

# **Biological Assessment**

**Browns Ferry Nuclear Power Plant  
License Renewal Review**

**Limestone County, Alabama**

**October 2004**

**Docket Numbers 50-259, 50-260, and 50-296**

**U.S. Nuclear Regulatory Commission  
Rockville, Maryland**

# Biological Assessment of the Potential Effects on Endangered or Threatened Species from the Proposed License Renewal for the Browns Ferry Nuclear Plant

## 1.0 Introduction

The U.S. Nuclear Regulatory Commission (NRC) licenses the operation of domestic nuclear power plants in accordance with the Atomic Energy Act of 1954, as amended, and NRC implementing regulations. The Tennessee Valley Authority (TVA) operates Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 (BFN) pursuant to NRC operating license (OL) numbers DPR-33, DPR-52, DPR-68, which expire on December 20, 2013, June 28, 2014, and July 2, 2016, respectively.

TVA has prepared an Environmental Report (ER) (TVA 2003) in conjunction with its application for renewal of the BFN OLs, as provided for by the following NRC regulations:

- C Title 10 of the Code of *Federal Regulations*, Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," Section 54.23, Contents of application - environmental information (10 CFR 54.23).
- C Title 10 of the Code of Federal Regulations, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," Section 51.53, Postconstruction environmental reports, Subsection 51.53(c), Operating license renewal stage (10 CFR 51.53(c)).

The renewed OLs would allow up to 20 additional years of plant operation beyond the current licensed operating term.

No major refurbishment or replacement of important systems, structures, or components are expected during the 20-year BFN license renewal term. In addition, no construction activities are expected to be associated with license renewal.

In a letter dated March 5, 2004, the staff requested comments from the U.S. Fish and Wildlife Service (FWS) on the OL renewal application for BFN (NRC 2004). Specifically, the staff requested a list of species and information on protected, proposed, and candidate species and critical habitat that may be in the vicinity of BFN and its associated transmission line rights-of-way. In a letter from the FWS dated May 19, 2004 (FWS 2004e), the staff was directed to an FWS website (<http://daphne.fws.gov/es/specieslst.htm>) for a list of species to include in this biological assessment (BA). A total of 11 terrestrial and 38 aquatic species were listed for the counties within which the BFN site and its transmission line rights-of-way are located, and for Wheeler Reservoir, which serves as the source of cooling water for BFN. The FWS expressed specific concern (FWS 2004) over the potential impact of all three BFN units operating at maximum power levels on the rough pigtoe (*Pleurobema plenum*).

## 2.0 Proposed Action

The proposed Federal action is the renewal of the OLs for BFN. In response to the increasing demands for bulk power, TVA seeks to use existing facilities to the greatest extent possible to meet requirements for electric power. TVA is pursuing this approach because: (1) it ensures that future power needs can be met; (2) it avoids the large capital expenditures associated with construction of new generating facilities; and (3) it avoids the environmental impacts resulting from siting and constructing new power generating facilities. Consistent with this approach, TVA proposes to continue operation of BFN after expiration of the current OL for each unit. Implementing the proposed action is dependent on the staff determining that renewal of the OLs for BFN is the best course of action. Renewal of the current OLs would permit operation of the units for an additional 20 years beyond their current (original) 40-year operating license period.

In July 2004, the TVA submitted extended power uprate (EPU) applications to increase the licensed power levels of each of the three units to 3952 megawatts thermal (MW(t)) (i.e., to 120% of the originally licensed power levels), thereby bringing the combined total power level for the three units to 11,856 MW(t). In a separate environmental assessment, NRC is currently evaluating the potential environmental impacts of the proposed EPUs at BFN. If approved, the EPUs would take effect during the existing license term and would continue during the 20 year term of the renewed OLs. This BA was prepared to evaluate the potential environmental impacts of operating Units 1, 2, and 3 at 120% of their originally licensed power levels for an additional 20 years beyond the current license term for each unit.

Continued maintenance activities on the transmission line rights-of-way that are used to connect BFN to the electric power grid would be required if the proposed action is adopted. The TVA Transmission and Power Supply-Transmission Operations and Maintenance organization conducts maintenance activities on transmission lines and rights-of-way in the TVA system. These activities include, but are not restricted to, maintenance of vegetation in each right-of-way, replacement of poles or towers, installation of lightning arresters and counterpoise, and upgrading existing equipment. Regular maintenance activities are conducted on a 3-to-5-year cycle (Muncy et al. 1999).

## **3.0 The Plant**

### **3.1 Plant Description**

The three-unit BFN plant, including the intake and discharge canals, is enclosed by a security fence. Primary access to the plant area is by way of an access road through a security gate. The plant has the following principal physical structures in the central site area: reactor containment building, turbine building, radioactive waste building, service building, intake pumping station, transformer yard, 161-kV and 500-kV switchyards, off-gas stack, sewage treatment facilities, and administration and maintenance buildings. The hot and cold water discharge channels and mechanical draft cooling towers are located northwest of the central site area, while the training center, employee physical fitness center, materials storage and procurement complex, and structures from a former aquatic research laboratory are located to the east of the central site area (see Figure 1).

### **3.2 Reactor Systems**

BFN has two active nuclear reactor units (Units 2 and 3) and one inactive unit (Unit 1). Each unit includes a boiling water reactor (BWR) and a steam-driven turbine generator manufactured by General Electric Company. Work began in 2002 to bring Unit 1 up to current standards, and operation of the reactor is currently scheduled to resume in 2007.

The nuclear steam supply system at BFN is typical of General Electric BWRs. Each nuclear system includes a single-cycle, forced-circulation, General Electric BWR that produces steam for direct use in a steam turbine. The design employs a pressure suppression primary containment that houses the reactor vessel, the reactor coolant recirculating loops, and other branch connections of the reactor primary system. The pressure suppression system consists of a dry well, a pressure suppression chamber that stores a large volume of water, connecting vents between the dry well and the pressure suppression chamber, isolation valves, containment cooling systems, and other service equipment. Cooling systems are provided to remove heat from the reactor core, the dry well, and the water in the pressure suppression chamber, thus providing continuous cooling of the primary containment under accident conditions. Appropriate isolation valves are actuated during this period to ensure confinement of radioactive material, which might otherwise be released from the reactor containment during the course of an accident.

The secondary containment substructure consists of poured-in-place, reinforced concrete exterior walls that extend up to the refueling floor. The refueling room floor is also constructed of reinforced, poured-in-place concrete. The secondary containment structure completely encloses the primary containment dry wells, fuel storage and handling facilities, and essentially all of the core standby cooling systems for the three units. During normal operation and when isolated, the secondary containment is maintained at a negative pressure relative to the building exterior.

### **3.3 Cooling and Auxiliary Water Systems**

Wheeler Reservoir on the Tennessee River is the source for cooling water and most of the auxiliary water systems for BFN (see Figure 2). Potable water is supplied by the City of Athens Utilities Water Department in Athens, Alabama. Groundwater is not used at the site. Figure 1 shows the general layout of the buildings and structures at the site.

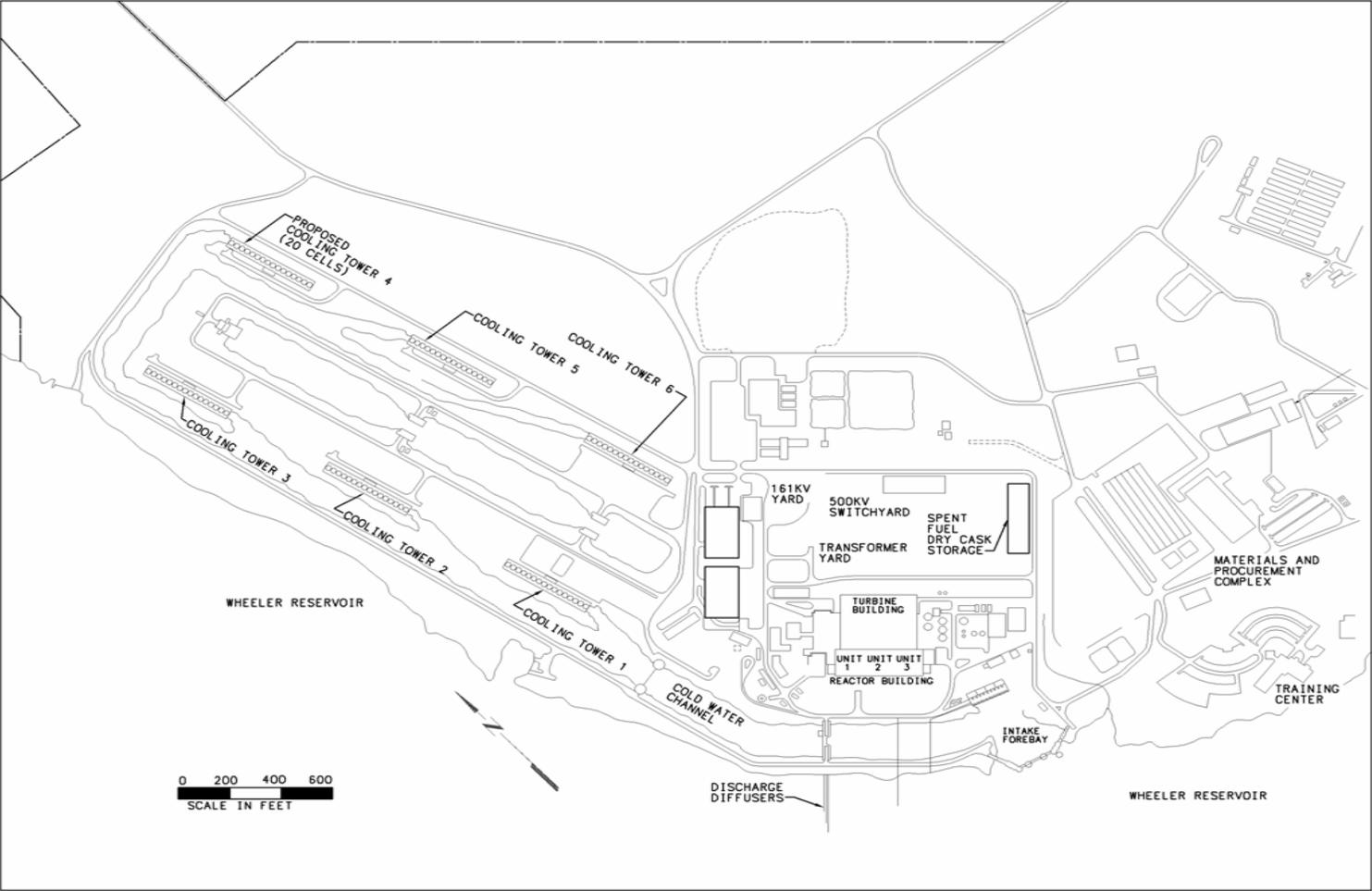


Figure 1. Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 Site Features

The intake forebay is separated from Wheeler Reservoir by a gate structure with three bays that are each 12 m (40 ft) wide by about 7.3 m (24 ft) high (TVA 1972). Each bay includes a 6-m (20-ft)-high gate that can be raised or lowered depending on the operational requirements of the plant. The flow velocity through the openings varies depending on the gate position. When the gates are in their full-open position and the plant is operated in either the open mode (once-through) or cooling tower helper mode, the average flow velocity through the openings is about 0.2 m/s (0.6 fps) for the operation of one unit, 0.34 m/s (1.1 fps) for the operation of two units, and 0.52 m/s (1.7 fps) for the operation of all three units (TVA 2003). These flow velocities are based on an intake flow per unit of about 46,300 L/s (734,000 gpm), which is 46.3 m<sup>3</sup>/s (1635 cfs).

The intake pumping station includes 18 bays (i.e., six bays per reactor unit), each with a traveling screen. Each bay has a net opening size of about 2.6 m by 6 m (8.75 ft by 20 ft). The maximum average flow velocity through each bay is about 0.49 m/s (1.6 fps) and is independent of the reservoir surface elevation. The maximum average velocity through a clean screen with net openings of 0.95 cm by 0.95 cm (3/8 in. by 3/8 in.) is about 0.64 m/s (2.1 fps) (TVA 2003). Flow velocities through the intake pump station bays and traveling screens are independent of the number of units in operation and the reservoir elevation.

The BFN units are normally cooled by pumping water from Wheeler Reservoir into the turbine generator condensers and discharging it back to the reservoir via three large submerged diffuser pipes that are perforated to maximize uniform mixing into the flow stream. These pipes range in diameter from 5.2 m to 6.2 m (17 ft to 20.5 ft). The flow exits each discharge pipe through 7800 5-cm (2-in.) ports (TVA 2003). This straight-through flow path is known as “open cycle” or “open mode” operation. As originally designed, the maximum thermal discharge from the once-through cooling water system is directed into the Wheeler Reservoir, with a temperature increase across the intake and discharge of 13.9°C (25°F) (TVA 1972). The flow exits the diffusers and mixes with the reservoir flow. At the edge of the discharge mixing zone, the water temperature is required to be less than 5.6°C (10°F) above ambient (ADEM 2003).

Through various gates, some of this cooling water can also be directed through mechanical draft cooling towers to reduce its temperature as necessary to comply with environmental regulations. This flow path is known as the “helper mode,” and the cooling towers are referred to as “helper towers.”

The capacity also exists to recycle cooling water from the cooling towers directly back to the intake structure without being discharged to the reservoir. This flow path, known as the “closed mode” of operation, has not been used since the restart of Units 2 and 3 because of difficulties in achieving temperature limits in summer months and problems with equipment reliability. TVA does not anticipate using this mode in the future, and no procedures for operating in this mode currently exist.

