ATTACHMENT 42

SUPPLEMENTAL ENVIRONMENTAL REPORT

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List of Acronyms, Abbreviations, and Symbols

Acronym	Definition
^oF	degrees Fahrenheit
ADEM	Alabama Department of Environmental Management
AEC	U.S. Atomic Energy Commission
ALARA	as low as reasonably achievable
ATL	alternate thermal limits
APE	area of potential effects
AST	alternative source term
BFN	Browns Ferry Nuclear Plant
BIP	Balanced Indigenous Populations
BLEU	blended low enriched uranium
BWR	boiling water reactor
CCW	condenser circulating water
cfs	cubic feet per second
CLTP	current licensed thermal power
CPPU	constant pressure power uprate
CT	cooling tower
CWA	Clean Water Act
dBA	decibels A-weighted scale
DBA	design basis accident
DO	dissolved oxygen
DOE	U.S. Department of Energy
EA	environmental assessment
EMF	electromagnetic field
EPA	U.S. Environmental Protection Agency
EPU	extended power uprate
ER	environmental report
ERM	Elk River Mile
FES	final environmental statement

FICON	Federal Interagency Committee on Noise
FONSI	finding of no significant impact
FSEIS	final supplemental environmental impact statement
FY	fiscal year
GEIS	generic environmental impact statement
gpm	gallons per minute
GWh	gigawatt-hour
GWPP	groundwater protection program
HEU	highly enriched uranium
hp	horsepower
IRP	Integrated Resource Plan
ISFSI	independent spent fuel storage installation
L_{dn}	day/night sound level
L_{eq}	equivalent sound level
LEU	low enriched uranium
LLRW	low-level radioactive waste
LRA	license renewal application
MGD	million gallons per day
MW	megawatt
MWd/MTU	megawatt-days per metric ton of uranium
MWt	megawatts thermal
NEI	Nuclear Energy Institute
NESC	National Electrical Safety Code
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NPDES	National Pollutant Discharge Elimination System
NPG	Nuclear Power Group (TVA)
NRC	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places
ODCM	Offsite Dose Calculation Manual

OLTP	original licensed thermal power
PFOS	perfluorooctane sulfonate
PUSAR	Power Uprate Safety Analysis Report
QA	quality assurance
RBI	Reservoir Benthic Index
RCRA	Resource Conservation and Recovery Act
REMP	Radiological Environmental Monitoring Program
RFAI	Reservoir Fish Assemblage Index
ROD	record of decision
RWCU	reactor water cleanup system
SEIS	supplemental environmental impact statement
SHPO	State Historic Preservation Officer
TLTP	target licensed thermal power
TRM	Tennessee River Mile
TVA	Tennessee Valley Authority
TWh	terawatt-hours
UFSAR	Updated Final Safety Analysis Report
USACE	U.S. Army Corps of Engineers
WMA	wildlife management area

1.0 EXECUTIVE SUMMARY

This supplemental environmental report (ER) contains the Tennessee Valley Authority's (TVA's) assessment of the environmental impacts of a proposed output power increase for Browns Ferry Nuclear Plant (BFN) Units 1, 2, and 3. Each unit was originally licensed to operate at 3,293 megawatts thermal (MWt). The proposed increase is from the current operating limit of 105 percent of the original licensed thermal power (OLTP), or 3,458 MWt, to 120 percent OLTP, or 3,952 MWt, for each unit. The increase to 105 percent OLTP was termed a "stretch" uprate, and the increase to 120 percent OLTP is termed an extended power uprate (EPU). The intent of this supplemental ER is to provide information needed by the U.S. Nuclear Regulatory Commission (NRC) to evaluate the environmental impact of the power uprate in accordance with 10 CFR Part 51, Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions.

EPU for BFN Units 1, 2, and 3 does not require extensive changes to plant systems that directly or indirectly interface with the environment. With the exception of any transmission system changes that might be identified by the Interconnection System Impact Study, all other modifications will be in or on existing BFN structures; none will involve disturbing additional land or constructing new facilities outside the existing plant areas. There will be no increase in condenser circulation (cooling) water, and BFN will maintain compliance with its National Pollutant Discharge Elimination System (NPDES) permit through use of the cooling towers or, if needed, by derating. The rate of low-level radioactive waste (LLRW) generation would increase slightly compared to the current rate, but would still be bounded by the BFN environmental licensing basis; this is also true for gaseous radiological emissions. Offsite radiation doses will remain small and within applicable regulatory limits. The number of dry storage casks of spent fuel would also increase.

As a federal agency subject to the requirements of the National Environmental Policy Act (NEPA), TVA evaluates the effects on the environment of all proposed actions. TVA concludes that with the exception of any offsite transmission system upgrades that may be deemed necessary, the environmental impacts of operating BFN Units 1, 2, and 3 at 120 percent OLTP are bounded by the impacts described in this supplemental ER and previous BFN environmental reviews and are appropriately constrained by applicable regulatory limits. TVA also concludes that human health and the environment would not be significantly affected.

2.0 INTRODUCTION

TVA operates BFN Units 1, 2, and 3 in Limestone County, Alabama, consistent with its broad responsibilities for the natural and social well-being of the Tennessee Valley Region as charged under the Tennessee Valley Authority Act of 1933. TVA is committed to operating BFN in a manner that will protect the environment and preserve natural resources while producing safe, reliable, and economical electric power. In keeping with this charge, TVA is requesting a license amendment to allow BFN Units 1, 2, and 3 to operate at up to 120 percent OLTP, deemed an EPU. As discussed in Section 2.2, the units have already been uprated by 5 percent, thus, the remaining power increase being requested is approximately a 15-percent increase for each BFN unit.

In June 2004, TVA submitted two license amendment requests for increasing the output power level of the three BFN units to 120 percent OLTP. One submittal addressed EPU of Units 2 and 3, and the other submittal addressed EPU of Unit 1. On September 22, 2006, TVA submitted a supplement to the application for EPU of BFN Unit 1 that requested interim operation at 105 percent OLTP. On March 6, 2007, NRC issued Amendment No. 269 to Renewed Facility Operating License No. DPR-33 for BFN Unit 1, allowing an operating power increase of Unit 1 from 3,293 to 3,458 MWt. TVA subsequently withdrew the 2004 EPU license amendment requests and corresponding ERs on September 18, 2014.

This supplemental ER, which addresses the environmental impacts of EPU for all three units, replaces the ER for Unit 1 and the ER for Units 2 and 3 that were submitted in June 2004. As a supplemental ER, this document supplements the NEPA documentation currently in place for previous licensing actions, as discussed in Section 2.2 and summarized in Table 2.2-1, and is intended as input for NRC's NEPA review of the requested EPU at BFN Units 1, 2, and 3.

2.1 Browns Ferry Nuclear Plant History and Background

BFN is located on an 840-acre tract located on the north shore of Wheeler Reservoir at Tennessee River Mile (TRM) 294 in Limestone County, Alabama, approximately 10 miles northwest of Decatur, Alabama, and 10 miles southwest of Athens, Alabama. TVA began major construction on BFN in 1967.

As a federal agency subject to the requirements of NEPA, enacted in 1969, TVA evaluated the effects on the environment of construction and operation of BFN in a three-volume document entitled *Final Environmental Statement, Browns Ferry Nuclear Plant, Units 1, 2, and 3* (FES), and dated September 1, 1972. The U.S. Atomic Energy Commission (AEC) participated in the preparation of the FES as a cooperating agency. The AEC concluded on August 28, 1972, that the FES was adequate to support the proposed license to operate the plant. The FES was sent to the Council on Environmental Quality and made available to the public on September 1, 1972.

BFN has three General Electric boiling water reactors (BWRs) and associated turbine generators that can produce more than three billion watts of power. Each of BFN's three nuclear reactors is connected to its own dedicated generator. Unit 1 began commercial operation in August 1974, Unit 2 in 1975, and Unit 3 in 1977. A fire shut down BFN Unit 1 in 1975 for over a year. All three units were taken off line in 1985 when TVA idled its nuclear fleet. After an extended shutdown to review the TVA nuclear power program and to correct significant weaknesses, TVA returned Unit 2 to service in May 1991, Unit 3 in November 1995 and, following extensive repairs and refurbishment, Unit 1 came back on line in May 2007. In 1998, BFN completed an Integrated Plant Improvement Project for Units 2 and 3 which, among other improvements, resulted in an NRC-approved 5-percent uprate of OLTP for each unit. The cooling towers serving Units 1, 2, and 3 have also undergone replacement in the past years with the last two of the original six cooling towers being currently planned for replacement in fiscal year (FY) 18 and FY19. To increase total plant cooling capacity, a new and larger cooling tower was constructed in May 2012.

TVA submitted a license renewal application (LRA) to the NRC in December 2003 for renewal of the facility operating licenses for each BFN unit. The NRC issued *Supplement 21 Regarding Browns Ferry Nuclear Plant Units 1, 2, and 3* to the Generic EIS for License Renewal of Nuclear Plants (NUREG-1437) in June 2005. NRC issued the renewed operating licenses for Units 1, 2, and 3 in May 2006, allowing continued operation of the three BFN units until 2033, 2034, and 2036, respectively.

2.2 Related Power Uprate Submittals and NEPA Documentation

As mentioned above, the BFN FES was prepared by TVA with the AEC as a cooperating agency to assess the effects on the environment of construction and operation of BFN and was issued in 1972.

To support a 5-percent uprate of OLTP for Units 2 and 3, termed a "stretch uprate", TVA prepared an environmental assessment (EA) dated August 1997, and a finding of no significant impact (FONSI) was issued by TVA on August 28, 1997. In response to TVA's application of October 1, 1997, for the 5-percent uprate on Units 2 and 3, the NRC issued an EA and FONSI of its own on August 26, 1998, and an amendment to the BFN operating licenses for Units 2 and 3 was approved by the NRC for the 5-percent uprate on September 8, 1998. Later, on March 6, 2007, the NRC approved an amendment to the BFN Unit 1 operating license allowing the same 5-percent "stretch" operating power increase (3,293 MWt to 3,458 MWt) as for Units 2 and 3.

Following review of licensing topical reports NEDC-32424P-A, "Generic Guidelines for General Electric Boiling Water Reactor Extended Power Uprate," dated February 1999, and NEDC-32523P-A, "Generic Evaluations of General Electric Boiling Water Reactor Extended Power Uprate," dated February 1999, the NRC concluded that the reports provided an acceptable methodology to uprate the power output of BWRs, such as the BFN units, up to 120 percent OLTP. Subsequent to these NRC's reviews, TVA initially pursued EPUs for Units 2 and 3.

TVA completed the *Browns Ferry Nuclear Plant Extended Power Uprate for Units 2 and 3 Environmental Assessment* in March 2001. This assessment described the potential environmental effects of increasing thermal output power from BFN Units 2 and 3 from 105 percent to 120 percent OLTP. A FONSI was issued for the proposed project contingent upon certain mitigation measures for rendering increased thermal loads to surface waters insignificant. At that time, thermal impact mitigation measures included construction of a new 16-cell cooling tower and the use of existing cooling towers. Following completion of this EA, on April 18, 2001, the TVA Board approved the EPU project for BFN Units 2 and 3.

After the Units 2 and 3 EPU FONSI was issued, additional technical analyses completed in late 2001 predicted that without the new cooling tower the plant would need to derate for no more than 183 hours in a 10-year period to stay in compliance with thermal limits. Subsequent refinements of the modeling effort in the summer of 2003, using 16 years of data, predicted that operation of the BFN Units 2 and 3 at 120 percent OLTP without the proposed new cooling tower was projected to need no more than 128 hours of derating in a 16-year period. Further economic analysis indicated that due to transmission system improvements, the cost of replacement power for 128 hours over a 16-year period would not be enough to justify construction of a new cooling tower as a part of the EPU project for Units 2 and 3. Based upon these modeling refinements, on August 7, 2003, TVA issued a new EA and FONSI for the Units 2 and 3 EPU project. This EA and FONSI concluded that implementation of EPU using the existing five cooling towers would not have a significant impact on the quality of the environment, contingent upon derating as necessary to remain compliant with NPDES permit discharge temperature limits and continuation of aquatic monitoring programs for 3 years after EPU.

In June 2004, TVA submitted two license amendment requests to the NRC for increasing the output power level of the three BFN units to 120 percent OLTP. One submittal addressed EPU of Units 2 and 3, and the other submittal addressed EPU of Unit 1 separately because, unlike the other two units, it had not undergone the 5-percent “stretch” uprate and was therefore seeking approval to go directly to 120 percent OLTP. On September 22, 2006, TVA submitted a supplement to the application for EPU of BFN Unit 1 that requested interim operation at 105 percent OLTP until certain steam dryer analyses could be completed. On March 6, 2007, NRC issued Amendment Number 269 to Renewed Facility Operating License No. DPR-33 for BFN Unit 1, allowing an operating power increase to 3,458 MWt. Subsequently, TVA withdrew the 2004 EPU license amendment requests on September 18, 2014.

To support a separate licensing action, application for renewal of BFN Units 1, 2, and 3 operation licenses, TVA completed work in March 2002 on *Final Supplemental Environmental Impact Statement for Operating License Renewal of the Browns Ferry Nuclear Plant in Athens, Alabama* (FSEIS), which also included an assessment of the impact of recovering and restarting Unit 1. Renewal of the operating licenses of all three units would allow operation to continue for an additional 20 years past the original 40-year operating license terms, which expired or will expire in 2013, 2014, and 2016 for Units 1, 2, and 3, respectively. A Record of Decision (ROD) was approved by the TVA Board in May 2002 and published in the June 18, 2002 *Federal Register*. The FSEIS and ROD acknowledge that restart of Unit 1 and operation of all three units at EPU up to 120 percent of the originally licensed power level would require additional cooling tower capacity beyond what was available at that time (2002). Therefore, the preferred alternative, as stated in the FSEIS and confirmed in the ROD, included the addition of a new 20-cell mechanical draft cooling tower to replace cooling tower 4 which was destroyed by fire in 1986.

As discussed in Section 2.1, TVA submitted an LRA to the NRC in December 2003 for renewal of the operating licenses for each BFN unit. The LRA contained an extensive ER, which updated analyses in some subject matter areas presented in the FSEIS, including thermal discharge (i.e., main condenser cooling water effluent temperatures and mixing characteristics); however, the basic conclusions of the FSEIS remained unaltered. A notice of receipt and availability of the application was published in the *Federal Register* on March 10, 2004 (69 FR 11462). The NRC issued *Supplement 21 Regarding Browns Ferry Nuclear Plant Units 1, 2, and 3,* to the Generic EIS for License Renewal of Nuclear Plants (NUREG-1437) in June 2005. The renewed operating licenses for Units 1, 2, and 3 were issued in May 2006, allowing continued operation of the three BFN units until 2033, 2034, and 2036, respectively.

During the summer of 2010, derates to below 50 percent power were required at BFN for several days in July and about half of August to meet the NPDES permit maximum allowable cooling water discharge temperature. To provide more efficient cooling and additional capacity needed for current operations and future uprates, TVA pursued replacement of four original cooling towers (CTs 1, 2, 5, and 6) with larger towers and the construction of an additional, much larger mechanical draft cooling tower (CT 7). In October 2010, TVA issued an EA and a FONSI for the *Browns Ferry Nuclear Plant Cooling Towers Addition and Replacements*. In addition, to support replacement of CT 3 with a more modern tower, TVA completed a supplemental EA and a FONSI in December 2012.

Currently, all but two of the six original cooling towers have been replaced and upgraded. CTs 1 and 2 are currently planned for replacement in FY18 and FY19. With the addition of CT 7, the current fleet of seven cooling towers is sufficient to maintain NPDES permit compliance. Details of current cooling tower characteristics are described in Table 7.2-1, BFN Cooling Tower Characteristics, October 2014.

2.2.1 References

69 FR 11462. Tennessee Valley Authority, Browns Ferry Nuclear Plant, Units 1, 2, and 3; Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process. *Federal Register* 69:11462 (March 10, 2004).

ADEM (Alabama Department of Environmental Management). 2002. “Final listing decision for Wheeler Reservoir on the Tennessee River waterbody identification number AL/Wheeler_Res01 pH temperature/thermal modification.”

Table 2.2-1: BFN NEPA Documentation[1]

NEPA Document	Decision
Operation of BFN	
Final Environmental Statement, Browns Ferry Nuclear Plant, Units 1, 2, and 3, August 1972 Prepared by TVA to evaluate the effects on the environment of construction and operation of BFN. The U.S. Atomic Energy Commission participated in the preparation of the FES as a cooperating agency.	ROD issued August 28, 1972
Final Supplemental Environmental Impact Statement for Operating License Renewal of the Browns Ferry Nuclear Plant in Athens, Alabama, March 2002 Prepared by TVA to seek extension of NRC licenses for BFN Units 1 through 3 at 120 percent OLTP for an additional 20 years beyond the original 40-year operating license terms. Mitigation measures for increased thermal loads to surface waters included use of existing cooling towers, construction of a new cooling tower, and derating the plant as necessary.	ROD issued May 16, 2002
License Renewal Application for Browns Ferry Nuclear Plant Units 1, 2, and 3, December 2003 Prepared by TVA to apply for renewal of BFN's operating licenses for an additional 20 years.	December 2003
Supplement 21 Regarding Browns Ferry Nuclear Plant Units 1, 2, and 3 to the Generic EIS for License Renewal of Nuclear Plants (NUREG-1437), June 2005 Prepared by NRC to evaluate the continued operation of BFN Units 1, 2, and 3 during a 20-year renewed license term at OLTP or at EPU of 120 percent.	June 2005
Power Uprates	
Browns Ferry Nuclear Plant Units 2 and 3 Power Uprate Project EA, August 1997. TVA prepared the EA to pursue action to request license amendment from NRC to increase BFN Units 2 and 3 maximum power level to 105 percent OLTP.	FONSI issued August 28, 1997
NRC-issued EA and FONSI NRC prepared this EA to support an amendment to the BFN operating licenses for Units 2 and 3 for a 5-percent uprate on September 8, 1998.	August 26, 1998

NEPA Document	Decision
Browns Ferry Nuclear Plant Extended Power Uprate for Units 2 and 3 Environmental Assessment, March 2001 This assessment described the potential environmental effects of increasing thermal output power from BFN Units 2 and 3 from 105 percent to 120 percent OLTP. A FONSI was issued for the proposed project contingent upon certain mitigation measures for rendering increased thermal loads to surface waters insignificant. At that time, thermal impact mitigation measures included construction of a new 16-cell cooling tower and the use of existing cooling towers.	FONSI issued March 15, 2001
Browns Ferry Nuclear Plant Extended Power Uprate for Units 2 and 3 EA, August 2003 Based on new technical and economic analyses, TVA prepared this new EA and FONSI. It concluded that implementation of EPU using the existing five cooling towers would not have a significant impact on the quality of the environment, contingent upon derating as necessary to remain compliant with NPDES permit discharge temperature limits and continuation of aquatic monitoring programs for three years after EPU.	FONSI issued August 7, 2003
Cooling Tower Replacement and Upgrades	
Final Environmental Assessment Browns Ferry Nuclear Plant Cooling Towers Addition and Replacements, October 2010 To provide more efficient cooling and additional capacity needed for current operations and future uprates, TVA prepared this EA for replacement of CTs 1, 2, 5, and 6 and a new CT 7.	FONSI issued October 28, 2010
Browns Ferry Nuclear Plant Cooling Tower 3 Replacement Supplemental EA, December 2012 In July 2012, CT 3 partially collapsed. To support its replacement with a more modern tower that included larger fan motors and a larger cold water basin, TVA prepared this supplemental EA.	FONSI issued December 6, 2012

1. Listing of BFN NEPA documentation pertinent to power uprates.

3.0 PURPOSE OF AND NEED FOR ACTION

3.1 The Proposed Action

In response to the increasing (continuing) demands for bulk power, TVA is requesting a license amendment for EPUs to increase the reactor thermal power for BFN Units 1, 2, and 3 such that each unit can be operated at 120 percent OLTP (3,293 MWt) or 3,952 MWt. Use of existing facilities to the greatest extent possible has the three-fold benefit of assuring future power supplies, avoiding the large capital outlays associated with new construction, and avoiding the environmental impacts from siting and constructing a new power generating facility.

Under the current schedule, EPU would be implemented at Unit 1 during the scheduled refueling outage in fall 2018 (Refueling Outage—Unit 1 Cycle 12), at Unit 2 in spring 2019 (Refueling Outage—Unit 2 Cycle 20), and at Unit 3 during spring 2018 (Refueling Outage—Unit 3 Cycle 18). Upon approval of the EPU by the NRC, each unit would begin operating at the uprated power level following the outages identified above.

3.2 Need for TVA Action

Determination of a need for power begins with long-term forecasts of the growth in demand for electricity, both in terms of peak demand and energy sales to the end-user. TVA estimates that energy consumption will increase at a compound annual growth rate of 1.2 percent from 2015 to 2020, with moderate growth continuing beyond 2020. The total firm capacity of existing resources decreases over time primarily due to retirement of coal-fired units and the expiration of existing power purchase agreements.

Watts Bar Unit 2 is anticipated to be operational by the end of 2015 and will add approximately 1,150 MW of nearly zero carbon emission generating capacity to the system. However, by spring 2016, five coal units totaling more than 1,000 MW will be idled or retired. Since 2011, TVA has retired, or plans to retire by 2019, more than 6,500 MW (net dependable capacity) of coal-fired generation.

TVA estimates that, with current resources and those planned to be available, when compared to the demand forecast, additional capacity and energy of 2,400 MW and almost 10,000 GWh will be needed in 2020. The BFN EPUs would offer lower-cost, nearly zero carbon emission base-load power without the high capital cost typical of most nuclear power additions.

3.3 Alternatives to the Proposed Action

TVA considered various alternatives to the proposed action. If the proposed action is not undertaken, TVA would need to supply system energy and capacity needs from other resources.

In the “No Action” alternative, where the BFN EPU project is not approved, TVA would need to purchase market capacity and/or employ new gas generation without the uprates in order to satisfy firm requirements. Both of these actions raise system fixed and capital costs relative to the proposed action. Energy requirements would need to be met with coal and gas generating resources and spot energy purchases resulting in higher system operational costs.

4.0 OVERVIEW OF OPERATIONAL AND EQUIPMENT CHANGES

Increasing the electrical output of a BWR power plant is accomplished primarily by generating higher steam flow in the reactor and supplying it to the turbine generator. The activities needed to produce thermal power increases are a combination of those that directly produce more power and those that will accommodate the effects of the power increase. The additional reactor energy requirements for extended power are accomplished by increasing the reload fuel batch size, changing the fuel loading pattern, and changing the planned deployment of fuel enrichment and burnable poison. This is operationally accomplished by enhancements to core management throughout the fuel cycle. These enhancements address both control rod pattern and core flow management. Collectively, the core design and operational enhancements that achieve the increase in core thermal power result in a more uniform power distribution. Therefore, operating at EPU conditions will not challenge fuel design limits.

