BROWNS FERRY NUCLEAR PLANT LICENSE RENEWAL APPLICATION

APPENDIX E

ENVIRONMENTAL REPORT

Applicant's Environmental Report Operating License Renewal Stage

Browns Ferry Nuclear Power Plant Units 1, 2, and 3

TENNESSEE VALLEY AUTHORITY
December 2003

NOTE TO REVIEWERS

THE TEXT ENCLOSED IN SHADED BORDERS THROUGHOUT THIS ENVIRONMENTAL REPORT IS GUIDANCE FROM NRC REGULATORY GUIDE 4.2S1.

APPENDIX E

APPLICANT'S ENVIRONMENTAL REPORT –
OPERATING LICENSE RENEWAL STAGE
BROWNS FERRY NUCLEAR PLANT UNITS 1, 2, AND 3

TENNESSEE VALLEY AUTHORITY

LICENSE NOS. 50-259, 50-260, AND 50-296

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ATTACHMENTS

ACRONYMS AND ABBREVIATIONS

µg/L	micrograms per liter
ABWR	advanced boiling water reactor
ACHP	Advisory Council on Historic Preservation
ADEM	Alabama Department of Environmental Management
ADT	Average Daily Traffic
ADWFF	Alabama Division of Wildlife and Freshwater Fisheries
APE	area of potential effects
ARPA	Archaeological Resources Protection Act
ASME	American Society of Mechanical Engineers
BFN	Browns Ferry Nuclear Power Plant
BIP	balanced indigenous populations
BMP	best management practice
BWR	boiling water reactor
CCW	condenser circulating water
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Resource, Compensation, and Liability Act
cfs	cubic feet per second
CT	combustion turbine generator
CWA	Clean Water Act
DEC	Decatur Energy Center
DO	dissolved oxygen
EECW	Emergency Equipment Cooling Water
EIS	Environmental Impact Statement
EMF	electromagnetic field
EO	Executive Order
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FMCRD	five motion control rod drive
FSAR	Final Safety Analysis Report
FSEIS	Final Supplemental Environmental Impact Statement
GEIS	Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants
GPM	gallons per minute
GWHrs	gigawatt-hours
ha	hectare
HAP	hazardous air pollutant
HRSG	heat recovery steam generator

HWSF	Hazardous Waste Storage Facility
IGCC	Integrated Gasification Combined Cycle
IPA	Integrated Plant Assessment
ISFSI	independent spent fuel storage installation
ISO	Inspection Services Organization
kg/ha	kilogram per hectare
kV	kilovolt
LLRW	low level radioactive waste
LOS	level of service
M/M	maintenance and modification
MEC	Morgan Energy Center
mg/L	milligrams per liter
MGD	million gallons per day
mph	miles per hour
MPRSA	Marine Protection, Research, and Sanctuaries Act
MW	megawatts
NAAQS	National Ambient Air Quality Standards
NDE	nondestructive examinations
NEPA	National Environmental Policy Act
NESC	National Electrical Safety Code
NHPA	National Historic Preservation Act
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NWI	National Wetland Inventory
OPA	option purchase agreement
OSHA	Occupational Safety and Health Administration
PAME	primary aerobic meningoencephalitis
PCB	polychlorinated biphenyls
PM	particulate material
PSD	prevention of significant deterioration
PSD	proportional stock density
psi	pounds per square inch
QC	quality control
RCCV	reinforced concrete containment vessel
RCRA	Resource Conservation and Recovery Act
RFAI	Reservoir Fish Assemblage Index
RFP	request for proposal
RHR	residual heat removal
ROS	Reservoir Operations Study
RPV	reactor pressure vessel
RSDM	relative stock density of memorable-sized fish

RSDP	relative stock density of preferred-sized fish
RSDT	relative stock density of trophy-sized fish
SAMA	Severe Accident Mitigation Alternatives
SEIS	Supplemental Environmental Impact Statement
SFI	Sport Fish Index
SHPO	State Historic Preservation Office
TLAAs	time-limited aging analyses
TMDL	total maximum daily load
TRM	Tennessee River Mile
TSCA	Toxic Substance Control Act
TVA	Tennessee Valley Authority
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UTM	Universal Transverse Mercator
VOC	volatile organic compound
vpd	vehicles per day
VS	Vital Signs
Wr	relative weight

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E.1.0 PURPOSE OF AND NEED FOR ACTION

> This chapter should briefly describe the purpose of and need for the proposed action. The Commission identified the purpose of and need for the proposed action in 61 FR 28467 and in NUREG-1437 on pages 1-2; this statement should be included in the applicant's ER.
>
> The purpose and need for the proposed action (renewal of an operating license) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and, where authorized, Federal (other than NRC) decision makers.

The Nuclear Regulatory Commission (NRC) has adopted the following definition of the purpose of and need for the proposed action of nuclear power plant operating license renewal in 61 FR 28467 and in Section 1.3 of NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants:"

> "The purpose and need for the proposed action (renewal of an operating license) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and where authorized, Federal (other than NRC) decision makers."

In response to the increasing demands for bulk power, the Tennessee Valley Authority (TVA) seeks to use existing facilities to the greatest extent possible. This approach has the three-fold benefits of assuring future power supplies, avoiding the large capital outlays associated with new construction, and avoiding the environmental impacts resulting from siting and constructing a new power generating facility.

Consistent with the above, TVA proposes to continue operation of Units 1, 2, and 3 of its Browns Ferry Nuclear Power Plant (BFN) located in Limestone County, Alabama, after expiration of the current operating license for each unit. This requires renewal of the units' operating licenses from the NRC. Renewal of the current operating licenses would permit operation for an additional twenty years past the current (original) 40-year operating license terms which expire in 2013, 2014, and 2016 for Units 1, 2, and 3, respectively. The current NRC operating licenses for the three BFN units are numbered 50-259, 50-260, and 50-296, consecutively.

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E.2.0 SITE AND ENVIRONMENTAL INTERFACES

The information in this chapter is intended to allow the reviewer to understand the overall character of the site and local environment. This chapter should describe the plant's setting and the environment affected. The description should give particular attention to information required to address the environmental issues designated Category 2 and environmental justice and to environmental issues raised by new and significant information that has been identified. Guidance on the treatment of these issues is provided in Chapter 4 of this regulatory guide.

The following information should be included in this chapter of the ER.

- Site location: State, county, latitude and longitude Universal Transverse Mercator (UTM) coordinates, township, range, and sections.
- A map of the site showing site boundaries; exclusion area; site structures and facilities; major land uses (with land use classifications consistent with the U.S. Geological Survey (USGS) categories); the construction zone for refurbishment, if any; sites for any other planned buildings and structures (both temporary and permanent); and transportation routes adjacent to the site.
- A map or maps of the site vicinity within about a 10-km (6-mi) radius of the plant showing county and local municipality boundaries; place names; residential areas; airports; industrial and commercial facilities; roads; railroads; major land uses (with land use classifications consistent with the USGS categories); utility rights-of-way; rivers; other bodies of water; wetlands; trust lands; historic sites; archaeological sites; Native American lands; military reservations; and designated Federal, State, and local parks and natural areas. Orient true north at the top of the map.
- A map of the region within about an 80-km (50-mi) radius of the plant showing major civil divisions; highways; transmission corridors serving the plant (specifically identify those transmission lines that were identified in the construction permit review as being constructed to connect the plant to the transmission system); rivers; other bodies of water; Native American lands; military reservations; designated Federal, State, and local parks and natural areas; and nonattainment and maintenance areas defined under the Clean Air Act, as amended (Title 42 U.S.C. 7401, et seq.). Orient true north at the top of the map.

To the extent any information provided on a map relates to an issue addressed in Chapter 4, "Environmental Consequences of the Proposed Action and Mitigating Actions," of this guide or to any new and significant information, that information should be developed in sufficient depth in textual, tabular, and graphic form to support the analysis. The topics listed below correspond to the issues identified in Chapter 4. The level of information provided on each of these topics should be commensurate with the extent of the analysis required. The information identified below should be represented on the maps identified above; separate maps or tables may be used if they better support the analysis specified in Chapter 4.

- Aquatic and riparian ecological communities that may be affected by a once-through or cooling pond heat dissipation system.
- Ground-water resources that may be subject to use conflicts or quality degradation.
- Critical and important terrestrial (plant and animal) habitats that may be disturbed by power plant refurbishment activities or changes in plant operation. Critical habitats are listed and described in 50 CFR 17.95 (fish and wildlife) and 17.96 (plants).

- Threatened or endangered and special concern species identified on the site or within the site vicinity. These species include those:
  - listed at 50 CFR 17.11 (fish and wildlife) or 50 CFR 17.12 (plants)
  - listed as a threatened, endangered, or other species of concern by the host State
  - proposed for listing, or are current candidates for the listing in the *Federal Register*.
- Regional demography, based on the most current (updated) U.S. Census data: population by city, town, and county for those jurisdictions lying fully or partially within 80 km (50 mi) of the plant. Provide by political jurisdiction the composition of minority persons and households below the poverty line within 80 km (50 miles) of the plant. Migrant workers as well as full-time residents should be included. Provide these data by census tract/block for those geographic areas where the potential has been identified for adverse environmental impacts from refurbishment or from continued operation during the renewal term. The most recent Bureau of the Census demographic information should be supplemented with demographic information from State and local planning agencies.
- Information related to the area's economic base, including construction industry and construction labor force, total regional labor force, unemployment levels, and future economic outlook.
- Housing information, including the sales and rental markets in the region, number and types of units, turnover and vacancy rates, and trends in additions.
- Information about the local educational system (regional primary and secondary schools and higher institutions), including present and projected capacity and percentage of utilization.
- Public and private recreational facilities and opportunities, including present and projected capacity and percentage of utilization.
- Regional tax structure and distribution of the present revenues to each jurisdiction and district.
- Local plans concerning land use and zoning that are relevant to population growth, housing, and changes in land use patterns.
- Social services and public facilities, present and projected.
- Data on local and regional meteorology and air quality.
- Historic and archaeological resources.

Known and reasonably foreseeable Federal and non-Federal projects and other actions in the vicinity of the site that may contribute to the cumulative environmental impacts of license renewal and extended plant operation should be identified and described.

E.2.1 LOCATION AND FEATURES

Site Location

The Browns Ferry Nuclear Power Plant site is located on the north shore of Wheeler Reservoir in Limestone County, Alabama, at Tennessee River Mile (TRM) 294. The site is approximately 30 miles west of Huntsville, Alabama. It is 10 miles northwest of Decatur, Alabama, and 10 miles southwest of Athens, Alabama. The Universal Transverse Mercator (UTM) Zone 16 coordinates for BFN in meters on the NAD83 datum are: (489,137.74 and 3,840,243.51).

The site is an 840-acre tract just south of U.S. Highway 72 and is directly accessible from County Road 25 (Nuclear Plant Road). County Road 25 intersects U.S. Highway 72 approximately six miles north of the site and it also intersects U.S. Highway 31 approximately nine miles east of the site.

Site Description

The plant is located on property owned by the United States and held in the custody of TVA, a corporate agency and instrumentality of the United States. The three-unit plant, including the intake and discharge canals, is enclosed by a security fence. Primary access to the plant area is by way of an access road through a security gate.

The plant has the following principal physical structures in the central site area: reactor containment building, turbine building, radwaste building, service building, intake pumping station, transformer yard, 161-kV and 500-kV switchyards, off-gas stack, sewage treatment facilities, and administration and maintenance buildings. Northwest of the central site area are the hot and cold water discharge channels and mechanical draft cooling towers. To the east of the central site area are located the training center, employee physical fitness center, materials storage and procurement complex, and structures from a former aquatic research laboratory.

Prior to expiration of the current operating licenses it is planned to construct a larger administration building, a new modifications/fabrication building, and an expandable dry cask storage facility for spent reactor fuel, all in the central site area.

Site Environs

The site is situated in an area where the land is used primarily for agriculture. Population densities are low, with no population centers of significance within ten miles of the plant. The site is surrounded to the north and east by rural countryside. It includes open pasturelands, scattered farmsteads, few residents, and little industry within several miles. The terrain is gently rolling with open views to higher elevations to the north. The south and west side of the plant site abuts Wheeler Reservoir, which is a wide expanse of open river used for an array of recreational purposes. The reservoir in the vicinity of the plant site is moderately utilized by recreational boaters and fishermen.

There are no homes within foreground viewing distance to the north and east. However, adjacent to the site there is a small residential development to the northwest, another across Wheeler Reservoir to the southwest, and the Mallard Creek public use area directly across the reservoir, that have partial views of the plant site. A berm, graded during the initial construction of the plant site and containing approximately 3.3 million cubic yards of earth excavated to make cooling water channels, lies adjacent to the cooling tower complex and blocks views of the northern and eastern plant areas.

Two wildlife management areas occur within three miles of the BFN site, Swan Creek State Wildlife Management Area and Mallard-Fox Creek State Wildlife Management Area. The Swan Creek Wildlife Management Area includes over 3,000 acres of land and over 5,000 acres of water surrounded by numerous industrial facilities. The Mallard-Fox Creek State Wildlife Management Area encompasses approximately 700 acres of land and 1,700 acres of water and is primarily utilized for small game hunting.

Approximately 3.5 miles upstream of BFN is the Round Island Recreation Area.

Site Area Physiography and Soils

Limestone County is part of the Highland Rim section of the Interior Low Plateaus physiographic province. It is comprised of three physiographic subdivisions: The Limestone Valleys, the Plateau, and the Alluvial Plains. The Limestone Valleys, locally called the red lands, include the southeastern part of the county. The Alluvial Plains include the nearly level to undulating first bottoms and stream terraces along the Tennessee and Elk Rivers. BFN is located in the Limestone Valleys and Alluvial Plains (USDA, 1953).

The soils that have developed in the Limestone Valleys and Alluvial Plains are inherently productive for growing crops. Those that developed from high-grade limestone originally contained a relatively high quantity of organic matter, and the depth of soil over bedrock is 15 to 20 feet in most places. Drainage is good and the acidity is moderate. The alluvial soils are fairly well supplied with lime, organic matter, and plant materials, which provide fertility needed to obtain high crop yields (USDA, 1953).

There are about 279,229 acres (73.5%) of soils in the county classified as prime and/or statewide important farmland (USDA-NRCS, 1997). These are soils that have the chemical and physical properties to economically sustain high yields of crop production.

Soils comprising the majority of the region immediately surrounding the BFN and including the site are Abernathy, Cumberland, and Decatur soils. Phases of these soils that occur on slopes less than 6% are classified as prime farmland. The Abernathy soils have developed from colluvial material washed from surrounding soils of high-grade limestone. This well-drained soil occupies mainly basins or depressions. The Cumberland soils are located on the river and stream banks and have developed from alluvium material washed from soils underlain by limestone and to a small extent by shale and sandstone. This soil is well adapted to cultivated crops because of its fertility and physical characteristics. The Decatur soils have developed from residual material weathered from high-grade limestone of the Tuscumbia formation. It is well suited for cropping and is one of the most extensively cropped soils in the county. (USDA, 1953).

Most of the soil on the BFN site was disturbed when the plant was constructed and is no longer considered as prime farmland. The entire site is classified as urban built-up land.

E.2.2 AQUATIC AND RIPARIAN ECOLOGICAL COMMUNITIES

E.2.2.1 HYDROLOGY AND WATER QUALITY

Hydrology

BFN is located on the north bank of Wheeler Reservoir at Tennessee River Mile (TRM) 294. At the BFN site, the Tennessee River flows from southeast to northwest and averages 1 to 1.5 miles in width. Wheeler reservoir extends from Guntersville Dam at TRM 349 to Wheeler Dam at TRM 274.9. The drainage area upstream of Wheeler Dam is 29,590 square miles. The reservoir was created in 1936 as one of the first major dam projects on the Tennessee River for flood control, power generation, and navigation. Wheeler has a normal summer elevation of 556 feet (mean sea level) msl and a minimum water elevation of 550 feet. The lake usually reaches summer elevation by April 15. Fall drawdown, in anticipation of winter rains, usually begins around August 1. At summer pool elevation, the reservoir has an area of 67,070 acres, a volume of 1,050,000 acre-feet, a mean depth of 15.7 feet, and a hydraulic residence time of 10.7 days.

In 2002 and 2003, the TVA undertook a study to determine if changes in TVA's reservoir system operating policies would produce greater overall public value. This study, in the form of an Environmental Impact Statement, is expected to be issued in February 2004. On the basis of this study, TVA may decide to alter reservoir levels and when summer pool and fall drawdown occur. A no action alternative and eight alternative operating policies were evaluated. It was determined that for all hydrologic conditions and for all alternatives that the existing minimum flow past BFN Plant could be maintained. Under TVA's preferred alternative, additional water would be scheduled for release through Chickamauga Dam, which is upstream of Wheeler Reservoir, and the minimum pool elevation within Wheeler Reservoir would be increased by 0.5 foot in the winter.

Interfacing waterways include Round Island Creek embayment 4 miles upstream (TRM 298) on the north bank, and Fox Creek embayment (TRM 296) 2 miles upstream on the south bank. Mallard-Fox Creek Wildlife Management area is located just across the reservoir from BFN. Mallard Creek embayment is located approximately ½ mile downstream of BFN on the opposite bank. The Elk River flows into Wheeler Dam about 10 miles downstream of the plant on the north bank.

Surface water at BFN is derived from precipitation remaining after losses due to infiltration and evapotranspiration. It can generally be classified as local surface runoff or streamflow. Surface water runoff from the plant site is to the Tennessee River.

Rainfall in the area averages 57 inches per year, with March being the wettest month at 6.6 inches, and October the driest month at 3.3 inches. The average monthly air temperature ranges from 39°F in January to 79°F in July with an annual mean of about 60°F. Average unregulated streamflow at the dam is 49,800 cubic feet per second (cfs) or 1.7 cfs per square mile of drainage area.

Water Quality

Historically, the dissolved oxygen concentration of reservoir releases ranges from about 11 milligrams per liter (mg/L) in late January to 6 mg/L in early July, with an annual average of 8 mg/L. The release water temperature ranges from about 43°F in January to 84°F in July with an annual average of 68°F. Most of Wheeler Reservoir is classified by the Alabama department of environmental management (ADEM) for use as public water supply, swimming and other whole body water-contact sports, and fish and wildlife. However, the area of the reservoir immediately upstream and downstream of BFN is not classified for public water supply. Water quality is generally good and is suitable for designated uses. The section of Wheeler Reservoir from the Elk River to Wheeler Dam was on the 2000 Alabama 303(d) list as partially supporting its designated uses due to pH and temperature/thermal modifications caused by industrial sources and flow regulation and modification. However, in 2002, ADEM determined that the mean temperatures in the photic zone (top four meters in the water column) are statistically similar to values measured at other locations along the Tennessee River and that designated uses of Wheeler Reservoir are not impaired due to pH and temperature (ADEM, 2002). Table E.2-1 summarizes general water quality conditions in Wheeler Reservoir using 1990 through 1998 data available from the EPA STORET data base.

Table E.2-1 Summary of Wheeler Reservoir Water Quality[a]

Parameter	Units	Number Samples	Mean	Standard Division	Maximum	Minimum
Turbidity	NTU	63	8.91	11.07	75.0	1.2
Secchi Depth	meters	305	1.06	0.39	2.5	0.2
Total Alkalinity	mg/L	462	58.13	8.74	112	15
Dissolved Oxygen	mg/L	6542	7.42	1.98	16.8	0.1
Temperature	°F	6537	78.66	8.39	91.9	43.6
BOD_5	mg/L	2334	2.39	1.36	11.0	0.1
Total Suspended Solids	mg/L	2669	6.38	5.05	130	1
Fecal Coliform	100ml	168	159.6	556.8	6200	0
Organic Nitrogen	mg/L	166	0.26	0.27	1.3	0.02
NH_3+NH_4 Nitrogen	mg/L	613	0.058	0.068	0.88	0.01
NO_2+NO_3 Nitrogen	mg/L	622	0.30	0.32	3.8	0.01
Total Phosphorus	mg/L	624	0.056	0.11	1.8	0.002
Total Organic Carbon	mg/L	144	2.35	1.06	5.9	0.2

[a]EPA STORET data collected by ADEM, EPA Region IV, and TVA from 1990 through 1998.

Using conventional classification methods, Wheeler Reservoir would be considered eutrophic (Higgins and Kim, 1981). The TVA 2001 Vital Signs Monitoring program rated the overall ecological condition of the reservoir as fair (TVA, 2002). The 2001 rating was lower than typically observed for this reservoir, primarily due to low flows. Much of the spring and early summer of 2001 was characterized by low flows that increased reservoir retention time, algal production, and dissolved oxygen depletion. Dissolved oxygen concentrations of less than 2.0 mg/L occurred near Wheeler dam in mid-summer. That was partly because water remained in the reservoir longer than usual due to the unusually dry weather and resulting low flows. There were no swimming advisories on Wheeler Reservoir in 2001. Fecal coliform bacteria in samples collected at four swimming beaches and four boat ramps in 2001 were within the State of Alabama guidelines for water contact.

Temperature

Water temperature patterns in Wheeler Reservoir are constantly changing in response to varying meteorological and flow conditions. Important heat transfer variables include air temperature, relative humidity, wind speed, solar radiation, evaporation, advection, and convection. Reservoir flow rates and geometry are also key factors. For a detailed discussion of hydrothermal conditions in Wheeler Reservoir see TVA, 1983.

BFN is located in a region of expanding reservoir cross section. Upstream riverine conditions change to deep channel and expansive overbank just upstream of BFN. Downstream, the reservoir is deep and wide. River flows depend on discharges from upstream Guntersville Dam and downstream Wheeler Dam. Travel times from BFN to Wheeler Dam range from three days to two weeks, depending on river flows.

The current temperature limits for the BFN thermal discharge, obtained via Section 316(a) of the Clean Water Act, include two parameters--the maximum temperature downstream of the plant, and the maximum temperature rise from upstream to downstream of the plant. These limits must be met at the edges of a mixing zone with the following dimensions: 1) a maximum length of 2,400 feet downstream of the diffusers; 2) a maximum width of 2,000 feet; and 3) a maximum length of 150 feet upstream of the diffusers to the top of the diffuser pipes and extends to the bottom downstream of the diffusers. Downstream river temperature measurements are obtained by three permanent monitoring stations located in a line across the reservoir at approximate river mile 293.45. Upstream river temperature measurements are obtained by a permanent monitoring station located in the main channel at about river mile 297.8. The maximum temperature downstream of the plant includes a 1-hour average limit and a 24-hour average limit. The 1-hour average limit is 93°F (33.9°C) and the 24-hour average limit is 90°F (32.2°C). The maximum temperature rise includes only a 24-hour average limit, which is 10 Fahrenheit degrees (5.6 Celsius degrees). Historical data shows that it is possible for the 24-hour average upstream (i.e., ambient) water temperature to exceed 90°F. To allow plant operation under these conditions, if the upstream 24-hour temperature exceeds 90°F, the 24-hour downstream temperature may equal, but not exceed, the upstream value. That is, the temperature rise must be zero or less. As ambient temperature increases, this type of operation is acceptable until the 1-hour average limit of 93°F is obtained.

Natural water temperatures in the reservoir vary from around 35°F in January to near 90°F in July. Monthly changes of 15 to 20°F are common in the spring and fall. Meteorological conditions can cause temperatures throughout the reservoir to change 5°F in 10 days. Daily variations due to solar heating can cause 1 to 2°F changes during fully mixed conditions and up to 3 to 5°F changes in the surface layer down to 5 feet.

Temperature patterns upstream of BFN are fully mixed during the fall, winter, and spring with weak thermal stratification from June through September. Temperatures in the overbank near BFN are similar to those in the main channel except that the overbank areas are more responsive to changing meteorological conditions. Spatial differences, overbank to main channel, caused by wind and flow mixing can cause 1 to 3°F differences on an hourly basis. In the lower portion of the reservoir weak thermal stratification can result in a 5°F difference from surface to bottom.

E.2.2.2 AQUATIC COMMUNITIES

Fish

TVA has conducted extensive sampling of the fish community in the vicinity of Browns Ferry Nuclear Plant (BFN) and elsewhere in Wheeler Reservoir in recent years, both in monitoring programs conducted specifically for BFN (Baxter and Buchanan, 1998), and as part of TVA's Reservoir Monitoring Program (Dycus and Baker, 2000). A total of 60 species (excluding hybrids) has been collected in recent years by various sampling methods (Table E.2-2).

Table E.2-2 – Fish Species Collected in the Vicinity of Browns Ferry Nuclear Plant by TVA During Browns Ferry Nuclear Plant Monitoring and Reservoir Monitoring Activities, 1995-2000

Common Name	Fall 2000 Gill Net and Electrofishing TRM 292.5	Fall 2000 Gill Net and Electrofishing TRM 295.9	Cove Rotenone 1995-1997	Fall 1999 Gill Net and Electrofishing TRM 295.9
Chestnut lamprey	-	-	x	-
Spotted gar	-	x	x	-
Longnose gar	-	-	x	-
Bowfin	-	-	x	-
Skipjack herring	x	x	x	x
Gizzard shad	x	x	x	x
Threadfin shad	x	x	x	x
Central stoneroller	-	-	x	-
Grass carp	-	x	-	-
Spotfin shiner	-	-	x	-
Steelcolor shiner	-	-	x	-
Common carp	-	x	x	x
Striped shiner	-	-	x	-
Silver chub	-	-	x	-
Golden shiner	-	-	x	-
Emerald shiner	x	x	x	-
Ghost shiner	-	-	x	-
Mimic shiner	-	-	x	-
Bullhead minnow	-	-	x	-
Northern hog sucker	x	x	x	-
Smallmouth buffalo	x	x	x	x
Bigmouth buffalo	-	-	x	-
Spotted sucker	x	x	x	x
Silver redhorse	-	-	x	-
River redhorse	x	x	-	-
Black redhorse	x	-	-	-
Golden redhorse	-	-	x	x

Table E.2-2 (cont.) – Fish Species Collected in the Vicinity of Browns Ferry Nuclear Plant by TVA During Browns Ferry Nuclear Plant Monitoring and Reservoir Monitoring Activities, 1995-2000				
Common Name	**Fall 2000 Gill Net and Electrofishing TRM 292.5**	**Fall 2000 Gill Net and Electrofishing TRM 295.9**	**Cove Rotenone 1995-1997**	**Fall 1999 Gill Net and Electrofishing TRM 295.9**
Shorthead redhorse	-	-	x	-
Black bullhead	-	-	x	-
Yellow bullhead	-	-	x	-
Brown bullhead	-	-	x	-
Blue catfish	x	x	x	x
Channel catfish	x	x	x	x
Flathead catfish	x	x	x	x
Blackstripe topminnow	-	-	x	-
Blackspotted topminnow	-	-	x	-
Western mosquitofish	-	-	x	-
Brook silverside	x	-	x	-
Inland silverside	-	-	x	-
White bass	x	x	x	x
Yellow bass	x	x	x	x
Hybrid striped x white bass	-	x	-	x
Striped bass	x	-	-	x
Redbreast sunfish	-	-	x	-
Green sunfish	-	-	x	-
Warmouth	-	x	x	-
Orangespotted sunfish	-	-	x	-
Bluegill	x	x	x	x
Longear sunfish	x	-	x	-
Redear sunfish	x	x	x	x
Hybrid sunfish	-	-	x	-
Smallmouth bass	x	x	x	-
Spotted bass	x	x	x	x
Largemouth bass	x	x	x	x
White crappie	-	-	x	-
Black crappie	-	-	x	-
Stripetail darter	-	-	x	-
Yellow perch	-	x	x	x
Logperch	x	x	x	-
River darter	-	-	x	-
Sauger	x	x	x	x
Freshwater drum	x	x	x	x

Cove rotenone samples were collected annually from 1969 through 1997 as a component of the TVA environmental monitoring program for BFN, to provide a database on the fish community in the vicinity of BFN, and later to serve as a part of the thermal variance monitoring program. In more recent samples, 52 species were collected in 1995; 45 species in 1996; and 43 species in 1997. Annual standing stock estimates were 105,655 fish per hectare (ha) and 683 kilograms per hectare (kg/ha) in 1995 and decreased to 11,713 fish/ha and 366 kg/ha in 1996, then increased to 24,497 fish/ha and 489 kg/ha in 1997. Forage fish (primarily clupeids) were numerically dominant in samples, and also dominated biomass estimates in 1995 and 1996, but rough fish were highest in biomass in 1997. Gizzard shad exhibited the highest biomass during all three years, followed by threadfin shad in 1995 and smallmouth buffalo in 1996 and 1997 (Baxter and Buchanan, 1998).

TVA began a program to systematically monitor the ecological conditions of its reservoirs in 1990. Previously, reservoir studies had been confined to assessments to meet specific needs as they arose. Reservoir (and stream) monitoring programs were combined with TVA's fish tissue and bacteriological studies to form an integrated Vital Signs (VS) Monitoring program. VS monitoring activities focus on:

1. Physical/chemical characteristics of waters;

2. Physical/chemical characteristics of sediments;

3. Benthic macroinvertebrate community sampling; and

4. Fish assemblage sampling.

Fish are included in aquatic monitoring programs because they are important to the aquatic food chain and because they have a long life-cycle, which allows them to reflect conditions over time. Fish are also important to the public for aesthetic, recreational, and commercial reasons (Dycus and Baker, 2000).

Fish samples were taken in three areas of Wheeler Reservoir from 1990 through 1995, and again in 1997 and 1999 as part of TVA's VS monitoring program. Areas sampled included the forebay (area of the reservoir nearest the dam), a mid-reservoir transition station in the vicinity of Tennessee River Mile (TRM) 295.9, an upper-reservoir inflow station at TRM 348, and the Elk River Embayment. Although any fish species known from elsewhere in the reservoir could occur in the vicinity of BFN, results of sampling at the transition station are presented here because they are more representative of fish communities in the vicinity of BFN.

Reservoir Fish Assemblage Index (RFAI) ratings are based primarily on fish community structure and function. Ratings are derived from scores of 12 individual metrics described in Baxter and Gardner (2003). Compared to other similar Tennessee reservoirs, the fish assemblage at the Wheeler mid-reservoir station (TRM 295.9) rated poor in 1992 and 1999, fair in 1990, 1991, 1995, and 1997, and good in 1993 and 1994. In the fall of 2000, additional (i.e., not on the regular RFAI monitoring schedule) electrofishing and gill net samples were taken at the transition station (TRM 295.9) and a newly-established sampling station for BFN monitoring downstream of the diffuser at TRM 292.5. A total of 30 fish species (excluding hybrids) was collected; the fish assemblage rated good at TRM 292.5 and fair at TRM 295.9 (Table E.2-2) (Dycus and Baker, 2001).

Benthic Organisms

As mentioned, BFN is located on Wheeler Reservoir, which TVA classifies as a run-of-the-river reservoir. Run-of-the-river reservoirs typically have short water retention times (one to two weeks) and little winter drawdown. Benthic habitats in the reservoir range from deposits of finely divided silts to river channel cobble and bedrock. The most extensive benthic habitat is composed of fine-grained brown silt, which is deposited both in the old river channel and on the former overbank areas. The overbank areas, on either side of the old river channel, are far more extensive than the channel and are the most productive (TVA, 1972). These overbanks, located directly across from BFN, extend approximately 2 miles downstream. The overbanks support communities of Asiatic and fingernail clams, burrowing mayflies, aquatic worms, and midges. Cobble and bedrock areas, found primarily in the old channel, support freshwater mussels, zebra mussels, bryozoa, sponges, caddisflies, snails, and some leeches. The Asiatic clam is nonindigenous to North America and common in the Tennessee River system.

TVA began a program entitled VS monitoring to systematically monitor the ecological condition of its reservoirs in 1990. Benthic macroinvertebrates are included in VS monitoring because of their importance to the aquatic food chain, and because they have limited capability of movement, thereby preventing them from avoiding undesirable conditions. Since 1995, VS samples have been collected in the late fall/winter (November - December). Depending on reservoir size, as many as three stations are sampled (i.e., inflow, transition, and forebay).

Benthic macroinvertebrate VS monitoring data are analyzed using metrics. The number of metrics has varied through the sample years as reservoir benthic analysis has been fine-tuned. The current analysis is comprised of nine metrics: taxa richness, EPT (Ephemeroptera, Plecoptera, Trichoptera) taxa, long-lived taxa, non-chironomid and oligochaete density, percent oligochaete, dominant taxa, zero samples, non-chironomid and oligochaete taxa, and chironomid density. The number derived for each metric is totaled and the score is applied to a range of values that identify the overall condition of the benthic community (i.e., very poor, poor, fair, good, or excellent).

BFN is located a short distance downstream from the VS transition station on Wheeler Reservoir (TRM 295.5). The transition station is the zone considered to be between riverine (the inflow station) and impoundment habitats (the forebay station). Benthic community scores at the transition station ranged from “excellent” in 1994 to “good” in 1995 and “excellent” again in 1997 and 1999 (Dycus and Baker, 2000).

In addition to VS benthic macroinvertebrate monitoring, benthic community sampling in support of BFN thermal variance monitoring was begun in the fall of 2000 (and will continue at least for the term of the current permit cycle - five years). Station locations are TRM 296 and TRM 292, upstream and downstream of the BFN diffusers respectively. Analysis of the 2000 sample data indicated the benthic community above BFN diffusers was in “excellent” condition and the community below the diffusers was in “good” condition (Dycus and Baker, 2001).

Freshwater mussels are excellent indicators of water quality due to their sessile nature and inability to avoid perturbations impacting water quality. Mussels feed on microorganisms (protozoans, bacteria, diatoms) and organic particles suspended in the water that are brought into the body via siphon action and consumed. Thirty-eight freshwater mussel species had been documented in Wheeler Reservoir through 1991 (Ahlstedt and McDonough, 1993). Twelve species were identified in the vicinity of BFN during a 1982 survey for a proposed barge facility (Henson and Pryor, 1982). Most recently, Alabama Division of Wildlife and Freshwater fisheries (ADWFF) identified 14 species upstream of BFN and 12 species downstream (Garner, 2001). A listing of these species appears in Table E.2-3.

Table E.2-3 – Mussel Species Collected by Alabama Division of Wildlife and Freshwater Fisheries Near Browns Ferry Nuclear Plant in 1999

Common Name	Scientific Name
TRM 292, October 13-14, 1999	
Washboard	*Megalonaias nervosa*
Pink heelsplitter	*Potamilus alatus*
Threehorn wartyback	*Obliquaria reflexa*
Mapleleaf	*Quadrula quadrula*
Threeridge	*Amblema plicata*
Pimpleback	*Quadrula pustulosa*
Elephantear	*Elliptio crassidens*
Flat floater	*Anodonta suborbiculata*
Ebonyshell	*Fusconaia ebena*
Fragile papershell	*Leptodea fragilis*
Giant floater	*Pyganondon grandis*
Pistolgrip*	*Tritogonia verrucosa*
TRM 298, August 17 and October 20, 1999	
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	*Tritogonia verrucosa*
Purple waryback	*Cyclonaias tuberculata*
Mapleleaf	*Quadrula quadrula*
Butterfly*	*Ellipsaria lineolata*
Giant floater*	*Pyganodon grandis*
Pink papershell*	*Potamilus ohiensis*
Flat floater*	*Anodonta suborbiculata*

* = collected as dead shells

Introduced Aquatic Species

The Asiatic clam (*Corbicula fluminea*) was first documented in the Tennessee River in 1959 below Pickwick Dam and has spread throughout the system (Sinclair and Isome, 1961). No recent data exist on the status of the Asiatic clam near BFN; however, specimens have been collected during VS monitoring.

A nonindigenous water flea, *Daphnia lumholtzi*, has been documented throughout the Tennessee River system (Baker, 2001). It is therefore expected to occur in Wheeler Reservoir.

Nine occurrences of the freshwater jellyfish (*Craspedacusta sowerbyi*), a species probably introduced from China, were documented in the vicinity of BFN in 1980 and 1981 (Yeager 1987). It's presence in ichthyoplankton samples was documented throughout most of the TVA reservoir system between 1978 and 1985. It is assumed this introduced species continues to occur in the vicinity.

Zebra mussel (*Driessena polymorpha*) reproduction is monitored at BFN weekly between April and October. Plankton net samples are collected from BFN's raw water system and the number of zebra mussel veligers per cubic meter of water entering the plant is estimated. The proportion of the veligers in samples that are of a size that could settle in the BFN raw water system is also estimated. Data from these samples indicate that zebra mussel reproduction near BFN remains at a low level and that zebra mussels should not pose a threat to the plant in the immediate future.

Grass carp have been introduced to reservoirs in the TVA system, both by individuals seeking to control heavy infestations of aquatic vegetation, and by TVA in Guntersville Reservoir. Grass carp have not been collected in high numbers; they were not included in cove rotenone samples taken through 1997, and have been taken infrequently in reservoir monitoring gill net and electrofishing samples (Table E.2-3).

Entrainment and Impingement of Fish and Shellfish, Heat Shock

Fish eggs and larvae entrained in cooling water may suffer mortality from one or more physical effects of passage through the plant. Consequently, in conjunction with the construction of BFN, TVA investigated the preoperational characteristics and dynamics of the annual ichthyoplankton populations in Wheeler Reservoir (TVA, 1978a). This investigation was continued through the initiation of commercial operation in 1974, and data from 1971-1977 were reported (TVA, 1978b); 1978 and 1979 data were also reported (TVA, 1980). These studies concluded that estimated plant entrainment under open-cycle, 3-unit operation would not add significantly to expected natural mortality of fish eggs and larvae in the reservoir (TVA, 1980). Impingement of adult fish at BFN did not appear to adversely impact Wheeler Reservoir fish community (TVA, 1978b).

Response of fish and other aquatic life to elevated temperatures found in power plant discharges can range from acute, which includes immediate disability and death; to chronic or low level, which may include physiological or behavioral responses such as changes in spawning, migration, or feed behaviors. Since the discharge diffusers at BFN are located such that fish do not become trapped in areas of elevated temperatures, acute impacts are highly unlikely. TVA studies have documented that thermal releases from BFN have not had a significant impact on the aquatic community of Wheeler Reservoir (TVA 1983, Baxter and Buchanan ,1998).

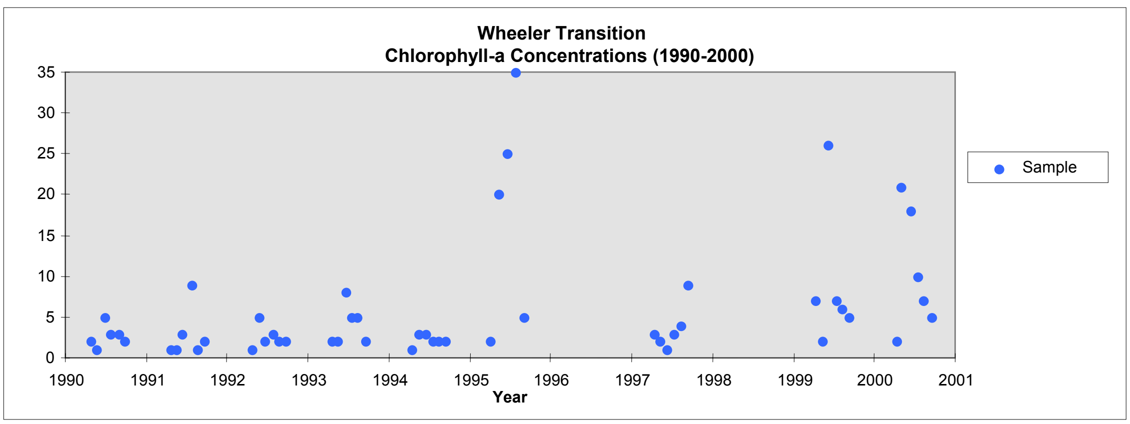
Microbiological Organisms

Plankton surveys were conducted during BFN preoperational monitoring in the early 1970s and have been a component of many BFN aquatic community surveys since then. The earliest phytoplankton surveys for Wheeler Reservoir found the assemblage to be quite diverse. As many as 27 Chrysophyta, 52 Chlorophyta, and 17 Cyanophyta taxa have been documented (TVA, 1977). Early zooplankton surveys documented a diverse assemblage as well, with 32 Dladocera, 24 Copepoda, and 47 Rotifera taxa represented (TVA, 1977). More recently, algal dynamics surveys were conducted in 1989 during plant shutdown and again in 1991 when the plant was operational as part of the approved BFN thermal variance monitoring program (Lowery and Poppe, 1992). The objective of this activity was to determine the effect of BFN thermal discharges on the phytoplankton community in Wheeler Reservoir. The study was initiated as a result of recommendations made during the operational monitoring reporting process for BFN.

The validity of preoperational and operational BFN algal surveys conducted in the 1970s has been brought into question with advancements in reservoir limnology during the past 18 to 20 years. Considerable research and monitoring, conducted by TVA and others to evaluate phytoplankton/nutrient interactions in reservoirs has found that several factors must be considered to determine cause/effect relationships in reservoirs. These factors include flow-through conditions, overbank/embayment areas, residence time, zonation, and placement of point and non-point pollution sources (Lowery and Poppe, 1992). Erroneous results can occur when using annual “snapshot” surveys to analyze algal communities in reservoirs.

BFN preoperational and operational monitoring collections were typically conducted on an annual basis – once per summer. VS monitoring is conducted on a monthly schedule, April through September. Plankton data gathered during VS monitoring is believed to be more reliable. According to Lowery and Poppe (1992), the importance in sampling monthly lies in the fact that algal division rates are such that several generations can be missed in less frequent sampling and hence the chances for observing “boom or bust” situations increase as sampling frequency decreases. Unfortunately, abnormally high densities observed during operational monitoring may have been nothing more than chance collections, during peak densities just as lower numbers in other years may have been underestimates (Lowery and Poppe, 1992). If BFN is having a stimulatory or depressing effect on the plankton community in the near field, numbers should be significantly increased or decreased downstream of the plant in at least some habitats as compared to similar upstream habitats. Examination of the 1989 and 1992 samples and the VS monitoring network data (far field) showed no consistent changes in either the near field or downstream (Lowery and Poppe, 1992). The only consistent observation that could be made from the 1989 and 1991 surveys and the VS monitoring data was that plankton communities vary on a daily basis regardless of location or habitat type.

Chlorophyll *a* is a simple, long-standing, and well-accepted measurement for estimating algal biomass, algal productivity, and trophic condition of a lake or reservoir (Carlson, 1977). Generally, lower chlorophyll concentrations in the oligotrophic range are thought to be indicative of good water quality conditions, and high chlorophyll concentrations are usually considered indicative of cultural eutrophication (Dycus and Baker, 2000). Average chlorophyll *a* concentrations (µg/L) recorded from Wheeler Reservoir's transition station between 1992 and 1999 are illustrated in Figure E.2-1. Wheeler Reservoir's chlorophyll levels at the transition station, in the vicinity of BFN, received a "fair" rating in 1992 and 1994, a "good" rating in 1993, 1997, and 1999, and a "poor" rating in 1995 (TVA, 1993, 1994, 1995, 1996, 1998, Dycus and Baker, 2000). Low flow conditions in 1995 are believed to have allowed for longer water retention times in the reservoir contributing to increased algal production and a substantially lower score. For a detailed explanation of how chlorophyll *a* concentrations are translated into a rating, see Dycus and Baker (2000).



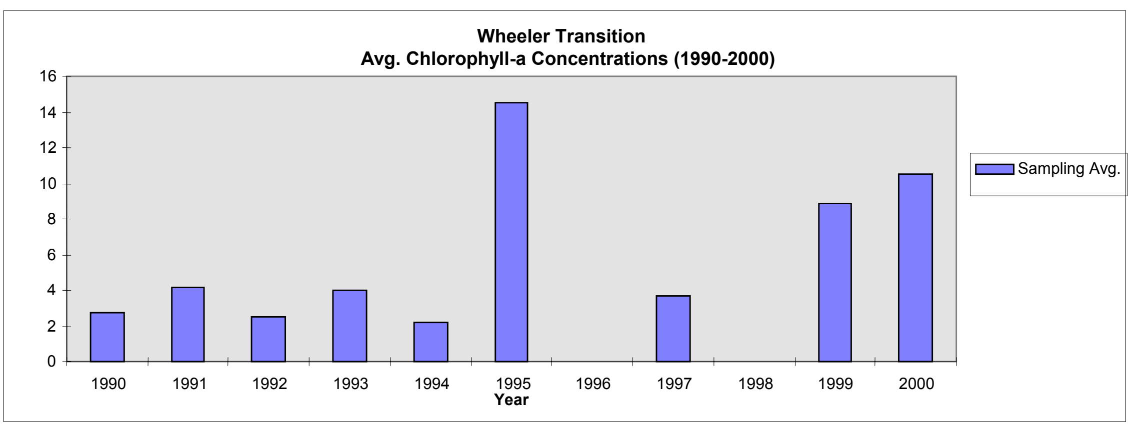


Figure E.2-1 – Chlorophyll *a* Concentrations from Wheeler Reservoir Transition Station, Vital Signs Monitoring 1990-2000

E.2.2.3 RIPARIAN ECOLOGY

Terrestrial Animals

Riparian communities and other terrestrial habitats associated with aquatic resources, such as streams, ponds, rivers, mudflats, shorelines, and wetlands are often the most productive habitats in a given area. Wildlife use these habitats for foraging, reproduction, and movements from one area to another. Wildlife species found among riparian habitats on, and adjacent to, BFN are generally common and have widespread distributions. For the most part, riparian communities are very limited on BFN. Waste water lagoons, sedimentation ponds, and river shoreline comprise the majority of the wet-habitats on BFN.

Riparian communities often support breeding habitats for toads, frogs, and salamanders; and a variety of other animal life such as turtles, snakes and mammals often occur there. Amphibians and reptiles found in riparian forests include bullfrog, green frog, eastern newt, southern two-lined salamander, common snapping turtle, and northern water snake. Some waterholes along Wheeler Reservoir are used by American alligators in the winter. Birds that nest here include wood duck, belted kingfisher, barred owl, American woodcock, Carolina wren, prothonotary warbler, and eastern phoebe. The Tennessee River is used extensively by a variety of wintering waterfowl and wading birds. Wheeler Wildlife Refuge, located upstream from BFN, is one of the southern-most wintering areas for ducks and geese in the Southeast. Mammals found in the vicinity would include muskrat, mink, beaver, and raccoon.

Terrestrial Plants

The riparian zone encompasses land along the shoreline of Wheeler Reservoir at Browns Ferry Nuclear Plant. The shoreline of BFN is approximately 12,375 feet, with 58% stabilized with riprap and the remaining 42% of the shoreline is partially eroded and is comprised of mixed upland forest vegetation. The land bordering the shoreline stabilized with riprap is adjacent to the nuclear plant and is primarily vegetated by young (approximately 4-5 years old) black willow, hackberry, sumac, privet, Japanese honeysuckle and trumpet creeper. The remainder of the shoreline is just west of the facility and is a young mixed upland forested scattered with a few large species (approximately 80+ years old) of oak and loblolly pine. The remaining young plants associated with the upland forest include various species of black locust, sweetgum, sassafras, cottonwood, elm, hackberry and black cherry. The remaining vegetation dominating the forested area includes Chinese privet, spleenwort, Virginia creeper and poison ivy. There are no uncommon or unusual plant communities.

Wetlands

The National Wetland Inventory (NWI) identifies forested wetlands, scrub-shrub wetlands, and emergent (marsh) wetlands associated with the mainstem of the Tennessee River/Wheeler Reservoir in the vicinity of BFN. These occur primarily along embayments of the main channel. In the vicinity of the BFN site, the NWI indicates wetlands associated with Douglas Branch, Poplar Creek, Dry Creek, and Round Island Creek. Wetlands in these areas are generally confined to narrow strips of forested or scrub-shrub wetlands in the riparian zone, and many have been reduced both in extent and function due to clearing and channelization associated with agricultural activities.

The NWI data indicates a total of approximately 25 acres of wetlands occurring within the BFN site, including forested wetlands, emergent (marsh) wetlands, and scrub-shrub/emergent wetlands (based on 1980's aerial photography). The Limestone County Soil Survey (1953) indicates a total of approximately 75 acres of hydric soils within the BFN site; much of this hydric soil area represents historic wetland areas which were previously drained and converted, and are no longer functioning as wetlands. During ground surveys in July of 2003, a total of approximately 12 acres of wetlands were determined to meet the US Army Corps of Engineers (USACE) wetland parameters (Environmental Laboratory 1987) for federal jurisdictional wetlands which may be regulated under the Clean Water Act (Figure E.2-2). Wetland determination data forms of these areas are provided in Attachment E-1. These federal jurisdictional wetlands include two areas which are shown on the NWI (W1 and W3) and occur in the riparian zones of channelized streams, and an additional area (W2), which was not identified by the NWI, and which is associated with drainage swales in areas previously cleared for agriculture. Wetland determinations were performed according to USACE wetland standards (Environmental Laboratory, 1987), which require documentation of hydrophytic vegetation (USFWS 1996), hydric soil, and wetland hydrology. Broader definitions of wetlands, such as the US Fish and Wildlife Service (USFWS) definition (Cowardin et al. 1979), Executive Order 11990 Protection of Wetlands, and the TVA Environmental Review Procedures definition (TVA 1983), were also considered in this review. Wetlands were classified according to the USFWS system (Cowardin et al. 1979).

The wetland ecological communities identified on the BFN site are dominated by plant species that are common in the region. These include black willow (*Salix nigra*), buttonbush (*Cephalanthus occidentalis*), sedges (*Carex lupulina, Carex vulpinoidea, Rhyncospora corniculata*), rushes (*Juncus effusus, J. brachycarpus*), water hemlock (*Conium maculatum*), and smartweeds (*Polygonum* spp.). The water regimes of the onsite wetlands include temporary and seasonal saturation and inundation resulting from precipitation, surface runoff, and seasonal high water tables. During periods of low precipitation or low water tables in the late summer and early fall, it is likely that these wetlands contain only limited areas of inundation or saturation, or are dry. These wetlands occur in areas that have been previously disturbed by clearing and agriculture, and parts which are currently maintained by periodic mowing. These types of wetlands on disturbed former or present agricultural land, and the dominant vegetation species occurring within them, are common in the region. Although they do not represent uncommon habitats locally or regionally, these onsite wetlands are functionally important for water quality enhancement, flood and stormwater control, wildlife habitat, and plant species diversity.

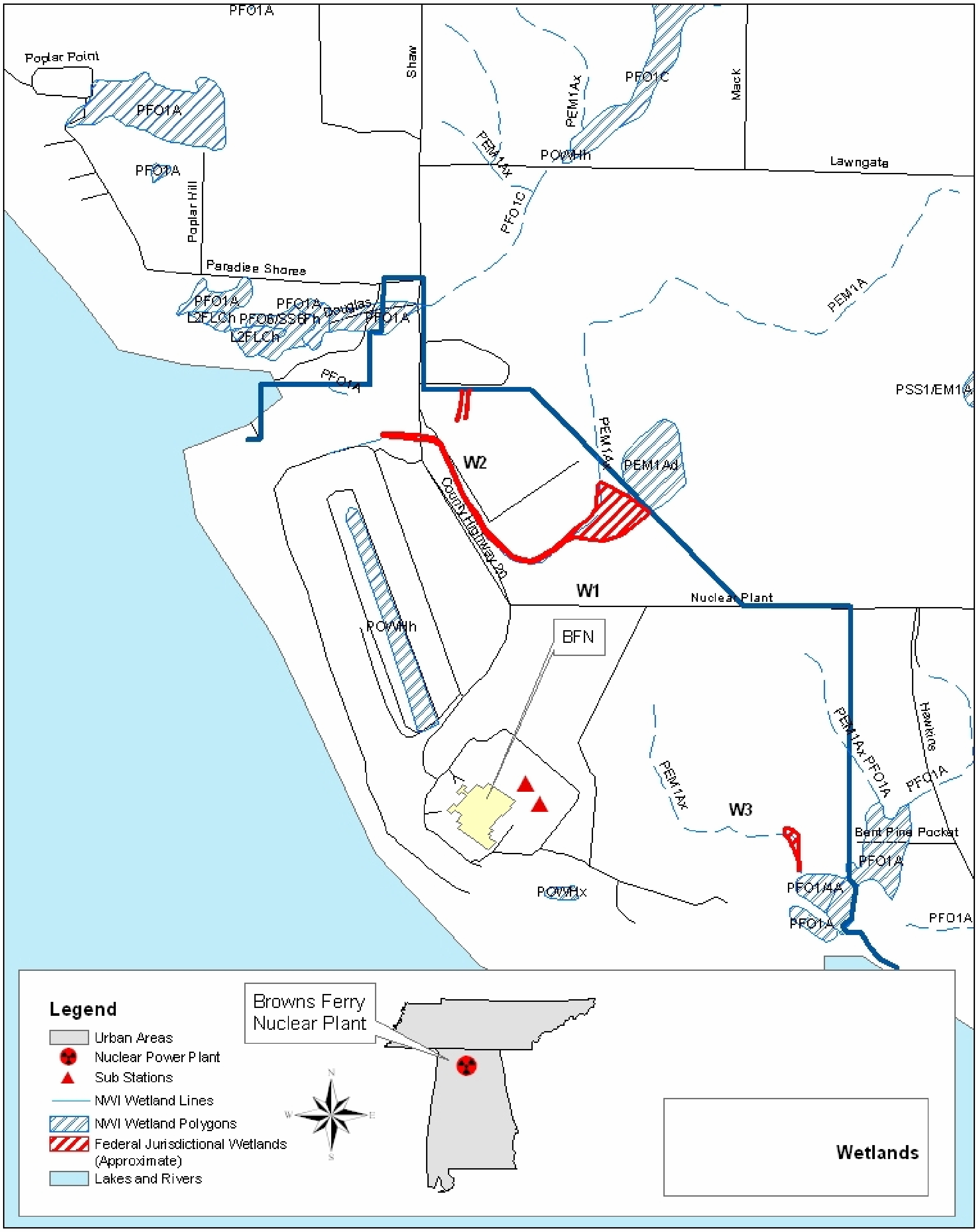


Figure E.2-2 – Wetlands

Wetland ecological communities in Alabama have suffered a marked decline as the result of channelization of major streams and the clearing of wetlands for agricultural and other purposes. Past land-use changes and stream channelization have resulted in reduction of total wetland acreage, changes in wetland types, and diminished ecological integrity of many of the remaining wetlands throughout the region. Channelized streams result in less frequent flooding and allow rapid runoff and drainage of the floodplain and adjacent areas. The extensive areas of bottomland forested wetlands that occurred in the major stream bottoms prior to channelization and land clearing are largely absent from the landscape. Alabama sustained a net loss of 42,000 acres of wetlands out of 2.7 million acres between 1974 and 1983. The greatest losses were due to the conversion of forested wetlands to non-wetland or other wetland types (Heffner, et al., 1994). Since 1983 wetland losses have slowed but continue steadily as urbanization and impacts associated with transportation construction projects still impact wetlands in the state (Flynn, 1991).