In recent years, only Units 2 and 3 have been in operation, but because of a combination of system upgrades and improved flow calibrations, the measured total per-unit condenser circulating water (CCW) flow rate in open mode (with three CCW water pumps per unit) has increased. The condenser tubes were replaced with stainless steel tubing that have a larger

internal diameter and lower flow resistance. This modification increased flow through the condenser by approximately 6 percent. TVA estimates total intake for three-unit operation in open mode to be 139 m<sup>3</sup>/s (4907 cfs) or 12,000 m<sup>3</sup>/d (3171 MGD) (TVA 2003).

Because of various system limitations, BFN cannot pass all the CCW through the cooling towers when operating in the helper mode. The fraction of cooling water that cannot be passed through the cooling towers is routed directly to the river. Almost all of the cooling water that passes through the cooling towers is returned to the river, but a small amount is lost to the atmosphere during operation. If cooling tower capacity is increased during the license renewal term, this consumptive use could increase proportionately. The cooling towers are only operated when necessary to meet thermal discharge temperature limits specified in the National Pollutant Discharge Elimination System (NPDES) permit, typically a few weeks during the hottest part of the summer (typically July and August).

For the last 6 years, during which Units 2 and 3 have both been in service, the greatest amount of time cooling tower operation has been required has been about 8 percent of a year (TVA 2003). Increased thermal power limits proposed for Units 2 and 3 will result in an additional increase of approximately 2.2°C (4°F) in the circulating water temperature leaving the main condenser (for each operating unit) (Hopping 2004). This increase in water discharge temperature will result in increased use of the cooling tower during summer periods to maintain compliance with discharge limitations. No changes to the plant intake system or to the individual unit intake flow rates are expected to be required as a result of the Units 2 and 3 EPU project, and operations will continue to meet regulatory limits established in the existing NPDES permit.

Simulations with the near-field hydrothermal model were conducted for the period 1985 through 2002, excluding 2 years (1989 and 1990) for which no river ambient temperature data are available (TVA 2003). TVA varied both the use of the helper towers and unit power levels to maintain discharge temperatures to within NPDES permit limits. Model results showed that, with Units 2 and 3 operating at 120 percent power, the cooling towers will be used on average approximately 5.3 percent of the time, and derating will be required approximately 0.10 percent of the time (i.e., 6.2 days over the 16-year simulation period). On average, with all three units at 120 percent power, use of the cooling towers will increase to approximately 7.2 percent of the time and derating will increase to approximately 0.29 percent of the time (i.e., 17 days over the 16-year simulation). The simulation of three unit operation at 120 percent power assumed the construction and operation of an additional sixth 20 cell cooling tower. The licensee has committed placing the new tower in operation prior to the first summer following the return of Unit 1 to service(TVA 2004c).

The residual heat removal service water (RHRSW) system consists of four pairs of pumps located on the intake structure for pumping raw river water to the heat exchangers in the RHRSW system and four additional pumps for supplying water to the emergency equipment cooling water (EECU) system. The EECU system distributes cooling water supplied by the RHRSW system to essential equipment during normal and accident conditions.

The impacts evaluated in this BA include those from operation of all three of the BFN reactor units, each at 120 percent of the original licensed thermal power level. TVA has stated

(TVA 2002a) that “no changes are expected to be required to the plant intake system or to the individual unit intake flow rates as a result of the EPU project.” TVA also indicated that existing thermal discharge limits would be met by increased use of the helper towers, and if necessary, derating one or more units

## 4.0 Environmental Setting

The proposed license renewal will apply to all three units BFN, which is located on the north shore of Wheeler Reservoir in Limestone County, Alabama, at Tennessee River Mile (TRM) 294. The BFN site is approximately 48 km (30 mi) west of Huntsville, Alabama; 16 km (10 mi) northwest of Decatur, Alabama; and 16 km (10 mi) southwest of Athens, Alabama (Figure 2). The power plant is located on a 340-ha (840-ac) tract owned by the Federal government and held in custody by TVA, a corporate agency and instrumentality of the United States.

### 4.1 Terrestrial Resources

BFN is located within the Highland Rim section of the Interior Low Plateau Physiographic Province. Botanically, the site is within the Mississippian Plateau section of the Western Mesophytic Forest Region (EPA 2004). In this region of northern Alabama, native forest communities generally consist of mixed oak forests that vary in composition in relation to topography and soils. Historically, upland forests in the vicinity of the site were characterized by mixtures of southern red oak (*Quercus falcata*), black oak (*Q. velutina*), post oak (*Q. stellata*), and white oak (*Q. alba*), with dogwood (*Cornus* spp.) commonly present in the understory. The clearing of forested lands for agriculture has converted many of these forest communities to early successional habitats, allowing introduced plant species to replace representative native plant communities.

The site is situated in an area where the land is used primarily for agriculture (TVA 2003). The countryside includes open pasture lands, scattered farmsteads, few residents, and little industry within several miles. The south and west side of the BFN site abuts Wheeler Reservoir, and has a shoreline of approximately 3772 m (12,375 ft), with 58 percent of the shoreline stabilized with riprap. The remaining 42 percent of the shoreline of the site is partially eroded and is composed of mixed upland forest vegetation. The stabilized shoreline adjacent to the BFN facilities is primarily vegetated by young (approximately 4-to-5-year-old) black willow (*Salix nigra*), common hackberry (*Celtis occidentalis*), sumac (*Rhus* spp.), and exotic species such as Chinese privet (*Ligustrum sinense*), Japanese honeysuckle (*Lonicera japonica*), and trumpet creeper (*Campsis radicans*). The remainder of the shoreline just west of the facility is vegetated with a young mixed upland forest scattered with a few large, old specimens (approximately 80-plus years) of oaks and loblolly pine (*Pinus taeda*). Young plants associated with the upland forest include black locust (*Robinia pseudoacacia*), sweetgum (*Liquidambar styraciflua*), sassafras (*Sassafras albidum*), cottonwood (*Populus* spp.), elm (*Ulmus* spp.), common hackberry, and black cherry (*Prunus serotina*). Common understory vegetation in the forested area includes Chinese privet, spleenwort (*Asplenium* spp.), Virginia creeper (*Parthenocissus quinquefolia*), and poison ivy (*Toxicodendron radicans*).

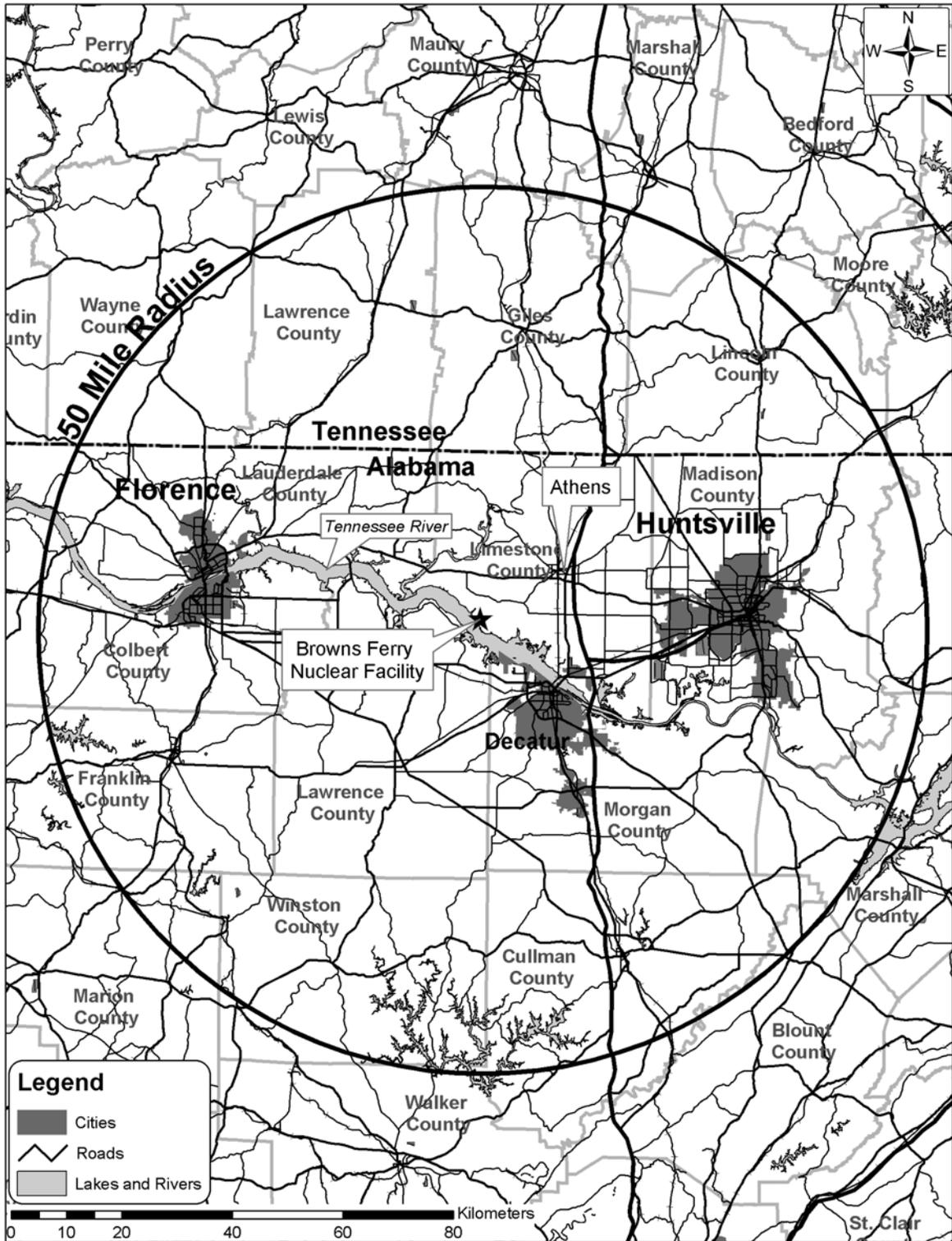
Invasive exotic plant species are a concern in the area. TVA reports approximately 19 invasive species in the area with a special emphasis on Chinese privet, Japanese honeysuckle, Japanese knotweed (*Polygonum cuspidatum*), and Nepal grass (*Microstegium vimineum*)

(TVA 2003).

There are approximately 10 ha (25 ac) and 5 ha (12 ac) of National Wetlands Inventory and U.S. Army Corps of Engineers-classified wetlands, respectively, occurring at the BFN site (TVA 2003). These areas include forested wetlands, emergent (marsh) wetlands, and scrub-shrub/emergent wetlands (based on 1980s aerial photography). The wetland ecological communities identified at the site are dominated by plant species that are common in the region, including black willow, buttonbush (*Cephalanthus occidentalis*), sedges (*Carex lupulina*, *C. vulpinoidea*, *Rhynchospora corniculata*), rushes (*Juncus* spp., *J. brachycarpus*), water hemlock (*Conium maculatum*), and smartweeds (*Polygonum* spp.). These wetlands occur in areas that have been previously disturbed by clearing and agriculture, and areas that are mowed periodically. These types of wetlands commonly occur on previously disturbed former or presently used agricultural land, and the dominant vegetation species occurring within them are common in the region.

The vegetation communities described above are not unusual for the area and provide no sensitive or rare forms of wildlife habitat. Wildlife habitat on the site can be broadly classified as upland and riparian/wetland. Animal species commonly associated with upland communities include white-tailed deer (*Odocoileus virginianus*), cottontail rabbit (*Sylvilagus floridanus*), Virginia opossum (*Didelphis virginiana*), hispid cotton rat (*Sigmodon hispidus*), song sparrow (*Melospiza melodia*), eastern bluebird (*Sialia sialis*), northern mockingbird (*Mimus polyglottus*), turkey vulture (*Cathartes aura*), tufted titmouse (*Baeolophus bicolor*), American toad (*Bufo americanus*), spring peeper (*Pseudacris crucifer*), black racer (*Coluber constrictor constrictor*), and eastern box turtle (*Terrapene carolina*) (TVA 2003). Riparian communities can support a unique assemblage of wildlife including muskrat (*Ondatra zibethicus*), beaver (*Castor canadensis*), raccoon (*Procyon lotor*), wood duck (*Aix sponsa*), belted kingfisher (*Ceryle alcyon*), barred owl (*Strix varia*), American woodcock (*Scolopax minor*), Carolina wren (*Thryothorus ludovicianus*), prothonotary warbler (*Protonotaria citrea*), eastern phoebe (*Sayornis phoebe*), bullfrog (*Rana catesbeiana*), green frog (*Rana clamitans*), eastern newt (*Notophthalmus viridescens*), southern two-lined salamander (*Eurycea cirrigera*), common snapping turtle (*Chelydra serpentina serpentina*), and northern water snake (*Nerodia sipedon*) (TVA 2003). Some water holes along Wheeler Reservoir are used by American alligators (*Alligator mississippiensis*) in the winter. Invasive terrestrial animals that are expected to occur in the project vicinity include European starling (*Sturnus vulgaris*), house sparrow (*Passer domesticus*), and rock dove (*Columba livia*).

