MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING OPERATION

This section summarizes the principal adverse environmental impacts of operations and controls to limit these impacts. A modified Leopold Matrix is presented in Table 5.10-1 that depicts the cause-and-effect relationships between operational environmental disturbances and the corresponding affected environmental receptors/resources, with the horizontal axis on the matrix representing the principal environmental disturbances and the vertical axis depicting the environmental receptors or resources that could be affected by those disturbances. The table also summarizes feasible measures and controls that have been identified for mitigating operational impacts.

The significance indicators provided in Table 5.10-1 are designated using the following descriptors: SMALL (S), MODERATE (M), or LARGE (L). The significance indicators are defined in Section 5.0. The assignment of significance levels (S, M, and L) is based on the assumption that for each impact, corresponding feasible and adequate measures and controls (or equivalents) are implemented. If a SMALL (S) significance determination is made without the implementation of measures and controls, then no additional measures and controls are identified in Table 5.10-1. A blank cell in the elements column, "Potential Environmental Disturbances and Significance Level" column denotes "no impact" of that type on the environmental resource. Each "Impact Description or Activity" attribute is assigned a number and each "Feasible and Adequate Measures and Controls" attribute is assigned a number in parenthesis that corresponds to the respective "Impact Description or Activity."

In addition to the standard outline provided in Chapter 5 of NUREG-1555, the following additional environmental resources are explicitly called out on Table 5.10-1: Water Quality Impacts (5.2.3) and Air Impacts on Humans (5.8.4). These sections have been specifically added to provide a more thorough consideration of the adverse impacts and their mitigation measures. The feasible and adequate measures and controls described in Table 5.10-1 are considered reasonable from a practical, engineering, and economic view; many are based on statutes and regulatory requirements or are generally accepted practices within the utility industry. Therefore, these measures and controls are not expected to present an undue hardship on the applicant. Based on a review of the operational impacts described in this chapter, some general feasible and adequate measures and controls for reducing adverse impacts at the BLN include:

- An environmental safety and health plan has been prepared.
- As appropriate, operational employees receive appropriate training in environmental compliance and safety procedures (operational commitment).
- Materials safety data sheets are required for use of applicable hazardous materials at the BLN. Operational employees are trained in the appropriate use of hazardous materials. Hazardous materials are used in accordance with applicable federal, state, and local laws and regulations.
- Hazardous wastes are treated, stored, and disposed of in accordance with the Resource Conservation and Recovery Act (RCRA) (Reference 1), and other applicable federal, state, and local laws and regulations. Operational employees are trained in the appropriate handling and disposal of hazardous wastes.

- As appropriate, a safety/environmental officer oversees and inspects operational activities (operational commitment).
- Operational activities are performed in accordance with applicable local, state, and federal ordinances, laws, and regulations intended to prevent or minimize adverse environmental effects of operational activities on air, water, and land, and on workers and the public.
- Operational activities comply with applicable environmental laws, regulations, permits, and licenses, which place strict controls on how activities are performed.
- Operational activities are performed in compliance with applicable corporate environmental, safety, and operational procedures, which place controls on how activities are performed
- Applicable operational permits and environmental requirements are included in operating contracts.

More specific mitigation measures are detailed in Table 5.10-1.