E.2.3 GROUNDWATER RESOURCES

Shallow groundwater at BFN occurs within unconsolidated terrace deposits and residual soils, and along a relatively thin but highly weathered horizon (epikarst zone) at the top of bedrock. At depth, groundwater occurs exclusively in fractures and solution features of the Tuscumbia limestone and Fort Payne chert. The Tuscumbia limestone and Fort Payne chert are collectively described as the Tuscumbia-Fort Payne aquifer system. This aquifer system is the most important water-bearing unit in the site vicinity from a regional perspective since it is a source of water for both wells and springs in the area.

Recharge to the shallow groundwater system at the plant site is derived primarily from precipitation. Regional water balance studies (Zurawski, 1978) show that approximately 10 to 13 inches of this precipitation enters groundwater storage. A total of 18 monitoring wells have been installed at the BFN site since 1980 and groundwater level measurements were initially monitored on a monthly basis.

Groundwater levels at the site are generally highest during the months of January through March. During September and October, water levels are usually at a minimum. Correlation between water levels in site wells and neighboring surface waters indicates that the Tennessee River and plant water channels exert some control on local groundwater elevations and hydraulic gradients. The direction of groundwater movement is generally W-SW toward the Tennessee River. Exceptions to this directional flux occur at the plant site during dewatering operations that can reverse gradient conditions, in the vicinity of leaking water lines serving the site, in areas of topographic highs/lows, and in the vicinity of the Low-Level Radioactive Waste (LLRW) storage facility where more complex movement exists.

Within overburden soils at the site, groundwater movement is predominantly downward. Local areas of lateral flow likely occur near some streams, topographic lows, and where extensive root systems exist. Based on 15 undisturbed soil samples, Boggs (1982) determined that the saturated hydraulic conductivity of site soils in the vicinity of the LLRW storage facility averages 3.7E-08 feet per second. Water supply wells developed within such low permeability soils are primarily of limited capacity. Based on aquifer testing in a similar setting (Julian, et al., 1993) the cherty gravel horizon near bedrock (epikarst) can be significantly transmissive. Measured transmissivity values by Julian, et al. (1993) suggest horizontal hydraulic conductivity values that are from one to two orders of magnitude greater than those measured in the shallow Tuscumbia limestone. Observations of groundwater levels during early site borings (TVA, 1972) also suggest that groundwater within the epikarst zone and Tuscumbia-Fort Payne aquifer might be confined.

Groundwater flow in the Tuscumbia limestone occurs solely in fractured and weathered zones. The orientation of fractures and solution features within the Tuscumbia is coincident with a structurally controlled joint system (i.e., along strike and dip). Studies by Julian, et al. (1993) indicate that the transmissivities of bedrock fractures and solution features in the Tuscumbia may decrease with depth. However, the interconnectivity of these features is equally important. Although fractured, the silty, siliceous nature of the Fort Payne chert inhibits the development of solution features. Therefore, the average permeability of the Fort Payne at the site is expected to be less than that of the Tuscumbia limestone.

There are two sets of on-site lagoons at BFN.

Wastewater Lagoons. There is a series of three interconnected lagoons located north of the switchyard that are used to provide secondary treatment for the plant's sanitary wastewater. The lagoons were constructed using compacted clay and possess no synthetic linings. There is no monitoring of lagoon influent. However, effluent is discharged under the plant NPDES permit (DSN 013a(1)) that is monitored for flow, pH, BOD5, TSS, and fecal coliform. There are no groundwater monitoring wells installed in the vicinity of these lagoons.

Sedimentation Ponds. There are two sedimentation ponds (Ponds A & B) located east of the plant and adjacent to the end of the central perimeter (switchyard) drainage ditch. These ponds are both lined with Hypalon Synthetic liners. The ponds receive reject water from the Ecolochem Reverse Osmosis process used to generate demineralized water for the plant, water discharged from the Diesel Generator building sumps, and water from the Water Intake Building sump. Discharge from Pond A, the larger of the two ponds, is permitted under an NPDES permit (DSN 013b). The pond is released on a batch basis as needed, and the outfall is monitored for flow, pH, TSS and Oil and Grease under the terms of the NPDES permit. Pond B has no outfall. When it fills, effluent from Pond B is manually pumped to Pond A and released through the permitted outfall. Piping and valves are provided to allow flexibility in filling either of the ponds. There are no groundwater monitoring wells installed in the vicinity of these ponds. Although an original plant bedrock monitoring well (well 7) was located about 100 feet southwest of pond A (between the pond and the river), it was destroyed when the Ecolochem building was constructed.

The Tuscumbia-Fort Payne aquifer system provides volumes of water sufficient for domestic supplies and some municipal and industrial supplies in the region. Groundwater in this aquifer system is a calcium bicarbonate type and can generally be used without extensive treatment. Public groundwater supplies within a 50-mile radius of BFN were previously identified by TVA (TVA, 1972). An off-site well survey was conducted in May 1995 to identify groundwater supplies within a two-mile radius of the BFN site and this information is provided by TVA (1999). The closest known public groundwater supply (Limestone County Water System, Well G-1) resides approximately two-miles north of BFN (ADEM, 2001). There is no groundwater use by BFN, and site dewatering wells have been inactive since the 1980s.

E.2.4 CRITICAL AND IMPORTANT TERRESTRIAL HABITATS

Terrestrial Animal Habitats

Most areas on BFN have been previously disturbed and provide limited wildlife habitat, particularly areas that have been impacted by agricultural activities and development. Due to the lack of features that provide high quality wildlife habitats, such as streams, springs, wetlands, caves, rock bluffs, and moist forested habitats, the overall diversity of wildlife on BFN is not uncommon from a local, state, or regional perspective. Terrestrial wildlife species found among upland habitats on BFN are generally common and have widespread distributions. No uncommon wildlife communities or important terrestrial habitats occur within, or immediately adjacent to, BFN.

Uplands habitats found on BFN include old fields and other early successional habitats interspersed with scattered trees. Small woodlots occur along the shoreline, near the eastern portion of BFN. In many cases dry, upland habitats contain a lower diversity of wildlife species and are less productive from a wildlife standpoint than are riparian communities. However, distinctive animal species are associated with upland communities.

Amphibians and reptiles found in early successional habitats with scattered trees include American toad, spring peeper, black racer, and eastern box turtle. Birds that nest here include song sparrow, eastern bluebird, northern mockingbird, turkey vulture, and tufted titmouse. Mammals found here would include white-tailed deer, eastern cottontail rabbit, Virginia opossum, and hispid cotton rat.

Numerous caves are reported from Limestone County, Alabama. Caves are sensitive ecological communities that are strongly influenced by conditions that limit light and nutrients and maintain somewhat stable temperature and humidity levels. Many terrestrial animals are dependent on caves during all or part of their lifecycle. These animals include birds, bats, rodents, salamanders, and insects. No caves occur on, or immediately adjacent to, BFN.

Introduced species — Invasive terrestrial animals often occur in developed areas. Invasive terrestrial animals that are expected to occur in the project vicinity include European starling, house sparrow, and rock dove.

Wetlands in the Project Area

Wetland habitats existing within and around the BFN site are described in Section E.2.2. These seasonally and temporarily flooded wetlands which dry up later in the year are important as breeding habitats for amphibians, as well as foraging and nesting habitats for amphibians, birds and small mammals.

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E.2.5 THREATENED OR ENDANGERED SPECIES

Terrestrial Animals

A review of the TVA Regional Natural Heritage database indicates that no federally- or state-listed species of animals have been reported from areas within three miles of the BFN. Two federal-listed and three state-listed species have been reported from Limestone County, Alabama (Table E.2-4). Habitat for one species, the Bewick's wren, may occur on BFN. Otherwise, no designated critical habitat or otherwise suitable habitat for listed species occurs on BFN.

Table E.2-4 – Federal- and State-Listed Terrestrial Animals Reported from Limestone County, Alabama.

Species	Scientific Name	State Status	Federal Status
Amphibians			
Eastern Hellbender	*Cryptobranchus alleganiensis alleganiensis*	Protected	—
Tennessee Cave Salamander	*Gyrinophilus palleucus*	Protected	—
Birds			
Appalachian Bewick's Wren	*Thryomanes bewickii altus*	Protected	—
Mammals			
Gray Bat	*Myotis grisescens*	Protected	Endangered
Indiana Bat	*Myotis sodalis*	Protected	Endangered

Federal-endangered gray and Indiana bats are reported from caves along the Elk River. Gray bats are monitored at these caves annually by Arnold Engineering Development Center biologists. Gray bat populations appear to be stable at these sites. Indiana bats have not been reported from these caves in recent years.

Gray bats are colonial bats which roost and form maternity colonies in caves located along rivers and reservoirs over which they feed. In the winter, gray bats congregate and hibernate in a limited number of caves across the southeast. Indiana bats are colonial bats that hibernate in caves during winter months, and can be found in hollow trees and under loose tree bark during the summer, where they form small maternity colonies. Indiana bats forage for insects primarily in riparian and upland forests.

Roosting and foraging habitat for gray and Indiana bats is very limited on BFN. Water sources are comprised of water lagoons, sedimentation ponds and drainage canals; and forested habitats are primarily small woodlots of poor quality. Although no suitable habitats for these species occur on BFN, gray bats likely forage along the Tennessee River, adjacent to the plant site.

State-protected Tennessee cave salamanders, eastern hellbenders, and Appalachian Bewick's wren have been reported from northern portions of Limestone County.

Tennessee cave salamanders are found in clean, permanent streams and pools in limestone caves. No caves have been reported from the immediate vicinity of BFN; therefore, this species is not expected to occur there.

Eastern hellbenders inhabit large, clear, fast-flowing streams that contain large flat rocks and logs. Preferred habitat is often a major stream surrounded by mature woodlands. No suitable habitat for this species occurs on BFN.

Appalachian Bewick's wrens may occur in open, brushy fields or riparian woodlands, if suitable artificial nest sites in the form of outbuildings, machinery, woodpiles, or nest boxes are found nearby. Habitat for this species on BFN is lacking. However, opportunistic breeding birds may make occasional use of the limited nesting opportunities on the site.

<u>Aquatic Animals</u>

Five federally listed endangered aquatic species are known to occur in either the main channel of the Tennessee River (Wheeler Reservoir) or its tributaries in the vicinity (within a 15-mile radius) of BFN. Five state-listed species are also known to occur in this area (Table E.2-5). An additional thirty-seven (37) federally or state-listed aquatic animal species, such as the Orangefoot Pimpleback mussel (*Plethobasus cooperianus*), the Cracking Pearly mussel (*Hemistena lata*), the Fine-Rayed Pigtoe mussel (*Fusconaia cuneolus*), the Shiny Pigtoe mussel (*F. cor*), the Slackwater Darter (*Etheostoma boschungi*), the Boulder Darter (*E. wapiti*), and the Alabama Blind Cave Shrimp (*Palaemonias alabamae*) are known to occur in the general North Alabama area (i.e., Limestone, Lawrence, and Morgan Counties). None of these species are presently known to exist in the vicinity of BFN.

Two federally-listed mussel species known from the area, Rough Pigtoe (*Pleurobema plenum*) and the Pink Mucket (*Lampsilis abrupta*), historically occurred in silt-free, stable gravel and cobble habitats in large river habitats throughout the Tennessee River system (Parmalee and Bogan, 1998). These species are now extremely rare and are primarily found in unimpounded tributary rivers and in the more riverine reaches of the largely impounded mainstream Tennessee River. In Wheeler Reservoir, most of the surviving large river habitat occurs upstream of BFN. All recent records of these two species are from upstream of BFN (Ahlstedt and McDonough, 1993; Colaw and Carroll, 1982; Garner, 1998 and 2001; Gooch, et al., 1979; Henson and Pryor, 1982; TVA Regional Natural Heritage Database, 2001; Yokely, 1998). It is very unlikely that populations of these species exist in Wheeler Reservoir adjacent to or downstream of BFN (Koch, 1999). Two state-listed mussels; Pink Papershell (*Potamilus ohiensis*), and Spectaclecase (*Cumberlandia monodonta*), are also reported from the Tennessee River upstream of BFN, and are not likely to be found downstream of BFN

Three federally-listed endangered aquatic snails, Armored Snail (*Pyrgulopsis pachyta*), Slender Campeloma (*Campeloma decampi*), and Anthony's River Snail (*Leptoxis* [=*Athearnia*] *anthonyi*), are restricted to tributary creeks to Wheeler Reservoir upstream of BFN. No evidence exists to suggest that populations of these species exist in the mainstem of the Tennessee River (Wheeler Reservoir) in the vicinity of BFN, or in tributary streams downstream of BFN. One state-listed snail Warty Rocksnail (*Lithasia lima*) is reported from tributary streams upstream of BFN, but is not likely to occur in the mainstem Tennessee River adjacent to or downstream of BFN

Table E.2-5 – State- and Federally-Listed Aquatic Animal Species Present in the Tennessee River (Wheeler Reservoir) and Its Tributaries in Limestone, Lawrence, and Morgan Counties, Alabama

Common Name	Scientific Name	Federal Status	State Status	Recent Record in the vicinity of BFN?
SNAILS				
Armored Snail	*Pyrgulopsis pachyta*	Endangered	Protected	Yes
Slender Campeloma	*Campeloma decampi*	Endangered	Protected	Yes
Anthony's River Snail	*Athearnia anthonyi*	Endangered	Protected	Yes
Warty Rocksnail	*Lithasia lima*	-	NOST	Yes
Varicose Rocksnail	*Lithasia verrucosa*	-	NOST	-
MUSSELS				
Rough Pigtoe	*Pleurobema plenum*	Endangered	Protected	Yes
Pink Mucket	*Lampsilis abrupta*	Endangered	Protected	Yes
Pink Papershell	*Potamilus ohiensis*	-	NOST	Yes
Spectaclecase	*Cumberlandia monodonta*	-	Protected	Yes
Orangefoot Pimpleback	*Plethobasus cooperianus*	Endangered	Protected	-
Ring Pink	*Obovaria retusa*	Endangered	Protected	-
Fluted Kidneyshell	*Ptychobranchus subtentum*	Candidate	NOST	-
Slabside Pearlymussel	*Lexingtonia dolabelloides*	Candidate	Protected	-
Cumberland Monkeyface	*Quadrula intermedia*	Endangered	Protected	-
Cracking Pearlymussel	*Hemistena lata*	Endangered	Protected	-
Fine-Rayed Pigtoe	*Fusconaia cuneolus*	Endangered	Protected	-
Tuberculed Blossom Pearlymussel	*Epioblasma torulosa torulosa*	Endangered	Protected	-
Cumberland Combshell	*Epioblasma brevidens*	Endangered	Protected	-
Dromedary Pearlymussel	*Dromus dromas*	Endangered	Protected	-
Birdwing Pearlymussel	*Lemiox rimosus*	Endangered	NOST	-
Cumberland Bean	*Villosa trabalis*	Endangered	NOST	-
Mountain Creekshell	*Villosa vanuxemensis*	-	NOST	-
Painted Creekshell	*Villosa taeniata*	-	NOST	-
Purple Lilliput	*Toxolasma lividus*	-	NOST	-
Monkeyface	*Quadrula metanevra*	-	NOST	-
Kidneyshell	*Ptychobranchus fasciolaris*	-	NOST	-
Tennessee Clubshell	*Pleurobema oviforme*	-	NOST	-
Cumberland Moccasinshell	*Medionidus conradicus*	-	NOST	-
Pocketbook	*Lampsilis ovata*	-	NOST	-
Butterfly	*Ellipsaria lineolata*	-	NOST	-
Tennessee Pigtoe	*Fusconaia barnesiana*	-	NOST	-
Sheepnose	*Plethobasus cyphyus*	-	Protected	-

Table E.2-5 (cont.) – State- and Federally-Listed Aquatic Animal Species Present in the Tennessee River (Wheeler Reservoir) and Its Tributaries in Limestone, Lawrence, and Morgan Counties, Alabama

Common Name	Scientific Name	Federal Status	State Status	Recent Record in the vicinity of BFN?
CRAYFISH				
A Troglobitic Crayfish	*Cambarus veitchorum*	-	NOST	-
Troglobitic Crayfish	*Procambarus pecki*	-	NOST	-
Troglobitic Crayfish	*Cambarus jonesi*	-	NOST	-
FISH				
Tuscumbia Darter	*Etheostoma tuscumbia*	-	Protected	Yes
Spring Pygmy Sunfish	*Elassoma alabamae*	-	Protected	Yes
Slackwater Darter	*Etheostoma boschungi*	Threatened	Protected	-
Boulder Darter	*Etheostoma wapiti*	Endangered	Protected	-
Tuskaloosa Darter	*Etheostoma douglasi*	-	NOST	-
Paddlefish	*Polyodon spathula*	-	NOST	-
Southern Cavefish	*Typhlichthys subterraneus*	-	Protected	-

State Status Codes:
Protected = Aquatic animals protected under official statutes by the state of Alabama.
NOST = Aquatic animals considered rare or sensitive by the state of Alabama, but having no official listing status.

Two state-listed fish species; Tuscumbia Darter (*Etheostoma tuscumbia*) and Spring Pygmy Sunfish (*Elassoma alabamae*), are known to occur in tributary streams upstream of BFN. The Tuscumbia Darter was reported (in pre-impoundment surveys) from areas along the Tennessee River in the vicinity of the BFN site that are now inundated by Wheeler Reservoir. These populations are no longer believed to exist. Populations of the Spring Pygmy Sunfish are known only from a few tributary streams upstream of BFN. No existing populations of Spring Pygmy Sunfish are known from tributary streams downstream of BFN.

E.2.6 REGIONAL DEMOGRAPHY

The *Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants* (GEIS) presents a population characterization method that is based on two factors: "sparseness" and "proximity" (Ref. 2.2-4, Section C.1.4). "Sparseness" measures population density and city size within 20 miles of a site and categorizes the demographic information as follows:

DEMOGRAPHIC CATEGORIES BASED ON SPARSENESS

(Range is from 1 = most sparse to 4 = least sparse)

1. Less than 40 persons per square mile and no community with 25,000 or more persons within 20 miles
2. 40 to 60 persons per square mile and no community with 25,000 or more persons within 20 miles
3. 60 to 120 persons per square mile or less than 60 persons per square mile with at least one community with 25,000 or more persons within 20 miles
4. Greater than or equal to 120 persons per square mile within 20 miles

"Proximity" measures population density and city size within 50 miles and categorizes the demographic information as follows:

DEMOGRAPHIC CATEGORIES BASED ON PROXIMITY

(Range is from 1 = not in close proximity to 4 = in close proximity)

1. No city with 100,000 or more persons and less than 50 persons per square mile within 50 miles
2. No city with 100,000 or more persons and between 50 and 190 persons per square mile within 50 miles
3. One or more cities with 100,000 or more persons and less than 190 persons per square mile within 50 miles
4. Greater than or equal to 190 persons per square mile within 50 miles

The GEIS then uses the following matrix to rank the population category as low, medium, or high:

	Proximity			
Sparseness	1	2	3	4
1	1.1	1.2	1.3	1.4
2	2.1	2.2	2.3	2.4
3	3.1	3.2	3.3	3.4
4	4.1	4.2	4.3	4.4

Low Population Area **Medium Population Area** **High Population Area**

Source: Ref. 2.2-4, pg. C-6.

TVA used the 2000 Census of Population data by census tract to estimate total population within 20 and within 50 miles of the site (U. S. Bureau of the Census, Census of Population 2000, www.census.gov). Tracts not wholly within the area were allocated on the basis of the land area within the area. According to this analysis, 164,936 people live within 20 miles of the Browns Ferry site, for a population density of 136 persons per square mile within 20 miles. This falls into the least sparse category, Category 4 (having greater than or equal to 120 persons per square mile within 20 miles). A total of 872,478 live within 50 miles of the site, for a population density of 112 persons per square mile; in addition, the city of Huntsville, which has a population of 158,216, is located about 30 miles to the east of the site. This places the site in proximity category 3 (one or more cities with 100,000 or more persons and less than 190 persons per square mile within 50 miles). These ratings place Browns Ferry in category 4.3 of the GEIS Sparseness and Proximity Matrix (above), which means it is considered to be in a high population area.

All or significant parts of 19 counties are located within 50 miles of the Browns Ferry site (Figure E.2-3). Of these counties, 14 are located in Alabama and 5 in Tennessee. Two of the Alabama counties have only a very small edge or corner and very little population within the 50 mile zone. Three metropolitan areas are located largely or totally in the 50 mile zone. These are the Decatur, Florence, and Huntsville areas. About 92 percent of TVA employees at the Browns Ferry site live in six nearby counties, all in Alabama: Colbert, Lauderdale, Lawrence, Limestone, Madison, and Morgan. Of the contract employees currently working at the site, about 89 percent live in these six counties.

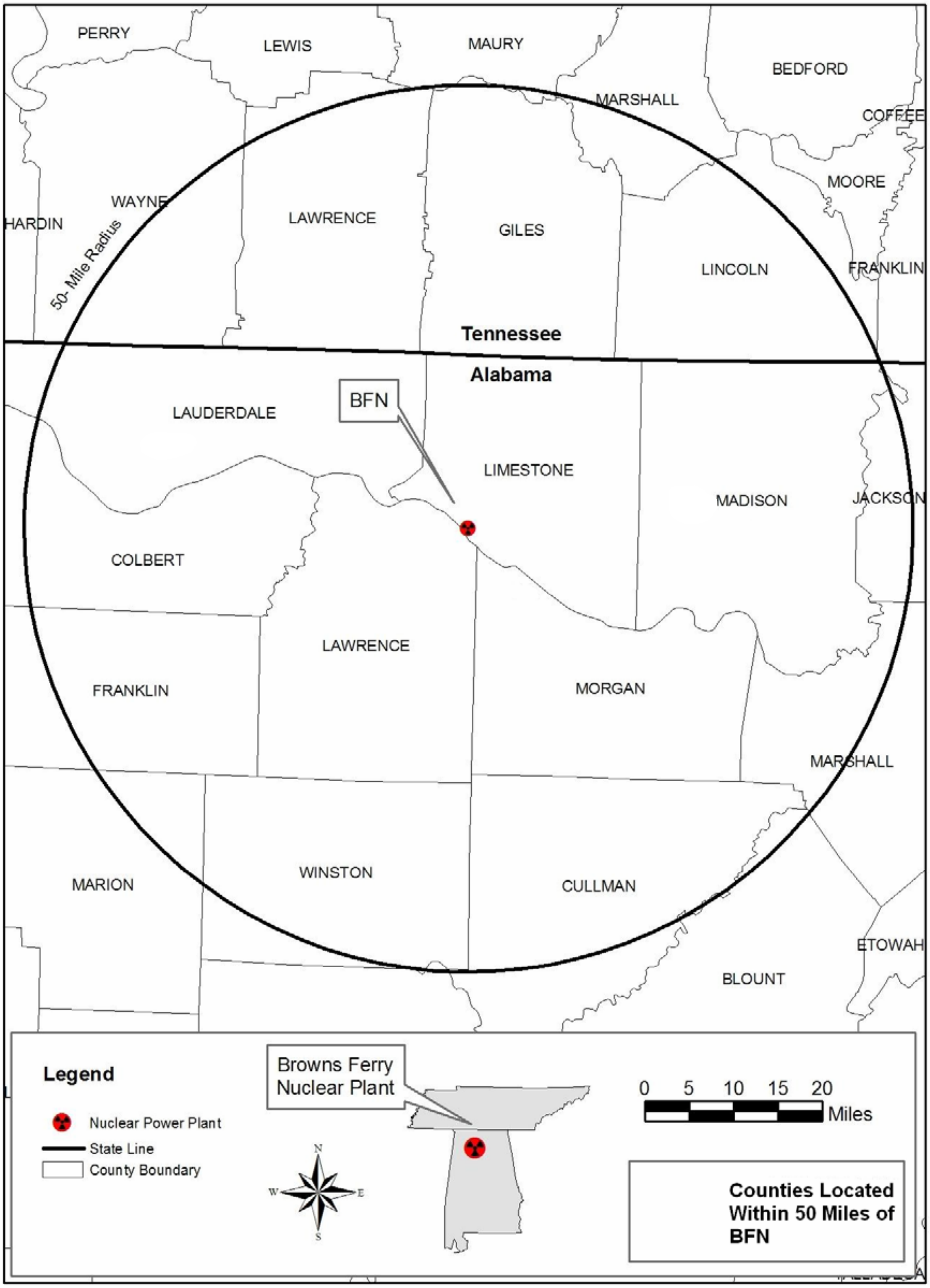

Figure E.2-3 – Counties Located Within 50 Miles of BFN

As a group, these six counties have been growing faster than the state of Alabama, and projections indicate that this trend is expected to continue for the next several years (Table E.2-6). However, the faster growth is limited to Limestone and Madison Counties, which constitute the Huntsville metropolitan area. Annual growth in this primary labor market area has averaged more than 6,600 persons per year over the past two decades. Limestone and Madison counties increased at the rate of 1.28 percent per year between 1990 and 2000, well above the state rate of 0.96 percent per year.

Table E.2-6 – Population and Annual Average Percent Change

POPULATION					
	1980	**1990**	**2000**	**2015**	**2025**
Alabama	3,894,025	4,040,587	4,447,100	5,028,045	5,385,997
Colbert County	54,519	51,666	54,984	58,208	59,484
Lauderdale County	80,546	79,661	87,966	98,015	103,176
Lawrence County	30,170	31,513	34,803	38,347	39,664
Limestone County	46,005	54,135	65,676	81,747	90,865
Madison County	196,966	238,912	276,700	324,153	349,713
Morgan County	90,231	100,043	111,064	124,358	131,112
Primary Labor Market Area	498,437	555,930	631,193	724,828	774,014
ANNUAL AVERAGE PERCENT CHANGE IN POPULATION					
	1980-1990	**1990-2000**	**2000-2015**	**2015-2025**	**2000-2025**
Alabama	0.37	0.96	0.82	0.69	0.77
Colbert County	-0.54	0.62	0.38	0.22	0.32
Lauderdale County	-0.11	1.00	0.72	0.51	0.64
Lawrence County	0.44	1.00	0.65	0.34	0.52
Limestone County	1.64	1.95	1.47	1.06	1.31
Madison County	1.95	1.48	1.06	0.76	0.94
Morgan County	1.04	1.05	0.76	0.53	0.67
Primary Labor Market Area	1.10	1.28	0.93	0.66	0.82

Source: Historical data from the U. S. Bureau of the Census, Census of Population; projections by the University of Alabama, Center for Business and Economic Research, August 2001.

Minority and Low-Income Populations

NRC guidance indicates that the Environmental Report should include the composition of minority and low-income persons within 80 km (50 miles) of the plant (NRC Regulatory Guide 4.2S1 – Supplement 1 to Regulatory Guide 4.2 *Preparation of Supplemental Environmental Reports for Applications to Renew Nuclear Power Plant Operating Licenses*). The data should be provided by census tract/block for geographic areas where the potential is identified for adverse impacts from refurbishment and from continued operation during the renewal term. NRC guidance also calls for use of the most recent Bureau of the Census demographic information, supplemented with demographic information from State and local planning agencies. For this ER, TVA has used the 2000 Census of Population data to identify concentrations of minority or low-income populations for census tracts within 50 miles of the plant. No more recent information is available for such populations in this area.

TVA used the standard cutoff points as utilized in other Environmental Reports. Any census tract within 50 miles of the plant site is identified as having potential for environmental justice concerns if any category of minority populations or if the low-income population meets the following criteria:

1. The share of the total population of the area exceeds 50 percent;

2. The share of the total population of the area is at least 20 points greater than the state average.

In all cases, the second criterion is more restrictive for the area around the plant site and, therefore, the first criterion was not used.

Minority Populations

Minority populations are defined in this analysis as all nonwhite population groups, plus Hispanics or Latinos. The following specific categories are used in this study: Black or African American; American Indian and Alaska Native; Asian; Some Other Race (including Native Hawaiian and Other Pacific Islander); two or more races; and Hispanic or Latino. The Native Hawaiian and Other Pacific Islander category was combined with Some Other Race because the former category was extremely small in the area around the Browns Ferry site, generally rounding to 0.0 percent. NRC guidance indicates that a minority population exists if either of the two following conditions exists:

> Exceeds 50 Percent – the minority population of the environmental impact area exceeds 50 percent or
>
> More than 20 Percent Greater – the minority population percentage of the environmental impact area is significantly greater (at least 20 percent) than the minority population percentage in the geographic area chosen for comparative analysis.

Table E.2-7 Minority Population, 2000, and Percent Below Poverty Level, 1999

	Total Population	Minority Population	Percent Minority	Percent Below Poverty Level
Limestone Co.	65,676	11,534	17.6	12.3
Colbert Co.	54,984	10,514	19.1	14.0
Lauderdale Co.	87,966	10,726	12.2	14.4
Lawrence Co.	34,803	7,904	22.7	15.3
Madison Co.	276,700	80,204	29.0	10.5
Morgan Co.	111,064	18,480	16.6	12.3
LMA	631,193	139,362	22.1	12.1
Alabama	4,447,100	1,321,281	29.7	16.1
U. S.	281,421,906	86,869,132	30.9	12.4

Source: U. S. Bureau of the Census, Census of Population 2000.

As shown in Table E.2-7 above, the primary labor market area and all of the counties within that area have both a minority population share and a poverty rate below the state level. There are a few census tracts within 50 miles that exceed the “20 points greater” criterion; these are shown in Figures E.2-4 through E.2-6. However, the tracts where the plant is located do not exceed this criterion. The Browns Ferry plant is located in Census Tract 211, immediately adjacent to Census Tract 204.01 (Figures E.2-4 through E.2-6). The minority population in Tract 211 is 35.0% of the total, and in Tract 204.01, only 8.6% of the population is minority. Poverty rates in both tracts are below the state average, at 12.4 percent in Census Tract 211 and 13.6 percent in Tract 204.01. The census tract immediately across the Tennessee River in Lawrence County has a minority population share (26.4 percent) that exceeds the criterion; however, the poverty rate (12.0 percent) does not exceed that level.

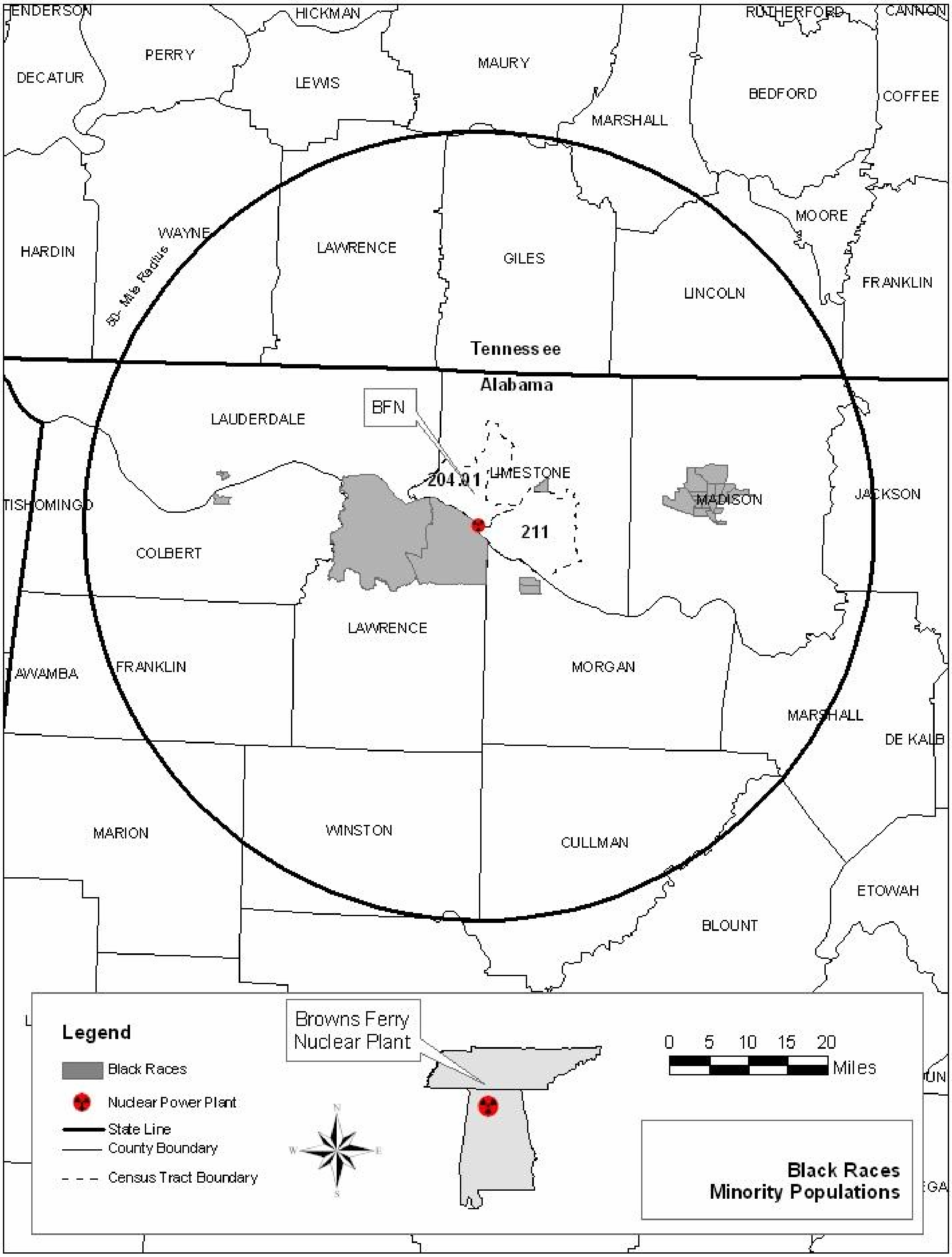

Figure E.2-4 – Black Races Minority Populations

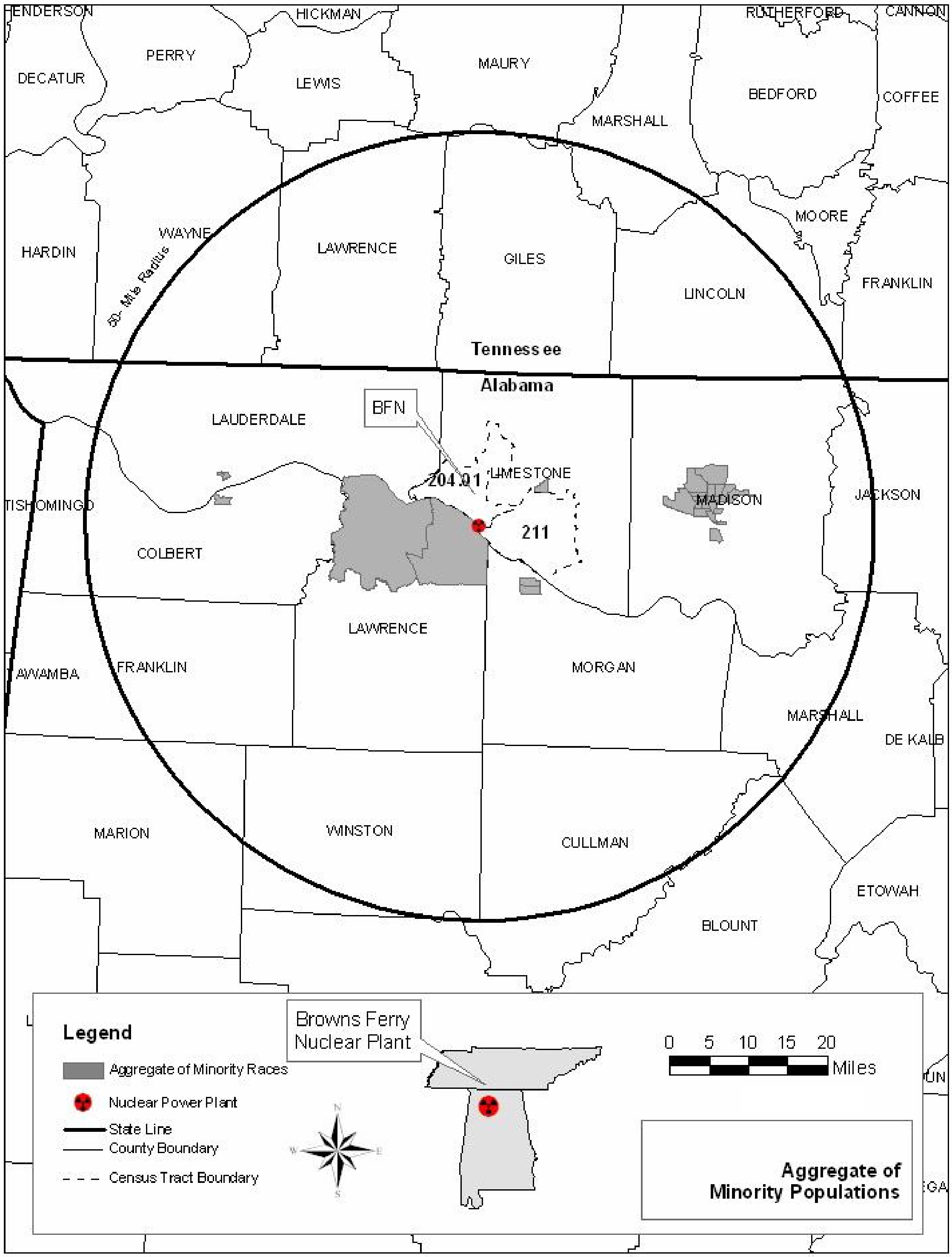

Figure E.2-5 – Aggregate of Minority Populations

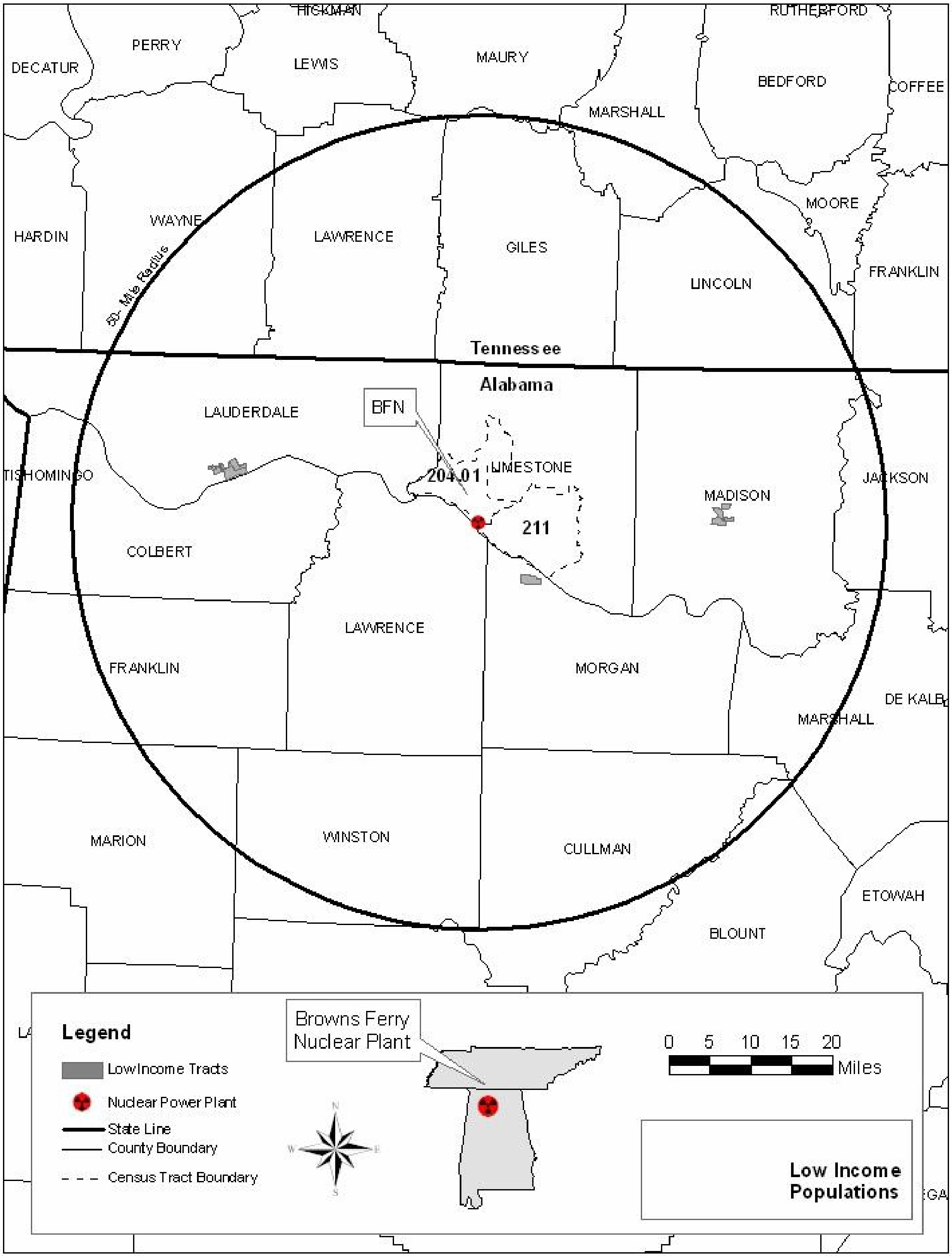

Figure E.2-6 – Low Income Populations

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E.2.7 ECONOMIC BASE

Virtually all of the impacts would occur in six Alabama counties near the plant site: Colbert, Lauderdale, Lawrence, Limestone, Madison, and Morgan. Limestone County, in which the plant is located, had a total labor force of 31,275 persons on average during 2002, while the labor force in the six-county impact area was almost 312,000 (Table E.2-8). The unemployment rate in the impact area was 6.2%, higher than both the state average and the national average. Limestone County, itself, had a lower rate of unemployment, 5.3%, below the state and national averages. These rates of unemployment meant that almost 1,700 persons in Limestone County and over 19,000 in the impact area were unemployed.

Table E.2-8 – Labor Force and Unemployment, 2002

	Civilian Labor Force	Number Unemployed	Unemployment Rate
Limestone Co.	31,275	1,667	5.3
Colbert Co.	24,299	2,347	9.7
Lauderdale Co.	39,660	4,170	10.5
Lawrence Co.	16,313	1,180	7.2
Madison Co.	144,768	6,063	4.2
Morgan Co.	55,474	3,811	6.9
Impact Area	311,789	19,238	6.2
Alabama	2,102,821	124,359	5.9
U. S. (000)	144,863	8,378	5.8

Source: Alabama Department of Industrial Relations, Employment Security Division, and U.S. Department of Labor, Bureau of Labor Statistics.

The number of jobs in Limestone County has more than doubled since 1970, reaching a total of 32,068 jobs in 2001 (Table E.2-9). This 2001 level is 17.9% higher than in 1990. Growth since 1970 has been faster than the impact area, the state, and the nation. However, since 1990 the rate of growth was somewhat slower than the nation, although still faster than the state and the impact area as a whole. On the other hand, as discussed above, population grew faster since 1990 as well as over the longer term. This suggests that over the last several years, Limestone County has become more of a bedroom community to Huntsville as its growth has continued to spread toward the west.

Table E.2-9 – Total Employment (Full-time and Part-time), by Place of Work						
	1970	**1980**	**1990**	**2001**	**Percent Change, 1970-2001**	**Percent Change, 1990-2001**
Limestone Co.	14,056	18,300	27,188	32,068	128.1	17.9
Colbert Co.	25,045	29,775	28,594	28,292	13.0	- 1.1
Lauderdale Co.	20,518	29,126	36,579	43,171	110.4	18.0
Lawrence Co.	7,289	8,905	11,445	11,766	61.4	2.8
Madison Co.	93,110	108,507	165,710	194,841	109.3	17.6
Morgan Co.	34,144	42,699	54,151	64,473	88.8	19.1
Impact Area	194,162	237,312	323,667	374,611	92.9	15.7
Alabama (000)	1,412.9	1,736.0	2,061.9	2,409,7	70.5	16.9
U. S. (000)	91,281.6	114,231.2	139,426.9	167,535.6	83.5	20.2

Source: U. S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System.

The labor market area (LMA) grew more slowly from 1990 to 2001 than did the state and the nation, although it grew more rapidly than either during the overall time period since 1970.

Based on the population projected above and on the TVA forecasts of employment for the TVA Power Service Area, employment in Limestone County is expected to be around 41,000 at the time of current license expiration, and about 53,000 by the time a 20-year license renewal period would expire (Table E.2-10). The LMA is projected to exceed 463,000 jobs and 585,000 jobs, respectively, by these dates.

Table E.2-10 – Projected Total Employment, 2015 and 2035					
	2001	**2015**	**2035**	**Percent Change, 2001-2015**	**Percent Change, 2001-2035**
Limestone Co.	32,068	41,052	53,253	28.0	66.1
Colbert Co.	28,292	30,346	31,973	7.3	13.0
Lauderdale Co.	43,171	54,090	68,707	25.3	59.2
Lawrence Co.	11,766	14,435	17,516	22.7	48.9
Madison Co.	194,841	245,152	315,478	25.8	61.9
Morgan Co.	64,473	78,451	98,340	21.7	52.5
Impact Area	374,611	463,527	585,267	23.7	56.2

Source: Projections by TVA, based on trends from 1970 to 2001.

Limestone County is more dependent on manufacturing, government, and farm employment than the LMA, the state, or the nation and less dependent on trade and services employment (Table E.2-11). The LMA has an industrial distribution similar to that of the state as a whole, although it is slightly more dependent on manufacturing. The state as well as the LMA is more dependent on manufacturing and less on trade and services employment than is the nation as a whole.

Table E.2-11 – Percent Distribution by Industry Employment (Full-time and Part-time), by Place of Work, 2001

	Total	Farm	Manufac-turing	Trade and Services	Govern-ment	Other
Limestone Co.	32,068	6.7	19.9	41.1	18.2	14.1
Colbert Co.	28,292	3.0	15.1	43.8	20.8	17.3
Lauderdale Co.	43,171	5.0	14.1	49.1	17.1	14.7
Lawrence Co.	11,766	16.6	16.0	35.4	14.9	17.1
Madison Co.	194,841	1.6	14.0	53.1	19.3	12.1
Morgan Co.	64,473	2.5	21.4	44.4	12.3	19.4
LMA	374,611	3.1	15.9	48.8	17.7	14.4
Alabama	2,409,693	3.5	13.9	47.8	15.9	18.9
U. S.	167,535.6	2.4	10.2	53.0	13.8	20.6

Note: Percentages may not add to 100 due to rounding.
Source: U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System.

Per capita income in both Limestone County and the LMA declined relative to the state and the nation between 1991 and 2001 (Table E.2-12). In 1991, per capita income in Limestone County was 81.6% of the national average, but in 2001 the percentage had declined to 74.4%; in the meantime, the state had also declined relative to the nation, but to a lesser extent. In a similar pattern, per capita income in the impact area was 92.8% of the national average in 1991, but only 86.8% in 2001. None of the counties in the LMA had average income above the national average in 1999, although Madison County did in 1991. Both Madison and Morgan Counties had average incomes higher than the state average in 2001, as well as in 1991.

Table E.2-12 – Per Capita Personal Income

	Per Capita Personal Income, 1991	Per Capita Personal Income, 2001	Percent of Nation, 1989	Percent of Nation 2001
Limestone Co.	16,331	22,633	81.6	74.4
Colbert Co.	16,071	22,595	80.3	74.3
Lauderdale Co.	16,418	21,686	82.0	71.3
Lawrence Co.	13,795	21,955	68.9	72.2
Madison Co.	21,087	30,126	105.3	99.1
Morgan Co.	18,298	26,256	91.4	86.3
LMA	18,584	26,404	92.8	86.8
Alabama	16,503	24,477	82.4	80.5
U. S.	20,023	30,413	100.0	100.0

Source: U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System.

E.2.8 HOUSING AND COMMUNITY SERVICES

Limestone County is a fast-growing county and a part of the Huntsville metropolitan area. As such, it has experienced relatively fast growth in housing and in the provision of government and other local services. It is also adjacent to the central metropolitan counties of Madison (Huntsville), Morgan (Decatur), and Lauderdale (Florence). These counties have well-developed community services and housing markets. Schools, fire and police protection, and medical services have all been exposed to growth and change in their communities in recent years, as have the local housing markets.

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E.2.9 LOCAL EDUCATIONAL SYSTEMS

The impact area has a total of 15 public school systems, six county systems and 9 municipal systems. Average daily membership in these systems is shown below in Table E.2-13.

Table E.2-13 – Average Daily Membership, School Systems in Impact Area

County	System	Average Daily Membership, 2001-2002
Limestone County	Limestone County	7,953
Limestone County	Athens City	2,802
Colbert County	Colbert County	3,344
Colbert County	Muscle Shoals City	2,444
Colbert County	Sheffield City	1,381
Colbert County	Tuscumbia City	1,381
Lauderdale County	Lauderdale County	8,777
Lauderdale County	Florence City	4,308
Lawrence County	Lawrence County	6,088
Madison	Madison County	16,149
Madison	Huntsville City	22,591
Madison	Madison City	6,348
Morgan	Morgan County	7,446
Morgan	Decatur City	8,842
Morgan	Hartselle City	3,067
Impact Area	**Total**	**102,921**

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E.2.10 RECREATIONAL FACILITIES

There are no developed public recreation facilities located at the BFN site. Located directly across the Tennessee River from the site is Mallard Creek Recreation Area. This is a TVA-developed and operated area. It includes camping, picnicking, swimming beach, and a boat launch area. Approximately 3.5 miles upstream of BFN is Round Island Recreation Area, also developed and operated by TVA. It features facilities for camping, swimming, picnicking and boat launching. The reservoir in the vicinity of the plant site is moderately utilized by recreational boaters and fishermen.

Two managed areas are known to occur within three miles of the site. These areas have been recognized and are protected, to varying degrees, because they contain unique natural resources, scenic values, or public use opportunities. These areas are owned by TVA and presently managed by the ADC.

Swan Creek State Wildlife Management Area

This wildlife management area includes over 3,000 acres of land and over 5,000 acres of water surrounded by numerous industrial facilities. Wooded lands and grassy pastures, occasionally interrupted by railroad tracts and transmission lines, provide one of the most important waterfowl management areas in the state of Alabama. Although the primary management focus is for waterfowl and small game hunting, this area is becoming increasingly important for migrating bird species. In addition, the area is increasingly utilized by bird watchers and other outdoor enthusiasts.

Mallard-Fox Creek State Wildlife Management Area

Encompassing approximately 700 acres of land and 1,700 acres of water this wildlife management area is primarily utilized for small game hunting.

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E.2.11 REGIONAL TAX STRUCTURE AND DISTRIBUTION

The state of Alabama has a wide variety of revenue sources; however, the largest sources are the individual income tax and the sales and use taxes. Total tax collections in fiscal year 2001 were $6.005 billion, of which 40.6 percent consisted of individual income tax collections and 28.5 percent, sales and use tax collections.

Some taxes collected by the state are partially redistributed to local governments and public school systems; examples of these include property taxes, sales and use taxes, lodging taxes, and gasoline taxes. In addition, counties and municipalities may also levy taxes, including the following: property, cigarette, tobacco products, sales and use, occupation, and gasoline and motor fuel. Property and sales taxes are primary revenue sources for local governments.