As part of the EPU project, plant systems have been analyzed to determine modifications required to support changes in system operation. The majority of these modifications are to address the increase to reactor steam and feedwater flow. A complete list of planned modifications is provided in Attachment 47. A representative list, but not all inclusive of the modifications to plant equipment necessary for EPU implementation, is as follows:

- Modifications to the high-pressure turbine
- Replacement of reactor feedwater pumps
- Installation of higher capacity condensate booster pumps and motors
- Modifications to the condensate demineralizer system
- Modifications to the feedwater heaters
- Replacement of the reactor pressure vessel steam dryers
- Upgrades of miscellaneous instrumentation, setpoint changes, and software modifications

All onsite modifications will be within the existing structures, buildings, and fenced equipment yards that currently house the major unit components. The project will make use of existing parking lots, road access, laydown areas, offices, workshops, warehouses, and restrooms located in previously disturbed surface areas at BFN. Transmission Planning has conducted a preliminary screening study to evaluate the impact of the added power on the TVA transmission system. The transmission screening study indicates upgrades may be required. A more definitive interconnection system impact study is underway to identify specific transmission system upgrades that are required.

All deliveries of materials to support the work identified above will be by truck. Equipment will be unloaded on site with equipment typical to material receipt and construction activities and will be temporarily stored in existing storage buildings and laydown areas. Existing land uses will not be altered.

5.0 SOCIOECONOMIC AND ENVIRONMENTAL JUSTICE CONSIDERATIONS

5.1 Socioeconomics

BFN is located in Limestone County, Alabama, which is part of the Huntsville Metropolitan Area. The population of Limestone County in 2010 was 82,782. The primary labor market area for the plant consists of three metropolitan areas: Huntsville (Limestone and Madison counties), Decatur (Lawrence and Morgan counties), and Florence (Colbert and Lauderdale counties). The 2010 population of these three metropolitan areas combined was 718,559. (USCB 2010) Based on 2013 data, the labor force in Limestone County was 40,640; the primary labor market area had a labor force of 351,412. The unemployment rate in 2013 was 5.5 percent in Limestone County, while the average in the primary labor market area was 5.8 percent. Both Limestone County and the labor market area had lower unemployment rates than did the state (7.2 percent) and the nation (7.4 percent). (BLS 2013)

5.1.1 Payments in Lieu of Taxes

TVA does not pay property taxes; however, in accordance with federal law, Section 13 of the TVA Act, 16 U.S.C. §8311, it makes payments in lieu of taxes to states and counties in which its power operations are carried on and in which it has acquired properties previously subject to state and local taxation. Under Section 13, TVA pays 5 percent of its gross power revenues to such states and counties. Only a very small share of the payments is paid directly by TVA to counties; most is paid to the states, which use their own formulas for redistribution of some or all of the payments to local governments. TVA's payments in lieu of taxes are apportioned among the state and counties according to the state’s allocation formula but, in general, half of the payment is apportioned based on power sales and half is apportioned based on the "book" value of TVA power property. Therefore, for a capital improvement project such as EPU, the in-lieu-of-tax payments are affected in two ways: (1) as power sales increase, the total amount of the in-lieu-of-tax payment to be distributed increases, and (2) the increased “book” value of BFN causes a greater proportion of the total payment to be allocated to Limestone County. The state’s general fund, as well as all counties in Alabama that receive TVA in-lieu-of-tax distributions from the State of Alabama, benefit under this method of distribution. In 2014, TVA’s payments in lieu of taxes to Alabama were approximately $104 million. Limestone County’s share was approximately $8.3 million, largely because of the TVA fixed assets (BFN) in the county.

5.1.2 Project Employment

Under the current EPU schedule, implementation would occur at Unit 1 during the scheduled refueling outage in fall 2018 (Refueling Outage—Unit 1 Cycle 12), at Unit 2 in spring 2019 (Refueling Outage—Unit 2 Cycle 20), and at Unit 3 during spring 2018 (Refueling Outage—Unit 3 Cycle 18). Typically, the increased staffing for an outage is 800–1,200 supplemental workers for an average of 1,000. Supplemental staffing ramps up 2 to 3 weeks prior to the outage start with maximum staffing reached at about Day 3 of the outage and continuing until Day 21 to 28 when ramping down usually begins, whereby normal staffing is reached 1 week after the end of the outage. TVA's current business plan outage duration is 35 days or less. BFN typically targets 25- to 30-day durations.

The EPU work will be coordinated with other outage activities and completed by workers who have other outage duties as well. An estimated 10 percent or less of the average supplemental workforce of 1,000 will be dedicated to the EPU portion of the outage work. The maximum employment level for all outage work would represent about 2.5 percent of the current labor force of Limestone County and about 0.3 percent of the labor force in the primary labor market area.

5.1.3 Impacts on the Area

In addition to the areas included in the primary labor market area, the Birmingham, Alabama, and Nashville, Tennessee, areas are sources of workers for the proposed activity. Workers from these areas generally would commute rather than relocate for the relatively short duration of the proposed activity. TVA experience at BFN suggests that it is likely that less than half of all the workers hired for outage activities would move into the primary labor market area. The remaining workers generally would already reside within the primary labor market area or locations, such as the Birmingham or Nashville areas, close enough to commute on a temporary basis. Based on this, it is anticipated that the maximum impact from workers moving into the area would be about 400 to 450 workers, not all resulting from this proposed action. Because of the very short-term nature of the work, about five weeks, and the short duration of the maximum employment level, very few workers who do move in are expected to bring families with them. It is not likely that the increased population in the area due to all outage activities would exceed about 450 persons. However, it is possible that the demand for the required skills would make recruiting difficult, resulting in a somewhat larger number of workers moving temporarily into the local area.

Due to the short duration of the project, the total impact on annual earnings and income in Limestone County and in the labor market area would be very small and insignificant. Impacts on community services such as police, fire, and medical would also be very small and insignificant because of the small size of the impact on population, dispersal of the workers who move within the labor market area, and the short duration of the maximum workforce.

After it is implemented, the EPU project is not expected to affect the size of the BFN permanent workforce and would not have a material effect on the labor force required for future plant outages; however, there would be some continuing positive benefits to the local economy. Capitalization of some costs associated with the EPU would increase the "book" value of BFN and thereby result in a small increase in the in-lieu-of-tax payments received by Limestone County. EPU would also have a positive impact on the long-term viability of BFN as described in Chapter 6.0 (Cost-Benefit Analysis) of this report.

5.2 Environmental Justice

The population of Limestone County is 21.3 percent minority (non-white), well below both the state of Alabama (33.0 percent) and the nation (36.3 percent) (USCB 2010). The labor market area has a higher minority population share (26.5 percent), still well below the state and national levels. The "below the poverty threshold rate" in Limestone County is 13.3 percent, lower than both the state average of 18.1 percent and the national average of 14.9 percent. The poverty rate in the labor market area is 14.1 percent, higher than Limestone County, but still lower than the state and the nation. (USCB 2012) Almost all of the activity associated with the proposed action would occur inside the plant, further removing it from the population in the surrounding area. Also, no significant negative impacts to the environment are expected if the proposed action occurs. Therefore, no disproportionate negative impacts to disadvantaged populations are expected.

5.3 Conclusion

The favorable cost effectiveness of the EPU project compared with that for any other means of new generation, and the associated reduction in incremental operating costs, make the project economically attractive; this, in turn, allows it to contribute to keeping BFN a competitive electric power producer for years to come. Maintaining BFN as a reliable equal opportunity employer, in-lieu-of-tax provider, and source of reliable and clean electric power contributes a measure of stability and prosperity to the local social structure.

5.4 References

BLS (U.S. Bureau of Labor Statistics). 2013. U.S. Bureau of Labor Statistics 2013 Annual Data.

USCB (U.S. Census Bureau). 2010. Census of Population, 2010 and American Fact Finder.

USCB. 2012. American Fact Finder 2012 Alabama Poverty Data, 2012 USA Poverty Data, U.S. Bureau of the Census, American Community Survey.

6.0 COST-BENEFIT ANALYSIS

TVA performed analysis to study the cost effectiveness of implementing EPUs at the BFN site. The proposed EPUs provide additional supply of approximately 155 MW per unit (465 MW total) capacity and approximately 4 terrawatt-hours (TWh) of reliable energy to the TVA system. The EPU project is expected to be economically beneficial by $870 million through the end of the plant life.

Based on TVA's load forecast, capacity plans have shown TVA would need to purchase market capacity and/or employ new gas generation without the uprates in order to satisfy firm requirements. The capacity savings from the EPU project are largely driven by deferring or reducing the need for future gas generation (combined cycle or combustion turbine). Detailed model simulations were completed to estimate the capacity and energy (fuel) cost impacts. The low variable cost of the additional nuclear generation delivers significant fuel savings by offsetting more expensive coal generation, gas generation, and the need for market purchases. The operating cost savings also include reduced emission expenses. In total, TVA projects that total expenses will be lowered by approximately $1.3 billion over the remaining asset life of BFN, which is offset by the $432 million remaining cost of the project (includes transmission).

A preliminary screening study was also conducted to evaluate the impact of the project on the TVA transmission system. The transmission system preliminary screening study indicates upgrades may be required and estimates the highest cost associated with the upgrades to be approximately $375 million, and the most probable cost to be nearly $225 million. TVA's transmission organization is conducting a large generator interconnect study to thoroughly evaluate the impact to the TVA system and specify the exact system upgrades required, the total costs, and the schedule for completion. The transmission expense, once finalized, will lower the economic benefit, but it would still remain highly positive.

7.0 NONRADIOLOGICAL ENVIRONMENTAL IMPACTS

7.1 Terrestrial Effects

7.1.1 BFN Site and Surroundings

7.1.1.1 Land Use, Wetlands, and Natural Areas

The changes associated with EPU are within the existing structures, buildings, and fenced equipment yards housing the major unit components at the 840-acre BFN site. The project will make use of existing parking lots, road access, laydown areas, offices, workshops, warehouses, and restrooms located in previously disturbed surface areas at BFN. No other changes to BFN properties or immediately surrounding environs are expected. The only potential land use changes are associated with upgrades to the power transmission system distant from BFN.

Site surveys conducted in 2003 (TVA 2003) indicated approximately 12 acres of wetlands present on the BFN site meet the U.S. Army Corps of Engineers (USACE) wetland parameters for federal jurisdictional wetlands which may be regulated under the Clean Water Act (CWA). However, no wetlands are present within areas proposed for construction activities associated with the proposed EPU. Therefore, the project would have no impacts or effects upon wetlands.

The TVA Natural Heritage database indicated on May 12, 2015, that two natural areas occur within a 6-mile vicinity of the project area. The Mallard-Fox Creek Wildlife Management Area (WMA) and the Swan Creek WMA. The Mallard-Fox Creek WMA is located across the Tennessee River from the BFN site. Swan Creek WMA is located approximately 5.2 miles upstream from the BFN site. The proposed EPU of BFN Units 1, 2, and 3 would not affect either WMA because, with the exception of potential transmission system upgrades, construction work would occur within the boundaries of the BFN site. No offsite impacts from operation are expected at that location.

7.1.1.2 Cultural Resources and Visual Aesthetics

TVA complies with Section 106 of the National Historic Preservation Act (NHPA) for every TVA undertaking that has the potential to affect properties included or eligible for inclusion in the National Register of Historic Places (NRHP). TVA's practice includes identifying historic properties, evaluating project effects, and resolving any adverse effects to historic properties, in consultation with the appropriate parties including State Historic Preservation Officer(s) (SHPO) and tribal governments, pursuant to the procedures stipulated by 36 CFR 800.3-800.13. In addition, for any actions requiring compliance with NEPA, TVA considers the action's possible effects on historic structures, Native American religious or cultural properties, and archaeological sites.

In 2001, TVA conducted a Phase I archaeological survey during the preparation of the BFN Operating License Renewal Supplemental Environmental Impact Statement (SEIS) on three areas within the BFN site that were proposed for use as disposal areas for soil that could be removed for some of the potential cooling tower expansion alternatives being considered in the

SEIS (Gage 2001). Two historic properties were identified. One was an Early to Middle Woodland (600 B.C. to 1000 A.D.) occupation considered eligible for listing on the NRHP; the other was the Cox Cemetery, which was relocated during construction of BFN. Neither of these resources is located within the area of potential effects (APE) for the current EPU undertaking. The APE consists of the areas where ground-disturbing actions could occur as part of the undertaking. The current APE's potential to contain intact archaeological sites is low; native soils and sediments throughout most of the APE were destroyed during plant construction. However, photographs of plant construction taken in November 1968 and March 1969 (TVA 1968, 1969) indicate that the wooded hill along the southern border of the APE was not disturbed and could contain archaeological sites. Although facilities were added in that area at a later date, there remain approximately 4 acres of wooded area within the 840-acre BFN site that contain intact soils and sediments. No modern archaeological surveys have taken place in those areas and the presence or absence of archaeological sites there would have to be determined should TVA, in the future, propose an undertaking that would affect the wooded area and be subject to NEPA or NHPA Section 106.

BFN is considered by TVA to be eligible for listing in the NRHP under Criterion A (association with events that have made a significant contribution to the broad patterns of our history), based on an in-house assessment. Contributing resources include the powerhouse, water intake and skimmer, cooling towers, and the Aquatic Research Center. TVA found that the cooling tower replacements and addition of CT 7 would not appreciably alter the existing silhouette of BFN and would therefore have no visual effect. The Alabama SHPO agreed with this finding (Section 7.1.1.3).

Due to the time elapsed between that finding and the current ER, TVA researched current historic property records for aboveground resources at the Alabama Historical Commission, in order to verify whether the APE contained any recently identified properties. Figure 7.1-1 shows all previously identified above-ground properties within a 6-mile radius of BFN. No architectural resources included or eligible for inclusion in the NRHP have been recorded within 3 miles of BFN. The nearest such resource is the Burt Cemetery, located approximately 3.5 miles southeast of the plant on the opposite side of the Tennessee River.

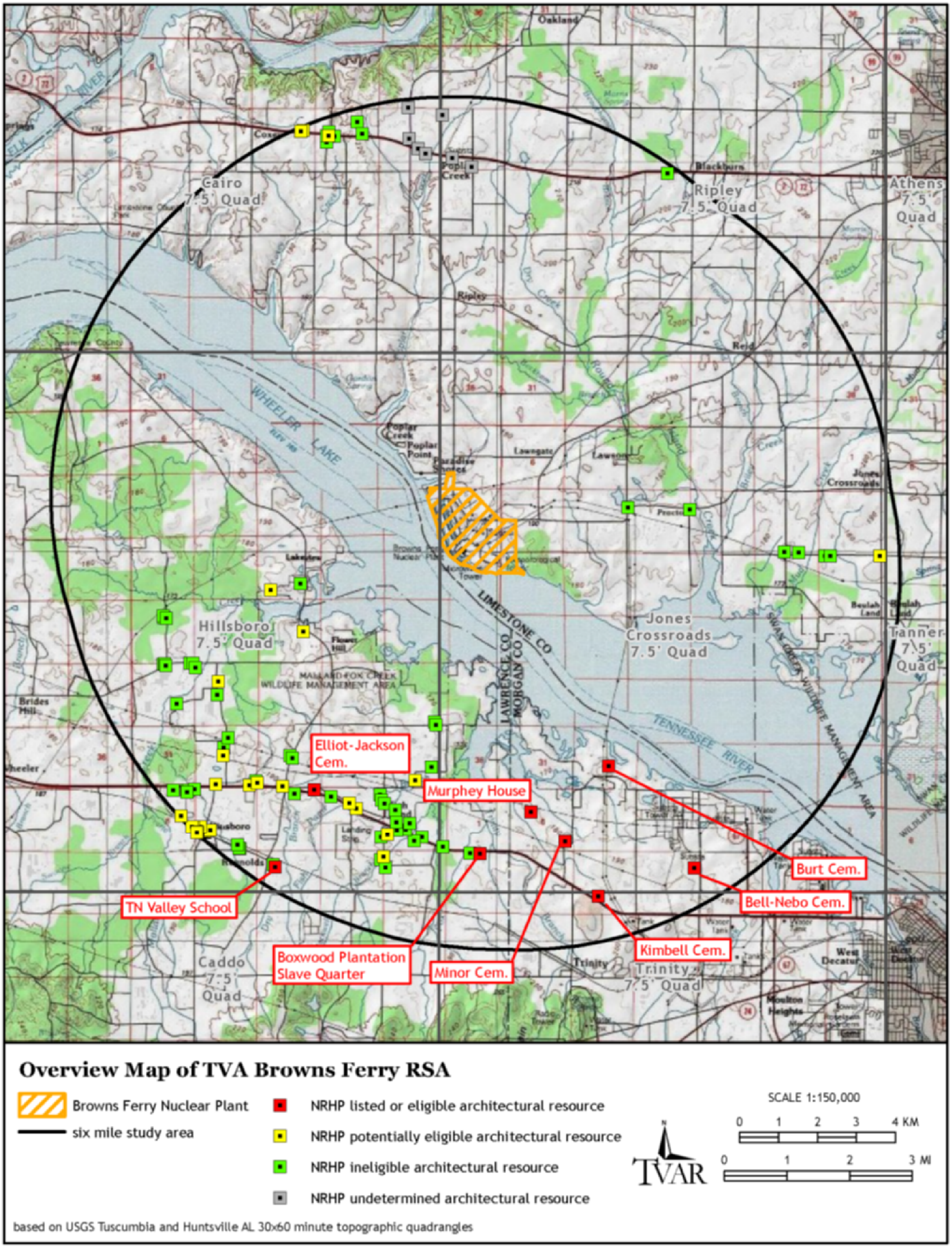

Figure 7.1-1: Recorded Architectural Resources Within 6 Miles of BFN, Coded by NRHP Status

7.1.1.3 Written Communications

To support a NEPA review of previously proposed construction activities by TVA for replacement of CTs 1, 2, 5, and 6 and construction of an additional cooling tower, CT 7, TVA consulted with the Alabama SHPO and federally recognized Indian tribes. TVA determined that no below-ground archaeological resources would be affected by the undertaking and the Alabama SHPO agreed. No tribes objected to the undertaking. The SHPO and tribal correspondence is included below.

Tennessee Valley Authority, 400 West Summit Hill Drive, Knoxville, Tennessee 37902-1499

September 24, 2010

Ms. Stacye Hathorn
Alabama Historical Commission
468 South Perry Street
Montgomery, Alabama 36130-0900

Dear Ms. Hathorn:

BROWNS FERRY NUCLEAR (BFN) POWER PLANT COOLING TOWER ADDITIONS, LIMESTONE COUNTY, ALABAMA

The Tennessee Valley Authority (TVA) proposes to replace four of six existing cooling towers (Towers 1, 2, 5, and 6) with larger units and construct one additional 25–30 cell linear mechanical draft cooling tower site at BFN (Figures 1 and 2). The four existing cooling towers would be demolished and rebuilt within the existing footprint. In 2001, TVA consulted with your office regarding the Environmental Impact Statement (EIS) for the relicensing of Units 1, 2, and 3 and additional cooling towers for BFN (AHC 2001-1439). Your office concurred with TVA that there would be no effect provided that 1LI535 could be avoided. The EIS did not include the currently proposed new cooling tower (Tower 7).

Tower 7 would be located along the east side of Shaw Road at the location of an existing perimeter ditch and includes the installation of a new pumping station, a cold water discharge canal, lift pumps and piping, and two new transformers (Figure 2) A portion of the ditch would be relocated directly northeast of proposed Tower 7 to maintain a perimeter ditch north of the new cooling tower In addition, the cold water discharge canal is proposed between the north end of the spoil pile and the existing western perimeter ditch, and approximately a five-acre construction staging area is necessary

TVA considers the archaeological area of potential effect (APE) to be the footprint where ground disturbance would take place (1LI535 is outside of the APE) TVA finds the proposed undertaking would not appreciably add to the existing silhouette of BFN and there would be no visual effect

The archaeological APE has been extensively disturbed with the construction of BFN, such that no intact archaeological deposits would be present It is TVA's finding that no cultural resources potentially eligible for the National Register of Historic Places (NRHP) would be affected by the proposed undertaking and no further investigations are recommended Pursuant to 36 CFR Part 800, we are seeking your concurrence with TVA's findings and recommendations

Pursuant to 36 CFR Part 800 3(f)(2), TVA is consulting with federally recognized Indian tribes regarding properties within the proposed project's APE that may be of religious and cultural significance and eligible for the NRHP

Ms. Stacye Hathorn
Page 2
September 24, 2010

If you have any questions or comments, please call me or Richard Yarnell at telephone (865) 632-3463 or by e-mail at wryarnell@tva.gov.

Sincerely,

Eric Howard

A. Eric Howard
Federal Preservation Officer
Manager (Acting), Cultural Compliance
WT 11D-K

MH:RY:IKS
Enclosures
cc: Cynthia M. Anderson, LP 5D-C
Brenda E. Brickhouse, LP 5U-C
Ruth M. Horton, WT 11D-K
Susan J. Kelly, LP 5U-C
Khurshid K. Mehta, WT 6A-K
EDMS, WT 11D-K

Tennessee Valley Authority, 400 West Summit Hill Drive, Knoxville, Tennessee 37902-1499

September 24, 2010

To those listed:

BROWNS FERRY NUCLEAR (BFN) POWER PLANT COOLING TOWER ADDITIONS, LIMESTONE COUNTY, ALABAMA

The Tennessee Valley Authority (TVA) proposes to replace four of six existing cooling towers (Towers 1, 2, 5, and 6) with larger units and construct one additional 25–30 cell linear mechanical draft cooling tower site at BFN (Figures 1 and 2). The four existing cooling towers would be demolished and rebuilt within the existing footprint.

The new cooling tower (Tower 7) would be located along the east side of Shaw Road at the location of an existing perimeter ditch and includes the installation of a new pumping station, a cold water discharge canal, lift pumps and piping; and two new transformers (Figure 2). A portion of the ditch would be relocated directly northeast of proposed Tower 7 to maintain a perimeter ditch north of the new cooling tower. In addition, the cold water discharge canal is proposed between the north end of the spoil pile and the existing western perimeter ditch, and an approximate five-acre construction staging area is necessary.

TVA considers the archaeological area of potential effect (APE) to be the footprint where ground disturbance would take place. The majority of the BFN reservation has been previously disturbed by construction of the power plant and associated infrastructure. The majority of the land not disturbed by construction of BFN was surveyed in 2001 as part of the BFN relicensing and expansion Environmental Impact Statement. The survey identified one historic property, Site 1LI535, an Early to Middle Woodland period occupation that is considered potentially eligible for the National Register of Historic Places (NRHP) and is outside of the APE. The APE for the proposed undertaking has been extensively disturbed with the construction of BFN. It is TVA's findings that no cultural resources would be affected by the proposed undertaking.