BFN is connected to the TVA system network by seven 500-kilovolt (kV) transmission lines via the 500-kV switchyard (TVA 2003). One line is to the Madison substation; two are to the Trinity substation; one line each are to the West Point, Maury, and Union substations; and one line is to the Limestone 500-kV substation. There are two additional 161-kV lines, one to the Athens substation and one to the Trinity substation. All lines occupy portions of four rights-of-way; three that terminate at the Maury, Trinity, and Athens substations, Alabama, and one that



**Figure 2.** Brown's Ferry Nuclear Power Plant, Units 1, 2, and 3 Site and Surrounding Area

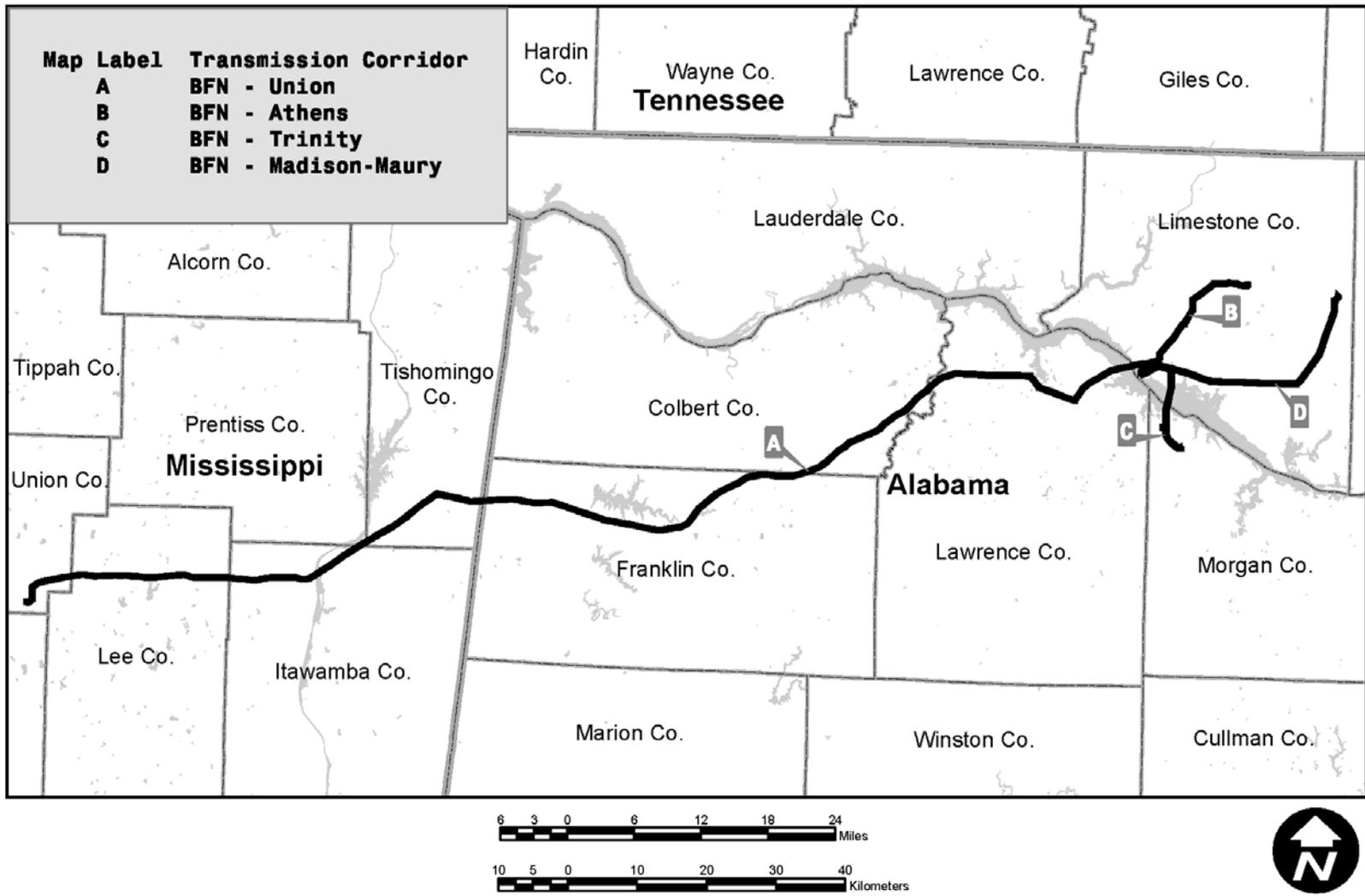
terminates at the Union substation in Union County, Mississippi (Figure 3). In all, there are approximately 257 km (160 mi) of transmission line rights-of-way associated with BFN. The rights-of-way pass through Colbert, Franklin, Lawrence, Limestone, and Morgan Counties, Alabama, and Itawamba, Lee, Tishomingo, and Union Counties, Mississippi.<sup>(a)</sup> The Maury, Trinity, and Athens transmission line rights-of-way are found in the Eastern Highland Plain ecoregion, while the 175-km (109-mi)-long Union right-of-way traverses the Eastern Highland Plain and Transition Hills, crosses into Mississippi and passes through the Fall Line Hills, Flatwoods/Blackland Prairie Margins, and Blackland Prairie ecoregions (EPA 2004).

Transmission line maintenance activities are reviewed for potential resource issues by technical specialists in the TVA Regional Natural Heritage and Cultural Resources programs (Muncy et al. 1999). A 1.6-km (1.0-mi) buffer area on either side of each transmission line right-of-way is reviewed for the presence of terrestrial species, while a 16.1-km (10-mi) buffer area is used for aquatic species (TVA 2003). The TVA Regional Natural Heritage program maintains a database of more than 27,000 occurrence records for protected plants, animals, caves, National Wetland Inventory wetlands, cultural resources, and areas of management concern for the entire TVA Power Service Area. TVA also conducts fieldwork to inventory and protect threatened and endangered species and environmentally sensitive areas on public lands it administers. Activities conducted by project staff members include monitoring species populations, educating the public, and managing and maintaining habitats (including caves) at TVA-managed sites.

Transmission line rights-of-way are regularly surveyed and video taped from a helicopter. Video tapes can then be used to search for sensitive habitat types before field crews are dispatched. Access routes and restrictions for maintenance activities are determined based on knowledge of the species or resources to be protected. Vehicles and equipment are restricted from a site when habitat-sensitive resources are present (Class 2 restrictions). Within Class 2 restricted areas, all vegetation clearing and herbicide applications are done by hand. Class 1 restrictions allow hand or mechanical clearing and herbicide use for vegetation control on transmission line rights-of-way. There is no broadcast application of herbicides. Herbicide application is carefully controlled and personnel who apply the herbicides are trained, licensed, and follow manufacturer's guidelines, U.S. Environmental Protection Agency (EPA) guidelines, and State regulations. The streamside management zone is maintained to (1) slow and spread surface-water flow so particulate matter will be trapped and filtered before reaching the stream channel, (2) protect stream bank integrity, and (3) protect water temperature in the stream.

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(a) Prentiss County, Mississippi is not included. Species accounted for in adjacent counties.



**Figure 3.** Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 and Its Associated Transmission Lines and Rights-of-Way

## 4.2 Aquatic Resources

The aquatic resources in the vicinity of BFN are primarily associated with the Wheeler Reservoir portion of the Tennessee River. Wheeler Reservoir is the source and receiving body for the BFN cooling system (TVA 2003). Other aquatic habitats include several tributaries to Wheeler Reservoir: Paint Rock and Flint Rivers in the upper reach; Indian, Cotaco, and Flint Creeks in the middle reach; and Limestone, Piney, Swan, Fox, Mallard, Spring, First, and Second Creeks and the Elk River in the lower section. Elk River, the largest of these tributaries, flows into Wheeler Reservoir about 16 km (10 mi) downstream of BFN. Guntersville Reservoir is upstream of Wheeler Reservoir, while Wilson Reservoir is downstream. All three reservoirs are run-of-the-river impoundments on the Tennessee River.

The seven transmission lines located in four rights-of-way associated with BFN cross a number of streams ranging in size from small intermittent streams to the Tennessee River. Rivers and larger streams crossed by or near the transmission lines include Limestone, Piney, Swan, Round Island, Big Nance, Town, Spring, Cedar, Little Bear, and Bear Creeks in Alabama; and Bear, Little Brown, Donivan, Twentymile, Mantachie, Mud, and Bridge Creeks and the Tennessee-Tombigbee Waterway in Mississippi. Transmission line right-of-way maintenance activities in the vicinity of stream and river crossings employ best management practices to minimize erosion and shoreline disturbance while encouraging vegetative cover (TVA 2003).

A total of 63 fish species plus hybrid sunfish, hybrid striped bass x white bass (*Morone saxatilis* x *M. chrysops*), and hybrid walleye x sauger (*Stizostedion vitreum* x *S. canadense*) were collected from 1995 through 2002 in the vicinity of BFN (TVA 2002b, 2003). A total of 72 fish species were identified in impingement samples collected between 1974 and 1977 (TVA 1978). Important commercial fish species that occur in Wheeler Reservoir include blue catfish (*Ictalurus furcatus*), channel catfish (*I. punctatus*), flathead catfish (*Pylodictis olivaris*), bigmouth buffalo (*Ictiobus cyprinellus*), smallmouth buffalo (*I. bubalus*), and common carp (*Cyprinus carpio*). Gizzard shad (*Dorosoma cepedianum*) and threadfin shad (*D. petenense*) are the dominant forage species in Wheeler Reservoir (TVA 2003). Threadfin shad has been the dominant species numerically in Wheeler Reservoir since 1990 (Baxter and Buchanan 1998). Game fish species include largemouth bass (*Micropterus salmoides*), smallmouth bass (*M. dolomieu*), spotted bass (*M. punctulatus*), black crappie (*Pomoxis nigromaculatus*), white crappie (*P. annularis*), bluegill (*Lepomis macrochirus*), longear sunfish (*L. megalotis*), redbreast sunfish (*L. microlophus*), sauger, striped bass, hybrid striped bass, yellow bass (*Morone mississippiensis*), and yellow perch (*Perca flavescens*).

Historically, 39 mussel species occurred in Wheeler Reservoir. Thirty-one of these species were considered riverine (i.e., those that evolved in free-flowing reaches), with 19 of these species now considered non-reproducing riverine species within Wheeler Reservoir (Ahlstedt and McDonough 1992). In 1982, 12 mussel species were collected during a survey for the proposed barge facility at BFN (Pryor 1982), and 11 species were collected across the river during a survey for a proposed barge terminal for the Mallard-Fox Creek Development Project (Carroll 1982). The washboard (*Megaloniais nervosa*) was the most common species collected

during both surveys. It is currently the predominant species that is commercially harvested (TVA 2003). The Ohio pigtoe (*Pleurobema cordatum*) was previously the most valuable commercial species, but its numbers have decreased because of habitat alterations due to impoundment (Ahlstedt and McDonough 1992). None of the species collected were Federally or State protected.

In 1991, 24 species of mussels were collected from Wheeler Reservoir, with six species represented by weathered, empty shells (Ahlstedt and McDonough 1992). The 24 species included all species previously collected near BFN in the two 1982 collections by Pryor and Carroll. It was estimated that 460 million mussels or 2.33 mussels/m<sup>2</sup> (0.22 mussels/ft<sup>2</sup>) occurred in the reservoir in 1991 (Ahlstedt and McDonough 1992). The most common species (and estimated number within Wheeler Reservoir) collected in 1991 were the elephant-ear (*Elliptio crassidens*, 116 million), washboard (88 million), pink heelsplitter (*Potamilus alatus*, 56 million), and threehorn wartyback (*Obliquaria reflexa*, 44 million) (Ahlstedt and McDonough 1992). In addition to the habitat alteration resulting from reservoir creation, over-harvesting and periods of drought (e.g., from 1983 to 1988) may have affected reproduction and/or survival of most thick-shelled mussel species in Wheeler Reservoir (Ahlstedt and McDonough 1992). Water-quality impairments and loss of necessary fish hosts have also contributed to the decline of mussel populations. The biodiversity of mussel communities in the mainstem Tennessee River reservoirs is anticipated to continue the long-term downward trend in terms of abundance and diversity (TVA 2004a).

In 1998, 17 mussel species were collected on the east channel of Wheeler Reservoir near Hobbs Island, over 64 river kilometers (40 river miles) upstream of BFN, between TRMs 336.4 and 335.5. The two most common mussel species were the elephant-ear and the Ohio pigtoe. Two Federally endangered species were also collected: one specimen of the rough pigtoe (*Pleurobema plenum*) and 16 specimens of the pink mucket (*Lampsilis abrupta*) (Yokely 1998). In 1999, 16 native mussel species were collected in the vicinity of BFN: 14 species at (TRM) 298 upstream of BFN and 12 species at TRM 292 downstream of BFN. None of these were Federally listed species (TVA 2003). Eleven commercial mussel species have been reported near BFN from TRM 305 to TRM 275 (Ahlstedt and McDonough 1992).

Two areas of Wheeler Reservoir are designated as State-protected mussel sanctuaries where commercial mussel fishing is not permitted. One sanctuary extends from Guntersville Dam (TRM 349) downstream to the mouth of Shoal Creek (TRM 347); the second extends from the upstream end of Hobbs Island (TRM 337) downstream to Whitesburg Bridge (TRM 333) (TVA 2003). In the reservoir overbanks, mussels are generally spread over large areas and are not concentrated in mussel beds (TVA 2003).

## **5.0 Evaluation of Threatened and Endangered Species**

A review of the TVA Regional Natural Heritage database indicates that no Federally listed species of animals or plants have been reported from areas within 4.8 km (3.0 mi) of the BFN site (TVA 2003). However, there are 49 species (11 terrestrial and 38 aquatic species) that are listed as threatened, endangered, or candidate species by FWS that occur, at least historically,

within the portion of the Tennessee River that encompasses Wheeler Reservoir or within one or more of the counties of Alabama and Mississippi within which the BFN transmission lines are located.