Another revenue source for the counties around the site is in-lieu-of-tax payments from TVA. These payments are made to the state, but much of the total is redistributed to the counties that are served by TVA power. In FY 2001-2002, Limestone County received over $4.5 million from the state as redistribution of these payments from TVA. Other counties in the primary labor market area received substantial amounts as well. For example, Madison County received over $13 million and Morgan County more than $10 million. The other counties in the area received lesser amounts.

Based on the current formulas, it is estimated that recovery of Unit 1 would result in an additional annual allocation to Limestone County of about $770,000. Madison and Morgan Counties would also receive similar increases, estimated to be about $838,000 and $666,000, respectively. Due to depreciation, the impact of Unit 1 recovery would gradually decline throughout the renewed license period.

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E.2.12 LAND USE

BFN is located in an agricultural area, surrounded by cropland planted with cotton. About 66.8% of the total acreage in the county is used for agriculture, the highest in Alabama (Figure E.2-7). There are an estimated 78,900 acres (23.9%) of land in forest. The majority of the forestland is located in the northern two-thirds of the county. Trends show that land used for forest has been declining since the early sixties. During the sixties, thousands of acres were cleared for agriculture and other land uses associated with population growth (Limestone County Comprehensive Plan, 1983). Cropland has increased from 166,841 acres in 1987 to 181,292 acres in 1997 (USDA-NRCS).

Limestone County is ranked first in Alabama for the most cotton grown. In 1999, 69,200 acres of cotton were harvested, a total production yield of 79,000 bales. There were 6,400 acres of corn harvested, 16,500 acres of soybeans, 10,000 acres of wheat, and 24,000 acres of hay. Agriculture Census data for the county lists crop production cash receipts at $31,614,000. Livestock and poultry receipts were $21,905,000. Agriculture is, and will continue to be, a major economic component in the county.

From the 1994 EPA land use database (Figure E.2-7), only about 2% of the county is urban built-up land. The current trend in population growth will promote a larger amount of land to become urbanized. Population growth for Limestone County from 1980 to 1990 was 17.7%. Athens City had a population increase of 17% from 1990 to 1998. These trends are attributable to the increased employment opportunity in the county as well as in nearby Huntsville and Decatur. During the last part of the 1980's, unprecedented growth in industrial employment occurred in each of the four outlying counties. Madison County also added thousands of new manufacturing jobs, but the change was most noticeable in the predominantly rural counties, such as Limestone. This trend in Limestone County suggests that a new era of economic development has already begun. Most of the residential development is occurring in the eastern portion of the county in the Capshaw French Mill area. There is also a significant number of new dwellings in the Browns Ferry Road area. It is expected that the majority of residential growth will occur around the City of Athens and the Elkmont Village area (Limestone County Comprehensive Plan, 1983). Development of commercial property is rapidly occurring in the area of intersection of U. S. Highway 72 and U. S. 65 and along the U.S. Highway 72 corridor to Huntsville.

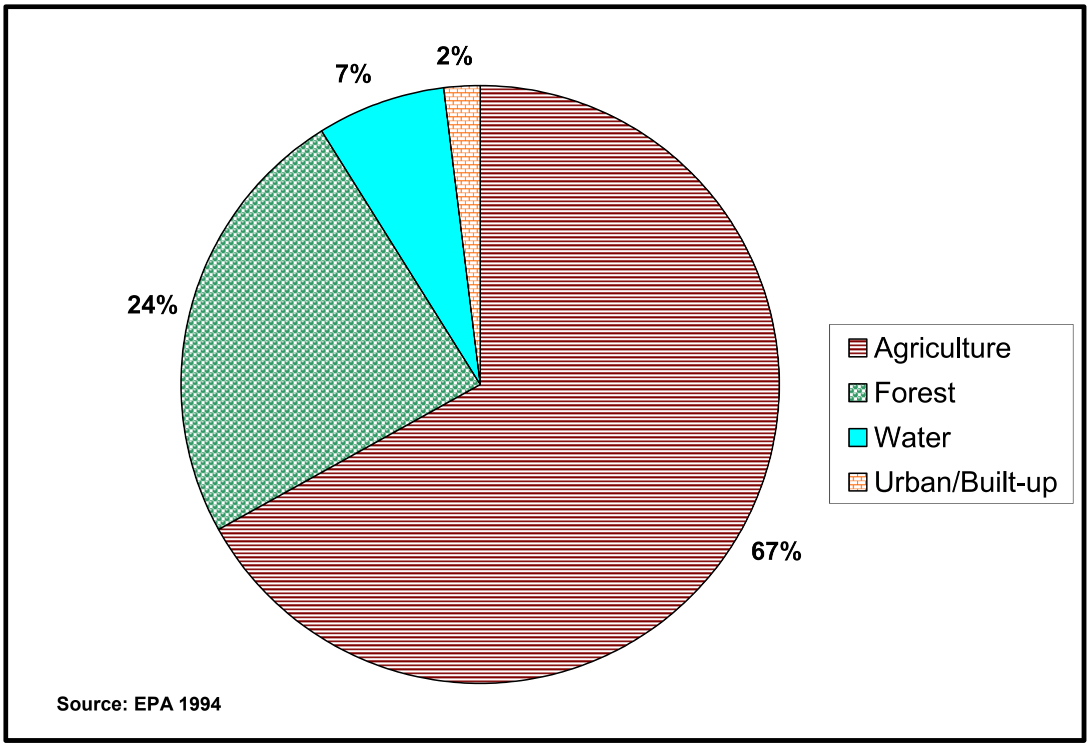

Figure E.2-7 Land Use in Limestone County

Limestone County, as part of Top of Alabama Regional Council of Governments, developed a Comprehensive Plan in 1983 to cover the period to year 2000 (Limestone County Comprehensive Plan, 1983). The vision of the Plan includes goals for land use, community facilities, transportation, and a capital improvements program and budget. The Plan has not been updated, but the same vision is reflected in the "Vision 2000, Strategic Agenda" document prepared by the Limestone County Vision 2000 Quality Council in March 2000.

The goal of the Land Use Plan was to achieve a balance among various land uses to accommodate a diversity of total life styles which will fulfill the requirements of county residents. The Plan has three objectives. The first is to promote a variety of housing types and a high level of efficiency in residential development patterns. The second is to promote the spatial distribution of various land uses that will result in a compatible relationship of land use activities. The third objective is to provide land for a wide variety of employment opportunities for the residents. The implementation of these objectives would provide utilities, services, and transportation to achieve the desired land use developments.

E.2.13 SOCIAL SERVICES AND PUBLIC FACILITIES

E.2.13.1 PUBLIC WATER SUPPLY

Tables E.2-14 and E.2-15 list the potable water supply intakes and wastewater discharges on Wheeler Reservoir (ADEM, 2001). There are eight water intakes withdrawing approximately 124 million gallons per day (MGD) for municipal and industrial use. Wastewater discharges include 11 municipal plants discharging over 30 MGD and 18 industrial plants discharging over 2,513 MGD.

In 2000 an average of 12,200 million gallons of water per day were used for public supply, industrial water supply, irrigation, and thermoelectric power generation in the Tennessee River watershed. Only 5 percent of the water or about 650 million gallons per day was used consumptively. All the rest of the water was returned to the receiving streams. The amount of water used consumptively within the watershed upstream of Wheeler Dam was estimated to be 530 million gallons of water per day in 2000. By the year 2030, it is estimated that the consumptive use upstream of Wheeler Dam is expected to increase to 760 million gallons per day (Hutson and others, 2003).

Table E.2-14 – Potable Water Intakes on Wheeler Reservoir

Name	Intake Location	Population Served	Daily Use (MGD)
Municipal			
West Morgan - East Lawrence Counties	TRM 286.5	24,000	4.0
Decatur Utilities	TRM 306.0	64,500	27.2
Huntsville Utilities	TRM 319.4	199.500	16.5
Huntsville Utilities (South Plant)	TRM 334.2	199,500	8.5
Northeast Morgan County Water Authority	TRM 334.7	17,529	0.9
Industrial			
Redstone Arsenal - Plant 2	TRM 330.2	19,940	11.3
Redstone Arsenal - Plant 1	TRM 323.9	1,240	0.7
International Paper Co. (Courtland)	TRM 282.4	2,500	55.0

Table E.2-15 – Wastewater Discharges on Wheeler Reservoir

Name	Location	Flow (MGD)
Municipal		
Decatur Dry Creek	Dry Branch Mile 0.6 at TRM 302.8	18.5
Huntsville West Area	TRM 318.5	11.1
Priceville WWTP	TRM 311.5	0.2
Cotaco School	Cotaco Creek Mile 2 at TRM 319.2	N/A
Crosscreek Subdivision	TRM 317	N/A
Lawson Trailer Park Lagoon	TRM 303.1	N/A
Reid School	TRM 298	N/A
Sherbrooke Utilities Inc.	Dry Creek Mile 1 at TRM 328.5	N/A
Tanner High School	TRM 301	N/A
Aldridge Creek WWTP	TRM 332.1	4.8
Union Grove Junior High School	Shoal Creek Mile 2.1 at TRM 347	N/A
Industrial		
Saint Gobain Indust. Ceramics	TRM 335.1	1.2
Tru-Line Manufacturing	Flint Creek Mile 3 at TRM 308.4	N/A
General Electric Co.	TRM 307.1	0.3
Goodyear Tire & Rubber	TRM 305.9	N/A
Decatur Transit	TRM 302	N/A
Nova Chemicals	Dry Branch Mile 0.2 at TRM 302.8	N/A
3M Corporation	Bakers Creek Mile 0.1 at TRM 301.2	16.0
Air Products & Chemicals	Bakers Creek Mile 1 at TRM 301.2	N/A
BP Amoco Chemical	Bakers Creek Mile 0.1 at TRM 301.2	4.5
Cerestar USA – Decatur	Bakers Creek Mile 0.4 at TRM 301.2	1.3
Daikin America	Bakers Creek Mile 0.5 at TRM 301.2	1.5
Diamond Wood Treaters	Bakers Creek Mile 1 at TRM 301.2	N/A
Solutia Inc.	Bakers Creek Mile 0.9 at TRM 301.2	115.0
Solvay Advanced Polymers	Bakers Creek Mile 0.4 at TRM 301.2	N/A
City of Decatur/Morgan Co.	Trinity Branch Mile 2.4 at TRM 295.9	N/A
Trico Steel Co.	Trinity Branch Mile 2.4 at TRM 295.9	1.0
TVA BFN	TRM 294.4	2325.0*
International Paper	TRM 2822.4	47.0

The discharge from BFN is cooling water, not Municipal or Industrial wastewater.

Consumptive and off-stream water uses have not resulted in significant use conflicts due to the large volume of reservoir water available, the high river flow rate, and the return of most of the water withdrawn. Regulatory control of withdrawal rates and National Pollutant Discharge Elimination System (NPDES) permit limits for return water quality also mitigate potential conflicts. Potential trade-offs can occur with instream water uses, however (e.g., instream use conflicts among aquatic life, waste assimilation, navigation, power generation, flood control, and lake levels). These potential conflicts are addressed by historic operating procedures, legal requirements, and regulatory procedures.

In 2002 and 2003 the TVA undertook a study to determine if changes in TVA's reservoir system operating policies would produce greater overall public value. A no action alternative and eight alternative operating policies were evaluated. The evaluations included the assumption that the consumptive use of water above Wheeler Dam would increase by 230 million gallons per day. Reservoir operations over the 100 year hydrologic record were simulated. It was determined that for all hydrologic conditions and for all alternatives that the existing minimum flow past BFN Plant could be maintained. Therefore the growth in consumptive water use will not affect minimum flow past BFN Plant regardless of the reservoir operating policy adopted. This study, in the form of an environmental impact study, is expected to be released in final in February 2004. TVA's reservoir operations policy guides the day-to-day operation of the Tennessee River system. It sets the balance of trade-offs for the sometimes competing uses of water in the system.

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E.2.13.2 TRANSPORTATION

The site is located approximately ten miles southwest of Athens in northern Alabama in Limestone County and is located just south of U. S. Highway 72, which runs from South Pittsburg, Tennessee, west to Memphis, Tennessee. The site is directly accessible from County Road 25. County Road 25 (Shaw Road) intersects U. S. Highway 72 approximately six miles north of the site. County Road 25 (Nuclear Plant Road) also intersects U. S. Highway 31 approximately nine miles east of the site. U. S. Highway 31 intersects U. S. Highway 72 northeast of the site. Browns Ferry Road to County Road 25 just east of the site provides a more direct route to the site from Athens. U. S. Highway 72 and U. S. Highway 31 are both high quality four-lane routes with good lane widths, alignments, turning lanes, and speed limits of 50 miles per hour (mph) through Athens and increasing away from the city. County Road 25 and Browns Ferry Road are medium quality two lane roads with level alignment, some passing zones, and speed limits of 45 mph. Direct accessibility into the plant facility off County Road 25 is good. The large diamond intersection at one entrance allows for smooth turning movements into and out of the plant. Another access road into the plant commonly used by contractors utilizes a traffic light at the intersection with Nuclear Plant Road.

The primary traffic generator in the vicinity of the site is the nuclear plant. BFN currently averages a daily site population of approximately 1,200 persons. The population currently peaks at approximately 2,000 persons during outages, which occur every 24 months (per unit) for approximately two months. Current truck deliveries are minimal (less than ten per week) and include hydrogen trucks, Calgon water chemistry trucks, and occasional diesel fuel deliveries during peak months. Rural residences located along the county roads that provide access to the site are also traffic generators in the area.

Figure E.2-8 shows a map of the local road network for the area. The latest available 1998 Average Daily Traffic (ADT) counts in close proximity to the site indicate approximately 13,440 vehicles per day (vpd) on U. S. Highway 72 north of the site and 16,260 vpd on U. S. Highway 31 south of U. S. Highway 72. There are no available traffic counts on the county roads; however, TVA estimates approximately 1,600 vpd on Shaw Road, Browns Ferry Road, and Nuclear Plant Road.

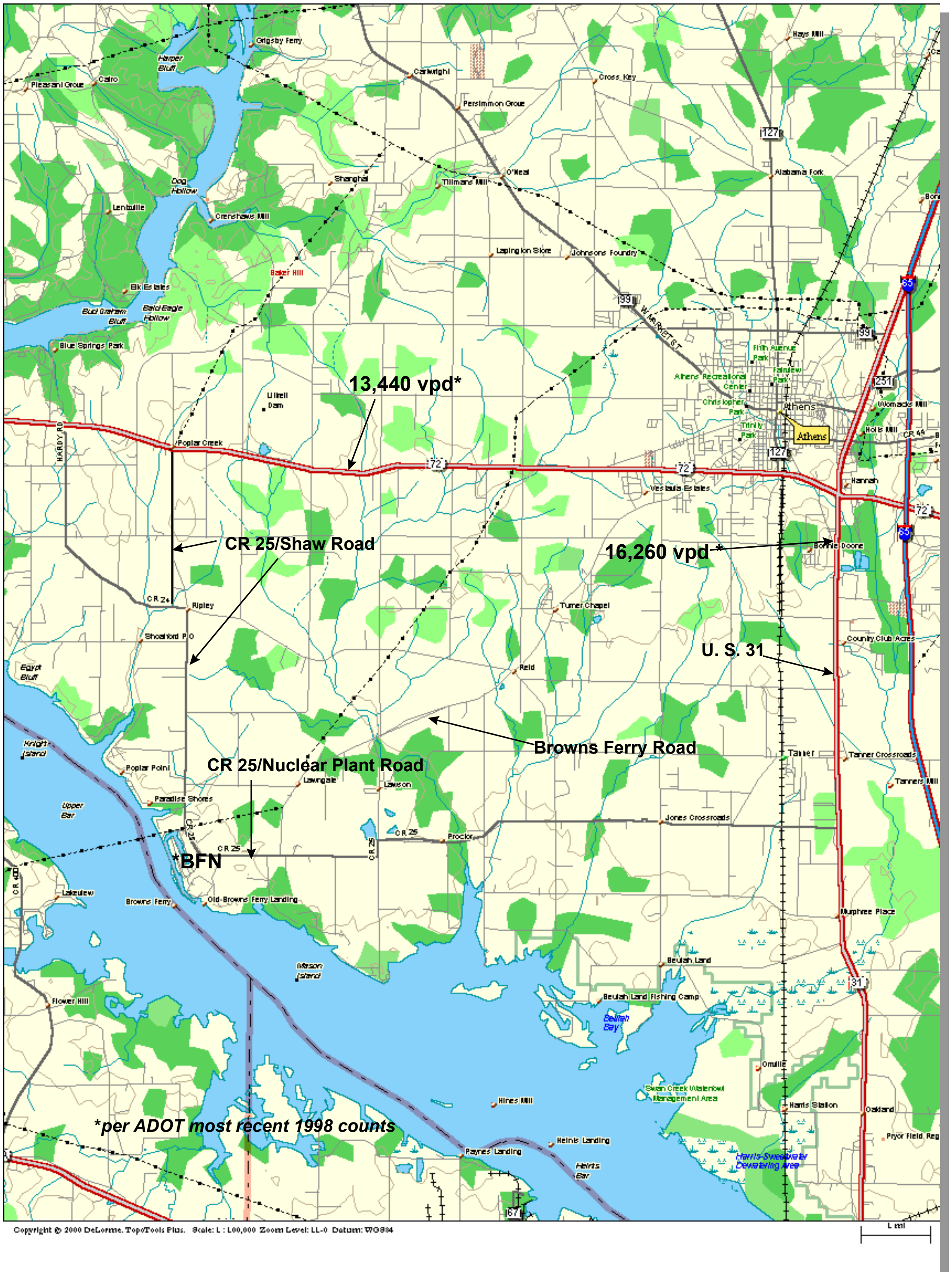

Figure E.2-8 Local Road Network for BFN

Direct rail access does not serve BFN. A railway spur track and unloading area is located off the CSX mainline which runs north and south in Tanner, Alabama, approximately eight miles east of BFN. TVA leased this small parcel of land from CSX (Louisville and Nashville Railroad) and used it for offloading during construction of the plant; however, TVA has not used this area for offloading and transporting materials to the plant since then. After offloading, heavy items were transported on heavy trucks via a “hardened” pathway to the site that included shallow fords through creek beds along the way. At the site itself a short railroad spur runs into the turbine building for transport into the plant.

The railroad spur track and unloading area is currently planned for future removal off site of dry cask spent fuel storage canisters. There are no plans to use it for Unit 1 refurbishment or regular plant operations.

BFN is located along the Tennessee River at approximately TRM 294. Guntersville Lock and Dam are located 55 miles upstream from the site and Wheeler Lock and Dam are located 20 miles downstream from the site. Traffic on the Tennessee River near BFN includes both commercial and recreational vessels. The locks and channels are more than adequate in handling river traffic. Both Guntersville Lock and Wheeler Lock are operating below their utilization capacity.

BFN has a qualified barge facility near the northwest corner of the site. Currently it consists of barge tie points and a wide ramp going down into the water. The ramp was used during initial plant construction for very heavy loads such as reactor vessels. The barge facility is currently used several times per year, but each usage requires a temporary crane. The roadbed from the plant to the barge facility is “hardened” for heavy loads. Future work is contemplated to upgrade the barge facility by stabilizing the riverbank and installing anchoring cells and a permanent dock (so that the facility will no longer require use of a temporary crane). An upgraded barge facility could eventually be used to transport spent fuel canisters offsite for disposal in a national repository. The barge facility would likely be used for some heavy items during Unit 1 refurbishment; however, this upgrade is independent of the decision to refurbish Unit 1. Appropriate environmental analyses would be done if TVA decides to propose upgrading the barge facility.

Three pipelines pass within five miles of the center of the BFN plant site. One is an eight-inch line carrying xylene at a maximum pressure of 175 pounds per square inch (psi); it runs north and south and passes about 2.4 miles east of the plant. The other two carry natural gas in a common right-of-way about 3.8 miles south-southwest of the plant. They run generally east-west. One line is eight-inch and the other 12-inch and both have a maximum pressure of 600 psi.

The only pipeline crossing the BFN site boundary is a ten-inch potable water line from the Athens Water District. There are no plans to install or connect to any pipelines in the foreseeable future.

BFN is connected into the TVA system network by seven 500-Kilovolt (kV) lines. One line is to Madison substation, two to Trinity substation, one line each to the West Point, Maury, and Union substations, and one line to the Limestone 500-kV Substation. Any three lines excluding more than one Trinity line can transmit the entire station output into the TVA system network.

Normal station power is from the unit station service transformers connected between the generator breaker and main transformer of each unit. Startup power is from the TVA 500-kV system network through the 500- to 20.7-kV main and 20.7- to 4.16-kV unit station service transformers. Auxiliary power is available through the two common station service transformers that are fed from two 161-kV lines supplying the 161-kV switchyard, one line each from the Athens and Trinity substations.

E.2.14 METEOROLOGY AND AIR QUALITY

The local climate and meteorology of the BFN site is characterized in the TVA BFN Environmental Statement, Volume 2, Section 3.3, which was prepared in the early 1970s. More extensive information and detailed data summaries, especially for on-site meteorological data, can be found in Section 2.3 of the Final Safety Analysis Report (FSAR). Among minor climate variations that have been observed during the past century was a trend of decreasing average temperatures from the 1930s and 1940s to the 1970s that was followed by the current warming trend. This global warming trend is expected to continue through the renewed license period. From 1971 to 2000, temperatures throughout the TVA power service area, except for the mountains of North Carolina, have been declining. However, the conditions for the 1879-1958 period of temperature data presented in the original Environmental Statement are expected to be representative of these near future conditions that will extend well into the 2030s. Other climate and meteorology variables are also not expected to change significantly in that time frame.

National Ambient Air Quality Standards establish concentration limits in the outside air for six pollutants: particulate matter, sulfur dioxide, carbon monoxide, ozone, nitrogen dioxide, and lead. These standards are designed to protect public health and welfare. With one exception, the standards are essentially unchanged from those considered in the TVA Environmental Statement of the early 1970s. The standard for hydrocarbons in effect at that time was later rescinded and a standard for ozone was implemented. An area where any air quality standard is violated is designated as a nonattainment area for that pollutant, and emissions of that pollutant from new or expanding sources are carefully controlled. There are no nonattainment areas near the BFN site, which is located in Limestone County, Alabama. Although Huntsville, Alabama, in adjacent Madison County is currently in attainment of the one-hour ozone standard and the particulates standard, United States Environmental Protection Agency (EPA) promulgated new, more restrictive standards for ozone and particulate matter in July 1997. These new standards, including an eight-hour standard for ozone that would supersede the old one-hour standard, were challenged in the courts and are unlikely to be implemented until after the year 2003. Full implementation of the new standards is expected to take place over a period of several years. However, it is anticipated that Madison County and possibly some surrounding counties will face significant air quality challenges for ozone and particulate matter.

In addition, Prevention of Significant Deterioration (PSD) regulations that restrict emissions and any significant reduction in ambient air quality include protection of national parks and wilderness areas that are designated PSD Class I air quality areas. A new or expanding major air pollutant source is required to estimate potential impact of its emissions on the air quality of any nearby Class I area, as specified by the State or local air regulatory agency, with input from the Federal Land Manager(s) having jurisdiction over the given Class I area(s). The closest PSD Class I area is the Sipsey Wilderness Area about 28 miles (45 kilometers) southwest of BFN.

Sources of non-radiological air pollutants at BFN include the mechanical draft cooling towers, the auxiliary steam boilers for heating and other uses, the diesel-powered auxiliary (emergency) generators, and miscellaneous other small sources such as fuel storage facilities. The cooling towers, auxiliary boilers, and diesel generators and associated estimated emissions are discussed in the TVA Environmental Statement, Volume 1, Section 2.5.

In Volume 1, Section 2.5, of the original Environmental Impact Statement (EIS), potential emissions and ambient air quality impacts are discussed. However, these earlier analyses only considered emissions from four of the eight diesel generators at the site. The emission estimates from the eight diesel generators should have been twice the emission estimates used in the original EIS. However, this does not change the expected impacts on air resources analyzed in the original EIS because those impacts are still enveloped by the combination of the auxiliary boilers and the diesel generators that was assessed. The auxiliary boilers were evaluated for the maximum possible fuel consumption, and the expected actual maximum annual operation was stated to be less than half the level that was assessed.

Actual emissions are much smaller than those estimated in the original EIS, with one exception. There is an inconsistency in the estimated emissions and ambient concentration for carbon monoxide in Section 2.5 in comparison to the magnitudes for the other pollutants calculated there and the relative magnitudes for the actual annual emissions reported during 1996-1999. Apparently, the carbon monoxide emissions and ambient concentrations presented in Section 2.5 are about two orders of magnitude too small. However, the ambient air quality standard is still about five orders of magnitude larger than the revised estimate. Thus, the impact of carbon monoxide emissions is still considered negligible, consistent with the conclusion in Section 2.5, Volume 1, of the original EIS.

Though generation of carbon dioxide (CO_2) at a nuclear facility is very minor compared to that of a fossil-fueled plant, the auxiliary boilers, emergency diesel generators, diesel-driven pumps, motorized vehicles, etc., collectively produce approximately 4,250 tons of carbon dioxide per year at BFN.

Potential impact on ambient air quality from operation of the cooling towers is associated with particulates emitted as part of the drift losses. Conservative estimated emissions of particulates are presented in Section 2.5, Volume 1, of the original EIS. Associated assumptions included closed mode operation for 7% of the time, helper mode operation for 22% of the time, and a conservative drift loss rate of 0.1%. Actual operating experience under the thermal regulations in effect, the reservoir conditions, and the plant's cooling requirements has shown that closed mode operation of the cooling towers has been unnecessary and is not expected to be done in the future. Cooling tower operation is conducted only in the warmer months of the year. During the last six years, Units 2 and 3 have both been back in service and the greatest amount of time that cooling tower operation has been required has been about 8% of a year.

Because the cooling towers at BFN are normally only needed during late July to early August, icing and fogging have not been concerns. If the wind is in a certain direction there can be some moisture deposition on employee vehicles in nearby parking lots, but this has not been an issue for local landowners in the subdivision adjacent to the site and just north of the cooling towers. During cooling tower operation the plume is often visible in the early morning and evening, but as the temperature rises during the day it usually becomes invisible. Since the BFN cooling towers operate with fresh water and have such limited duration of operation, no salt deposition has been observed. The nearest crop fields (cotton) are half a mile from the cooling towers, over a ridge formed by the 70-foot spoils berm (created when the cooling tower channels were excavated, and which is slightly higher than the cooling towers). There have been no known problems or complaints resulting from cooling tower operation, including potential impacts to crops and native or ornamental plants.

The Plant operates under the air quality permit category of a minor source of air pollutants as approved by the State of Alabama air regulatory agency, Alabama Department of Environmental Management (ADEM).

Air quality conditions are expected to remain about the same as now during the Unit 1 recovery period, with the exception of possible regulatory constraints that may develop in association with the eventual implementation of the new EPA standards on ozone and particulates.

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E.2.15 HISTORIC AND ARCHAEOLOGICAL RESOURCES

Historic Background of the Project Area

Prehistoric Period

Archaeological research has indicated prehistoric human occupation in north central Alabama has occurred from the Paleo-Indian to the Mississippian period. Archaeological periods are based on changing settlement and land use patterns and artifact styles. In Alabama, prehistoric chronology is divided into five broad time periods: Paleo-Indian, Archaic, Gulf Formational, Woodland, and Mississippian. Each of these broad periods is further broken down into sub-periods (generally Early, Middle, and Late), which are also based on artifact styles and settlement patterns. Smaller time periods, known as "Phases," are representative of distinctive sets of artifacts.

The Paleo-Indian period (12000-8500 B.C.) represents the first human occupation of the area. The settlement and land use pattern of this period was dominated by highly mobile bands of hunter/gatherers. Following the Paleo-Indian period, the Archaic period (8500-1200 B.C.) continued to represent a hunter/gatherer lifestyle. An increase in social complexity and the appearance of horticulture characterized the later part of the period. The settlement pattern during this period is characterized by spring and summer campsites situated along river ways that exploit riverine resources and dispersed fall and winter campsites in the adjacent uplands. It is during the Gulf Formational Period (1200-400 B.C.) when pottery first appears in north central Alabama. The Early Gulf Formational Period is a transitional period from the Late Archaic during which there is a continuance of Archaic Period settlement patterns but there are also influences from the Gulf Coastal area to the south. The Gulf Formational period in the lower Tennessee Valley begins with the Middle Gulf Formational period and is associated with Wheeler series, fiber-tempered pottery. The Late Gulf Formational Phase is associated with Alexander series, fiber- and sand-tempered pottery, and correlates with Early Woodland Period cultures elsewhere. Increased social complexity, reliance on horticulture and agriculture, and a continuation and fluorescence of ceramic technology characterize the Woodland Period (600 B.C. - 1000 A.D.). The increased importance of horticulture is associated with a less mobile lifestyle as suggested by semi-permanent structures. Residential base camps were located on flood plains and alluvial terraces with specialized procurement sites in the adjoining uplands. The Middle Woodland Period is classified by various Colbert and Copena components. The Late Woodland is associated with the Flint River and Baytown cultures. The Mississippian Period (900-1700 A.D.), the last prehistoric period in north central Mississippi, is associated with the pinnacle of social complexity in the Southeastern United States. In north central Alabama this period is characterized by permanent settlements, maize agriculture, and chiefdom level societies.

Historic Period

The Historic Period is represented by the settlement of Europeans, Euro-Americans, and African-Americans in the region and the subsequent removal of Native American tribes. The first recorded European encounter with Native American groups in northern Mississippi by Europeans was Hernado de Soto's expedition in 1540. Continued expeditions into the area by French, Spanish and English traders and explorers occurred during the 16th, 17th, and 18th centuries. Clashes between the native Creeks and Europeans continued through the 18th century. By the early 19th century, the Creeks were defeated by Jackson and forced to surrender their lands and leave the area. The first permanent Euro-American settlements occurred in the early 19th century and the area was predominately occupied by Euro-Americans and African-Americans. Subsistence and cotton farming characterized the region from the Antebellum period to the early 20th century. Industrialization and urbanization has characterized the region in the late 20th century.

TVA Stewardship

TVA is mandated, under the National Historic Preservation Act (NHPA) of 1966, to protect significant archaeological resources and historic structures located on land under TVA's control and custody, subject to the availability of resources. In addition, NHPA Section 106 [16 U.S.C. 470f] requires Federal agencies prior to taking action that implements an undertaking to:

1) Take into account the effects of their undertaking on historic properties; and

2) Afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment regarding such undertaking.

The State Historic Preservation Office (SHPO) serves as a proxy to the ACHP. TVA consults with the applicable SHPO concerning project alternatives and any potential affect to historic properties.

BFN License Renewal

In the Supplemental Environmental Impact Statement for Operating License Renewal of the Browns Ferry Nuclear Plant (TVA 2002), the possibility of adding significant cooling tower capacity was discussed. As part of the modifications associated with these potential changes, three potential spoils disposal areas were described. The alternative eventually chosen for additional cooling tower capacity did not require use of these areas, but as part of the proposed license renewal the areas were evaluated for cultural significance.

At the initiation of this proposal, TVA Cultural Resources staff considered the nature of the undertaking and determined that the project had the potential to affect historic properties should those be present in the area. The APE for archaeological resources was determined as the three areas designated as soil disposal or spoil pile locations. The APE for historic structures was determined as those areas from which the disposal locations would be visible.

A Phase I survey was conducted at the three disposal site/spoil pile locations. This survey identified two historic properties. The survey of Area 1 (see Figure E.2-9) identified a prehistoric archaeological site (1Li535) with an Early to Middle Woodland occupation. This site is considered potentially eligible for listing in the National Register of Historic Places. Cox Cemetery was identified in Area 2. This cemetery was relocated during the initial construction of the BFN. No historic properties were identified in Area 3. An architectural survey was conducted within the visual APE of the proposed project area. No historic structures were identified.

TVA consulted with the Alabama SHPO regarding Cox Cemetery and the potential archaeological site in Area 1. The SHPO agreed that project activities will have no effect on significant cultural resources provided that site 1Li535 and the Cox Cemetery are avoided as stated in the BFN License Renewal Final Supplemental EIS.

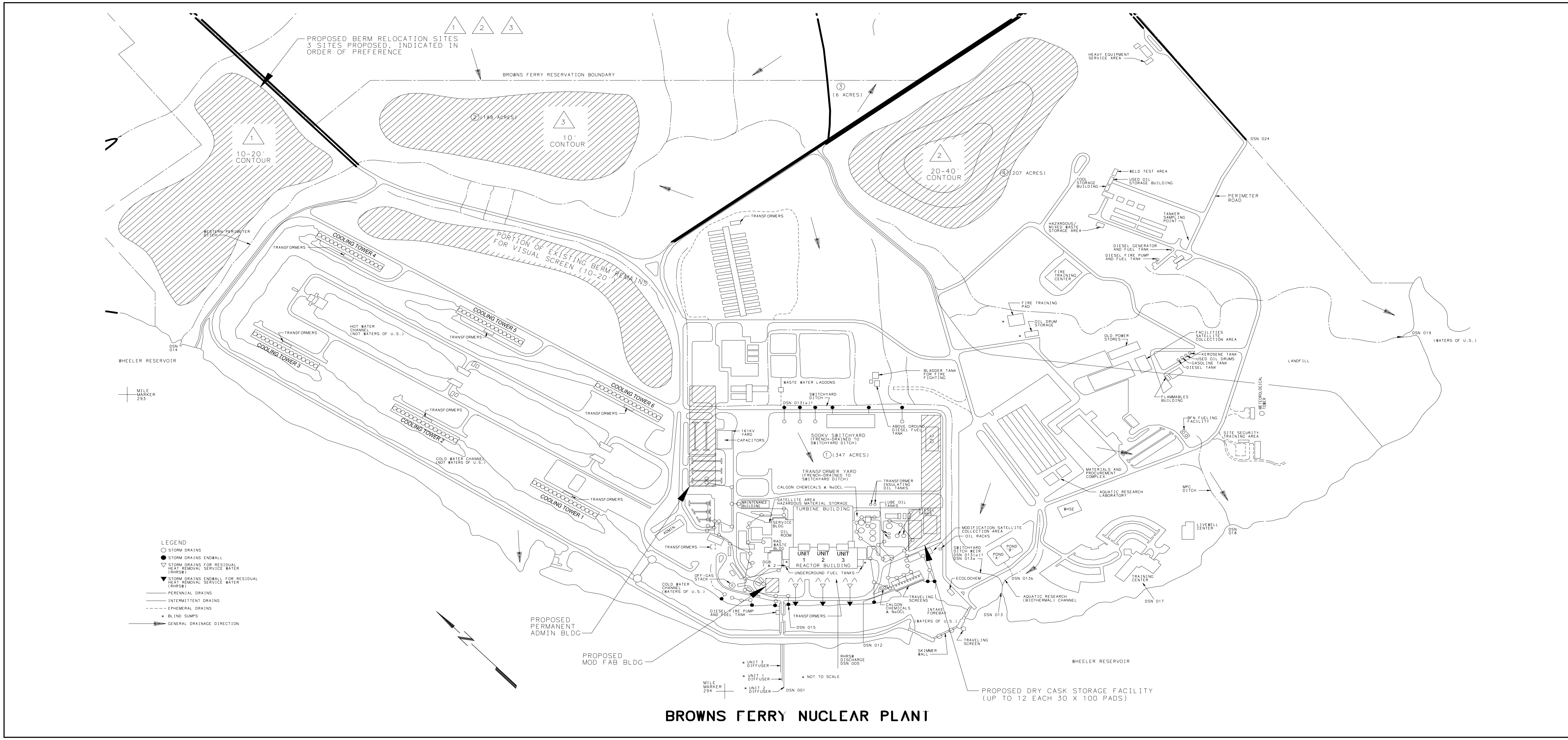

Figure E.2-9 – Location of Areas for Spoils Deposition

E.2.16 OTHER PROJECTS AND ACTIVITIES

> "Known and reasonably foreseeable Federal and non-Federal projects and other actions in the vicinity of the site that may contribute to the cumulative environmental impacts of license renewal and extended plant operation should be identified and described."

BFN Site

The only current or projected use of the BFN site is for power generation from the nuclear units. There are no other commercial facilities, power generation or otherwise, at Browns Ferry.

TVA Navigation Facilities and Power Plants

Within a 50-mile radius of BFN there are the following TVA dams and power plants:

Guntersville Dam

Guntersville Dam lies upstream of BFN on the Tennessee River, approximately 45 miles east southeast of BFN, near the city of Guntersville, AL. The dam is approximately 97 feet (30 m) high and 3,979 feet (1,213 m) in length. The Guntersville Lake reservoir is approximately 76 miles (122 km) long and has a flood storage capacity of 262 million cubic yards (200 million cubic meters). The winter net dependable generation capacity of the electrical power generators is 114 megawatts. No major projects are currently planned or known for Guntersville Dam.

Guntersville Dam has a main and an auxiliary lock, each with a 39 foot lift. In 2002, traffic through the dam was as follows: 2,462 recreational vessels; 1,123 commercial vessels; 59 government (i.e., Corps of Engineers, military, TVA, law enforcement, etc.) vessels; 5,923 loaded and 4,251 unloaded barges; and a total shipped tonnage of 9,090,652.

Wheeler Dam

Wheeler Dam lies downstream of BFN on the Tennessee River, approximately 17 miles west northwest of BFN, near the city of Rogersville, AL. The dam is approximately 72 feet (22 m) high and 6,342 feet (1,933 m) in length. The Wheeler Lake reservoir is approximately 74 miles (119 km) long and has a flood storage capacity of 564 million cubic yards (431 million cubic meters). The winter net dependable generation capacity of the electrical power generators is 355 megawatts. No major projects are currently planned or known for Wheeler Dam.

General Joe Wheeler Dam has a main and an auxiliary lock, each with a 48 foot lift. In 2002, traffic through the dam was as follows: 1,624 recreational vessels; 1,640 commercial vessels; 117 government (i.e., Corps of Engineers, military, TVA, law enforcement, etc.) vessels; 8,351 loaded and 5,818 unloaded barges; and a total shipped tonnage of 13,120,442.

Wilson Dam

Wilson Dam lies downstream of Wheeler Dam (and BFN) on the Tennessee River, approximately 30 miles west of BFN, near the city of Florence, AL. The dam is approximately 137 feet (42 m) high and 4,541 feet (1,384 m) in length. The Wilson Lake reservoir is approximately 16 miles (26 km) long and has a flood storage capacity of 86 million cubic yards (66 million cubic meters). The winter net dependable generation capacity of the electrical power generators is 611 megawatts.

Wilson Dam has a main lock with a 94-foot lift, and a two-tiered auxiliary lock (i.e., double lift via two locks in series), one with a 49 foot lift and the other with a 45-foot lock, total also 94 feet. Upgrading the auxiliary lock at Wilson Dam is being considered but has not been planned or scheduled. In 2002, traffic through the dam was as follows: 1,746 recreational vessels; 1,718 commercial vessels; 327 government (i.e., Corps of Engineers, military, TVA, law enforcement, etc.) vessels; 8,433 loaded and 5,704 unloaded barges; and a total shipped tonnage of 13,272,308.

Colbert Steam Plant

Colbert Steam Plant lies downstream of Wilson Dam on the Tennessee River, approximately 42 miles west of BFN, between the cities of Tuscumbia, AL and Cherokee, AL. The five coal-fired units consume approximately 470 short tons (518 metric tons) per hour of coal and generate 1,204 megawatts of winter net dependable capacity. TVA plans to reduce SO_2 emissions from Colbert's five units by installing scrubbers by 2010 and to reduce NO_x emissions by installing selective catalytic reduction or similar technology by 2005.

Non-TVA Power Plants

Calpine Projects

Headquartered in San Jose, California, Calpine Corporation has more than 80 power generation facilities in operation in the U.S. and Canada, having a total capacity of about 20,000 megawatts. There are two Calpine power generation plant projects near Decatur, AL.

The first Calpine project is called Decatur Energy Center (DEC). DEC is a combined cycle generating plant which utilizes three natural gas-fired combustion turbines and one steam turbine to generate a total plant output of 701 MW baseload/822 MW peaking. DEC is presently in service, with two combustion turbines and one steam turbine going commercial in 2002 and the one remaining combustion turbine going commercial in 2003. DEC also supplies process steam to nearby Solutia Corporation.

The second Calpine project is called Morgan Energy Center (MEC). MEC is a partially completed combined cycle generating plant which when complete will utilize three natural gas-fired combustion turbines and one steam turbine to generate a total plant output of about 720 MW baseload/807 MW peaking. Two of the three MEC units are presently in service. MEC also supplies process steam to a nearby BP facility.

Major Highway Projects

Huntsville Southern Bypass Extension

The route for this limited-access bypass extension is from I-565 on the western side of Huntsville through the Redstone Arsenal and ending at South Memorial Parkway (US 231). The Arsenal exits will have appropriate security controls (i.e., gated and guarded) but the highway will be open to through traffic. The design work for this project is currently underway and construction is scheduled to begin in 2006.

Memphis to Atlanta Interstate

The Alabama Department of Transportation lists this project in the proposal stage since it currently has no construction or detailed design funding and is not on the five-year plan. It has, however, been approximately routed, including the addition of a new bridge across the Tennessee River, southeast of the BFN site.

Off-Site Impacts on Emergency Preparedness

Demographic and physical changes surrounding the BFN site can affect emergency response plans. There have been no changes in recent years to evacuation routes or emergency planning, but the process is in place to recognize and address potential impacts. TVA has contractual commitments with governmental emergency management agencies to provide them funding for development of off-site emergency preparedness programs, including training, planning, maintenance of facilities and equipment, procedure preparation, exercise support, etc., to comply with Federal Emergency Management Agency requirements. It is a requirement in the contracts with the States of Alabama and Tennessee for their respective emergency management agencies to annually review and evaluate changes in site proximity hazards and demography to determine their effects on the safety of TVA nuclear plants, including emergency evacuation plans. These reviews will include changes in population distribution or in industrial, military, or transportation hazards. Both states submit an annual report to TVA of their findings, and incorporate any necessary changes into their procedures (Radiological Emergency Plans and Standard Operating Plans). The results of these reviews are also provided to TVA's Corporate Nuclear Licensing staff for independent consideration as to whether they could possibly present a hazard that would impact the safety of a TVAN Nuclear facility. This information is also incorporated into periodic FSAR updates.

Cumulative Impact Summary

Contacts were made with the Chambers of Commerce for Athens, AL and Decatur, AL, and with the Limestone County and Morgan County Economic Development Associations, to discuss future projects and development in the vicinity of BFN. Morgan County is typically among the top five counties in Alabama in terms of annual growth in recent years, and Limestone County grew 20% between 1990 and 2000. It is projected that this steady growth will continue, with much of it being concentrated in a triangle between Huntsville, Athens and Decatur, and greatly influenced in future years by the forthcoming Atlanta to Memphis expressway. No significant projects are planned or contemplated which would impact (or be impacted by) continued operation of BFN, and the only projected cumulative impact relative to BFN license renewal is its being a source of reliable electric power to support continued economic growth.

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E.3.0 THE PROPOSED ACTION

> The proposed action is described in 10 CFR 51.53(c)(2)
>
> > The report must contain a description of the proposed action, including the applicant's plans to modify the facility or its administrative control procedures as described in accordance with § 54.21 of this chapter. This report must describe in detail the modifications directly affecting the environment or affecting plant effluents that affect the environment.
>
> The proposed action is renewal of an operating license and continued operation of the plant during the renewal term, including all attendant activities. In addition to continuing operation and maintenance activities, attendant activities may include refurbishment to allow for extended plant operation and changes to surveillance, on-line monitoring, inspections, testing, trending, and recordkeeping (SMITTR). Refurbishment and SMITTR activities may be undertaken as a result of the 10 CFR Part 54 aging management review, or they may be undertaken for other reasons, such as opportunities for improved economic operation and maintenance during the term of the renewed license. This chapter of the ER should identify those activities attendant to license renewal that can affect the environment external to the plant. The level of detail provided should be sufficient to support the analyses called for in Chapter 4. Possible activities attendant to license renewal are discussed in Chapter 2 of NUREG-1437.

TVA proposes that the NRC renew the operating licenses for BFN Units 1, 2 and 3 for an additional 20 years beyond the current license expiration dates of December 20, 2013, June 28, 2014, and July 2, 2016, respectively. Renewal would give TVA the option of relying on BFN to help meet the future electricity needs of the approximately eight million people currently being served in a seven-state region. Section E.3.1 discusses the major features of the plant and the operation and maintenance practices directly related to the license renewal period. Sections E.3.2 through E.3.4 address potential changes that could occur as a result of license renewal, as well as other projects affecting the plant site. These other projects include restart of BFN Unit 1 because of the potential for cumulative impacts on some resource areas.

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E.3.1 GENERAL PLANT INFORMATION

Briefly describe the major features of the plant and the operation and maintenance practices directly related to operations under license renewal. Information presented in this section should include descriptions of:

- Reactor and containment systems
- Cooling and auxiliary water systems
- Radioactive waste treatment processes (gaseous, liquid, and solid)
- Transportation of radioactive materials
- Non-radioactive waste systems
- Maintenance, inspection and refueling activities
- Power transmission systems

(also put in the 10 CFR 51.53(c(2) statement)

BFN is an 840-acre tract located on Wheeler Reservoir in Limestone County, Alabama, 10 miles southwest of Athens, Alabama. BFN has three General Electric boiling water reactors and associated turbine-generators that can produce more than 3 billion watts of power. Each of BFN's three nuclear reactors is connected to its own dedicated power plant.

BFN is TVA's first nuclear power plant. TVA began major construction on BFN in 1967. Unit 1 began commercial operation in August 1974, Unit 2 in 1975, and Unit 3 in 1977. Unit 1 was idled in 1985, but work began in 2002 to bring the unit up to current standards, and operation is currently scheduled to resume in 2007.

Similarly, after an extended shutdown in 1985 to review the TVA nuclear power program and to correct significant weaknesses, Unit 2 returned to service in May 1991, and Unit 3 in November 1995. Operating characteristics, since restart from this regulatory outage, are expected to be more representative of future operations because of the changes in personnel, procedures, and equipment, as compared to the pre-1985 period. For example, since return to service from the regulatory outage, Units 2 and 3 have performed well, with consistently higher levels of availability and generating capacity than before the outage.

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E.3.1.1 REACTOR AND CONTAINMENT SYSTEMS

The nuclear steam supply system at BFN is typical of General Electric BWRs. Each nuclear system includes a single-cycle, forced-circulation, General Electric boiling water reactor producing steam for direct use in a steam turbine. The fuel for the reactor core consists of uranium dioxide pellets made from slightly enriched uranium. These pellets are contained in sealed Zircaloy-2 fuel rod tubes which are assembled into individual fuel bundles.

The reactor vessel contains the core and supporting structure, the steam separators and dryers, the jet pumps, the control rod guide tubes, distribution lines for the feedwater, core spray, and standby liquid control, the incore instrumentation, and other components. The main connections to the vessel include the steam lines, the coolant recirculation lines, feedwater lines, control rod drive housings, and core standby cooling lines.

The reactor core is cooled by demineralized water which enters the lower portion of the core and boils as it flows upward around the fuel rods. The steam leaving the core is dried by steam separators and dryers, located in the upper portion of the reactor vessel. The steam is then directed to the turbine through the main steam lines. Each steam line is provided with two isolation valves in series—one on each side of the primary containment barrier.

The design employs a pressure suppression primary containment which houses the reactor vessel, the reactor coolant recirculating loops, and other branch connections of the Reactor Primary System. The pressure suppression system consists of a drywell, a pressure suppression chamber which stores a large volume of water, connecting vents between the drywell and the pressure suppression chamber, isolation valves, containment cooling systems, and other service equipment. In the event of a process system piping failure within the drywell, reactor water and steam would be released into the drywell air space. The resulting increased drywell pressure would then force a mixture of air, drywell atmosphere, steam, and water through the vents into the pool of water in the pressure suppression chamber. The steam would condense in the pressure suppression pool, resulting in a rapid pressure reduction in the drywell. Air that was transferred to the pressure suppression chamber pressurizes the chamber and is subsequently vented back to the drywell to equalize the pressure between the two vessels. Cooling systems are provided to remove heat from the reactor core, the drywell, and from the water in the pressure suppression chamber, and thus provide continuous cooling of the primary containment under accident conditions. Appropriate isolation valves are actuated during this period to ensure containment of radioactive material, which might otherwise be released from the reactor containment during the course of the accident.

The secondary containment substructure consists of poured-in-place, reinforced concrete exterior walls that extend up to the refueling floor. The refueling room floor is also constructed of reinforced, poured-in-place concrete. The superstructure of the secondary containment above the refueling floor is a structural steel frame which supports metal roof decking, foamwall-stepped fascia panels, and insulated metal siding panels. The secondary containment structure completely encloses the primary containment drywells, fuel storage and handling facilities, and essentially all of the Core

Standby Cooling Systems for the three units. During normal operation and when isolated, the secondary containment is maintained at a negative pressure relative to the building exterior. Excessive pressure differentials are relieved by blowout panels in the metal siding.

E.3.1.2 COOLING AND AUXILIARY WATER SYSTEMS

Condenser Circulating Water System

The BFN units are normally cooled by pumping water from Wheeler Reservoir into the turbine-generator condensers and discharging it back to the reservoir via large submerged diffuser pipes that are perforated to maximize uniform mixing into the flowstream. This straight-through flow path is known as “open cycle” or “open mode” operation. Through various gates, some of this cooling water can also be directed through cooling towers to reduce its temperature as necessary to comply with environmental regulations. This flow path is known as the “helper mode.”

The physical capability also exists to recycle the cooling water from the cooling towers directly back to the intake structure without being discharged to the reservoir; this is known as the “closed mode” of operation. However, when operating in this mode in the past, BFN has experienced difficulties in keeping intake cooling water temperatures below limits during the summer months. This often resulted in forcing the plant to reduce power output during high demand periods. In addition, closed mode operation reduced plant reliability considerably because it increased vulnerability to sudden cooling tower performance degradation caused by equipment failures or changes in wind direction. BFN has not operated in this mode since restart of Units 2 and 3, and currently has no procedures for it; doing so would require some instrumentation and control circuitry refurbishment.

RHR Service Water System

The RHR Service Water System consists of four pairs of pumps located on the intake structure for pumping raw river water to the heat exchangers in the Residual Heat Removal (RHR) System and four additional pumps for supplying water to the Emergency Equipment Cooling Water (EECW) System. The EECW System distributes cooling water supplied by the RHR Service Water System to essential equipment during normal and accident conditions.

Residual Heat Removal System

The Residual Heat Removal (RHR) System is comprised of pumps, heat exchangers, and piping that fulfills the following functions:

a. Removal of decay heat during and after plant shutdown
b. Injection of water into the reactor vessel following a loss-of-coolant accident rapidly enough to reflood the core and prevent excessive fuel clad temperatures independent of other core cooling systems.
c. Removal of heat from primary containment following a loss-of-coolant accident to limit the increase in primary containment pressure. This is accomplished by cooling and recirculating the water inside the primary containment. The redundancy of the equipment provided for containment cooling is further extended by a separate part of the RHRS which sprays cooling water into the drywell and pressure suppression pool.
d. Provide standby cooling.
e. Provide assistance for fuel pool cooling when required.

E.3.1.3 RADIOACTIVE WASTE TREATMENT PROCESSES (LIQUID, SOLID, AND GASEOUS)

The radioactive Waste Systems are designed to control the release of plant-produced radioactive material to within the limits specified in the Offsite Dose Calculation Manual and National Pollutant Discharge Elimination System permits. The methods employed for the controlled release of those contaminants are dependent primarily upon the state of the material: liquid, solid, or gaseous.

Liquid Radwaste System

The Liquid Radioactive Waste Control System collects, treats, stores, and disposes of all radioactive liquid wastes. These wastes are collected in sumps and drain tanks at various locations throughout the plant and then transferred to the appropriate collection tanks in the Radwaste Building for treatment, storage, and disposal. Wastes to be discharged from the system are processed on a batch basis, with each batch being processed by such method or methods appropriate for the quality and quantity of materials determined to be present. Processed liquid wastes may be returned to the condensate system or discharged to the environs through the circulating water discharge canal. The liquid wastes in the discharge canal are diluted with condenser effluent circulating water to achieve a permissible concentration at the site boundary.

Batches of low-conductivity liquid waste are processed through a filter and a waste demineralizer. Demineralizer effluent is sent to a waste sample tank. Depending upon the conductivity and level of radioactivity, the liquid may then be discharged to the circulating-water discharge canal or the cooling tower blowdown line, transferred to condensate storage tanks, or returned for further processing through the waste demineralizer.

High-conductivity liquids are processed through a filter and are collected in a floor drain sample tank. If the concentration after dilution is less than or equal to the applicable limits, the filtered liquid may be discharged.

An alternate method of processing low and high conductivity liquid is the use of vendor-supplied skid-mounted equipment, interconnected to the permanent Radwaste System. Depending on effluent quality and plant needs, the water can be sent to either the waste sample tank or floor drain sample tank. Processing from the waste sample tank or floor drain sample tank is identical as described above.