5.10.1 REFERENCES

1. Resource Conservation and Recovery Act, 42 USC 6901 et seq.

TABLE 5.10-1 (Sheet 1 of 11)
SUMMARY OF MEASURES AND CONTROLS TO LIMIT ADVERSE OPERATIONAL IMPACTS

ENVIRONMENTAL RESOURCES	Potential Environmental Disturbances and Significance Levels														Impact Description or Activity	Feasible and Adequate Measures and Controls
	Noise	Erosion/Sedimentation	Air Disturbances/ Emissions	Traffic	Hazardous Materials/ Wastes	Surface Water Disturbances	Groundwater Disturbances	Land usage/Disturbances	Water Use Consumption	Terrestrial Disturbances	Aquatic Disturbances	Socioeconomic Changes	Radiation Releases/ Exposure	Aesthetics/dust/odor		
5.1 Land and Land-Use Impacts																
5.1.1 The Site and Vicinity								S		S					1. Project implementation restricts use of the land for most purposes other than those involving siting of utility projects. 2. Plant construction may effect nearby agricultural lands. 3. Offsite disposal of BLN waste.	(1) Land has already been dedicated for construction and operation of Bellefonte Units 1 and 2. No additional land is needed to operate Units 3 and 4. (2) Limit disturbance of vegetation to the area within the site designated for BLN construction. (1-2) Minimize potential impacts through best management practices. (3) Disposal of waste in accordance with applicable regulations and procedures. • No additional mitigation is deemed necessary.
5.1.2 Transmission Corridors and Off-site Areas					S	S		S		S	S				1. Project implementation restricts use of land for most purposes other than those involving utility corridor activities. 2. Maintenance on the existing transmission line corridors continues to impact land, and terrestrial and aquatic species.	(1) To the extent feasible, avoid any additional disturbances on critical or sensitive habitats/species. (1-2) TVA conducts a Sensitive Area Review to assist in making maintenance decisions. (2) Limit continued vegetation removal to the minimal amount needed to support the corridor right-of-way. • No additional mitigation is deemed necessary.
5.1.3 Historic Properties								S							1. Potential to adversely affect historic and archaeological properties in areas of ground disturbance. 2. No substantial effects beyond those associated with construction activities.	(1-2) Operations are conducted in accordance with National Historic Preservation Act. • No mitigation is required.
5.2 Water-Related Impacts																
5.2.1 Hydrologic Alterations and Plant Water Supply						S									1. The cooling water system has a minor localized influence on river hydraulics. 2. May have small adverse impact on hydrological characteristics 3. Stormwater discharge into nearby water bodies.	(3) Operations are conducted in accordance with National Pollution Discharge Elimination System (NPDES) permit requirements. • No additional mitigation is required.

TABLE 5.10-1 (Sheet 2 of 11)
SUMMARY OF MEASURES AND CONTROLS TO LIMIT ADVERSE OPERATIONAL IMPACTS

	Potential Environmental Disturbances and Significance Levels															
ENVIRONMENTAL RESOURCES	Noise	Erosion/Sedimentation	Air Disturbances/ Emissions	Traffic	Hazardous Materials/ Wastes	Surface Water Disturbances	Groundwater Disturbances	Land usage/Disturbances	Water Use Consumption	Terrestrial Disturbances	Aquatic Disturbances	Socioeconomic Changes	Radiation Releases/ Exposure	Aesthetics/dust/odor	Impact Description or Activity	Feasible and Adequate Measures and Controls
5.2.2 Water-Use Impacts									S		S	S			1. Water loss primarily as a result of evaporative loses and drift from cooling tower; maximum consumptive water loss from the Guntersville Reservoir (Tennessee River) is less than 1 percent of the 7Q10 low flow conditions.	(1) Cooling towers are designed to limit drift and evaporative water loss. (1) As warranted, community policies or ordinances may be adopted to encourage water conservation or re-cycling. • No additional mitigation is deemed necessary.
5.2.3 Water-Quality Impacts						S					S		S		1. Small thermal discharge into reservoir. 2. Discharge of small quantities of water treatment chemicals into reservoir.	(1) Use best management practices to maintain equipment, and prevent spills and leaks. (1) Invoke BLN spill prevention control and countermeasure plan. (1-2) Minimize potential of hazardous materials/waste spills or releases through training and rigorous compliance with RCRA and applicable regulations. (1-2) Water usage is in compliance with National Pollution Discharge Elimination System (NPDES) permitting requirements. (2) Planned effluent discharges are limited and in compliance with Clean Water Act (CWA) regulations (40 CFR 100 and 400-501), Federal Water Pollution Control Act (FWPCA), and National Pollution Discharge Elimination System (NPDES) permit specifications. (2) Water discharges are monitored. • No additional mitigation is deemed necessary.
5.3 Cooling-System Impacts																
5.3.1 Intake System																
5.3.1.1 Hydrodynamic Impact and Physical Impacts		S				S									1. Intake system induces a slight hydrodynamic force near the intake structure.	(1) To the extent practical, pumps and machinery are designed to reduce hydrodynamic impacts. • No additional mitigation is deemed necessary.
5.3.1.2 Aquatic Ecosystems						S			S		S				1. Impingement, entrapment, and entrainment may kill some aquatic species. 2. Minor aquatic impact resulting from consumption of water from the Tennessee River 3. Small turbidity effect on aquatic organisms near the intake structure 4. Small effect on aquatic organisms as a result of bottom scouring near the intake structure	(1) The reactors utilize a closed-loop cooling cycle that significantly reduces detrimental impacts from impingement and entrainment. (2) Cooling water is designed to minimize water losses. (3) To the extent practical, equipment is employed and positioned so as to reduce the scouring effects. (4) To the extent practical, equipment is employed and positioned so as to reduce the turbidity effects.
5.3.2 Discharge System																
5.3.2.1 Thermal Description and Physical Impacts						S									1. Discharged water into the reservoir forms a thermal plume that results in a small localized increase in surface water temperature.	(1) The cooling towers uses a closed-loop cooling system that significantly reduces the thermal discharge to the Tennessee River. • No additional mitigation is deemed necessary.