TVA is consulting with the following federally recognized Indian tribes regarding properties within the proposed project's APE that may be of religious and cultural significance to them and eligible for the NRHP: Cherokee Nation, Eastern Band of Cherokee Indians, United Keetoowah Band of Cherokee Indians in Oklahoma, The Chickasaw Nation, Muscogee (Creek) Nation of Oklahoma, Alabama-Coushatta Tribe of Texas, Alabama-Quassarte Tribal Town, Kialegee Tribal Town, Poarch Band of Creek Indians, Thlopthlocco Tribal Town, Seminole Nation of Oklahoma, Seminole Tribe of Florida, Absentee Shawnee Tribe of Oklahoma, Eastern Shawnee Tribe of Oklahoma, and the Shawnee Tribe.

By this letter, TVA is providing notification of these findings and is seeking your comments regarding this undertaking and any properties that may be of religious and cultural significance and may be eligible for the NRHP pursuant to 36CFR § 800.2 (c)(2)(ii), 800.3 (f)(2), and 800.4 (a)(4)(b).

If you have any questions, please contact me by telephone at (865) 632-6461 or by e-mail at pbezzell@tva.gov. Please respond within 30 days of receipt of this letter, if you have any comments on the proposed undertaking.

Sincerely,

Pat Bernard Ezzell

Pat Bernard Ezzell
Tribal Liaison and Corporate Historian
Federal Determinations
WT 11D-K

MH:RY:PBE:IKS
Enclosures
cc: Cynthia M. Anderson, LP 5D-C
Brenda E. Brickhouse, LP 5U-C
Ruth M. Horton, WT 11D-K
Susan J. Kelly, LP 5U-C
Khurshid K. Mehta, WT 6A-K
EDMS, WT 11D-K

THOSE LISTED:

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Policy Analyst
Cherokee Nation
Post Office Box 948
Tahlequah, Oklahoma 74465

Governor Bill Anoatubby
The Chickasaw Nation
Post Office Box 1548
Ada. Oklahoma 72821-1548

Ms. Augustine Asbury
Cultural Preservation Coordinator
Alabama Quassarte Tribal Town
Post Office Box 187
Wetumka. Oklahoma 74883

Mr. Bryant Celestine
Tribal Historic Preservation Officer
Alabama-Coushatta Tribe of Texas
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Livingston, Texas 77351

Mr. Charles Coleman
NAGPRA Representative
Thlopthlocco Tribal Town
Route 1, Box 190-A
Weleetka, Oklahoma 74880

Ms. Natalie Deere
Tribal Historic Preservation Officer
Seminole Nation of Oklahoma
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Wewoka, Oklahoma 74884

Ms Robin DuShane
Cultural Preservation Director
Eastern Shawnee Tribe of Oklahoma
127 West Oneida
Seneca. Missouri 64865

Mr Henry Harjo
Environmental Director
Kialegee Tribal Town
Post Office Box 332
Wetumka. Oklahoma 74883

Mr. Tyler Howe
Historic Preservation Specialist
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Post Office Box 455
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cc: Mr. Russ Townsend
Tribal Historic Preservation Officer
Eastern Band of the Cherokee Indians
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Cherokee, North Carolina 28719

Mr. Ted Isham
Manager
Cultural Preservation
Muscogee (Creek) Nation
Post Office Box 580
Okmulgee, Oklahoma 74447

Ms. Karen Kaniatobe
Tribal Historic Preservation Officer
Absentee Shawnee Tribe of Oklahoma
2025 S. Gordon Cooper
Shawnee, Oklahoma 74801

Ms. Lisa C. LaRue
Director, Language, History and Culture &
Acting Tribal Historic Preservation Officer
United Keetoowah Band
of Cherokee Indians in Oklahoma
Post Office Box 746
Tahlequah, Oklahoma 74464

Mr. Kirk Perry
Administrator
Division of Policy and Standards
The Chickasaw Nation
Post Office Box 1548
Ada, Oklahoma 72821-1548

Ms. Jennifer Pietarila
Archaeological Data Analyst
Seminole Tribe of Florida
Ah-Tah-Thi-Ki Museum
HC-61 Box 21-A
Clewiston, Florida 33440

cc: Ms. Anne Mullins
Project Coordinator
Seminole Tribe of Florida
Ah-Tah-Thi-Ki Museum
HC-61, Box 21-A
Clewiston, Florida 33440

cc: Mr. Willard Steele
Tribal Historic Preservation Officer
Seminole Tribe of Florida
Ah-Tah-Thi-Ki Museum
HC-61, Box 21-A
Clewiston, Florida 33440

the Chickasaw Nation

Bill Anoatubby, Governor
Jefferson Keel, Lt. Governor

Headquarters

October 4, 2010

Ms. Patricia B. Ezzell
Tribal Liaison and Corporate Historian
Federal Determinations
WT 11D-K
Tennessee Valley Authority
400 West Summit Hill Drive
Knoxville, TN 37902-1499

Dear Ms. Ezzell:

Thank you for your letter of notification regarding your proposal to replace four of six existing cooling towers with larger units and construct one additional 25-30 cell linear mechanical draft cooling tower site at Browns Ferry Nuclear Power Plant in Limestone County, Alabama. We accept your finding that no cultural resources will be affected by this proposed undertaking.

This area is located within the aboriginal lands of the Chickasaw Nation and is an important area to us. We are unaware of any specific historic properties or traditional cultural, religious and/or sacred sites at this time. However, in the event of inadvertent discoveries, we expect all construction activities to cease and we be notified according to all applicable state and federal laws.

If you have any questions, please contact Ms. Gingy Nail, historic preservation officer at (580) 559-0817, gingy.nail@chickasaw.net or Ms. Julie Ray, historic preservation and repatriation manager at (580) 559-0825, julie.ray@chickasaw.net.

Sincerely,

Jefferson Keel

Jefferson Keel, Lt. Governor
The Chickasaw Nation

jar

Arlington at Mississippi · Post Office Box 1548 · Ada, OK 74821-1548 · 580-436-2603 · www.chickasaw.net

UNITED WE THRIVE

SEMINOLE TRIBE OF FLORIDA
TRIBAL HISTORIC PRESERVATION OFFICE

TRIBAL HISTORIC PRESERVATION OFFICE
SEMINOLE TRIBE OF FLORIDA
AH-TAH-THI-KI MUSEUM
34725 WEST BOUNDARY ROAD
CLEWISTON, FL 33440
PHONE: (863) 983-6549
FAX (863) 902-1117

TRIBAL OFFICERS
CHAIRMAN
MITCHELL CYPRESS
VICE CHAIRMAN
RICHARD BOWERS JR.
SECRETARY
PRISCILLA D. SAYEN
TREASURER
MICHAEL D. TIGER

Pat Bernard Ezzell
Tennessee Valley Authority
400 W. Summit Hill Drive
Knoxville, TN 37902

THPO#: 006967

October 20, 2010

Subject: Browns Ferry Nuclear Power Plant Cooling Tower Additions, Limestone County, Alabama

Dear Ms. Ezzell,

The Seminole Tribe of Florida's Tribal Historic Preservation Office (STOF-THPO) has received the Tennessee Valley Authority's correspondence concerning the aforementioned project. The STOF-THPO has no objection to your findings at this time. However, the STOF-THPO would like to be informed if cultural resources that are potentially ancestral or historically relevant to the Seminole Tribe of Florida are inadvertently discovered during the construction process. We thank you for the opportunity to review the information that has been sent to date regarding this project. Please reference ***THPO-006967*** for any related issues.

We look forward to working with you in the future.

Sincerely,

Willard Steele
Tribal Historic Preservation Officer
Seminole Tribe of Florida

Direct routine inquiries to:

Anne Mullins
Compliance Review Supervisor
annemullins@semtribe.com

JLP:am

STATE OF ALABAMA
ALABAMA HISTORICAL COMMISSION
468 SOUTH PERRY STREET
MONTGOMERY, ALABAMA 36130-0900

FRANK W. WHITE
EXECUTIVE DIRECTOR

TEL: 334-242-3184
FAX: 334-240-3477

October 25, 2010

Eric Howard
TVA
400 West Summit Hill Drive
Knoxville, Tennessee 37902-1499

Re: AHC 10-1306
Cooling Tower Additions
Browns Ferry Nuclear Plant
Cooling Tower Additions
Limestone County, Alabama

Dear ~~Mr. Howard:~~ Eric

Upon review of the information forwarded by your office, we have determined the proposed action should have no effect on significant cultural resources provided archaeological site 1Li535 is avoid, as stated in your letter.

We appreciate your efforts on this project. Should you have any questions, please contact Greg Rhinehart at (334) 230-2662. Please have the AHC tracking number referenced above available and include it with any correspondence.

Truly yours,

Elizabeth Ann Brown
Deputy State Historic Preservation Officer

EAB/LAW/GCR/gcr

7.1.2 Transmission Facilities

TVA owns, operates, and maintains the electrical transmission grid to which BFN is connected. The proposed uprate would contribute more power to the TVA transmission grid. A preliminary screening study was conducted by TVA Transmission Planning to estimate the potential impacts of EPU on the transmission system. The screening study determined that a number of transmission system issues need to be addressed, and transmission system upgrades may be required. A more definitive interconnection system impact study is underway. This study will identify specific transmission system upgrades that are required. If modifications to the transmission system are required, TVA will plan and design the upgrades and seek appropriate regulatory and environmental approvals prior to implementation of construction.

7.1.3 Electric Shock and Electromagnetic Field

Design criteria that limit hazards from steady-state currents are based on the National Electrical Safety Code (NESC), which requires that transmission lines are designed to limit the short-circuit current to ground produced from the largest anticipated vehicle to less than 5 milliamperes. TVA has designed transmission lines to exceed the requirements given in the NESC at the time the lines were constructed. As a general rule, TVA's transmission lines are upgraded consistent with current codes when work such as re-conductoring or re-sagging is performed on the lines, or the land use has changed under or around the line to cause a clearance problem.

TVA performs transmission line inspections to identify defects that could cause an interruption or an unsafe condition for employees or the public. Inspections are also used to plan maintenance activities and to protect TVA's easement rights. Typically, aerial patrol (i.e., usually helicopter fly-by) inspections are conducted every 6 months, and foot patrol (i.e., walking inspection of the entire transmission line and a visual inspection of the conductors, structures, and right-of-way) inspections are conducted every 4 years. If the land use under or adjacent to the line has changed causing a clearance problem, steps are taken to correct it such as removing the encroachment or adjusting line height.

A study documented in the 2003 BFN LRA ER concluded that the vertical clearances of all transmission lines built to connect BFN to TVA's transmission system met or exceeded the vertical clearance requirements of the 2002 Edition of the NESC. In January 2015, TVA analyzed the modifications that have occurred to each BFN transmission line since the 2003 license renewal study, and concluded that no modifications have been made since the 2003 study that would result in noncompliance with the vertical clearance and electric field requirements of the current NESC (2012 edition). It was concluded in 2003, and it remains a valid conclusion in 2015, that all BFN transmission lines have sufficient clearance to limit the steady-state current due to electrostatic effects to 5 milliamperes, should the largest anticipated truck, vehicle, or equipment under the line be short-circuited to ground.

TVA Transmission and Power Supply is cognizant of current findings of research into the health effects of electromagnetic fields (EMF) via literature and publications. EPU at BFN will increase line currents accordingly, which will result in higher magnetic fields. However, in 1999 the National Institute of Environmental Health Science concluded that the scientific evidence suggesting that EMF exposure poses any health risk is weak. The United States does not have national guidelines for exposure to power frequency EMF.

7.1.4 Non-Radiological Waste Streams

BFN generates four categories of non-radiological solid waste. These categories are:

1. General plant solid waste consisting of paper, cardboard, wood, metals, and garbage,
2. Recycled solid waste such as office paper, cardboard, wood pallets, scrap metal, aluminum cans, plastic bottles, and batteries,
3. Construction and demolition debris associated with site activities,
4. Universal Waste and Hazardous Waste as defined under the Resource Conservation and Recovery Act (RCRA).

7.1.4.1 Solid Waste

BFN generates municipal solid waste commonly known as “trash” or “garbage” which consists of food waste, plastic film, paper waste, and food product packaging waste. General plant trash is collected as part of routine plant operation activities and is managed through TVA Long-term Valley Wide Contract 4394 with Republic Service. Waste material is collected in dumpsters and transported to a state-licensed regional landfill permitted to accept waste materials. BFN uses Morris Farms Landfill in Lawrence County, Alabama, which is owned and operated by BFI Waste Systems of America. Generation rates for BFN are approximately 1.6 tons per day.

7.1.4.2 Recycled Solid Waste

BFN has an active recycling program that segregates and recycles scrap metal, cardboard, office paper, wood pallets, aluminum cans, plastic bottles, and batteries. The segregated materials are accepted for recycling by TVA-approved waste treatment and disposal facilities through contract with C&D Recycling.

7.1.4.3 Construction/Demolition Solid Waste

BFN has a permitted construction/demolition (C and D) landfill that is operated under ADEM Permit No. 42-02 and is designed to accept C and D waste such as unwanted material produced directly or incidentally by C and D at BFN. This includes material such as non-asbestos insulation, nails, wood, electrical wiring, rebar, bricks, concrete, excavated dirt, tree stumps, and rubble. The BFN C and D landfill is approximately 7.7 acres in size. The BFN Solid Waste Disposal Facility Permit allows a maximum average daily volume of 5 tons per day of C and D waste disposal. BFN can either use its own on-site C and D landfill or contract with local solid waste haulers to dispose of C and D solid waste in permitted local landfills. BFN currently has in place the necessary contracts for proper disposal of C and D wastes. The BFN C and D landfill permit from ADEM expires in September 2015. TVA requested renewal of the BFN five-year C and D landfill permit in March 2015.

7.1.4.4 Hazardous Waste

BFN generates a variety of wastes that are classified as hazardous under RCRA. The majority of the hazardous wastes generated at BFN are from spent solvents used in cleaning and degreasing activities and paint-related wastes from coating activities. In addition to these two major waste streams, BFN generates universal waste such as spent batteries, fluorescent light bulbs, and used oil for recycling.

TVA Nuclear Power Group (NPG) has design change procedures in place to evaluate modifications for potential changes in, or additions to, hazardous waste generation. Some of the plant modifications required to implement the EPU could result in the generation of small amounts of hazardous waste. Neither the types nor amounts of waste generated are expected to be different from those routinely handled at BFN. No new waste streams have been identified due to the uprate activities. The volumes of waste inclusive of the waste attributable to EPU are anticipated to be within the ranges defined by Title 40 of the Code of Federal Regulations for a Small Quantity Hazardous Waste Generator and would not impact site hazardous waste reduction goals. RCRA regulations define a Large Quantity Generator as generating more than 2,200 pounds (i.e., 1,000 kilograms) per month of hazardous waste. Hazardous wastes generated at BFN are managed through the TVA Direct Shipment Program with Waste Management's permitted landfill at Emelle, Alabama. Hazardous waste generation rates for BFN for the past 5 years are presented in Table 7.1-1.

Table 7.1-1: Annual Hazardous Waste Generation

Year	Hazardous Waste Generated at BFN (Pounds)	RCRA Generator Status
2010	1,917	Small Quantity Generator
2011	3,179	Small Quantity Generator
2012	3,601	Small Quantity Generator
2013	4,343	Small Quantity Generator
2014	2,335	Small Quantity Generator

BFN has not generated more than 2,200 pounds in any 1 month in the last 5 years; therefore, BFN is not a Large Quantity Generator.

7.1.4.5 Groundwater

TVA's NPG participates in an active program of groundwater monitoring consistent with the Nuclear Energy Institute's (NEI) guidance given in NEI 07-07, Industry Groundwater Protection Initiative—Final Guidance Document. TVA's NPG meets the requirements of the initiative through implementation of the Groundwater Protection Program (GWPP). The implementation of the GWPP demonstrates a commitment to the control of licensed material through prevention, early detection, and mitigation/remediation of impacts associated with groundwater contamination. TVA's GWPP also includes provisions to monitor, inspect, and improve underground piping and tank integrity to prevent future unintended releases of radiological materials to groundwater. TVA's NPG communicates events involving radiological contaminated spills and leaks to the NRC in accordance with 10 CFR 50.72 (b)(2)(xi) and to other outside agencies as required by the GWPP. The BFN EPU will not impact implementation of this voluntary initiative. No changes to the GWPP are required as a result of EPU implementation.

7.1.5 Noise

The only noise source of any significance from BFN which can periodically be heard off site is from the cooling towers, which operate most frequently during the summer months. After EPU is implemented, the increased discharge temperatures would require some additional cooling tower operation, which would slightly lengthen the duration of noise for residents nearest the cooling towers. There are no federal, State of Alabama, or local municipal noise standards, regulations or ordinances that apply to the action alternatives evaluated in this supplemental ER.

Areas that are potentially affected by environmental noise from typical industrial operations are usually within a 1-mile radius of the noise source(s). However, under special conditions that are favorable to outdoor sound propagation, affected areas can be as much as 2 miles distant. The results of past noise surveys and projections of noise levels indicate that the increase in noise level at the nearest residence to BFN, during cooling tower operation, is minor, and not noticeably altered. Current BFN Communications personnel are not aware of any complaints from area residents regarding noise from BFN operations; their tenure is at least 4 years. Also, a search of news clips by BFN Media Relations personnel for the past 5 years did not find anything about noise complaints. Cooling tower operations at BFN began in 1976 and are not new to the surrounding residents. Figure 7.1-2 shows the residential subdivisions within a 2-mile radius of BFN.

There are waterfront homes upstream and adjacent to BFN property (Pointe Westmoreland and Lookingbill subdivisions), but these residences are more than a mile from the closest cooling towers (CT 1 and CT 6) and there is a small hill and the main plant in between them and the cooling towers. Because of the physical configuration and the lack of favorable conditions for sound propagation in this direction, this residential area is not considered sensitive to environmental noise.

The Lakeview Community is across the river and approximately 8,500 feet from the center of the cooling tower area. It is primarily year-round homes with a few recreational residences. Even though Lakeview is well over a mile from BFN, it could be sensitive to environmental noise because the open pathway across water is favorable to sound propagation. However, BFN cooling tower noise has not been audible in the past at the Lakeview Community.

The older waterfront community of Paradise Shores is situated downstream of BFN and adjacent to the cooling tower area. Paradise Shores is currently a mix of year-round and recreational homes, forming a medium-to high-density suburban area that could be sensitive to environmental noise. There are about 100 residences within 1 mile of the closest cooling towers, and some are as close as 1,500 feet.

Because no physical changes for EPU are being made external to existing buildings, no construction noise is expected which could be heard off site.

The U.S. Environmental Protection Agency's (EPA's) protective noise guideline (EPA 1974) recommends an average annual equivalent day/night sound level (L_{dn}) of 55 decibels A-weighted scale (dBA) to protect the health and well-being of the public with an adequate margin of safety. TVA uses the EPA guideline of 55 dBA L_{dn} as a design goal, when feasible, if the nearest receptor is residential. For industrial and commercial areas, TVA uses the equivalent sound level (L_{eq}) of 60 dBA at the property line. In addition, TVA uses the Federal Interagency Committee on Noise (FICON) recommendation that a 3-decibel increase in L_{dn} indicates possible impact and the need for further analysis when the background is 60 dBA or less (FICON 1992). There are no federal, State of Alabama, or local municipal noise standards, regulations, or ordinances that apply to the action alternatives evaluated in this supplemental ER.

An environmental sound pressure level assessment was performed at BFN on August 8, 2012, while six of the seven cooling towers were in operation. From this 24-hour ambient noise sample, the L_{dn} was calculated at 61.9 dBA. A second 24-hour ambient noise sample was collected on September 6, 2012, while none of the cooling towers were operating; the calculated L_{dn} for this sample was 59.7 dBA. Both noise sample sets were collected at the location of the nearest residence to BFN, which is in the Paradise Shores community, located approximately 1,500 feet from the BFN property boundary. The measured 2012 background or ambient baseline noise levels without operation of the cooling towers exceeded the 55 dBA guideline for residential areas, but the FICON guideline of an allowable 3-decibel increase in L_{dn} at residences and exterior plant boundaries was met during cooling towers operation.

Since the August/September 2012 sound level measurements, CTs 3, 5, and 6 have been replaced. CT 4 had been replaced earlier in 2007, and CT 7 was constructed in 2011. Currently, work on all but two BFN cooling towers (CTs 1 and 2) of the seven BFN cooling towers is complete, and replacement of CTs 1 and 2 is scheduled for completion in FY 2018 and FY 2019. Additional sound monitoring is planned to be conducted following replacement of CTs 1 and 2. Sound level measurements will also be taken at the subdivisions within a 2-mile radius of BFN.

TVA will continue to meet FICON guidelines by working with the selected cooling tower vendor to ensure noise attenuating features are incorporated as required, such as low-noise fans, lower speed fans, and sound attenuators. Operational noise levels will be verified by a qualified acoustical engineer to ensure that noise levels comply with applicable guidelines and are consistent with previous commitments. In the event that the resulting noise levels are found to exceed the FICON guidelines, TVA would develop and implement additional acoustical mitigation such as modifications to fans and motors, or the installation of barriers. On site, TVA will continue to comply with Occupational Safety and Health Administration regulations to protect worker health.

The area around the cooling towers has been an industrialized area for more than 40 years, and wildlife species commonly observed in the area include those species that are less sensitive to human disturbance and common in the region. The noise produced during cooling tower operation is a combination of low-frequency steady humming produced by the cooling tower fans and sounds associated with the water cascading through the cooling tower fill. Under normal operation, there are no high-pitched sounds or intermittent loud noises that would serve to disrupt local wildlife. Onsite observations indicate that the wildlife in the area has adapted to the industrial noise of the site, and there is no indication that operation of the cooling towers disturbs the wildlife in the area. There are no state-protected or federally listed terrestrial animal species within 3 miles of the BFN site, which is well beyond the audible range of noises associated with cooling tower operation.

Figure 7.1-2: Residential Subdivisions Within 2-Mile Radius of BFN

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7.1.6 Terrestrial Biota

7.1.6.1 Terrestrial Biota—Animals

The BFN site is a heavily disturbed area and provides limited wildlife habitat. Due to the lack of features that provide high-quality wildlife habitats, such as streams, springs, caves, rock bluffs, and moist forested habitats, the overall diversity of wildlife at BFN is not uncommon from a local, state, or regional perspective. Terrestrial wildlife species found among upland habitats on the BFN site are generally common and have widespread distributions. No uncommon wildlife communities, important terrestrial habitats such as caves, or wading bird colonies occur within 6 miles of BFN. Proposed actions would not impact unique or important terrestrial habitats or populations of migratory birds.