Equipment is selected, arranged, and shielded to permit operation, inspection, and maintenance with minimum personnel exposure. For example, tanks and processing equipment which will contain significant radiation sources are located in controlled access rooms or spaces. Processing equipment is selected and designed to require a minimum of maintenance.

Protection against accidental discharge of liquid radioactive waste is provided by valve redundancy, instrumentation for detection of alarms of abnormal conditions, procedural controls, interlocks, and radiation monitor controlled valves.

Solid Radwaste System

With the Solid Radwaste System, solid radioactive wastes are collected, processed, and packaged for storage. Generally, these wastes are stored onsite until the short half-lived activities are insignificant. Solid wastes from equipment originating in the nuclear system are stored for radioactive decay in the fuel storage pool and prepared for reprocessing or offsite storage. Examples of these wastes are spent fuel, spent control rods, in-core ion chambers, etc. Process solid wastes such as spent demineralizer resins and filter aid are collected, dewatered, and either temporarily stored on-site in concrete storage modules or shipped directly for burial offsite in a licensed disposal facility. Dry Active Wastes such as paper, rags, and used clothing are either placed into containers for storage or shipped directly to a waste processor for volume reduction and subsequent transport offsite to a licensed disposal repository. Generation rates for these types of materials are approximately 30-40 cubic meters per month, which after Unit 1 resumes operation could increase to 40-50 cubic meters per month.

As a result of Unit 1 recovery activities, generation rates of low level radioactive waste would be expected to increase during construction activities, primarily due to additional asbestos removal operations and the normal increases associated with nuclear construction.

Gaseous Radwaste System

The Gaseous Radwaste System collects, processes, and delivers to the plant stack, for elevated release to the atmosphere, gases from each main condenser air ejector, startup vacuum pump, condensate drain tank vent, and steam packing exhauster. Gases from each main condenser air ejector are passed through a preheater, a catalytic recombiner, a condenser, a moisture separator, and a dehumidification coil. The gases then enter a decay pipe which provides a retention time of approximately 6 hours, during which N-16 and O-19 decay to negligible levels. The gases are then passed through a cooler condenser, a moisture separator, a reheater, a prefilter, six charcoal beds, an afterfilter, and mixed with dilution air, after which they are exhausted to the stack. The charcoal beds provide about 9.7 hours retention for krypton isotopes and 7.3 days retention for xenon isotopes. Gland seal and startup vacuum-pump gases are held up for approximately 1 ¾ minutes, to allow sufficient decay of N-16 and O-19, and then passed directly to the stack for release.

Three-Unit Operation

When all three units become operational at the uprated power level, the generation rate of low level radioactive waste would increase proportionately, i.e., three units instead of two, and all three at 120% of the originally licensed power level. For example, the generation rate of solid low-level radwaste will be expected to increase to approximately 45 to 60 cubic meters per month. These increases are expected to remain within the storage and disposal capacities of existing facilities. The existing contractors are capable of handling the increased volumes anticipated.

E.3.1.4 TRANSPORTATION OF RADIOACTIVE MATERIALS

Spent Nuclear Fuel

In response to the Nuclear Waste Policy Act of 1982 and subsequent amendments, DOE was required to develop a deep, mined geological repository for high-level waste and spent nuclear fuel. The repository was to begin receiving utility spent fuel by January 31, 1998, and based on DOE's last published Acceptance Priority Ranking (DOE/RW0457), was to begin receiving TVA's spent nuclear fuel during the fifth year of repository operation. By law, DOE will take responsibility for the spent fuel at the BFN site boundary, i.e., transport of the spent nuclear fuel, including the means of conveyance and the choice of route to the permanent repository, will be determined and controlled by DOE and not TVA.

However, the repository is now at least 12 years behind schedule. BFN is currently storing spent fuel in three spent fuel pools which were re-racked to a capacity of 3,471 spent fuel assemblies. As a result of the DOE repository delay, Unit 3 is expected to lose full core off-load capability in November 2005. TVA has therefore determined that BFN must increase spent fuel storage capacity by 2005 to avoid impacting plant availability, regardless of license renewal or the operations alternatives chosen. To meet this need, TVA has elected to construct an independent spent fuel storage installation (ISFSI) on the BFN site.

The BFN ISFSI will result in aboveground storage of spent fuel in dual-purpose metal (non-canister) casks or modular metal canisters with concrete overpacks. These dual-purpose storage modules are licensed by NRC for both storage and transportation of spent nuclear fuel. Dry storage in dual-purpose storage casks minimizes BFN efforts in preparing fuel for shipment when a DOE repository is available. Procurement of additional storage modules can be accomplished incrementally (i.e., the size can be expanded as needed). Current BFN dry storage plans provide adequate space for future ISFSI expansion sufficient to assure storage capacity for the renewed license period with all three units operating at extended power uprate, as well as for additional delays in the DOE spent fuel repository. Therefore, this technology assures life-of-plant capability regardless of DOE schedules or plant operations changes.

Low-Level Radioactive Waste

Dry Active Wastes such as paper, rags, and used clothing are placed into containers for storage and shipment to a waste processor for volume reduction and subsequent transport to a disposal repository licensed to accept Class A wastes. Spent Resins are packaged, dewatered and either temporarily stored on site in concrete storage modules or shipped directly to a disposal facility licensed to accept Class B wastes. Irradiated non-fuel plant components such as spent control rods, in-core ion chambers, etc., are stored on-site or processed for shipment to a disposal facility licensed to accept Class C low-level radioactive wastes.

Shipments of TVA low-level radioactive waste, whether to an off-site processor or off-site repository, are by a contracted carrier who is paid for exclusive use of the transport vehicle. Shipments are made via major highways, primarily interstate freeways, to minimize transport time and potential hazards. Under this arrangement it is financially advantageous for the carrier to avoid alternate routes and complete the shipment expeditiously.

E.3.1.5 NON-RADIOACTIVE WASTE SYSTEMS

General Plant Trash

General plant trash such as paper, metals, garbage and other items collected as part of routine plant operation activities is managed through a TVA-wide contract with a licensed waste disposal company. Waste material is collected in dumpsters and transported to a State licensed regional landfill permitted to accept Subtitle D waste materials from Limestone County. Generation rates for this type of material are currently approximately 50 tons per month. BFN has an active recycling program that segregates and recycles scrap metal, cardboard, paper, batteries, and aluminum cans at approved State and local recycling facilities.

During recovery activities for Unit 1, the amount of general plant trash has increased in proportion to the increase in site population required for the Unit 1 recovery effort. In addition, there is additional trash generated as a part of construction activities, but this amount is significantly less than that generated by construction of a new facility. Together these are expected to peak at a 60% increase over pre-recovery levels.

Once Unit 1 is operational, the amount of trash generated would be similar to the other operating units, and the overall amount generated would increase slightly (approximately 12.5%) from the current 50 tons per month level due to the small increase in permanent plant staff necessary to operate three units. The increase in general plant trash could be offset to some extent by implementation of recycling efforts beyond those currently in place. This would include increasing the amount of white paper, aluminum cans, and special stock paper sent to recycling centers, and improving recycling of waste wood. The existing contractor is capable of handling the increased volumes anticipated. Landfill capacity and projections for availability of landfill space in Alabama indicate that sufficient space to accommodate this material from BFN should be available during the duration of operating under renewed licenses.

Construction/Demolition Debris

For construction and demolition debris associated with site activities such as modifications and additions, BFN operates a State-permitted Construction/Demolition (C/D) landfill (Permit No. 42-02) within the confines of the BFN site. This landfill is permitted to accept non-hazardous, non-radioactive solid wastes including scrap lumber, bricks, sandblast grit, crushed metal drums, glass, wiring, non-asbestos insulation, roofing materials, building siding, scrap metal, concrete with reinforcing steel and similar construction and demolition wastes at an average daily volume of five tons per day from the BFN site. The landfill is approximately 7.7 acres in size. The generation rate for this type of material over the past two years is approximately 0.04 tons per day. The C/D landfill permit is issued for five-year cycles, with the current permit set to expire in May 2005.

A small amount of addition C/D wastes associated with construction activities are expected as part of the Unit 1 recovery effort. This amount may be as much as twice that currently experienced (0.04 tons per day, increased to 0.08 tons per day). The on-site landfill has the space and capacity to handle the anticipated increase without expansion, and there is sufficient alternative capacity in surrounding off-site landfills should the on-site facility prove inadequate. Once Unit 1 is recovered, the amount of C/D waste generated as a result of three-unit operation would not be expected to increase significantly over the rates experienced for two-unit operations.

One or more cooling towers might possibly be refurbished or replaced with larger, more efficient cooling towers, in their approximate present locations. To demolish the existing cooling towers, a Notice of Demolition to ADEM would be required and would be initiated by the Environmental staff at BFN. The advance notice requirement is that this written notification must be post marked in the mail at least ten days before the work is actually started. Also, for the cooling towers that contain asbestos, the workers that remove the asbestos panels will also have to be trained and certified by the State of Alabama in asbestos regulation compliance.

Hazardous Waste

As is the case with any large industrial facility, BFN generates a variety of wastes that are classified as hazardous under the Resource Conservation and Recovery Act (RCRA). These wastes include paint-related materials, spent solvents used for cleaning and degreasing, as well as Universal Wastes such as spent batteries, fluorescent light tubes, etc. TVA operates a Hazardous Waste Storage Facility (HWSF) in Muscle Shoals, Alabama that holds a RCRA Part B permit for temporary storage of hazardous wastes. The HWSF serves as a central collection point for TVA-generated hazardous wastes, and maintains contracts with waste treatment and disposal facilities through TVA's Environmental Restricted Awards Process. All hazardous waste generated at BFN is shipped to the HWSF for consolidation, storage, and disposal through approved and licensed facilities. BFN recycles paint solvents (primarily Methyl Ethyl Ketone) using an on-site still. Universal wastes are collected for recycling and shipped to recycling firms listed on the Environmental Restricted Awards List. Hazardous waste generation rates for BFN average approximately 3,400 pounds per calendar year. While not a hazardous waste as defined in the RCRA regulations, used oil is also generated at BFN as a result of maintenance activities on plant equipment. All used oil is collected, stored on site, and shipped to an approved recycling center for energy recovery.

Construction activities associated with Unit 1 recovery would temporarily increase rates of hazardous waste, universal wastes and used oil generation due to the increased use of solvents and paint related materials necessary for refurbishment, and the recovery of various plant equipment. The increases anticipated could be as much as 25 to 30% over current levels of approximately 3,000 to 3,500 pounds per year. The existing TVA process for management of this type of waste is adequate to handle the expected increase. Once operational, hazardous waste generated as a result of operation of Unit 1 would be within the normal year to year variation currently experienced. The existing contractors are capable of handling the increased volumes anticipated, both during Unit 1 recovery and with all three units operating throughout the renewed license period.

E.3.1.6 MAINTENANCE, INSPECTION AND REFUELING ACTIVITIES

Maintenance and Modification Practices

The BFN maintenance and modification (M/M) program supports safe, reliable, and efficient operation of the nuclear power plant and assures that equipment, systems, and structures are maintained and modified in accordance with applicable requirements and at a quality level required for them to perform their intended functions as specified in the original design, material specifications, and inspection requirements. Applicable requirements of the program are set forth in the following documents:

- Site Operating License
- Updated Final Safety Analysis Report and Technical Specifications
- 10CFR50.65, "Maintenance Rule"
- TVAN Quality Assurance Plan
- ANSI N18.7-1976, Administrative Controls and Quality Assurance Program for Operating Phase of Nuclear Plants
- 10CFR50.49, "Environmental Qualification"
- ANSI N18.1-1971, Selection and Training of Nuclear Power Plant Personnel

Additionally, the following guidance from the Institute of Nuclear Power Operations has been utilized and incorporated into the M/M program as appropriate:

- INPO 92-001 – Guidelines for the Conduct of Maintenance at Nuclear Power Stations
- INPO 87-028 – Good Practice: Post Maintenance Testing
- INPO 92-014 – Good Practice: Preventive Maintenance Program Enhancement
- INPO AP-901—Work Practice Description: Minor Maintenance Process Description

Inspection and Testing Practices

Inspections are performed by qualified individuals in Nuclear Assurance or other TVAN organizations where necessary to assure quality. Inspections are performed by individuals other than those who performed or directly supervised the activity being inspected. Inspection results are documented and maintained as records.

The BFN inspection program provides assurance that plant quality-related items and activities within the scope of the NQAP conform to predetermined quality requirements called for in specifications, procedures, and drawings. The inspection program as described in this section includes quality control (QC) inspections, nondestructive examinations (NDE), line verifications, and special inspections.

TVAN Standard Programs and Processes address procedural requirements for material receipt and inspection, the ASME Section XI in-service inspection program, special nuclear material control, and nuclear fuel management.

The Inspection Services Organization (ISO) is responsible for the development and control of the following programs: inspector certification; inspection plans; and non-destructive examination (including inspector certification and NDE procedures).

The General Manager, Nuclear Assurance, or designee, is required to concur with the ISO procedures that contain inspection/NDE programmatic requirements. The General Manager, NA, also reviews and approves the inspection program for control of special processes to ensure inclusion of QA requirements. The General Manager, NA, or designee, also concurs with TVAN inspector/NDE inspector certifications.

BFN testing programs ensure that plant equipment and components (1) are tested in accordance with applicable regulatory and quality requirements, and (2) function in a manner which supports plant operation. The inspection and test programs establish controls which ensure that components and systems are periodically tested to meet Technical Specification requirements and are tested following modification or maintenance in order to support the safe, efficient, and reliable operation of TVAN plants.

Requirements which the testing programs must meet are specified in the following documents:

- TVA NQA PLN 89-A, TVAN Quality Assurance Plan
- BFN Technical Specifications
- Technical Requirements Manuals
- Updated Final Safety Analysis Report
- ANSI N45.2-1971, Quality Assurance Program Requirements for Nuclear Power Plants
- ANSI N18.7-1976, Administrative Controls and Quality Assurance for the Operational Phase of Nuclear Power Plants
- ANSI N45.2.8(1975), Supplementary Quality Assurance Requirements for Installation, Inspection and Testing of Mechanical Equipment and Systems for the Construction of Nuclear Plants
- 10CFR50, Appendix B, Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants

Although not requirements for these programs, the following additional documents that address standard practices and methods for plant testing have also been used in the development of this program. These documents provide information that enhances the program.

- INPO Significant Operating Experience Report (SOER) 91-001, Infrequently Performed Tests or Evolutions
- INPO Good Practice 85-010, Surveillance and Periodic Task Scheduling Program.
- INPO SOER 87-001, Core-Damaging Accidents Following Improperly Conducted Tests
- INPO 87-028, Post-Maintenance Testing

Refueling Operations Practices

Detailed refueling procedures are used to ensure a safe and orderly refueling. The procedures specify or make reference to other system operation documents that specify periodic shutdown margin checks, detailed channeling and fuel handling techniques, and other precautionary steps to ensure that the facility license and technical specifications are not violated.

BFN complies with the criticality requirements specified in 10CFR50.68(b). Appropriate restrictions are provided in plant procedures which prohibit the handling at any one time of more fuel assemblies than have been determined to be safely subcritical under the most adverse moderation conditions feasible by unborated water.

When fuel is being inserted, removed, or rearranged in the core or when control rods are being installed, removed, or manipulated, licensed operators are in the control room and on the refueling floor supervising the operations. Technical personnel provide guidance where necessary and verify that all fuel has the proper orientation and is in the correct location. An essential part of plant nuclear materials control and of refueling outage requirements is to have complete knowledge of the identity, location, composition, and condition of all fuel and other core components. The location of each control rod in the core is recorded by serial number. Each fuel assembly is identified by a serial number on the handle. A permanent file of NRC material transfer reports is maintained on site. Documentation for each fuel assembly will have assembly type, unit and batch number, serial number, date received, as-built uranium weight, as-built U-235 weight, net weight, and other applicable date. The fuel transfer forms and documentation are lifetime records. In addition, there are records for the reactor and spent fuel storage pool. All instructions for removing, rearranging, or adding fuel to the core are performed from detailed procedures. An independent check is made after the core is fully loaded to ascertain that all fuel assemblies have been loaded correctly.

During the reactor refuelings the fuel of highest burnup in general is removed from the core, some fuel is rearranged, and new fuel is loaded into the core. The loading patterns for all refuelings are selected to provide an optimum power distribution to satisfy plant safety and economic considerations.

Other refueling operations include the replacement of control rods and in-core monitors, channeling operations, fuel “sipping” (i.e., testing for leakers) when necessary, and the inspection of selected portions of the reactor vessel and primary system.

Refueling operations are similar for all three units.

Renewed License Period

No changes to maintenance, inspection and refueling activities to accommodate operation during the renewed license period are anticipated.

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E.3.1.7 POWER TRANSMISSION SYSTEMS

BFN is connected into the TVA system network by seven 500-Kilovolt (kV) lines via the 500-kV switchyard. One line is to the Madison substation, two are to the Trinity substation, one line each are to the West Point, Maury, and Union substations, and one line is to the Limestone 500-kV Substation. Any three lines excluding more than one Trinity line can transmit the entire station output into the TVA system network.

The 500-kV switchyard has a main and transfer zigzag bus arrangement. The two main bus sections are physically separated, and the transfer bus sections are separated from the main bus section by sectionalizing disconnect switches. Normally, the main and transfer bus sections are tied together through their respective disconnect switches.

Normal station power is from the unit station service transformers connected between the generator breaker and main transformer of each unit. Startup power is from the TVA, 500-kV system network through the 500- to 20.7-kV main and 20.7- to 4.16-kV unit station service transformers. Auxiliary power is available through the two common station service transformers that are fed from two 161-kV lines supplying the 161-kV switchyard, one line each from the Athens and Trinity substations. The two 161-kV lines terminate at separate buses which are connected by a circuit breaker. Normally the switchyard will be operated with the breaker closed and both transformers energized. Disconnect switches are provided to permit either incoming line to be isolated from the switchyard and both transformers supplied from the remaining line.

Changes to the power transmission systems to accommodate Unit 1 recovery at extended power uprate conditions are described in the following section. No other changes to the power transmission systems to accommodate three-unit operation during the renewed license period are anticipated.

Attachment E-6 contains a summary of the environmental review process TVA uses for maintenance and modifications of transmission lines and presents the results of this process, by subject matter area, for the area immediately surrounding BFN.

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E.3.2 REFURBISHMENT ACTIVITIES

> Facility refurbishments performed in support of license renewal should be described in this section. These descriptions should identify the major structures and components that will be replaced or modified. The section should identify where materials will be stored between their arrival on the site and installation in the plant, and between their removal from the plant and disposal. If refurbishment activities that directly or indirectly affect the environment will be required, the locations and nature of those activities should be described. This section should identify the schedule for the refurbishment work and describe how it would be integrated with refueling and other maintenance activities. Applicants should ensure that the information in this section meets the information requirements of Chapter 4.

License Renewal

The objective of the review required by 10CFR54.21 is to determine whether the detrimental effects of plant aging could preclude certain systems, structures and components from performing their intended function during the extended period of operation. The evaluation of systems, structures and components as required by 10CFR54.21 has been completed and is described in the body of the BFN License Renewal Application. This evaluation did not identify the need for refurbishment of structures or components related to license renewal. Routine replacement of certain components during the period of renewed license operation is expected to occur within the bounds of normal plant maintenance. Modifications to improve operation of plant systems, structures or components are reviewed for environmental impact by station personnel during the planning stage for the modification; these reviews are controlled by site procedures.

Recovery

BFN Unit 1 has been in a non-operation status since it was shut down by TVA in March 1985. Recovery work on Unit 1 began in May 2002 and is expected to be completed in May 2007.

To a large degree, the work involved in recovering Unit 1 is similar to the work scope previously experienced in recovering Units 2 and 3. Considerable reanalysis was involved in updating the Units 2 and 3 design bases to current standards and re-establishing consistency between design control drawings and the actually installed equipment configuration. Special programs were defined and carried out to resolve a number of plant hardware issues for Units 2 and 3, including environmental qualification of electrical equipment, seismic design basis adequacy of suspended components, fire protection compliance with current industry standards, adequacy of past welding practices and installed welds, primary system pressure boundary susceptibility to inter-granular stress corrosion cracking, safety-related instrument sensing line installation (i.e., slope, separation, material, fabrication, etc.), piping wall loss due to erosion-corrosion, safety-related qualification of past and present piece part procurements, and capability of electrical switchgear to mitigate safe shutdown design basis events. Though largely analytical in nature, these programs resulted in a large number of plant modifications to improve nuclear safety. Similarly, although much of this same work for BFN Unit 1 recovery is analytical in nature and will result in changes to drawings and other design basis documentation, it will also likely result in a large number of modifications and equipment changes. Because most of these modification and equipment changes are internal to the plant, the impact on the air, land, and water environment surrounding the facility is expected to be negligible.

Refurbishment Waste

No substantial non-radioactive waste was generated as a result of recovery of Units 2 and 3, although at the conclusion of the work, one site temporary office building was demolished and placed in the site land fill. Radioactively contaminated waste generated during the recovery work was shipped to the permanent low-level waste repository in Barnwell, South Carolina; these materials (predominantly steel and other fabricated metals) resulted from control rod drive change-out, reactor recirculation piping replacement, cleanout of miscellaneous parts and pieces stored in the spent fuel pool, and various C-zone activities (booties, gloves, tape, rags, etc.). It is anticipated that recovery and restart of Unit 1 will have similar minor waste generation. Following Unit 1 recovery, waste generation rates are expected to return to pre-recovery normal operation levels and remain there throughout the renewed license period.

Equipment Changes

In addition to the plant changes, which will be confirmed by the reanalysis, based on both the experience from recovery of Units 2 and 3 and the known equipment status of Unit 1, the planned Unit 1 work also includes a number of specific equipment additions, replacements and refurbishments. Equipment additions or changes include such things as the Hydrogen Water Chemistry system, Control Rod Drive seismic restraints, 416/480V Shutdown Transformer and Control Bay Vent Board feed, Condenser Circulating Water Debris Filter, Site Sewer System augmentation, back-up Post-Accident Auxiliary Power System sequencing logic, Auxiliary Decay Heat Removal System connections, Balance-of-Plant Battery Load re-allocation cables, Auxiliary Trip Unit Inverters and Power Supply. The only environmental impacts associated with these additions or changes would be transportation into the site of material or equipment and eventual disposal via maintenance or decommissioning.

For equipment replacements, an added consideration is the disposal of the original items, which in some cases might involve decontamination and/or eventual shipment to a low-level radioactive waste facility. Some highly radioactive waste items may remain on site until a repository for high-level radioactive waste (such as the one at Yucca Mountain, Nevada) becomes available. Most often there will be some minor amount of scrap fabricated steel components and housings, electrical and piping connections, etc., requiring disposition. Equipment replacement primarily addresses obsolete items, but it can also include replacement of items scavenged for operation and/or maintenance of Units 2 and 3 such as feedwater heater level control components.

Refurbishments may result in producing other materials requiring disposal besides scrap metal, such as decontamination chemicals used to reduce thin-film radioactivity in piping and equipment and thereby limit worker radiation exposure.

Table E.3-1 lists some of the major hardware impacts associated with Unit 1 recovery, together with any disposal considerations involved.

Table E.3-1 – Hardware Impacts Associated with Unit 1 Recovery	
Physical Change	**Disposal Consideration**
[1]Pipe replacement	scrap steel (some contaminated)
Piping hangars and supports	scrap steel (some contaminated)
[2]Control Rod Drive (CRD) replacement	contaminated scrap steel (from drywell)
[3]CRD Hydraulic Control Unit refurbishment	scrap metal
RHR pump impeller replacement	contaminated scrap steel
RHR Service Water pipe loop replacement	scrap steel
Possible Rx Vessel Internals repair/replace.	scrap metal (low level radioactive waste)
Possible Shroud Head Bolt replacement	contaminated scrap steel
Turbine Generator refurbishment	contaminated misc. maintenance materials
Miscellaneous valve replacements	scrap steel (some contaminated)
Generator Field upgrade	misc. wiring & conductor supports
Ampacity Study cable replacements	scrap cable (some abandoned in place)
Shutdown Buswork Cabling upgrade	scrap cable
Bus Tie Board/Cooling Tower cable replace.	scrap cable
Inter-Unit DG Bus Tie cable replacement	scrap cable
Chemical decontamination of piping	mixed chemical waste
Low Power Range Monitor upgrade	scrap contaminated cables and connectors
Power Range Neutron Monitor upgrade	scrap detectors (low level radioactive waste)
High Pressure Coolant Injection upgrade	scrap instruments & controls, piping & hangars
Traveling In-core Probe logic upgrade	scrap switches & controls (possibly contaminated)
Control Rod Blade (possible) changeout	scrap metal components (high level rad waste)
Feedwater Nozzle Thermal Monitor upgrade	contaminated scrap steel, wiring & connectors
Feedwater Control upgrade to digital	scrap instruments & controls
Rx Fdwtr Pump min. flow valve replacement	contaminated scrap steel and connectors
Refueling bridge control replacement	scrap instruments & controls
Recirculation Flow Control upgrade to digital	scrap instruments & controls
ECCS Suction Strainer replacement	contaminated scrap steel
Main Steam Ruggedness upgrades	scrap steel
Main Steam Tunnel cooling system upgrade	misc. scrap equipment (potentially contaminated)

Table E.3-1 (cont.) – Hardware Impacts Associated with Unit 1 Recovery	
Physical Change	**Disposal Consideration**
Moisture Separator Level Control upgrade	misc. scrap equipment (potentially contaminated)
Electrohydraulic Control electronics upgrade	scrap instruments & controls
Possible Main Bank Transformer replacement	scrap steel and conductors (mineral oil insulated)
4kV Breaker replacement (new Siemens units)	scrap steel and conductors
Load Sequence Timer replacement	scrap controls
Load Shed Logic upgrade	scrap controls
Generator Breaker upgrade	scrap steel and conductors

[1]Pipe replacement involves those portions of various plant systems which are susceptible to inter-granular stress corrosion cracking, including the suction, discharge, risers, and ring header of the reactor recirculation piping; reactor water clean-up system (RWCU); core spray system; and residual heat removal (RHR) system. Included in this effort is re-routing of the RWCU piping to allow the RWCU pumps to operate at lower temperatures.

[2]CRD replacement scope includes replacement of the existing 185 BWR-4 drives with new upgraded BWR-6 drives.

[3]For the CRD Hydraulic Control Unit refurbishment, the scram valves and scram pilot valves will need to have rubber parts replaced because of shelf life considerations, and some accumulators will need to be replaced due to pitting corrosion.

Following resumption of three-unit operation, no further equipment changes attributable to continuing operation through the renewed license period are anticipated.

New Structures

Unit 1 recovery required construction of a new administration building to make space available to incoming (temporary) workers and to move (permanent) office workers away from radiation sources associated with operating Unit 1 with hydrogen water chemistry.

Unit 1 is adjacent to buildings that house plant personnel. Operation of Unit 1, especially with the hydrogen water chemistry process currently employed in Units 2 and 3, would result in plant personnel dose rates which would be higher than that which could reasonably be achieved by relocating plant operating staff offices. Therefore, a new Administration (office) Building located further from Unit 1 has been constructed to minimize dose to site workers at BFN.

The new Administration Building was erected early in the Unit 1 recovery effort to house existing staff, thereby allowing space to be freed up in the existing office buildings to house the incoming Unit 1 team. After completion of Unit 1 recovery, the existing (old) office buildings will be kept for use during outages. The new office building will house almost all site office staff, approximately 514 individuals.

The new two-story office building consists of light commercial-grade construction, and was largely prefabricated, involving delivery of prefabricated items, concrete and other construction materials. The new office building required approximately 40 truckloads of concrete, 35 gravel truckloads, and approximately 20 truckloads of various other building materials (5 of construction steel, 15 for items such as sheetrock, electrical, plumbing, etc.). The number of workers peaked at 60, but no more than 40 were ever on site simultaneously.

The location for the new dry cask storage facility for spent nuclear fuel will require tearing down the existing Modifications Fabrication Building. However, the old building would not have to be displaced until approximately 2008, which is expected to be well after the new Modifications Fabrication Building would be operational. Although the primary motivation for erecting a new Modifications Fabrication Building is to make room for the new dry cask storage facility, initially it will be used for Unit 1 recovery. Compared to the existing Modifications Fabrication Building, this new building will be larger and more flexible in the number and kind of activities it can house.

The new Modifications Fabrication Building will be designed as light commercial grade construction. It will be largely prefabricated, involving delivery of prefabricated items, concrete, and other construction materials. Construction of this new building will require approximately 8 truckloads of concrete, 6 to 8 gravel truckloads, and approximately 4 truckloads of various other building materials (one of construction steel, 3 for items such as sheetrock, electrical, plumbing, etc.). The number of workers will peak at about 12, but no more than 8 will normally be on site simultaneously.

Unit 1 recovery also requires the addition of a sixth linear mechanical draft cooling tower in the currently vacant position (4). This new tower will be slightly larger than the others, having 20 cells instead of 16. Since this is a significant new structure, its construction and operational impacts are addressed under the respective Section 4.0 subjects.

No other new structures attributable to continuing operation through the renewed license period are anticipated.

<u>Transmission Lines</u>

Unit 1 is projected to return to operation in 2007 with an output of 1,280 MW. An interim study of the impact on the transmission system of BFN Unit 1 restart as an upgraded unit being added in the year 2007 to the previously upgraded Units 2 and 3 has been completed. No new line right-of-ways or construction of new transmission lines would be required or are proposed for the restart of Unit 1. The results of this 2007 load flow study identify the cumulative effects of the three-unit generation changes as well as increased loads in the area and other generation changes in the area. The results of the analysis are:

1. An additional 500-kV circuit breaker will have to be installed in the existing BFN 500-kV switchyard. Other transient stability improvements may be required.
2. The Madison-Redstone 161-kV transmission line (13.2 miles) becomes overloaded due to a single contingency event and will require reconductoring.
3. The following 161-kV lines would become overloaded due to a single contingency event and will require the addition of a second 500-161kV transformer bank at the Madison 500kV substation.
   - Limestone-Jetport 161-kV transmission line – 8.1 miles.
   - Limestone-North Huntsville 161-kV transmission line – 15.9 miles.

4. Three 161kV circuit breakers at the Farley 161kV Substation will be replaced due to the increased fault currents associated with the addition of the second Madison transformer.
5. A Static Var Compensator would have to be installed at an existing TVA substation in order to supply area voltage support.

The right-of-ways that are occupied by the affected transmission lines have been kept clear of tall vegetation. Mowing and other maintenance equipment has been on these right-of-ways periodically over the operation life of the lines and extensive re-clearing of the right-of-ways would not be required to reconductor the lines. Impacts associated with these activities are expected to be insignificant. The new Madison 500-161kV transformer bank and the Farley and Browns Ferry circuit breaker installation/replacement involve work within existing TVA property. There are already spaces available for the new transformer bank and circuit breaker installation/replacements; therefore, the work will require minimal site work. All work will be completed using TVA's Best Management Practices.

TVA continues to study the capability of its transmission system and analyses will be appropriately updated in the future. Following recovery of Unit 1, however, no further transmission system changes attributable to continuing operation of the three BFN units through the renewed license period are anticipated.

E.3.3 PROGRAMS AND ACTIVITIES FOR MANAGING THE EFFECTS OF AGING

This section should characterize any changes planned in the plant's operating practices, inspections, maintenance activities, systems, and administrative control procedures during the renewal term that are designed to manage the effects of aging. Any specific changes that may lead to environmental impacts should be identified and discussed in detail.

The programs for managing aging of systems, structures and components at BFN are described in the body of the BFN License Renewal Application. The evaluation of systems, structures and components required by 10CFR54.21 identified some new inspection activities necessary to continue operation of BFN during the 20-year renewed license period of operation. These activities are also described in the body of the BFN License Renewal Application. The additional inspection activities are consistent with normal plant component inspections, and therefore are not expected to cause significant environmental impact. The majority of the aging management programs are existing programs or modest modifications of existing programs.

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E.3.4 EMPLOYMENT

> Provide current estimates of full-time and occasional onsite (refueling) employment. Provide projections of the incremental onsite work force required for major refurbishment activities or outages associated with license renewal. The employment figures for refurbishment and outages should be presented by the month. Provide projections of any changes anticipated in the full-time and occasional work force during the license renewal term and identify changes in the work force arising from changes in SMITTR activities. For refurbishment and for the renewal term, estimate the number of temporary and permanent in-migrating incremental workers and their dependents, including school-age children, and their anticipated residential distribution.
>
> Provide an estimate of the indirect employment resulting from changes in the full-time and the temporary work forces. This section should address any employment multipliers that were used and the source or sources of the multipliers, with any additional information needed to verify the appropriateness of the multipliers. Using an estimate of average household size for the region, estimate the change in total population associated with license renewal.
>
> Estimate the residential distribution of the total (direct and indirect) incremental permanent and temporary populations by government jurisdiction or community (e.g., county, city, or town). Absent better assumptions, it may be assumed that the residential pattern will be the same as that of the current and occasional work force.

Current Plant Employment

As of August 2003, which did not have a refueling outage, the total number of people on site was 3510. This includes 1297 for operation of Units 2 and 3 (936 permanent TVAN; 75 non-TVAN TVA persons assigned to BFN (such as Transmission, Medical, Information Systems, etc.); and 286 contractors) and 2213 for Unit 1 recovery (24 TVAN and 2189 contractors).

Refueling Outage Employment

Figure E.3-1 illustrates the rise in site employment (exclusive of Unit 1 recovery personnel) at BFN for the most recent BFN refueling outage in February 2003, which was a typical refueling outage. The number of refueling outage contractors rises and falls dramatically in a short period of time (in preparation for, conduct of, and recovery from the outage), peaking at approximately 900. There are also some (usually <100) TVA employees loaned to BFN from other TVAN locations for the outage.

At the same time, the number of TVA (TVAN + non-TVAN TVA) employees permanently stationed on site remains relatively steady at about 1000, unchanged by the outage. The number of contractors supporting Units 2 and 3 for non-outage operations is also unchanged by the outage and remains steady at about 300, making a total non-outage U2/U3 headcount of 1,300.

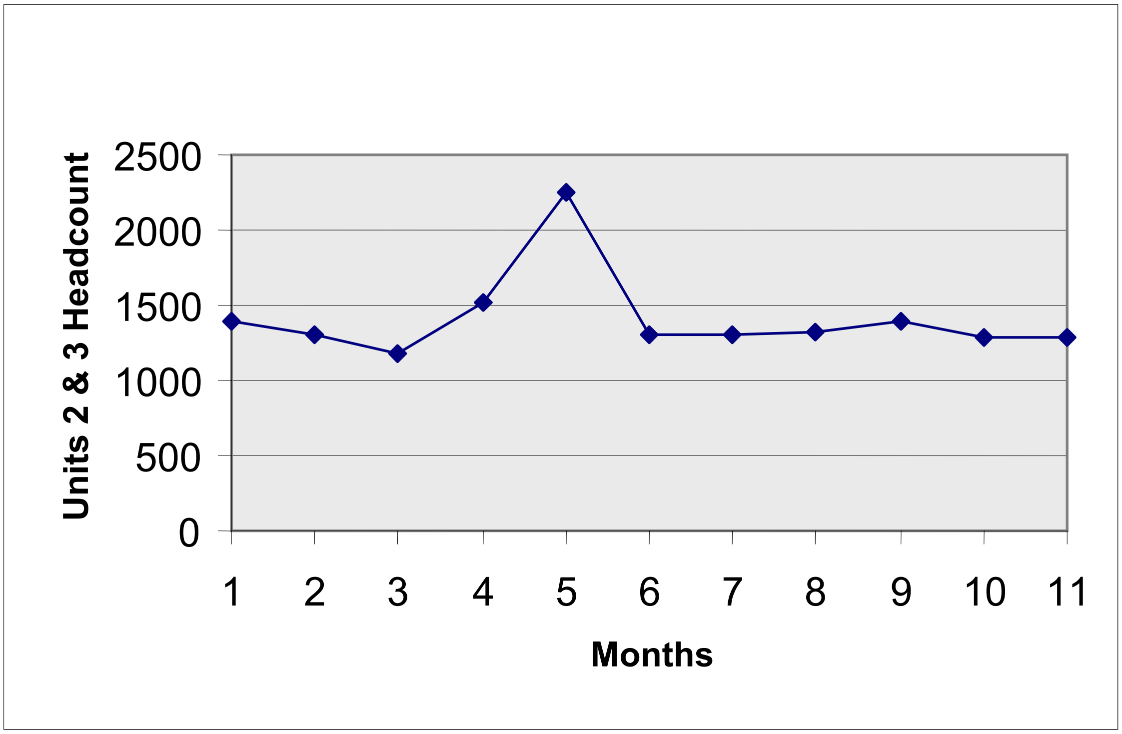

Figure E.3-1 – Rise in Headcount to Support Outage

The total Unit 1 recovery force at the time of the refueling outage was roughly 1200, almost all of which were contractors, with the remainder being a dozen or so TVAN personnel.

The total peak number of people on site during the most recent BFN outage in February 2003 was about 3487 (921 Unit 2&3 TVAN; 1173 Unit 2&3 contractors; 68 loaned TVAN for outage; 75 Non-TVAN TVA (TPS, Medical, IS, etc.); 13 Unit 1 TVAN; and 1237 Unit 1 contractors).

Currently, future plans for outages when there are three units in operation call for Units 2 and 3 to have spring outages in alternate years, and Unit 1 to have a fall outage every other year. In other words, two units would refuel in the same year (one in the spring, one in the fall) and the remaining unit would refuel in the spring of the following year.

Refurbishment

Figure E.3-2 below shows the actual-to-date and projected BFN Unit 1 recovery manpower at the site, including both contractors and TVAN personnel. Staffing for plant refurbishment would require a peak employment level of approximately 2,460 workers in January 2004, including 2,435 contractors and about 25 TVAN persons stationed at BFN. The largest numbers (over 2,000) would last about 30 months, while the construction project would last about six years in total. An on-site staffing level of at least 1,500 would be maintained over approximately three years. The off-site design staff has had approximately 100 workers for about two years, located mainly at contractor home offices, not in Alabama, but will drop to near zero before 2004

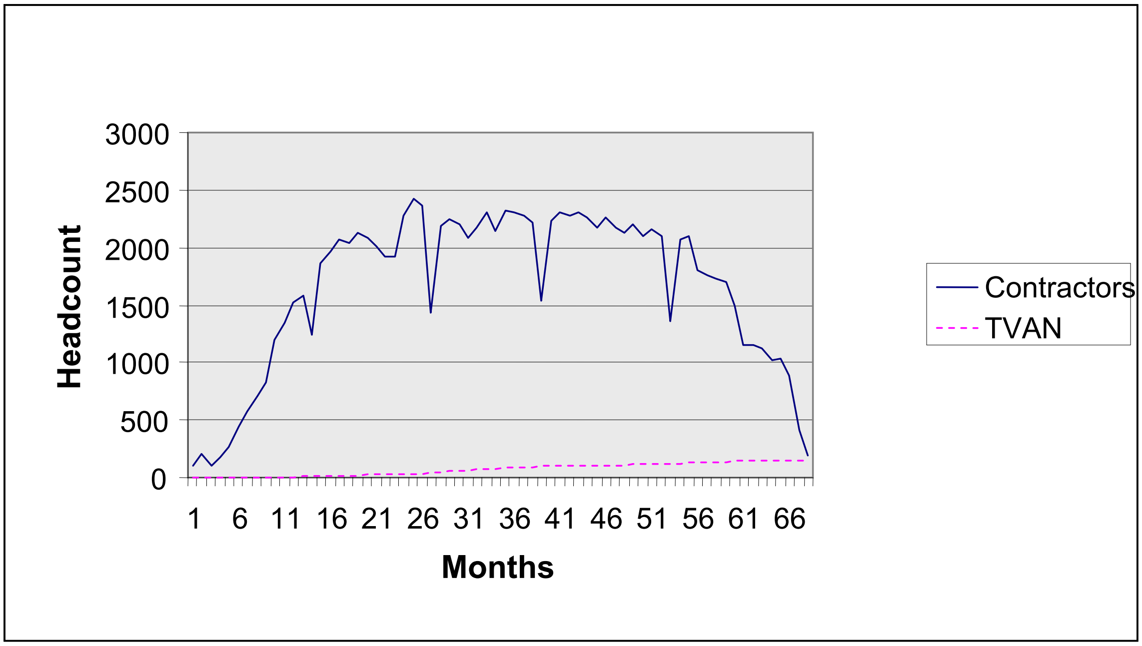

Figure E.3-2 – Unit 1 Recovery Employment

As shown in the above graph, the number of on-site TVAN personnel associated with Unit 1 recovery and operation starts out small but grows steadily to a permanent staff addition of 150 workers. There are four “dips” in the contractor headcount curve; these occur during the annual refueling outages (each unit refuels on a two-year cycle) when some of the Unit 1 recovery contractors are “borrowed” to (temporarily) support outage activities. Note that by itself, Unit 1 refurbishment and recovery is not expected to require any special outages on Unit 2 (or Unit 3); all work needed is projected to fit into the regular outage plans for Unit 2.

As discussed in Section E.2.6, the vast majority of contract workers currently engaged in refurbishment activities are residing in the six county primary labor market area immediately around the site, as do the permanent employees at the site. These six counties constitute the Huntsville, Decatur, and Florence metropolitan areas. Based on this and on other TVA construction experience, it is expected that a similar pattern will continue for future construction activities. Some workers will commute from outside this primary labor market area, including the Birmingham and Nashville areas. The current residential patterns indicate that the impacts would be scattered throughout the primary labor market area, minimizing the impacts on any one local area or local government.

TVA experience at this site and at other construction sites indicates that it is likely that less than one-third of the workers at the site would be movers, i.e., persons who would move from outside the area to the area in order to work at the site. As discussed above, the highest level of employment at the site for refurbishment would be about 2,500, resulting in an estimated maximum of about 830 movers. Based on recent experience, the likely residential location of these movers would be as follows:

County	Number of Movers
Lauderdale	208
Limestone	166
Madison	141
Morgan	108
Colbert	91
Lawrence	33
Other	83

Estimates produced by TVA's regional economic model for the north Alabama area (the model is developed by and rented from REMI, Amherst, MA) estimates an employment multiplier of 1.6 for this area. This means that a sustained level of 2,200 workers at the site for 2½ years would result in an additional 1,500 jobs created in the area as a result of the multiplier effects arising from the site employment. It is likely that the residential location of these workers would be similar to that of the workers at the plant. However, it is likely also that most of these workers would already reside in the area, and so no significant increase in the population of the area would result from these multiplier effects.

The sustained employment level of 2,200 for site refurbishment would be about 7.8% of Limestone County's current employment level, or 0.7 % of the primary labor market area employment. The income earned by 2,200 on-site workers would represent approximately the same percent of annual earnings in Limestone County and the primary labor market area (and many of these workers would reside outside Limestone County).

Some workers who would move into the area in order to work at the site would bring families with them, although not all would. Past experience at TVA sites indicate that about 65 to 85 percent of movers relocate their families. Based on this, with 830 movers, as discussed above, the total impact on population would be an increase of close to 2,100 persons. This is about 3.2 percent of the current population of Limestone County, and only about three-tenths of one percent of the population of the primary labor market area. The estimated number of dependents would be 1,244, consisting of about 622 spouses and about the same number of children, of which about 460 would be school-age; their residential location would be similar to that of all movers.

Once Unit 1 is recovered, no further refurbishment is necessary for continuing operation of the units through the renewed license period; consequently, there are no associated employment impacts.

Additional staffing to operate Unit 1

Operation of Unit 1 in addition to Units 2 and 3 would require an increase of about 150 workers above the current operational level for Units 2 and 3. Earnings of these workers would represent about 0.7% of Limestone County annual earnings and 0.1% of area earnings. The result would be beneficial, albeit relatively minor, effect on income in Limestone County and the broader labor market area.

It is expected that these workers would locate in a pattern very similar to that of current workers at the site. In that case, the distribution would be as follows:

County	Number of Workers
Lauderdale	38
Limestone	30
Madison	25
Morgan	20
Colbert	16
Lawrence	6
Other	15

No further changes to site staffing are currently anticipated during the renewed license period.

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E.4.0 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION AND MITIGATING ACTIONS

NUREG-1437 analyzed 92 environmental issues for license renewal and reached conclusions about the impacts of refurbishment and operation during the license renewal period. For most issues, the GEIS concluded that the impacts were such that the issue met the definition of Category 1 (refer to Table B-1 in Appendix B to Subpart A of 10 CFR Part 51). Part 51 does not require the ER to contain any analyses of Category 1 issues; however, the rule requires that licensees report on any new and significant information that may bear on the applicability of conclusions of NUREG-1437 on Category 1 issues at their plants or on issues not previously identified. The definition of and the process for identifying new and significant information is provided in the Introduction section of this regulatory guide. The applicant may adopt the findings for the codified Category 1 issues, unless the need for additional analysis is triggered by knowledge of new and significant information. Such analysis should be developed according to Section 4.3, "Assessment of New and Significant Information," of this guide.

The sequence of the Category 2 issues covered in this section follows that of Table B-1 in Appendix B to Subpart A of 10 CFR Part 51. Reference is also made to the specific requirements stated in 10 CFR 51.53(c)(3)(ii). The steps for reviewing each Category 2 issue are (1) using the criteria given in 10 CFR 51.53(c)(3)(ii), determine whether the issue is applicable to the plant, (2) if not applicable, provide a short statement on the rationale, and (3) if the issue is applicable, provide the information and analysis specified in the appropriate section below. The information and analysis should be sufficient to determine the size and extent of the impacts associated with the issue and the significance of the impacts as defined in the Impacts Findings section above.

Impacts may be adverse or beneficial and of small, moderate, or large significance. These impact significance levels are defined in Table B-1 of 10 CFR Part 51 and in NUREG-1437 and are explained in the Introduction to this guide.

Direct, indirect, and cumulative effects should be analyzed. The cumulative or indirect effects of the action may be of moderate or large significance even when the direct effect is of small significance. These effects are defined in the Introduction to this guide.

Mitigation measures to eliminate or reduce the level of adverse impacts should be considered for each Category 2 issue. The applicant's effort to identify possible mitigation measures and assess the efficacy of those measures should be in proportion to the significance of the impact. If no suitable mitigation measure is identified, the basis of that finding should be provided. For suitable mitigation measures, the applicant should describe the benefits and costs of each of the measures and indicate which measures, if any, would be implemented if the license is renewed. If suitable mitigation measures will not be implemented, the applicant should explain the rationale. Mitigation measures are defined in the Introduction to this guide.

This section presents an assessment of the environmental consequences and potential mitigating actions associated with the operating licenses renewal process for BFN. The assessment references NRC's *Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS)* (NRC 1996). The GEIS identified and analyzed 92 environmental issues that the NRC considered to be associated with nuclear power plant operating license renewal. As part its analysis, the NRC designated each of the 92 issues as Category 1, Category 2, or NA (not applicable) and required plant-specific analysis of on the Category 2 issues.

An issue was designated as Category 1 if, based on the results of the NRC's analysis, the following criteria were met.

- The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic;

- A single significance level (i.e., small, moderate, or large) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal); and

- Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

NRC rules do not require analysis of Category 1 issues because NRC resolved them and presented generic finding in 10 CFR51, Appendix B, Table B-1. An applicant may reference the generic findings or GEIS analyses for Category 1 issues.

If the NRC analysis concluded that one or more of the Category 1 criteria could not be met, the issue was assigned as Category 2. The NRC does required plant-specific analyses for Category 2 issues.

The NRC designated two issues as "NA", signifying that the categorization and impact definitions do not apply to these issues. The first of these issues was the chronic effects of electromagnetic fields. The findings of the NRC was, "Biological and physical studies of 60-HZ electromagnetic fields have not found consistent evidence linking harmful effects with field exposures. However, because the sate of the science is currently inadequate, no generic conclusion on human health impacts is possible." It was also noted that if, in the future, the NRC finds that, contrary to current indications, a consensus has bee reached by appropriate Federal health agencies that there are adverse health effects from electromagnetic fields, the NRC will require applicants to submit plant-specific reviews of these health effects as part of their license renewal applications. Until such time, applicants for license renewal are not required to submit information on this issue.

The second issue designated as "NA" was environmental justice. Environmental justice was not addressed in NUREG-1437 because guidance for implementing Executive Order 12898 issued on February 11, 1994, was not available prior to the completion of NUREG-1437. The issue of environmental justice is to be addressed in the plant-specific reviews.

The analyses of the NRC resulted in 21 issues being designated as Category 2 issues. Each of these issues is addressed in sections 4.1 through 4.22. Analyses are provided for the 18 Category 2 issues that TVA has determined to be applicable to BFN. These analyses provide a conclusion of the significance of the impacts relative to renewal of the operating licenses for BFN. When applicable, these analyses also discuss potential mitigating actions to the extent required. TVA has identified the significance of the impacts associated with each issue as being Small, Moderate, or Large. This is in keeping with the criteria established in 10 CFR 51, Appendix B, Table B-1, Footnote 3 as follows:

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

- MODERATE – For the issue, environmental effects are sufficient to alter noticeable, but not to destabilize, important attributes of the resource.

- LARGE – For the issue, environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

In accordance with National Environmental Policy Act practice, TVA considered ongoing and potential mitigation in proportion to the significance of the impact to be addressed (i.e., impacts that are small receive less mitigation consideration than impacts that are large).

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E.4.1 WATER USE CONFLICTS

> This section applies to plants with cooling ponds or cooling towers using makeup water from a small river with low flow.
>
> Table B-1 notes that the impacts of this issue are anticipated to be small or moderate and that
>
> > The issue has been a concern at nuclear power plants with cooling ponds and at plants with cooling towers. Impacts on instream and riparian communities near these plants could be of moderate significance in some situations.
>
> Specifically, 10 CFR 51.53(c)(3)(ii)(A) requires, in part, that
>
> > If the applicant's plant utilizes cooling towers or cooling ponds and withdraws makeup water from a river whose annual flow rate is less than 3.15×10^{12} ft^3/year (9×10^{10} m^3/year), an assessment of the impact of the proposed action on the flow of the river and related impacts on instream and riparian ecological communities must be provided.
>
> This issue is discussed in Sections 4.3.2.1 and 4.4.2.1 of NUREG-1437.
>
> If the plant takes its makeup water for the cooling towers or cooling ponds from a river with an annual flow greater than 3.15×10^{12} ft^3/year (9×10^{10} m^3/year), the licensee should report this fact. The method used to determine the annual flow should be provided and explained, and no further information is needed with reference to these issues. If the plant does not meet the above conditions, the information and analysis described below in Sections 4.1.1 and 4.1.2 must be responsive to the requirements of 10 CFR 51.53(c)(3)(ii)(A) specified above.

<u>Water Use at BFN</u>

The BFN units are normally cooled by water pumped from Wheeler Reservoir into the turbine- generator condensers and discharging it back to the reservoir via large submerged multiport diffuser pipes that are designed to maximize mixing of the effluent into the receiving water. This straight-through flow path is known as the “open cycle” or “open mode” of operation. By manipulating various gates, most of this cooling water can also be directed through cooling towers to reduce its temperature as necessary to comply with environmental regulations; this flow path is known as the “helper mode.” The physical capability also exists to recycle the cooling water from the cooling towers directly back to the intake structure without being discharged to the reservoir; this flow path, known as the “closed mode” of operation, has not be used in recent years due to difficulties in meeting temperature limits in summer months and also problems with equipment reliability.

For all three units operating simultaneously in the open mode, the total BFN intake flow rate, consisting of the condenser circulating (i.e., cooling) water (CCW) intake flow rate (with all 3 CCW pumps per unit) plus various smaller intake flow rates to plant auxiliaries, originally was expected to total 1,980,000 gallons per minute (GPM). This is 2,851.2 million gallons per day (MGD), which when combined with miscellaneous other minor effluent flows became the 2,855 MGD in the application TVA submitted for the National Pollutant Discharge Elimination System (NPDES) Permit of July 10, 1984.

In recent years, BFN has operated with only Units 2 and 3, but due to a combination of system upgrades and improved flow calibrations the measured total per-unit CCW flow rate in the open mode (with 3 condenser circulating water pumps per unit) has increased. For example, the condensers were re-tubed with stainless steel tubing having a larger internal diameter and decreased flow resistance, which increased flow approximately 6%. The most recent total intake flow reported to the Alabama Department of Environmental Management (ADEM) in the monthly Discharge Monitoring Report and to the Alabama Department of Economic and Community Affairs in the Annual Certificate of Use Report is 2,114 MGD (approximately 734,000 GPM or 1,635 cfs per unit). With the return of Unit 1 (which will also be re-tubed), the total intake flow would then become approximately 3,171 MGD (4,907 cfs), which represents an increase over the previous high reported number (2,855) of 11%. This value may be known with greater certainty as more accurate means of measuring flow become available, but it is not expected to change significantly throughout the term of the renewed licenses.