TABLE 5.10-1 (Sheet 3 of 11)
SUMMARY OF MEASURES AND CONTROLS TO LIMIT ADVERSE OPERATIONAL IMPACTS

ENVIRONMENTAL RESOURCES	Potential Environmental Disturbances and Significance Levels														Impact Description or Activity	Feasible and Adequate Measures and Controls
	Noise	Erosion/Sedimentation	Air Disturbances/ Emissions	Traffic	Hazardous Materials/ Wastes	Surface Water Disturbances	Groundwater Disturbances	Land usage/Disturbances	Water Use Consumption	Terrestrial Disturbances	Aquatic Disturbances	Socioeconomic Changes	Radiation Releases/ Exposure	Aesthetics/dust/odor		
5.3.2.2 Aquatic Ecosystems		S			S	S					S		S		1. Potential for minor erosion or sedimentation near the discharge point may have a small impact on aquatic organisms 2. Thermal plume has a minor impact on aquatic organisms. 3. Small turbidity effect near the discharge structure may have a small impact on aquatic organisms. 4. Small effect as a result of bottom scouring near the discharge structure may have a small impact on aquatic organisms. 5. Discharges of chemicals from blowdown water.	(1) To the extent practical, discharge structure is employed and positioned so as to reduce the erosion/sedimentation effects on aquatic organisms. (2) The reactors utilize cooling towers and a closed-loop cooling cycle that significantly reduces the thermal plume effects on aquatic organisms. (3) To the extent practical, discharge structure is employed and positioned so as to reduce the turbidity effects on aquatic organisms. (4) To the extent practical, discharge structure is employed and positioned so as to reduce the scouring effects on aquatic organisms. (5) Chemical concentrations are monitored. • No additional mitigation necessary.

TABLE 5.10-1 (Sheet 4 of 11)
SUMMARY OF MEASURES AND CONTROLS TO LIMIT ADVERSE OPERATIONAL IMPACTS

ENVIRONMENTAL RESOURCES	Potential Environmental Disturbances and Significance Levels: Noise	Erosion/Sedimentation	Air Disturbances/ Emissions	Traffic	Hazardous Materials/ Wastes	Surface Water Disturbances	Groundwater Disturbances	Land usage/Disturbances	Water Use Consumption	Terrestrial Disturbances	Aquatic Disturbances	Socioeconomic Changes	Radiation Releases/ Exposure	Aesthetics/dust/odor	Impact Description or Activity	Feasible and Adequate Measures and Controls
5.3.3 Heat-Discharge System																
5.3.3.1 Heat Dissipation to the Atmosphere			S						S						1. The cooling towers l release a steam plume to the atmosphere. 2. The cooling towers discharge small amounts of waste salts and other chemicals to the atmosphere that can contaminate soil. 3. The cooling towers result in a minor increase in humidity near the site vicinity. 4. Cloud shadowing has a minor impact on humans and terrestrial organisms. 5. Cooling tower drift and evaporative loses consume water from the reservoir. 6. Produces steam plume that obscures the skyview	(1) To the extent practical, cooling towers were designed using Best Available Technology to reduce evaporative loses. (2) Water is treated prior to discharge to reduce salt and mineral concentration. • No additional mitigation is deemed necessary.
5.3.3.2 Terrestrial Ecosystems	S		S					S		S					1. Operating noise has a minor effect on species near the cooling tower. 2. The cooling towers discharge small amounts of waste salts (drift deposition) and other chemicals to the atmosphere but are not in high enough concentrations to significantly contaminate the soil or significantly damage leaves. 3. Minor potential for bird collisions with cooling towers or electrocution from power lines	(2) Water is treated to remove some of the salts and other dissolved solids. • No additional mitigation is deemed necessary.