The TVA Natural Heritage database indicated on September 23, 2014, the presence of one federally listed species and no state-listed species within 6 miles of the BFN EPU project footprint. One federally listed species with partial status (hellbender) and one federally listed endangered species (gray bat) have been recorded within Limestone County, Alabama. The federally listed endangered Indiana bat and federally listed threatened northern long-eared bat also have the potential to exist across the known range for these species (Pruitt and TeWinkel 2007; USFWS 2014a; USFWS 2015). Although these bat species have not yet been reported from Limestone County, Alabama, they are thought to have the potential to occur across the northern portion of Alabama (Pruitt and TeWinkel 2007; USFWS 2014a; USFWS 2015). Table 7.1-2 provides a summary of federally listed and state-listed as protected terrestrial animals reported, or with the potential to occur, in Limestone County, Alabama. Thus, impacts to these species will also be evaluated.

Hellbenders are generally found in clear, rocky creeks and rivers where water temperatures are typically less than 20°C. They are associated with large shelter rocks and submerged logs (Hammerson 2005). This species has been reported approximately 15.4 miles away from the project footprint and is known to occur in the Tennessee River. Proposed actions would not increase temperature or flow rates of discharged water beyond permitted NPDES limits. Suitable habitat for this species is also plentiful along the Tennessee River and its tributaries. Hellbenders would not be impacted by the proposed EPU.

Bald eagles are protected under the Bald and Golden Eagle Protection Act (USFWS 2013). This species is associated with larger mature trees capable of supporting its massive nests. These are usually found near larger waterways where the eagles forage on fish (USFWS 2007). The TVA Natural Heritage database indicated that the nearest bald eagle nest is approximately 5.4 miles away from BFN. Proposed modifications actions would occur in or on existing BFN structures and no tree removal would occur in association with this project. Proposed actions are not expected to adversely impact the fish community of Wheeler Reservoir either (see Sections 7.2.4 and 7.2.6). Nesting and foraging habitat for the bald eagle would not be impacted by the proposed actions, thus bald eagles would not be impacted by the proposed actions.

Table 7.1-2: Federally Listed and State-Listed as Protected Terrestrial Animals Reported From or With Potential to Occur in Limestone County, Alabama

Common Name	Scientific Name	Status	
		Federal	State (Rank)
Amphibians			
Hellbender	*Cryptobranchus alleganiensis*	PS	PROT(S2)
Birds			
Bald eagle	*Haliaeetus leucocephalus*	DM	NMGT(S3)
Mammals			
Gray bat	*Myotis grisescens*	LE	END(S2)
Northern long-eared bat	*Myotis septentrionalis*	LT	NMGT(S4)
Indiana bat	*Myotis sodalis*	LE	END(S1)

Source: TVA Natural Heritage database.

Federal Status Abbreviations: DM = Delisted; Recovered but Monitored; LE = Listed Endangered; LT = Listed Threatened; PS = Partial Status.

State Status Abbreviations: END = Endangered; NMGT = In need of management; PE = Proposed Endangered; PROT = Protected;

State Rank Information:

S1 = Critically Imperiled
S2 = Imperiled
S3 = Vulnerable
S4 = Apparently Secure

Gray bats roost in caves year-round and migrate between summer and winter roosts during spring and fall (Brady et al. 1982; Tuttle 1976). Bats disperse over bodies of water at dusk where they forage for insects emerging from the surface of the water (Harvey 1992). The TVA Natural Heritage database on September 23, 2014, indicated two gray bat caves have been recorded, approximately 9.5 and 13.7 miles away from the project footprint. There are no caves that occur on or immediately adjacent to BFN property. Gray bats foraging habitat exists over Wheeler Reservoir; however, proposed actions would not impact foraging bats. Gray bats would not be impacted by the proposed project.

Indiana bats inhabit caves during winter and migrate to roost under exfoliating bark and within cavities of trees (typically greater than or equal to 5 inches in diameter) during summer (USFWS 2014b; Pruitt and TeWinkel 2007; Kurta et al. 2002). Foraging occurs along riparian zones, above the tops of forests, and along forested edges and tree lines (Pruitt and TeWinkel 2007). Some habitat requirements overlap between the Indiana and northern long-eared bat, which roosts in caves or cave-like structures in winter, and utilizes cave-like structures as well as live in dead trees with exfoliating bark and crevices in the summer (USFWS 2014a). There are no known records of the northern long-eared bat within Limestone County, Alabama or within 10 miles of the project footprint. The nearest known Indiana bat record is from a hibernaculum approximately 9.5 miles from BFN in Lauderdale County, Alabama. Both species are thought to occur throughout northern Alabama, thus both have the potential to occur in the area (Pruitt and TeWinkel 2007; USFWS 2014a; USFWS 2015). However, no suitable habitat for either bat species would be impacted by the proposed actions. There is no tree clearing occurring in association with this project nor are any caves known on or within 6 miles of BFN property. Proposed actions would not impact bats foraging over Wheeler Reservoir. Proposed actions would not impact the Indiana bat. The northern long-eared bat has recently been federally listed as threatened, and interim measures for their conservation were issued by the USFWS (USFWS 2015). In the interim, federal action agencies are required to make determinations with respect to whether proposed actions would result in jeopardy to the species based on guidance provided by the USFWS on January 6th, 2014 (USFWS 2014a; USFWS 2015). Based on the nature and scope of the project, the proposed actions are not likely to jeopardize the continued existence of the northern long-eared bat.

7.1.6.2 Terrestrial Biota—Plants

Threatened and Endangered Species and Terrestrial Ecology (Plants)

The TVA Natural Heritage Database indicated that no federally listed or state-listed plant species have been previously reported from within a 6-mile radius of the project area. No federally listed plant species or designated critical habitat for plant species occur in Limestone County, Alabama.

The proposed EPU of BFN Units 1, 2, and 3 would not affect federally listed or state-protected plant species, because all work would occur in areas that have been heavily impacted by previous construction, operation, and maintenance of the facility. These areas are incapable of supporting rare species or habitats and do support a large component of nonnative, invasive species indicative of disturbed sites.

7.1.7 Air Impacts

The remaining BFN EPU construction and equipment installation would occur during the refueling outages between now and EPU implementation. During those outages, additional air emissions will be from the increased workforce driving to and from the site. As described in Section 5.1, the increased staffing for an outage is 800 to 1,200 supplemental workers. Staffing ramps up 2 to 3 weeks prior to the outage start. Staffing begins to ramp down 21 to 28 days from the start of the outage. TVA's current business plan outage duration is 35 days or less. For the EPU outages, TVA estimates that 10 percent or less of the supplemental work force will be dedicated to the EPU portion of the outage. The short-term impacts on air emissions would be commensurate with the increased supplemental staffing. The major equipment and materials to support the EPU outages will mostly be supplied and stored on site well before the start of the outage period. Most of the smaller EPU supplies will be delivered on trucks that routinely supply similar tools and materials to support plant operations. Therefore, temporary increases in air emissions prior to and during EPU outages are expected to be minor.

The emergency diesel generators are operated under a Synthetic Minor Source Air Operating Permit. The BFN EPU will not increase the frequency or duration of the emergency diesel generator surveillance test and the future operation of the diesel generators will be in accordance with the requirements of the air permit. Therefore, no increase in emissions from this source is anticipated.

7.1.8 References

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7.2 Hydrology and Aquatic Ecology Effects

7.2.1 Wheeler Reservoir

BFN is located on the north shore of Wheeler Reservoir at TRM 294. Wheeler Reservoir extends from TRM 274.9 to TRM 349. For orientation, TRM 0.0 is downstream where the Tennessee River joins the Ohio River in Paducah, Kentucky. Wheeler Dam is downstream of BFN at TRM 274.9, and Guntersville Dam lies upstream at TRM 349.0.

Wheeler Reservoir was created in 1936 and has an area of 67,070 acres and a volume of 1,050,000 acre-feet at the normal summer pool elevation of 556 feet mean sea level. Most of Wheeler Reservoir is classified by ADEM for use as public water supply, swimming and other whole-body water-contact sports, and fish and wildlife. Although the area of the reservoir immediately upstream and downstream of BFN is not currently classified for public water supply, it potentially could be if a municipal water intake was sited there in the future. Water quality is generally good in Wheeler Reservoir, but nutrient loads are a concern. The reservoir is on the 2014 Alabama 303(d) list as partially supporting its designated uses due to excess nutrients attributed to agricultural sources (ADEM 2014).

Fish consumption advisories have also been issued for certain areas of the reservoir. The State of Alabama recommends (1) limiting consumption of largemouth bass from TRM 296.0 to TRM 303.0 and all species of fish from Baker's Creek embayment because of perfluorooctane sulfonate (PFOS) contamination, and (2) limiting consumption of largemouth bass from Limestone Creek and Round Island Creek embayments because of elevated concentrations of mercury. PFOS is a manmade compound used in a variety of industrial and commercial products. PFOS is no longer manufactured in the United States and its use is being phased out. (EPA 2014a) Mercury occurs naturally in rock and soils but can also originate from other sources, including atmospheric emissions from human activities (fossil fuel combustion, waste incinerations, steel mills) or from natural processes (forest fires, volcanoes) (USGS 2014).

Water temperature patterns in Wheeler Reservoir are constantly changing in response to varying meteorological and flow conditions. Natural water temperatures in the reservoir vary from around 35 degrees Fahrenheit (^{o}F) in January to around 88 to 90^{o}F in July and August. Temperature patterns upstream of BFN are typically well mixed or develop only weak thermal stratification.

There are nine potable water intakes on Wheeler Reservoir withdrawing a total of approximately 216 million gallons per day (MGD) for municipal and industrial use. Wastewater discharges include 13 municipal plants discharging approximately 54 MGD. Eight (non-TVA) industrial entities discharge approximately 146 MGD. The largest withdrawal and discharge by far is cooling water from BFN. In 2010, BFN withdrew approximately 2,750 MGD and returned approximately 2,741 MGD. Consumptive and off-stream water uses do not conflict significantly due to the large volume of reservoir water available, the river flow rate that has 24-hour average minimum flows ranging from 7,000 cubic feet per second (cfs) to 10,000 cfs, and the return of almost all of the water withdrawn.

7.2.2 Impact on Withdrawal

BFN uses a once-through condenser circulating water (CCW) system to dissipate waste heat from the plant steam turbines. The water is withdrawn from the Tennessee River by an intake structure located at about TRM 294.3. For open mode operation, the CCW system is designed to provide a flow of 630,000 gpm for Unit 1 and 675,000 gpm for Unit 2 and Unit 3. For all three units, this suggests a total CCW design flow of 1,980,000 gpm or 4,412 cfs. Due to system upgrades, such as refitting the condensers with larger diameter and lower resistance tubes, the total per-unit condenser circulating water system flow, in general, is now higher than the design values. In addition to flow through the CCW pumps, the plant total intake also includes withdrawals for the emergency equipment cooling water system, the residual heat removal service water system, the fire protection system, and the intake screen wash system. Velocity measurements collected in front of the plant intake in November 2014 suggest a total intake flow on the day of the measurements of about 2,118,300 gpm or 4,720 cfs. No changes are expected for the plant intake systems as a result of the power uprate. That is, the uprate project will not impact the current volume of water withdrawn from Wheeler Reservoir by the plant.

7.2.3 Impact on Discharge

Most of the water withdrawn at the plant intake is returned to the river. Water losses by evaporation and drift (water droplets entrained in airstream passing through tower) will occur for the CCW system when cooling towers are in service. For the other systems, the only loss of water would be comparatively negligible, unquantifiable amounts due to evaporation whenever the water is exposed to air.

The water returned to the river from the plant is accomplished using submerged diffusers situated on the bottom of the river at about TRM 294.0. The diffusers are designed to mix the plant thermal effluent with the water in the river by discharging the effluent through thousands of small outlet ports in the diffuser pipes. In terms of hydrothermal impacts on the Tennessee River, operation of the circulating water system is regulated by the State of Alabama under NPDES Permit No. AL0022080 (ADEM 2012). The permit specifies that the river ambient temperature shall be measured by an upstream monitor located at about TRM 297.8, and that impacts relative to the ambient temperature shall be measured by three downstream monitors located at about TRM 293.5. The upstream monitor is about 3.8 miles upstream of the diffusers, whereas the downstream monitors are located near the end of a mixing zone, which extends 2,400 feet (0.45 miles) downstream of the diffusers. The NPDES permit specifies that at the downstream end of the mixing zone, the operation of the plant shall not cause:

- The measured 1-hour average temperature to exceed 93°F.
- The measured daily average temperature to exceed 90°F.
- The measured daily average temperature rise (relative to ambient) to exceed 10 F°.

Furthermore, if the natural heating of Tennessee River causes the daily average upstream ambient river temperature to exceed 90°F, the daily average downstream temperature may equal, but not exceed, the upstream value. However, in connection with such an event, if the daily average upstream ambient river temperature begins to cool at a rate of 0.5 F° per day or more, the downstream temperature is allowed to exceed the upstream value for that day. In the NPDES permit, the latter occurrence is identified as a cooling anomaly condition.

When plant operating conditions create a river temperature threatening one of the NPDES limits given above, the plant is shifted from open mode operation to helper mode operation, wherein the condenser circulating water is treated (cooled) by cooling towers before it is routed to the river. The amount of water treated by the cooling towers depends on the amount of cooling needed for the plant to remain in compliance with the NPDES limits. The three units can be placed in helper mode individually or collectively (i.e., one, two or all three units). If helper mode operation is not sufficient in keeping the river temperature from threatening an NPDES limit, TVA reduces the thermal power of one or more of the units to maintain regulatory compliance.

Hydrothermal impacts are assessed on the changes in water temperature and other water quality parameters of the Tennessee River as a result of the power uprate. Previous studies of the thermal impacts due to the proposed power uprate are given by TVA (2003) and TVA (2004). The evaluations summarized herein incorporate observations from recent years containing warm and dry meteorology, and recent and planned future changes in the plant cooling system. The plant has seven cooling towers, and the same is expected throughout the life of the power uprate. The current characteristics of the plant cooling towers are summarized in Table 7.2-1. Compared to previous studies, recent changes in the cooling system include the rebuilding of four of the original six cooling towers, and the addition of the new seventh cooling tower. Planned future changes in the cooling system include rebuilding of the two remaining original cooling towers (CTs 1 and 2).

To predict the impact of this additional heat, hydrothermal model simulations were updated from those performed previously (TVA 2003; TVA 2004). The computer simulations were limited to the evaluation of river temperature in the immediate vicinity of the plant as represented by the NPDES mixing zone. It is in this region that the impact of the additional heat is the greatest, and it is in this region that regulatory requirements for river temperature have the greatest influence on the operation of the plant. In previous studies, simulations also were performed to examine impacts reservoir wide and not only for river temperature, but also for algal biomass and dissolved oxygen. In these studies, even in years that were warmer and dryer than normal, the predicted impacts on these parameters were minor, and not noticeably altered. Because the plant cooling tower capacity is now greater than that assumed in the previous studies, reservoir-wide impacts are expected to be bounded by previous studies and therefore reservoir-wide modeling was not repeated in the current evaluations.

It is important to note that in previous studies, the number of cooling towers was insufficient to treat all of the condenser circulating water flowing through the plant when all of the units were operating at the full flow capacity of the individual CCW systems. In contrast, the current number of cooling towers (as summarized in Table 7.2-1) have enough capacity to treat all of the condenser circulating water flowing through the plant.

The dissipation of waste heat from the plant is of greatest concern in the summer, when the largest potential exists for aquatic wildlife to become stressed by high water temperature. TVA classifies summer hydrothermal conditions for the Tennessee Valley based on the average June-July-August air temperature and average June-July-August river flow at Chattanooga (TRM 464). For the available period of record, from 1948 through 2014 (67 years), Figure 7.2-1 summarizes these conditions in a cross plot showing for each year the deviation in average air temperature from the long-term mean at Chattanooga (x-axis), and the deviation in average natural river flow from the long-term mean at Chickamauga Dam (y-axis). The natural river flow is a theoretical discharge based on (1) observed rainfall/runoff upstream of Chickamauga Dam, and (2) no flow regulation by any control structures in the Tennessee River and its tributaries (e.g., dams). The natural flow at Chickamauga Dam (TRM 471) provides a measure of the extent of wet or dry conditions in the eastern part of the Tennessee Valley. The long-term mean air temperature and mean natural river flow are based on the summertime values for the entire 67-year period of record. The cross plot divides summer conditions into one of four quadrants: warm and wet, warm and dry, cool and dry, and cool and wet. For BFN, only summers in the warm and dry quadrant yield conditions that seriously challenge the NPDES limits for river temperature. For the period of record, about 43 percent of years fall in the warm and dry quadrant. However, in the past 10 years (highlighted in Figure 7.2-1), seven have fallen in the warm and dry quadrant.

To mimic a possible future dominated by warm and dry summer meteorology, the simulations presented herein evaluate the plant operation based on river flows and meteorology as observed for the 6-year period from 2007 through 2012 (highlighted in red in Figure 7.2-1). All but one of these years include a warm and dry summer. Summer 2009 was warm and barely wet (average natural flow only 0.5 percent above mean). This 6-year period includes the warmest summer of record, 2010, and extreme drought conditions that occurred in 2007 and 2008.

A detailed description of the hydrothermal model is given by TVA (2005). For the results presented herein, Table 7.2-2 provides a summary of basic model assumptions. In general, the model marches forward in time, computing the NPDES temperatures based on the ambient conditions of the river, the operating conditions of the plant, and meteorology. The model also computes the turbine backpressure for each unit, which also contains an operating limit. Depending on the computed temperatures verses the NPDES limits (or the computed backpressure verses the backpressure limit), the model decides whether or not helper mode operation is needed, and whether or not a derate is needed. In this process, it is important to note that the model examines operating conditions only one hour into the future. Furthermore, to maintain compliance, the model only considers changes in the operating conditions of the plant, not that of the river. In actuality, the TVA process for managing the river and thermal plants examines forecast conditions for up to a week or more into the future, allowing changes to be made perhaps days in advance to avert, defer, or reduce the need for helper mode operation and/or a derate. The process also allows changes in the operation of the river as well as changes in the operation of the plant. The dynamics of the actual process for managing the river and BFN are far too indefinite and complex to be captured in the model. For this reason, model results are considered to represent only a rough order of magnitude estimate of the potential bounding impacts of the power uprate.

For the simulations summarized herein, the results at 105 percent OLTP assume the configuration of cooling towers is the same as that summarized in Table 7.2-1. Results at 120 percent OLTP assume that CTs 1 and 2 are replaced with new cooling towers with design characteristics the same as those for CT 5.

Presented in Table 7.2-3 are the results comparing plant operation at 120 percent OLTP with plant operation at 105 percent OLTP. The table includes four sections: the first summarizes impacts on water temperature, the second summarizes impacts on helper mode operation (i.e., cooling tower operation), the third and fourth summarize impacts on plant electrical generation (i.e., derates and net generation). Notable observations include the following:

- For years with warm summers, the temperature of water exiting the diffusers at 120 percent OLTP, on the average, will be about 2.6 F° warmer than the temperature of water at 105 percent OLTP. For the maximum hourly value, as well as the maximum 24-hour average value, the model results imply a change in the temperature of water exiting the diffusers of 4.7 F° warmer and 3.4 F° warmer, respectively.
- For years with warm summers, the temperature of the river at the compliance depth at the downstream end of the mixing zone at 120 percent OLTP, on the average, will be about 0.6 F° warmer than the temperature at 105 percent OLTP. For the maximum hourly value, as well as the maximum 24-hour average value, the model results imply very subtle changes in the temperature of the river at the compliance depth at the downstream end of the mixing zone (only 0.1 F° cooler). This primarily is due to additional helper mode operation.
- For years with warm summers, the number of days of helper mode operation, on the average, is expected to increase by about 13 days at 120 percent OLTP as compared to 105 percent OLTP. At 120 percent OLTP, the most extreme years are expected to include about 121 days of helper mode operation.
- For years with warm summers the number of summers containing derates is expected to remain at 1 in 6 at EPU conditions. For warm summers containing derates, the maximum number of hours of derate per year is expected to increase by about 28 at 120 percent OLTP with a maximum overall increase in annual hydrothermal derate energy loss of about 20,785 MWh. In derate events, the average amount of derate power loss is expected to increase by about 54 MW at 120 percent OLTP.
- The average annual net generation with the uprate from 105 percent OLTP to 120 percent OLTP is expected to increase by about 4.9×10^6 MWh.

At both 105 percent and 120 percent OLTP, the derate predictions summarized in Table 7.2-3 occurred only for 2010, the warmest summer of record (see Figure 7.2-1). Other notable observations from the hydrothermal simulations include the following:

- In helper mode operation, the model results indicate a water loss due to cooling tower evaporation of about 2.7 percent of the cooling tower flow on average. Berger (1995) suggests that manufacturers strive to limit cooling tower drift to about 0.2 percent of the flow. Thus, during helper mode operation, the combined loss due to evaporation and drift is expected to be roughly 3 percent of the cooling tower flow. If all seven cooling towers are in service, and for the power uprate (i.e., CT 1 and 2 replaced with new cooling towers the same as CT 5), the design flows in Table 7.2-1 suggest the water loss by cooling tower evaporation and drift to be magnitude 60,300 gpm or 134 cfs.

- The hydrothermal derates of Table 7.2-3 include events wherein the downstream temperature challenged the 1-hour average NPDES temperature limit of 93°F. To protect this limit in the hydrothermal model, cooling tower operation and derates were triggered when hourly temperatures reached 92°F. However, if the model predictions emerge as accurate, these events will come as one hour temperature spikes with little or no warning to the plant. In these events, and in contrast to the model, current plant operating procedures do not support such a rapid response for implementing cooling tower operation and derates. In fact, operating limitations of some plant equipment make it impossible to respond to these types of events within one hour. To prepare for such, plant operating procedures will need to be updated to initiate cooling tower operation and derates more conservatively; for example, by specifying a lower value of the measured 1-hour average downstream temperature to trigger changes in helper mode operation and derates. The use of a hydrothermal forecast model (such as the one utilized herein) also may help to identify conditions conducive for potential threats to the 93°F limit.
- At 120 percent OLTP, model predictions for helper mode operation include events to protect the NPDES limit for the maximum instream temperature rise of 10 F°. These events will occur in the cooler months of the year, primarily in the late winter and early spring when river flows are curtailed to allow filling of tributary reservoirs in the eastern part of the Tennessee River watershed. Although such events have occurred for existing plant conditions (e.g., March 2014), the frequency and duration of these events will increase at 120 percent OLTP. That is, cooling tower equipment will need to be prepared for operation during periods outside of the normal period of high readiness in the summer.

The existing protocol between TVA River Operations and BFN Operations ensures that during normal conditions the cooling towers are operated and/or the units are de-rated to comply with the NPDES permit.

In addition to the diffuser discharge, effluent discharges also occur from other plant systems such as yard drainage, station sumps, and sewage treatment. These are not expected to change due to the power uprate, and as such are expected to remain within the bounding conditions established in the NPDES permit for these discharges. Overall, in terms of plant discharges to the river, the power uprate will have minimal impact either individually or cumulatively on the environment.