When operating in the helper mode, however, due to various system limitations, BFN cannot put all the condenser cooling water through the cooling towers. The maximum practical throughput for the six cooling towers is 3,685 cfs, and remaining flow bypasses the cooling towers and goes directly to the river. Almost all of the cooling tower flow is also returned to the river, but there is a small amount lost into the air during operation. Between evaporation and "drift" these losses can approach 2% of the total cooling tower flow, or 0.02 x 3,685 = 73.7 cfs. If cooling tower capacity is increased during the term of the renewed licenses this consumptive use could increase proportionately. The cooling towers are only operated when necessary to meet thermal discharge temperature limits specified in the NPDES permit, typically a few weeks during the hottest part of the summer (usually July and August).

Although most of the intake water is used for condenser cooling, a small amount (~3%) of it is used for other plant uses such as emergency equipment cooling water, residual heat removal service water, raw cooling water, fire protection, and raw service water systems. Almost all of this water is ultimately returned to the river, either directly or indirectly through leakage drains. The only consumption of this water at the site would be from a negligible and unquantifiable amount of evaporation wherever the water is exposed to air.

BFN also consumes a relatively small amount of river water for use in making highly purified or "demineralized" water for various uses in the plant that require high-grade water. Most of the demineralized water lost to various leakages in the plant is recovered and reprocessed for recycling, but some of it is lost through evaporation as it passes to floor drains and other open-air collection, and the remainder is consumed via end uses such as evaporative losses in air scrubbers, make-up for auxiliary boiler blow-down, auxiliary decay heat removal during refueling, and spent fuel pool evaporative make-up. On average this consumptive rate is approximately 1.5 million gallons per month in the summer, which is somewhat higher than the winter consumption because of running the turbine building air wash system to keep equipment operating temperatures down. This consumptive rate is equivalent to 0.077 cfs.

Because of aggressive filtration and reprocessing of its various liquid radwaste sources for recycling, BFN is very close to being a "zero discharge plant" in terms of radioactively contaminated water discharges to the river. Exceptions are infrequent, and are generally the result of an unusual activity such as disposal of the large low-activity volume of water resulting from draining the Unit 1 suppression pool for refurbishment. The only contaminated water which is not either recycled or returned to the river would be insignificant amounts associated with contaminated materials such as spent resins.

Wheeler Reservoir Flow Rate

TVA maintains hourly water records for the flow released from Guntersville Dam and Wheeler Dam. Each dam includes hydro turbines and a spillway. The flow through each hydro turbine is determined based on a pressure differential measured between two pressure taps located in the turbine scroll case. The flow through each spillway gate is determined based on the measured gate opening and depth of water behind the gate. The total flow at each site is obtained by summing the flow from all the hydro turbines and spillway gates at the site.

Using an unsteady flow model of Wheeler Reservoir, the releases from Guntersville Dam and Wheeler Dam were used to compute the hourly flow in Wheeler Reservoir at Browns Ferry (e.g., see TVA, 1977). TVA analyzed these data to obtain a time series of the daily average flow for years 1976 through 2002. For this period, the following statistical properties are identified for the flow at Browns Ferry:

- The average daily flow was 46606 cfs.
- The maximum daily average flow was 378742 cfs and occurred on 12/26/1990.
- The minimum daily average flow was 2638 cfs and occurred on 5/27/2001.

In general, daily average flows historically have been much higher that the minimum value given above. For example, the percentages of time the daily average flows exceeded selected values are as follows:

Flow Q	Percent of Time Flow ≥ Q
2000 cfs	100.0
5000 cfs	99.7
10,000 cfs	95.6
15,000 cfs	90.1
20,000 cfs	82.1
30,000 cfs	63.9
40,000 cfs	45.3
50,000 cfs	31.5

It should be noted that target minimum flows currently used for TVA river operations were established by an Environmental Impact Statement in 1990 (i.e., see TVA 1990). The minimum daily average flows for BFN are 10,000 cfs for July through September, 8,000 cfs for December through February, and 5,000 cfs otherwise. It is emphasized that these are target minimum flows, not firm requirements imposed by a regulatory document. Even so, under normal operating conditions, events producing daily average reservoir flows as low as that observed on 5/27/2001 should be very rare.

Based on the information given above, the Tennessee River average annual flow at BFN for 1976 through 2002 equates to 1.47 X $10^{12}ft^3$/year. This is less than the 3.15 X $10^{12}ft^3$/year criterion stated by NRC in 10 CFR 51.53(c)(3)(ii)(A) as the value beneath which “an assessment of the impact of the proposed action on the flow of the river and related impacts on instream and riparian ecological communities must be provided.”

The critical time for approaching the maximum river water temperature limits specified in the BFN National Pollutant Discharge Elimination System (NPDES) Permit, and therefore requiring the use of cooling towers or plant derates, is July and August. Based on the time series data from 1976 through 2002, the average flow in Wheeler Reservoir at BFN was 34,028 cfs during July and August. During these same months and same period, the minimum daily average flow observed at BFN was 2815 cfs, occurring on 7/01/1987. Again, days of such low flows are very rare. For comparison, the "7Q10" low flow value (i.e., the lowest average flow for seven consecutive days that has an average recurrence interval of ten years) given in the rationale for the BFN NPDES permit is 8,700 cfs. The daily average flow exceeded the 7Q10 low flow value 98.6% of the time in July and 98.8% of the time in August.

In summary, the total BFN intake water flow (4,907 cfs) can in rare events encompass a significant fraction of the daily average river flow past the plant, but consumptive water uses are negligible (<100 cfs) and are expected to remain so throughout the license renewal term.

E.4.1.1 INSTREAM ECOLOGICAL COMMUNITIES

> …Information and analysis requirements for this issue may be restricted to consideration of impacts on one or a few aquatic species, as appropriate. As needed, existing and potential measures to mitigate losses of aquatic habitats from cooling water withdrawals should be described, and the effects of these measures should be estimated. The following process for developing and presenting information should be used.
>
> 1. Document any consultations with regulatory agencies … and resource agencies … related to the issue of consumptive water use and its effects on instream communities … identifying agreements that describe (a) the nuclear power plant's standing in priority for makeup water withdrawals or (b) the criteria for reducing the withdrawal of makeup water in order to protect instream habitats and aquatic biota during low-flow periods. If the regulatory and resources agencies concur that these agreements or criteria are sufficiently protective of instream communities, further considerations of the issue of effects of water use conflicts on instream communities may be omitted. If further analysis of water use conflicts is needed, and consultation with regulatory and resource agencies indicates concerns about only one or a few aquatic species, the information and analysis required in the following items may be restricted to only that needed to address effects on those species. Identify and unambiguously define the resource or resources of concern.

BFN has a water withdrawal permit (Certificate of Use No. OWR - 1058) issued by the Alabama Department of Economic and Community Affairs, Office of Water Resources, and renewed every 5 years. It names the facility (BFN), water source (Wheeler Lake), location (34°42'15.00"/ 87°07'15.00'), maximum capacity of "water withdrawn, diverted, or consumed" (2,312.1 MGD) and average daily use (2,206.3 MGD). Prior to license renewal efforts there have been no other consultations with regulatory agencies regarding water consumption or impacts of consumptive water use. Consumptive and off-stream water uses have not resulted in significant use problems or conflicts due to the large volume of reservoir water available, the high river flow rate, and the return of almost all of the water withdrawn.

> 2. Describe the fish and shellfish community in the source water body ... Lists of species and estimates of the numbers of fish and shellfish that are present in the portion of the water body affected by consumptive water use should be included. The distribution and value of commercial and sport fisheries should be discussed. The locations of important habitats for fish and shellfish (e.g., spawning areas, nursery grounds, feeding areas, wintering areas, and migration routes) within the area affected by consumptive water use should be fully described.

TVA has conducted extensive sampling of the fish community in the vicinity of BFN and elsewhere in Wheeler Reservoir in recent years, both in monitoring programs conducted specifically for BFN (Baxter and Buchanan, 1998), and as part of TVA's Reservoir Monitoring Program (Dycus and Baker, 2000). A total of 60 species (excluding hybrids) has been collected in recent years by various sampling methods (Table E.2-2).

Cove rotenone samples were collected annually from 1969 through 1997 as a component of the TVA environmental monitoring program for BFN, to provide a database on the fish community in the vicinity of BFN, and later to serve as a part of the thermal variance monitoring program. In more recent samples, 52 species were collected in 1995; 45 species in 1996; and 43 species in 1997. Annual standing stock estimates were 105,655 fish/hectare (ha) and 683 kilograms per hectare (kg/ha) in 1995 and decreased to 11,713 fish/ha and 366 kg/ha in 1996, then increased to 24,497 fish/ha and 489 kg/ha in 1997. As usual, forage fish were numerically dominant in samples, and also dominated biomass estimates in 1995 and 1996, but rough fish were highest in biomass in 1997. Gizzard shad exhibited the highest biomass during all three years, followed by threadfin shad in 1995 and smallmouth buffalo in 1996 and 1997 (Baxter and Buchanan, 1998).

TVA began a program to systematically monitor the ecological conditions of its reservoirs in 1990. Previously, reservoir studies had been confined to assessments to meet specific needs as they arose. Reservoir (and stream) monitoring programs were combined with TVA's fish tissue and bacteriological studies to form an integrated Vital Signs (VS) Monitoring program. VS monitoring activities focus on:

- Physical/chemical characteristics of waters;
- Physical/chemical characteristics of sediments;
- Benthic macroinvertebrate community sampling; and
- Fish assemblage sampling.

Fish are included in aquatic monitoring programs because they are important to the aquatic food chain and because they have a long life-cycle, which allows them to reflect conditions over time. Fish are also important to the public for aesthetic, recreational, and commercial reasons (Dycus and Baker, 2000).

Fish samples were taken in three areas of Wheeler Reservoir from 1990 through 1995, and again in 1997 and 1999 as part of TVA's VS monitoring program. Areas sampled included the forebay transition, and inflow stations. Although any fish species known from elsewhere in the reservoir could occur in the vicinity of BFN, results of sampling at the transition station are presented here because they are more representative of fish communities in the vicinity of BFN.

Reservoir Fish Assemblage Index (RFAI) ratings are based primarily on fish community structure and function. Also considered in the rating are the percentage of the sample represented by omnivores and insectivores, overall number of fish collected, and the occurrence of fish with anomalies such as diseases, lesions, parasites, deformities, etc. Compared to other similar Tennessee River reservoirs, the fish assemblage at the Wheeler mid-reservoir station (TRM 295.9) rated poor in 1992 and 1999, fair in 1990, 1991, 1995, and 1997, and good in 1993 and 1994. In the fall of 2000, additional (i.e., not on the regular RFAI monitoring schedule) electrofishing and gill net samples were taken at the transition station (TRM 295.9) and a newly-established sampling station for BFN monitoring at TRM 292.5. A total of 30 fish species (excluding hybrids) was collected; the fish assemblage rated good at TRM 292.5 and fair at TRM 295.9 (Table E.2-2) (Dycus and Baker, 2001).

As mentioned, BFN is located on Wheeler Reservoir, which TVA classifies as a run-of-the-river reservoir. Run-of-river reservoirs typically have short water retention times (one to two weeks) and little winter drawdown. Benthic habitats in the reservoir range from deposits of finely divided silts to river channel cobble and bedrock. The most extensive benthic habitat is composed of fine-grained brown silt, which is deposited both in the old river channel and on the former overbank areas. The overbank areas, on either side of the old river channel, are far more extensive than the channel and are the most productive (TVA, 1972a). These overbanks, located directly across from BFN, extend approximately two miles downstream. The overbanks support communities of Asiatic and fingernail clams, burrowing mayflies, aquatic worms, and midges. Cobble and bedrock areas, found primarily in the old channel, support Asiatic clams, bryozoa, sponges, caddisflies, snails, and some leeches. The Asiatic clam is nonindigenous to North America and is common in the Tennessee River system.

TVA began a program entitled VS monitoring to systematically monitor the ecological condition of its reservoirs in 1990. Benthic macroinvertebrates are included in VS monitoring because of their importance to the aquatic food chain, and because they have limited capability of movement, thereby preventing them from avoiding undesirable conditions. Since 1995, VS samples have been collected in the late fall/winter (November - December). Depending on reservoir size, as many as three stations are sampled (i.e., inflow, transition, and forebay).

Benthic macroinvertebrate VS monitoring data are analyzed using metrics. The number of metrics has varied through the sample years as reservoir benthic analysis has been fine-tuned. The most recent analysis is comprised of nine metrics: taxa richness, EPT (Ephemeroptera, Plecoptera, Trichoptera) taxa, long-lived taxa, non-chironomid and oligochaete density, percent oligochaete, dominant taxa, zero samples, non-chironomid and oligochaete taxa, and chironomid density. The number derived for each metric is totaled and the score is applied to a range of values that identify the overall condition of the benthic community (i.e., very poor, poor, fair, good, or excellent).

BFN is located a short distance downstream from the VS transition station on Wheeler Reservoir (TRM 295.5). The transition station is the zone considered to be between riverine (the inflow station) and impoundment habitats (the forebay station). Benthic community scores at the transition station ranged from “excellent” in 1994 to “good” in 1995 and “excellent” again in 1997 and 1999 (Dycus and Baker, 2000).

In addition to VS benthic macroinvertebrate monitoring, benthic community sampling in support of BFN thermal variance monitoring was begun in the fall of 2000 (and will continue at least for the term of the current permit cycle - five years). Station locations are TRM 296 and TRM 292, upstream and downstream of the BFN diffusers respectively. An analysis of the 2000 sample year data indicated the benthic community above BFN diffusers was in “excellent” condition and the community below the diffusers was in “good” condition (Dycus and Baker, 2001).

Freshwater mussel are excellent indicators of water quality due to their sessile nature and inability to avoid perturbations impacting water quality. Mussels feed on microorganisms (protozoans, bacteria, diatoms) and organic particles suspended in the water that are brought into the body via siphon action and consumed.

Thirty-eight freshwater mussel species had been documented in Wheeler Reservoir through 1991 (Ahlstedt and McDonough, 1993). Twelve species were identified in the vicinity of BFN during a 1982 survey for a proposed barge facility (Henson and Pryor, 1982). Most recently (1999), Alabama Division of Wildlife and Freshwater Fisheries (ADWFF) identified 14 species upstream of BFN and 12 species downstream (Garner, 2001). A listing of these species appears in Table E.2-3.

A nonindigenous water flea, *Daphnia lumholtzi*, has been documented throughout the Tennessee River system (Baker, 2001). It is therefore expected to occur in Wheeler Reservoir.

Nine occurrences of the freshwater jellyfish (*Craspedacusta sowerbyi*), a species probably introduced from China, were documented in the vicinity of Browns Ferry in 1980 and 1981 (Yeager 1987). Its presence in ichthyoplankton samples was documented throughout most of the TVA reservoir system between 1978 and 1985. It is assumed this introduced species continues to occur in the vicinity.

Nonindigenous Asiatic clam and zebra mussel (*Dreissena polymorpha*) populations in Wheeler Reservoir would not be prone to exacerbation or extirpation due to BFN's thermal discharge. Thermal discharge limits permitted by Alabama Department of Environmental Management (ADEM) would not exceed thermal thresholds of both organisms. Asiatic clams cannot survive extreme ambient water temperatures less than 36°F (2.2°C) and greater than 95°F (35°C). Thermal tolerance of Zebra mussels is 32°F to 98.6°F (Nalepa and Schloesser, 1993). Potential biofouling by zebra mussels would actually be reduced by thermal addition as mortality of 60 percent was reported by Nalepa and Schloesser, (1993) at 89.6°F. BFN treats its raw water intake biannually with molluscide to control biofouling by Asiatic clams and zebra mussels. In addition, biweekly raw water samples are analyzed during April through October for zebra mussel veligers as an early warning for potential biofouling.

Grass carp have been introduced to reservoirs in the TVA system, both by individuals seeking to control heavy infestations of aquatic vegetation, and by TVA in Guntersville Reservoir. Grass carp have not been collected in high numbers; they were not included in cove rotenone samples taken through 1997, and have been taken infrequently in reservoir monitoring gill net and electrofishing samples (Table E.2-2).

Neither the Alabama Division of Wildlife and Freshwater Fisheries (ADWFF) (Nichols, 2002) nor TVA have a formal protocol for tracking commercial fisheries. Important commercial fish species known from Wheeler Reservoir include blue, channel, and flathead catfish, buffalo species and carp (Floyd, 2003). Important sport fish known from Wheeler Reservoir include largemouth bass, black crappie, white crappie, bluegill, longear sunfish, redear sunfish, sauger, white bass, yellow bass, and yellow perch. The ADWFF supplements the Wheeler Reservoir sport fishery by stocking Gulf Coast and Atlantic strain striped bass and Florida strain largemouth bass (Nichols, 2002).

A team of biologists, including representatives from TVA and state fishery resource agencies in the Tennessee Valley, developed an index to quantify sport fishing quality for individual sport fish species. The Sport Fish Index (SFI) provides biologists with a reference point. Comparison of the population sampling parameters and creel results for a particular sport fish species with expectations of these parameters from a high quality fishery (reference conditions) allows for the determination of fishing quality. To date, indices have been developed for black bass (largemouth, smallmouth and spotted), crappies (black and white combined); walleye; sauger; channel catfish; striped bass, and bluegill. Each SFI relies on measurements of quantity and quality aspects of angler success and fish population characteristics. In recent years, SFI information has been used to describe the quality of the resident sport fishery in conjunction with compliance monitoring, thermal variance requests, and other regulatory issues at TVA generating facilities in Tennessee. Similar NPDES compliance monitoring programs using the methodologies described above are also being performed at Colbert and Widows Creek Fossil Plants in Alabama.

In utilizing the SFI methodology, calculations described by Hickman (2000) were used to compare SFI values for selected quantity and quality parameters from creel and population samples to expected values that would occur in a good or high quality fishery. Quantity parameters include angler success and catch per unit effort from standard population samples (electrofishing, trap and experimental gill netting). Population quality is based on measurement of five aspects of each resident sport fish community. Four of these aspects address size structure (proportional number of fish in each length group) of the community, Proportional Stock Density (PSD), Relative Stock Density of Preferred-sized fish (RSDP), Relative Stock Density of Memorable-sized fish (RSDM), and Relative Stock Density of Trophy-sized fish (RSDT) (Figure E.4-1). Relative weight (Wr), a measure of the average condition of individual fish makes up the fifth population quality aspect.

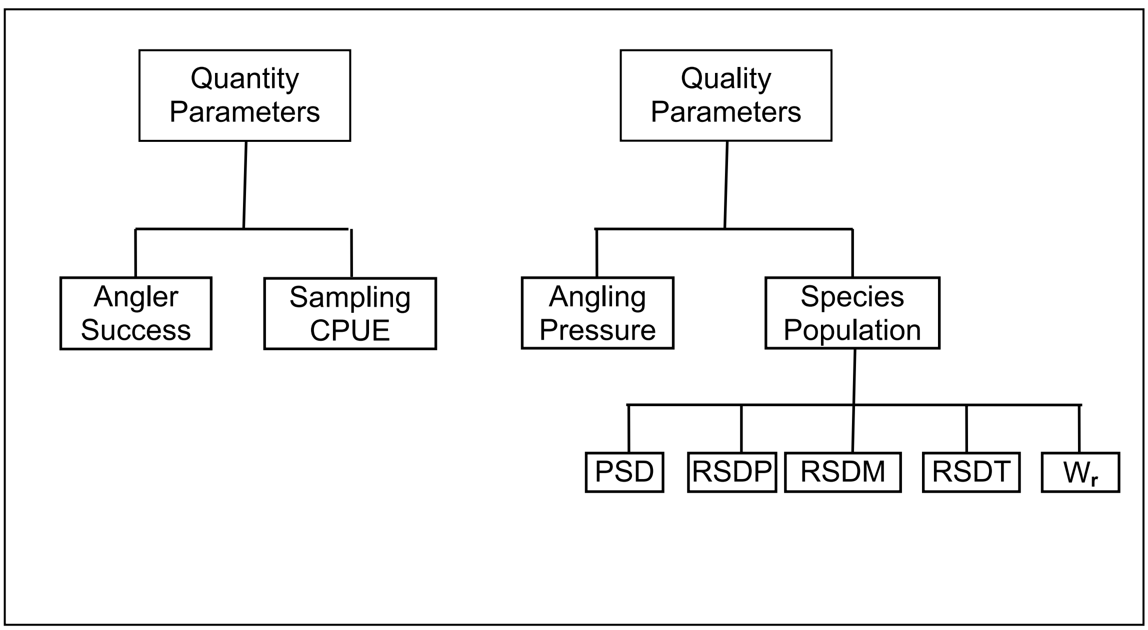

Figure E.4-1 – Parameters used to calculate the Sport Fish Index (SFI).

As described by Hickman (2000), observed values were compared to reference ranges and assigned a corresponding numerical value. The SFI value is calculated by adding up the scores for quantity and quality from existing data and multiplying by two when only creel or population data are available. Species received a low score when insufficient numbers of individuals were captured to reliably determine proportional densities or relative weights for particular parameters.

In the autumn of 2002, Wheeler Reservoir's black bass received a lower SFI score than in 2001 (Table E.4-1 and Figure E.4-2). This is only one year's dataset and not indicative of a trend. If future scores would continue to decline, further investigation would be warranted. Sauger, bluegill, and channel catfish fisheries received either their highest SFI scores to date or matched their highest scores in 2002; striped bass were not collected in sufficient numbers to analyze (Table E.4-1 and Figure E.4-2). Tables E.4-2 and E.4-3 illustrate sport fish index scoring criteria for population metrics and creel quantity and quality.

Table E.4-1 – Sport Fish Index Results for Wheeler Reservoir, 2002

	Year						
Species	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**1997-2002 Average SFI Score**
Black bass	36	37	50	46	51	38	43
Largemouth bass	34	34	50	28	42	34	37
Smallmouth bass	44	28	52	44	40	36	41
Spotted bass	20	20	20	20	44	42	28
Sauger	36			20	26	42	31
Striped bass	20			20	24		21
Bluegill	20			24	26	26	24
Channel catfish	24			20	24	28	24

Sauger population estimates based on cove rotenone data have increased annually since 1988 in Wheeler Reservoir. The 1994 sauger population estimate (38 fish/ha) and the estimated number of young-of-year (35 fish/ha) were the second highest reported for each category during the 1969-1997 time period. In 1997, the last year rotenone data were collected, Wheeler Reservoir sauger population averaged 5.6 fish/ha (Baxter and Buchanan 1998).

Hickman et al., (1990) noted that sauger populations across the Tennessee Valley declined during the mid- to late-1980's due to a prolonged drought. The Tennessee Valley is currently in another drought cycle and populations may decline further. Maceina et al., (1998) described population characteristics and exploitation rates of sauger during 1993-1995 in Guntersville, Wheeler, and Wilson Dam tailraces. Maceina reported that total annual mortality between age-1 and age-2 fish was high (64 percent-83 percent) and that sauger were harvested at high rates before reaching their full growth potential.

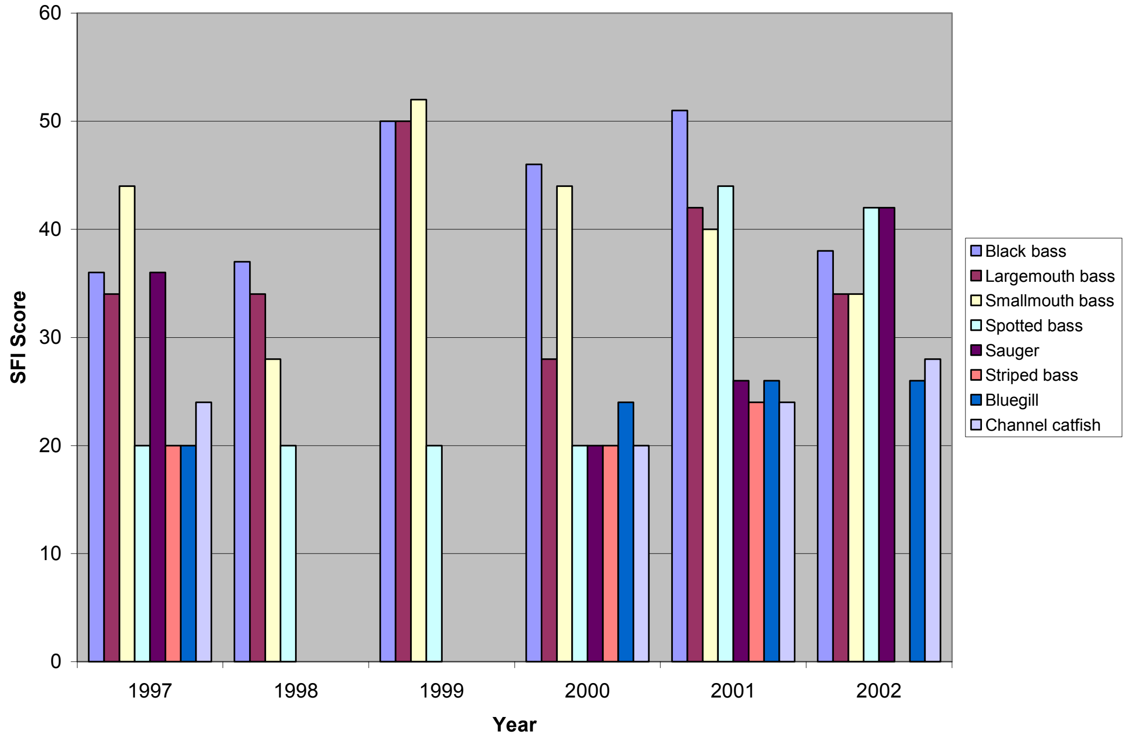

Figure E.4-2 – Sport Fish Index results for Wheeler Reservoir between 1997 and 2002.

Sauger and striped bass are easily caught during their spawning migrations to preferred spawning habitats. Creel surveys conducted in the spring would better quantify and evaluate these species compared to only using TVA's autumn fisheries monitoring.

Table E.4-2 – Sport Fish Index Population Quantity and Creel Quantity and Quality Metrics and Scoring Criteria

Metrics	**Scores** 5	10	15
Black bass			
Population (quantity)			
TVA electrofishing catch/hour	< 15	15-31	> 31
State electrofishing (catch/hour)	< 62	62-124	> 124
Creel (quantity)[a]			
Anglers (catch/hour)	< 0.3	0.3-0.6	> 0.6
BAIT and BITE data	< 1.1	1.1-2.3	> 2.3
Creel (quality)			
Pressure (hours/acre)	< 8	8-16	> 16

Table E.4-2 (cont.) – Sport Fish Index Population Quantity and Creel Quantity and Quality Metrics and Scoring Criteria			
Metrics	**Scores**		
	5	**10**	**15**
Largemouth bass			
Population (quantity)[b]			
TVA electrofishing catch/hour	< 13	13-25	> 25
State electrofishing (catch/hour)	< 53	53-106	> 106
Creel (quantity)			
Anglers (catch/hour)	< 0.29	0.29-0.58	> 0.58
Creel (quality)			
Pressure (hours/acre)	< 8	8-16	> 16
Smallmouth bass			
Population (quantity)			
TVA electrofishing catch/hour	< 4	4-8	> 8
State electrofishing (catch/hour)	< 8	8-15	> 15
Creel (quantity)			
Anglers (catch/hour)	< 0.1	0.1-0.3	> 0.3
Creel (quality)			
Pressure (hours/acre)	< 8	8-16	> 16
Spotted bass			
Population (quantity)			
TVA electrofishing catch/hour	< 5	5-11	> 11
State electrofishing (catch/hour)	< 14	14-27	> 27
Creel (quantity)			
Anglers (catch/hour)	< 0.07	0.07-0.13	> 0.13
Creel (quality)			
Pressure (hours/acre)	< 8	8-16	> 16
Sauger			
Population (quantity)			
Experimental gill net (catch/net night)	< 9	9-17	> 17
Creel (quantity)			
Anglers (catch/hour)	< 0.5	0.5-1	> 1
Creel (quality)			
Pressure (hours/acre)	< 5	5-10	> 10

Table E.4-2 (cont.) – Sport Fish Index Population Quantity and Creel Quantity and Quality Metrics and Scoring Criteria

Metrics	**Scores** 5	10	15
Channel catfish			
Population (quantity)			
Experimental gill net (catch/net night)	< 2	2-4	> 4
Creel (quantity)			
Anglers (catch/hour)	< 0.3	0.3-0.7	> 0.7
Creel (quality)			
Pressure (hours/acre)	< 9	9-19	> 19

[a]Each worth 2.5, 5.0, and 7.5 points if both data sets are available.
[b]TVA electrofishing only used when state agency electrofishing data are unavailable.

Table E.4-3 – Sport Fish Index Population Quality Metrics and Scoring Criteria.

	Scores 5	10	15
Metrics			
Population (quality)	1	2	3
PSD	< 20 or > 80	20-39 or 61-80	40-60
RSDP (preferred)	0 or > 60	1-9 or 41-60	10-40
RSDM (memorable)	0 or > 25	1-4 or 11-25	5-10
RSDT (trophy)	0	< 1	≥ 1
W_r (Stock-preferred size fish)	< 90	> 110	90-110

Sauger and striped bass are known to migrate in late winter and spring to their preferred spawning habitats either in the tailwaters of Guntersville Dam or a major tributary such as the Elk River. TVA research has shown that sauger migrate past BFN during their spawning migration to Guntersville Dam (Baxter and Buchanan 1998).

Following the impoundment of Wheeler Reservoir, the freshwater mussel fauna could be found in two distinct habitats, the old river channel and the overbanks or old floodplain areas of the river. In Wheeler Reservoir downstream from Guntersville Dam, the original river channel is well defined to Decatur, Alabama (TRM 305), a distance of approximately 44 river miles. The river then slows and spreads out into extensive, shallow overbanks with average depths of 2-5 feet near BFN (TRM 294).

Commercial mussel species occur in most of the area around BFN. In the reservoir overbanks, mussels are generally spread over large areas and not concentrated in beds (Garner, 2003). The most favorable freshwater mussel habitat is located upstream of BFN (Ahlstedt and McDonough 1993). Two areas of Wheeler Reservoir are designated state-protected mussel sanctuaries and are off-limits to commercial musselers. The first sanctuary extends from Guntersville Dam (TRM 349) downstream to the mouth of Shoal Creek (TRM 347); the second extends from the upstream end of Hobbs Island (TRM 337) downstream to Whitesburg Bridge (TRM 333).

Table E.4-4 illustrates the findings of a 1991 survey in the vicinity of BFN (TRM 305 to TRM 275) when eleven commercial mussel species were documented (Ahlstedt and McDonough 1993). The most abundant mussel in the area surrounding BFN in 1991 was the Washboard (*Megalonaias nervosa*). Historically, the most valuable commercial species in Wheeler Reservoir was the Ohio pigtoe (*Pleurobema cordatum*), which accounted for 80% of all mussels harvested during 1956 and 1957 (Ahlstedt and McDonough 1993). This species has since been replaced by the Washboard as the most valuable commercial shell, constituting 45% of all shells harvested in 1991 (Ahlstedt and McDonough 1993). This trend continues today with the Washboard accounting for 99% of the mussels harvested in 2000 and 63% in 2001 (Garner, 2002).

Table E.4-4 – Commercial Mussel Species Collected by TVA Near Browns Ferry Nuclear Plant (TRM 305 to TRM 275) in 1991.

Common Name	Scientific Name
Threeridge	*Amblema plicata*
Purple wartyback	*Cyclonaias tuberculata*
Butterfly	*Ellipsaria lineolata*
Elephantear	*Elliptio crassidens*
Washboard	*Megalonaias nervosa*
Threehorn wartyback	*Obliquaria reflexa*
Ohio pigtoe	*Pleurobema cordatum*
Pink heelsplitter	*Potamilus alatus*
Pimpleback	*Quadrula pustulosa*
Mapleleaf	*Quadrula quadrula*
Pistolgrip	*Tritogonia verrucosa*

3. Include estimates of the quantities and timing of cooling water withdrawals and discharges in Chapter 3. Estimate current consumptive water use and future consumptive water use during the license renewal period.

4. Compare the consumptive water used by the heat-dissipation system to flows in the source water body. This comparison should be based on records of the initial license period. Project and compare consumptive use and stream flows during the license renewal period.

These have been addressed in the text of E.4.1.1 above.

5. Estimate the quantities of other ongoing water withdrawals and consumptive water uses in the portion of the water body affected by the plant and indicate whether these withdrawals or uses are expected to change during the license renewal period.

Tables E.2-14 and E.2-15 list the potable water supply intakes and wastewater discharges on Wheeler Reservoir (ADEM, 2001). There are eight water intakes withdrawing approximately 124 million gallons per day (MGD) for municipal and industrial use. Wastewater discharges include 11 municipal plants discharging over 30 MGD and 18 industrial plants discharging over 2,513 MGD.

Consumptive and off-stream water uses have not resulted in significant use conflicts due to the large volume of reservoir water available, the high river flow rate, and the return of most of the water withdrawn. Regulatory control of withdrawal rates and National Pollutant Discharge Elimination System (NPDES) permit limits for return water quality also mitigate potential conflicts. Potential trade-offs can occur with instream water uses, however (e.g., instream use conflicts among aquatic life, waste assimilation, navigation, power generation, flood control, and lake levels). These potential conflicts are addressed by historic operating procedures, legal requirements, and regulatory requirements and procedures.

Operation of all three units is not expected to adversely affect the availability of water or water use by others, as the maximum cooling water withdrawal for all three units will be approximately 4,907 cfs, compared to an annual average flow past BFN of 46,606 cfs and a 7Q10 flow of 8,700. With once-through cooling essentially all of the water is returned to the river. Even during times of minimum river flow sufficient water will be available from reservoir storage for use by others.

6. Estimate the effects of consumptive water use by the nuclear power plant on aquatic habitats in the water body and discuss the significance of these effects in terms of changes in populations of individual species. Describe the techniques used to estimate the habitat changes that result from water withdrawals.

TVA has determined that consumptive and off-stream water uses would not have a significant conflict with aquatic habitats due to the large volume of reservoir water available, the high river flow rate, and the return of most of the water withdrawn (TVA 2002, TVA 2003). At BFN, there is no well water usage or diversion of natural water drainage that would otherwise flow into the river.

Wheeler Reservoir water volume is 1,050,000 ac-ft or 3.42×10^{10} gallons. As reported in Section E.4.1 on Water Use Conflicts, the annual average flow rate for the Tennessee River at BFN from 1976 through 2002 is 46,606 cubic feet per second (cfs). This compares with a BFN maximum (i.e., "open" mode) 3-unit total intake water withdrawal of 4907 cfs (3,171 MGD), or approximately 734,000 gpm intake total flow per unit. This compares favorably with the design value for open mode operation of 700,000 gpm intake flow per unit (4,679 cfs total).

The Tennessee River annual average flow at BFN of 46,606 cfs equates to 1.47×10^{12} cubic feet per year (ft^3/yr). This is less than the 3.15×10^{12} ft^3/yr value used by the NRC in 10 CFR 51.53 (c)(3)(ii)(A) as the value beneath which "an assessment of the impact of the proposed action on the flow of the river and related impacts on instream and riparian ecological communities must be provided."

However, almost all of the cooling water running through the power plant and the cooling towers returns to the river. Some of the cooling water bypasses the cooling towers since they can only take a maximum flow of 3,685 cfs. Cooling tower evaporative losses can be as much as 1.7% and cooling tower "drift" (i.e., water droplets forced into the air by the cooling tower fans and forming a cloud) adds another potential 0.2% in losses. For conservatism, this total can be rounded off to 2%, bounding the cooling tower water consumption at 3,685 X .02 = 73.7 cfs. Other water consumptive losses by BFN are negligible in comparison.

Based on these findings, there would be no consumptive water use effects by the nuclear power plant on aquatic habitats in the vicinity of the plant.

7. Estimate the total (cumulative) effects of all water withdrawals on aquatic habitats and populations of individual species in the water body (i.e., the effects of power plant withdrawals during the license renewal period in combination with other existing and foreseeable future withdrawals).

See Surface Water Resources sections 3.6.4 (Water Intakes and Wastewater Discharges), 3.6.5. (Water Use Conflicts), and 4.2.6.4. (Water Use/Water Availability).

8. Describe mitigation measures (e.g., limiting withdrawals during droughts) that have been used to reduce the adverse impacts on aquatic habitats of consumptive water use and the mitigation measures that are expected to be used during the license renewal period. Briefly explain the rationale for not implementing any measures that were considered but rejected.

As explained above, due to the large size of Wheeler Reservoir and the relatively minor water consumption rate, the impacts of consumptive water use by BFN on Wheeler Reservoir are negligible and do not represent a potentially adverse impact on aquatic habitats during all but the most extreme weather conditions. Therefore, no specific mitigating measures relative to consumptive water use by BFN have been needed in the past or are currently contemplated for the term of license renewal.

During drought conditions, TVA must continue to meet water quality and water supply commitments, and TVA utilizes the flexibility in its reservoir operations policy to maintain other minimum benefits to the extent possible. As outlined in its Draft Reservoir Operations Study (ROS) which is in the form of an Environmental Impact Statement, TVA is considering development of a formal drought management plan that would include other agencies and entities and provide revised guidelines for operating under drought conditions. Depending on the recommendations that may result from this effort, a supplement to the reservoir operations policy that TVA may adopt as a result of the ROS could be proposed. For purposes of the ROS, simulated operations assumed continued operation at only minimum flows during drought conditions.

E.4.1.2 RIPARIAN ECOLOGICAL COMMUNITIES

> The primary impacts expected are reduction in the areal extent or species composition of riparian communities. Consumption of water by the plant may significantly reduce the amount of habitat available to riparian ecological communities, either year-round or seasonally. Increasing water demand (e.g., as a result of population growth) may result in additional impacts to riparian ecological communities that were not anticipated during the initial licensing. The methods used to determine the characteristics and magnitude of impacts should be explained and documented. As needed, existing and potential measures to mitigate adverse impacts on riparian ecological communities should be described, and the effects of these measures should be estimated. The following process for developing and presenting information should be used.
>
> 1. Document any consultations with regulatory agencies … and resource agencies … related to the issue of consumptive water use and its effects on stream-related habitat and riparian ecological communities. Summarize the results of such consultations, identifying agreements that describe (a) the plant's priority for makeup water withdrawals or (b) the criteria for reducing the withdrawal of makeup water in order to protect stream-related habitat and riparian ecological communities during low-flow periods. If the regulatory and resource agencies concur that these agreements or criteria are sufficiently protective of riparian communities, further consideration of the issue of water use conflicts on riparian ecological communities may be omitted. If further analysis is needed, and consultation with regulatory and resource agencies indicates concerns about only one or a few types of riparian ecological communities or species in these communities, the information and analyses required in the following items may be restricted to only that needed to address effects on those community types or species. Identify and unambiguously define the resource or resources of concern.

The Alabama Department of Environmental Management (ADEM) and the Alabama Department of Economic and Community Affairs (ADECA) were consulted as to whether there are any concerns regarding the effects of consumptive water use at BFN and its effects on stream-related habitat and ecological communities. ADEM and ADECA replied that they are not aware of any such concerns. Copies of this correspondence are included in Attachment E-2.

2. Describe the riparian ecological community in the source water body in Chapter 2. For the portions of the water body affected by consumptive water use, describe the associated riparian ecological community types, including (a) their extent and locations, (b) lists of plant and animal species they contain, and (c) estimates of the abundance of those species.

3. Include estimates of the quantities and timing of cooling water withdrawals and discharges in Chapter 3 and in 4.1.1 Instream Ecological Communities. Estimate consumptive water use during the initial license period and during the license renewal period.

4. Compare consumptive water use by the heat-dissipation system to flows in the source water body (i.e., the stream from which water is withdrawn for cooling tower or cooling pond makeup water). This comparison should be based on records of the initial license period and, if expected to be different, projected consumptive use and stream flows during the license renewal period.

5. Estimate the quantities of other ongoing water withdrawals and consumptive water uses in the portion of the water body affected by the plant and indicate whether these withdrawals or uses are expected to change during the license renewal period.

6. Provide an explanation of the mechanisms by which the riparian ecological communities that are present would be likely to be affected by the loss of flow attributed to makeup water (e.g., depression of the water table or loss of nutrient replenishment because of decreased floods).

7. Estimate the effects of consumptive water use by the plant on the riparian ecological communities associated with the water body. Describe the techniques used to estimate the changes in these communities that result from water withdrawals. The estimates should be expressed in units appropriate to the particular resources under consideration (e.g., percent loss of habitat, number of plants or animals affected, number of acres affected, percent reduction in harvest).

8. Describe mitigation measures (e.g., limiting water withdrawals during droughts) used to reduce the adverse impacts of consumptive water use on riparian ecological communities and the mitigation measures that are expected to be used during the license renewal period. Briefly explain the rationale for not implementing measures that were considered but rejected.

As documented in Sections E.4.1 and E.4.1.1, almost all of the water withdrawn from the reservoir is returned, and the actual amount of water consumed by BFN is insignificant relative to the available volume and flow rate of Wheeler Reservoir. The amount of consumption is negligible except possibly during cooling tower operation, which is typically limited to only one or two weeks during late July to mid-August. Moreover, essentially all of the water that is consumed ultimately returns to the environment via evaporation, drift and leakage.

The water sources for the onsite riparian wetlands are precipitation, surface runoff, and a seasonal high water table. No adverse impacts to groundwater resources are anticipated from operation of all three units, thus no wetland impacts associated with lower water tables are expected to occur.

E.4.2 ENTRAINMENT OF FISH AND SHELLFISH IN EARLY LIFE STAGES

This section applies to plants with once-through cooling or cooling pond heat dissipation systems. Table B-1 notes that

> The impacts of entrainment are small at many plants but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems. Further, ongoing efforts in the vicinity of these plants to restore fish populations may increase the numbers of fish susceptible to intake effects during the license renewal period, such that entrainment studies conducted in support of the original license may no longer be valid.

Specifically, 10 CFR 51.53(c)(3)(ii)(B) requires, in part, that

> If the applicant's plant utilizes once-through cooling or cooling pond heat dissipation systems, the applicant shall provide a copy of current Clean Water Act 316(b) determinations . . . or equivalent State permits and supporting documentation. If the applicant can not provide these documents, it shall assess the impact of the proposed action on fish and shellfish resources resulting from ... entrainment.

This issue is discussed in Sections 4.2.2.1.2 and 4.4.3 of NUREG-1437.

If the plant does not use once-through cooling or closed-cycle cooling pond heat dissipation systems, the ER should note this fact and no additional information is needed for this issue.

If the plant uses a once-through or closed-cycle cooling pond heat dissipation system and the applicant holds a current Clean Water Act Section 316(b) determination, copies of the determination, supporting documentation, and relevant correspondence with the water quality permitting agency (EPA or permitted State agency) should be provided to the NRC. Information about how mitigation measures were considered during the permit process, and any commitment to mitigation measures, should be provided.

For resumption of operation of all three units, the total Condenser Cooling Water (CCW) flowrate would increase by about ten percent over original three-unit operation. This increased CCW intake volume would potentially result in increased impingement of adult fish and entrainment of fish eggs and larvae. Monitoring of impingement and entrainment under current 2-unit operation and after the return to service of Unit 1 will verify the level of intake impacts and allow more refined assessment of the impact, if any, to fish populations of Wheeler Reservoir. TVA's VS monitoring program currently being conducted would also help verify effects on the fish community (structure and function), and additional monitoring will be conducted as needed to identify any effects on populations of recreationally or commercially important species.

The discharges are regulated under the Clean Water Act (CWA) by the U.S. Environmental Protection Agency (USEPA) and the Alabama Department of Environmental Management. The NPDES permit specifies the discharge standards and monitoring requirements for each discharge. The permit is renewed every five years and this helps to ensure that no changes have been made to the facility that would alter aquatic impacts and that no significant adverse impacts have occurred. Compliance with the NPDES process, other provisions of the CWA (e.g., Sections 316 (a) and (b), 401, 404), and other regulatory requirements are expected to adequately control potential chemical effluent effects. In general, under these regulatory programs, TVA treats wastewater effluents, collects and properly disposes potential contaminants, and undertakes pollution prevention activities that comply with regulatory requirements and minimize the risk of adverse environmental impacts.

> Information and Analysis Content
>
> Sufficient information should be provided in the ER to put into perspective the loss to entrainment of fish and shellfish in their early life stages, not only in terms of the overall numbers of eggs, larvae, and juveniles in the water body, but also in terms of the numbers of adult fish and shellfish that these losses represent. Existing and potential new measures to mitigate entrainment losses should also be fully described, and the effects of these measures should be estimated. The following process for developing and presenting information should be used.
>
> 1. Document any consultations with regulatory agencies … and resource agencies … regarding the issue of entrainment. Provide a copy of any Clean Water Act Section 316(b) demonstration. If a determination has not been made that the "location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact," discuss the outstanding issues. If consultation with regulatory and resource agencies indicates concerns about only one or a few aquatic species, the information and analysis required in the following items may be restricted to only that needed to address effects on those species. Identify and unambiguously define the resource or resources of concern.

Consultation with regulatory and resource agencies has focused on the following taxa; Clupeids, Catastomids and Sciaenids due to the highest estimated entrainment percentages. Neither of these taxa have commercial nor sport fishery value. Mitigation measures would likely not be applicable to these taxa. Clupeids, the most abundant taxon in both entrainment and impingement samples, are comprised mainly of gizzard and threadfin shad and serve as the dominant prey or forage species in Wheeler Reservoir. Forage species such as these have high reproductive rates and natural mortality is extremely high during egg and larval stages (e.g. 2-10% per day in plaice and clupeoids – Cushing 1975).

> 2. From Chapter 2 of the ER, describe the fish and shellfish resources in the vicinity of the plant susceptible to entrainment. Include lists of species and estimates of the numbers of entrainable fish and shellfish in the water body. The distribution and value of commercial and sport fisheries should be discussed. Locations of important habitats for entrainable fish and shellfish (e.g., spawning areas, nursery grounds, feeding areas, wintering areas, and migration routes) should be described.

A description of the fish and shellfish resources in the vicinity of BFN is presented in Section 4.1.1. Table E.2-2 lists all fish species collected in the vicinity of BFN during monitoring activities conducted from 1995-2000.

Fish eggs and larvae entrained in cooling water may suffer mortality from one or more physical effects of passage through the plant. Consequently, in conjunction with the construction of BFN, TVA investigated the preoperational characteristics and dynamics of the annual ichthyoplankton populations in Wheeler Reservoir (TVA, 1978a). This investigation was continued through the initiation of commercial operation in 1974, and data from 1971-1977 were reported (TVA, 1978b); 1978 and 1979 data were also reported (TVA, 1980a). The larval fish populations were consistently dominated (80-98%) by clupeids (shad). Total annual percent fish entrainment increased over the four-year study period from 1.0 to 11.7% of the total number estimated passing the plant. Mean hydraulic entrainment (portion of river flow passing through the plant) increased during this same period from 3.0 to 12.%. Other significant taxa comprising greater than one percent of the total number of larval fish collected were catastomids (suckers), cyprinids (minnows and carp), sciaenids (drum), and percichthyids (white and yellow basses). The three families of fish with the highest estimated entrainment during three-unit operation at BFN in 1977 were Clupeidae (12.1%), Catostomidae (4.5%) and Sciaenidae (6.1%). No spawning or nursery areas or migration routes for any of the species entrained in significant numbers are located specifically or uniquely upstream of BFN intake which would make eggs or larvae of these species unusually susceptible to entrainment. These estimates were reported to result in no significant impact to the reservoir population with concurrence from regulatory agencies. Subsequent monitoring of adult populations (TVA, 2000), including gillnetting and electrofishing, have reported no obvious decline in the populations of these families in Wheeler Reservoir. With the return of three-unit operation and the associated approximately ten percent increase in CCW flow, entrainment rates would be expected to similarly increase (i.e., to 13 % for Clupeidae, 5% for Catostomidae, and 6.7 % for Scianedae). This estimated change is not expected to result in any significant impact to fish populations in Wheeler Reservoir.

3. From Chapter 3 of the ER, describe the cooling system, including the rates of water withdrawal, the flow rates or volume of the water body from which cooling water is withdrawn, and the location of water withdrawal. The intake structure and any structural or operational measures used to reduce entrainment of fish and shellfish should be described in detail.

BFN raw water is pumped directly from the river, through traveling screens at the BFN Intake Structure. Additional detail may be found in Sections E.3.1.2 and E.4.1.

The average annual river flow for the Tennessee River at BFN is 46,606 cubic feet per second (cfs). This compares with a BFN maximum (i.e., "open" mode) 3-unit total intake water withdrawal of 4,907 cfs (or 3,171 MGD).

The Tennessee River annual average flow at BFN of 46,606 cfs equates to 1.47 X 10^{12} ft^3/year. This is less than the 3.15 X 10^{12} ft^3/year value used by NRC in 10 CFR 51.53 (c)(3)(ii)(A) as the value beneath which "an assessment of the impact of the proposed action on the flow of the river and related impacts on instream and riparian ecological communities must be provided."

Flow studies conducted by TVA at BFN have indicated that the majority of water entrained originates from the right side of the main river channel. This pelagic area contains significantly lower densities of drifting fish larvae than found in the overbank areas (Figure E.4-3). Higher densities of fish eggs (primarily freshwater drum eggs) are transported in the channel portion of the river, but entrainment of drum eggs (and larvae) has not resulted in noticeable decreased abundance of this species; nor is it expected to, under the increased CCW flow rates.

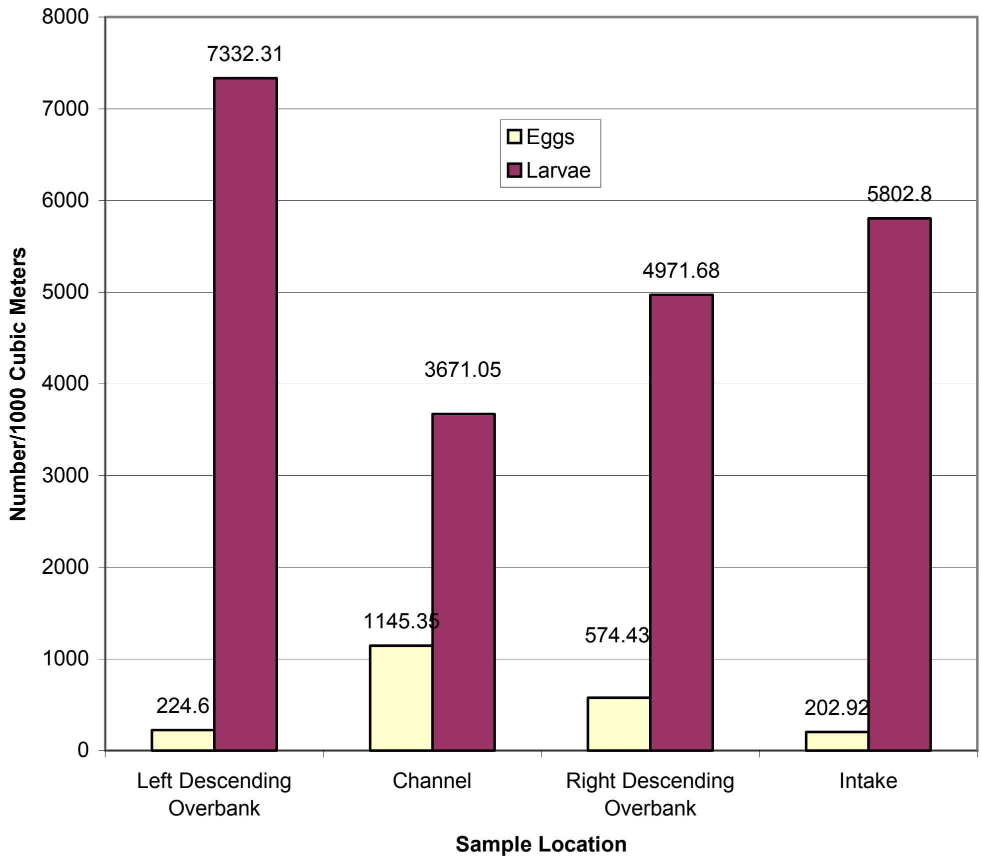

Figure E.4-3 – Average density of fish eggs and larvae at plant transect (TRM 294.5) and intake basin at Browns Ferry Nuclear, 1978 - 1980

The intake pumping station is separated from Wheeler Reservoir by a gate structure that includes three bays, each 40 feet wide by about 24 feet high (TVA, 1972b). Each bay includes a 20 foot high gate that can be moved up or down depending on the operational requirements of the plant. The velocity through the openings, thus, will vary depending on the gate position. When the gates are in their full open position and the plant is operated in either the open or helper modes, the average velocity through the openings will be about 0.6 fps for the operation of one unit, 1.1 fps for the operation of two units, and 1.7 fps for the operation of three units. These are based on an intake flow of about 1635 cfs per unit (734,000 gpm), as given in E.4.1 (Water Use Conflicts). Also, these velocities are independent of the reservoir elevation. Average velocities will be higher if the gates are in a lower position, and will need to be carefully monitored to avert adverse entrainment of aquatic organisms.