TABLE 5.10-1 (Sheet 5 of 11)
SUMMARY OF MEASURES AND CONTROLS TO LIMIT ADVERSE OPERATIONAL IMPACTS

ENVIRONMENTAL RESOURCES	Potential Environmental Disturbances and Significance Levels: Noise	Erosion/Sedimentation	Air Disturbances/ Emissions	Traffic	Hazardous Materials/ Wastes	Surface Water Disturbances	Groundwater Disturbances	Land usage/Disturbances	Water Use Consumption	Terrestrial Disturbances	Aquatic Disturbances	Socioeconomic Changes	Radiation Releases/ Exposure	Aesthetics/dust/odor	Impact Description or Activity	Feasible and Adequate Measures and Controls
5.3.4 Impacts to the Public	S														1. The discharge system results in a small increase in the background noise level. 2. Increased humidity, vapor, and mineral emissions from the cooling towers may present a small impact to humans. 3. Evaporative and drift water loss have a small cumulative socioeconomic impact on the surrounding region. 4. The vapor plume obscures the viewscape. 5. Growth of thermophilic microorganism in the water cooling system.	(1) As applicable, workers are trained in compliance with Noise Control Act (NCA), 42 USC 4901 et seq., and Occupational Safety and Heath Act (OSHA). (1) As appropriate, protective hearing equipment is used by employees working near the cooling towers. (1) To the extent practical, pumps and machinery are used that reduce noise levels. (2) The cooling water is treated to reduce salt and mineral impurities. (3) Cooling towers are designed to reduce evaporative and drift water loses. (3) If necessary, a water conservation program is initiated as a possible option. (5) Water is periodically monitored and tested for thermophilic microorganisms according to the Centers for Disease Control's *Surveillance for Waterborne-Disease Outbreaks—United States*. (5) Workers are trained on safe work procedures. (5) As appropriate, workers are assigned and trained to use air respirators. • No additional mitigation is deemed necessary.