Table 7.2-1: BFN Cooling Tower Characteristics, October 2014

Tower (1, 2)	Startup	Reference			No. Cells or Fans	Fan hp	No. Pumps	Pump hp	Flow per Pump Max (gpm)	Tower Flow			Capability (%)
		Wet Bulb Temp (°F)	Hot Water Temp (°F)	Cold Water Temp (°F)						Design (gpm)	Min (gpm)(3)	Max (gpm)	
1	1976	78.0(4)	126.7(4)	95.0(4)	16	200	2	3100	145,950	275,000	220,000	291,900(5)	94.0(5)
2	1976	80.0(5)	129.7(5)	98.0(5)	16	200	2	3100	139,800	275,000	220,000	279,600(5)	113.0(5)
3	2013	82.0(6)	118.5(6)	91.6(6)	16	250	2	3100	137,500	265,000(7, 8)	212,000	275,000(7, 8)	102.5(6)
4	2007	80.0(9)	119.2(9)	91.0(9)	16	250	2	3100	140,150	275,000	220,000	280,300(9)	102.0(9)
5	2013	82.0(10)	118.5(10)	90.0(10)	19	250	2	3100	137,500	265,000(8, 11)	212,000	275,000(8,11)	103.9(10)
6	2014	82.0(12)	118.5(12)	91.6(12)	16	250	2	3100	137,500	265,000(8, 13)	212,000	275,000(8, 13)	100.0(12)
7	2012	82.0(14)	118.5(14)	90.0(14)	28	250	4	2700	111,475	410,000(14)	328,000	445,900(14)	103.1(14)

Notes:

1. CT 1 and CT 2 = Ecodyne, Inc. (original towers). CT 3, CT 5, CT 6, and CT 7 = Composite Cooling Solutions, Inc. Tower 4 = Marley, Inc.
2. Cooling towers 1 and 2 are currently planned to be replaced in FY18 and FY19.
3. For BFN forecasting models, assume pumps can be throttled to 80 percent of design flow to balance CCW flow.
4. Reference wet bulb, hot water, and cold water temperatures derived from performance curves of original towers. Design wet bulb, hot water, and cold water temperatures of original towers are 55.0°F, 115.7°F, and 84.0°F, respectively.
5. Thermal Performance Tests, CTI Report No. CA08-13, Rev. 1, 01/21/2009, SPX Cooling Technologies, Inc.
6. Cooling Tower Performance Test At TVA Browns Ferry Nuclear Plant On Cooling Tower #3, BFN-CT3-2013-TEST, Fulkerson and Associates, Inc., September 12, 2013. Entered into TVA EDMS 04/24/2014: Document ID = BFN-CT3-2013-TEST (B41140424001).
7. MDN000272013000155, Calculation of Flow Rate to New Cooling Tower No. 3.
8. New towers designed for 275,000 gpm, but use of existing/original pumps results in lower flow because new towers are taller than original towers. Notes 9, 10, and 11 are hydraulic analyses supporting the replacement of the cooling towers. The calculated design flows at NORMAL water level in the warm water channel are 265,461 gpm (CT 3), 264,383 gpm (CT 5), and 266,091 gpm (CT 6). The calculated flows at MAXIMUM water level are 274,994 gpm (CT 3), 273,850 gpm (CT 5), and 275,586 gpm (CT 6). The design and maximum flows provided herein, 265,000 gpm and 275,000 gpm, respectively, are assigned as the average of the NORMAL and MAXIMUM calculated flows, respectively (rounded to the nearest 1000 gpm). In tests conducted in the summer 2013, CT 3 and CT 5 provided only 246,725 gpm and 246,329 gpm, respectively. Lift pump flow is a function of the water level in the warm water channel--flows higher than these measured values are expected when the water level in the warm water channel is higher (i.e., lower head to the top of the towers).

9. Thermal Acceptance Tests, T07-08, July 2007, Cooling Tower Test Associated, Inc.

10. Cooling Tower Performance Test At TVA Browns Ferry Nuclear Plant On Cooling Tower #5, BFN-CT5-2013-TEST, Fulkerson and Associates, Inc., October 31, 2013. Entered into TVA EDMS on 04/24/2014. Document ID = BFN-CT5-2013-TEST (B41140424002).
11. MDN0000272013000162, Calculation of Flow Rate to New Cooling Tower No. 5.
12. Results from cooling tower performance tests unknown as of 11/2014--assume 100 percent capability based on performance of other new towers.
13. MDN0000272013000197, Calculation of Flow Rate to New Cooling Tower No. 6.
14. Thermal Performance Tests, Mesa Specification No. 1057004-MS11-002, Calc No. MDN0027201000. Also, Cooling Tower Performance Test At TVA Browns Ferry Nuclear Plant, BFN-CT7-2012-TEST, B41140424003, Fulkerson and Associates, Inc., September 20, 2012.

Table 7.2-2: Basic Assumptions for BFN Hydrothermal Modeling

Unit Operation
All three units operate at full power unless a derate is required. For 120% OLTP, the maximum generation is 1,332 MWe (pf = 1.0) per unit. Unit power level is not reduced until all towers are brought into service, subject to the 80% minimum tower water loading (see below). Unit power level is reduced (derated) when operation at full load causes one or more of the following triggers to be attained: 1-hour downstream temperature = 92.5 (NPDES limit 93°F), 24-hour average downstream temperature = 89.5 (NPDES limit 90°F), 24-hour average temperature rise (ΔT or delta T) = 9.5 (NPDES limit 10 F°), or 1-hour unit backpressure = 5.5 in Hg (i.e., assume limit is 5.5 in Hg). Power reductions are reduced sequentially among the operating units (i.e., one unit at a time). Power is reduced in electric generation amounts equivalent to increments of 50 MWe. If power is reduced on a unit, it must remain at the lowest value for at least 8 hours before initiating recovery. If the equivalent generation on a unit drops below 440 MWe it is shut down.
Condenser Circulating Water (CCW) Operation
Open-mode CCW flows are 276,300; 531,237; 688,776 gpm for 1, 2, and 3 pumps, respectively. The static head on the CCW pumps is increased by 2.63 feet if the unit is operating in helper-mode. Helper-mode CCW flows are 276,300; 519,342; 670,105 gpm for 1, 2, and 3 pumps, respectively. Always operate with 3 CCW pumps. CCW pumps are throttled when specifically needed to balance the plant flow. The condenser cleanliness is 85% for all units.
Cooling Tower Operation
All cooling towers are assumed to be in reliable operating condition. At 105% OLTP all towers are assumed to be those currently existing (2014). At 120% OLTP CTs 1 and 2 are assumed to be replaced by 19 cell towers equivalent to the current (2014) CT 5. Cooling towers are brought into service in order of decreasing rating (best first to worst last). Cooling tower rating is a combination of maximum flow, the design point, and the capability. In this, the tower with the largest flow capacity is not necessarily brought into service first. Cooling towers are brought into service one lift pump at a time until all of the CCW flow is handled or all towers are in service. The last lift pump added can be throttled to 80% flow. Only the last lift pump on a tower may be throttled in order to not exceed the maximum flow for that cooling tower. All but the last tower added will be operated at their individual maximum water loading. If cooling towers are brought into service they must remain in service for at least 8 hours. Helper mode operation is initiated or increased if plant operation causes at least one of the following triggers to be attained: 1-hour downstream temperature of any single unit = 92.0°F (NPDES limit 93°F), 24-hour average downstream temperature = 88°F (NPDES limit 90°F), or 24-hour average temperature rise (ΔT or delta T) = 8 F° (NPDES limit 10 F°). Meteorology for cooling tower operation per historical data recorded at the BFN met station for the period of record 2007 through 2012.

Equipment Service Loads
The service load for the CCW pumps is 1.35 MWe/pump. The service load is the same for a CCW pump whether it is throttled or not. The service load for the cooling tower lift pumps is as given in Table 7.2-1. The service load is the same for a cooling tower lift pump whether it is throttled or not. The service load for the cooling tower fans is as given in Table 7.2-1.
Plant Water Routing
If a unit is operating in open mode, the water flows from the condenser directly to the diffuser. All of the water from all units operating in helper mode is fully mixed at the entrance to the cooling tower warm water channel. The mixed water from all units operating in helper mode is lifted to the cooling towers. All of the water leaving the cooling towers is mixed and then split evenly among the diffusers of units <u>not operating</u> in open mode. That is, water from the cooling towers is not mixed with water discharged from any unit operating in open mode. Any water from units operating in helper mode and not flowing through the cooling towers is bypassed to the diffusers. Bypass water is mixed with cooling tower discharge.
Ambient River Conditions
River flows past BFN computed based on historical operation of Wheeler Dam and Guntersville Dam per TVA Hourly Water Records for the period of record 2007 through 2012. Ambient river temperature per historical data recorded at BFN Water Station No. 4 for the period of record 2007 through 2012.
Diffuser Mixing
Equivalent diffuser slot width 1.5 feet. Ambient entrainment coefficients are 1.00 for one-unit operation and 0.25 for two-unit and three-unit operation. Diffuser re-entrainment coefficient is 0.25.

Table 7.2-3: Summary of BFN Hydrothermal Impacts for Warm, Summer Meteorology

Parameter [1]		0% OLTP [2]	105% OLTP	120% OLTP	Change 105%→120% OLTP
Water Temperature (°F)					
Ambient River Temperature at Compliance Depth	Average	66.5	66.5	66.5	0
	Hourly Max	94.3	94.3	94.3	0
	Hourly Min	37.6	37.6	37.6	0
	24-hr Avg Max	91.5	91.5	91.5	0
	24-hr Avg Min	38.4	38.4	38.4	0
Diffuser Discharge Temperature, Flow-Weighted	Average	NA [4]	86.9	89.5	+2.6 F°
	Hourly Max	NA	112.5	117.2	+4.7 F°
	Hourly Min	NA	60.3	58.0	-2.3 F°
	24-hr Avg Max	NA	107.1	110.5	+3.5 F°
	24-hr Avg Min	NA	60.8	64.3	+3.5 F°
Temperature at Downstream End of Mixing Zone at Compliance Depth	Average	66.5 [3]	70.8	71.4	+0.6 F°
	Hourly Max	94.3 [3]	92.1	92.0	-0.1 F°
	Hourly Min	37.6 [3]	39.8	40.3	+0.5 F°
	24-hr Avg Max	91.5 [3]	89.4	89.3	-0.1 F°
	24-hr Avg Min	38.4 [3]	40.4	41.2	+0.8 F°
Helper Mode Operation					
Max No. days of cooling tower operation per year		NA	82	121	+39
Avg No. days of cooling tower operation per year		NA	66	89	+13
Hydrothermal Derate Operation					
Percent of Summers with Derates		NA	1 in 6	1 in 6	unchanged
Max No. Hours of Derate for Summers with Derate		NA	185	207	+28
Max Derate MWH for Summers with Derate		NA	81065	101850	+20785
Avg Derate MWe for Summers with Derate		NA	438	492	54
Changes in Net Generation (10^6 MWH)					
Maximum Annual Net Generation		NA	29.6	34.5	+4.9
Minimum Annual Net Generation		NA	29.2	34.1	+4.9
Average Annual Net Generation		NA	29.4	34.3	+4.9

Notes:
1. Based on simulations with historical hydrology and meteorology for years 2007-2012.
2. 0% OLTP = no withdrawal from or discharge to the river from BFN.
3. Value assumed to be the same as ambient (i.e., neglects any heat exchange between the reservoir and the atmosphere/riverbed in the reach between the ambient measurement at TRM 297.8 and the downstream end of mixing zone at TRM 293.5).

NA=not applicable.

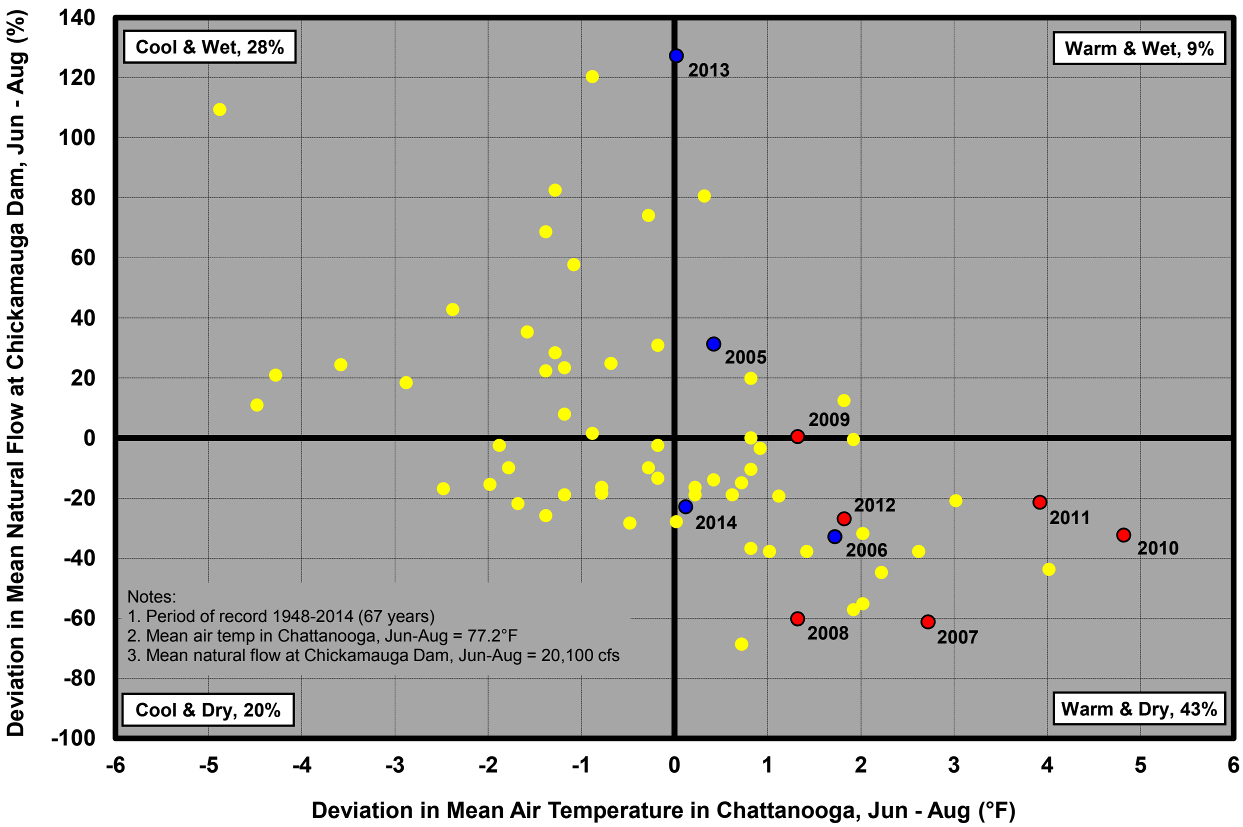

Figure 7.2-1: Classification of Summer Hydrothermal Conditions for the Tennessee River Valley

7.2.4 Fish

Baseline Wheeler Reservoir fish community data include 10 years of reservoir fish standing stock surveys (1949-1954 and 1969-1972), gill and trap net surveys (1968-1972), and ichthyoplankton (larval fish) investigations (1971-1973) (TVA 1978a). Aquatic monitoring continued until 1980 as required by BFN Technical Specifications issued by the NRC (Baxter and Buchanan 1998). In 1981, the NRC eliminated the aquatic monitoring requirement from the BFN Technical Specifications. TVA conducted a three-phase biological monitoring program to evaluate the effects of the BFN thermal discharge on total standing stocks and selected fish species in Wheeler Reservoir during the period 1985 through 1997 (Lowery and Poppe 1992; Buchanan 1990; Baxter and Buchanan 1998). The results were reported to ADEM in 1998 and were provided as part of the NPDES permit renewal application submitted in September 1999 (Baxter and Buchanan 1998; TVA 1999). This study concluded that the operation of BFN under the current permit limitations had not had a significant impact on the aquatic community of Wheeler Reservoir or on the specific species studied.

Section 316(a) of the Clean Water Act (CWA) authorizes alternate thermal limits (ATL) for the control of the thermal component of a point source discharge so long as the limits will assure the protection of Balanced Indigenous Populations (BIP) of aquatic life. The Reservoir Fish Assemblage Index (RFAI) is a measure of quality of the resident fish community in the Wheeler Reservoir in the vicinity of BFN. RFAI sampling in the Wheeler Reservoir was initiated as part of the TVA Vital Signs Monitoring Program. TVA proposed in its 1999 NPDES permit application, use of its RFAI and Reservoir Benthic Index (RBI) methodologies to demonstrate BIP.

From 2000 to 2011, and during 2013, TVA conducted extensive annual sampling of the fish community in the vicinity of BFN and used these methodologies to demonstrate maintenance of BIP in relation to BFN's thermal variance (TVA 2014). Sampling was conducted at two locations each autumn. The upstream station was centered on TRM 295.9 and served as a control station that was completely unaffected by the BFN discharge. The downstream station (TRM 292.5) was centered just downstream of the discharge and represented the potentially thermally affected area. Fish communities are used to evaluate ecological conditions because of their importance in the aquatic food web and because fish life cycles are long enough to integrate conditions over time. The RFAI methodology incorporates fish species richness and composition, trophic composition, and fish abundance and health. It has been thoroughly tested on TVA's reservoirs and other reservoirs and it has been published in peer-reviewed literature (Jennings et al. 1995; Hickman and McDonough 1996; McDonough and Hickman 1999).

TVA's Reservoir Monitoring Program (began in 1993 in Wheeler Reservoir) includes three additional RFAI sampling sites in the reservoir. TVA reservoirs are typically divided into three zones for monitoring: inflow, transition, and forebay. The inflow zone is generally in the upper reaches of the reservoir and is riverine in nature; the transition zone or mid-reservoir is the area where water velocity decreases due to increased cross-sectional area, and the forebay is the lacustrine area near the dam. The Wheeler Reservoir inflow zone sample site is located at TRM 347, the transition zone sample site is located at TRM 295.9 (also serves as BFN upstream control site), and the forebay zone sample site is located at TRM 277. An additional site is located on the Elk River embayment of Wheeler Reservoir at Elk River Mile (ERM) 6. Data from these sites are used to provide additional information about the health of the fish communities throughout Wheeler Reservoir; however, fish communities at these sites are not subject to thermal effects from BFN and are not used in determination of BIPs, as defined by the CWA in relation to the plant.

The RFAI uses 12 fish community metrics from four general categories: species richness and composition; trophic composition; abundance; and fish health. Together, these 12 metrics provide a balanced evaluation of fish community integrity and address all four attributes of a BIP as defined by the CWA. Scoring categories are based on “expected” fish community characteristics in the absence of human-induced impacts other than impoundment of the reservoir. These categories were developed from historical fish assemblage data representative of transition zones from lower main stem Tennessee River reservoirs (Hickman and McDonough 1996). Attained values for each of the 12 metrics were compared to the scoring criteria and assigned scores to represent relative degrees of degradation: least degraded (5); intermediately degraded (3); and most degraded (1).

TVA uses RFAI results to determine maintenance of BIP using two approaches. One is “absolute” in that it compares the RFAI scores and individual metrics to predetermined values. The other is “relative” in that it compares RFAI scores attained downstream to the upstream control site. The “absolute” approach is based on Jennings et al. (1995) who suggested that favorable comparisons of the RFAI score attained from the potential impact zone to a predetermined criterion can be used to identify the presence of normal community structure and function, and hence existence of BIP. For multi-metric indices, TVA uses two criteria to ensure a conservative screening of BIP. First, if an RFAI score reaches 70 percent of the highest attainable score of 60 (adjusted upward to include sample variability as described below), and second, if fewer than half of RFAI metrics receive a low (1) or moderate (3) score, then community structure and function are considered normal, indicating that BIP had been maintained and no further evaluation would be needed.

RFAI scores range from 12 to 60. Ecological health ratings (12-21 “Very Poor”, 22-31 “Poor”, 32-40 “Fair”, 41-50 “Good”, or 51-60 “Excellent”) are then applied to scores. The average variation for RFAI scores in TVA reservoirs is 6 (± 3). Therefore, any location that attains a RFAI score of 45 (75 percent of the highest score) or higher would be considered to have BIP. It must be stressed that scores below this threshold do not necessarily reflect an adversely impacted fish community. The threshold is used to serve as a conservative screening level meaning that any fish community that meets these criteria is not adversely impacted. RFAI scores below this level require a more in-depth look to determine if BIP exists. An inspection of individual RFAI metric results and species of fish used in each metric are an initial step to help identify if operation of BFN is a contributing factor. This approach is appropriate because a validated multi-metric index is being used and scoring criteria applicable to the zone of study are available.

A comparison of RFAI scores from the area downstream of BFN to those from the upstream (control) area is one basis for determining if operation of the plant has had any impacts on the resident fish community. The definition of “similar” is integral to accepting the validity of these interpretations. The Quality Assurance (QA) component of TVA’s Reservoir Monitoring Program deals with how well the RFAI scores can be repeated and is accomplished by collecting a second set of samples at 15 percent-20 percent of the areas each year. Comparison of paired-sample QA data collected over 7 years shows that the difference in RFAI index scores ranges from 0 to 18 points. The mean difference between these 54 paired scores is 4.6 points with 95 percent confidence limits of 3.4 and 5.8. The 75th percentile of the sample differences is 6, and the 90th percentile is 12. Based on these results, a difference of six points or less in the overall RFAI scores is the value selected for defining “similar” scores between upstream and downstream fish communities. That is, if the downstream RFAI score is within six points of the upstream score and if there are no major differences in overall fish community composition, then the two locations are considered similar. It is important to bear in mind that differences greater than six points can be expected simply due to method variation (25 percent of the QA paired sample sets exceeded that value). An examination of the 12 metrics (with emphases on fish species used for each metric) is conducted to analyze any difference in scores and the potential for the difference to be thermally related.

As previously discussed, RFAI scores have an intrinsic variability of ± 3 points. This variability comes from several sources, including annual variations in air temperature and stream flow; variations in pollutant loadings from nonpoint sources; changes in habitat, such as extent and density of aquatic vegetation; natural population cycles and movements of the species being measured (TWRA 2014). Another source of variability arises from the fact that nearly any practical measurement, lethal or non-lethal, of a biological community is a sample rather than a measurement of the entire population (TVA 2014).