The intake pumping station includes 18 bays, 6 per unit, each having a traveling screen. Each bay will have a net opening of 8 feet 8 inches by 20 feet. The maximum average velocity through each bay will be about 1.6 fps and will be independent of the reservoir elevation. The maximum average velocity through a clean screen which will have net openings 3/8 inch by 3/8 inch will be about 2.1 fps. Velocities through the intake pump station bays and traveling screens will be independent of the number of units in operation and the reservoir elevation.

4. Provide estimates of the species and numbers of fish and shellfish entrained on a daily, monthly, and annual basis.

Annual entrainment expressed as average density (No./1000 m^3) of fish eggs and larvae is seasonal related to spawning periods of the individual taxa. The period of drifting eggs and larvae is generally April through June with peak densities varying with climatic conditions (water temperature, flow).

5. Provide estimates of the mortality of entrained fish and shellfish in early life stages.

TVA has historically assumed (conservatively) that fish eggs and larvae entrained at BFN experience 100% mortality.

6. Provide estimates of the numbers of adult fish and shellfish that are lost to the water body because of entrainment in early life stages. Provide full documentation of analytical or modeling techniques that were used to extrapolate local entrainment losses to resulting long-term, far-field effects. As appropriate, compare these "equivalent adult" losses to the total estimated numbers of adults in the water body and commercial and recreational harvests.

Historical estimates of egg and larval entrainment at BFN have not utilizedmodeling techniques to extrapolate losses to equivalent adults or as “production foregone” used for forage species as these methods were not available when previous entrainment monitoring was conducted at BFN.

A modeling technique to extrapolate numbers of fish eggs and larvae lost from entrainment to “equivalent adults” is currently being refined (Barnthouse, 2003). This technique is primarily applied to predator species, of which none are among those entrained in significant numbers at BFN. A similar modeling technique designed to extrapolate eggs and larvae of forage species (e.g. Clupeids) lost to “production foregone” would be more appropriate for use in estimating far-field effects of entrainment at BFN. Analysis of current and future entrainment data collected at BFN will implement these techniques when they are available to more effectively assess potential entrainment impacts. Current or recent commercial and recreational fish harvest data for Wheeler Reservoir are not available through the ADWFF (Nichols, 2002). TVA will continue to conduct Vital Signs and RFAI monitoring on Wheeler Reservoir to assess trends in relation to potential long-term effects on the fish community. Additional monitoring will be conducted as needed to identify any effects on populations of recreationally or commercially important species.

> 7. If aquatic resources have been monitored, provide an analysis of time trends in the data that might indicate whether fish and shellfish populations have increased, decreased, or remained stable during the initial period of operation. Possible causes for these time trends should be discussed.

TVA's VS monitoring program reported (TVA, 2000, and Baxter and Gardner, 2003) no obvious decline in the fish and benthic macroinvertebrate communities in Wheeler Reservoir during the period 1993 through 2002 and indicated and there is a balanced indigenous fish community reservoir fish community. Additional analyses of VS and operational monitoring conducted BFN is provided in E.4.1.1.

> 8. Identify and, to the extent possible, quantify losses of fish and shellfish from other sources (e.g., other water withdrawals, temperature and water quality problems, impingement of juveniles and adults) in order to assess possible cumulative effects of plant entrainment losses when combined with other losses.

Impingement monitoring during 1974-1977 indicated four species of fish (threadfin shad, gizzard shad, freshwater drum and skipjack herring) represented 95% of the total fish impinged at BFN (TVA, 1980a). During 1980, impingement sampling collected 162,350 fish of which 88% were clupeids (65% gizzard shad).

Some additional drifting eggs, larval and juvenile fish are lost each year from Wheeler Reservoir through turbine (or spillgate) passage at Wheeler Dam. Turbine passage has been determined (Cada, 1990) to result in significantly less than 100% mortality and these losses would be compensated to some degree by recruitment to Wheeler Reservoir through turbine passage from Guntersville Dam upstream.

No additional entrainment or impingement losses from other water withdrawals are known to occur in the vicinity of BFN which would result in cumulative effects.

> 9. Describe mitigation measures that have been used to reduce the adverse impacts of entrainment during the initial license period. Identify additional mitigation measures that could be used to reduce entrainment impacts during the license renewal period. Explain the rationale for accepting or rejecting additional mitigation measures. Describe in detail the additional mitigation measures that are expected to be used during the license renewal period and their expected effects on entrainment losses.

As discussed with regulatory agencies, results of previous entrainment monitoring at BFN have identified no adverse impact to aquatic communities. Therefore, no technological or operational modifications to reduce entrainment have been identified as needed during the initial license period.

TVA will confirm the expected levels of impingement and entrainment by monitoring under current 2-unit operation and following the return of three-unit operation. TVA's VS monitoring program will also continue to assess aquatic communities in Wheeler Reservoir. Although not expected, if based on these monitoring studies it is determined that increased impingement and entrainment are resulting in unacceptable environmental impacts, TVA would assess the technologies, operational measures, and restoration measures that could be undertaken to remedy this and institute appropriate measures in consultation with appropriate federal and Alabama agencies.

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E.4.3 IMPINGEMENT OF FISH AND SHELLFISH

This section applies to plants with once-through cooling or cooling pond heat dissipation systems. Table B-1 notes that

> The impacts of impingement are small at many plants but may be moderate or even large at a few plants with once-through and cooling pond cooling systems.

Specifically, 10 CFR 51.53(c)(3)(ii)(B) requires, in part, that

> If the applicant's plant utilizes once-through cooling or cooling pond heat dissipation systems, the applicant shall provide a copy of current Clean Water Act 316(b) determinations . . . or equivalent State permits and supporting documentation. If the applicant can not provide these documents, it shall assess the impact of the proposed action on fish and shellfish resources resulting from ... impingement ….

This issue is discussed in Sections 4.2.2.1.3, 4.3.3, and 4.4.3 of NUREG-1437.

If the plant does not use once-through cooling or closed-cycle cooling pond heat dissipation systems, the ER should note this fact and no additional information is needed for this issue.

If the plant uses a once-through or closed-cycle cooling pond heat dissipation system and the applicant holds a current Clean Water Act Section 316(b) determination, copies of the determination, supporting documentation, and relevant correspondence with the water quality permitting agency (EPA or permitted State agency) should be provided to the NRC. Information about how mitigation measures were considered during the permit process, and any commitment to mitigation measures, should be provided.

If (a) the plant utilizes a once-through or cooling pond heat dissipation system and (b) the applicant does not possess a current Clean Water Act Section 316(b) determination, the issue of impingement of fish and shellfish must be considered in the ER. Information that should be provided to the NRC for review and analysis of the impingement issue is outlined below.

With the return of three-unit operation, the total CCW flowrate would increase by about ten percent over original three-unit operation. This increased CCW intake volume could potentially result in increased impingement of adult fish and entrainment of fish eggs and larvae. Monitoring of impingement and entrainment under current 2-unit operation and after the return of three-unit operation would verify the level of intake impacts and allow more refined assessment of the impact, if any, to fish populations of Wheeler Reservoir. TVA's VS monitoring program currently being conducted will also help verify effects on the fish community health (structure and function), and additional monitoring will be conducted as needed to identify any effects on populations of recreationally or commercially important species.

The discharges are regulated under the Clean Water Act (CWA) by the U.S. Environmental Protection Agency and the Alabama Department of Environmental Management. The NPDES permit specifies the discharge standards and monitoring requirements for each discharge. The permit is renewed every five years and this helps to ensure that no changes have been made to the facility that would alter aquatic impacts and that no significant adverse impacts have occurred. Compliance with the NPDES process, other provisions of the CWA (e.g., Sections 316 (a) and (b), 401, 404), and other regulatory requirements are expected to adequately control potential chemical effluent effects. In general, under these regulatory programs, TVA treats wastewater effluents, collects and properly disposes potential contaminants, and undertakes pollution prevention activities that comply with regulatory requirements and minimize the risk of adverse environmental impacts.

During operational monitoring (1974-1977), with all nine circulating pumps in operation, four species of fish (threadfin shad, gizzard shad, freshwater drum, and skipjack herring) represented 95% of the total fish impinged at BFN (TVA, 1980a). One other species, (yellow bass) comprised greater than one percent (1.4%) of total fish impinged. None of these are considered commercial or sport species although yellow bass occasionally are caught by sport fishermen. Therefore, the only species of potential concern with regard to impingement at BFN would be considered forage or rough species. It was concluded in TVA (1980a) that the operation of BFN has not caused an adverse environmental impact to the balanced indigenous fish community of Wheeler Reservoir. With the return of three-unit operation and the associated approximately ten percent increase in CCW flow, impingement rates are expected to slightly increase, but are not expected to result in significant impacts to fish populations of Wheeler Reservoir.

> Information and Analysis Content
>
> Sufficient information should be provided in the ER to put into perspective the loss to entrainment of fish and shellfish in their early life stages, not only in terms of the overall numbers of eggs, larvae, and juveniles in the water body, but also in terms of the numbers of adult fish and shellfish that these losses represent. Existing and potential new measures to mitigate entrainment losses should also be fully described, and the effects of these measures should be estimated. The following process for developing and presenting information should be used.
>
> 1. Document any consultations with regulatory agencies … and resource agencies … regarding the issue of impingement. Provide a copy of any Clean Water Act Section 316(b) demonstration. If a determination has not been made that the "location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact," discuss the outstanding issues. If consultation with regulatory and resource agencies indicates concerns about only one or a few aquatic species, the information and analysis required in the following items may be restricted to only that needed to address effects on those species. Identify and unambiguously define the resource or resources of concern.

Regulatory agencies have been apprised (TVA 1978b, 1980a) that 95-98% of fish impinged at BFN during 1974-1977 consisted of gizzard and threadfin shad, skipjack herring and freshwater drum. With the exception of freshwater drum, which is considered a rough or commercial species, these taxa are forage species and consistently dominate fish collected in entrainment, impingement or cove rotenone sampling.

> 2. From Chapter 2 of the ER, describe the fish and shellfish resources in the vicinity of the plant susceptible to impingement. Include lists of species and estimates of the numbers of entrainable fish and shellfish in the water body. The distribution and value of commercial and sport fisheries should be discussed. Locations of important habitats for impingeable fish and shellfish (e.g., spawning areas, nursery grounds, feeding areas, wintering areas, and migration routes) should be described.

A description of the fish and shellfish resources in the vicinity of BFN is presented in Section 4.1.1. Table E.2-2 lists all fish species collected in the vicinity of BFN during monitoring activities conducted from 1995-2000. No spawning areas, nursery grounds, feeding areas, wintering areas or migration routes (Baxter and Buchanan, 1998) are located near BFN which would result in greater susceptibility to impingement.

Although Wheeler Reservoir supports viable sport and commercial fisheries, recent commercial harvest data are unavailable from the Alabama Wildlife and Freshwater Fisheries Division (AWFFD) (Nichols, 2002).

> 3. From Chapter 3 of the ER, describe the cooling system, including the rates of water withdrawal, the flow rates or volume of the water body from which cooling water is withdrawn, and the location of water withdrawal. The intake structure, intake screens, and any structural or operational measures used to reduce impingement of fish and shellfish should be described in detail.

BFN CCW is pumped directly from the river, through traveling screens at the BFN intake. Its primary use is once-through cooling water for the main turbine condensers. The average annual river flow for the Tennessee River at BFN is 46,606 cubic feet per second (cfs). This compares with a BFN maximum (i.e., “open” mode) 3-unit total intake water withdrawal of 4,907 cfs (or 3,171 MGD).

The Tennessee River annual average flow at BFN of 46,606 cfs equates to 1.47×10^{12} ft^3/year. This is less than the 3.15×10^{12} ft^3/year value used by NRC in 10 CFR 51.53 (c)(3)(ii)(A) as the value beneath which “an assessment of the impact of the proposed action on the flow of the river and related impacts on instream and riparian ecological communities must be provided.”

The intake structure is described under guidance item 3 of Section 4.2. See FSAR 12.2.7, 12.2.16, and F.7.7 for additional details.

> 4. Provide estimates of the species and numbers of fish and shellfish impinged on a daily, monthly, and annual basis.

Four species of fish (threadfin shad, gizzard shad, freshwater drum, and skipjack herring) represented 95% of the total fish impinged at BFN. Yellow bass (1.4%) was the only other species comprising greater than 1% of total fish impinged (TVA, 1980a). A total of 162,350 fish representing 11 species were collected during 1980 impingement sampling. Peak impingement occurred during January – April and during August – December.

5. Provide estimates of the mortality of impinged fish and shellfish in early life stages.

TVA has historically assumed 100% mortality of fish impinged at BFN cooling water intake.

6. Provide estimates of the numbers of adult fish and shellfish that are lost to the water body because of impingement. Provide full documentation of analytical or modeling techniques that were used to extrapolate localized impingement losses to resulting long-term, far-field effects. As appropriate, compare these "equivalent adult" losses to the total estimated numbers of adults in the water body and commercial and recreational harvests.

Impingement monitoring during the first four years (March, 1974-August, 1977) of BFN operation included comparison of estimated 12-month impingement for selected species with numerical standing stock estimates derived from cove rotenone data. Results (TVA 1978b) were expressed for three operational periods and averaged 4.87 million fish estimated impinged during each period. Gizzard and threadfin shad, skipjack herring and freshwater drum comprised between 95 and 98 percent of all fish impinged during the entire period.

A total of 12 species were estimated to have greater than one percent of their reservoir standing stock impinged during at least one of the sample periods. Each of these species is discussed with relation to impacts in TVA 1978b. It was concluded that overall impingement of fish at BFN does not represent an adverse impact to the Wheeler Reservoir fish community.

Modeling techniques (Dey, 2003) are currently being refined which will allow more realistic analysis of the effects of impingement and allow extrapolation of impingement losses to “foregone yield” of forage fish. This or a similar technique will be employed to analyze future impingement data from BFN in order to better quantify long-term, far-field effects of impingement to the reservoir fish community.

According to Barnthouse (2003), studies of the ages of impinged fish have consistently shown that:

1. Most impinged fish are younger than one year of age, and not one year old or older as assumed by USEPA.

2. The vulnerability of most species to impingement decreases with age, so that USEPA’s use of survival rates to estimate the age composition of impinged fish usually overstates the relative contributions of older fish to impingement losses.

> 7. If aquatic resources have been monitored, provide an analysis of time trends in the data that might indicate whether fish and shellfish populations have increased, decreased, or remained stable during the initial period of operation. Possible causes for these time trends should be discussed.

TVA's VS monitoring program (TVA, 2000) reported no obvious decline in the fish community in Wheeler Reservoir and data support the assumption of a balanced indigenous fish community. Table E.2-2 lists results of all fisheries monitoring conducted in Wheeler Reservoir from 1995-2000. Additional analyses of VS and operational monitoring conducted BFN is provided in E.4.1.1.

> 8. Identify and, to the extent possible, quantify losses of fish and shellfish from other sources (e.g., other water withdrawals, temperature and water quality problems, impingement of juveniles and adults) in order to assess possible cumulative effects of plant impingement losses when combined with other losses.

Entrainment of drifting fish eggs and larvae during spring and early summer constitute an additional source for loss from the community.

No additional entrainment or impingement losses from other water withdrawals are known to occur in the vicinity of BFN which would result in cumulative effects.

> 9. Describe mitigation measures that have been used to reduce the adverse impacts of impingement during the initial license period. Describe additional mitigation measures that are expected to be used during the license renewal period and their expected effects on impingement losses, and briefly explain the rationale for not implementing any measures that were considered but rejected.

As discussed with regulatory agencies, results of previous impingement monitoring at BFN have identified no adverse impact to aquatic communities. Therefore, no technological or operational modifications to reduce impingement have been identified as needed during the initial license period.

TVA will confirm the expected levels of impingement and entrainment by monitoring under current 2-unit operation and following return of Unit 1 to service. TVA's VS monitoring program will also continue to assess aquatic ecological communities in Wheeler Reservoir. Although not expected, if based on these monitoring studies it is determined that increased impingement and entrainment are resulting in unacceptable environmental impacts, TVA would assess the technologies, operational measures, and restoration measures that could be undertaken to remedy this and institute appropriate measures in consultation with appropriate federal and Alabama agencies.

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E.4.4 HEAT SHOCK

> This section applies to plants with once-through and cooling pond heat dissipation systems. Table B-1 notes that
>
> > Because of continuing concerns about heat shock and the possible need to modify thermal discharges in response to changing environmental conditions, the impacts may be of moderate or large significance at some plants.
>
> Specifically, 10 CFR 51.53(c)(3)(ii)(B) requires, in part, that
>
> > If the applicant's plant utilizes once-through cooling or cooling pond heat dissipation systems, the applicant shall provide a copy of current Clean Water Act 316(b) determinations and, if necessary, a 316(a) variance in accordance with 40 CFR Part 125, or equivalent State permits and supporting documentation. If the applicant can not provide these documents, it shall assess the impact of the proposed action on fish and shellfish resources resulting from heat shock . . . .
>
> This issue is discussed in Sections 4.2.2.1.4 and 4.4.3 of NUREG-1437.
>
> If the plant does not use a once-through cooling or closed-cycle cooling pond heat dissipation system, the ER should note this fact and no additional information is needed for this issue.
>
> If the plant uses a once-through or closed-cycle cooling pond heat dissipation system and the applicant holds a current NPDES permit that demonstrates that the plant meets State water temperature standards, or a current Clean Water Act Section 316(a) determination, copies of the determination, NPDES permit, supporting documentation, and relevant correspondence with the water quality permitting agency (EPA or permitted State agency) should be provided to the NRC. Information about how mitigation measures were considered during the permit process should be provided, as well as any commitments to mitigation measures.
>
> If (a) the plant uses a once-through or cooling pond heat dissipation system and (b) the applicant does not possess a current NPDES permit that demonstrates that the plant meets State water temperature standards or possess a current Clean Water Act Section 316(a) determination, the issue of heat shock must be considered in the ER. Information that should be provided for review and analysis of the heat shock issue is outlined below.

Section 316(a) of the CWA specifies that industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters. Industries responsible for point-source dischargers of heated water can obtain a variance from state water quality standards if the industry can demonstrate compliance with thermal criteria by documenting the maintenance of balanced indigenous populations (BIP) of aquatic life in the vicinity of its discharges. As required by the NPDES permit (AL0022080), BFN is to provide "necessary technical data and relevant information to include supplemental data collected within the life of the permit to support the existing variance." In response to this requirement, and after discussions with ADEM and the U.S. Fish and Wildlife Service (USFWS), the TVA proposed use of its VS monitoring program, fish and benthic macroinvertebrate community data and analyses in its 1999 NPDES permit application. This method provides both a cost-effective and thorough means by which to evaluate aquatic communities in Wheeler Reservoir upstream and downstream of BFN discharge through the current permit cycle. Based on the results from this study from 1992 to present (Dycus and Baker 2000), it can be concluded that the operations of BFN under the current thermal limitations has not had a significant impact on aquatic communities of Wheeler Reservoir (Baxter and Gardner 2003).

Response of fish and other aquatic life to elevated temperatures found in power plant discharges can range from acute, which includes immediate disability and death; to chronic or low level, which may include physiological or behavioral responses such as changes in spawning, migration, or feed behaviors. Since the discharge diffusers at BFN are located such that fish do not become trapped in areas of elevated temperatures, acute impacts are highly unlikely. TVA studies have documented that thermal releases from BFN have not had a significant impact on the aquatic community of Wheeler Reservoir (TVA, 1983; Baxter and Buchanan, 1998; Baxter and Gardner, 2003).

In-river temperatures at the end of the mixing zone will remain within NPDES permitted limits, thus heat shock impacts are not anticipated.

Information and Analysis Content

Sufficient information should be provided to the NRC to allow the reviewer to put in perspective the loss of fish and shellfish to heat shock, not only in terms of the overall numbers of eggs, larvae, juveniles, and adults in the water body, but also in terms of the numbers of adult fish and shellfish that these losses represent. Existing and potential new measures to mitigate heat shock losses should also be fully described, and the effects of these measures should be estimated. The following process for developing and presenting information should be used.

1. Document any consultations with regulatory agencies … and resource agencies … regarding the issue of heat shock. Provide copies of any NPDES permits and Clean Water Act Section 316(a) determination. If a current NPDES permit relative to thermal discharges and/or a current Section 316(a) variance from State water temperature standards do not exist, discuss the outstanding issues. If consultation with regulatory and resource agencies indicates concerns about only one or a few aquatic species, the information and analysis required in the following items may be restricted to only that needed to address effects on those species. Identify and unambiguously define the resource or resources of concern.

Consultations with regulatory and resource agencies have focused on the BFN's thermal variance monitoring program. BFN currently operates under a thermal variance granted by the ADEM permitting thermal discharges up to 90^o F with a maximum temperature rise of 10^{o}F. A three-phase monitoring program was initiated in 1985 to evaluate the effects of the revised thermal discharge limitations on selected fish populations in Wheeler Reservoir, particularly the reproductive success and distribution of sauger (*Stizostedion canadense*). Annual cove rotenone sampling collected from 1969 to 1997, as a part of BFN pre-operational and operational monitoring, was used to monitor total fish standing stocks in Wheeler Reservoir.

Buchanan (1990) reported results of Phase I (larval fish sampling to estimate annual reproductive success of sauger), Phase II-A (evaluation of seasonal and spatial distribution of adult sauger) and Phase III (annual cove rotenone sampling which is used to monitor fish standing stocks). Baxter and Buchanan (1998) presented results of Phase II-B (determination of temperature preferences of adult sauger in the vicinity of BFN during annual extreme ambient water temperatures) and an update of Phase III which included cove rotenone historical and statistical analysis).

2. From Chapter 2 of the ER, describe the fish and shellfish resources in the vicinity of the plant that are susceptible to heat shock. Include lists of species and estimates of the numbers of fish and shellfish in the water body that are susceptible to heated discharges. The distribution and value of commercial and sport fisheries should be discussed. Locations of important fish and shellfish habitats (e.g., spawning areas, nursery grounds, feeding areas, wintering areas, and migration routes) should be fully described. The important habitats that could be affected by thermal discharges should be identified.

Refer to section 4.1.1 which describes the fish and shellfish resources found in Wheeler Reservoir.

Response of fish and other aquatic life to elevated temperatures found in power plant discharges can range from acute, which includes immediate disability and death to chronic or low level, which may include physiological or behavioral responses such as changes in spawning, migration, or feed behaviors. Since the discharge diffusers at BFN are located such that fish do not become trapped in areas of elevated temperatures, acute impacts are highly unlikely. TVA studies have documented that thermal releases from BFN have not had a significant impact on the aquatic community of Wheeler Reservoir (TVA, 1983; Baxter and Buchanan, 1998; and Baxter and Gardner, 2003).

Discharge temperatures will remain within the NPDES permit limits; thus, heat shock impacts are not anticipated.

3. From Chapter 3 of the ER, describe the cooling system, including heated water discharge rates, the flow rates or volume of the water body into which heated water is discharged, and the location of heated water discharge. The discharge structure and any structural or operational measures used to reduce heat shock to fish and shellfish should be described in detail. The location, temperatures, and areal extent of the heated discharge plume should be described; all techniques used to estimate these parameters (e.g., temperature monitoring, simulation monitoring) should be reported.

Potential thermal effects on Wheeler Reservoir were examined using a near-field hydrothermal model of the discharge mixing zone and a far-field water quality model of Wheeler Reservoir. A brief description of each model is provided herein, followed by key results for the restart of Unit 1.

The assessment of near-field impacts focused on requirements for water temperature as given in the plant NPDES permit. The evaluation was performed using a hydrothermal model that simulates the operation of the plant and computes the temperature at the five-foot (compliance) depth at the downstream end of the diffuser mixing zone. The model was developed by TVA and has been used on several occasions to evaluate the near-field mixing of waste heat from BFN in Wheeler Reservoir (TVA 1980b, TVA 1983, TVA 1986, Bechtel 1991).

The input for the hydrothermal model includes the upstream ambient river temperature at the five-foot depth, wet bulb temperature, and river flow. Historical hourly data were used for all the input requirements. The river temperature and wet bulb temperature were obtained from monitoring stations at the site. The river flow at BFN was computed from an unsteady flow model of Wheeler Reservoir based on measured hourly releases from Guntersville Dam, located 55 miles upstream, and Wheeler Dam, located 19 miles downstream (TVA, 1977). The compliance model computes the temperature of the discharged condenser cooling water (CCW) for each unit based on the ambient river temperature, wet bulb temperature, and unit load. The temperature at the five-foot depth at the downstream end of the mixing zone is then computed using an algorithm that estimates the dilution of the CCW discharge as it is released in the river through the plant submerged multiport diffusers. The dilution algorithm was developed based on work by the Massachusetts Institute of Technology and TVA (MIT 1973, Stolzenbach 1975, and TVA 1972c).

The hydrothermal model simulates operation of the cooling towers if they are needed to maintain compliance with the NPDES temperature limits. If temperatures are so high that the towers are insufficient for cooling, the model also simulates reduced generation of the units (i.e., derates). The output from the model includes not only the computed downstream temperature and related NPDES compliance parameters, but also the frequency, duration, and amount of energy lost for cooling tower operation and unit derates.

The far-field impacts were evaluated using BETTER, a two-dimensional reservoir water quality model (Bender et al., 1990). The model calculates the flow exchange among elements of a two-dimensional array of boxes representing the reservoir geometry. A heat budget including wind mixing and convective cooling simulates the seasonal patterns of a warm surface wedge and cold bottom water. The model calculates dissolved oxygen concentrations based on biochemical oxygen demand (BOD), ammonia, sediment oxygen demand (SOD), surface reaeration, and photosynthesis and respiration from algae. The model produces a seasonal pattern of DO throughout the reservoir

In the far-field model the reservoir was segmented longitudinally based on sampling locations and transition zones between reasonably homogeneous segments of the reservoir. Element volumes and conveyance area tables were determined from cross-sectional surveys, maps, and sediment ranges, adjusted to preserve the correct volume-elevation relationship. For each element, the model determines volume, downstream conveyance area, and surface interfacial area at each time step. Water quality in each volume element is assumed to be fully mixed and a set of volume-averaged concentrations is calculated at each time step for the element. Thus, model results are more likely to be representative of main channel areas rather than overbank areas. Due to the coarse geometry used in the BETTER model, the model cannot adequately simulate near-field effects such as patches of hot water or pockets of high BOD water normally found immediately below a point source.

The input for the far-field model includes meteorology, hydrology, and inflow water quality. The hourly meteorology observed at the airport in Huntsville, Alabama was used for the assessment. Hourly releases at Guntersville and Wheeler Dams and Wheeler headwater elevation were used to determine the river flow in Wheeler Reservoir. Computed hourly release water quality at the upstream Guntersville Dam was used as the inflow water quality. Hourly BFN thermal discharges (i.e., effluent flow and temperature) were computed by the BFN near-field scheduling model and incorporated as a point source in the water quality model.

Simulations with the near-field hydrothermal model were conduced for the period 1985 through 2002, excluding years 1989 and 1990 for which no river ambient temperature data are available (Harper, 2003). This period of record was selected because it more closely represents the expected future manner of operation of Wheeler Reservoir. The results of the near field modeling are given in Table E.4-5. In addition to the period 1985 through 2002 (without 1989 and 1990), results also are given for 1988, one of the hottest and driest years in the period of analyses. Simulations were performed for three cases: all three units operating at 100 percent (i.e., original power level), Units 2 and 3 operating at 120 percent power level (i.e., no Unit 1 operation), and all three units operating at 120 percent power level. In the simulations it is assumed that sufficient cooling tower capacity would be supplied in each case to routinely maintain the instream thermal limits in the current NPDES permit. If extremely hot and dry conditions should make it impossible for the cooling towers to meet the NPDES thermal limits, the plant would be de-rated to remain in compliance. For the case with the operation of Units 2 and 3 at 120 percent, the maximum flow rate for the once through Condenser Circulating Water system is approximately 2,114 MGD (actual annual average flow rates are slightly lower due to outages). With the restart of Unit 1 the maximum flow rate for all three units will increase to approximately 3,171 MGD. No changes are expected in the plant intake system to accommodate the flow rate for all three units.

The following results are emphasized in Table E.4-5:

- Due to the higher power level per unit, the water temperature at the discharge point of the cooling system is higher for Units 2 and 3 operating at 120 percent power compared to the original operation of the plant with three units at 100 percent power. The water temperature at the discharge point would be essentially the same for three-unit operation at 120 percent power as for operation of Units 2 and 3 at 120 percent power, due to the proportional increase in cooling water flow.

- The mean temperature at the edge of the mixing zone for Units 2 and 3 at 120 percent power, 69.2^{o}F, is basically the same as that of the original plant operation with all three units at 100 percent power, 69.1^{o}F. However, with all three units at 120 percent power, the total amount of heat added to the river will be higher, increasing the mean water temperature at the edge of mixing zone to about 69.6^{o}F. The model indicates a maximum day temperature at the edge of the mixing zone of 90.3^{o}F with two Units 2 and 3 operating at 120 percent and 90.3^{o}F with all three units operating at 120%. These values are in excess of the NPDES limit of 90^{o}F because the natural, upstream ambient temperature is in excess of 90^{o}F. The NPDES permit allows operation of the plant with the temperature at the edge of the mixing zone in excess of 90^{o}F, if this temperature does not exceed the upstream ambient temperature. That is, the temperature rise must be zero. The model result showing a 0.1 ^{o}F higher maximum day temperature with three units operating at 120 percent power (i.e., 90.4^{o}F vs. 90.3^{o}F) indicates that some additional de-rating above that simulated in the model will be needed to provide a zero temperature rise above the upstream ambient.

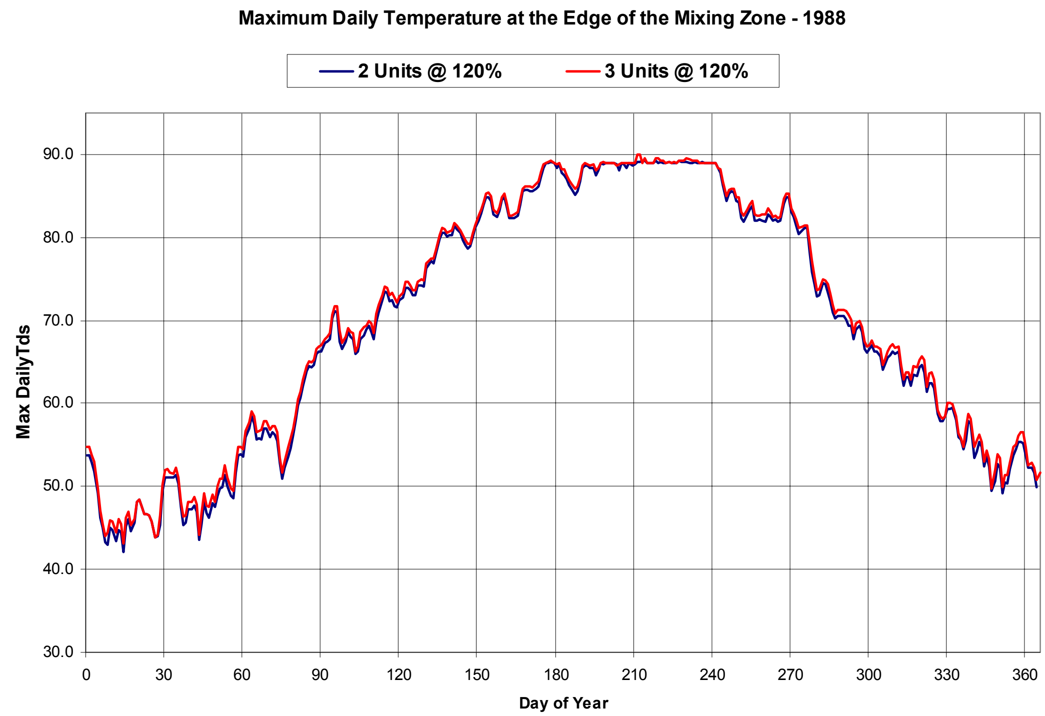
- Model results showed that with Units 2 and 3 operating at 120 percent power, the cooling towers will be used approximately 5.3 percent of the time and derating will be required approximately 0.10 percent of the time (i.e., 6.2 days over the 16 year of simulation). With all three units at 120 percent power, use of the cooling towers will increase to approximately 7.2 percent of the time and derating will increase to approximately 0.29 percent of the time (i.e., 17.0 days over the 16 year simulation).

Table E.4-5 – Summary of Wheeler Reservoir Water Quality Near-Field Computer Model Results for Equivalent Weather Years 1985-1988, 1991-2002[1]

Years	Discharge Point			Edge of Mixing Zone			Percent of Time	
Case 1. All Three Units Operating at 100%(2) (Original 6 Cooling Towers)								
	Min.	Mean.	Max.	Min.	Mean	Max.	Towers	Derate
1985-2002	53.9	87.4	113.7	36.4	69.1	90.3(5)	5.8	0.35
1988	59.7	6.2	111.1	42.0	68.9	89.7	7.2	0.00
Case 2. Units 2 and 3 Operating at 120%(3) (Existing 5 Cooling Towers)								
Years	Discharge Point			Edge of Mixing Zone			Percent of Time	
	Min.	Mean	Max.	Min.	Mean	Max.	Towers	Derate
1985-2002	58.2	92.0	119.1	35.9	69.2	90.3(5)	5.3	0.11
1988	64.1	90.7	116.4	41.6	69.0	89.4	6.6	0.00
Case 3. All Three Units Operating at 120%(4) (Existing 5 Towers Plus One New Tower)								
Years	Discharge Point			Edge of Mixing Zone			Percent of Time	
	Min.	Mean	Max.	Min.	Mean	Max.	Towers	Derate
1985-2002	58.2	91.8	117.4	37.3	69.6	90.3	7.2	0.29
1988	64.1	90.6	116.4	42.5	69.6	90.0	9.0	0.10

[1]Based on modeling analysis of hydrological and meteorological conditions for the years indicated (Harper 2003). 1989-1990 model results were omitted because historical meteorological data were not available.
[2]Includes six original 16-cell Ecodyne cooling towers.
[3]Includes four original 16-cell Ecodyne cooling towers and one 16-cell Balcke-Durr cooling tower.
[4]Includes four original 16-cell Ecodyne cooling towers, one 16-cell Balcke-Durr cooling tower, and one 20-cell Balcke-Durr cooling tower.
[5]Some additional plant derating would be required to prevent positive instream temperature rises during occurrences of 24-hour averaged downstream temperature in excess of 90 ºF.

Figure E.4-4 compares the model results for weather year 1988 under the case with Units 2 and 3 at 120 percent power and all three units at 120 percent power. In both cases, the maximum temperature at the edge of the mixing zone was maintained below 90.0 ^{o}F using cooling towers and plant derates. Figure E.4-4 also shows that the 1988 projected instream temperature rise ranged from 1.2 °F to 7.6 ^{o}F (i.e., the rise between the ambient river temperature upstream of the plant and the river temperature at the downstream edge of the mixing zone).



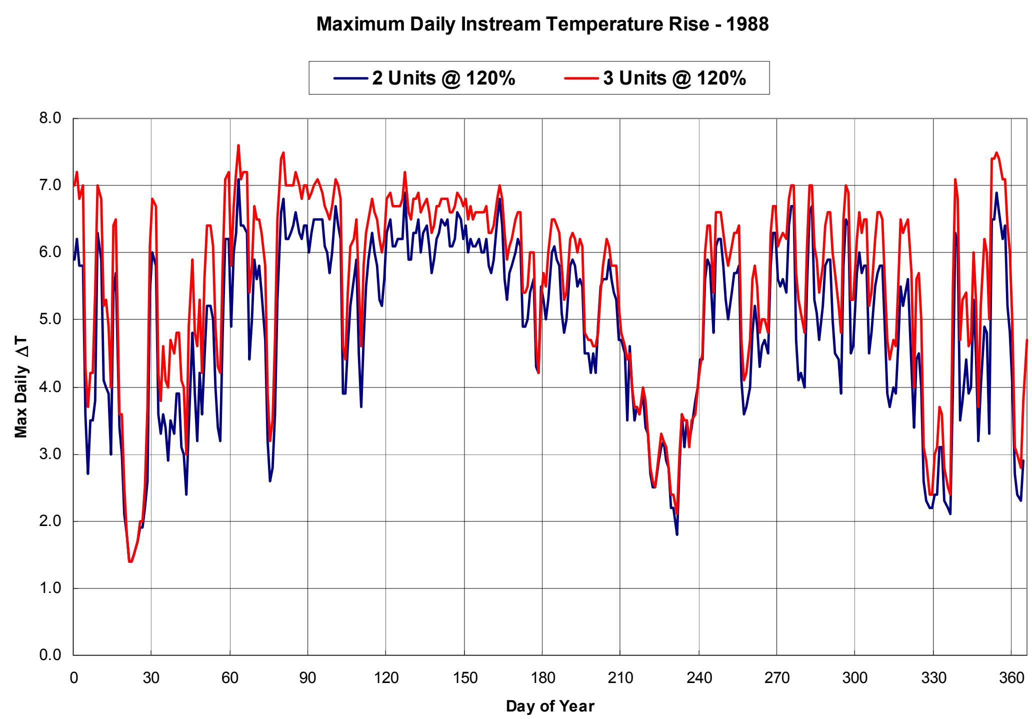


Figure E.4-4 – Water Temperatures for Two-Unit and Three-Unit Operation, 1988

Results from the two-dimensional, far-field model provide estimates of the thermal effects on reservoir water temperatures (i.e., beyond the plant mixing zone), dissolved oxygen (DO) concentrations, and eutrophication (Shiao, et al., 1993). The model was run for six years, 1987-1994, excluding years 1989 and 1990, for the reason previously mentioned. This time-frame included a range of operating conditions, including severely hot and dry years, a relatively cold and wet year, and a year of approximately average conditions. Results of the far-field analysis are shown in Table E.4-6 for three reservoir segments: upstream of BFN (TRMs 295.9-294.0), downstream of BFN (TRMs 294.0-291.8) and the reservoir forebay (TRMs 280.7-274.9), which is downstream of BFN and upstream of Wheeler Dam. The following results are emphasized:

- Over the six-year simulation, the far field model predicts an increase in the mean reservoir temperature in the forebay segment from approximately 65.8°F to 66.4°F as Unit 1 is added to Units 2 and 3, all at 120 percent of the original power. For all three units operating at 100 percent original power, the six-year mean water temperature predicted at the reservoir forebay segment was 66.1°F. Thus, the proposed restart of Unit 1 at 120 percent power represents an increase of 0.3°F compared to all three units operating at their original power level and an 0.6°F increase compared to two units operating at 120 percent power. Six-year means of the predicted water temperatures for July and August show a similar trend for the reservoir forebay segment.

- The maximum daily temperature (i.e., the warmest daily average river temperature) over the six-year simulation period predicted for the reservoir forebay ranged from 90.6°F to 90.7°F for all three cases for the years modeled. Thus, the maximum daily temperature downstream of BFN at the reservoir forebay would not be expected to change significantly with the proposed addition of Unit 1 at 120 percent of power.

- The six-year far-field analysis of algal and DO concentrations upstream of the plant and in the reservoir forebay were essentially unchanged under all three operating cases. Thus, significant changes in algal and DO concentrations would not be expected with the proposed addition of Unit 1 at 120 percent power.

Based on these results, as long as the plant maintains compliance with the NPDES regulatory requirements for thermal effects, operation of all three units at 120 percent of original power is expected to have an insignificant effect on reservoir stratification, DO concentrations, eutrophication, and cumulative impacts.

Table E.4-6 – Summary of Wheeler Reservoir Water Quality Far-Field Computer Model Results for Equivalent Weather Years 1987-1988, 1991-1994[1]

Parameter (Units)	Upstream of BFN Reservoir Segment TRM 295.9-294.0			Downstream of BFN Reservoir Segment TRM 294.0-291.8			Reservoir Forebay Reservoir Segment TRM 280.7-274.9		
Temperature (°F)[2]	**Max. Day[3]**	**Mean[4]**	**July-Aug. Mean[5]**	**Max. Day**	**Mean**	**July-Aug. Mean**	**Max. Day**	**Mean**	**July-Aug. Mean**
3 Units at 100%	90.2	65.6	84.6	89.9	66.0	84.9	90.6	66.1	85.1
2 Units at 120%	90.2	65.2	84.3	90.1	65.8	84.7	90.6	65.8	84.9
3 Units at 120%	90.1	65.9	85.0	89.9	66.4	85.3	90.7	66.4	85.3
Difference (3 units 120-100%)	-0.1	0.3	0.4	0.0	0.4	0.4	0.1	0.3	0.2
Algal Biomass (milligrams per liter [mg/L])[6]	**Max. Day**	**Mean**	**July-Aug. Mean**	**Max. Day**	**Mean**	**July-Aug. Mean**	**Max. Day**	**Mean**	**July-Aug. Mean**
3 Units at 100%	7.0	3.4	6.1	6.8	3.2	5.7	7.7	3.4	6.1
2 Units at 120%	7.2	3.5	6.2	6.8	3.2	5.7	8.0	3.5	6.2
3 Units at 120%	7.0	3.2	6.1	6.8	3.1	5.7	7.6	3.3	6.1
Difference (3 units 120-100%)	0.0	-0.2	0.0	0.0	-0.1	0.0	-0.1	-0.1	0.0
Dissolved Oxygen (mg/L)[7]	**Min. Day[8]**	**Mean**	**July-Aug. Mean**	**Min. Day**	**Mean**	**July-Aug. Mean**	**Min. Day**	**Mean**	**July-Aug. Mean**
3 Units at 100%	5.3	8.8	6.8	4.6	8.6	6.4	3.5	8.0	5.2
2 Units at 120%	4.8	8.8	6.7	3.8	8.5	6.1	2.9	7.9	4.8
3 Units at 120%	5.2	8.8	6.7	4.6	8.6	6.3	3.4	8.0	5.2
Difference (3 units 120-100%)	-0.1	0.0	-0.1	0.0	0.0	-0.1	-0.1	0.0	0.0

[1]All values in table are from model simulation results and are based on the daily average for the parameter indicated. 1989-1990 model results were omitted because historical meteorological data were not available.
[2]All temperature values are based on model results at the 5-foot depth.
[3]Max. day is the maximum daily value (1 day) out of the six-year period.
[4]Mean is the average of all daily values (2,192 days) over the six-year period.
[5]July-Aug. mean is the average of all June and July daily values (390 days) over the six-year period.
[6]Algal biomass values are based on model results at the 5-foot depth.
[7]Dissolved oxygen values are based on model results for the water column average.
[8]Min. day is the minimum daily value (1 day) out of the six-year period.

> 4. Provide estimates, on a daily, monthly, and annual basis, of the species and numbers of fish and shellfish susceptible to heat shock.

TVA studies have documented that thermal releases from BFN have not had a significant impact on the aquatic community of Wheeler Reservoir (TVA, 1983, Baxter and Buchanan, 1998 and Baxter and Gardner 2003).

Discharge temperatures will remain within the NPDES permit limits; thus, heat shock impacts are not anticipated

> 5. Provide estimates of the mortality of heat-shocked fish and shellfish.

TVA studies have documented that thermal releases from BFN have not had a significant impact on the aquatic community of Wheeler Reservoir (TVA, 1983, Baxter and Buchanan, 1998 and Baxter and Gardner 2003).

Discharge temperatures will remain within the NPDES permit limits; thus, heat shock impacts are not anticipated

> 6. Provide estimates of the numbers of adult fish and shellfish that are lost to the water body because of heat shock. Provide full documentation of analytical or modeling techniques that were used to extrapolate localized heat shock losses to resulting long-term, far-field effects. As appropriate, express these "equivalent adult" losses in terms of the total estimated numbers of adults in the water body and commercial and recreational harvests.

TVA studies have documented that thermal releases from BFN have not had a significant impact on the aquatic community of Wheeler Reservoir (TVA, 1983, Baxter and Buchanan, 1998 and Baxter and Gardner 2003).

Discharge temperatures will remain within the NPDES permit limits; thus, heat shock impacts are not anticipated

> 7. If aquatic resources have been monitored, provide an analysis of time trends in the data that might indicate whether fish and shellfish populations have increased, decreased, or remained stable during the initial period of operation. Possible causes for these time trends should be discussed.

Refer to section 4.1.1 which describes the fish and shellfish resources found in Wheeler Reservoir. Results of operational monitoring (Buchanan, 1990; Baxter and Buchanan, 1998; Baxter and Gardner, 2003) of Wheeler Reservoir fish and macroinvertebrate community indicated no adverse impacts from thermal discharges in the vicinity of BFN.

8. Identify and, to the extent possible, quantify losses of fish and shellfish from other sources (e.g., other water withdrawals and discharges, temperature and water quality problems, entrainment and impingement) in order to assess possible cumulative effects of heat shock losses when combined with other losses.

Refer to section E.4.2 Entrainment of Fish and Shellfish in Early Life Stages and Section E.4.3 Impingement of Fish and Shellfish.

9. Describe mitigation measures that have been used to reduce the adverse impacts of heat shock during the initial license period. Describe additional mitigation measures that could be used during the license renewal period and their expected effects on heat shock losses. Identify mitigation measures that will be implemented, and briefly explain the rationale for not implementing any measures that were considered but rejected.

TVA studies have documented that thermal releases from BFN have not had a significant impact on the aquatic community of Wheeler Reservoir (TVA, 1983, Baxter and Buchanan, 1998 and Baxter and Gardner, 2003).

Discharge temperatures will remain within the NPDES permit limits; thus, heat shock impacts are not anticipated.

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E.4.5 GROUNDWATER USE CONFLICTS (PLANT USING >100 GPM OF GROUNDWATER)

This section applies to plants that use more than an annual average of 100 gpm (6 L/s) of ground water. Table B-1 reports that

> Plants that use more than 100 gpm may cause ground-water use conflicts with nearby ground-water users.

Specifically, 10 CFR 51.53(c)(3)(ii)(C) requires in part that

> If the applicant's plant . . . pumps more than 100 gallons (total onsite) of ground water per minute, an assessment of the impact of the proposed action on ground water must be provided.

This issue is discussed in Section 4.8.1 of NUREG-1437. This section provides guidance to the applicant for identification and assessment of the environmental impacts of ground-water withdrawal and use during the license renewal period. If the applicant can provide withdrawal records or other evidence that the plant does not pump more than an annual average of 100 gpm (6 L/s) of ground water, the ER should note this fact, and no additional information is needed on this issue.

There is no (<100 gpm) groundwater use by BFN, and site dewatering wells have been inactive since the 1980s. All wells existing on the BFN site are used for environmental monitoring purposes only.

Currently, groundwater is not used by BFN, no groundwater use is anticipated during the renewed license period, and site dewatering wells have been inactive since the 1980s. Although excavations that penetrate the water table may require temporary construction dewatering (< 100 gpm), drawdowns would be temporary and of negligible magnitude to impact off-site private water supplies. No adverse groundwater use impacts are anticipated.

Information and Analysis Content

If the plant pumps more than an annual average of 100 gpm, the following information and analyses should be provided to assess the magnitude and significance of potential groundwater use conflicts during operation.

1. A description of all groundwater aquifers potentially impacted by operation of on-site wells, including approximate areal extent, thickness, porosities, and hydraulic conductivities of aquifer strata. The descriptions should discuss significant uncertainties and inhomogeneities.

2. A description of existing and known future off-site and on-site wells, including average flowrate, peak flowrate, water use, and completion depth.

3. Maps of steady-state piezometric surfaces estimated with on-site and off-site wells at peak pumpage, average pumpage, and no pumpage. These maps should indicate the location of all wells and should annotate each offsite well with the drawdown of the piezometric surface attributable to the onsite wells and with the drawdown of the piezometric surface attributable to the offsite wells. Describe the methods of analysis, including assumptions used.

4. A description of existing and known future water rights (including Native American tribal water rights).

5. A description of any wetlands in the vicinity that might be impacted by a lowered watertable.

6. An evaluation of the significance of present and future effects of onsite withdrawal on offsite wells and an assessment of the need for mitigation measures to reduce the adverse impacts, if any.

7. If a need for mitigation measures is found, discuss possible measures and whether they will be implemented.

This issue is not applicable since there is no (<100 gpm) groundwater use at BFN.

E.4.6 GROUNDWATER USE CONFLICTS (PLANTS USING COOLING TOWERS WITHDRAWING MAKE-UP WATER FROM A SMALL RIVER)

This section applies to plants using cooling towers withdrawing makeup water from a small river. Table B-1 reports that

> Water use conflicts may result from surface water withdrawals from small water bodies during low flow conditions which may affect aquifer recharge, especially if other ground-water or upstream surface water users come on line before the time of license renewal.

Specifically, 10 CFR 51.53(c)(3)(ii)(A) requires in part that

> If the applicant's plant utilizes cooling towers . . . and withdraws make-up water from a river whose annual flow rate is less than 3.15×10^{12} ft^3/year (9×10^{10} m^3/year) . . . . The applicant shall also provide an assessment of the impacts of the withdrawal of water from the river on alluvial aquifiers during low flow.

This issue is discussed in Section 4.8.1.3 of NUREG-1437.

If the applicant can provide evidence in the ER that its plant does not withdraw cooling tower make-up water from a small river [annual flow rate less than 3.15×10^{12} ft^3/year (9×10^{10} m^3/year)], no additional information is needed on this issue.

This issue is applicable to BFN because the plant uses cooling towers and withdraws makeup water from the Tennessee River, which has an average unregulated stream flow at Wheeler Dam of 1.57×10^{12} ft^3/year (49,800 cfs) and is therefore categorized as a small river.

Information and Analysis Content

If the plant withdraws cooling tower make-up water from a small river, the following information and analyses should be provided to assess the ground-water use conflicts during operation.

1. A description of alluvial aquifers near the site that could be affected by surface-water withdrawal, including approximate areal extent, thickness, porosities, and hydraulic conductivities of aquifer strata.

Although, shallow groundwater at BFN can occur within unconsolidated terrace deposits of alluvial origin, the terrace deposits are not recognized as an aquifer at the site. This is primarily due to the limited permeability and spatial extent of the terrace deposits. Therefore, there are no groundwater use conflicts associated with surface water withdrawals during low flow conditions which may affect aquifer recharge.

2. A description of existing and known future off-site and on-site wells, including average flow rate, peak flow rate, water use, and completion depth.

This is not applicable since there are no existing or proposed off-site or on-site groundwater supply wells.

A total of 18 environmental monitoring wells have been installed at the BFN site since 1980 and groundwater level measurements were initially monitored on a monthly basis. These wells are not used for groundwater supply.

Although an original plant bedrock monitoring well (well 7) was located about 100 feet southwest of pond A (between the pond and the river), it was destroyed when the Ecolochem building was constructed.

An off-site well survey was conducted in May 1995 to identify groundwater supplies within a two-mile radius of the BFN site and this information is provided by TVA (1999). The closest known public groundwater supply (Limestone County Water System, Well G-1) resides approximately two-miles north of BFN (ADEM, 2001). There is no groundwater use by BFN (< 100 gpm), and site dewatering wells have been inactive since the 1980s. All wells at the site are used for environmental monitoring purposes only.

3. Maps of steady-state piezometric surface estimated with on-site and off-site wells at peak pumpage, average pumpage, and no pumpage. These maps should indicate the location of all wells, and each offsite well should be annotated with the drawdown of the piezometric surface attributable to the onsite wells and with the drawdown of the pieziometric surface attributable to the offsite wells.

This is not applicable since there is no (<100 gpm) ground water use at BFN.

4. A description of existing and known future water rights (including Native American tribal water rights).

Rights to “use” of groundwater at BFN were acquired by ownership of property overlying aquifers. There are no future water rights to groundwaters underlying BFN (including Native American tribal rights).

5. A description of any wetlands in the vicinity that might be impacted by a lowered water table.

The water regimes of the onsite wetlands include temporary and seasonal saturation and inundation resulting from precipitation, surface runoff, and seasonal high water tables. During periods of low precipitation and low water tables in the late summer and early fall, it is likely that these wetlands contain only limited areas of inundation or saturation, or are dry.

6. An evaluation of the significance of present and future effects of onsite withdrawal on offsite wells and wetlands, and the need for mitigation measures to reduce the adverse impacts.

Currently, groundwater is not used by BFN, no groundwater use is anticipated during the renewed license period, and site dewatering wells have been inactive since the 1980's. Since any shallow groundwater drawdowns during construction would be temporary and of negligible magnitude (4.3.7.2) and no adverse impacts to groundwater resources are anticipated, no wetland impacts associated with lowered water tables are expected to occur.

Activities potentially affecting groundwater resources would include foundation treatment, excavation, and grading associated with new facilities. These facilities include a mechanical draft cooling tower, a Dry Cask Storage Facility, a Modifications Fabrication Building, and a permanent Administration Building. Although no groundwater use is anticipated during construction, excavations that penetrate the water table may require temporary construction dewatering. Therefore, transient impacts to groundwater resources from dewatering activities might be expected to produce localized and temporary reductions in the groundwater table. Although several water supplies are known to exist in the area, the only water supply identified close to BFN was Limestone County Water System Well G-1, more than two miles north of the proposed project site. Any groundwater drawdown impacts associated with plant construction dewatering would be temporary and of negligible magnitude due to the limited excavation depths, the relatively short duration of facility construction, and the distance of neighboring wells.