TABLE 5.10-1 (Sheet 6 of 11)
SUMMARY OF MEASURES AND CONTROLS TO LIMIT ADVERSE OPERATIONAL IMPACTS

ENVIRONMENTAL RESOURCES	Potential Environmental Disturbances and Significance Levels: Noise	Erosion/Sedimentation	Air Disturbances/ Emissions	Traffic	Hazardous Materials/ Wastes	Surface Water Disturbances	Groundwater Disturbances	Land usage/Disturbances	Water Use Consumption	Terrestrial Disturbances	Aquatic Disturbances	Socioeconomic Changes	Radiation Releases/ Exposure	Aesthetics/dust/odor	Impact Description or Activity	Feasible and Adequate Measures and Controls
5.4 Radiological Impacts of Normal Operations																
5.4.1 Exposure Pathways			S		S	S									1. Small planned discharges of radioactive gases. 2. Potential exposure of humans to low doses of radiation. 3. Relatively small planned discharges of radioactive effluents to the reservoir. 4. Generation, treatment, and disposal of mixed and radioactive waste. 5. Below ground disposal of radioactive waste. 6. Exposure of terrestrial species and habitats to waste, emissions, and effluents. 7. Exposure of aquatic species and habitats to waste, emissions, and effluents. 8. Potential spills or unplanned releases of radiation to the air, water, or soil. 9. Inhalation of radioactive contaminates. 10. Ingestion of contaminated food or water.	(1-8) Planned releases of radiation are within dose limits prescribed under 10 CFR 20.1301, "Dose limits for individual members of the public." (2) Procedures adopted to reduce worker radioactive exposure. (2) Radiation workers are trained in radioactive pathways, regulations, and procedures. (2) Radiation workers are monitored for exposure to radiation pursuant to 10 CFR 20 and 40 CFR 190. (2) As appropriate, employees are trained on hazardous, radioactive, and safety procedures, as applicable. (3) Effluent discharges are minimized in accordance with applicable regulations. (4) Radioactive wastes are stored, treated, and disposed in accordance with applicable regulations. (5) Radioactive waste is disposed in permitted waste disposal sites. (1-8) Sensors monitor and warn of any unacceptable radiation levels under work plans and procedures are developed for the handling of hazardous materials. (1-10) A Radiological Environmental Monitoring Program is implemented to monitor specified exposure pathways. (7) Radioactive waste, emission, and effluent pathways are monitored. (1-10) BLN has a comprehensive plan for routinely monitoring radiation pathways and releases on receptors. • No additional mitigation is necessary.

TABLE 5.10-1 (Sheet 7 of 11)
SUMMARY OF MEASURES AND CONTROLS TO LIMIT ADVERSE OPERATIONAL IMPACTS

ENVIRONMENTAL RESOURCES	Potential Environmental Disturbances and Significance Levels: Noise	Erosion/Sedimentation	Air Disturbances/ Emissions	Traffic	Hazardous Materials/ Wastes	Surface Water Disturbances	Groundwater Disturbances	Land usage/Disturbances	Water Use Consumption	Terrestrial Disturbances	Aquatic Disturbances	Socioeconomic Changes	Radiation Releases/ Exposure	Aesthetics/dust/odor	Impact Description or Activity	Feasible and Adequate Measures and Controls
5.4.2 Radiation Doses to Members of the Public			S		S	S							S		1. Members of the public are exposed to a small incremental radiation dose. 2. Radiation doses to the public from liquid effluent blowdown releases to the reservoir, and gaseous releases to the atmosphere. 3. Humans can digest radiation from terrestrial/aquatically derived food.	(1) Radiation workers are trained on radioactive and safety procedures to minimize exposure to the public. (3) Radiation doses to the public from liquid effluent releases to the reservoir and gaseous releases to the atmosphere are measured. Calculated doses to the public are within the design objectives of 10 CFR 50 Appendix I and within regulatory limits of 40 CFR 190. (1-4) Releases and exposure to radiation are within all regulatory limits. (1-4) Procedures are designed to reduce radiation doses to As Low As Reasonably Achievable (ALARA). • No additional mitigation is deemed necessary.
5.4.3 Impacts to Members of the Public			S		S	S		S					S		1. Workers are exposed to small monitored radioactive doses. 2. Members of the public are exposed to a small incremental radiation dose from the plants. 3. Members of the public can receive radioactive doses from breathing, swimming, food, drinking water, and contact with contaminated soil.	(1-3) Radiation workers are trained on radioactive and safety procedures to minimize exposure to the public. (1-3) Radiation doses to the public from liquid effluent releases to the reservoir and gaseous releases to the atmosphere are measured. Calculated doses to the public are within the design objectives of 10 CFR 50 Appendix I and within regulatory limits of 40 CFR 190. (1-3) A Radiological Environmental Monitoring Program is implemented to monitor specified exposure pathways. (1-3) Releases of radiation are within regulatory limits. Calculated doses to the public are within the design objectives of 10 CFR 50 Appendix I and within regulatory limits of 40 CFR 190. • No additional mitigation is deemed necessary.
5.4.4 Impacts to Biota other than Members of the Public			S		S	S	S			S	S		S		1. Biota can receive radioactive doses via breathing, direct contact with contaminated water or soil, and through ingestion. 2. Biota can receive radioactive doses by coming in contact with buried radioactive waste.	(1) Although there are no acceptance criteria specifically for biota, there is no scientific evidence that chronic doses below 100 mrad/day are harmful to plants or animals. The biota doses are less than 0.1 mrad/day. (1) As appropriate, barriers can be erected to restrict access to contaminated soil or water. (2) As appropriate, barriers can be erected to restrict access to contaminated waste sites. (1-2) Radiation workers are trained on radioactive and safety procedures to minimize radiation exposure on the environment, including biota to radiation. (1-2) Organisms are monitored to determine exposure to radiation • No additional mitigation is necessary.