A summary of RFAI scores for the sampling sites upstream and downstream of BFN and those from the three other Wheeler Reservoir are shown in Table 7.2-4. Over the 13 sample years (2000 to 2011, 2013), RFAI scores only differed by greater than six points during one year (2005). Long-term averages for these sites are identical (score of 41 “Good”), indicating that no substantial differences in ecological structure or balance between the two communities have persisted and that a BIP has been maintained. Additionally, all other Wheeler Reservoir monitoring sites have averaged a “Good” ecological health rating (Table 7.2-4). Most recent (autumn 2013) fish species collected and corresponding electrofishing and gill net catch per unit effort downstream (TRM 292.5) and upstream (TRM 295.9) of BFN discharge are shown in Tables 7.2-5 and 7.2-6 The EPU is not expected to have significant impacts on the fish communities of Wheeler reservoir in the vicinity of the BFN thermal discharge. TVA concludes that a BIP would continue to be maintained upstream and downstream of the plant through continued compliance with thermal discharge temperature limitations as specified in the NPDES permit.

Table 7.2-4: Summary of Autumn RFAI Scores

Site	Location	1993	1994	1995	1997	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2013	1993-2013 Avg.
Inflow	TRM 348.0	46	48	42	48	36	-	36	40	38	42	44	42	32	38	40	40	46	40	42
Transition BFN Upstream	TRM 295.9	45	43	34	40	30	41	37	43	39	43	46	41	39	42	39	43	40	46	41
Transition BFN Downstream	TRM 292.5	-	-	-	-	-	43	40	41	43	43	36	42	42	45	36	38	38	40	41
Forebay	TRM 277.0	52	44	48	45	42	-	41	45	44	43	45	44	49	46	47	40	46	43	45
Elk River Embayment	ERM 6.0	41	47	36	49	36	-	49	-	44	49	47	-	39	-	42	-	43	39	44

RFAI Scores: 12-21 (“Very Poor”), 22-31 (“Poor”), 32-40 (“Fair”), 41-50 (“Good”), or 51-60 (“Excellent”)

Table 7.2-5: Species Collected Upstream (TRM 295.9) of BFN Discharge—Autumn 2013

Common Name	Scientific Name	Trophic Level	Native Species	Tolerance	Thermally Sensitive Species	Comm. Valuable Species	Rec. Valuable Species	EF Catch Per Run	EF Catch Per Hr	Total Fish EF	GN Catch Per Net Night	Total Fish GN	Total Fish Combined	Percent Composition
Longnose gar	*Lepisosteus osseus*	TC	X	TOL	.	X	.	0.07	0.25	1	0.50	5	6	0.8
Gizzard shad	*Dorosoma cepedianum*	OM	X	TOL	.	X	X	11.73	44.67	176	0.50	5	181	25.4
Common carp*	*Cyprinus carpio*	OM	.	TOL	.	X	.	0.40	1.52	6	.	.	6	0.8
Golden shiner	*Notemigonus crysoleucas*	OM	X	TOL	.	X	X	0.40	1.52	6	.	.	6	0.8
Spotfin shiner	*Cyprinella spiloptera*	IN	X	TOL	.	.	.	1.27	4.82	19	.	.	19	2.7
Redbreast sunfish*	*Lepomis auritus*	IN	.	TOL	.	.	X	0.07	0.25	1	.	.	1	0.1
Green sunfish	*Lepomis cyanellus*	IN	X	TOL	.	.	X	0.80	3.05	12	.	.	12	1.7
Bluegill	*Lepomis macrochirus*	IN	X	TOL	.	.	X	4.73	18.02	71	.	.	71	9.9
Largemouth bass	*Micropterus salmoides*	TC	X	TOL	.	.	X	2.33	8.88	35	0.40	4	39	5.5
White crappie	*Pomoxis annularis*	TC	X	TOL	.	.	X	0.07	0.25	1	.	.	1	0.1
Skipjack herring	*Alosa chrysochloris*	TC	X	INT	.	X	.	.	.	.	0.60	6	6	0.8
Northern hog sucker	*Hypentelium nigricans*	BI	X	INT	.	.	.	0.07	0.25	1	.	.	1	0.1
Spotted sucker	*Minytrema melanops*	BI	X	INT	X	X	.	1.13	4.31	17	0.10	1	18	2.5
Black redhorse	*Moxostoma duquesnei*	BI	X	INT	.	X	.	0.07	0.25	1	.	.	1	0.1
Longear sunfish	*Lepomis megalotis*	IN	X	INT	.	.	X	1.13	4.31	17	.	.	17	2.4
Smallmouth bass	*Micropterus dolomieu*	TC	X	INT	.	.	X	0.60	2.28	9	.	.	9	1.3
Spotted gar	*Lepisosteus oculatus*	TC	X	.	.	X	.	0.33	1.27	5	0.10	1	6	0.8
Threadfin shad	*Dorosoma petenense*	PK	X	.	.	X	X	1.53	5.84	23	.	.	23	3.2
Emerald shiner	*Notropis atherinoides*	IN	X	.	X	.	.	0.07	0.25	1	.	.	1	0.1
Bullhead minnow	*Pimephales vigilax*	IN	X	.	.	.	X	0.47	1.78	7	.	.	7	1.0
Smallmouth buffalo	*Ictiobus bubalus*	OM	X	.	.	X	.	1.87	7.11	28	0.50	5	33	4.6
Black buffalo	*Ictiobus niger*	OM	X	.	.	X	.	0.07	0.25	1	0.20	2	3	0.4

Common Name	Scientific Name	Trophic Level	Native Species	Tolerance	Thermally Sensitive Species	Comm. Valuable Species	Rec. Valuable Species	EF Catch Per Run	EF Catch Per Hr	Total Fish EF	GN Catch Per Net Night	Total Fish GN	Total Fish Combined	Percent Composition
Blue catfish	*Ictalurus furcatus*	OM	X	.	.	X	X	.	.	.	0.40	4	4	0.6
Channel catfish	*Ictalurus punctatus*	OM	X	.	.	X	X	2.73	10.41	41	0.60	6	47	6.6
Flathead catfish	*Pylodictis olivaris*	TC	X	.	.	X	X	0.07	0.25	1	0.10	1	2	0.3
White bass	*Morone chrysops*	TC	X	.	.	.	X	1.07	4.06	16	0.20	2	18	2.5
Yellow bass	*Morone mississippiensis*	TC	X	.	.	X	X	0.67	2.54	10	.	.	10	1.4
Warmouth	*Lepomis gulosus*	IN	X	.	.	.	X	0.07	0.25	1	.	.	1	0.1
Orangespotted sunfish	*Lepomis humilis*	IN	X	.	.	.	X	0.20	0.76	3	.	.	3	0.4
Redear sunfish	*Lepomis microlophus*	IN	X	.	.	.	X	1.73	6.60	26	0.40	4	30	4.2
Hybrid sunfish	Hybrid *Lepomis* sp.	IN	X	.	.	.	.	0.20	0.76	3	.	.	3	0.4
Spotted bass	*Micropterus punctulatus*	TC	X	.	.	.	X	0.07	0.25	1	.	.	1	0.1
Black crappie	*Pomoxis nigromaculatus*	TC	X	.	.	.	X	0.07	0.25	1	.	.	1	0.1
Logperch	*Percina caprodes*	BI	X	.	X	.	.	2.33	8.88	35	.	.	35	4.9
Sauger	*Sander canadensis*	TC	X	.	.	.	X	.	.	.	0.40	4	4	0.6
Freshwater drum	*Aplodinotus grunniens*	BI	X	.	.	X	.	1.27	4.82	19	0.20	2	21	2.9
Mississippi silverside*	*Menidia audens*	IN	.	.	.	X	X	4.47	17.01	67	.	.	67	9.4
Total			**34**		**3**	**17**	**23**	**44.16**	**167.97**	**662**	**5.20**	**52**	**714**	**100.0**
Number Samples								**15**			**10**			
Species Collected								**34**			**15**			

Trophic level: benthic invertivore (BI), herbivore (HB), insectivore (IN), omnivore (OM), planktivore (PK), parasitic (PS), specialized insectivore (SP), top carnivore (TC);

Tolerance: tolerant species (TOL), intolerant species (INT); Comm.-Commercially, Rec.-Recreationally.

*Denotes aquatic nuisance species next to common name. All species are considered representative important species. No species collected are federally listed.

Table 7.2-6: Species Collected Downstream (TRM 292.5) of BFN Discharge—Autumn 2013

Common Name	Scientific Name	Trophic Level	Native Species	Tolerance	Thermally Sensitive Species	Comm. Valuable Species	Rec. Valuable Species	EF Catch Per Run	EF Catch Per Hr	Total Fish EF	GN Catch Per Net Night	Total Fish GN	Total Fish Combined	Percent Composition
Gizzard shad	*Dorosoma cepedianum*	OM	X	TOL	.	X	X	10.40	40.10	156	1.30	13	169	17.4
Common carp*	*Cyprinus carpio*	OM	.	TOL	.	X	.	0.13	0.51	2	0.10	1	3	0.3
Spotfin shiner	*Cyprinella spiloptera*	IN	X	TOL	.	.	.	7.13	27.51	107	.	.	107	11.0
Redbreast sunfish*	*Lepomis auritus*	IN	.	TOL	.	.	X	0.07	0.26	1	.	.	1	0.1
Green sunfish	*Lepomis cyanellus*	IN	X	TOL	.	.	X	2.87	11.05	43	.	.	43	4.4
Bluegill	*Lepomis macrochirus*	IN	X	TOL	.	.	X	2.00	7.71	30	0.20	2	32	3.3
Largemouth bass	*Micropterus salmoides*	TC	X	TOL	.	.	X	1.27	4.88	19	0.10	1	20	2.1
Skipjack herring	*Alosa chrysochloris*	TC	X	INT	.	X	.	.	.	.	1.20	12	12	1.2
Spotted sucker	*Minytrema melanops*	BI	X	INT	X	X	.	0.20	0.77	3	.	.	3	0.3
Black redhorse	*Moxostoma duquesnei*	BI	X	INT	.	X	.	0.07	0.26	1	.	.	1	0.1
Longear sunfish	*Lepomis megalotis*	IN	X	INT	.	.	X	4.00	15.42	60	.	.	60	6.2
Smallmouth bass	*Micropterus dolomieu*	TC	X	INT	.	.	X	1.53	5.91	23	.	.	23	2.4
Spotted gar	*Lepisosteus oculatus*	TC	X	.	.	X	.	.	.	.	0.20	2	2	0.2
Threadfin shad	*Dorosoma petenense*	PK	X	.	.	X	X	0.80	3.08	12	.	.	12	1.2
Emerald shiner	*Notropis atherinoides*	IN	X	.	X	.	.	0.20	0.77	3	.	.	3	0.3
Bullhead minnow	*Pimephales vigilax*	IN	X	.	.	.	.	0.33	1.29	5	.	.	5	0.5
Smallmouth buffalo	*Ictiobus bubalus*	OM	X	.	.	X	.	1.80	6.94	27	0.20	2	29	3.0
Black buffalo	*Ictiobus niger*	OM	X	.	.	X	.	.	.	.	0.10	1	1	0.1
Blue catfish	*Ictalurus furcatus*	OM	X	.	.	X	X	.	.	.	0.20	2	2	0.2
Channel catfish	*Ictalurus punctatus*	OM	X	.	.	X	X	1.40	5.40	21	0.10	1	22	2.3
Flathead catfish	*Pylodictis olivaris*	TC	X	.	.	X	X	.	.	.	0.40	4	4	0.4
Yellow bass	*Morone mississippiensis*	TC	X	.	.	X	X	0.13	0.51	2	0.20	2	4	0.4

Common Name	Scientific Name	Trophic Level	Native Species	Tolerance	Thermally Sensitive Species	Comm. Valuable Species	Rec. Valuable Species	EF Catch Per Run	EF Catch Per Hr	Total Fish EF	GN Catch Per Net Night	Total Fish GN	Total Fish Combined	Percent Composition
Warmouth	*Lepomis gulosus*	IN	X	.	.	.	X	0.13	0.51	2	.	.	2	0.2
Redear sunfish	*Lepomis microlophus*	IN	X	.	.	.	X	0.27	1.03	4	.	.	4	0.4
Hybrid sunfish	Hybrid *Lepomis* sp.	IN	X	.	.	.	.	0.13	0.51	2	.	.	2	0.2
Black crappie	*Pomoxis nigromaculatus*	TC	X	.	.	.	X	.	.	.	0.10	1	1	0.1
Stripetail darter	*Etheostoma kennicotti*	SP	X	.	.	.	.	0.07	0.26	1	.	.	1	0.1
Logperch	*Percina caprodes*	BI	X	.	X	.	.	1.87	7.20	28	.	.	28	2.9
Sauger	*Sander canadensis*	TC	X	.	.	.	X	.	.	.	0.30	3	3	0.3
Freshwater drum	*Aplodinotus grunniens*	BI	X	.	.	X	.	2.93	11.31	44	0.40	4	48	5.0
Mississippi silverside*	*Menidia audens*	IN	.	.	.	X	X	21.47	82.78	322	.	.	322	33.2
Total			**28**		**3**	**15**	**17**	**61.20**	**235.97**	**918**	**5.10**	**51**	**969**	**100**
Number Samples								**15**			**10**			
Species Collected								**24**			**15**			

Trophic level: benthic invertivore (BI), herbivore (HB), insectivore (IN), omnivore (OM), planktivore (PK), parasitic (PS), specialized insectivore (SP), top carnivore (TC);
Tolerance: tolerant species (TOL), intolerant species (INT); Comm.-Commercially, Rec.-Recreationally.

*Denotes aquatic nuisance species next to common name. All species are considered representative important species. No species collected are federally listed.

7.2.5 Benthic Organisms

As briefly mentioned in Section 7.2.4, benthic macroinvertebrate populations are assessed using the RBI methodology to provide additional information on the health of aquatic communities upstream and downstream of the BFN thermal discharge. Because benthic macroinvertebrates are relatively immobile, negative impacts to aquatic ecosystems can be detected earlier in benthic macroinvertebrate communities than in fish communities (TVA 2014).

During autumn 2013, benthic macroinvertebrate data were collected in the transition zone of Wheeler Reservoir along three transects established across the width of the reservoir. The upstream transect (TRM 295.9) was used as a control site to compare to benthic community composition potentially affected by the BFN thermal effluent. One downstream transect (TRM 293.2) was within the thermal plume and one transect (TRM 290.4) was located just below the downstream extent of the plume (TVA 2014). These two sites were established during 2011 to better determine the effect, if any, of the thermal discharge on benthic communities (TVA 2012a). Previously (2000 to 2010), the downstream site consisted of one transect located at TRM 291.7. A Ponar sampler (area per sample 0.06 m^2) was used to collect benthic samples at 10 points equally spaced along each transect. Sediments from each sample were washed on a 533μ screen, and organisms were picked from the screen and any remaining substrate.

Benthic samples are evaluated using seven metrics that represent characteristics of the benthic community (for a more detailed description of metrics and scoring criteria, refer to TVA 2014). Results for each metric were assigned a rating of 1, 3, or 5, based upon comparison to reference conditions developed for TVA's Reservoir Benthic Monitoring transition zone sample sites (Table 7.2-7). For each sample site, the ratings for the seven metrics were then summed to produce an RBI score. Potential RBI scores ranged from 7 to 35. Ecological health ratings derived from the range of potential values (7-12 "Very Poor", 13-18 "Poor", 19-23 "Fair", 24-29 "Good", or 30-35 "Excellent") were then applied to scores.

A similar or higher benthic index score at the downstream sites compared to the upstream site was used as the basis for determining absence of impact on the benthic macroinvertebrate community related to BFN's thermal discharge. The QA component of TVA's Reservoir Benthic Monitoring Program compared benthic index scores from 49 paired sample sets collected over seven years. Differences between these paired sets ranged from 0 to 14 points; the 75th percentile was four, the 90th percentile was six. The mean difference between these 49 paired scores was 3.1 points with 95 percent confidence limits of 2.2 and 4.1. Based on these results, a difference of four points or less was the value selected for defining "similar" scores between upstream and downstream benthic communities. That is, if benthic scores at the downstream sites are within four points of the upstream score, the communities are considered similar. However, differences greater than four points can be expected simply due to method variation (25 percent of the QA paired sample sets exceeded that value). Any difference in scores of greater than four points between communities is examined on a metric-by-metric basis to determine what caused the difference and the potential for the difference to be thermally related.

Similar to RFAI, TVA's Wheeler Reservoir Monitoring Program includes three additional RBI sampling sites, located at the same river miles as the RFAI stations. Data from these sites are used to provide additional information about the health of benthic macroinvertebrate communities throughout Wheeler Reservoir; however, aquatic communities at these sites are not subject to thermal effects from BFN and are not used in determination of BIP in relation to the plant (TVA 2014).

A summary of RBI scores for the sampling sites upstream and downstream of BFN and those from the three other Wheeler Reservoir monitoring stations are shown in Table 7.2-7. Over the 13 sample years (2000 to 2011, 2013), RBI scores only differed by greater than four points during one year (2009). Most recent assessments of the RBI (2013) at the reference station and at the two stations within the BFN thermal plume received "Excellent" ratings (Table 7.2-7). Long-term averages for these sites are within the "Good" to "Excellent" range, indicating that no substantial differences in ecological structure or balance between the two communities have persisted and that a BIP has been maintained. The Wheeler Reservoir inflow site has averaged "Good", while the forebay and Elk River embayment have averaged "Poor". Land use in the lower Elk River basin is predominantly agricultural, and high levels of sediment and nutrient input are most likely suppressing the benthic community. The Elk River discharges into the forebay, which may be a contributor to the low ecological health rating observed in the forebay. Mean density per square meter of benthic taxa collected upstream and downstream of BFN during autumn 2013 are shown in Table 7.2-8. Monitoring results for autumn 2013 support the conclusion that a BIP of benthic macroinvertebrates was maintained downstream of BFN, and the benthic community at the most downstream sampling site was considered similar to the upstream benthic community (2014).

Freshwater mussels are not directly assessed as part of TVA's Reservoir Monitoring Program; however, they are excellent indicators of water quality due to their sessile nature and inability to avoid perturbations impacting water quality. Various post-impoundment mussel surveys in Wheeler Reservoir have documented the occurrence of mussel species (Garner and McGregor 2001). Scruggs (1960) and Isom (1969) documented, as described in Ahlstedt and McDonough (1992), 24 species from various locations surveyed from TRM 275 to TRM 348. During these surveys, it was noted that commercial overharvest and siltation were major factors affecting abundance, recruitment, and survival of many species. Gooch et al. (1979) documented 32 mussel species, 7 of which were not collected during earlier surveys, from TRM 334.3 to TRM 348.4 and in Spring Creek embayment (TRM 283.8). During 1991, 18 live mussel species and 6 species represented by relict shell were documented in Wheeler Reservoir and the mussel fauna consisted of riverine and thin-shelled invader species that have adapted to lake-like conditions and soft bottomed substrates which are now predominate. Half of the species reported from Wheeler Reservoir post impoundment are uncommon or rare and may survive as old, non-reproducing individuals (Ahlstedt and McDonough 1992).

From 1995 to 2000, the Alabama Game and Fish Division (now Alabama Division of Wildlife and Freshwater Fisheries) identified 29 species from upstream of BFN to Guntersville Dam (TRM 294.5 to TRM 349) and 11 species downstream (Garner 2015) (see Table 7.2-9). These freshwater mussel species were collected in Wheeler Reservoir during 5 years of qualitative, non-standardized dives, using an unknown amount of effort, and during various years. There was a substantial difference in bottom time spent at multiple locations in searches for mussels upstream of BFN (63.1 hours) versus at one location, TRM 292, downstream of BFN (16.3 hours). Significant impacts on the benthic communities of Wheeler reservoir in the vicinity of the BFN thermal discharge are not expected due to EPU since BIPs are continually maintained upstream and downstream of the plant. See Section 7.2.7 for additional discussion.

Table 7.2-10 is a list of mussels collected in Ponar dredge samples while sampling reservoir benthic macroinvertebrates near BFN. These were not collected during a mussel-specific survey, but they are the most recent collections available from Wheeler Reservoir near BFN. These records are stored in TVA's reservoir benthic taxa database.

Table 7.2-7: Summary of RBI Scores

Site	Location	1994	1995	1997	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2013	LTA
Inflow	TRM 347	31	21	25	23	---	21	25	31	31	31	33	33	---	31	---	27	31	**28**
BFN Upstream (Transition)	TRM 295.9	33	25	31	31	31	29	31	31	33	31	31	33	25	29	25	27	35	**30**
BFN Downstream (Transition)	TRM 291.7	---	---	---	---	27	31	27	35	33	31	31	29	29	23	23	---	---	**29**
BFN Downstream (Transition)	TRM 293.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	23	35	**N/A**
BFN Downstream (Transition)	TRM 290.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	21	31	**N/A**
Forebay	TRM 277	19	15	23	17	---	17	15	15	19	15	13	13	15	13	---	13	17	**13**
Embayment	ERM 6	15	13	15	15	---	15	---	15	---	17	---	13	---	13	---	13	13	**13**

Reservoir Benthic Index Scores: 7-12 (“Very Poor”), 13-18 (“Poor”), 19-23 (“Fair”), 24-29 (“Good”), 30-35 (“Excellent”)
LTA = Long-term average

Table 7.2-8: Mean Density of Benthic Taxa Upstream and Downstream of BFN, Autumn 2013

Taxa	BFN Downstream TRM 290.4	BFN Downstream TRM 293.2	BFN Upstream TRM 295.9
ANNELIDA			
Hirudinea			
Rhynchobdellida			
Glossiphoniidae			
Actinobdella sp.	---	2	---
Actinobdella inequiannulata	2	---	---
Helobdella elongata	---	---	2
Helobdella stagnalis	7	8	8
Oligochaeta			
Haplotaxida			
Naididae	---	---	2
Tubificinae	30	78	20
Branchiura sowerbyi	3	7	5
Limnodrilus hoffmeisteri	5	7	18
ARTHROPODA			
Crustacea			
Malacostraca			
Amphipoda			
Corophiidae			
Apocorophium lacustre	167	38	282
Gammaridae			
Gammarus sp.	---	2	5
Hexapoda			
Insecta			
Coleoptera			
Elmidae			
Dubiraphia sp.	---	2	---
Diptera			
Ceratopogonidae	2	---	---
Chironomidae			
Orthocladiinae			
Chironominae	---	---	2
Axarus sp.	5	32	45
Chironomus sp.	43	28	70
Cryptochironomus sp.	---	7	5
Dicrotendipes neomodestus	---	---	7

Taxa	BFN Downstream TRM 290.4	BFN Downstream TRM 293.2	BFN Upstream TRM 295.9
Glyptotendipes sp.	---	---	3
Harnischia sp.	---	---	2
Microchironomus sp.	---	2	---
Polypedilum halterale gp.	---	3	2
Stempellina sp.	---	2	---
Xenochironomus xenolabis	---	---	5
Epoicocladius flavens	2	---	---
Thienemanniella lobapodema	---	2	---
Tanypodinae			
Ablabesmyia annulata	33	13	32
Ablabesmyia mallochi	---	---	2
Coelotanypus sp.	97	263	145
Paramerina sp.	---	30	---
Procladius sp.	---	2	7
Ephemeroptera			
Ephemeridae			
Hexagenia sp. <10mm	262	230	163
Hexagenia sp. >10mm	262	213	100
Trichoptera			
Leptoceridae	---	2	---
Oecetis sp.	2	37	28
Polycentropodidae			
Cyrnellus fraternus	18	---	32
MOLLUSCA			
Gastropoda			
Architaenioglossa			
Viviparidae			
Campeloma decisum	---	2	2
Lioplax sulculosa	---	3	3
Viviparus sp.	5	3	12
Neotaenioglossa			
Hydrobiidae			
Amnicola limosa	5	113	53
Somatogyrus sp.	---	3	2
Pleuroceridae			
Pleurocera canaliculata	---	---	3
Bivalvia			
Veneroida			
Corbiculidae			

Taxa	BFN Downstream TRM 290.4	BFN Downstream TRM 293.2	BFN Upstream TRM 295.9
Corbicula fluminea <10mm	263	312	278
Corbicula fluminea >10mm	---	3	40
Sphaeriidae			
Eupera cubensis	5	---	---
Musculium transversum	158	233	85
Pisidium compressum	2	---	---
Unionidae			
Truncilla donaciformis	---	---	3
Utterbackia imbecillis	---	---	2
NEMATODA	---	22	3
PLATYHELMINTHES			
Turbellaria			
Tricladida			
Planariidae			
Dugesia tigrina	3	2	5
Number of samples	**10**	**10**	**10**
Mean-Density per square meter²	**1,380**	**1,703**	**1,482**
Taxa Richness	**21**	**29**	**34**
Sum of area sampled (square meter²)	**0.6**	**0.6**	**0.6**

Note: All taxa listed contributed to individual RBI metrics and total scores.