Excavation and grading associated with construction of the new facilities would result in permanent displacement of shallow soils above the water table. However, the long-term impact of these activities on groundwater resources would be negligible for all facility configurations given the limited depth and area of disturbance. The areas proposed for the mechanical draft or hyperbolic cooling towers are underlain by weathered Tuscumbia limestone and Fort Payne chert bedrock that might require foundation treatment for stabilization. Although permanent local impacts to groundwater levels and movement might be experienced from foundation treatment, the long-term impacts of these activities on groundwater resources would be negligible for the new cooling tower configuration given the limited area of disturbance.

A secondary construction concern is associated with potential contaminant releases during construction activities. The potential contaminants are primarily fuels, oils, and solvents used for operation and maintenance of vehicles and equipment. However, this potential risk would be lessened by careful handling and proper disposal of potential contaminants according to BMP guidelines. Possible BMP measures include careful handling and proper disposal of contaminants according to guidelines of the BFN Spill Prevention, Control and Countermeasure Plan.

No adverse impacts to groundwater resources are anticipated from operation and maintenance of new facilities through the renewed license period.

Effluent discharges from plant systems such as yard drains, station sumps, and sanitary wastewater would not be expected to change significantly during three-unit operation through the renewed license period. Considering that the plant wastewater lagoons and sedimentation ponds possess clay and Hypalon liners, respectively, no impacts to groundwater resources are anticipated. The changes in pond/lagoon discharges to the river would remain within the bounding conditions established in the NPDES. These permits are renewed every five years and this helps to ensure that no changes have been made to the facility that would alter aquatic impacts and that no significant adverse impacts have occurred.

7. Possible mitigation measures, if they are needed, and whether they will be implemented.

No mitigation measures are needed.

E.4.7 GROUNDWATER USE CONFLICTS (PLANTS USING RANNEY WELLS)

> This section applies to plants using Ranney wells for cooling tower make-up water. This section provides guidance to the applicant on identification and assessment of the environmental impacts of ground-water withdrawal and use during the license renewal period. If the plant does not use Ranney wells, the ER should note the fact without further discussion.
>
> This issue is a combination of two related issues discussed in Section 4.8.1 of NUREG-1437.
>
> Table B-1 reports that
>
> > Ranney wells can result in potential ground-water depression beyond the site boundary. Impacts of large ground-water withdrawal for cooling tower makeup at nuclear power plants using Ranney wells must be evaluated at the time of application for license renewal.
>
> Specifically, 10 CFR 51.53(c)(3)(ii)(C) requires in part that
>
> > If the applicant's plant uses Ranney wells . . . an assessment of the impact of the proposed action on ground-water use must be provided.
>
> If the plant does not use Ranney wells, this fact should be noted in the ER and no further information need be provided.

This issue of ground water use conflicts does not apply to BFN, because the plant does not use Ranney wells and there are no future plans for construction of Ranney wells at the site.

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E.4.8 DEGRADATION OF GROUNDWATER QUALITY

This section applies to plants at inland sites with cooling ponds.

Table B-1 notes that

> Sites with closed-cycle cooling ponds may degrade ground-water quality. For plants located inland, the quality of the ground water in the vicinity of the ponds must be shown to be adequate to allow continuation of current uses.

Specifically, 10 CFR 51.53(c)(3)(ii)(D) requires that

> If the applicant's plant is located at an inland site and utilizes cooling ponds, an assessment of the impact of the proposed action on ground-water quality must be provided.

This issue is discussed in Section 4.8.3 of NUREG-1437.

If the plant does not use cooling ponds or if the cooling ponds are adjacent to salt marshes, the ER should note the fact and no further information need be provided.

In the strictest sense, this issue is not applicable to BFN because cooling ponds are not used at the site. However, for completeness, other similar features at the BFN site are described below.

Wastewater Lagoons. There is a series of three interconnected lagoons located north of the switchyard that are used to provide secondary treatment for the plant's sanitary wastewater. The lagoons were constructed using compacted clay and possess no synthetic linings. There is no monitoring of lagoon influent. However, effluent is discharged under the plant NPDES permit (DSN 013a(1)) that is monitored for flow, pH, BOD5, TSS, and fecal coliform. There are no groundwater monitoring wells installed in the vicinity of these lagoons.

Sedimentation Ponds. There are two sedimentation ponds (Ponds A & B) located east of the plant and adjacent to the end of the central perimeter (switchyard) drainage ditch. These ponds are both lined with Hypalon Synthetic liners. The ponds receive reject water from the Ecolochem Reverse Osmosis process used to generate demineralized water for the plant, water discharged from the Diesel Generator building sumps, and water from the Water Intake Building sump. Discharge from Pond A, the larger of the two ponds, is permitted under an NPDES permit (DSN 013b). The pond is released on a batch basis as needed, and the outfall is monitored for flow, pH, TSS and Oil and Grease under the terms of the NPDES permit. Pond B has no outfall. When it fills, effluent from Pond B is manually pumped to Pond A and released through the permitted outfall. Piping and valves are provided to allow flexibility in filling either of the ponds. There are no groundwater monitoring wells installed in the vicinity of these ponds. Although an original plant bedrock monitoring well (well 7) was located about 100 feet southwest of pond A (between the pond and the river), it was destroyed when the Ecolochem building was constructed.

Effluent discharges from plant systems such as yard drains, station sumps, and sanitary wastewater would not be expected to change significantly during three-unit operation and through the renewed license period. Considering that the plant wastewater lagoons and sedimentation ponds possess clay and Hypalon liners, respectively, no impacts to groundwater resources are anticipated. The changes in pond/lagoon discharges to the river would remain within the bounding conditions established in the NPDES. These permits are renewed every five years and this helps to ensure that no changes have been made to the facility that would alter aquatic impacts and that no significant adverse impacts have occurred.

Information and Analysis Content

If the plant uses cooling ponds and is not adjacent to salt marshes, the following information and analyses should be provided to assess the presence and magnitude of ground-water quality degradation during operation.

1. Cooling pond characteristics (e.g., liners or impermeable materials used, impermeable soils) that would retard or prevent infiltration into local aquifers.

2. Types and concentrations of impurities in the cooling pond water and chemistry of soils along pathways to local aquifers to determine whether cooling pond water can contaminate the ground water.

3. Water quality and other characteristics of local aquifers that could be affected by infiltration of cooling pond water.

4. Federal, State, and local ground-water quality requirements with emphasis on any changes to these requirements that have occurred during the plant's initial license term and any anticipated changes to those requirements during the license renewal term.

5. Identification and characterization of offsite ground-water users who could be affected by the degradation of aquifers. Characterization should include locations and elevations of off-site wells, their pumping rates, and the water needs of ground-water users.

6. A quantitative description of the cumulative effects of using closed cycle cooling ponds on ground-water quality. This description should include maps of the contaminant plume. Information should be provided on ground-water contamination existing at the time of license renewal application and projected contamination during the license renewal period.

7. The mitigation measures proposed to avoid or minimize ground-water quality degradation and the estimated impact of implementing those measures. Briefly explain the rationale for not implementing any measures that were considered but rejected.

This issue is not applicable.

E.4.9 IMPACTS OF REFURBISHMENT ON TERRESTRIAL RESOURCES

Table B-1 notes that

> Refurbishment impacts are insignificant if no loss of important plant and animal habitat occurs. However, it cannot be known whether important plant and animal communities may be affected until the specific proposal is presented with the license renewal application.

Specifically, 10 CFR 51.53 (c)(3)(ii)(E) requires in part that

> All license renewal applicants shall assess the impact of refurbishment and other license-renewal-related construction activities on important plant and animal habitats.

This issue is discussed in Section 3.6 of NUREG-1437.

The applicant should describe in Chapter 3 of the ER any activities associated with license renewal that will involve disturbance of any plant or wildlife habitat. If no area will be disturbed, the fact should be noted in Section 4.2.9 of the ER, and no further discussion of the issue is needed. Areas to be disturbed should be described in Chapter 2 of the ER with respect to (1) the amount of land to be disturbed, (2) ecological characteristics of the habitat, (3) species of plants and animals found in the area, and (4) the extent to which the habitat is unique. Note that the information and analysis for this issue overlaps the information and analysis covered in Section 4.10 of this guide for assessing impacts on threatened and endangered species.

There will be some disturbance of existing plant communities in conjunction with the addition of a new cooling tower for three-unit operation, and the relocation of soil that would accompany its construction. With respect to vegetation, any direct, indirect, or cumulative impacts to the terrestrial ecology resources of the region are expected to be insignificant as a result of these activities.

As part of the preparations for return to three-unit operation there will also be the construction of three new facilities. These construction activities would result in the removal of some early successional habitats in the vicinity of the existing facilities.

Because no intact native plant communities occur on lands to be disturbed by these construction activities, and because introduced plant species are already present in these areas, any direct, indirect, or cumulative impacts due to the establishment or spread of introduced plant species are anticipated to be insignificant as a result of the actions associated with these activities.

As described earlier, most areas on BFN have been previously disturbed and provide limited wildlife habitat. Terrestrial wildlife species found at BFN are generally common and have widespread distributions. No uncommon wildlife communities or important terrestrial habitats occur within, or immediately adjacent to, BFN.

Refurbishment for the return to three-unit operation will entail constructing a cooling tower and new buildings. In addition, new spent fuel storage capacity is also being constructed. Construction will take place near existing developed areas on BFN. In some cases these areas are devoid of vegetation or otherwise contain disturbed, early successional habitat. With respect to wildlife, any direct, indirect, or cumulative impacts to terrestrial ecology resources, as a result of these activities, are expected to be insignificant. This construction would not significantly contribute to the spread of invasive terrestrial animals in the vicinity.

No wetlands meeting USACE parameters for federal jurisdictional wetlands, and no wetlands identified by the National Wetland Inventory (NWI), occur on any portion of the sites proposed for construction and excavation or disposal of spoil materials. Therefore, there would be no impacts or effects upon wetlands in the proposed project area under any of the alternatives.

Following the return to three-unit operability, no further construction activities are expected to be needed for continuing operation through the renewed license period.

If any license renewal activity will disturb any plant or wildlife habitat, the following information and analyses should be provided.

1. The applicant should determine whether any of the plant and animal species are important. Important species are those that either (1) have high public interest or economic value or both or (2) may be critical to the structure and function of the ecosystem or provide a broader ecological perspective of an area. Important habitats are defined as those that support important species. Specific guidance on identifying important species to be evaluated is found in "U.S. Fish and Wildlife Service Mitigation Policy; Notice of Final Policy." Federal, State, and regional government agencies with jurisdiction over biological resources, and organizations concerned with such resources like the State office of The Nature Conservancy, should be consulted to assist with the identification of important species and habitats. If no important species is identified, the basis for this finding should be summarized in Section 4.2.9 of the ER, and no further discussion of this issue is needed.

No uncommon terrestrial communities or otherwise unusual or sensitive vegetation occur on or immediately adjacent to the lands to be disturbed by activities associated with recovery of Unit 1 and returning to three-unit operation. No further land disturbance is anticipated for continuing operation through the renewed license period.

> 2. If important plant or animal species are identified, the significance of the loss in population of the species should be assessed with respect to local, regional, and national social, economic, and ecological value.

Because no rare or uncommon communities of plants or animals exist on the site, activities associated with the return to three-unit operation would not result in adverse impacts to any uncommon wildlife or their habitats. No further disturbance of habitats is anticipated for continuing operation through the renewed license period.

> 3. Mitigation measures that are proposed, considered, or adopted to minimize the adverse impacts should be described. Briefly explain the rationale for not implementing any measures that were considered but rejected. Further guidance on determining the appropriate level of mitigation and methods for accomplishing mitigation can be found in the U.S. Fish and Wildlife Service Mitigation Policy (46 FR 7644, January 23, 1981).

No mitigation measures are needed.

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E.4.10 THREATENED OR ENDANGERED SPECIES

Table B-1 notes that

> Generally, plant refurbishment and continued operation are not expected to adversely affect threatened or endangered species. However, consultation with appropriate agencies would be needed at the time of license renewal to determine whether threatened or endangered species are present and whether they would be adversely affected.

Specifically, 10 CFR 51.53(c)(3)(ii)(E) requires, in part, that

> … Additionally, the applicant shall assess the impact of the proposed action on threatened or endangered species in accordance with the Endangered Species Act.

This issue is discussed in Sections 2.3.6, 3.9, and 4.1 of NUREG-1437.

In accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 USC 1531 *et seq.*), Federal agencies must review actions they undertake or support (such as issuing permits and licenses) to determine whether they may jeopardize the continued existence of an endangered species or their habitats. If such review reveals the potential for adversely affecting listed or candidate species, the Federal agency must consult with the U.S. Fish and Wildlife Service (FWS) or the National Marine Fisheries Service (NMFS), as appropriate. The interagency cooperation provisions of Section 7 are implemented by the FWS and the NMFS at 50 CFR Part 402. Further, Section 9 of the ESA prohibits certain actions by a Federal agency, licensee, or potential licensee that may hurt an endangered species or its habitat. The prohibited acts provisions of Section 9 are implemented at 50 CFR 17.31(a) and 17.71(a).

The applicant should determine whether the site and vicinity are within the range of listed species, and if they are, an assessment is made of the extent to which refurbishment activities associated with license renewal and continued plant operation are likely to jeopardize the continued existence of those listed species or to result in the destruction or adverse modification of critical habitat. If in compiling information and assessing the effects of license renewal on threatened and endangered species a need arises to consult with either FWS or NMFS, the prospective applicant should notify NRC so that the NRC can coordinate the consultation. Three levels of consultation are identified in 50 CFR Part 402, Subpart B--Consultation Procedures: (1) Early consultation (Sec. 402.11), (2) Informal consultation (Sec. 402.13), and (3) Formal consultation (Sec. 402.14). Most consultations are conducted informally with Federal agencies. If a prospective applicant feels a need to discuss data availability and interpretation with either FWS or NMFS, the NRC should be requested to initiate informal consultation. The prospective applicant should request NRC to initiate early consultation when, in developing information on threatened or endangered species, there is reason to believe that an endangered species or a threatened species may be present in the area affected by its project and that implementation of such action will likely affect such species. Consultation, as defined in 50 CFR Part 402, may not always be needed to complete this section of the ER. If the consultation process has not been initiated prior to submittal of the ER, NRC will fulfill its consultation requirements in preparing the SEIS. Consultation procedures are discussed in "Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act," U.S. Fish and Wildlife Service and National Marine Fisheries Service, March 1998.

Information and Analysis Content

The ER should include the following.

1. Reference should be made to threatened or endangered species, or candidate species, and critical habitat that may be found on the site or in the vicinity of the site as identified in Chapter 2; this should include the area within the applicant's transmission line corridor identified in Chapter 2 as being constructed to connect the plant to the transmission system. Reference should be made to any license renewal activities that will disrupt any natural areas and to modifications to plant operation that may change the effect on the environment, as identified in Chapter 3. If there has been early consultation with the FWS or the NMFS, reference should be made to any resulting FWS or NMFS memoranda.

Terrestrial Animals

As reported earlier, five protected terrestrial animals are reported from Limestone County, Alabama. Gray bats are not expected to occur on BFN; however, they likely forage along the shoreline of the Tennessee River near BFN.

Due to the lack of suitable habitat, only one species, the Appalachian Bewick's wren, a state-listed protected species, may occur on BFN. If Appalachian Bewick's wrens occur in the area, activities associated with Unit 1 recovery and the return to three-unit operation would not eliminate habitat for this species. Any impacts to this species, as a result of these activities, would be temporary and localized; and therefore, insignificant. The proposed license renewal has no additional associated activities and therefore would not result in adverse impacts to any listed terrestrial animals or their habitats, including the federally-endangered gray and Indiana bats.

Aquatic Animals

Five federally listed endangered aquatic species are known to occur in either the main channel of the Tennessee River (Wheeler Reservoir) or its tributaries in the vicinity (within a 15-mile radius) of BFN. Five state-listed species are also known to occur in this area (Table E.4-7). An additional thirty-seven (37) federally or state-listed aquatic animal species, such as the Orangefoot Pimpleback mussel (*Plethobasus cooperianus*), the Cracking Pearly mussel (*Hemistena lata*), the Fine-Rayed Pigtoe mussel (*Fusconaia cuneolus*), the Shiny Pigtoe mussel (*F. cor*), the Slackwater Darter (*Etheostoma boschungi*), the Boulder Darter (*E. wapiti*), and the Alabama Blind Cave Shrimp (*Palaemonias alabamae*) are known to occur in the general North Alabama area (i.e., Limestone, Lawrence, and Morgan Counties). None of these species are presently known to exist in the vicinity of BFN.

Table E.4-7 – Federally- and State-Listed Aquatic Animals

Common Name	Scientific Name	Federal Status	State Status	Recent Record in the vicinity of BFN?
SNAILS				
Armored Snail	*Pyrgulopsis pachyta*	Endangered	Protected	Yes
Slender Campeloma	*Campeloma decampi*	Endangered	Protected	Yes
Anthony's River Snail	*Athearnia anthonyi*	Endangered	Protected	Yes
Warty Rocksnail	*Lithasia lima*	-	NOST	Yes
Varicose Rocksnail	*Lithasia verrucosa*	-	NOST	-
MUSSELS				
Rough Pigtoe	*Pleurobema plenum*	Endangered	Protected	Yes
Pink Mucket	*Lampsilis abrupta*	Endangered	Protected	Yes
Pink Papershell	*Potamilus ohiensis*	-	NOST	Yes
Spectaclecase	*Cumberlandia monodonta*	-	Protected	Yes
Orangefoot Pimpleback	*Plethobasus cooperianus*	Endangered	Protected	-
Ring Pink	*Obovaria retusa*	Endangered	Protected	-
Fluted Kidneyshell	*Ptychobranchus subtentum*	Candidate	NOST	-
Slabside Pearlymussel	*Lexingtonia dolabelloides*	Candidate	Protected	-
Cumberland Monkeyface	*Quadrula intermedia*	Endangered	Protected	-
Cracking Pearlymussel	*Hemistena lata*	Endangered	Protected	-
Fine-Rayed Pigtoe	*Fusconaia cuneolus*	Endangered	Protected	-
Tuberculed Blossom Pearlymussel	*Epioblasma torulosa torulosa*	Endangered	Protected	-
Cumberland Combshell	*Epioblasma brevidens*	Endangered	Protected	-
Dromedary Pearlymussel	*Dromus dromas*	Endangered	Protected	-
Birdwing Pearlymussel	*Lemiox rimosus*	Endangered	NOST	-
Cumberland Bean	*Villosa trabalis*	Endangered	NOST	-
Mountain Creekshell	*Villosa vanuxemensis*	-	NOST	-
Painted Creekshell	*Villosa taeniata*	-	NOST	-
Purple Lilliput	*Toxolasma lividus*	-	NOST	-
Monkeyface	*Quadrula metanevra*	-	NOST	-
Kidneyshell	*Ptychobranchus fasciolaris*	-	NOST	-
Tennessee Clubshell	*Pleurobema oviforme*	-	NOST	-
Cumberland Moccasinshell	*Medionidus conradicus*	-	NOST	-
Pocketbook	*Lampsilis ovata*	-	NOST	-
Butterfly	*Ellipsaria lineolata*	-	NOST	-
Tennessee Pigtoe	*Fusconaia barnesiana*	-	NOST	-
Sheepnose	*Plethobasus cyphyus*	-	Protected	-
CRAYFISH				
A Troglobitic Crayfish	*Cambarus veitchorum*	-	NOST	-
Troglobitic Crayfish	*Procambarus pecki*	-	NOST	-
Troglobitic Crayfish	*Cambarus jonesi*	-	NOST	-

Table E.4-7 (cont.) – Federally- and State-Listed Aquatic Animals				
Common Name	**Scientific Name**	**Federal Status**	**State Status**	**Recent Record in the vicinity of BFN?**
FISH				
Tuscumbia Darter	*Etheostoma tuscumbia*	-	Protected	Yes
Spring Pygmy Sunfish	*Elassoma alabamae*	-	Protected	Yes
Slackwater Darter	*Etheostoma boschungi*	Threatened	Protected	-
Boulder Darter	*Etheostoma wapiti*	Endangered	Protected	-
Tuskaloosa Darter	*Etheostoma douglasi*	-	NOST	-
Paddlefish	*Polyodon spathula*	-	NOST	-
Southern Cavefish	*Typhlichthys subterraneus*	-	Protected	-

State Status Codes:
Protected = Aquatic animals protected under official statutes by the state of Alabama.
NOST = Aquatic animals considered rare or sensitive by the state of Alabama, but having no official listing status.

Two federally-listed mussel species known from the area, the Rough Pigtoe (*Pleurobema plenum*) and the Pink Mucket (*Lampsilis abrupta*) historically occurred in silt-free, stable gravel and cobble habitats in large river habitats throughout the Tennessee River system (Parmalee and Bogan, 1998). These species are now extremely rare and are primarily found in unimpounded tributary rivers and in the more riverine reaches of the largely impounded mainstream Tennessee River. In Wheeler Reservoir, most of the surviving large river habitat occurs upstream of BFN. All recent records of these two species are from upstream of BFN (Ahlstedt and McDonough, 1993; Colaw and Carroll, 1982; Garner, 1998 and 2001; Gooch, et al., 1979; Henson and Pryor, 1982; TVA Regional Natural Heritage Database, 2001; Yokely, 1998). It is very unlikely that populations of these species exist in Wheeler Reservoir adjacent to or downstream of BFN (Koch, 1999). Two state-listed mussels; Pink Papershell (*Potamilus ohiensis*), and Spectaclecase (*Cumberlandia monodonta*), are also reported from the Tennessee River upstream of BFN, and are not likely to be found downstream of BFN.

Three federally-listed endangered aquatic snails, Armored Snail (*Pyrgulopsis pachyta*), Slender Campeloma (*Campeloma decampi*), and Anthony's River Snail (*Leptoxis* [=*Athearnia*] *anthonyi*), are restricted to tributary creeks to Wheeler Reservoir upstream of BFN. No evidence exists to suggest that populations of these species exist in the mainstem of the Tennessee River (Wheeler Reservoir) in the vicinity of BFN, or in tributary streams downstream of BFN. One state-listed snail Warty Rocksnail (*Lithasia lima*) is reported from tributary streams upstream of BFN, but is not likely to occur in the mainstem Tennessee River adjacent to or downstream of BFN.

Two state-listed fish species; Tuscumbia Darter (*Etheostoma tuscumbia*) and Spring Pygmy Sunfish (*Elassoma alabamae*), are known to occur in tributary streams upstream of BFN. The Tuscumbia Darter was reported (in pre-impoundment surveys) from areas along the Tennessee River in the vicinity of the BFN site that are now inundated by Wheeler Reservoir. These populations are no longer believed to exist. Populations of the Spring Pygmy Sunfish are known only from a few tributary streams upstream of

BFN. No existing populations of Spring Pygmy Sunfish are known from tributary streams downstream of BFN.

2. Reference should be made specifically to any adverse impacts on listed and candidate threatened or endangered species or critical habitat found in the review of the topics in the following 10 sections of this guide.

4.1.1 Instream Ecological Communities
4.1.2 Riparian Ecological Communities
4.2 Entrainment of Fish and Shellfish in Early Life Stages
4.3 Impingement of Fish and Shellfish
4.4 Heat Shock
4.5 Ground-Water Use Conflicts (Plants Using >100 gpm of Ground Water)
4.6 Ground-Water Use Conflicts (Plants Using Cooling Towers Withdrawing Make-Up Water from a Small River)
4.7 Ground-Water Use Conflicts (Plants Using Ranney Wells)
4.8 Degradation of Ground-Water Quality
4.9 Impacts of Refurbishment on Terrestrial Resources

As described above, five listed species of animals are reported from Limestone County. Activities associated with Unit 1 recovery and continuing three-unit operation through the renewed license period would not result in adverse impacts to federally listed gray or Indiana bats. Gray bats likely forage along the shoreline of the Wheeler Reservoir, adjacent to the nuclear plant. However, planned facility modifications (including construction of the additional cooling tower) and renewal of the operating licenses resulting in the continued operation of the nuclear plant would not affect this species because gray bats only forage over aquatic habitats and their foraging areas would not be altered by these activities. No suitable habitat for Indiana bats or the Tennessee cave salamander exists on the project site. Some habitat suitable for the state-listed Appalachian Bewick's wren exists on the site; however, the planned modifications at the site would not eliminate this habitat. Therefore, operation is expected to have no effect on listed terrestrial species or their critical habitat.

As described above, there are five federally protected aquatic species in Wheeler Reservoir in the vicinity of BFN, but these are found in habitats upstream of the plant. During the three phases of BFN's thermal variance monitoring (1985-1998) and current Vital Signs Monitoring programs, no threatened or endangered aquatic species were found within the area affected by construction or operational changes at BFN as proposed herein. The seven survey reports cited in section 3.11.1 support the conclusion that either the activities associated with the return to three-unit operation or the continued operation through the renewed license period would have no effect on the species listed in Section 3.11.2.

No occurrences of rare (i.e., federal- or state-listed) plant species are known on or immediately adjacent to the lands to be disturbed associated with the proposed action. Therefore, no effects to rare plant species are anticipated.

3. A determination should be made whether the information from items 1 and 2 can support a conclusion either that there are no candidate, threatened, or endangered species or critical habitat in the site vicinity or that there are no activities associated with license renewal or changes in plant operating conditions that would adversely affect such species or critical habitat, if present. If such a determination can be made, it should be documented in this section, and no further analysis is required.

4. If the determination described in item 3 can not be made, an assessment of whether license renewal is likely to affect endangered species should be made. The content of the assessment should be guided by the content of a biological assessment suggested at 50 CFR 402.12(f). Early discussions with the State wildlife or fisheries agency, the State's Natural Heritage Program, local field offices of the FWS or NMFS, and the State office of The Nature Conservancy can provide useful information for designing the biological assessment. At this point in the development of the ER, discussion with the FWS or the NMFS would constitute either informal or early consultation, therefore the potential applicant should immediately request guidance on the early consultation process from the NRC. As a result of consultation, FWS or NMFS may require a biological assessment, especially if there are construction activities involved in license renewal.

5. If the assessment supports a determination that license renewal will not adversely affect listed or candidate species, the determination should be documented in this section. Documentation should include a description of the assessment and contacts with government agencies and private organizations. If a biological assessment is prepared, it should be provided to the NRC for submittal to the FWS or the NMFS for review and issuance of a preliminary biological opinion. Concerns raised by these agencies should be resolved, to the extent possible, to minimize the potential for endangered species being an issue during the NRC review and the FWS and NMFS review of the draft SEIS. The biological assessment should be included in the Environmental Report, and the biological opinion should also be included if it is available when the application is submitted.

6. If the biological assessment results in a determination of "may affect" listed species or designated critical habitat, or if the FWS or NMFS does not concur in writing with a finding that there will be no effects, or that the reasonably expected effects will be beneficial, insignificant, or discountable, the NRC will initiate formal consultation with the FWS or the NMFS in accordance with Section 7(a)(3) of the ESA. The applicant must participate fully in the consultation and furnish NRC with any additional information or studies that may be required. Requirements for formal consultation are given in 50 CFR 402.14 and in Chapter 4 of the Consultation Handbook. The status of consultation activities and findings, including a biological opinion issued by FWS or NMFS prior to submittal of an application, should be reported in the ER.

7. If a "jeopardy" opinion is issued, the applicant will be responsible for considering and responding, through the NRC, to any reasonable and prudent alternatives identified in the biological opinion. The response must be in accordance with the "incidental take" provisions at 10 CFR 402.14(i).

Based on the discussions above, no activities associated with either the return to three-unit operation or continuing operation through the renewed license period are anticipated to adversely affect candidate, threatened, or endangered species or critical habitat; and therefore, no further analysis is required.

E.4.11 AIR QUALITY DURING REFURBISHMENT (NONATTAINMENT AREAS)

Table B-1 states that

> Air quality impacts from plant refurbishment associated with license renewal are expected to be small. However, vehicle exhaust emissions could be cause for concern at locations in or near nonattainment or maintenance areas. The significance of the potential impact cannot be determined without considering the compliance status of each site and the numbers of workers expected to be employed during the outage.

Specifically, 10 CFR 51.53(c)(3)(ii)(F) requires that

> If the applicant's plant is located in or near a nonattainment or maintenance area, an assessment of vehicle exhaust emissions anticipated at the time of peak refurbishment work force must be provided in accordance with the Clean Air Act as amended.

The 1990 amendments to the Clean Air Act include a provision that no Federal agency may support any activity that does not conform to a State Implementation Plan (SIP) designed to achieve the National Ambient Air Quality Standards (NAAQS). On November 30, 1993, the EPA issued a final rule implementing the new statutory requirements for this provision (58 FR 63214); the rule was effective January 31, 1994. The final rule requires that Federal agencies prepare a written conformity analysis and determination for proposed actions in NAAQS nonattainment or maintenance areas for which the total of the action's direct and indirect emissions that contribute to criteria pollutants (i.e., ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, lead, and particulate matter less than 10 microns in diameter) would exceed threshold emission levels of 40 CFR 51.853(b).

The threshold emission levels serve as a screen to determine whether a conformity analysis should be performed for a proposed action. The threshold emission levels range from 10 to 100 tons (9 to 91 metric tons) per year. The EPA considers it extremely unlikely that emissions below the threshold emission levels would affect a nonattainment or maintenance area. If the threshold emission levels are not exceeded, a conformity analysis is not required unless the total direct and indirect emissions are 10% or more of a nonattainment or maintenance area's total emissions for that pollutant. Under this latter scenario, the action is defined as a "regionally significant action" and requires a conformity analysis.

Information and Analysis Content

The applicant should consult with the appropriate EPA regional office and the State air quality regulatory agency. Discussions with staff at EPA regional offices indicate that there may be some flexibility in the rigor of the analysis that would be acceptable, depending on the particular site, the extent of refurbishment, the pollutants in nonattainment, the severity of the nonattainment, and the State regulatory agency. Such consultations should be documented in the ER.

In support of NRC's responsibility to consider the conformity of its actions with the SIPs, the licensee should provide the following information.

1. Reference the estimates of the monthly incremental onsite work force associated with refurbishment that were reported in Section 3.4. If there will be no refurbishment or if refurbishment involves no additional workers, no further analysis is required.

2. Identify the positions of nonattainment and maintenance areas relative to the plant and probable areas where workers involved with refurbishment activities associated with license renewal will reside. Note the likely commuter routes for the workers. If there are no nonattainment and maintenance areas within 80 km (50 mi) of the plant and residential locations of refurbishment workers, this should be explained in the ER, and no further analysis is required.

3. Identify the pollutant or pollutants for which the area is in nonattainment or maintenance, as well as the severity of nonattainment.

4. Determine the meteorological conditions typically associated with poor air quality in each nonattainment and maintenance area.

5. Compare the meteorological conditions associated with poor air quality with regional climatology.

6. Estimate onsite and offsite vehicle emissions resulting from refurbishment activities that contribute to the pollutants identified in Step 3 (EPA's handbook AP-42, "Compilation of Air Pollutant Emission Factors," is a good reference), and identify the approximate locations of the emissions during the peak employment period. This estimate may be based on the applicant's estimate of vehicle miles associated with refurbishment worker commuting and other activities directly associated with refurbishment and on EPA emission factors found in the handbook AP-42, *Compilation of Air Pollutant Emission Factors*, Vol. 2, Appendix H, "Highway Mobile Source Emission Factors Tables" (5th Edition, April 3, 1998).

7. Determine whether the emissions related to license renewal activities have a reasonable likelihood of adversely affecting air quality in the nonattainment or maintenance area. Climatological considerations, simple atmospheric dispersion models, and conservative assumptions are appropriate for this screening analysis. For each nonattainment and maintenance area determined to have a reasonable likelihood of being adversely affected, continue the analysis in Step 8. No further analysis is required for those areas that were not determined to be adversely affected.

8.a Compare the total emissions calculated in Step 6 with the appropriate threshold emission levels of 40 CFR 51.853(b). If the threshold emission levels are exceeded, proceed to step 9. If not, continue the analysis at Step 8(b).

8.b Determine the nonattainment or maintenance area's total emissions of pollutants identified in Step 3. These determinations need only be sufficiently accurate to support evaluation of the regional significance of emission levels below the threshold emission levels of 40 CFR 51.853(b). Potential sources of this information include EPA regional offices, State and local air quality agencies, and final EISs. If an existing estimate of the area's total emissions is not found, estimate the emissions from readily available information, such as population, traffic counts, and published emission rates, using reasonable assumptions. Identify the information and the assumptions. Information developed for Section 4.18, Transportation, may be of value in this determination.

8.c Compare the total emissions from refurbishment estimated in step 6 with the area's total emissions estimated in 8(b). In accordance with 40 CFR 51.853(i), if the total emissions from refurbishment are 10% or more of the area's total emissions, proceed to Step 9. If not, the emissions are not regionally significant, and no further analysis is required.

9. For those pollutants identified in Step 8, use air dispersion modeling to estimate pollutant concentrations in the ambient air, which in turn are used to evaluate the extent to which refurbishment-related emission would cause or increase the frequency of exceeding threshold emission levels during the refurbishment. If analyses based on peak employment period emission indicate a potential for exceeding of annual air quality limits, the licensee may account for the fact that the refurbishment period is less than a year and that peak employment levels would not occur during the entire refurbishment period.

10. If refurbishment-related emissions would cause or contribute to exceeding threshold emission levels, the applicant should identify and analyze the extent to which potential mitigation measures would minimize the adverse impact on air quality and should briefly identify the rationale for not implementing any measures that were considered but rejected. Explain the extent to which mitigation measures directed at air quality will be coordinated with mitigation of transportation impacts discussed in Section 4.18.

No assessment of vehicle exhaust emissions during the refurbishment period is needed because no air quality nonattainment or maintenance areas are designated at or near the Browns Ferry Nuclear Plant (BFN) site. The designation status is officially documented in CFR 40, Part 81, Subpart C – Section 107, Attainment Status Designations, pp 61-64, revised as of July 1, 2002, and issued by the Government Printing Office. To date, no official designations of nonattainment or maintenance areas that include or are near BFN have been made in the Federal Register since the July 1, 2002 CFR update.

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E.4.12 IMPACT ON PUBLIC HEALTH OF MICROBIOLOGICAL ORGANISMS

With regard to public health effects of thermophilic organisms, Table B-1 states

> These organisms are not expected to be a problem at most operating plants except possibly at plants using cooling ponds, lakes, or canals that discharge to small rivers. Without site-specific data, it is not possible to predict the effects generically.

Specifically, 10 CFR 51.53(c)(3)(ii)(G) requires that

> If the applicant's plant uses a cooling pond, lake, or canal or discharges into a river having an annual average flow rate of less than 3.15×10^{12} ft^3/yr (9×10^{10} m^3/yr), an assessment of the impact of the proposed action on public health from thermophilic organisms in the affected water must be provided.

Plants that use cooling ponds, lakes, canals, or small rivers [i.e., plants that have an annual average flow rate of less than 3.15×10^{12} $ft^3/year$ (9×10^{10} $m^3/year$)] to receive their thermal discharge have a potential to enhance the concentration of thermophilic microorganisms. These include the enteric pathogens *Salmonella* sp. and *Shigella* sp., as well as *Pseudomonas aeriginosa*, thermophilic fungi, *Legionella* sp. in unusually high concentrations, and the free-living amoebae of the genera *Naegleria* and *Acanthomoeba*. Of greatest concern is *Naegleria* (*N.*) sp., four species of which have been isolated. To date, only one species *N. fowleri*, has been determined to be pathogenic in humans.

Information and Analysis Content

If the applicant can show that its plant does not use cooling ponds, lakes, canals, or small rivers to receive its thermal discharge, this fact should be noted in the ER and no further information or analysis is needed. If the plant does use cooling ponds, lakes, canals, or small rivers to receive its thermal discharge, the ER should include the following.

1. The State agency responsible for environmental health should be consulted as to whether there is a concern about the potential existence and concentration of *N. fowleri* in the receiving waters for plant cooling water discharge. The results of this consultation should be documented in the ER.

2. If the State advises that tests should be conducted for concentration of *N. fowleri* in the receiving waters, the tests should be performed when the facility has been operating at a power level typical of the level anticipated during the license renewal period for at least a month to ensure a steady state population during the sampling. Samples should be taken at locations of potential public use.

3. An evaluation of the data should be performed and a determination made of the magnitude of potential impacts of *N. fowleri* on public health during the license renewal term.

4. Proposed mitigation measures to minimize the exposure to members of the public should be described, if deemed necessary, and the rationale for not implementing any measures that were considered but rejected should be explained.

5. A letter report from the head of the State agency responsible for environmental health stating concurrence with the applicant's risk assessment and the proposed mitigation strategy, if one is required, should be included in the ER.

This issue is applicable to BFN because the plant uses the Tennessee River to receive its thermal discharge and the Tennessee River has an average flow rate of 1.47×10^{12} ft^3/year.

The Alabama Department of Public Health (ADPH) was consulted as to whether there are any concerns regarding the potential existence and concentration of thermophilic microorganisms such as *Naegleria fowleri* in the receiving water for plant cooling water discharge. ADPH replied that they are not aware of any such concerns. Copies of this correspondence are included in Attachment E-2.

BFN was one of nine power plants which participated in a 1981-1982 EPRI study of the presence of *Legionella* species in power plant cooling systems (EPRI/EA-3153). As with most locations studied, *Legionella* bacteria were found in ambient (intake), pre-condenser, post-condenser and outfall (discharge) waters, though not in concentrations sufficiently high to be a health concern. Subsequent studies determined that concentrated *Legionella* aerosols could present a health concern for workers cleaning condenser tubes and cooling towers, though members of the public were generally not at risk because of greatly diminished off-site concentrations (NUREG-1437 Vol. 2, Appendix D). As a precaution, BFN has adopted the practice of having workers engaged in these activities wear appropriate respiratory protection.

E.4.13 ELECTROMAGNETIC FIELDS – ACUTE EFFECTS

Table B-1 reports that

> Electrical shock resulting from direct access to energized conductors or from induced charges in metallic structures have not been found to be a problem at most operating plants and generally are not expected to be a problem during the license renewal term. However, site-specific review is required to determine the significance of the electric shock potential at the site.

Specifically, 10 CFR 51.23(c)(3)(ii)(H) requires that

> If the applicant's transmission lines that were constructed for the specific purpose of connecting the plant to the transmission system do not meet the recommendations of the National Electrical Safety Code for preventing electric shock from induced currents, an assessment of the impact of the proposed action on the potential shock hazard from the transmission lines must be provided.

This issue is discussed in Section 4.5.4.1 of NUREG-1437. It concerns transmission lines built to connect the power plant with the existing transmission system, and reviewed as part of the construction permit. Most transmission lines were designed to be in compliance with the National Electric Safety Code (NESC) recommendations for electric shock hazard. However, unless that utility has had an active program of transmission line management aimed at reviewing changes in the uses of the land in the right-of-way and the operating characteristics of the transmission line, and ensuring compliance with changes in the NESC, the line may not meet current NESC recommendations.

Information and Analysis Content

If the transmission lines that were built to connect the plant to the transmission system meet current NESC clearance standards, the applicant should demonstrate that fact in the ER. The demonstration should take one of two forms: (1) a description of an ongoing program of power line right of way supervision and management aimed at ensuring that current electrical shock provisions of the NESC are met, or (2) a transmission line survey that develops the following information.

1. Identification of any sites or areas that do not meet current NESC clearance standards, and any that may not meet the standards after anticipated changes in transmission line operations or reasonably foreseeable changes in land use in the right of way.

2. Maps, photographs, or drawings indicating the locations of all sites that do not meet the NESC clearance standards.

3. For those sites where transmission line characteristics, clearances, and human uses of the transmission corridor may not meet current NESC standards, provide a description of measures that could be taken to meet the standards, the measures the applicant plans or proposes to undertake, and whether those measures will meet the standards. Consider basic electrical design parameters, including transmission design voltage or voltages, line capacity, conductor type and configuration, spacing between phases, minimum conductor clearances to ground, maximum predicted electrical field strength(s) at 1 m above ground, the predicted electrical field strength(s) at the edge of the right-of-way in kilovolts per meter (kV/m), and the design bases for these values.

4. For any sites that will not meet NESC clearance standards, provide a detailed explanation of the rationale for concluding that the standards are not appropriate to the situation or the rationale for not making modifications to meet the standards.

Shock hazards are produced mainly through direct contact with conductors and have effects ranging from a mild tingling sensation to death. The transmission line towers associated with the BFN Plant are designed to preclude direct public access to the conductors. However, secondary shock currents are produced when persons contact capacitively charged objects (such as vehicles parked near a transmission line) or magnetically linked metallic structures (such as fences near a transmission line). Shock intensity depends on the strength of the electric field, the size and location of the object, and the ground insulation. 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. For example, of the transmission lines currently serving the plant, only the BFN – Maury 500 kV line has had major work which resulted in changing the line clearances; for all other lines, the applicable code requirements at the time of original construction continue to be met

Transmission line inspections are performed to identify defects that could cause an interruption or an unsafe condition for employees and the public. Inspections are also used to plan maintenance activities and to protect TVA's easement rights. Aerial Patrol (i.e., typically 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 to cause a clearance problem, steps would be taken to correct it; this could involve removing the encroachment or adjusting line height, for example.

An interim study of the impact on the transmission system of BFN Unit 1 restart as an upgraded unit being added in the year 2007 to the previously upgraded Units 2 and 3 has been completed. No new line right-of-ways or construction of new transmission lines will be required for the restart of Unit 1. The results of this 2007 load flow study identify the cumulative effects of the three-unit generation changes as well as increased loads and other generation changes in the area. The results of the analysis are that a number of equipment additions are required (e.g., switchyard and substation circuit breakers, substation transformers and static var compensation, etc.) but only the Madison-Redstone 161-kV transmission line will require a major modification (reconductoring) and thus be re-analyzed for consistency with current NESC codes.

Attachment E-3 contains a report which concludes that all nine (seven 500-kV and two 161-kV) transmission lines constructed to connect BFN to TVA's power transmission system meet the vertical clearance provisions of the current 2002 Edition of the NESC. More specifically, the report concludes that all applicable lines (i.e., those lines operating above 140-kV, which are the 500-kV lines) have sufficient clearance to limit the steady-state current due to electrostatic effects to 5 mA_{rms}, should the largest anticipated truck, vehicle, or equipment under the line be short-circuited to ground.

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E.4.14 HOUSING IMPACTS

Table B-1 concludes that

> Housing impacts are expected to be of small significance at plants located in a medium or high population area and not in an area where growth control measures that limit housing development are in effect. Moderate or large housing impacts of the work force associated with refurbishment may be associated with plants located in sparsely populated areas or in areas with growth control measures that limit housing development.

Specifically, 10 CFR 51.53(c)(ii)(I) requires in part that

> An assessment of the impact of the proposed action on housing availability . . . within the vicinity of the plant must be provided.

This issue is discussed in Section 3.7.2 (Refurbishment) and Section 4.7.1 (License Renewal Term) of NUREG-1437.

Impacts to housing availability result when the demand for housing, caused by the project-related population increase, approaches or exceeds the number of available housing units in the vicinity of the plant. The magnitude of the impact will be determined by the number of additional workers associated with refurbishment activities or continued operation and maintenance, and by the population and housing inventory within the region. Cumulative housing impacts result when the project-associated demand for housing combined with other anticipated increases in demand together approach or exceed the number of available housing units.

E.4.14.1 REFURBISHMENT

Information and Analysis Content

The ER should contain the following.

4.14.1 Refurbishment

1. Reference the estimates of the monthly incremental onsite work force associated with refurbishment, reported in Section 3.4. If there will be no refurbishment or if refurbishment involves no additional workers then there will be no impact on housing and no further analysis is required.

2. Reference the number of in-migrating incremental refurbishment workers and their dependents, and the anticipated residential distribution, reported in Section 3.4.

Employment levels by month to recover and restart Unit 1 are shown in Section E.3.4. Peak employment, which would last for only a few months, would be approximately 2,460; almost all of these, would be physically located at the site. Once BFN has returned to three-unit operation, no refurbishment is required for continuing operation through the renewed operating license period.

3. Using the regional demographic information from Chapter 2, determine whether the plant is in a region of low, medium, or high population. This determination can be made using Figure C.1, "Population categories, by sparseness and proximity," and Table C.1, "Sparseness and proximity measures used to classify potential case study sites," from Volume 2 of NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Appendices," May 1996. If the region is one of medium or high population where there are not growth control measures that limit housing development, housing impacts are expected to be of small significance. If these conditions are met, and if the number of additional on-site workers associated with refurbishment for both license renewal and current term operation and refueling does not exceed the peak work force estimate of 2,273 persons used for the socioeconomic impact analysis reported in Section 3.7 of NUREG-1437, the finding of "small significance" may be adopted without further analysis.

NRC guidance makes housing impacts a Category 2 issue because impact magnitude depends on local conditions that the NRC could not predict for all plants. Local conditions to be addressed are population categorization as low, medium, or high, and the applicability of growth control measures. The latter addresses the presence of institutional controls that would limit the market's ability to meet the demand for additional housing.

As described in Section E.2.6, the Browns Ferry site is considered to be in a high population area. Also, the primary labor market area has no growth control measures that would limit housing development.

Based on the analysis in Section E.3.4, Unit 1 refurbishment at maximum employment levels would require about 830 housing units. In 2000, Limestone County had a total of 2,209 vacant units (U. S. Bureau of the Census, *Census of Population, 2000*), and the primary labor market area had a total of 24,654. Of these units, 621 in Limestone County and a total of 9,264 in the primary labor market area were available for rent. Given this, along with the potential availability of sites for locating trailers for temporary living facilities, this additional demand would not create a significant change in housing availability or in rental rates and housing values, and would not spur housing construction or conversion.

4. If the conditions specified in number 3 above are not met, proceed with assessing the following information from Chapter 2: Ongoing and anticipated population change and economic development that could affect housing characteristics in the region or could contribute to cumulative impacts during the period of refurbishment. This information should be available from regional and local sources (e.g., government officials, planning and economic development agencies, realtors).

5. From Chapter 2, reference the number, type, and location of housing units in the region. Reference should be made to housing types (e.g., owner occupied, rental units, hotels or motels, trailer parks), vacancy rates, and turnover. Information from local sources (e.g., government officials and realtors) about housing characteristics should supplement the current decade U.S. Census data.

6. Based on the information above, make an assessment of the potential for impacts to housing availability, comparing the projected incremental demand for housing associated with the refurbishment and refueling related population increase to the stock of available housing in the area. The assessment should consider the magnitude of potential impacts in terms of housing availability, inflation, and changes in housing stock.

7. Describe mitigation measures to avoid or minimize potential adverse impacts. The range of mitigation measures considered and the type of mitigation proposed should be commensurate with the potential magnitude and duration of the impacts. Mitigation might include, at a minimum, hiring workers from the local area to the greatest extent possible. Mitigation of large impacts could include developing trailer pads or supplying temporary housing (e.g., mobile housing) on the site. The development and selection of appropriate mitigation measures should involve discussion with local government officials. The applicant should assess the effectiveness of the mitigation measures at reducing the potential impacts and should briefly explain the rationale for not implementing any measures that were considered but rejected.

For refurbishment of Unit 1, the small number of housing units required for movers (about 830) is not expected to create significant change in availability or prices and not to spur construction or conversion, in line with Section 4.7.1.1 of NUREG-1437. No further refurbishment is required for continued three-unit operation through the renewed license period. These constituted the justification for concluding that no further analysis or mitigation is needed.

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E.4.14.2 LICENSE RENEWAL TERM

1. Reference the estimates of the additional onsite work force during the license renewal term that were reported in Section 3.4. If additional workers are not anticipated there will be no impact on housing and no further analysis is required.

2. Reference the number that were reported in Section 3.4 of in-migrating incremental workers estimated for the license renewal term and their dependents and their predicted residential distribution.

3. If the conditions specified in Item 3 in 4.14.1 above are met, replacing the peak number of additional onsite workers associated with refurbishment with the number of additional onsite workers during the license renewal term, then the finding of "small significance" may be adopted for the license renewal term without further analysis.

4. If the conditions specified in Item 3 immediately above are not met, assess the following information from Chapter 2: Ongoing and anticipated population change and economic development that could affect housing characteristics in the region or could contribute to cumulative impacts during the period of refurbishment. This information should be available from regional and local sources (e.g., government officials, planning and economic development agencies, realtors).

5. From Chapter 2, reference the number, type, and location of housing units in the region. Reference should be made to housing types (e.g., owner occupied, rental units, hotels or motels, trailer parks), vacancy rates, and turnover. Emphasis should be on housing trends and projections that extend into the license renewal term. Information from local sources (e.g., government officials and realtors) about housing characteristics should supplement the current decade U.S. Census data.

6. Based on the information above, assess the potential for impacts to housing availability, comparing the projected incremental demand for housing associated with license renewal term-related population increase to the projected stock of available housing in the area. The assessment should consider the magnitude of potential impacts in terms of housing availability,[18] inflation, and changes in housing stock.

7. Describe mitigation measures to avoid or minimize potential adverse impacts. The range of mitigation measures considered and the type of mitigation proposed should be commensurate with the potential magnitude and duration of the impacts. Mitigation might include, at a minimum, hiring workers from the local area to the greatest extent possible. Mitigation of large impacts could include developing trailer pads or supplying temporary housing (e.g., mobile housing) on the site. The development and selection of appropriate mitigation measures should involve discussion with local government officials. The applicant should assess the effectiveness of the mitigation measures for reducing the potential impacts and should briefly explain the rationale for not implementing any measures that were considered but rejected.

As discussed in Section E.3.4, operation of Unit 1 would require an increase of about 150 workers above the current operational levels for Units 2 and 3. Based on the analysis in Section E.4.14.1, this increase would be of small significance. Therefore, no further analysis is necessary and no mitigation measures are needed.

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E.4.15 PUBLIC UTILITIES: PUBLIC WATER SUPPLY AVAILABILITY

Table B-1 concludes that

> An increased problem with water shortages at some sites may lead to impacts of moderate significance on public water supply availability.

Specifically, 10 CFR 51.53(c)(ii)(I) requires in part that

> . . . [T]he applicant shall provide an assessment of the impact of population increases attributable to the proposed project on the public water supply.

This issue is discussed in Section 3.7.4.5 (for refurbishment) and in Section 4.7.3.5 (for operation) of NUREG-1437.

Information and Analysis Content

The ER should include the following information.

1. The information developed for Section 3.4 on the work force, in-migrating population, and residential location associated with refurbishment and with the renewal period.

The total work force and in-migrating population for recovery of BFN Unit 1 does not approach that for the Unit 3 recovery team, for which the BFN total worker population peaked at over 6,000 (5,917 in 1992 at the BFN site; other team personnel worked off-site in Athens). The strain on local services such as water supplies will peak during Unit 1 recovery and diminish considerably for resumption of three-unit operation, including the renewed operating license period.

2. If water used at the plant is provided by a water utility, identify anticipated increases in the amount of water used during refurbishment and during the renewal term.

BFN gets its potable water via an underground pipeline connection with the City of Athens [Alabama] Utilities Water Department. Potable water consumption at the site is partly a function of the number of people working at the site. Besides drinking fountains and bathrooms, potable water is also used for fire protection, supplied to a 500,000 gallon fire protection water bladder tank, and for various clean water uses such as window and building wash water and pressurized spray water for equipment cleaning. Some flow is lost to occasional leaks.

According to billing records from the Athens Utilities Water Department, the potable water consumption rate at Browns Ferry Nuclear Plant can vary from less than 4 to over 8 million gallons per month, but typically averages out over the course of a year such that annual consumption shows a consistent trend. Usage can increase significantly if fire protection lines are being flushed. As of June 2003 the projected annual consumption for 2003 was less than 60 million gallons, or about 5 million gallons per month. The July 2003 consumption was 4,580,000 gallons. For comparison, per the TVA Accounts Payable Department in Knoxville, TN, TVA was billed for 50,673,000 gallons in fiscal year 2002 for BFN potable water.

The peak consumption rate of 5 million gallons per month partially represents the current total workforce at BFN, which is at the expected peak number of 3600. When Unit 1 is restarted in 2007 the total site workforce (TVA plus contractors) is projected to be less than 1400. The potable water consumption at BFN after Unit 1 restart will likely return to nearly the pre-Unit-1 recovery rate of less than 50 million gallons per year and remain there throughout the twenty-year renewed operating license period.

For off-site consumptive impacts, it has been found that only a minority of the Unit 1 recovery on-site workers have relocated as a result of employment on the project, greatly mitigating the impact on the local area water supplies. Many of the workers commute from their homes outside Limestone County. As listed in Table E.2-14, Wheeler Reservoir has a number of potable water intakes. However, the temporary local population increase from workers and their families associated with Unit 1 recovery is distributed over such a large work force population area that the consumptive impacts on Wheeler Reservoir are negligible.