TABLE 5.10-1 (Sheet 8 of 11)
SUMMARY OF MEASURES AND CONTROLS TO LIMIT ADVERSE OPERATIONAL IMPACTS

ENVIRONMENTAL RESOURCES	Potential Environmental Disturbances and Significance Levels: Noise	Erosion/Sedimentation	Air Disturbances/ Emissions	Traffic	Hazardous Materials/ Wastes	Surface Water Disturbances	Groundwater Disturbances	Land usage/Disturbances	Water Use Consumption	Terrestrial Disturbances	Aquatic Disturbances	Socioeconomic Changes	Radiation Releases/ Exposure	Aesthetics/dust/odor	Impact Description or Activity	Feasible and Adequate Measures and Controls
5.5 Environmental Impacts of Waste																
5.5.1 Nonradioactive-Waste-System Impacts			S		S	S		S		S	S				1. As part of routine operations, relatively low concentrations of Hazardous nonradioactive emissions and effluents are discharged to the air, reservoir, and soil column. 2. Hazardous nonradioactive waste (concrete, scrap steel, etc.) is generated and disposed of in licensed hazardous waste landfills 3. Nonhazardous waste is generated and disposed of in licensed landfills. 4. Effluent and stormwater discharge. 5. Air emissions from equipment.	(1) Hazardous air waste emissions are released according to limits imposed by the Clean Air Act (CAA) Amendments of 1977, as amended, 41 USC 7401 et seq, and the CAA regulations (40 CFR 50-99). (1) Hazardous water effluents are released according to limits imposed by the CWA/FWPCA and NPDES program and permit requirements. (2) Hazardous waste is managed, treated, and disposed of according to RCRA regulations. (1 and 2) Hazardous waste is carefully monitored. (3) Nonhazardous nonradioactive waste is generated and disposed of according to applicable local, state, and federal regulations, including the Solid Waste Disposal Act, as amended, 42 USC 6901 et seq., and 40 CFR 261, "Identification and Listing of Hazardous Waste." (1-3) Inspections are performed for compliance with applicable waste management laws and regulations. (1-3) As appropriate, employees are trained to follow applicable procedures and waste regulations. (1-3) A BLN waste management and monitoring plan has been developed. (1-3) A BLN waste minimization plan has been developed. (4) Implement stormwater prevention plan. (2-3) Approved transporters and off-site landfills are used for disposal of solid wastes. Continue the existing program of waste minimization reuse and recycling. (4) Effluent discharges are in compliance with applicable NPDES permit requirements. (5) Equipment is maintained in good working order.