## **5.1 Terrestrial Species**

There are 11 terrestrial species that are listed as threatened, endangered by the FWS and that potentially occur in the vicinity of BFN or along the transmission line rights-of-way (Table 1). All 11 Federally listed species have been reported from counties that contain BFN transmission line rights-of-way (Table 1).

### **Bald Eagle (*Haliaeetus leucocephalus*)**

The bald eagle is reported to occur in Franklin County, Alabama, and Itawamba and Tishomingo Counties, Mississippi. Bald eagles prefer habitat along coastlines, lakes, rivers and other water bodies that provide their primary food source – fish and waterfowl (NatureServe 2004). Eagles generally nest in tall trees or on cliff faces near water and away from human disturbance. Bald eagles are known in the area around BFN, but there is no known nesting habitat within 4.8 km (3.0 mi) of the site. Nesting sites on other TVA property are managed using FWS guidelines (FWS 1987a). Transmission line rights-of-way are likely to be within foraging areas for this species, particularly those that cross Wheeler Reservoir and the Tennessee-Tombigbee Waterway. The TVA reports incidents of eagle mortality associated with transmission lines but no mortality has been observed on BFN-associated lines.

Construction and maintenance of transmission line rights-of-way are designed to minimize environmental impacts, and transmission line right-of-way maintenance activities are reviewed for potential resource issues by TVA (Muncy et al. 1999). Access routes and activity restrictions are determined based on knowledge of the eagles in the area. Mechanical clearing and herbicide use may be used for vegetation control in transmission line rights-of-way. Access routes and activity restrictions are determined based on knowledge of the eagles in the area. Herbicide application is carefully controlled and personnel who apply the herbicides are trained, licensed, and follow manufacturer's guidelines, EPA guidelines, and State regulations. The staff reviewed TVA maintenance activities and determined that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, bald eagles.

**Table 1.** Federally Listed and Candidate Terrestrial Species for Colbert, Franklin, Lawrence, Limestone, and Morgan Counties, Alabama, and Itawamba, Lee, Tishomingo, and Union Counties, Mississippi, Occurring Near Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 and Along the Transmission Line Rights-of-Way.

Scientific Name	Common Name	Status <sup>(a)</sup>	County Listings		Habitat
			AL <sup>(b)</sup>	MS <sup>(c)</sup>	
<b>Birds</b>					
<i>Haliaeetus leucocephalus</i>	bald eagle	T	Fr	It Ti	Coastlines, lakes, rivers and other water bodies
<i>Picoides borealis</i>	red-cockaded woodpecker	E	La	--	Open pine forests, generally at least 80 to 120 years old
<b>Mammals</b>					
<i>Myotis grisescens</i>	gray bat	E	Co Fr La Li Mo	Ti	Restricted to cave or cave-like habitats. Gray bats roost and form maternity colonies in caves located along rivers and reservoirs
<i>Myotis sodalis</i>	Indiana bat	E	Co La Li Mo	Ti	Hibernate in caves during winter months but can be found in hollow trees and under loose tree bark during the summer
<b>Plants</b>					
<i>Apios priceana</i>	Price's potato bean	T	--	Le	Open mixed hardwood forests often on floodplains, in or near riparian areas
<i>Asplenium scolopendrium</i> var. <i>americanum</i>	American hart's-tongue fern	T	Mo	--	Around the openings to limestone caves and sinkholes
<i>Dalea foliosa</i>	leafy prairie-clover	E	Fr La Mo	--	Cedar glades in northern Alabama and central Tennessee
<i>Helianthus eggertii</i>	Eggert's sunflower	T	Co Fr La Li Mo	--	Barrens habitats within the Interior Plateau Ecoregion of Kentucky, Tennessee, and Alabama

**Table 1. (contd)**

Scientific Name	Common Name	Status <sup>(a)</sup>	County Listings		Habitat
			AL <sup>(b)</sup>	MS <sup>(c)</sup>	
<i>Lesquerella lyrata</i>	lyrate bladder-pod	T	Co Fr La	--	Disturbed glade habitats
<i>Xyris tennesseensis</i>	Tennessee yellow-eyed grass	E	Fr	--	Moist to wet, limestone-derived soils in open or lightly wooded sites
<i>Leavenworthia crassa</i>	Fleshy-fruited gladecress	C	La Mo	--	Endemic to limestone glades in Lawrence and Morgan Counties

(a) Status: C = candidate, E = endangered, T = threatened;

(b) AL counties: Co = Colbert; Fr = Franklin; La = Lawrence; Li = Limestone; Mo = Morgan;

(c) MS counties: It = Itawamba; Le = Lee; Ti = Tishomingo; – = not listed.

Sources: FWS 2000b, 2004a; NatureServe 2004.

### **Red-Cockaded Woodpecker (*Picoides borealis*)**

The red-cockaded woodpecker is reported to occur in Lawrence County, Alabama, but not within at least 4.8 km (3.0 mi) of the transmission line rights-of-way. Red-cockaded woodpeckers inhabit open pine forests that are at least 80 to 120 years old (NatureServe 2004). Hardwood forests, or pine forests with a hardwood understory are usually avoided. There is no woodpecker habitat within 4.8 km (3.0 mi) of BFN, and it is unlikely that there is any suitable habitat along the BFN transmission line rights-of-way.

Because there is no habitat on the BFN site or transmission line rights-of-way, the staff determined that continued operation of BFN over the 20-year license renewal term will have no effect on the red-cockaded woodpecker.

### **Gray Bat (*Myotis grisescens*)**

The gray bat is reported to occur in Colbert, Franklin, Lawrence, Limestone, and Morgan Counties, Alabama, and in Tishomingo County, Mississippi. Gray bats are colonial and are restricted to cave or cave-like habitats (NatureServe 2004). They roost, and the females form maternity colonies in caves located along rivers and reservoirs over which they feed. During the winter, gray bats congregate and hibernate in a limited number of caves across the southeast.

Although no suitable habitat for this species occurs within 4.8 km (3.0 mi) of BFN, gray bats likely forage along the Tennessee River, adjacent to the plant site. Some of the BFN transmission line rights-of-way are likely to be within foraging areas for this species.

Construction and maintenance of transmission line rights-of-way are designed to minimize environmental impacts and transmission line right-of-way maintenance activities are reviewed for potential resource issues by the TVA (Muncy et al. 1999). Access routes and activity restrictions are determined based on knowledge of gray bats in the area. Mechanical clearing and herbicides may be used for vegetation control in transmission line rights-of-way. Herbicide application is carefully controlled and personnel who apply the herbicides are trained, licensed, and follow manufacturer's guidelines, EPA guidelines, and State regulations.

The staff has reviewed TVA maintenance activities and has determined that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the gray bat.

### **Indiana Bat (*Myotis sodalis*)**

The Indiana bat is reported to occur in Colbert, Lawrence, Limestone, and Morgan Counties, Alabama, and in Tishomingo County, Mississippi. Indiana bats are colonial and hibernate in caves during winter months, but they can be found in hollow trees and under loose tree bark during the summer, where they form small maternity colonies (NatureServe 2004). Indiana bats forage for insects primarily in riparian and upland forests. Roosting and foraging habitat for Indiana bats is very limited on the BFN site. Water sources are composed of water lagoons, sedimentation ponds, and drainage canals, and forested habitats are primarily small woodlots of poor quality. No suitable Indiana bat habitat is known to occur within 4.8 km (3.0 mi) of the BFN site. Some of the BFN transmission line rights-of-way are likely to be within foraging areas for this species.

Construction and maintenance of transmission line rights-of-way are designed to minimize environmental impacts, and may improve foraging habitat for Indiana bats. Transmission line right-of-way maintenance activities are reviewed for potential resource issues by the TVA (Muncy et al. 1999). Access routes and activity restrictions are determined based on knowledge of Indiana bats in the area. Mechanical clearing and herbicides may be used for vegetation control in transmission line rights-of-way. Herbicide application is carefully controlled and personnel who apply the herbicides are trained, licensed, and follow manufacturer's guidelines, EPA guidelines, and State regulations.

Because there is no habitat for Indiana bats on the BFN site, and after reviewing the TVA maintenance activities, which may improve habitat along transmission line rights-of-way, the staff determined that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the Indiana bat.

### **Price's Potato Bean (*Apios priceana*)**

Price's potato bean is reported to occur in Lee County, Mississippi. This species is found in open mixed hardwood forests, often on flood plains in or near riparian areas (NatureServe 2004). Although thought to be somewhat dependent on disturbances that maintain an early successional environment, it is also reported to be sensitive to some management activities such as logging, cattle grazing, and highway rights-of-way maintenance. No populations of Price's potato bean are known to exist within 4.8 km (3.0 mi) of BFN, but suitable habitat could be found along the BFN transmission line rights-of-way.

Construction and maintenance of transmission line rights-of-way are designed to minimize environmental impacts (Muncy et al. 1999), and may improve habitat for this species. Transmission line rights-of-way maintenance activities are reviewed for potential resource issues by the TVA (Muncy et al. 1999). Access routes and activity restrictions are determined based on knowledge of Price's potato bean in the area. Mechanical clearing and herbicide use may be used for vegetation control on transmission line rights-of-way. Herbicide application is carefully controlled and personnel who apply the herbicides are trained, licensed, and follow manufacturer's guidelines, EPA guidelines, and State regulations.

Because there is no habitat for Price's potato bean on the BFN site, and after reviewing the TVA maintenance activities, which may improve habitat along transmission line rights-of-way, the staff determined that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, Price's potato bean.

### **American Hart's-Tongue Fern (*Asplenium scolopendrium* var. *americanum*)**

American hart's-tongue fern is reported to occur in Morgan County, Alabama. In the southern portions of its range, this fern is found only around the openings to limestone caves and sinkholes (NatureServe 2004). No populations have been recorded within 4.8 km (3.0 mi) of BFN, and no suitable cave habitat has been identified along the BFN transmission line rights-of-way.

Because it does not occur at the BFN site or along BFN-associated transmission line rights-of-way, the staff has determined that continued operation of BFN over the 20-year license renewal term will have no effect on the American hart's tongue fern.

### **Leafy Prairie Clover (*Dalea foliosa*)**

Leafy prairie clover is reported to occur in Franklin, Lawrence, and Morgan Counties, Alabama. This species is found in association with cedar glades in northern Alabama and central Tennessee. No populations of leafy prairie clover are known from within 4.8 km (3.0 mi) of

BFN, but suitable habitat could be found along the transmission line rights-of-way. The leafy

prairie clover has been found within 4.8 km (3.0 mi) of the Union transmission line in Colbert County, Alabama (TVA 2004b).

Construction and maintenance of the transmission line rights-of-way are designed to minimize environmental impacts, and transmission line rights-of-way maintenance activities are reviewed for potential resource issues by TVA (Muncy et al. 1999). Access routes and activity restrictions are determined based on knowledge of leafy prairie clover in the area. Mechanical clearing and herbicides may be used for vegetation control on transmission line rights-of-way. Herbicide application is carefully controlled and personnel who apply the herbicides are trained, licensed, and follow manufacturer's guidelines, EPA guidelines, and State regulations.

There is no habitat on the BFN site but suitable habitat could exist along a portion of the Union transmission line in Colbert County, Alabama. After reviewing the TVA maintenance activities, the staff has determined that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the leafy prairie clover.

### **Eggert's Sunflower (*Helianthus eggertii*)**

Eggert's sunflower is reported to occur in Colbert, Franklin, Lawrence, Limestone, and Morgan Counties, Alabama. This species is found in barrens habitat within the Interior Plateau Ecoregion of Kentucky, Tennessee, and Alabama (NatureServe 2004). No populations have been recorded within 4.8 km (3.0 mi) of BFN. Populations may occur along the BFN transmission rights-of-way because the species is reported to respond favorably to management activities such as burning and mowing (NatureServe 2004).

Construction and maintenance of transmission line rights-of-way are designed to minimize environmental impacts (Muncy et al. 1999), and may improve habitat for this species. Transmission line right-of-way maintenance activities are reviewed for potential resource issues by the TVA (Muncy et al. 1999). Access routes and activity restrictions are determined based on knowledge of the Eggert's sunflower in the area. Mechanical clearing and herbicides may be used for vegetation control on transmission line rights-of-way. Herbicide application is carefully controlled and personnel who apply the herbicides are trained, licensed, and follow manufacturer's guidelines, EPA guidelines, and State regulations.

Because there is no habitat on the BFN site and after reviewing the TVA maintenance activities, which may improve habitat along transmission line rights-of-way, the staff determined that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the Eggert's sunflower.

### **Fleshy-Fruited Gladecress (*Leavenworthia crassa*)**

The fleshy-fruited gladecress is listed as a candidate species by FWS and is reported to occur in Lawrence and Morgan Counties, Alabama. Reportedly endemic to Lawrence and Morgan Counties, this species inhabits limestone glades and has been identified from only six sites (NatureServe 2004). No populations have been recorded within 4.8 km (3.0 mi) of BFN, but suitable habitat could be found along the BFN transmission line rights-of-way.

Construction and maintenance of transmission line rights-of-way are designed to minimize environmental impacts (Muncy et al. 1999), and may improve habitat for this species. Transmission line right-of-way maintenance activities are reviewed for potential resource issues by the TVA (Muncy et al. 1999). Access routes and activity restrictions are determined based on knowledge of fleshy-fruited gladecress in the area. Mechanical clearing and herbicide use may be used for vegetation control on transmission line rights-of-way. Herbicide application is carefully controlled and personnel who apply the herbicides are trained, licensed, and follow manufacturer's guidelines, EPA guidelines, and State regulations.