Table 7.2-9: Mussel Species Collected by Alabama Game and Fish Division Near BFN and Upstream From BFN to Guntersville Dam, 1995–2000

Common Name	Scientific Name
TRM 292 (Total dive bottom time 16.3 hours)	
Washboard	*Megalonaias nervosa*
Pink Heelsplitter	*Potamilus alatus*
Threehorn Wartyback	*Obliquaria reflexa*
Mapleleaf	*Quadrula quadrula*
Threeridge	*Amblema plicata*
Flat Floater	*Anodonta suborbiculata*
Ebonyshell	*Fusconaia ebena*
Fragile Papershell	*Leptodea fragilis*
Giant Floater	*Pyganodon grandis*
Pistolgrip*	*Quadrula verrucosa*
White Heelsplitter	*Lasmigona complanata*
Upstream of BFN (TRM 294.5) to Guntersville Dam (TRM 349) (Total dive bottom time 63.1 hours)	
Washboard	*Megalonaias nervosa*
Pink Heelsplitter	*Potamilus alatus*
Pimpleback	*Quadrula pustulosa*
Threehorn Wartyback	*Obliquaria reflexa*
Threeridge	*Amblema plicata*
Elephantear	*Elliptio crassidens*
White Heelsplitter	*Lasmigona complanata*
Pistolgrip*	*Quadrula verrucosa*
Purple Wartyback	*Cyclonaias tuberculata*
Mapleleaf	*Quadrula quadrula*
Butterfly*	*Ellipsaria lineolata*
Giant Floater*	*Pyganodon grandis*
Pink Papershell*	*Potamilus ohiensis*
Flat Floater*	*Anodonta suborbiculata*
Spectaclecase	*Cumberlandia monodonta*
Spike	*Elliptio dilatata*
Ebonyshell	*Fusconaia ebena*
Yellow Sandshell	*Lampsilis teres*
Pink Mucket	*Lampsilis abrupta*
Fragile Papershell	*Leptodea fragilis*
Monkeyface	*Quadrula metanevra*
Black Sandshell	*Ligumia recta*
Sheepnose*	*Plethobasus cyphyus*
Ohio Pigtoe	*Pleurobema cordatum*
Pyramid Pigtoe	*Pleurobema rubrum*
Kidneyshell*	*Ptychobranchus fasciolaris*

Common Name	Scientific Name
Purple Lilliput	*Toxolasma lividus*
Fawnsfoot	*Truncilla donaciformis*
Paper Pondshell	*Utterbackia imbecillis*

* Collected as dead shells

Table 7.2-10: Mussels Collected in Ponar Dredge Samples

River Mile	Taxa	Count	Date
TRM 290.4	*Megalonaias nervosa*	1	10/3/2011
TRM 291.7	*Utterbackia imbecillis*	1	9/26/2006
TRM 293.2	*Truncilla donaciformi*	1	10/3/2011
TRM 295.9	*Obliquaria reflexa*	1	10/20/2004
TRM 295.9	*Obliqueria reflexa*	2	10/4/2011
TRM 295.9	*Truncilla donaciformis*	2	10/15/2013
TRM 295.9	*Utterbackia imbecillis*	1	10/15/2013

7.2.6 Entrainment and Impingement of Fish

EPA's final rule for CWA Section 316(b) established requirements for cooling water intake structures and procedures for assessing impacts (EPA 2014). Compliance requires the permittee to characterize the aquatic community in the vicinity of the intake structure prior to operation, monitor during normal operation to assess impacts due to entrainment and impingement, and periodically review current operational demands, reservoir operation, and condition of the aquatic community to ensure no significant changes have occurred.

7.2.6.1 Entrainment

Prior to 1980, extensive biological and hydrological studies were conducted to assess the effects of CCW withdrawal on the aquatic community in Wheeler Reservoir (TVA 1978a; TVA 1978b; Buchanan and Barr 1980). Preoperational larval fish studies were conducted during 1971 to 1973 to determine the composition and magnitude of the ichthyoplankton populations in Wheeler Reservoir and to define the seasonal fluctuations and relative abundance of various ichthyoplankton taxa (TVA 1978a). From 1974 to 1977, all three units at BFN became operational. Six years (1974–1979) of entrainment sampling were conducted in the plant intake basin to assess operational effects of BFN on fish eggs and larvae (TVA 1978b; Buchanan and Barr 1980). These studies concluded that estimated plant entrainment under open-cycle, three-unit operation would not add significantly to expected natural mortality of fish eggs and larvae in Wheeler Reservoir (Buchanan and Barr 1980). In 1995, TVA initiated an Integrated Resource Plan (IRP) to assess the most cost effective approach to meeting future power demands (TVA 1995). In concert with the IRP, TVA planned to apply for license renewal and EPU of all units at BFN and as a federal agency subject to NEPA, prepared a FSEIS regarding the decision to pursue license renewal and EPU (TVA 2002). As described in Section 2.1, after an extended shutdown, Unit 2 returned to service in 1991, Unit 3 in 1995, and Unit 1 in 2007. The FSEIS committed to evaluate effects of the 10 percent increase in CCW flow on rate of entrainment of fish eggs and larvae (TVA 2002). As a result, TVA conducted a two-year entrainment study in 2003 and 2004 to evaluate effects of two-unit operation on the fish community and update baseline data prior to the restart of Unit 1 (Baxter et al. 2006). To evaluate the effect of the return of Unit 1 and increased generating levels, TVA conducted additional entrainment monitoring during 2008 and 2009 under the current (105 percent OLTP) three-unit uprated operation (TVA 2012b).

For each of these studies, densities of fish eggs and larvae in the reservoir near the intake and daily volume of water transported past the BFN were compared to daily CCW demand and densities of fish eggs and larvae at the intake skimmer wall to estimate percent entrainment. During 2003 to 2004, freshwater drum eggs comprised 94 percent of the eggs collected and clupeids (shad) comprised 94.5 percent of the larval fish collected (Baxter et al. 2006). During 2008 and 2009, freshwater drum eggs constituted 86.7 percent of the total eggs collected and clupeid eggs made up a majority (13.3 percent) of the remaining eggs collected (TVA 2012b). Clupeid larvae were dominant in samples during 2008 and 2009 (94.6 percent), which was almost identical to collections in 2003 and 2004 (TVA 2012b).

The 2008 and 2009 entrainment estimates (TVA 2012b) and recent fish community assessments (TVA 2014) in Wheeler Reservoir near BFN show no significant impacts from current operation of BFN on the fish community near the plant. Both estimated ichthyoplankton entrainment percentages were comparable to historical levels. Results demonstrate annual variations in the relative abundance and temporal distribution of fish and fluctuations in reservoir flow are common in the vicinity of BFN. Life cycles of the dominant fish species and fluctuation in reservoir flow past BFN are significant factors influencing variations observed in the annual entrainment estimates. Based on the annual RFAI scores for Wheeler Reservoir, a viable and balanced indigenous fish community is present in Wheeler Reservoir in the vicinity of BFN. The proposed EPU will not result in an increase in current intake velocities, therefore future entrainment impacts should be comparable to historical levels after implementation of the EPU.

7.2.6.2 Impingement

Four years (1974-1977) of monitoring were conducted to assess operational effects of BFN on fish impingement (TVA 1978b). During this time, impinged fish were dominated by threadfin shad (76.5 percent) and gizzard shad (12.3 percent). Most species contributed less than 1 percent of total fish impinged (TVA 1978b). These studies concluded that overall impingement did not appear to represent an adverse environmental impact to the Wheeler Reservoir fish community.

TVA conducted a two-year impingement study in 2003 and 2004 to evaluate effects of two unit operation on the fish community and update baseline data prior to the restart of Unit 1 (Baxter et al. 2006). To evaluate the effect of the return of Unit 1 and increased generating levels, TVA conducted additional impingement monitoring from September 2007 to September 2009 (TVA 2010). During 2003 to 2004, impinged fish were dominated by threadfin shad (61 percent), freshwater drum (21.2 percent), and gizzard shad (7.8 percent). During 2007 to 2009, impinged fish were dominated by threadfin shad (96 percent) and gizzard shad (2 percent). These studies also concluded that fish impingement at BFN did not have an adverse effect on the fish community of Wheeler Reservoir.

During historical and most recent impingement studies, threadfin shad was the dominant species impinged. Threadfin shad are highly susceptible to thermal shock during the winter, and when this occurs, they become lethargic and are more susceptible to be drawn into the intake and impinged on the traveling screens (EPRI 2008). Highest impingement rates during historical and more recent studies at BFN occurred during this season. EPRI (2008) provided data indicating that during weather related cold shock events, a substantial proportion of threadfin shad were already dead or moribund before being impinged. McLean et al. (1980) found that even after mass mortality from winter die off and impingement occurred in a Tennessee River reservoir, threadfin shad populations quickly rebounded by autumn of each year. Baxter and Buchanan (1998) noted that in standing stock assessments of Wheeler Reservoir, gizzard shad exhibited the highest biomass, followed by threadfin shad and smallmouth buffalo. This provides additional evidence that two of the species that are most prone to impingement continue to persist in abundance in Wheeler Reservoir. The proposed

EPU will not result in an increase in current intake velocities, therefore future impingement impacts should be comparable to historical levels after implementation of the EPU.

7.2.7 Threatened and Endangered Species – Aquatic

Six federally listed endangered and one federally listed threatened aquatic species are known to occur in the vicinity of BFN (Table 7.2-11). The rough pigtoe (*Pleurobema plenum*), spectaclecase (*Cumberlandia monodonta*), and the pink mucket (*Lampsilis abrupta*) are freshwater mussels that occur in sand, gravel, and cobble substrates in large river habitats in the Tennessee River system. These species are now extremely rare and are primarily found in unimpounded tributary rivers and in the more riverine reaches of the largely impounded main stem Tennessee River. In Wheeler Reservoir, most of the remaining large river habitat occurs upstream of BFN. All recent records of these three species are from upstream of BFN (Ahlstedt and McDonough 1992; Garner 1998 and 2001; Gooch et al. 1979; Henson and Pryor 1982; Yokely 1998).

Three federally listed endangered aquatic snails, armored snail (*Pyrgulopsis [=Marstonia] pachyta*), slender campeloma (*Campeloma decampi*), and Anthony's river snail (*Athearnia anthonyi*), and one federally listed threatened fish, the spring pygmy sunfish (*Elassoma alabamae*), are restricted to tributary streams to Wheeler Reservoir, located upstream from BFN (Haggerty and Garner 2008; Garner and Haggerty 2010; Kuhajda et al. 2009). The federally listed threatened spring pygmy sunfish has designated critical habitat in the Beaverdam creek and Pryor branch systems which are upstream tributaries to Wheeler Reservoir (USFWS 2014). No evidence exists to suggest that populations of these species exist in the main stem of the Tennessee River (Wheeler Reservoir), or in tributary streams downstream of BFN. Biological monitoring data and TVA Natural Heritage database indicated no state or federally listed aquatic species have been collected or are currently known to occur within 0.25 miles of BFN; however, state and federally listed aquatic species have been collected in the Tennessee River and tributaries to Wheeler Reservoir within 10 miles of BFN (Table 7.2-11), (TVA 2014).

TVA concludes that the expected impacts from use of cooling towers in combination with possible derating of BFN on thermal conditions for water quality, reservoir stratification, dissolved oxygen (DO) concentrations, eutrophication, and condition of general reservoir biological communities would be minor, insignificant, and within the bounds of the previously permitted thermal discharge of the plant for three-unit operation. Since no state or federally listed aquatic species have been collected or are currently known to occur within 0.25 miles of BFN, no effects to listed species are expected.

TVA's corporate Environmental Policy commits the agency to protecting environmental resources of the Tennessee Valley. TVA's Environmental Principles include assessing the effects of TVA operations to ensure environmental compliance. TVA has monitored aquatic communities within Wheeler Reservoir since 1985 to assure that plant operation does not adversely impact Wheeler Reservoir. In accordance with the NPDES permit and previous commitments (TVA 1999; TVA 2002), TVA will continue monitoring of reservoir conditions. Biological monitoring is performed in order to demonstrate there has not been significant impact on a balanced indigenous population of fish, shellfish, and wildlife, in and on Wheeler Reservoir caused by the alternative thermal limit granted under the NPDES permit in accordance with section 316(a) of the CWA as administered by the ADEM. Biological monitoring results are reported to the State of Alabama in accordance with the NPDES permit.

Table 7.2-11: Aquatic Listed Species Known to Occur Within Tributaries to Wheeler Reservoir, in a 10-Mile Radius of BFN, and From Tennessee River Miles 274.9 to 310.7

Common Name	Federal Status	State Status
Snails		
Anthony's river snail	E	AP
Slender campeloma	E	AP
Armored snail	E	AP
Mussels		
Spectaclecase	E	AP
Pink mucket	E	AP
Rough pigtoe	E	AP
Fishes		
Spring pygmy sunfish	T	AP
Tuscumbia darter		AP
Paddlefish		AP
Southern cavefish		AP

Federal Status Codes: E – Endangered; T – Threatened

State Status Codes: First letter – state designation: A – Alabama. Second letter – status in that state: P – Protected (Alabama) – level of endangerment not specified.

7.2.8 References

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8.0 RADIOLOGICAL ENVIRONMENTAL IMPACTS

8.1 Radiological Waste Streams

The radioactive waste systems at BFN Units 1, 2, and 3 are designed to collect, process, and dispose of radioactive wastes in a controlled and safe manner. These systems are designed to limit discharges in accordance with 10 CFR Part 50, Appendix I. The actual performance and operation of installed equipment, as well as reporting of actual offsite releases and doses, are controlled by the requirements of the Offsite Dose Calculation Manual (ODCM) (TVA 2015). The ODCM is subject to NRC inspection and describes the methods and parameters used for calculating offsite doses resulting from radioactive gaseous and liquid effluents, and ensuring compliance with NRC regulations. Adherence to these limits and objectives would continue under the proposed EPU.

Operation at the proposed EPU conditions would not result in any physical changes to the solid waste, liquid waste, or gaseous waste systems. The safety and reliability of these systems would be unaffected by the proposed EPU. Also, the proposed action would not affect the environmental monitoring of any of these waste streams or the radiological monitoring requirements of the BFN Units 1, 2, and 3, Radiation Protection Program. Under normal operating conditions, the proposed action would not introduce any new or different radiological release pathways and would not increase the probability of an operator error or equipment malfunction that would result in an uncontrolled radioactive release from the radioactive waste streams.

BFN Power Uprate Safety Analysis Report (PUSAR) Section 2.5.5.1, Gaseous Waste Management System, PUSAR Section 2.5.5.2, Liquid Waste Management System, and PUSAR Section 2.5.5.3, Solid Waste Management System, provide an assessment of the effect of the proposed EPU on the gaseous, liquid and solid radioactive waste systems and the associated effluents. The assessment is based on a comparison of ANSI/ANS 18.1-1984 based 10 CFR Part 50 Appendix I type analyses for both pre-EPU and EPU conditions using the ANSI/ANS 18.1-1984 Reference BWR concentrations (Table 8.2-1) as the starting point.

The following subsections summarize the results of additional assessment of the effect of the proposed EPU on radwaste effluents and associated doses to the public. The impact of the EPU on the radwaste gaseous and liquid releases and doses to the public is assessed herein by applying EPU scaling factors (NRC 1979) to the radioactive effluent release and dose information reported in the annual Radioactive Effluent Reports for the years 2009 to 2013 for BFN Units 1, 2, and 3 (TVA 2009; TVA 2010; TVA 2011; TVA 2012; TVA 2013). The average effluent releases for the site for the years 2009 to 2013 are reported in Tables 8.1-2 and 8.1-3. It is noted that the sum of the values for activity and volume, reported in Tables 8.1-1 through 8.1-3, represent the combined operations of BFN Units 1, 2, and 3.

8.1.1 Solid Low Level Radioactive Waste

BFN low-level radioactive waste (LLRW) includes solids from reactor coolant systems, solids in contact with liquids or gases from reactor coolant systems, and solids used in support of reactor coolant systems operation. The majority of BFN solid radioactive waste, as documented in Table 8.1-1, is shipped offsite as dry active waste. This waste is from outages, special projects and normal operations for Units 1, 2, and 3. Normal operations is a major contributor for BFN LLRW shipments due to system cleanup activities. Resin is a major contributor for BFN LLRW shipments as the BFN radwaste system utilizes six waste phase separators and three reactor water cleanup phase separators. On average, BFN has 29 spent resin shipments per year.

BFN LLRW includes resins, filters and evaporator bottoms; dry active waste; irradiated components; other waste (combined packages). These four LLRW categories are documented below in Table 8.1-1 in cubic feet, cubic meters and curies. Table 8.1-1 also presents the total average annual LLRW shipped offsite (2009-2013) as well.

BFN future LLRW shipments for processing and disposal will continue to be similar to those in Table 8.1-1 for the 5 year average annual volumes.

BFN PUSAR Section 2.5.5.3, Solid Waste Management System, provides an evaluation of effects the proposed EPU may have on the solid waste management system for BFN. The results of the evaluation indicate that the proposed EPU will result in a 15 percent increase in the total volume of solid waste generated for shipment offsite.

Assessment performed for this supplemental ER indicates that the activity levels of the solid waste would increase proportionately to the increase in activity of long-lived radionuclides in the reactor coolant with an increase of 5-13 percent. This percentage increase reflects the EPU increase in power level and is based on BFN operation at the current licensed thermal power (CLTP) level of 3,458 MWt and EPU operation at the proposed Target Licensed Thermal Power (TLTP) level of 3,952 MWt. EPU does not generate a new type of waste or create a new waste stream. Therefore, the types of radioactive waste that requires shipment are unchanged. Because the solid waste volume increase is small, the current design and operation of the solid waste management system will accommodate the effects of BFN EPU with no changes. The existing equipment and procedures that control radwaste shipments and releases to the environment will continue to ensure that BFN remains within the applicable regulatory guidance. Therefore, there are no significant environmental effects due to EPU.

Table 8.1-1: BFN Average Annual Low-Level Radioactive Waste Shipped Off Site, 2009-2013

Category of Waste	Cubic Feet	Cubic Meters	Curies
Resins, Filters and Evaporator Bottoms	5.04E+03	1.43E+02	4.74E+02
Dry Active Waste	7.95E+04	2.25E+03	5.03E+00
Irradiated Components	3.44E+01	9.76E-01	1.98E+04
Other Waste (Combined Packages)	4.92E+03	1.39E+02	1.11E+01
Total Average Annual Low-Level Radioactive Waste Shipped Off Site (2009–2013)	8.95E+04	2.53E+03	2.03E+04

8.1.2 Liquid Waste

Liquid radioactive wastes include liquids from the reactor process systems and liquids that have become contaminated with process system liquids. Table 8.1-2 presents liquid releases from BFN Units 1, 2 and 3 for the 5 year period from 2009 through 2013. As noted in Table 8.1-2, approximately 289 million liters and 8.0 Ci fission and activation products were released in an average year. The 5 year average includes abnormal releases in 2009, 2010, and 2012. The abnormal releases included the activity from F-18 (T1/2 - 110 minutes). There is significant transit time between the effluent point of release and the nearest water purification facility intake. The abnormal releases are included in the basis for this assessment, but are not expected to occur. If the abnormal releases were excluded the yearly average would be 0.26 Ci.

As indicated in BFN PUSAR Section 2.5.5.2, Liquid Waste Management System, the volume of liquid waste effluents is expected to increase by approximately 3.44 percent due operation at EPU conditions. The increased flow in the condensate demineralizers requires more frequent backwashes due to increased loading of soluble and insoluble species. The total volume of liquid waste (a 3.44 increase of pre-EPU volume) does not significantly challenge the radwaste system's capacity. Therefore, EPU does not have an adverse effect on the processing of liquid and solid radwaste.

The assessment performed indicates that the proposed EPU would have the following impact on the equilibrium radioactivity in the reactor coolant, which would in turn impact the concentrations of radioactive nuclides in the waste management systems. Consistent with ANSI/ANS-18.1-1984, the expected equilibrium concentration of tritium in the reactor coolant and steam is not dependent upon the thermal power level. The inventory of radionuclides with long half-lives increase by approximately 13 percent (due to the power increase). The iodine concentration in reactor coolant would increase by approximately 5 percent.

The assessment performed herein addresses the expected increase due to the EPU based on the reported average annual releases during this five-year period. Consistent with NUREG-0016, the expected total annual release of tritium is a function of the power level. Therefore, the annual release of tritium is expected to increase by approximately 15 percent. The concentration of non-tritiated activity in the reactor coolant system would increase by approximately 13 percent which would result in an estimated annual release of non-tritiated activity of 9.04 Curies.

The assessment also concluded that the projected releases following EPU discussed herein remain bounded by values provided in the BFN PUSAR, which are based on 10 CFR Part 50 Appendix I type analysis that used the radioactive and volumetric source terms identified in ANSI/ANS-18.1-1984. The existing equipment and procedures that control releases to the environment will continue to ensure that BFN remains within applicable limits. There are no significant environmental effects due to EPU.

Section 8.2 addresses the offsite radiation dose consequences of the EPU liquid effluent releases.