TABLE 5.10-1 (Sheet 9 of 11)
SUMMARY OF MEASURES AND CONTROLS TO LIMIT ADVERSE OPERATIONAL IMPACTS

ENVIRONMENTAL RESOURCES	Potential Environmental Disturbances and Significance Levels: Noise	Erosion/Sedimentation	Air Disturbances/ Emissions	Traffic	Hazardous Materials/ Wastes	Surface Water Disturbances	Groundwater Disturbances	Land usage/Disturbances	Water Use Consumption	Terrestrial Disturbances	Aquatic Disturbances	Socioeconomic Changes	Radiation Releases/ Exposure	Aesthetics/dust/odor	Impact Description or Activity	Feasible and Adequate Measures and Controls
5.5.2 Mixed Waste Impacts			S		S	S		S					S		1. As part of routine operations, mixed waste emissions and effluents are discharged to the air, reservoir, or soil column. 2. Mixed waste is disposed of in licensed mixed waste landfills. 3. Potential chemical hazard and occupational exposure to radiological materials during handling and storage.	(1) Hazardous air constituents are managed and released in accordance with the Clean Air Act (CAA) regulations (40 CFR 50-99). (1) Hazardous water constituents are managed and released in accordance with the Clean Water Act. (1-3) Hazardous waste constituents are managed, treated, and disposed of according to RCRA regulations. (1-3) Radioactive constituents are managed and disposed of according to applicable regulations. (1-3) As appropriate, employees are trained to follow applicable waste management procedures and regulations. (1-3). Mixed waste is carefully monitored. (1-3) Inspections are performed for compliance with applicable waste management laws and regulations. (1-3) Limit mixed waste generation through source reduction, recycling, and treatment options. (1-3) A BLN waste plan specifies procedures for managing waste. (1-3) A BLN waste minimization plan reduces the amount of waste that is generated. (1-3) Adopt ALARA program and train employees in implementation of this program, as appropriate.
5.6 Transmission System Impacts																
5.6.1 Terrestrial Ecosystems										S					1. Continued maintenance involving clearing of vegetation along the existing corridors may impact terrestrial ecology. 2. Potential for some erosion following vegetative clearing and/or excavation operations. 3. Application of herbicides. 4. Operation of noisy equipment that produces air emissions.	(1-5) Minimize potential impacts through compliance with permitting requirements and best management practices. (1-2) As appropriate, employees are trained on how to perform work in a manner that reduces adverse environmental impacts; to the extent feasible, avoid any additional disturbances on critical or sensitive terrestrial habitats/ species. (1,3) sensitive areas requiring restrictions on types of vegetation maintenance are identified in the Sensitive Area Review. (2) As practical, cleared areas are reseeded to limit erosion. (3) Herbicides are applied by trained employees licensed to apply herbicides. (4) As practical, vehicles/machinery use noise suppression/mufflers and vehicles are maintained to reduce emissions.

TABLE 5.10-1 (Sheet 10 of 11)
SUMMARY OF MEASURES AND CONTROLS TO LIMIT ADVERSE OPERATIONAL IMPACTS

ENVIRONMENTAL RESOURCES	Potential Environmental Disturbances and Significance Levels: Noise	Erosion/Sedimentation	Air Disturbances/ Emissions	Traffic	Hazardous Materials/ Wastes	Surface Water Disturbances	Groundwater Disturbances	Land usage/Disturbances	Water Use Consumption	Terrestrial Disturbances	Aquatic Disturbances	Socioeconomic Changes	Radiation Releases/ Exposure	Aesthetics/dust/odor	Impact Description or Activity	Feasible and Adequate Measures and Controls
5.6.2 Aquatic Ecosystems		S			S	S		S			S				1. Continued maintenance involving clearing of vegetation along the corridor near water bodies may impact aquatic biota. 2. Potential for some erosion and subsequent runoff into water bodies. 3. Herbicides can migrate into water bodies. 4. Potential discharge or spills of herbicides that pollute the aquatic ecosystem.	(1-4) Minimize potential impacts through compliance with permitting requirements and best management practices. (1-4) Streamside Management Zones (SMZs) requiring restrictions on the type of vegetation management activities performed are identified in the Sensitive Area Review. (1) To the extent feasible, avoid any additional disturbances on critical or sensitive aquatic habitats/species. (2) As practical, cleared areas are reseeded to limit erosion. (3) Herbicides are applied by trained employees who possess an application permit. (4) As appropriate employees are trained in herbicides procedures to minimize the risk of spills or discharges.
5.6.3 Impacts to Members of the Public	S			S				S			S			S	1. Noise from vehicles and equipment operated near inhabited or residential areas can affect humans. 2. Potential electric and magnetic fields effects. 3. Potential for electric shock. 4. Maintenance of the corridor continues to affect aesthetics.	(1-4) Minimize potential impacts through compliance with permitting requirements and best management practices. (1) As practical, vehicles and machinery use mufflers or noise suppression equipment. (1) Operate machinery according to applicable noise regulations under NCA and OSHA. (1) To the extent feasible, operate machinery during hours and times that minimize noise or traffic impacts. (3) Safety procedures and training programs are employed to reduce the risk of electrocution.
5.7 Uranium Fuel Cycle Impacts			S	S	S	S		S	S				S		1. Commitment of land for uranium professing facilities. 2. Consumption of cooling water during UO2 fuel fabrication. 3. Electrical energy used to power facilities. 4. Management of hazardous and radioactive air emissions and effluents from the gaseous diffusion plant. 5. Management of hazardous, mixed, and radioactive waste. 6. Occupational radioactive dose to workers. 7. Transportation dose to workers and public. 8. Waste management from operations, and decontamination and decommissioning.	(1) Construct plant according the best management practices. (2) Incorporates closed-loop cooling system. (3) As feasible, use energy efficient equipment/processes and introduce energy conservation program. (4) Air emissions are discharged per CAA regulations (40 CFR 50-99). (4) Water effluents are discharged per CWA/FWPCA and NPDES permit specifications. (4) Best available pollution control technology is incorporated. (4) Emissions and effluents are treated and monitored. (5) Consider use of new technology that requires less uranium hexafluoride. (5) Hazardous constituents are managed according to RCRA regulations. (5) Radioactive constituents are managed according to applicable regulations. (5) Implement waste minimization plans. (6-7) As appropriate, employees are monitored and trained in radiation procedures/regulations pursuant to 10 CFR 20, 40 CFR 190, and 10 CFR 20.1301. (8) Prepare a detailed decontamination and decommissioning plan. (3, 4, and 5) Consider centrifuge process over gaseous diffusion process that could significantly reduce energy requirements and environmental impacts. (3, 4, and 5) Consider use of new technologies with less fuel loading to reduce emissions, energy, and water usage. • No additional mitigation is necessary.