Because there is no habitat on the BFN site and after reviewing the TVA maintenance activities, which may improve habitat along transmission line rights-of-way, the staff determined that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the fleshy-fruited gladecress.

#### **Lyrate Bladder-Pod (*Lesquerella lyrata*)**

Lyrate bladder-pod is reported to occur in Colbert, Franklin, and Lawrence Counties, Alabama. The species is known from only two populations in Franklin and Colbert Counties (FWS 2004b). The plant is an annual in the mustard family and is found in disturbed glade habitats. No populations have been recorded within 4.8 km (3.0 mi) of BFN, but suitable habitat could be found along the BFN transmission line rights-of-way.

Construction and maintenance of transmission line rights-of-way are designed to minimize environmental impacts (Muncy et al. 1999), and may improve habitat for this species. Transmission line right-of-way maintenance activities are reviewed for potential resource issues by the TVA (Muncy et al. 1999). Access routes and activity restrictions are determined based on knowledge of lyrate bladder-pod in the area. Mechanical clearing and herbicide use may be used for vegetation control on transmission line rights-of-way. Herbicide application is carefully controlled and personnel who apply the herbicides are trained, licensed, and follow manufacturer's guidelines, EPA guidelines, and State regulations.

Because there is no habitat on the BFN site and after reviewing the TVA maintenance activities, which may improve habitat along transmission line rights-of-way, the staff determined that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to

adversely affect, the lyrate bladder-pod.

### **Tennessee Yellow-Eyed Grass (*Xyris tennesseensis*)**

Tennessee yellow-eyed grass is reported to occur in Franklin County, Alabama. This species is found in moist-to-wet, limestone-derived soils in open or lightly wooded sites (NatureServe 2004). No populations are known to exist within 4.8 km (3.0 mi) of BFN, but suitable habitat could be found along the BFN transmission line rights-of-way. It has been found within 4.8 km (3.0 mi) of the Union transmission line in Franklin County, Alabama (TVA 2004b).

Construction and maintenance of transmission line rights-of-way are designed to minimize environmental impacts (Muncy et al. 1999), and may improve habitat for this species. Transmission line right-of-way maintenance activities are reviewed for potential resource issues by the TVA (Muncy et al. 1999). Access routes and activity restrictions are determined based on knowledge of Tennessee yellow-eyed grass in the area. Mechanical clearing and herbicides may be used for vegetation control on transmission line rights-of-way. Herbicide application is carefully controlled and personnel who apply the herbicides are trained, licensed, and follow manufacturer's guidelines, EPA guidelines, and State regulations.

Because there is no habitat on the BFN site and after reviewing the TVA maintenance activities, which may improve habitat along transmission line rights-of-way, the staff determined that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the Tennessee yellow-eyed grass.

## **5.2 Aquatic Species**

A total of 38 Federally listed aquatic species on the FWS website are identified as potentially occurring in the project area (i.e. Wheeler Reservoir or in streams crossed by transmission line rights-of-way associated with the BFN site). Nine of these species have a reasonable potential of occurring in the project area and are discussed in Section 5.2.1 below. The remaining 29 species are only briefly discussed in Section 5.2.2 because of presumed extinction or extirpation from the project area, no recent records of collection, or because the habitat of the project area is clearly unsuitable for the species.

### **5.2.1 Species Potentially Occurring in the Project Area**

Nine aquatic species are listed as threatened, endangered, or candidate species by FWS and have a reasonable potential to occur in the project area (i.e., Wheeler Reservoir or within streams crossed by the transmission lines associated with BFN) (Table 2).

#### **Anthony's Riversnail (*Athearnia anthonyi*)**

**Table 2.** (contd)

Anthony's riversnail is Federally listed as endangered throughout its entire range (FWS 1994), except where proposed for establishment as a nonessential experimental population in the free-flowing reach of the Tennessee River from the base of Wilson Dam downstream to the backwaters of Pickwick Reservoir (about 19 km [12 mi]) and the lower 8 km (5 mi) of all tributaries to this reach in Colbert and Lauderdale Counties, Alabama (FWS 2001). It was known to occur in Alabama, Georgia, and Tennessee. It has been extirpated from most of its historic range due to pollution, siltation, and habitat modification or destruction. Many populations were lost when the Tennessee River and the lower reaches of its tributaries were impounded (FWS 1994). Only two populations of Anthony's riversnail are known to survive. The largest of these occurs in the Tennessee River, Jackson County, Alabama, and Marion County, Tennessee, a short distance downstream of Nickajack Dam. This population also extends a short distance into the lower section Sequatchie River, Marion County, Tennessee (FWS 1997b). This population occurs well upstream from the BFN site. The other surviving population is restricted to a relatively short reach of lower Limestone Creek, Limestone County, Alabama (FWS 1997b). Limestone Creek is crossed at three locations by a BFN transmission line and is closely paralleled by the transmission line along two stream segments (TVA 2004b). However, the BFN transmission line does not cross or parallel the lower section of Limestone Creek where the snail is known to occur. Anthony's riversnail inhabits large rivers and the lower reaches of larger creeks, occurring on cobble/boulder substrates in the vicinity of riffles. However, it does not always occur in strongly flowing sections (NatureServe 2004). At the two sites in Limestone

**Table 2.** Federally Listed and Candidate Aquatic Species Potentially Occurring in Wheeler Reservoir or Streams Crossed by the Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 Transmission Line Rights-of-Way.

Scientific Name	Common Name	Status <sup>(a)</sup>	County Listings <sup>(b)</sup>		Habitat
			AL	MS	
<b>Snails</b>					
<i>Athearnia anthonyi</i>	Anthony's riversnail	E	Co Li	--	Large rivers and lower reaches of large creeks on cobble/boulder substrates near riffles.
<i>Campeloma decampi</i>	slender campeloma	E	Li	--	Large creeks in soft sediments (sand or mud) or detritus.
<i>Pyrgulopsis pachyta</i>	armored snail	E	Li	--	Shallow, still water along the edge of pools on tree roots and detritus of creeks.
Scientific Name	Common Name	Status <sup>(b)</sup>	County Listings <sup>(a)</sup>		Habitat

		AL	MS		
Mussels					
<i>Cumberlandia monodonta</i>	spectaclecase	C	Co La Li Mo	--	Large rivers with swiftly flowing water, among boulders in patches of sand, cobble, or gravel in areas where current is reduced.
<i>Epioblasma brevidens</i>	Cumberlandian combshell	E	Co Fr Li	Ti	Coarse sand to mixtures of gravel, cobble and boulder-sized rocks in medium to large rivers; tends to occur at depths less than 1m (3 ft).
<i>Lampsilis abrupta</i>	pink mucket	E	Co La Li Mo	--	Larger rivers in gravel or sand.
<i>Lexingtonia dolabelloides</i>	slabside pearlymussel	C	Co Fr Li	Ti	Moderate to high gradient riffles in medium to large rivers.
<i>Pleurobema plenum</i>	rough pigtoe	E	Co La Li Mo	--	Medium to large rivers in sand or gravel.
Fish					
<i>Etheostoma boschungii</i>	slackwater darter	T	Li	--	Gravel-bottomed pools and runs of creeks and small rivers.

(a) Co = Colbert; Fr = Franklin; It = Itawamba; La = Lawrence; Li = Limestone; Mo = Morgan; Ti = Tishomingo; -- = not listed.

(b) Status: C = candidate, E = endangered, T = threatened.

Sources: ADCNR 2003; Cummings and Mayer 1992; FWS 1990b, 2000b, 2004c; Johnson and Wehrle 2004; MMNS 2002; MNHP 2002; NatureServe 2004; NCWRC 2004; Page and Burr 1991; TVA 2003, 2004a.

Creek where Anthony's riversnail is known to occur, its density reaches several hundred individuals per square meter. However, both Sequatchie and Limestone Creeks have been severely impacted in the past, and continue to be impacted, by siltation and other sources of pollution (e.g., pesticide spraying and mining effluents). A single catastrophic pollution event could potentially destroy all populations of the snail within a creek (FWS 1994, 1997b). A recovery plan for Anthony's riversnail has been prepared (FWS 1997b).

The staff visited the site and reviewed the life history information about Anthony's riversnail. Based on this information, and that previously described for the TVA transmission line rights-of-way maintenance procedures, the staff concludes that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, Anthony's riversnail.

### **Slender Campeloma (*Campeloma decampi*)**

The slender campeloma is Federally listed as endangered throughout its entire range (FWS 2000a). It is known to occur in only several isolated populations along Limestone, Piney, and Round Island Creeks in northern Alabama (NatureServe 2004). All three creeks are crossed by BFN transmission lines. Piney Creek is crossed once, while Round Island and Limestone Creeks are each crossed three times. Segments of Round Island and Limestone Creeks are also closely paralleled by the transmission lines. The slender campeloma has been found within 4.8 km (3.0 mi) of the Trinity, Maury, and Athens transmission lines in Limestone County, Alabama (TVA 2004b). The slender campeloma typically burrows in soft sediment or detritus. Impacts to slender campeloma include siltation and other pollutants from poor land-use practices and waste discharges (FWS 2000a).

The staff visited the site and reviewed the life history information about the slender campeloma. On the basis of this information and information previously described for the TVA transmission line right-of-way maintenance procedures, the staff concludes that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the slender campeloma.

### **Armored Snail (*Pyrgulopsis pachyta*)**

The armored snail (or armored marstonia) is Federally listed as endangered throughout its entire range (FWS 2000a). It is known to occur in Alabama from several isolated sites in Limestone and Piney Creeks near Mooresville, Alabama (NatureServe 2004). Piney Creek was formerly a tributary of Limestone Creek before the construction of Wheeler Reservoir (NatureServe 2004). The BFN transmission lines cross both of these streams. BFN transmission lines cross Limestone Creek at three locations and closely parallels along two segments of the creek. Both streams are crossed several miles upstream from Mooresville. The armored snail has been collected within 4.8 km (3.0 mi) of the Maury transmission line in Limestone County, Alabama (TVA 2004b). The armored snail is found in shallow, still water along the edge of pools on tree roots and detritus. It probably also occurs on mud (NatureServe 2004). Impacts to the armored snail include siltation and other pollutants from poor land-use practices and waste discharges (FWS 2000a).

The staff visited the site and reviewed the life history information about the armored snail. On the basis of this information and information previously described for the TVA transmission line right-of-way maintenance procedures, the staff concludes that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the armored

snail.

### **Spectaclecase (*Cumberlandia monodonta*)**

The spectaclecase is a candidate for Federal listing. Its historic range includes Alabama, Arkansas, Iowa, Indiana, Illinois, Kentucky, Missouri, Nebraska, Ohio, Tennessee, Virginia, and Wisconsin (FWS 2004c). It has been largely reduced to a relatively few disjunct sites. The mussels at some of the sites may no longer be capable of reproduction because of loss of fish hosts or adverse environmental conditions (e.g., hypolimnetic releases from reservoirs) (NatureServe 2004). In Alabama, the spectaclecase is known from Limestone and Morgan Counties. The spectaclecase is usually found in areas with a strong current. In medium-sized rivers, it prefers coarse substrates such as cobble, gravel, or cracks in bedrock. In large rivers, substrates used are typically finer and include sand or mud. The spectaclecase may be associated with shoals, bars, and islands (NatureServe 2004). It is often found in small clusters of the same-aged individuals (NatureServe 2004). Fish hosts for the spectaclecase are unknown (Schulz and Marbain 1998). Live specimens have been collected in the main stem of the Tennessee River in Colbert, Lauderdale, Limestone, and Morgan Counties as recently as 2000. Recent collections in the mainstem of the Tennessee River have been made in the tailwaters downstream of dams. Weathered shells were collected in the Elk River, Limestone County, Alabama, in 1998 and 1974 (Butler 2002).

The staff visited the site and reviewed the life history information about the spectaclecase. On the basis of this information and information previously described for the TVA transmission line right-of-way maintenance procedures, the staff concludes that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the spectaclecase.

### **Cumberlandian Combshell (*Epioblasma brevidens*)**

The Cumberlandian combshell is Federally listed as endangered throughout its entire range (FWS 1997a), except where proposed for establishment as a nonessential experimental population in the free-flowing reach of the Tennessee River from the base of Wilson Dam downstream to the backwaters of Pickwick Reservoir (about 19 km [12 mi]) and the lower 8 km (5 mi) of all tributaries to this reach in Colbert and Lauderdale Counties, Alabama (FWS 2001). A draft recovery plan has been prepared for the species (FWS 2003). The Cumberlandian combshell is known to occur in Alabama, Kentucky, Tennessee, and Virginia (FWS 1997a). The Cumberlandian combshell is now restricted to populations in limited areas of five drainages, and some of these may no longer be reproducing. The species was eliminated from much of its historic range by impoundments. Existing populations are in decline due to pollution (especially from mining activities), impoundments, and siltation (FWS 1997a). It was last collected from Muscle Shoals (the area now incorporated within the upper reaches of Pickwick Reservoir through Wilson Reservoir and into Wheeler Reservoir) in 1925 (Garner 1997). The Cumberlandian combshell is typically associated with riffle and shoal areas in medium and large rivers in substrates of coarse sand to cobble. It has been apparently eliminated from the main

stem of the Tennessee and Cumberland Rivers (FWS 2004d). In Alabama, moribund specimens were found in the late 1990s in Bear Creek, a tributary of the Tennessee River (NatureServe 2004). Fish hosts for the Cumberlandian combshell include darters and sculpins (Schulz and Marbain 1998). Critical habitat has been designated for the species within the Tennessee and Cumberland River basins, including a portion of Bear Creek that flows through Colbert County, Alabama, and Tishomingo County, Mississippi (FWS 2004d). One of the BFN transmission lines crosses Bear Creek in Tishomingo County, Mississippi, within the proposed reach of critical habitat.