Table 8.1-2: Liquid Effluent Releases From BFN, 2009–2013

Year	Volume of Waste Released (Liters)	Activity Released (Ci)	Tritium (Ci)
2009	7.09E+06	3.48E+01[1]	8.43E+01[2]
2010	1.57E+06	3.82E+00[1]	1.09E+01[2]
2011	1.98E+06	1.47E-02	5.21E+00
2012	1.39E+09[3]	7.81E-02[1]	9.58E+00[2]
2013	4.40E+07	1.26E+00	8.79E+01
Annual Average	2.89E+08	8.00E+00	3.96E+01

Notes:

1. The sum of the activity released would be 1.99E-02 Ci(2009), 4.13E-03 Ci(2010), and 9.43E-04 Ci(2012) if F-18 from abnormal releases were excluded. The 5-year annual average includes abnormal F-18 releases.
2. The sum of the activity released would be 1.15E+01 Ci(2009), 2.82E+00 Ci(2010), and 1.41E+00 Ci(2012) if H-3 from abnormal releases were excluded. Abnormal releases were included in the 5-year annual average for tritium.
3. The sum of the volume released would be 2.65E+05 Liters(2012) if the volume from abnormal releases were excluded.

8.1.3 Gaseous Waste

Gaseous radioactive wastes mainly include activation gases and fission product radioactive noble gases vented from process equipment and, under certain circumstances, building ventilation exhaust air. Table 8.1-3 presents gaseous releases from BFN Units 1, 2, and 3 from 2009 through 2013. The evaluation presented in BFN PUSAR section 2.5.5.1, Gaseous Waste Management System, indicates that implementation of the proposed EPU does not significantly increase the inventory of nonradioactive carrier gases, such as air, normally processed in the gaseous waste management system. This is because plant system functions are not changing and the volume inputs remain the same.

Calculations of steam activity consistent with NUREG-0016 show that the activity of fission gases is not increased; however, iodine increases by approximately 5 percent and particulates increase approximately 13 percent. Consistent with NUREG-0016, the expected total annual release of tritium is a function of the power level. Therefore, the annual release of tritium is expected to increase by approximately 15 percent. The dose for the different types of airborne releases have been consistently less than 2 percent (TVA 2009; TVA 2010; TVA 2011; TVA 2012; TVA 2013) of the allowable limits. Increasing all of the activity by 15 percent would result in doses which are still less than 2 percent of the allowable limits.

The gaseous effluents are well within limits at original power operation and will remain well within limits following implementation of EPU. There are no significant environmental effects due to EPU.

Table 8.1-3: Gaseous Effluent Releases From BFN, 2009–2013

Year	Fission and Activation Gases (Ci)	Particulates (T1/2> 8 Days) (Ci)	Iodines (Ci)	Tritium (Ci)	C-14 (Ci)
2009	None Detected	2.04E-04	1.35E-03	9.55E+01	None Reported
2010	None Detected	1.03E-03	7.51E-03	3.13E+02	3.52E+01
2011	1.09E-02	5.98E-03	8.36E-03	9.74E+01	3.45E+01
2012	6.93E+02	2.55E-03	8.42E-03	5.97E+02	3.61E+01
2013	None Detected	4.37E-02	5.01E-03	2.87E+02	3.71E+01
Annual Average	1.39E+02	1.07E-02	6.13E-03	2.78E+02	2.86E+01

8.1.4 Spent Fuel

The proposed EPU would increase the average batch size of fuel assemblies needed for a refueling. The impact of EPU on spent fuel storage is that the number of dry storage casks required would increase by approximately 19 percent with EPU implementation. Casks will be loaded to maintain adequate spent fuel pool capacity. Implementation of the independent spent fuel storage installation (ISFSI) was reviewed as part of the TVA FSEIS for license renewal of the three units and restart of BFN Unit 1 (TVA 2002). BFN's proposed plans for an ISFSI dry storage facility included sufficient expansion room to accommodate uncertainty in the DOE schedule for a national repository and additional storage required for license extension, three unit operation, and EPU implementation (TVA 2002). The additional spent fuel would be accommodated in the independent spent fuel storage installation pending shipment of the waste to a permanent disposal facility. Therefore, there are no significant effects on the environment due to EPU.

8.2 Radiation Levels and Offsite Doses

8.2.1 Occupational Radiation Dose (Onsite Dose)

During power operation, the radiation sources in the core are directly related to the fission rate. These sources include radiation from the fission process, accumulated fission products and neutron reactions as a secondary result of fission. Historically, these sources have been defined in terms of energy or activity released per unit of power. Therefore, for a constant pressure power uprate (CPPU), the percent increase in the operating source terms is no greater than the percent increase in power. Core radiation sources increase proportional to the increase in reactor power. Radiation sources in the reactor coolant include activation products, activation corrosion products, and fission products. Scaling factors for major dose contributors were calculated for normal and post-accident doses to address EPU conditions. Normal operation scaling factors were calculated for direct radiation from the core, off-gas, reactor liquid coolant (fission products, activation products, and N-16), the reactor steam, (N-16), Turbine Building (N-16), the reactor water cleanup system (RWCU), and the condensate demineralizers. The calculations are based upon the alternate source term analysis and AREVA ATRIUM-10XM fuel. The EPU scaling factors were applied to the BFN dose calculations to evaluate the impact of EPU implementation.

As indicated in BFN PUSAR Section 2.10.1.2, Occupational and Onsite Radiation Exposure, the normal operation radiation levels increase slightly under EPU conditions. Plant shielding is designed to provide for personnel access to the plant to perform maintenance and carry out operational duties with personnel exposures limited to the criteria established by 10 CFR Part 20. Evaluations at the uprated power level conclude that the pre-uprate values for activity still bound the uprated values. Thus, the increase in radiation levels does not affect radiation zoning or shielding in the various areas of the plant, because it is offset by conservatism in the original design, source terms used, and analytical techniques.

In-plant radiation levels and associated doses are controlled by the BFN Radiation Protection Program to ensure that internal and external radiation exposures to station personnel, and the general population will be as low as reasonably achievable (ALARA), as required by 10 CFR Part 20. The TVA policy is to maintain occupational doses to individuals and the sum of dose equivalents received by all exposed workers ALARA.

Individual worker exposures can be maintained within acceptable limits by controlling access to radiation areas using the site ALARA program. Procedural controls compensate for increased radiation levels. In addition, BFN has previously implemented zinc injection and noble metal chemical addition to limit the increase in normal radiation doses from the implementation of hydrogen water chemistry.

Post-uprate radiation levels in most areas of the plant are expected to increase by no more than the percentage increase in power level. In a few areas near the reactor water piping and liquid radwaste equipment, the increase could be slightly higher due to the increase in production of activated corrosion products. Access to these areas is strictly controlled by existing Radiation Protection procedures. Individual worker exposures are maintained within acceptable limits by controlling access to radiation areas using the site ALARA program. Procedural controls compensate for increased radiation levels. Therefore, no new dose reduction programs are planned and the ALARA program would continue in its current form. Therefore, there are no significant effects on occupational radiation dose due to EPU.

8.2.2 Radiological Impacts Normal Operation (Offsite Dose)

Using scaling techniques of NUREG-0016, this analysis conservatively projects maximum doses from normal operation under the proposed EPU conditions taking into consideration the following:

- The reported gaseous and liquid effluent and dose data during that period
- NUREG-0016 equations and assumptions
- Conservative methodology

Pre-EPU dose estimates are calculated by taking the average 5 year annual organ and whole body dose values for gaseous and liquid effluents during the period from 2009 through 2013 - (TVA 2009; TVA 2010; TVA 2011; TVA 2012; TVA 2013). To predict doses under the proposed EPU conditions, the analysis assumes that the maximum increase in radioactivity content of the liquid and gaseous releases is related to the maximum percentage change per chemical class (NRC 1979) in the reactor and steam coolants over that of the pre-EPU case. To conservatively estimate the offsite dose due to EPU the average value from the annual radioactive effluent release reports is increased by a factor of 1.2.

Following EPU, TVA predicts that the maximum annual total body and organ doses (all pathways) from liquid effluent releases would increase slightly. As demonstrated in Table 8.2-1, the estimated EPU doses due to liquid effluents are significantly below the ODCM and EPA limits. Following EPU, TVA predicts that the maximum annual total body and organ doses (all pathways) from gaseous effluent releases would increase slightly. As demonstrated in Table 8.2-2, the estimated EPU doses due to gaseous effluents are significantly below the ODCM and EPA limits.

The current ISFSI storage pad is projected to be filled on or before 2022, prior to being loaded with EPU fuel. An additional storage pad is anticipated to be required, even if no EPU is approved. ISFSI dose contributions will continue to be monitored using the ODCM process.

The offsite doses due to the ISFSI would be negligibly affected by storage of EPU fuel, as changes in neutron and gamma sources are primarily a function of fuel burn up and cooling time rather than power.

Under pre-EPU conditions, direct radiation measurements made at the site boundary measured by environmental dosimeters deployed around BFN as part of the offsite Radiological Environmental Monitoring Program (REMP) indicated no increase in ambient radiation levels from plant operation. This is expected to continue under EPU conditions.

For CPPU, normal operation gaseous activity levels increase slightly while the level of N-16 in the turbine increase proportional to the rated steam flow. The increased steam flow rate and velocity result in shorter travel time to the turbine and less radioactive decay in transit. This leads to higher radiation levels in and around turbines and offsite skyshine. The typical shielding design more than adequately bounds increases due to power uprate. Although implementation of EPU increases the skyshine component to the offsite doses up to 32 percent due to N-16 in the equipment above grade, the expected post-EPU increase in the in-plant radiation exposure in the turbine building complex has a negligible effect on the estimated doses to members of the public. The turbine building concrete shielding and distance between the turbine building and offsite boundary are such that the post-EPU direct dose contribution from the steam components in the turbine building is negligible. The post-EPU N-16 skyshine dose rate at the nearest boundary is expected to be near the background radiation level. Therefore, it does not significantly impact the total estimated doses to members of the public.

A review was performed to determine the highest dose to a member of the public within the site boundary. The dose to a member of the public consists of the sum of dose commitments from effluent releases as well as any direct radiation dose. The gaseous effluent dose commitment is negligible compared to the direct radiation dose. The direct radiation dose was determined from area environmental dosimeters located onsite. It consisted of gamma dose from the plume, ground contamination, and from equipment sources (i.e., tanks, turbine shine, radioactive material storage areas, etc.). The critical location was determined to be an environmental dosimeter near the Livewell Center (Training Center). The average annual direct radiation dose accounting for background and occupancy was 0.87 mrem during the period of 2009 through 2013. It can be concluded that the dose limit for a member of the public at the site boundary as specified in 10 CFR 20.1301 would not be exceeded even at the projected 32 percent increase due to skyshine from N-16 after EPU.

The 40 CFR Part 190 annual whole body dose limit of 25 mrem to any member of the public includes the following:

- Contributions from direct radiation (including skyshine) from contained radioactive sources within the facility
- Whole body dose from liquid release pathways
- Whole body dose to an individual via airborne pathways

Taking into consideration the magnitude of the estimated annual EPU doses due to gaseous and liquid effluent releases and the negligible direct shine dose contribution from components within the facilities, ISFSI and skyshine, it is concluded that the 40 CFR Part 190 whole body dose limit of 25 mrem/yr will not be exceeded by operation at EPU conditions. Therefore, there are no significant effects on the environment due to EPU.

Table 8.2-1: Average Offsite Dose Commitments From Liquid Effluents

Type of Dose	ODCM Limit (mrem/year)	EPA Limit (mrem/year)	2009–2013 Average Annual Dose (mrem)	Projected Annual Dose (mrem)	Percentage of ODCM Limit Current / Projected (%)	Percentage of EPA Limit Current / Projected (%)
Total Body	3	25	0.014	0.0168	0.47 / 0.56	0.056 / 0.067
Any Organ	10	25	0.0204	0.0245	0.20 / 0.25	0.082 / 0.098

Table 8.2-2: Average Offsite Dose Commitments From Gaseous Effluents

Type of Dose	ODCM Limit (mrem/year)	EPA Limit (mrem/year)	2009–2013 Average Annual Dose(mrem)	Projected Annual Dose (mrem)	Percentage of ODCM Limit Current / Projected (%)	Percentage of EPA Limit Current / Projected (%)
Gamma Dose in Air (mrad)	10	25	2.28E-6	2.74E-6	0.000023 / 0.000027	0.000009 / 0.000011
Beta Dose in Air (mrad)	20	25	1.54E-6	1.85E-6	0.000008 / 0.000009	0.000006 / 0.000008
Any Organ (mrem)	15	25	9.83E-2	1.18E-1	0.66 / 0.79	0.39 / 0.47

8.3 Radiological Consequences of Accidents

8.3.1 Radiological Impacts—Accident Related

The radiological consequences resulting from the postulated designed basis accidents (DBAs) of loss of coolant accident, main steam line break accident, fuel-handling accident, and the control rod drop accident have been evaluated using NRC accepted methods. The results indicate existing regulatory requirements would continue to be met. Table 8.3-1 presents a summary of the radiological consequences of these postulated DBAs.

On July 31, 2002, in accordance with the provisions of 10 CFR 50.4 and 10 CFR 50.90, TVA submitted a request for a license amendment that supports a full scope application of an Alternative Source Term (AST) methodology for BFN Units 1, 2, and 3. This request was approved on September 27, 2004 (ML042730028). Full scope AST analyses were performed following the guidance in Regulatory Guide 1.183, Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors and Standard Review Plan Section 15.0.1, "Radiological Consequences Analyses using Alternative Source Terms." AST analyses were performed for the four Updated Final Safety Analysis Report (UFSAR) Chapter 14 BFN DBAs that could potentially result in offsite doses, those previously mentioned above. The core inventory assumed for these analyses consisted of choosing the bounding value of each isotope between GE14 fuel and AREVA's ATRIUM-10 fuel at EPU conditions. Subsequent evaluations have shown that the ATRIUM-10XM core inventory is bounded by the combined GE14/ATRIUM-10 source term. Bounding results appear in Table 8.3-1.

The analyses demonstrated that using AST methodologies, post-accident offsite doses remain within regulatory limits.

Table 8.3-1: Summary of Radiological Consequences of Postulated Accidents

Design Basis Accident	Offsite Dose at Exclusion Area Boundary (Rem TEDE)		Offsite Dose at Low Population Zone (Rem TEDE)	
	Value	Limit	Value	Limit
Loss of Coolant (LOCA)	1.71	25	2.38	25
Main Steam Line Break				
3.2 µCi/g DE I-131	0.13	2.5	0.07	2.5
32 µCi/g DE I-131	1.30	25	0.65	25
Fuel Handling	0.86	6.3	0.43	6.3
Control Rod Drop	1.17	6.3	0.70	6.3

Notes:
Rem = Roentgen Equivalent Man
TEDE =Total Effective Dose Equivalent
µCi/g = micro Curies per gram
DE = Dose Equivalent
I-131 = Iodine 131

8.4 References

ANSI/ANS 18.1 - 1984. American National Standard Radioactive Source Term for Normal Operation of Light Water Reactors.

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

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TVA. 2013. Browns Ferry Nuclear Plant Units 1, 2, and 3 2013 Annual Radioactive Effluent Release Report, January 1, 2013 through December 31, 2013. Accession No. ML14122A344.

TVA. 2015. Tennessee Valley Authority Browns Ferry Nuclear Plant Offsite Dose Calculation Manual, 0-ODCM-001, Revision 22. Browns Ferry Nuclear Plant. February 17, 2015.

9.0 ENVIRONMENTAL EFFECTS OF URANIUM FUEL CYCLE ACTIVITIES AND FUEL AND RADIOACTIVE WASTE TRANSPORT

Table S-3 of 10 CFR 51.51 provides the basis for evaluating the contribution of the environmental effects of the uranium fuel cycle to the environmental impacts of licensing nuclear power plants. Summary Table S-4 of 10 CFR 51.52 lists the environmental impacts of transporting nuclear fuel and waste to and from one light-water-cooled nuclear power plant under both normal conditions and accidents. However, since the 1970s when these tables were developed, most nuclear plants have increased both uranium-235 enrichment and fuel burnup limits, which are fundamental parameters that affect environmental impacts of the uranium fuel cycle, including transport.

In 1988, the NRC generically evaluated the impacts of increased enrichment and extended burnup fuel on the uranium fuel cycle, including transportation of nuclear fuel and wastes, to determine whether higher burnup and enrichment could result in environmental impacts greater than those described in Tables S-3 and S-4. The EA and FONSI (53 FR 6040) concluded that uranium enrichments up to 5 percent uranium-235 and burnup limits of up to 60,000 MWd/MTU would have no significant adverse environmental effects on the uranium fuel cycle or the transport of nuclear fuel and wastes, and would not change the impacts presented in Tables S-3 and S-4.

In 1999, in connection with the generic EIS (GEIS) for license renewal of nuclear power plants, the NRC examined the transport of spent fuel having higher initial enrichment (up to 5 percent) and higher discharge burnup (up to 62,000 MWd/MTU) to a geologic repository (NRC 1999). The conclusion of that evaluation was that the environmental impacts would be consistent with the values presented in Table S-4 and that the impacts in Table S-4 are bounding.

Increasing the electrical output of a BWR power plant is accomplished primarily by generating higher steam flow in the reactor and supplying it to the turbine generator. The higher steam flow is achieved by increasing the reactor power level and the feedwater flowing to the reactor. The additional reactor energy requirements for EPU are met primarily by increasing the reload fuel batch size and changing the fuel loading pattern and planned deployment of fuel enrichment and burnable poison, supplemented by adjustments to core management control rod pattern and/or core flow. The increase in core thermal power is achieved with a more uniform (flattened) power distribution such that EPU does not require any changes to fuel design limits.

Design studies project that, compared with the current re-load batch size at the current power level, EPU will require more assemblies per re-load, resulting in a slight increase in cycle dose associated with the production, handling, and storage of more fresh and spent fuel. However, because the burn-up limit is unchanged (the upper exposure limit is bounded by maintaining the fuel within the NRC-approved vendor-specific exposure limits) for EPU, and the U-235 enrichment limit of 5 percent also remains the same, the BFN fuel cycles will remain bounded by the impacts listed in Tables S-3 and S-4 of 10 CFR Part 51. For the purpose of bounding the impacts, TVA used a range of fuel vendor specifications for this analysis. TVA concludes, therefore, that impacts to the uranium fuel cycle and transport of nuclear fuel from the proposed action would be insignificant and not require mitigation.

While the analysis discussed above was based on a range of fuel vendor specifications, the analysis discussed below is based on a single vendor, TVA's current fuel vendor for Units 1, 2, and 3, AREVA NP.

On February 14, 2001, TVA published a notice of adoption in the *Federal Register* for the FEIS, "Disposition of Surplus Highly Enriched Uranium," prepared by the U.S. Department of Energy (DOE), Office of Fissile Materials. TVA's actions related to the preferred alternative include entering into an interagency agreement with DOE to obtain approximately 33 metric tons of highly enriched uranium (HEU) for blend down and subsequently to use the low enriched uranium (LEU) in the form of nuclear reactor fuel at BFN. TVA actions related to the preferred alternative also include entering into contracts with a consortium composed of AREVA NP of Lynchburg, Virginia and Richland, Washington, and Nuclear Fuel Services of Erwin, Tennessee, to process and blend the uranium and to fabricate the fuel. After analysis of the adequacy and applicability and subsequent adoption of the DOE's FEIS, and following recirculation of the DOE's FEIS and consideration of public comments received on its adoption by TVA, TVA decided to implement the actions (as described above) related to the preferred alternative identified in DOE's FEIS. The decision was based on the substantial savings to TVA ratepayers in nuclear fuel costs in the years 2005–2015 without significantly impacting the environment, and that the environmental impacts associated with producing and transporting an equivalent amount of LEU from 14 million pounds of natural uranium (as U_3O_8) that, in turn, would require mining of 140,000 tons of ore would be avoided. The ROD for this action was published in the *Federal Register* on November 19, 2001 (66 FR 57997). The first fuel resulting from these processing, blending, and fabrication contracts was loaded into Unit 2 during the spring 2005, and the last full reload is expected to occur in the fall 2016 in Unit 1. (There may be partial core reloads later, depending on material availability, which may or may not occur during EPU operations.)

For blended low enriched uranium (BLEU) fuel, there is a higher percentage of the uranium-236 (U-236) isotope than for virgin uranium. U-236 is a neutron poison, requiring the enrichment to be increased as a compensation for reactivity loss. For fresh fuel with BLEU, the number of assemblies to be shipped increases, and the associated handling doses are increased due to the presence of the U-236 (surface contact source term increases from 4 to 8 mR/hr with commercial grade uranium to 10 to 15 mR/hr with BLEU). However, because the maximum enrichment and discharge burnup remain within the 5 percent and 62,000 MWd/MTU limits, respectively, the BFN fuel cycles with BLEU will still remain bounded by the impacts of Tables S-3 and S-4 of 10 CFR Part 51.

9.1 References

53 FR 6040. Extended Burnup Fuel Use in Commercial LWRs; Environmental Assessment and Finding of No Significant Impact. *Federal Register* 53:6040 (February 29, 1988).

66 FR 57997. Blending of Surplus Highly Enriched Uranium From the Department of Energy, to Low Enriched Uranium for Subsequent Use as Reactor Fuel at the Tennessee Valley Authority's Browns Ferry Nuclear Plant. *Federal Register* 66:57997 (November 19, 2001).

NRC (U.S. Nuclear Regulatory Commission). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*. NUREG-1437, Vol. 1, Addendum 1, Main Report Section 6.3—Transportation, Table 9.1 Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants. August 1999.

10.0 EFFECTS OF DECOMMISSIONING

In 2002, NRC published NUREG-0586, Supplement 1, *Final GEIS on Decommissioning of Nuclear Facilities*, that discusses decommissioning of nuclear power reactors. The conclusion of NUREG-0586, Supplement 1, is that the environmental impacts of decommissioning are generally small and that only two environmental issues would require site specific evaluation: threatened and endangered species and environmental justice. (NRC 2002)

Prior to the projected end of operations, TVA would submit a preliminary decommissioning plan describing decommissioning activities, any environmental impacts of those activities, a schedule, and estimated costs. Implementation of EPU does not affect the ability of TVA to maintain sufficient financial reserves for decommissioning.

The slight potential for increase in environmental impacts due to decommissioning attributable to EPU is due to increases in the feedwater flow rate and increased neutron fluence. These increases in flow rate and neutron fluence could increase the amount of activated reactor vessel and corrosion products, respectively, and consequently, increase post-shutdown radiation levels. However, increases in radiation levels are expected to be insignificant, and would be addressed in the post-shutdown decommissioning activities report.

10.1 References

NRC (U.S. Nuclear Regulatory Commission). 2002. Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors. NUREG-0586, Supplement 1. Volume 1: Main Report, Appendices A through M.