TABLE 5.10-1 (Sheet 11 of 11)
SUMMARY OF MEASURES AND CONTROLS TO LIMIT ADVERSE OPERATIONAL IMPACTS

ENVIRONMENTAL RESOURCES	Potential Environmental Disturbances and Significance Levels: Noise	Erosion/Sedimentation	Air Disturbances/ Emissions	Traffic	Hazardous Materials/ Wastes	Surface Water Disturbances	Groundwater Disturbances	Land usage/Disturbances	Water Use Consumption	Terrestrial Disturbances	Aquatic Disturbances	Socioeconomic Changes	Radiation Releases/ Exposure	Aesthetics/dust/odor	Impact Description or Activity	Feasible and Adequate Measures and Controls
5.8 Socioeconomic Impacts																
5.8.1 Physical Impacts of Station Operation	S		S	S										S	1. Potential episodic and limited noise impacts to workers and nearby residents. 2. Air pollution emissions and effluents can affect humans. 3. Congestion of local roads may result from worker traffic.	(1) As appropriate, train and appropriately protect BLN employees to reduce the risk of potential exposure to noise. (2) Monitor release of waste emissions and effluents. (3) Perform traffic study to evaluate methods of reducing traffic congestion. (3) Develop traffic control mitigation plan. (3) Stagger shifts, encourage car pooling, and time deliveries to avoid shift change or commute times. • No additional mitigation is necessary.
5.8.2 Social and Economic Impacts of Station Operation				S								S-M		S	1. Impact on local and regional economy. 2. Potential short-term housing shortage. 3. Potential short-term ability of services such as schools to accommodate influx of students without additional facilities and teachers 4. Small strain on existing recreational facilities.	(1) Increased tax revenues offset some economic impacts. (2) Mitigate housing shortage through new construction in anticipation of arrival of operational workforce. (2) Local land zoning and ordinances can help mitigate potential socioeconomic housing shortages. (4) Increased property and worker-related revenues can help offset some of the problems related to increased population such as community facilities and infrastructure, police, and fire protection. To meet immediate problems, some up-front services may have to be provided before project revenues are received. (4) Use land-use ordinances to prevent over-crowding and promote "smart growth." • No additional mitigation is necessary.
5.8.3 Environmental Justice Impacts												S			1. No disproportionately high or adverse impacts identified.	(1) No mitigation measures required beyond those listed above.