The staff visited the site and reviewed the life history information about the Cumberlandian combshell. On the basis of this information, information previously provided on the aquatic resources within the Wheeler Reservoir, and information previously described for the TVA transmission line right-of-way maintenance procedures, the staff concludes that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the Cumberlandian combshell.

### **Pink Mucket (*Lampsilis abrupta*)**

The pink mucket is Federally listed as endangered throughout its entire range (FWS 1976). It is known to occur in Alabama, Arkansas, Illinois, Indiana, Kentucky, Louisiana, Missouri, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia (NatureServe 2004). It is apparently surviving and reproducing in river segments that have been altered by impoundments; however, its range has diminished (e.g., it has been extirpated from Ohio, Pennsylvania, and Illinois) (NatureServe 2004). Within Alabama, the pink mucket occurs in Colbert, Lauderdale, Limestone, Madison, Marshall, and Morgan Counties (NatureServe 2004). Suitable hosts for the glochidia of the pink mucket include freshwater drum, largemouth bass, smallmouth bass, spotted bass, sauger, and walleye (Fuller 1974; Barnhart et al. 1997). Use of mostly piscivorous hosts by this mussel is consistent with the display of a relatively large fish-like lure used by the mussel to attach hosts (Barnhart et al. 1997). The pink mucket inhabits areas of large rivers with swift currents at depths ranging from 0.5 to 8.0 m (1.6 to 26.2 ft) and mixed sand/gravel/cobble substrate (Barclay 2004). They are generally collected in the tailwater areas downstream from the Tennessee River drainage dams (Barclay 2004). Therefore, it is unlikely that the pink mucket exists in Wheeler Reservoir in the areas near or downstream from BFN. The pink mucket has been found within 4.8 km (3.0 mi) of the Union transmission line in Lawrence County, Alabama (TVA 2004b). Sixteen specimens of the pink mucket were collected near Hobbs Island (over 64 km [40 mi] upstream of BFN) in 1998 (Yokely 1998). Past and ongoing threats to the pink mucket include habitat loss and modification from dams and dredging, water quality degradation, and commercial over-harvesting (NatureServe 2004). The zebra mussel would also pose a threat to the pink mucket in areas where they co-exist.

The staff visited the site and reviewed the life history information about the pink mucket. On the basis of this information, information previously provided on the aquatic resources in Wheeler Reservoir, and information previously described for the TVA transmission line right-of-way maintenance procedures, the staff concludes that continued operation of BFN over the 20-year

license renewal term may affect, but is not likely to adversely affect, the pink mucket.

### **Slabside Pearlymussel (*Lexingtonia dolabelloides*)**

The slabside pearlymussel is a candidate for Federal listing. Its historic range includes Alabama, Kentucky, Tennessee, and Virginia (FWS 2004c). Most surviving individuals are restricted to two or three populations; and the long-term viability of all extant occurrences is questionable (NatureServe 2004). It historically occurred in the Cumberland River, although it is now extirpated from the entire Cumberland River system. The slabside pearlymussel was once prevalent in the Tennessee River system. Historically, it was fairly common from Muscle Shoals (the area is now incorporated within the upper reaches of Pickwick Reservoir through Wilson Reservoir and into Wheeler Reservoir) to the Tennessee River headwater tributaries in Virginia and the Duck River drainage. It was last collected from Muscle Shoals in 1963 (Garner 1997). Remaining populations occur in a number of tributary streams of the Tennessee River system, but not in the main stem of the Tennessee River (NatureServe 2004). Bear Creek is the only one of these streams that is crossed by a BFN transmission line. Fish hosts for the slabside pearlymussel include the smallmouth bass and, possibly, various minnow species (Schulz and Marbain 1998). Threats to the species include channel alterations, impoundments, siltation, pollution, commercial clamming, and gravel and coal mining (NatureServe 2004). It is generally found in areas of moderate to swift current velocities with substrates ranging from coarse sand to heterogenous assemblages of larger-sized particles (NatureServe 2004).

The staff visited the site and reviewed the life history information about the slabside pearlymussel. On the basis of this information, information previously provided on the aquatic resources within the Wheeler Reservoir, and information previously described for the TVA transmission line rights-of-way maintenance procedures, the staff concludes that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the slabside pearlymussel.

### **Rough Pigtoe (*Pleurobema plenum*)**

The rough pigtoe is Federally listed as endangered throughout its entire range (FWS 1976). It has a wide, but very fragmented, distribution in Alabama, Indiana, Kentucky, Pennsylvania, Tennessee, and Virginia (NatureServe 2004). The distribution of the rough pigtoe in Alabama includes Colbert, Lauderdale, Limestone, and Morgan Counties. Within the Tennessee River, the rough pigtoe is currently present in tailwaters downstream of Pickwick, Wilson, and Guntersville Dams (NatureServe 2004). The rough pigtoe occurs in medium to large rivers in sand, gravel, and cobble substrates in shoals, although it is occasionally found on flats and muddy sand (NatureServe 2004). It does not occur in the impounded sections of rivers (FWIE 1996). Therefore, it is unlikely that the rough pigtoe exists in Wheeler Reservoir in the areas near or downstream from BFN. One specimen was collected near Hobbs Island (over 64 km [40 mi] upstream of BFN) in 1998 (Yokely 1998). Possible host fish for the rough pigtoe are bluegill and rosefin shiner (*Lythrurus ardens*) (Schulz and Marbain 1998). The long-term

viability of most populations is in jeopardy, particularly for those in large rivers where zebra mussels are established (NatureServe 2004). Other threats to the rough pigtoe include impoundments, channelization, dredging, industrial and residential discharges, siltation, herbicide and fertilizer run-off, loss of fish hosts, and natural predators (NatureServe 2004).

The staff visited the site and reviewed the life history information about the rough pigtoe. On the basis of this information and information previously described for the TVA transmission line right-of-way maintenance procedures, the staff concludes that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the rough pigtoe.

### **Slackwater Darter (*Etheostoma boschungii*)**

The slackwater darter is Federally listed as threatened throughout its entire range (FWS 1977b). Critical habitat was also designated for the species (FWS 1977b). It is known to occur in Alabama and Tennessee. The slackwater darter occupies five tributaries of the Tennessee River: Buffalo River and upper Shoal Creek in Lawrence County, Tennessee; Flint River, Madison County, Alabama; Swan Creek, Limestone County, Alabama, and Cypress Creek, Lauderdale County, Alabama (NatureServe 2004). Swan Creek is crossed by the Maury transmission line. The slackwater darter has been found within 4.8 km (3.0 mi) of the Trinity and Maury transmission lines in Limestone County, Alabama (TVA 2004b). Critical habitat for the slackwater darter includes many of the permanent and intermittent streams that are tributaries to Cypress Creek in Lauderdale County, Alabama, and Wayne County, Tennessee (FWS 1977b). None of these streams are located near BFN transmission lines. The slackwater darter typically occurs in gravel-bottomed pools in sluggish areas of creeks and small rivers that are not more than 12 m (39 ft) wide and 2 m (6.6 ft) deep. They often inhabit slow waters beneath undercut banks or accumulations of leaf litter or detritus. Spawning occurs in very shallow (5 to 10 cm [2 to 4 in.]) clear, flowing seepage water characterized by the presence of *Juncus* spp. and *Eleocharis* spp. in fields and open woods. Threats to the species include habitat loss and degradation. In some locations, the heavy use of groundwater causes seepage areas used for spawning to dry up (NatureServe 2004).

The staff visited the site and reviewed the life history and distribution of the slackwater darter. On the basis of this information and information provided by TVA, the staff concludes that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the slackwater darter.

### **5.2.2 Additional Aquatic Species**

In addition to the nine species discussed above, there are 29 additional Federally listed aquatic species (including one candidate species) whose distribution includes, or historically included, the Wheeler Reservoir portion of the Tennessee River or other streams, rivers, or caves within the counties of Alabama and Mississippi within which the BFN transmission lines occur (Table 3). However, these 29 species would not currently be expected to occur within Wheeler Reservoir near or downstream of BFN (i.e., the portions of the Tennessee River that could be affected by BFN operations) or within the streams crossed by the transmission lines associated

with BFN. The rationale for this determination is based on the following: (1) the species are presumed extinct; (2) the species are presumed to be extirpated from the region; (3) there are no recent records of the species in the BFN project area; (4) there are no collection records for the species from pertinent locations; and/or (5) project areas of concern do not have appropriate habitat for the species (e.g., county records are for streams or caves that are not crossed by the BFN transmission lines). The notes column of Table 3 provides the rationale for each species. The staff reviewed the design, operation, and location of the intake and discharge structures at BFN and the impingement and entrainment data collected during plant operation. The staff also visited the site and reviewed the life history information about these 29 species. On the basis of this information, information previously provided on the aquatic resources within the Wheeler Reservoir, and information previously described for the TVA transmission line rights-of-way maintenance procedures, the staff concludes that continued operation of BFN over the 20-year license renewal Term would have no effect on these species. Therefore, these species are not evaluated in any detail in this BA.

## 5.0 Conclusions

The staff identified nine terrestrial and nine aquatic species listed as threatened, endangered, or candidate under the Endangered Species Act that have a reasonable potential to occur in the vicinity of BFN or along the transmission line rights-of-way (including Wheeler Reservoir near and downstream of BFN and within streams crossed by the BFN transmission lines). Two terrestrial species were evaluated and determined that they would not occur in the project area. In addition, 29 aquatic species listed by FWS were identified by the staff as having no reasonable potential to occur in the project areas and were not evaluated in detail.

None of the terrestrial or aquatic species are known to inhabit areas within 4.8 km (3.0 mi) of BFN. The transmission line rights-of-way may cross or contain suitable habitat for some of these species, including designated critical habitat for the Cumberlandian combshell. Given this possibility, TVA has designed and implemented maintenance procedures for its transmission line rights-of-way that protect listed species and their habitats.

**Table 3.** Federally Listed Aquatic Species in Northwestern Alabama and Northeastern Mississippi that are Considered Unlikely to be Present Near the Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 Site or Its Transmission Line Rights-of-Way.

Scientific Name (Common Name)	Status <sup>(b)</sup>	County Listings <sup>(a)</sup>		Notes
		AL	MS	

**Mussels**

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<i>Cyprogenia stegaria</i> (fanshell)	E	Co	--	Relatively deep water in gravelly substrates with moderate currents in medium to large rivers. Last collected in Muscle Shoals <sup>(c)</sup> circa 1976 to 1978. Live specimen last reported from Wheeler Reservoir in 1979. Possibly extirpated from Alabama.
<i>Dromus dromas</i> (dromedary pearlymussel)	E	Co Li Mo	--	Sand and gravel substrates in riffles and shoals of medium to large rivers. Last collected in Muscle Shoals in 1931. Only current Tennessee River records are from Meigs County, Tennessee. Possibly extirpated from Alabama.
<i>Epioblasma capsaeformis</i> (oyster mussel)	E	Co	--	Usually in small- to medium-sized rivers in substrates of coarse sand to boulder substrates in moderate to swift currents. Last collected from Muscle Shoals circa 1925. No longer present in the mainstem of the Tennessee River. Presumed extirpated from Alabama.
<i>Epioblasma florentina florentina</i> (yellow-blossom pearlymussel)	E	Co	--	Riffle and shoal areas of small-sized to medium-sized streams. Last collected from Muscle Shoals circa 1925. Not collected anywhere since 1970. Possibly extinct.
<i>Epioblasma florentina walkeri</i> (tan riffleshell)	E	Li	--	Headwaters, riffles, and shoals in sand and gravel substrates. Only one reproducing population known (Indian Creek of the upper Clinch River, Virginia). Presumed extirpated from Alabama.

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Table 3. (contd)

Scientific Name (Common Name)	Status <sup>(b)</sup>	County Listings <sup>(a)</sup>		Notes
		AL	MS	
<i>Epioblasma penita</i> (Southern combshell)	E	--	It	Riffles or shoals of medium-sized rivers with sandy gravel to gravel-cobble substrates in moderate to swift current. Currently limited to the East Fork Tombigbee River, Sipsey River, and Buttahatchie River, well south of the BFN project area. Presumed extirpated from Alabama.
<i>Epioblasma torulosa</i> <i>torulosa</i> (tubercled blossom pearlymussel)	E	Co Li Mo	--	Sandy gravel substrates in riffles and shoals in rapid currents of medium to large rivers. Last collected from Muscle Shoals in 1931. Presumed extirpated from Alabama, species possibly extinct.
<i>Epioblasma turgidula</i> (turgid blossom pearlymussel)	E	Co Fr	--	Sand and gravel substrates of shallow, fast-flowing streams. Last collected from Muscle Shoals circa 1925. Not collected anywhere since the mid-1960s, possibly extinct.
<i>Fusconaia cor</i> (shiny pigtoe)	E	Co	--	Shoals and riffles in clear streams with moderate to fast current. Last collected from Muscle Shoals circa 1925. No recent collections from the Tennessee River or its tributaries that are crossed by the BFN transmission lines. Currently exists in the North Fork of the Holston River, the Clinch and Powell Rivers in Tennessee, and in the Paint Rock River in Alabama.
<i>Fusconaia cuneolus</i> (finerayed pigtoe)	E	Fr Li	--	Firm cobble and gravel substrates of clear, high-gradient streams. Last collected from Muscle Shoals circa 1925. No recent collections from the Tennessee River or its tributaries that are crossed by the BFN transmission lines. Currently persists in Clinch and Powell Rivers, the North Fork of the Holston River, and in the Paint Rock River.

**Table 3.** (contd)

Scientific Name (Common Name)	Status <sup>(b)</sup>	County Listings <sup>(a)</sup>		Notes
		AL	MS	
<i>Hemistena lata</i> (cracking pearlymussel)	E	Co Li	--	Sand, gravel and cobble substrates in swift currents or mud and sand in slower currents of medium to large rivers. Last collected from Muscle Shoals circa 1925. Presumed extirpated from Alabama. May exist in the Clinch River, Tennessee.
<i>Lampsilis perovalis</i> (orangenacre mucket)	T	--	It	Medium and large rivers in gravel/cobble or gravel/coarse sand substrates. Survives in a few Tombigbee, Black Warrior, and Alabama River tributaries well south of the BFN transmission lines.
<i>Lampsilis virescens</i> (Alabama lampmussel)	E	Co Fr	--	Sand and gravel substrates in shoal areas of medium to large rivers. Last collected from Muscle Shoals circa 1925. Extirpated from most of its range. Only one live specimen found in recent years from Paint Rock River drainage in Jackson County, Alabama, well upstream from the BFN project area.
<i>Lemiox rimosus</i> (birdwing pearlymussel)	E	Co Li	--	Riffle areas with sand and gravel substrates in moderate to fast currents of creeks to medium-sized rivers. Last collected from Muscle Shoals circa 1925. Presumed extirpated from Alabama. Only a few known occurrences in the Clinch, Powell, Elk, and Duck Rivers in Tennessee and Virginia.
<i>Obovaria retusa</i> (ring pink)	E	Co Li Mo	--	Gravel and sand bars of large rivers. Last collected from Muscle Shoals in 1992. Empty shells collected from Wheeler Reservoir in 1991. Possibly extirpated from Alabama.
<i>Plethobasus cicatricosus</i> (white wartyback pearlymussel)	E	Co	--	Gravel substrates of large rivers. No living specimens found in the Tennessee River since the 1960s, although fresh dead specimens collected in 1979 and 1982 downstream of Pickwick Dam near Savannah, Tennessee. Possibly extinct.

**Table 3.** (contd)

Scientific Name (Common Name)	Status <sup>(b)</sup>	County Listings <sup>(a)</sup>		Notes
		AL	MS	
<i>Plethobasus cooperianus</i> (orangefoot pimpleback)	E	Co Li Mo	--	Sand, gravel, and cobble substrates in riffles and shoals in deep water and steady current of large rivers. Last collected from Muscle Shoals in 1978. Possibly extirpated from Alabama.
<i>Pleurobema clava</i> (clubshell)	E	Co	--	Medium to large rivers in clean gravel or mixed gravel and sand. Last collected from Muscle Shoals circa 1925. Presumed extirpated from Alabama.
<i>Pleurobema curtum</i> (black clubshell)	E	--	It	Sandy gravel to gravel-cobble substrates in riffles and shoals with moderate to fast currents in medium to large rivers. Current range limited to the East Fork Tombigbee River. Possibly extinct.
<i>Pleurobema decisum</i> (southern clubshell)	E	--	It	Sand and gravel substrates of medium to large rivers. Very few viable populations occur in the Sipsey River (Tombigbee River drainage), Chewacla Creek (Tallapoosa River drainage), and the Conasauga River (upper Coosa River drainage); all three waterbodies located well outside the BFN project area. It does not occur in the Tennessee River drainage.
<i>Pleurobema perovatum</i> (ovate clubshell)	E	--	It	Moderate gradient pools and riffles of medium to large rivers. Currently found in Tombigbee River tributaries and Chewacla Creek in the Tallapoosa River drainage. It does not occur in the Tennessee River drainage.
<i>Pleurobema taitianum</i> (heavy pigtoe)	E	--	It	Riffles and shoals on sandy gravel to gravel-cobble substrates in areas of moderate to fast currents of medium to large rivers. Not known from the Tennessee River drainage. Currently only found in the Alabama River in Dallas and Lowndes Counties, Alabama.

**Table 3.** (contd)

Scientific Name (Common Name)	Status <sup>(b)</sup>	County Listings <sup>(a)</sup>		Notes
		AL	MS	
<i>Ptychobranchus subtentum</i> (fluted kidneyshell)	C	Li	--	Small to medium rivers in areas with swift current or riffles; larger rivers in shoal areas. Last collected from Muscle Shoals circa 1925. Presumed extirpated from Alabama.
<i>Quadrula intermedia</i> (Cumberland monkeyface)	E	Co Li	--	Sand and gravel substrates in shallow riffle and shoal areas of headwater streams to bigger rivers at depths to 0.6 m (2 ft). Last collected from Muscle Shoals circa 1925. Possibly extirpated from Alabama.
<i>Toxolasma cylindrellus</i> (pale lilliput)	E	Co	--	Firm rubble, gravel, and sand substrates in shallow riffles and shoals of clean, fast-flowing streams. Currently known only from the Paint Rock River drainage in Jackson County, Alabama, well upstream from the BFN project area.
<i>Villosa trabalis</i> (Cumberland bean)	E	Mo	--	Sand, gravel, and cobble substrates in waters of moderate to swift currents and depths less than 1m (3 ft) in medium to large rivers. Last collected from Muscle Shoals circa 1925. Presumed extirpated from Alabama.
<b>Shrimp</b>				
<i>Palaemonias alabamae</i> (Alabama cave shrimp)	E	Co	--	Silt-bottom pools in caves. Currently known to occur in two caves in Madison County, Alabama. No BFN transmission lines occur near these caves.
<b>Fishes</b>				
<i>Cyprinella monacha</i> (spotfin chub)	E	Co	--	Rocky riffles and runs of clean small to medium riffles. Currently only known to exist in Tennessee and North Carolina. It is possibly extirpated from Alabama.
<i>Etheostoma wapiti</i> (boulder darter)	E	Li	--	Fast, rocky riffles of small to medium rivers. Presently restricted to the Elk River in Tennessee and Alabama, and Richland and Indian Creeks in Giles County, Tennessee. No BFN transmission lines cross these waterbodies.

**Table 3. (contd)**

Scientific Name (Common Name)	Status <sup>(b)</sup>	County Listings <sup>(a)</sup>		Notes
		AL	MS	
<p>(a) Co = Colbert; Fr = Franklin; It = Itawamba; La = Lawrence; Li = Limestone; Mo = Morgan. Ti = Tishomingo; – = not listed.</p> <p>(b) Status: C = candidate, E = endangered, T = threatened.</p> <p>(c) Muscle Shoals is the area now incorporated within the upper reach of Pickwick Reservoir, through Wilson Reservoir, and into Wheeler Reservoir.</p> <p>Sources: ADCNR 2003; Ahlstedt and McDonough 1992; Cummings and Mayer 1992; FWS 1976, 1977a, b, 1987b, 1988a, b, 1989a, b, 1990a, b, c, 1993a,b, 1997a, 2000b, 2004c; Garner 1997; Johnson and Wehrle 2004; MMNS 2002; MNHP 2002; NatureServe 2004; NCWRC 2004; Page and Burr 1991; Rogers et al. 2001; TVA 2003, 2004a.</p>				

The staff has determined that license renewal for BFN would have no effect on the red-cockaded woodpecker, the American hart's tongue fern, and 29 of the aquatic species. License renewal may affect, but is not likely to adversely affect, the bald eagle, gray bat, Indiana bat, Price's potato bean, leafy prairie clover, Eggert's sunflower, fleshy-fruited gladecress, lyrate bladder pod, Tennessee yellow-eyed grass, Anthony's riversnail, slender campeloma, armored snail, spectaclecase, Cumberlandian combshell, pink mucket, slabside pearlymussel, rough pigtoe, and the slackwater darter.

## 6.0 References

10 CFR Part 51. Code of *Federal Regulations*, Title 10, *Energy*, Part 51, “Environmental Protection Regulations for Domestic Licensing and Regulatory Requirements.”

10 CFR Part 54. Code of *Federal Regulations*, Title 10, *Energy*, Part 51, “Requirements for Renewal of Operating Licenses for Nuclear Power Plants.”

Ahlstedt, S. A. and T. A. McDonough. 1992. “Quantitative Evaluation of Commercial Mussel Populations in the Tennessee River Portion of Wheeler Reservoir of Wheeler Reservoir, Alabama.” Tennessee River Authority, Norris and Knoxville, Tennessee. Available on the Internet under Accession No. ML041530161, May 27, 2004 at <http://www.nrc.gov/reading-rm/adams.html>.

Alabama Department of Conservation and Natural Resources (ADCNR). 2003. “County-by-County Listing of Alabama Species on the Federal List for Threatened and Endangered Species or Whose Status Is a Concern.” Alabama Department of Conservation and Natural Resources, Montgomery, Alabama. Accessed on the Internet, March 25, 2004 at <http://dcnr.state.al.us/watchable-wildlife/regulations/endangered-county.cfm>.

Alabama Department of Environmental Management (ADEM). 2003. NPDES Permit Modification Rationale Fact Sheet. Revised August, 13, 2003, Montgomery, Alabama.

Atomic Energy Act of 1954. 42 USC 2011, et seq.

Barclay, L. A. 2004. *Biological Opinion of the Tennessee Valley Authority’s Proposed Reservoir Operation Study*. U.S. Fish and Wildlife Service, Tennessee Ecological Services Field Office, Cookeville, Tennessee.

Barnhart, M. C., F. A. Riusech, and A. D. Roberts. 1997. “Fish Hosts of the Federally Endangered Pink Mucket, *Lampsilis abrupta*.” Triannual Unionid Report No. 13. Accessed on the Internet, January 19, 2004 at <http://ellipse.inhs.uiuc.edu/FMCS/TUR/TUR13.html>.

Baxter, D. S. and J. P. Buchanan. 1998. *Browns Ferry Nuclear Plant Thermal Variance Monitoring Program Including Statistical Analyses. Final Report*. Tennessee Valley Authority, Water Management Environmental Compliance. Available on the Internet under ADAMS Accession No. ML041530161, May 27, 2004, at <http://www.nrc.gov/reading-rm/adams.html>.

Butler, R. S. (Leader). 2002. “Status Assessment Report for the Spectaclecase, *Cumberlandia monodonta*, Occurring in the Mississippi River System (U.S. Fish and Wildlife Service Regions 3, 4, 4, and 6).” U.S. Fish and Wildlife Service, Ohio River Valley Ecosystem Team, Mollusk Subgroup, Asheville, North Carolina. Accessed on the Internet, January 20, 2004 at <http://midwest.fws.gov/endangered/clams/spectaclecase-sa.pdf>.

Carroll, B. B. 1982. Letter from B. B. Carroll, Chief, Fisheries and Aquatic Ecology Branch, Division of Water Resources, to L. W. Colaw, Assistant Director, Industrial Development, Office of Economic and Community Development, Subject: "Mallard-Fox Mussel Survey - Report." September 30, 1982. Available on the Internet under ADAMS Accession No. ML041530161, May 27, 2004, at <http://www.nrc.gov/reading-rm/adams.html>.

Cummings, K. S. and C. A. Mayer. 1992. "Field Guide to Freshwater Mussels of the Midwest. Illinois Natural History Survey, Manual 5." Illinois Natural History Survey, Urbana, Illinois. Accessed on the Internet, March 15, 2004 at [http://www.inhs.uiuc.edu/chf/pub/mussel\\_man/cover.html](http://www.inhs.uiuc.edu/chf/pub/mussel_man/cover.html).

Endangered Species Act of 1973. 16 USC 1531, et seq.

Fish and Wildlife Information Exchange (FWIE). 1996. "Endangered Species Information System." Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Accessed on the Internet, May 20, 2004 at <http://fwie.fw.vt.edu/WWW/esis/index.html>.

Fuller, S. L. H. 1974. "Clams and Mussels (Mollusca: Bivalvia)." In *Pollution Ecology of Freshwater Invertebrates*, Hart, C. W., Jr. and S. L. H. Fuller (eds.), Chapter 8, Academic Press, Inc.

Garner, J. T. 1997. "Mussels of Muscle Shoals." *Triannual Unionid, Report Number 13*. Accessed on the Internet, March 25, 2004 at <http://ellipse.inhs.uiuc.edu/FMCS/TUR/TUR13.html>.

Hopping, P.N. 2004. "Heat Rejection and Water Flows." Email of model results to C.L. Wilson and A. Stegen, Tennessee Valley Authority Environmental Hydraulics, May 2004, Knoxville, Tennessee. Available on the Internet under ADAMS Accession No. ML041530161, dated May 27, 2004, at <http://www.nrc.gov/reading-rm/adams.html>.

Johnson, R. and B. Wehrle. 2004. "Threatened and Endangered Species of Alabama: A Guide to Assist with Forestry Activities. Invertebrates." Private Forest Management Team, Auburn University, Auburn, Alabama. Accessed on the Internet, January 20, 2004 at <http://www.pfmt.org/wildlife/endangered/invertebrates.htm>.

Mississippi Museum of Natural Science (MMNS). 2002. "Natural Heritage Inventory: Search Animal Database." Jackson, Mississippi. Accessed on the Internet, March 17, 2004 at [http://www.mdwfp.com/museum/html/research/query\\_animals.asp?cntyID=71](http://www.mdwfp.com/museum/html/research/query_animals.asp?cntyID=71).

Mississippi Natural Heritage Program (MNHP). 2002. "Endangered Species of Mississippi." Museum of Natural Science, Mississippi Department of Wildlife, Fisheries, and Parks, Jackson, Mississippi. Accessed on the Internet, March 25, 2004 at <http://www.mdwfp.com/museum/html/heritage/tandelist.pdf>.

Muncy, J. A., C. Austin, C. Brewster, A. Lewis, K. Smithson, T. Broyles, and T. Wojtalik. 1999. *A Guide for Environmental Protection and Best Management Practices for Tennessee Valley Authority Transmission Construction and Maintenance Activities*. Chattanooga, Tennessee.

NatureServe. 2004. "NatureServe Explorer: An Online Encyclopedia of Life." Version 3.1, NatureServe, Arlington, Virginia. Accessed on the Internet, May 26, 2004 at <http://www.natureserve.org/explorer>.

North Carolina Wildlife Resources Commission (NCWRC). 2004. "North Carolina Freshwater Mussels – Species Information and Status." North Carolina Wildlife Resources Commission, Nongame and Endangered Wildlife Program, Raleigh, North Carolina. Accessed on the Internet, March 26, 2004 at [http://www.ncwildlife.org/fs\\_index\\_07\\_conservation.htm](http://www.ncwildlife.org/fs_index_07_conservation.htm).

Page, L. M. and B. M. Burr. 1991. *A Field Guide to Freshwater Fishes*. Houghton Mifflin Company, Boston, Massachusetts.

Pryor, R. J. 1982. Letter from R. J. Pryor, Program Manager, Aquatic Resource Protection, Fisheries and Aquatic Ecology Branch, Division of Water Resources, TVA, to J. D. Henson, Supervisor, Radiological and Environmental Protection Section, Controls and Test Branch, Division of Nuclear Power, TVA, Subject: "Browns Ferry Nuclear Plant (BFNP) – Proposed Barge Facility." April 13, 1982. Available on the Internet under ADAMS Accession No. ML041530161, May 27, 2004, at <http://www.nrc.gov/reading-rm/adams.html>.

Rogers, S. O., B. T. Watson, and R. J. Neves. 2001. "Life History and Population Biology of the Endangered Tan Riffleshell (*Epioblasma Florentina Walkeri*) (Bivalvia: Unionidae)." *Journal of the North American Benthological Society* 20(4):582-594.

Schulz, C. and K. Marbain. 1998. "A List of Host Species for Rare Freshwater Mussels in Virginia." Triannual Unionid Report No. 15. Accessed on the Internet, January 19, 2004 at <http://ellipse.inhs.uiuc.edu/FMCS/TUR/TUR15.html>.

Tennessee Valley Authority (TVA). 1972. *Final Environmental Statement Browns Ferry Nuclear Plant Units 1, 2, and 3*. Office of Health and Environmental Science, Chattanooga, Tennessee.

Tennessee Valley Authority (TVA). 1978. "Biological Effects of Intake Browns Ferry Nuclear Plant. Volume 4: Effects of the Browns Ferry Nuclear Plant Cooling Water Intake on the Fish Populations of Wheeler Reservoir." Tennessee Valley Authority, Division of Forestry, Fisheries, and Wildlife Development, Fisheries and Waterfowl Resources Branch, Norris, Tennessee. Available on the Internet under ADAMS Accession No. ML041530161, May 27, 2004, at <http://www.nrc.gov/reading-rm/adams.html>.

Tennessee Valley Authority (TVA). 2002a. *Final Supplemental Environmental Impact Statement for Operating License Renewal of the Browns Ferry Nuclear Plant in Athens, Alabama*. Tennessee Valley Authority. Chattanooga, Tennessee.

Tennessee Valley Authority (TVA). 2002b. "Sport Fishing Index Ratings." Accessed on the Internet <http://www.tva.gov/environment/water/sportfish.htm> on January 19, 2004.

Tennessee Valley Authority (TVA). 2003. *Applicant's Environmental Report – Operating License Renewal Stage Browns Ferry Nuclear Plant Units 1, 2, and 3*. Tennessee Valley Authority, License Nos. 50-259, 50-260, and 50-296, Tennessee Valley Authority, Knoxville, Tennessee.

Tennessee Valley Authority (TVA). 2004a. *Final Programmatic Environmental Impact Statement Tennessee Valley Authority Reservoir Operations Study Volume 1 – Environmental Impact Study*. Tennessee Valley Authority, Chattanooga, Tennessee.

Tennessee Valley Authority (TVA). 2004b. Email from Chuck Wilson, Tennessee Valley Authority, to Mike Sackschewsky, Pacific Northwest National Laboratory. Available on the Internet under ADAMS accession no. ML042520143, September 2, 2004, at <http://www.nrc.gov/reading-rm/adams.html>.

Tennessee Valley Authority (TVA). 2004c. *Browns Ferry Nuclear Plant (BFN), Unit 1, Proposed Technical Specifications (TS) Change TS-431, Request for License Amendment for Extended Power Uprate Operation, Browns Ferry Unit 1 Extended Power Uprate Environmental Report*. Tennessee Valley Authority, Decatur, Alabama.

U.S. Environmental Protection Agency (EPA). 2004. "Ecoregions of Alabama and Georgia." Accessed on the Internet, May 11, 2004 at [http://www.epa.gov/wed/pages/ecoregions/alga\\_eco.htm](http://www.epa.gov/wed/pages/ecoregions/alga_eco.htm).

U.S. Fish and Wildlife Service (FWS). 1976. "Endangered and Threatened Wildlife and Plants; Endangered Status for 159 Taxa of Animals." *Federal Register* 41(115):24062-24067.

U.S. Fish and Wildlife Service (FWS). 1977a. "Determination that the Tan Riffle Shell Is an Endangered Species." *Federal Register* 42(163):42351-42353.

U.S. Fish and Wildlife Service (FWS). 1977b. "Final Threatened Status and Critical Habitat for Five Species of Southeastern Fishes." *Federal Register* 42(175):45526-45530.

U.S. Fish and Wildlife Service (FWS). 1987a. *Habitat Guidelines for the Bald Eagle in the Southeast Region*, Revision 3, Atlanta, Georgia.

U.S. Fish and Wildlife Service (FWS). 1987b. "Endangered and Threatened Wildlife and Plants; Endangered Status for Marshall's Mussel (*Pleurobema marshalli*), Curtus' Mussel

(*Pleurobema curtum*), Judge Tait's Mussel (*Pleurobema taitianum*), the Stirrup Shell (*Quadrula stapes*), and the Penitent Mussel (*Epioblasma (=Dysnomia) penita*)." *Federal Register* 52(66):311162-11169.

U.S. Fish and Wildlife Service (FWS). 1988a. "Endangered and Threatened Wildlife and Plants: Determination of Endangered Species Status for the Boulder Darter." *Federal Register* 53(170):33996-33998.

U.S. Fish and Wildlife Service (FWS). 1988b. "Endangered and Threatened Wildlife and Plants; Endangered Status for the Alabama Cave Shrimp, *Palaemonias Alabamae*." *Federal Register* 53(173):34696-34698.

U.S. Fish and Wildlife Service (FWS). 1989a. "Endangered and Threatened Wildlife and Plants: Designation of the Cracking Pearly-Mussel as an Endangered Species." *Federal Register* 54(187):39850-39853.

U.S. Fish and Wildlife Service (FWS). 1989b. "Endangered and Threatened Wildlife and Plants: Designation of the Ring Pink Mussel as an Endangered Species." *Federal Register* 54(188):40109-40112.

U.S. Fish and Wildlife Service (FWS). 1990a. "Fanshell (*Cyprogenia stegaria* [= *C. irrorta*])." U.S. Fish and Wildlife Service, Region 4 (Southeast Region), Atlanta, Georgia. Accessed on the Internet, May 24, 2004 at <http://endangered.fws.gov/i/f/saf14.html>.

U.S. Fish and Wildlife Service (FWS). 1990b. "Endangered and Threatened Wildlife and Plants: Designation of the Freshwater Mussel, the Fanshell, as an Endangered Species." *Federal Register* 55(120):25591-25596.

U.S. Fish and Wildlife Service (FWS). 1990c. "Species Accounts. Alabama Cave Shrimp *Palaemonias (sic) alabamiae*." U.S. Fish and Wildlife Service, Jackson, Mississippi. Accessed on the Internet, May 20, 2004 at <http://endangered.fws.gov/i/k/sak07.html>.

U.S. Fish and Wildlife Service (FWS). 1993a. "Endangered and Threatened Wildlife and Plants: Determination of Endangered Status for the Northern Riffleshell Mussel (*Epioblasma Torulosa Rangiana*) and the Clubshell Mussel (*Pleurobema Clava*)." *Federal Register* 58(13):5638-5642.

U.S. Fish and Wildlife Service (FWS). 1993b. "Endangered and Threatened Wildlife and Plants: Endangered Status for Eight Freshwater Mussels and Threatened Status for Three Freshwater Mussels in the Mobil (*sic*) River Drainage." *Federal Register* 58(50):14330-14340.

U.S. Fish and Wildlife Service (FWS). 1994. "Endangered and Threatened Wildlife and Plants: Determination of Endangered Status for the Royal Snail and Anthony's Riversnail." *Federal Register* 59:17994-17998.

U.S. Fish and Wildlife Service (FWS). 1997a. "Endangered and Threatened Wildlife and Plants: Determination of Endangered Status for the Cumberland Elktoe, Oyster Mussel, Cumberlandian Combshell, Purple Bean, and Rough Rabbitsfoot." *Federal Register* 62(7):1647-1658.

U.S. Fish and Wildlife Service (FWS). 1997b. *Recovery Plan for Anthony's Riversnail*. U.S. Fish and Wildlife Service, Region 4 (Southeast Region), Atlanta, Georgia.

U.S. Fish and Wildlife Service (FWS). 2000a. "Endangered and Threatened Wildlife and Plants; Endangered Status for the Armored Snail and Slender Campeloma." *Federal Register* 65(38):10033-10039.

U.S. Fish and Wildlife Service (FWS). 2000b. "Endangered and Threatened Species of Mississippi (Federally Listed Species by County)." U.S. Fish and Wildlife Service, Mississippi Ecological Services Field Office, Jackson, Mississippi. Accessed on the Internet, March 25, 2004 at [http://southeast.fws.gov/jackson/MsCo\\_TE.html](http://southeast.fws.gov/jackson/MsCo_TE.html).

U.S. Fish and Wildlife Service (FWS). 2001. "Endangered and Threatened Wildlife and Plants: Establishment of Nonessential Experimental Population Status for 16 Freshwater Mussels and 1 Freshwater Snail (Anthony's Riversnail) in the Free-Flowing Reach of the Tennessee River below the Wilson Dam, Colbert and Lauderdale Counties, Alabama." *Federal Register* 66(115):32250- 32264.

U.S. Fish and Wildlife Service (FWS). 2003. *Agency Draft Recovery Plan for Cumberland Elktoe (Alasmidonta Atropurpurea), Oyster Mussel (Epioblasma Capsaeformis), Cumberlandian Combshell (Epioblasma Brevidens), Purple bean (Villosa Perpurpurea), and Rough Rabbitsfoot (Quadrula Cylindrica Strigillata)*. Prepared by R. S. Butler and R. G. Biggins, Asheville Field Office, U.S. Fish and Wildlife Service, Asheville, North Carolina for U.S. Fish and Wildlife Service, Southeast Region, Atlanta, Georgia.

U.S. Fish and Wildlife Service (FWS). 2004a. "Alabama's Federally Listed Species." U.S. Fish and Wildlife Service, Daphne Ecological Services Field Office, Daphne, Alabama. Accessed on the Internet, January 20, 2004 at <http://daphne.fws.gov/es/specieslst.htm>.

U.S. Fish and Wildlife Service (FWS). 2004b. "U.S. Fish and Wildlife, Species Information, Threatened and Endangered Animals and Plants." Accessed on the Internet, May 26, 2004 at <http://endangered.fws.gov/wildlife.html>.

U.S. Fish and Wildlife Service (FWS). 2004c "Endangered and Threatened Wildlife and Plants: Review of Species that Are Candidates or Proposed for Listing as Endangered or Threatened; Annual Notice of Findings on Resubmitted Petitions; Annual Description of Progress on Listing Actions." *Federal Register* 69(86):24876-24904.

U.S. Fish and Wildlife Service (FWS). 2004d. "Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for Five Endangered Mussels in the Tennessee and Cumberland River Basins." *Federal Register* 69(168)53136-53180.

U.S. Fish and Wildlife Service (FWS). 2004e. Letter from L. E. Goldman, Field Supervisor, U.S. Fish and Wildlife Service, Daphne Field Office, Daphne, Alabama, to M. Masnik, U.S. Nuclear Regulatory Commission, Division of Regulatory Improvement Programs, Washington, D.C., Subject: "List of Protected Species within the Area under Evaluation for the Browns Ferry Nuclear Plant License Renewal." May 19, 2004.

U.S. Nuclear Regulatory Commission (NRC). 2004. Letter from P.T. Kuo, U.S. Nuclear Regulatory Commission, to L. Goldman, U.S. Fish & Wildlife Service, Requesting List of Protected Species Within the Area Under Evaluation for the BFN License Renewal. Available on the Internet under ADAMS accession No. ML040680881, March 5, 2004, at <http://www.nrc.gov/reading-rm/adams.html>.

Yokely, P., Jr. 1998. "Mussel Study near Hobbs Island on the Tennessee River for Butler Basin Marina." Unpublished report prepared for MST Engineering, Decatur, Alabama. Available on the Internet under ADAMS accession no. ML041530161, May 27, 2004, at <http://www.nrc.gov/reading-rm/adams.html>.