In 2002 and 2003, TVA undertook a study to determine if changes in TVA's reservoir system operating policies would produce greater overall public value. A no-action alternative and eight alternative operating policies were evaluated. The evaluations included the assumption that the consumptive use of water above Wheeler Dam would increase by 230 million gallons per day. Reservoir operations over the 99-year hydrologic record were simulated. It was determined that for all hydrologic conditions and for all alternatives that the existing minimum flow past BFN could be maintained. Therefore, the growth in consumptive water use will not affect minimum flow past BFN regardless of the reservoir operating policy adopted. TVA has conducted the study by preparing a programmatic environmental impact statement. TVA's reservoir operations policy guides the day-to-day operation of the Tennessee River system. It sets the balance of trade-offs for the sometimes competing uses of water in the system.

3. For each water utility service area that may be affected, provide information on the capacity and utilization rate of the public water system projected to exist at the time of peak refurbishment work force, as well as capacity and cumulative utilization rate caused by general population increase during the renewal period. Document discussions with the potentially affected water utilities as to whether the projected population increase will stress the water supply or require an increase in capacity.

The City of Athens Water Services department expects no problems meeting water demands are projected during Unit 1 recovery and the twenty year renewed operating license period. Their average total daily water demand on their system is about 6.5 MGD, well more than BFN consumes in an entire year. Their peak day occurred approximately two years ago at 10.7 MGD when the Limestone County Water Authority was drawing (temporarily) very heavily from the Athens Utilities Water system; since then, however, Limestone County has installed a 4 MGD treatment plant in the SE portion of the county, and therefore it is very unlikely that they will generate any significant demand on Athens for more than a day or two for unexpected outages in the future. The Athens water treatment plant is rated at 13.5 MGD, having a Safe Yield from the Elk River of 56 MGD. Athens Utilities has plans to upgrade its intake structure to 18 MGD to ensure supply reliability, which is scheduled for implementation in calendar year 2004. The next step will be to upgrade the entire production capability to 18 MGD, which will be done as warranted by growing demand.

4. If the water supply will be stressed as a result of refurbishment or operation during the renewal period, identify, in coordination with the water utility, what mitigating measures would be appropriate. Describe these measures and state which, if any, will be taken. Briefly explain the rationale for not implementing any measures that were considered but rejected.

The potable water supply to BFN is not expected to be stressed during refurbishment or during operation throughout the renewed operating license period. There are two parallel and redundant water lines going to BFN, which the Athens Water Services department considers to be a reasonably reliable and secure supply connection. Therefore, no mitigation measures are contemplated relative to the BFN potable water supply.

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E.4.16 EDUCATION IMPACTS FROM REFURBISHMENT

Table B-1 states that

> Most sites would experience impacts of small significance but larger impacts are possible depending on site- and project-specific factors.

Specifically, 10 CFR 51.53(c)(ii)(I) requires in part that

> An assessment of the impact of the proposed action on . . . public schools (impacts from refurbishment activities only) within the vicinity of the plant must be provided.

This issue is discussed with regard to plant refurbishment in Section 3.7.4.1 of NUREG-1437. Section 4.7.3.1 of NUREG-1437 placed this issue in Category 1 for the license renewal period.

Impacts to education are a product of (1) the additional demand on the public education system resulting from the refurbishment-related population growth and (2) the capacity of the education system to absorb additional students. The capacity of the system to absorb additional students is related to the size of the school system (i.e., larger school systems typically can absorb more students than smaller systems) and whether the system already is experiencing growth pressures. Section 3.7.4.1 of NUREG-1437 includes definitions of small, moderate, and large impacts to education. Cumulative impacts can result if the project-related demand for education, coupled with demand associated with other ongoing economic development or with changes in the level of service (e.g., resulting from changes in fiscal policy), affects the school system's ability to provide educational services.

Information and Analysis Content

The analysis of potential effects on education in the ER is to include the following information.

1. The information developed for Section 3.4 on the incremental work force, in-migrating population, the number of school-age children, and their residential locations during the refurbishment period.

2. For each school system that may be affected, information on the classroom capacity and student-teacher ratio projected to exist at the time of peak refurbishment work force. Document discussions with the potentially affected school systems as to whether the projected increase in students will stress the capacity of the school system.

3. If educational resources will be stressed by the additional students during the refurbishment period, identify, in coordination with the school officials, what mitigation measures would be appropriate. Describe these measures and state which, if any, will be taken. Briefly explain the rationale for not implementing any measures that were considered but rejected.

As discussed in Section E.3.4, it is anticipated that about 460 additional children of school-age would result from Unit 1 refurbishment. The likely geographic distribution of these children and their relative impact on the school systems in each county are shown in Table E.4-8. These estimates indicate that in no case would the impact on school systems be as high as one percent of the school membership. Therefore, the impact on schools would be classified as small and no further analysis or mitigation measures are needed.

Table E.4-8 – Impact on Public Schools by County

County	Number of Movers	Percent of Average Daily Membership, 2001-2002
Lauderdale	115	0.9
Limestone	92	0.9
Madison	78	0.2
Morgan	60	0.3
Colbert	51	0.6
Lawrence	18	0.3
Other	46	--

E.4.17 OFFSITE LAND USE

E.4.17.1 REFURBISHMENT

Table B-1 concludes that

> Impacts may be of moderate significance at plants in low population areas.

Specifically, 10 CFR 51.53(c)(ii)(I) requires in part that

> An assessment of the impact of the proposed action on . . . land-use . . . within the vicinity of the plant must be provided.

This issue is discussed in Section 3.7.5 of NUREG-1437, in which general standards are provided for determining the magnitude of land-use impacts. The phrase "vicinity of the plant" used in the regulation and the phrase "study area" used in this footnote are synonymous. This area is generally defined as the host county and municipality, as well as other counties or municipalities in which a substantial segment of the in-migrating population would be expected to reside.

Impacts to off-site land use result when the development pressures resulting from the project-related population increases result in changes to local land-use and development patterns. Development pressures are closely tied to population increase impacts on housing covered in Section 4.14. These changes can have either positive or negative impacts, depending upon the value attributed to land-use changes by different individuals and groups. Cumulative land-use impacts result when the project-associated population growth, combined with other population growth and land-use pressures, induces changes to local land-use and development patterns.

Information and Analysis Content

The information and analyses developed in this section should build from the information and analyses developed in Section 3.4 and Section 4.14 relevant to the period of refurbishment. If there will be no additional workers due to refurbishment, there will be no impact on land-use and no further analysis is required. If the population and growth control criteria given in Section 4.14 resulted in a determination that ". . . the impact on housing is expected to be minor and no further analysis of project-specific impacts to housing is required," it is likely that offsite land-use impacts will also be minor. In any case, further screening for land-use impacts is appropriate. If the applicant can demonstrate the validity of the following three conditions, it may be concluded that the effects of refurbishment-related population growth on land-use and development patterns will be small, and no further analysis is needed.

(1) Project-related population growth (including direct and indirect workers and their families), when added to other anticipated or reasonably foreseeable population growth, would not increase existing area population by more than 5 percent.

(2) The project area has established development patterns. Established development patterns are indicated if the community has established land use controls or infrastructure in place to support reasonably foreseeable development.

(3) The project area is not extremely isolated or sparsely populated. Extreme isolation is indicated if the area is more than 50 miles (80 km) from the nearest urban area with a population of 100,000 or more; sparsely populated is indicated if the population density is less than 60/mile^2 (21/km^2) within a 20-mile (32-km) radius from the plant.

If any of these cannot be demonstrated, an assessment of the impact of the proposed action on off-site land use should be provided in the ER.

The assessment should consider the size of the peak incremental labor force (onsite and indirect) associated with the project, the number of workers expected to commute daily, the number expected to migrate to the area and require temporary or permanent housing, the potential demand for new temporary or permanent housing as determined in the analysis of potential housing effects, land-use controls in the area, and the physical infrastructure in place in the area. If refurbishment and refueling workers are to be on-site simultaneously, the analysis should consider the combined work forces. Similarly, the analysis of impacts from post-relicensing refueling and maintenance activities should consider potential effects of the total number of temporary refueling/maintenance workers. Section 3.7.5 of NUREG-1437 provides definitions of small, moderate, and large land-use impacts

> Information in the ER for the analysis of potential effects on land use should include the following.
>
> 1. The information and analysis developed in Section 4.14.1 should be referenced.
>
> 2. A description of land-use controls, zoning, or restrictions in the area, including reasonably foreseeable future changes.
>
> 3. A description of land-use patterns in the area, including the scale and type of commercial development and the housing stock (see Section 4.14.1).
>
> 4. A description of existing and planned infrastructure (including gas, water, sewer, and power lines and roads).
>
> 5. An analysis of the potential for population changes arising from refurbishment to cause changes in patterns of land use. If potential changes in land use are identified, assess their significance. Document discussions with local planning authorities as to their assessment of the significance of any changes in patterns of land use.
>
> 6. If the local planning authorities believe the potential changes in land use are significant, identify, in coordination with the authorities, mitigation measures that would be appropriate. Describe these measures and state which, if any, will be taken and briefly explain the rationale for not implementing any measures that were considered but rejected.

Any impacts to land use associated with refurbishment would result from increased population. This increase could influence development of residential and commercial properties to support this growth. Limestone County developed a Comprehensive Plan in 1983 to cover the period to year 2000 (Limestone County Comprehensive Plan, 1983). The vision of the Plan includes goals for land use, community facilities, transportation, and a capital improvements program and budget. An updated plan is currently being developed which will assist in decision-making and planning for the next two decades. Statistics provided in Section 3.4 predict a probable population increase of about 2,100 persons during the refurbishment. This is approximately 3.2 percent of the population in Limestone County, and only about three-tenths of one percent of the population in the six-county geographic region from which workers would commute. According to GEIS criteria discussed in Section E 2.6, based on proximity and sparseness, Brown's Ferry is located in a high population area. The increase in population for the refurbishment would be temporary and compared to the existing population would be small. As discussed in Section E 4.14.1, at maximum employment levels, only 830 housing units would be required and Limestone County had a total of 2,209 vacant units in 2000 and the six-county region had 24,654. Therefore no impacts to land use are expected as a result of this refurbishment.

All of the three aforementioned conditions are met; therefore no further analysis is required.

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E.4.17.2 LICENSE RENEWAL TERM

Table B-1 states

> Significant changes in land use may be associated with population and tax revenue changes resulting from license renewal.

Specifically, 10 CFR 51.53(c)(3)(ii)(I) requires, in part, that

> An assessment of the impact of the proposed action on . . . land-use . . . within the vicinity of the plant must be provided.

This issue is addressed in Section 4.7.4 of NUREG-1437. The specifics of the magnitude of land-use change and impact predictor criteria, and the definition of the term "vicinity of the plant," are as given in Section 4.17.1 of this guide. Table B-1 of 10 CFR Part 51 partially misstates the conclusion reached in Section 4.7.4 of NUREG-1437. Section 4.7.4 concludes that "population-driven land-use changes during the license renewal term at all nuclear plants will be small." A Category 2 finding for land-use changes during the license renewal term was made because of potential tax-driven land-use changes and the inability to reach a generic conclusion as to whether communities would see such changes as negative or positive. Until Table B-1 is changed, applicants need only cite NUREG-1437 to address population-induced land-use change during the license renewal term.

During the license renewal term, new land-use impacts could result from plant-related population growth or from the use of tax payments from the plant by local government to provide public services that encourage development. The resulting changes can have either positive or negative impacts, depending upon the value attributed to land-use changes by different individuals and groups. Cumulative land-use impacts result when tax revenues generated by the plant combine with land-use pressures (e.g., rapid, unexpected population growth) to induce changes to local land-use and development patterns.

Information and Analysis Content

The assessment should consider the size of the plant-generated revenues relative to the total revenues of the taxing jurisdictions, land-use controls in the area, and the physical infrastructure in place in the area.

Information for the analysis of potential effects on land use includes the following.

1. The information and analyses developed in Section 4.14.2 should be referenced.

As stated in Section E.4.12.2, resuming three-unit operation and continuing through the renewed operating license period would require an increase of about 150 workers above the current (two-unit) operational levels. Based on the analysis in Section E.4.14.1, this increase would be of small significance.

2. A description of land-use controls, zoning, or restrictions in the area, including reasonably foreseeable future changes.

Limestone County, as part of Top of Alabama Regional Council of Governments, developed a Comprehensive Plan in 1983 to cover the period to year 2000 (Limestone County Comprehensive Plan, 1983). The vision of the Plan includes goals for land use, community facilities, transportation, and a capital improvements program and budget. The same vision is reflected in the "Vision 2000, Strategic Agenda" document prepared by the Limestone County Vision 2000 Quality Council in March 2000. An updated plan is currently being developed.

The goal of the Land Use Plan was to achieve a balance among various land uses to accommodate a diversity of total life styles which will fulfill the requirements of county residents. The Plan has three objectives. The first is to promote a variety of housing types and a high level of efficiency in residential development patterns. The second is to promote the spatial distribution of various land uses that will result in a compatible relationship of land use activities. The third objective is to provide land for a wide variety of employment opportunities for the residents. The implementation of these objectives would provide utilities, services, and transportation to achieve the desired land use developments. The Plan sets guidelines but does not limit development.

3. A description of land-use patterns in the area, including the scale and type of commercial development and the housing stock (see Section 4.14.1).

BFN is located in an agricultural area, surrounded by cropland planted with cotton. About 66.8% of the total acreage in the county is used for agriculture, the highest in Alabama. There are an estimated 78,900 acres (23.9%) of land in forest. The majority of the forestland is located in the northern two-thirds of the county. Trends show that land used for forest has been declining since the early sixties. During the sixties, thousands of acres were cleared for agriculture and other land uses associated with population growth (Limestone County Comprehensive Plan, 1983). Cropland has increased from 166,841 acres in 1987 to 181,292 acres in 1997 (USDA-NRCS).

From the 1994 EPA land use database (Figure E.2-7), only about 2% of the county is urban built-up land. The current trend in population growth will promote a larger amount of land to become urbanized. Population growth for Limestone County from 1980 to 1990 was 17.7%. Athens City had a population increase of 17% from 1990 to 1998. These trends are attributable to the increased employment opportunity in the county as well as in nearby Huntsville and Decatur. Most of the residential development is occurring in the eastern portion of the county in the Capshaw French Mill area. There is also a significant number of new dwellings in the Browns Ferry Road area. It is expected that the majority of residential growth will occur around the City of Athens and the Elkmont Village area (Limestone County Comprehensive Plan, 1983). Development of commercial property is rapidly occurring in the area of intersection of U. S. Highway 72 and U. S. 65 and along the U. S. Highway 72 corridor to Huntsville.

According to Section 4.14.1, in 2000, Limestone County had a total of 2,209 vacant housing units with 621 available for rent. The current Comprehensive Plan sets guidelines but does not limit housing development.

4. A description of existing and planned infrastructure (gas, water, sewer, and power lines, roads).

A new Athens Comprehensive Plan is currently being developed. This plan will assist in decision-making and planning for the next two decades. Except for the development of industrial park areas, the traditional actions have not been for installation of infrastructure in undeveloped areas as part of "growth promotion". Athens Utilities is currently developing a plan for the expansion of the sanitary sewer system. This expansion is partially located in the area where significant growth trends have been occurring. Recently, new sewer infrastructure has replaced the aged and failing systems. Currently, the infrastructure (gas, water, sewer, roads, and power) is fully adequate to support the population. New infrastructure is provided in all newly developed areas.

5. An estimate of the tax or other revenue to be paid to local governmental jurisdictions during the license renewal term (considering all tax payments by the plant--not just the increment arising from refurbishment-related improvements--whether paid directly to local jurisdictions or indirectly through State tax revenue-sharing programs). Relevant jurisdictions include the State, city, county, school district, or other special purpose districts in which the plant is located.

As discussed in section E.2.11, in 2001, the state of Alabama received $6.005 billion in total tax revenues, of which 40.6 percent consisted of income tax, and 28.5 percent from sales and use taxes. Revenues from in-lieu-of tax payments from TVA are paid to the state but most of the total is redistributed to the counties that are served by TVA power. Limestone County received over $4.5 million of this revenue in FY 2001-2002. Madison County received over $13 million and Morgan County more than $10 million. The other counties in the primary labor market area received lesser amounts. Based on the current formulas, it is estimated that the capital investment to recover Unit 1 would result in additional revenues to Limestone County of about $770,000, Madison County about $838,000, and Morgan County about $666,000. From these initial values the in-lieu-of tax payments would gradually decline via amortization over the remainder of the current operating license terms and the renewed operating license period.

6. The total revenue for the current year of the taxing jurisdictions and an estimate of total revenue during the plant's license renewal term.

In 2002, revenues from TVA represented 5.88 percent of the total budget of Limestone County. A certain amount of this revenue is used for development and infrastructure within the community. It is not expected that this percentage will vary significantly in the future.

> 7. If potential changes in land use are identified, assess their significance. Discuss with local planning authorities whether tax revenue changes during the license renewal term will cause land-use changes in their jurisdiction. Document discussions with local planning authorities as to their assessment of the significance of any anticipated changes in patterns of land use.

As stated in Section E.4.12.2, operation of Unit 1 in addition to Units 2 and 3 would require an increase of about 150 workers above the current operational levels and this increase would be of small significance. Since there are sufficient vacant housing units, 2,209 with 621 available for rent, this action should not promote housing construction. No impacts to land use or infrastructure are expected because of the additional workers. With only about 2 percent of the county urbanized, increased revenue from TVA due to this action might have a small positive impact on land use due to increased funds for development.

> 8. If the local planning authorities believe the potential changes in land use are significant, identify, in coordination with the authorities, mitigation measures that would be appropriate. Describe these measures and state which, if any, will be taken and briefly explain the rationale for not implementing any measures that were considered but rejected.

Staff increases for the return to three-unit operation are relatively modest and the total staffing is expected to remain relatively constant through the renewed license operating period. Little if any recent growth in the area is attributable to BFN, and per discussions with the Athens and Decatur Chambers of Commerce and the Limestone and Morgan County Economic Development Associations (described in the Cumulative Impact Summary in Section E.2.16) no significant land use changes during the renewed license operating period are expected to result from continued operation of BFN. For these reasons, no mitigating measures are needed.

E.4.18 TRANSPORTATION

Table B-1 states that

> Transportation impacts (level of service) of highway traffic generated during plant refurbishment and during the term of the renewed license are generally expected to be of small significance. However, the increase in traffic associated with the additional workers and the local road and traffic control conditions may lead to impacts of moderate or large significance at some sites.

Specifically, 10 CFR 51.53(c)(ii)(J) requires that

> All applicants shall assess the impact of highway traffic generated by the proposed project on the level of service of local highways during periods of license renewal refurbishment activities and during the term of the renewed license.

These impacts are addressed in Sections 3.7.4.2 and 4.7.3.2 of NUREG-1437.

Transportation impacts are related to the total size of the work force and to the prevailing road and traffic conditions at the time of the project. Transportation effects result when project-related traffic induces a change in the level of service (LOS) such that LOS of C or higher occurs on highway segments or intersections in the vicinity of the plant. Section 3.7.4.2 states that

LOS A and B are associated with small impacts because operation of individual users is not substantially affected by the presence of other users. At this level, no delays occur and no improvements are needed. LOS C and D are associated with moderate impacts because the operation of individual users begins to be severely restricted by other users, and at level D small increases in traffic cause operational problems. Consequently, upgrading of roads or additional control systems may be required. LOS E and F are associated with large impacts because the use of the roadway is at or above capacity level, causing breakdowns in flow that result in long traffic delays and potentially increased accident rates. Major renovations of existing roads or additional roads may be needed to accommodate the traffic flow.

NUREG-1437 defines small, moderate, and large impacts to transportation in Section 3.7.4.2. Cumulative transportation impacts are the result of project-related traffic increases coupled with traffic increases resulting from other activities (e.g., other large construction projects or new economic development) in the area. Although plant-related traffic will use highway segments not in the vicinity of the plant, such traffic likely will be dispersed over a number of roads. Highway segments and intersections that are a considerable distance from the plant may need to be assessed if the majority of project-related traffic will flow through them.

Table from NUREG-1437

Level of service	Conditions
A	Free flow of the traffic stream; users are unaffected by the presence of others.
B	Stable flow in which the freedom to select speed is unaffected but the freedom to maneuver is slightly diminished.
C	Stable flow that marks the beginning of the range of flow in which the operation of individual users is significantly affected by interactions with the traffic stream.
D	High-density, stable flow in which speed and freedom to maneuver are severely restricted; small increases in traffic will generally cause operational problems.
E	Operating conditions at or near capacity level causing low but uniform speeds and extremely difficult maneuvering that is accomplished by forcing another vehicle to give way; small increases in flow or minor perturbations will cause breakdowns.
F	Defines forced or breakdown flow that occurs wherever the amount of traffic approaching a point exceeds the amount which can traverse the point. This situation causes the formation of queues characterized by stop-and-go waves and extreme instability.

Information and Analysis Content

The information to analyze potential impacts to transportation includes the following.

1. From the refurbishment and license renewal term employment information provided in Section 3.4, "Employment," estimate the daily traffic associated with refurbishment activities and with the license renewal term. The estimate should include commuting workers (including refueling workers if the refueling and refurbishment activities will occur simultaneously) and shipments of materials. The effect of carpooling and the availability and use of public transportation should be considered in the estimate. Peak traffic times should be determined or estimated.

Additional traffic would be generated due to refurbishment of Unit 1. The recovery period spans almost six years with a workforce rising to peak levels of approximately 2,460 employees on-site during the refurbishment period. Carpooling is highly encouraged by TVA and will be considered in the analysis. Public transportation is not available in the immediate vicinity of the site. Therefore, assuming an average ridership of 1.6 persons per vehicle, and a trip in and out each day, about 3,075 vehicles will be added to the road network due to daily commuters during this peak construction period.

After resumption of three-unit operation, with only 150 additional permanent employees beyond two-unit staffing levels, increased traffic attributable to continued operation of BFN through the renewed operating license period would be insignificant.

2. A forecast, for both periods, of the highway segments and interchanges likely to be affected by the increased traffic, inferred from current traffic patterns associated with operations and refueling workers.

Assuming traffic is split equally in three directions on Shaw Road, Nuclear Plant Road, and Browns Ferry Road, the Average Daily Traffic (ADT) on these county roads would increase to approximately 2,625 vehicles per day, or a 165% increase in ADT. U.S. Highways 72 and 31 would not be significantly impacted.

For a more detailed analysis (Highway Capacity Analysis), the assessment of traffic effects for the project is based on the transportation planning and engineering concept of level of service (LOS). This concept addresses the quality of service, or operating conditions, provided by the roadway network, as perceived by motorists during the peak hour of traffic, typically the morning and afternoon rush hour. The morning rush hour from 5:30-7:30 a.m. is typically the highest at the site. Six LOS are designated as A through F, with A being the best. With this type of analysis, level of service D is viewed as the minimally acceptable LOS of the roadway because associated conditions can be tolerable for short periods of time, or peak hour conditions. In contrast, an LOS of E or F would be viewed as an unacceptable level. Peak work force levels were calculated using certain assumptions. First, it was assumed that 80% of the peak on-site personnel would work day shift and travel during peak hours. Also, at worst case, peak work force was determined using both peak restart forces and existing work forces common during an outage. As for the broad ADT analysis, an average ridership of 1.6 workers per vehicle was assumed. Current peak traffic was assumed at 12% ADT and the current truck composition is 10% of average daily traffic. Also, for this analysis, an even split was assumed on the three county roads toward U.S. Highway 72 or U.S. Highway 31.

The results of the level of service analysis show a decrease on U.S. Highway 72 and the county roads from level of service C to D during the restart phase. These roads would provide traffic flow conditions where tolerable average operating speeds are maintained but would be subject to considerable and sudden variation. These conditions can be tolerable for short periods of time. In this instance, such conditions could occur twice during the day and last for up to one hour. U.S. Highway 31 functions as a LOS C roadway and shows no decrease in the service level of the road.

There will also be additional traffic added to the road network throughout the day in the form of refurbishment material deliveries to the site and disposals from the site. This truck traffic will vary over the length of the refurbishment project. For example, the dry cask storage pad construction may generate up to 25 truck trips per day, but would only last approximately a month. The level of service analysis is based upon peak commuter traffic. This condition would only last approximately six months when the maximum work force would be on site; therefore, the analysis provides a conservative estimate. This conservatism offsets and compensates for unknown construction material truck deliveries and disposals, traffic growth, possibility of fewer sharing rides, and variation of traffic flows during peak hours on the local roads, without altering the final results regarding the significance of future road transportation impacts. The level of service analysis concentrates on peak hours; therefore, there would be no loss of level of service during off-peak hours when trucks will mostly travel.

The most substantial effect on local roadway conditions would be at the intersections. The major signalized intersections affected include U. S. Highway 72 with Browns Ferry Road and Shaw Road. These intersections are fully actuated where all signal phases are controlled by detector actuators where cycle lengths and green times vary in response to demand. The level of service of these intersection approaches on U. S. Highway 72 are LOS B, where there is good progression and short cycle length. Assuming worst case peak conditions, the level of service on these major roads at these intersections decrease to LOS C, where higher delays may result from fair progression and longer cycle lengths. At this LOS, the number of vehicles stopping is significant, though some still pass without stopping. U. S. Highway 31 and Nuclear Plant Road is another major intersection affected. This intersection has a two-way stop controlled T-intersection and has a stop sign at Nuclear Plant Road. Left-turning traffic can progress to a median before making the full turn. The LOS on the U.S. Highway 31 approach will remain at a LOS B. The most significant changes to level of service at the intersections due to increased plant traffic occur on the county roads including Browns Ferry Road, Shaw Road, and Nuclear Plant Road. From the plant entrances to the approaches of the major highway intersections, several of these county road intersection approaches fall to a level of service that has poor progression and long cycle lengths to the point that it is considered unacceptable to most drivers. However, those experiencing the delay would primarily be the construction commuters. Such a problem can be easily tolerated for the short duration of the peak construction period. Conditions will improve to acceptable levels of service after this period. Delayed shift changes could be instituted to help alleviate the problem.

Additional commuter traffic generated during operation of the refurbished Unit 1 at EPU would result in an ADT increase on the county roads of less than five percent due to an additional workforce of approximately 150 employees. There would also be approximately 50% additional hydrogen and Calgon water chemistry truck deliveries; or less than ten trucks per week. This minor increase in operational traffic results in an insignificant impact to the transportation system.

Traffic growth would continue during the renewed operating license period for 20 years following to year 2033. During this time, traffic volumes would increase, assuming 15% growth rate per decade, to approximately 22,000 vpd on U.S. Highway 72, and 26,600 vpd on U.S. Highway 31. The county roads would increase to approximately 2,700 vpd.

3. Information on recent LOS, capacity, and usage for highway segments and intersections forecast to be impact areas. State or county departments of transportation typically maintain these data.

The site is located approximately ten miles southwest of Athens in northern Alabama in Limestone County and is located just south of U. S. Highway 72, which runs from South Pittsburg, Tennessee, west to Memphis, Tennessee. The site is directly accessible from County Road 25. County Road 25 (Shaw Road) intersects U. S. Highway 72 approximately six miles north of the site. County Road 25 (Nuclear Plant Road) also intersects U. S. Highway 31 approximately nine miles east of the site. U. S. Highway 31 intersects U. S. Highway 72 northeast of the site. Browns Ferry Road to County Road 25 just east of the site provides a more direct route to the site from Athens. U. S. Highway 72 and U. S. Highway 31 are both high quality four-lane routes with good lane widths, alignments, turning lanes, and speed limits of 50 miles per hour (mph) through Athens and increasing away from the city. County Road 25 and Browns Ferry Road are medium quality two lane roads with level alignment, some passing zones, and speed limits of 45 mph. Accessibility into the plant facility off County Road 25 near the intersection with Browns Ferry Road has been altered for security reasons but is still good.

The primary traffic generator in the vicinity of the site is the nuclear plant. Prior to the current influx of workers for recovery of Unit 1, BFN averaged a daily site population of approximately 1,300 persons. The worker population associated with two-unit operation currently peaks at approximately 2,300 persons during outages, which occur every 24 months (per unit) for approximately two months. Current truck deliveries (exclusive of Unit 1 recovery) are minimal (less than ten per week) and include hydrogen trucks, Calgon water chemistry trucks, and occasional diesel fuel deliveries during peak months. Rural residences located along the county roads that provide access to the site are also traffic generators in the area.

Figure E.2-8 shows a map of the local road network for the area. The latest available 1998 Average Daily Traffic (ADT) counts in close proximity to the site indicate approximately 13,440 vehicles per day (vpd) on U. S. Highway 72 north of the site and 16,260 vpd on U. S. Highway 31 south of U. S. Highway 72. There are no available traffic counts on the county roads; however, TVA estimates approximately 1,600 vpd on Shaw Road, Browns Ferry Road, and Nuclear Plant Road. There are no known road upgrades or project-related traffic in the vicinity of the site.

The county roads are in good condition for access and would be adequate to support the traffic requirements during both construction and operation. Traffic increases during construction are much higher than that during operation; however, construction periods are temporary and peak forces only last for approximately six months. Nevertheless, even the traffic increases associated with the peak construction force levels do not result in any unacceptable service levels on the adjacent roadways. There would be additional delay from the plant to the major highways due to traffic congestion at shift changes and leaving multiple exits simultaneously. Generally, as distance from the site increases and traffic becomes more disbursed, impacts to the transportation network decrease. The major multi-lane highways U.S. Highway 72 and U.S. Highway 31 would provide higher capacity levels and an increase in traffic would tend to be less noticeable in these areas.

> 4. Information from local sources (e.g., government officials, planning and economic development agencies) about ongoing and anticipated economic development (e.g., new construction or industry in the area of the plant) and changes in road conditions that could affect LOS and be a contributor to cumulative impacts.

Traffic and ADT predictions are projected over many years. These projections may vary greatly over such a length of time. However, over a long period of time, there is a natural progression to improve the quality of the local roadway network. Therefore, as traffic increases, roadway networks are expected to also improve. For example, an interstate project between Memphis and Atlanta is currently in proposal stages; however, the proposal is not part of the Alabama Department of Transportation's five year plan. If this interstate were constructed, traffic on U. S. Highway 72 would most likely decrease significantly and traffic conditions would improve due to the addition of a major thoroughfare across North Alabama.

> 5. Based on this information, the applicant, for both periods, should project the volume of project-related traffic likely to occur at each segment, calculate the increase in traffic on affected highway segments and intersections, and project the LOS that would result during peak periods on each segment. Consultation with local and State departments of transportation, who often have guidelines about how LOS is affected by an increase in traffic volume given specific road conditions, should facilitate the LOS determination. The analysis and the resulting LOS for each segment or intersection considered should be documented in the ER.

The information for this guidance point is contained in the responses to the four previous guidance points.

> 6. A discussion of potential mitigation measures, commensurate with the projected level of impact, should be included in the ER. Mitigation measures could include, for example, adjusting shift change time to nonpeak traffic times, busing, or road and traffic control improvements. The applicant should estimate the potential effect of the mitigation measures, include this assessment in the ER, and briefly explain the rationale for not implementing the measures that were considered but rejected.

Specific site mitigation measure to improve the local roadway should include employee programs that provide flexible working hours. This would reduce road travel during peak hours. Delayed shift changes would also help alleviate the congestions at the plant entrances/exits. Restrictions for trucks traveling during the peak hour could also be made to reduce peak hour traffic. Roadway improvements, which would include lane widening, realignment, lane addition, repaving, etc., would not be necessary due primarily to the short span of time that peak construction forces exists onsite. Unfavorable conditions felt at the intersections primarily by plant personnel quickly dissipate as the peak construction forces fade.

E.4.19 HISTORIC AND ARCHAEOLOGICAL RESOURCES

Table B-1 states that

> Generally, plant refurbishment and continued operation are expected to have no more than small adverse impacts on historic and archaeological resources. However, the National Historic Preservation Act requires the Federal agency to consult with the State Historic Preservation Officer to determine whether there are properties present that require protection.

Specifically, 10 CFR 51.53(c)(ii)(K) requires that

> All applicants shall assess whether any historic or archaeological properties will be affected by the proposed project.

This issue is discussed in Section 3.7.7 and Section 4.7.7 of NUREG-1437.

The National Historic Preservation Act of 1966, as amended, 16 U.S.C. 470-470w-6, in Section 106, requires that Federal agencies take into account the effects of the agency's undertaking (including issuance of a license) on properties included in or eligible for the National Register of Historic Places and, prior to approval of an undertaking, to afford the Advisory Council on Historic Preservation a reasonable opportunity to comment on the undertaking. The procedure for meeting Section 106 reguirements is defined in regulations of the Advisory Council, "Protection of Historic Properties" (36 CFR Part 800). The guidance that follows instructs the applicant as to the information and analysis that is required for the NRC to comply with Section 106 requirements in a manner that minimizes the potential for the consultation process with the Advisory Council to delay review of the application. The applicant should also consider the effects on properties that are not eligible for the National Register of Historic Places but, nevertheless, are likely to be considered by the State Historic Preservation Officer or local historians to have local historic value and to contribute substantially to an area's sense of historic character.

TVA is mandated, under the National Historic Preservation Act (NHPA) of 1966, to protect significant archaeological resources and historic structures located on land affected by TVA undertakings. NHPA Section 106 [16 U.S.C. 470f] requires Federal agencies prior to taking action that implements an undertaking to:

1. Take into account the effects of their undertaking on historic properties; and

2. Afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment regarding such undertaking.

The State Historic Preservation Office (SHPO) serves as a proxy to the ACHP. The Alabama SHPO has been consulted concerning the project alternatives and any potential affect to historic properties.

The determination that an action is an undertaking does not require knowledge that historic properties are present. An agency determines that a given proposal is an undertaking based solely on that proposal's inherent ability to directly or indirectly affect historic properties. The area of potential effects (APE) for an undertaking is usually defined for archaeological resources as any area where facilities would be situated and for historic structures as any area from which those facilities would be visible.

At the initiation of this proposal, TVA Cultural Resources staff considered the nature of the undertaking and determined that the project had the potential to affect historic properties should those be present in the area. The APE for archaeological resources was determined as the three areas designated as soil disposal or spoil pile locations. The APE for historic structures was determined as those areas from which the disposal locations would be visible.

An architectural survey was conducted within the visual APE of the proposed project area. No historic structures were identified.

Information and Analysis Content

The ER should include the following information.

1. From Chapter 3 of this guide, identify those refurbishment and license renewal term activities that could affect onsite or offsite historic properties. Such activities would include ground disturbing activity, increases in traffic, and audio and visual intrusions.

TVA is refurbishing Unit 1 in preparation for resuming operation of all three units, and is also requesting renewal of the three operating licenses. The construction activities included in refurbishment of Unit 1 are in previously disturbed locations and would not affect historic properties, but could result in disposal of excess spoils in the three designated spoil disposal areas if more than the currently planned additional cooling tower capacity (i.e., more than one new cooling tower) is constructed. The construction of the proposed dry cask storage facility, Modifications Fabrication Building, and Administration Building will not have any direct affects on historic properties, and would not result in disposal of spoils in the three designated spoil disposal areas.

2. On a copy of the site map or, if appropriate, the site vicinity map included in Chapter 2, identify the areas of potential effects if historic properties were to be found.

3. On the map, identify historic properties that may be affected. All on-site historic properties and any off-site historic properties located in or near areas of potential effects should be identified. These properties should be described in the text. Properties can be identified by referring to the "National Register of Historic Places," 36 CFR Part 60; consultation with the State Historic Preservation Officer (SHPO), local preservation officials, and nearby Native American Tribal officials; and field surveys.

In the Supplemental Environmental Impact Statement for Operating License Renewal of the Browns Ferry Nuclear Plant (TVA 2002), the possibility of adding significant cooling tower capacity was discussed. As part of the modifications associated with these potential changes, three potential spoils disposal areas were described. The alternative eventually chosen for additional cooling tower capacity did not require use of these areas, but as part of the proposed license renewal the areas were evaluated for cultural significance.

A Phase I survey was conducted at the three disposal site/spoil pile locations (Figure E.2-9). This survey report is not included in this Environmental Report because the survey report is exempt from public disclosure under the Archaeological Resources Protection Act (ARPA) §470hh to protect sites from theft. The survey identified two historic properties. The survey of Area 1 (see Figure E.2-9) identified a prehistoric archaeological (1Li535) site with an Early to Middle Woodland occupation. This site is considered potentially eligible for listing in the National Register of Historic Places. Cox Cemetery was identified in Area 2. This cemetery was relocated during the initial construction of the BFN. No historic properties were identified in Area 3.

Maps depicting the locations of archaeological sites will not be included in this Environmental Report. These are resources which are subject to illegal looting by collectors, and are therefore considered sensitive. TVA is exempt from disclosing such information to the public under ARPA §470hh.

The disposal of materials in these areas may affect historic properties that are listed or have the potential to be listed in the NRHP. One potentially eligible archaeological site (1Li535) was identified during the Phase I survey of Area 1 (see Figure E.2-9). This site has a potential to have intact deposits that would provide valuable information about the prehistoric period in this region. The site is marked on BFN drawings and would be avoided by any future or current project activities. Therefore, Unit 1 recovery and the proposed renewal of operating licens es for the three BFN units will have no effect on historic properties.

4. If historic properties are found in or near areas of potential effects, assess those effects. Criteria of effect and adverse effect are given in 36 CFR 800.9. Applicants are encouraged to involve the SHPO and local historic preservation officials in the assessment. The assessment should lead to one of three conclusions.

1. No effect: the undertaking will not affect historic properties;
2. No adverse effect: the undertaking will affect one or more historic properties, but the effect will not be harmful;
3. Adverse effect: the undertaking will harm one or more historic properties.

5. If an adverse effect will occur, the applicant, in consultation with the SHPO and other interested parties should identify measures to make the refurbishment or license renewal term activities less harmful.

TVA consulted with the Alabama SHPO regarding Cox Cemetary and the potential archaeological site in Area 1. The SHPO agreed that project activities will have no effect on significant cultural resources since Cox Cemetery and site 1Li535 will be avoided. Site 1Li535 has been marked on BFN drawings with instructions to contact the TVA cultural resources staff prior to disturbance. If site 1Li535 could potentially be disturbed by future plant activities, Phase II testing will first be conducted to confirm the significance of the site. A Phase II survey would require excavation and potentially backhoe trenching in order to delineate the site boundaries and establish site significance. Any such investigations would be conducted after consultation with the SHPO.

Because of the avoidance of those two identified historic properties, there will be no adverse effect.

E.4.20 SEVERE ACCIDENT MITIGATION ALTERNATIVES

Table B-1 states that

> The probability weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives.

Specifically, 10 CFR 51.53(c)(3)(ii)(L) requires that

> If the staff has not previously considered severe accident mitigation alternatives for the applicant's plant in an environmental impact statement or related supplement or in an environmental assessment, a consideration of alternatives to mitigate severe accidents must be provided.

Severe accident mitigation alternatives are discussed in Section 5.4 of NUREG-1437.

The analyses performed for Chapter 5, "Environmental Impacts of Postulated Accidents," of NUREG-1437 represent adequate, plant-specific estimates of the environmental impacts of severe accidents. However, the Commission determined that a site-specific consideration of severe accident mitigation alternatives (SAMAs) will be required at the time of license renewal unless a previous consideration of such alternatives regarding plant operation has been included in a final environmental impact statement, or final environmental assessment, or a related supplement. The applicant should provide the relevant citation. If no such citations exist, the applicant should provide the following information.

Information and Analysis Content

The identification of possible SAMAs and evaluation of their merits should use the information and analyses developed for the plant-specific individual plant examination (IPE) for severe accident vulnerabilities (and modifications made subsequent thereto) and, when available, the plant-specific individual plant examination of external events (IPEEE) for severe accident vulnerabilities (e.g., earthquakes, fires, winds). If an IPEEE has not been completed, the applicant may use the results of IPEEEs performed for other plants, adjusted for plant-specific variables. In preparing the SAMA analyses, applicants may be guided by analyses performed for previous applications for renewal of operating licenses and by the NRC for Watts Bar Unit 1 Nuclear Power Plant, NUREG-0498, Supplement 1, "Final Environmental Statement Related to the Operation of Watts Bar Nuclear Plant, Units 1 and 2," April 1995, and supplements to NUREG-1437. In structuring the analysis, the applicant should consider the methodology presented in NUREG/BR-0184, "Regulatory Analysis Technical Evaluation Handbook," January 1997.

The results of the following analytical steps should be presented in the ER, and the methodology or analytical process should be described.

1. Based on the plant-specific risk study and supplementary analyses, identify and characterize the leading contributors to core damage frequency and offsite risk (i.e., population dose). The frequency and contributors to core damage frequency and large release frequency are generally available from the plant-specific risk study, such as the IPE. Development of offsite risk information may require additional site-specific analyses if the existing risk study does not include an assessment of offsite consequences.

2. From the IPEEE and any other external event analyses, provide estimates of the incremental contribution to dose consequence risk identified from the IPE.

3. Identify practical physical plant modifications and plant procedural and administrative changes that can reduce severe accident dose consequence risk. For each modification or change, estimate the approximate reduction in risk.

4. Estimate the value of the reduction in risk. Value is usually calculated for public health, occupational health, offsite property, and onsite property. A detailed discussion of calculating values is found in Chapter 5 of NUREG/BR-0184

5. Estimate the approximate cost of each modification and procedural and administrative change found to reduce the dose consequence risk of severe accidents. Potential SAMAs that are not expected to be cost beneficial, even when uncertainties in the analysis (e.g., a factor of 10) are taken into consideration, may be screened out based on a bounding analysis.

6. Perform a more detailed value-impact analysis for remaining SAMAs to identify any plant modifications and procedural changes that may be cost effective (see Chapter 5 of NUREG/BR-0184).

7. List plant modifications and procedural changes (if any) that have or will be implemented to reduce the severe accident dose consequence risk.

Input for SAMA is found in Attachment E-4. The end of Attachment E-4 also provides the reconciliation of results from the analyses conducted for the Final Supplemental EIS for Operating License Renewal of BFN versus the results from the analyses conducted for this Environmental Report.

E.4.21 TRANPORTATION OF RADIOLOGICAL WASTE

This is a Category 1 issue and the impacts are small as long as the fuel used is not enriched beyond 5 percent uranium-235 and average burnup for the peak rod does not exceed 62,000 Mwd/MTU.

Table B-1states that

> The impacts of transporting spent fuel enriched up to 5 percent uranium-235 with average burnup for the peak rod to current levels approved by NRC up to 62,000 MWd/MTU and the cumulative impacts of transporting high-level waste to a repository, such as Yucca Mountain, Nevada are found to be consistent with the impact values contained in Summary Table S-4--Environmental Impact of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor. If fuel enrichment or burnup conditions are not met, the applicant must submit an assessment of the implications for the environmental values reported in Sec. 51.52.

This issue is discussed in Section 5.4 and Section 5.5.2.5 of NUREG-1437, which has been updated by Volume 1, Addendum 1, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Main Report Section 6.3--`Transportation,' Table 9.1, `Summary of findings on NEPA issues for license renewal of nuclear power plants,' Final Report,"[2] August 1999.

Addendum 1 provided the technical basis to the final rule, 64 FR 48496, September 3, 1999, that changed the transportation of fuel and waste from a Category 2 issue to Category 1. The staff is closely monitoring industry and NRC programs that would lead to fuel burnup higher than 62,000 MWd/MTU to modify the September 3, 1999, rule in a timely manner. Meanwhile, any potential applicant for license renewal seeking approval for burnup beyond 62,000 MWd/MTU should request early guidance from the NRC staff on how to handle this issue in the ER.

TVA complies fully with the stated current NRC limits of 5% U235 fuel enrichment and 62,000 megawatt days per metric ton of uranium average burnup for the peak fuel rod. TVA currently has no plans to seek approval for increased enrichment or burnup beyond these limits, and would likely do so in the future only as a participant in an industry-based development and demonstration project, subject to NRC approval.

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E.4.22 ENVIRONMENTAL JUSTICE

Table B-1 states that

> The need for and the content of an analysis of environmental justice will be addressed in plant-specific reviews.

Environmental justice was not reviewed in NUREG-1437. Executive Order 12898, "Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations," issued on February 11, 1994, is designed to focus the attention of Federal agencies on the human health and environmental conditions in minority and low-income communities. The NRC Office of Nuclear Reactor Regulation (NRR) is guided in its consideration of environmental justice by Attachment 4, "NRR Procedures for Environmental Justice Reviews," to NRR Office Letter No. 906, Revision 2, "Procedural Guidance for Preparing Environmental Assessments and Considering Environmental Issues," September 21, 1999. NRR Office Letter No. 906 is revised periodically. The environmental justice review involves identifying off-site environmental impacts, their geographic locations, minority and low-income populations that may be affected, the significance of such effects and whether they are disproportionately high and adverse compared to the population at large within the geographic area, and if so, what mitigative measures are available, and which will be implemented. The NRC staff will perform the environmental justice review to determine whether there will be disproportionately high human heath and environmental effects on minority and low-income populations and report the review in its SEIS. The staff's review will be based on information provided in the ER and developed during the staff's site-specific scoping process.

Information and Analysis Content

The ER should include the following information to assist the staff in its environmental justice review.

- From Chapter 2, provide by political jurisdiction the composition of minority and low-income persons within 80 km (50 miles) of the plant. Migrant workers as well as full time residents should be included. Provide these data by census tract/block for those geographic areas where the potential has been identified in Chapter 4 for adverse impacts from refurbishment and from continued operation during the renewal term. The most recent Bureau of the Census demographic information should be supplemented with demographic information from State and local planning agencies.
- Identify in Chapter 4, Chapter 5, and Chapter 6 the geographic location of each environmental impact and proposed mitigating action addressed.

As discussed in Section E.2.6, the disadvantaged population percentage in the primary labor market area is relatively small. In the census tract where the plant is located, the minority population share is slightly larger than the state average (35.0 percent versus 29.7 percent). In the next closest tract, the minority share is 8.6 percent, much lower than the state. In both tracts, poverty rates are lower than the state average. There are no known significant concentrations of migrant workers in the area. Any negative impacts to persons living near the site would be small and would tend to be dispersed through the area. Potential impacts of concern would include air quality, transportation, visual, and noise. The use of BMPs and planned mitigation, as discussed in Sections

E.4.0 and E.6.2 of this report, would help maintain such impacts at a level of no significance. Therefore, no disproportionate impacts to disadvantaged populations are expected.

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E.5.0 ASSESSMENT OF NEW AND SIGNIFICANT INFORMATION

The regulatory requirement to report new and significant information of which the applicant is aware and the definition of new and significant information is discussed in the "General Guidance" section in the Introduction of this regulatory guide. While the identification of new and significant information may result from the scoping process (including the staff's site visit) and from public comments on the draft SEIS, it is appropriate for the applicant to identify any new and significant information early. To achieve early identification, the NRC encourages the applicant, as it develops the ER, to employ methods that will reveal potential new and significant information. To the extent the following information exists, it should be summarized in this chapter of the ER.

1. Describe the information gathering and review process used in developing this ER. Explain how the process would result in the identification of new and significant information concerning Category 1 issues and issues not listed in Appendix B to Subpart A of 10 CFR Part 51. The explanation should address (1) the methods used by the applicant that will make it cognizant of new information, if it exists, and (2) the process for evaluating the significance of new information, if found. Examples of means for identifying new information include review of environmental monitoring results, review of related scientific literature, surveys of the applicant's environmental and operations staff, exchange of information among licensees through peer groups and industry organizations, consultations with academicians knowledgeable of the local environment, and consultations with Federal, State, Tribal, and local environmental, natural resource, permitting, and land use agencies. The description of the review process for evaluating new information for significance should include the organizational procedures for handling reports of new information and the criteria used to determine the applicability of such information. An applicant who is not cognizant of any new and significant information should so state in the ER.

As a federal agency, TVA is subject to the requirements of the National Environmental Policy Act of 1969 (i.e., NEPA). The original Environmental Statement (or Environmental Impact Statement (EIS) in more current NEPA parlance) for the construction and operation of Browns Ferry was prepared by TVA in 1972 with the Atomic Energy Commission participating as a cooperating agency. TVA also complies with the regulations published by the Council on Environmental Quality (CEQ) (40 CFR §§ 1500 – 1508), and TVA's regulations implementing NEPA. The Commission concluded on August 28, 1972, that the statement was adequate to support the proposed license to operate the plant.

To provide the public and TVA decision-makers an assessment of the environmental impacts of recovering BFN Unit 1 and continuing operation of all three BFN units through the 20-year renewed operating license period, TVA subsequently prepared a Supplemental Environmental Impact Statement (SEIS). A Notice of Intent to prepare the SEIS was published in the February 15, 2001, *Federal Register*. A public scoping meeting was held on March 6, 2001, near Decatur, Alabama, close to Browns Ferry. Comments and suggestions received at that meeting and during the scoping period were used to identify the scope of the Draft SEIS. A Notice of Availability of the Draft SEIS was published in the December 14, 2001, *Federal Register*. A second public meeting was then held on January 17, 2002, also near Decatur, to provide the public the opportunity to comment on and ask questions about the Draft SEIS. The public comment period ran from December 14, 2001, to January 30, 2002. Comments received from the public were considered in completing the Final SEIS.

In accordance with standard NEPA practice, TVA also coordinated an inter-governmental review of the SEIS, sending information to and soliciting the views of numerous government agencies and offices within the state of Alabama and the federal government. The federal inter-governmental review included the Fish and Wildlife Service, Army Corps of Engineers, Department of the Interior, Environmental Protection Agency, as well as the Nuclear Regulatory Commission (Headquarters and Region II).

On March 26, 2002, TVA mailed copies of the Final SEIS to interested members of the public and various government offices, agencies, and officials. An electronic version of the document was also made available (and remains so) on TVA's website (www.tva.gov). To ensure the highest degree of public notice and participation in the NEPA process, TVA provided an additional 30-day comment period on the Final SEIS. TVA addressed the comments provided within this period in its Record of Decision which was published in the June 18, 2002, *Federal Register*.

Being a Federal Agency which is involved in numerous activities having potential environmental impacts, TVA has a staff of subject matter experts which is accustomed to performing NEPA reviews. For the SEIS, since the original Environmental Statement dates back to 1972 and its methodologies may have changed or additional information may have become available, these subject matter experts revisited each of their areas for BFN license renewal and reevaluated them in the light of current knowledge and practices. These topics included surface water quality, aquatic ecology, groundwater use and quality, terrestrial resources, threatened or endangered species, air quality, land use, human health, socioeconomics, postulated accidents, uranium fuel cycles and waste management, decommissioning, and environmental justice. Additional topics were addressed also, as appropriate.

Analyses conducted for the SEIS indicated that no significant impacts would be expected as a result of implementing the adopted alternative (i.e., unit 1 recovery plus license renewal of all three units). These findings were primarily a result of the fact that BFN is already an existing facility operating under an NRC license and that the proposed recovery of Unit 1 and continuation of three-unit operations for an additional twenty years after expiration of the current operating licenses result in relatively minor changes to those operations that have the potential for environmental effects.

Under the designs, commitments and conditions described in the Final SEIS for BFN License Renewal, TVA concluded that there would be no effects to the geologic setting, threatened or endangered species, wetlands, soils, recreation, or cultural resources. With the exception of carbon monoxide emissions, the impacts on ambient air quality are expected to be even less than those assessed in the original BFN EIS. The ambient air quality standard for carbon monoxide is still five orders of magnitude greater than emission estimates, so the impact is considered negligible.

Minor, insignificant effects (predominantly from modifications or currently ongoing activities that would proportionately extend in time with relicensing or slightly increase with restart of Unit 1) are anticipated for generation of solid and hazardous waste, spent fuel management, groundwater resources, floodplains/flood risk, terrestrial resources, socioeconomic conditions, transportation, land use, visual resources, and environmental noise, as well as public and occupational safety and health. Proper implementation of best management practices and compliance with applicable laws, regulations and Executive Orders will help ensure that these impacts are negligible. The addition of Unit 1 and increasing the power output of the units to 120% of their originally licensed power levels would increase radioactive effluent releases and exposures to the public proportionally, however, the total exposures to the public are expected to remain a small fraction of the regulatory dose limits.

With best management practices implemented, impacts of modifications on surface waters and aquatic ecological resources are expected to be insignificant. Resumption of three-unit operation after recovery of Unit 1 will require upgrading of the cooling tower system and an increase of intake flow rates by approximately 10 percent from those of past three-unit operation. Thermal impacts to aquatic life would be insignificant because the plant would be operated to ensure that the maximum discharge temperature and the temperature rise between intake and discharge remain within approved regulatory limits. Use of cooling towers would increase, and on rare occasions when the cooling towers are unable to meet thermal limits, the plant would be derated to remain in compliance. Although significant impacts are not anticipated, TVA will also confirm expected levels of impingement and entrainment resulting from increased intake flow rates by monitoring during current 2-unit operation and following resumption of three-unit operability.

Modifications associated with Unit 1 recovery will result in impacts on population, employment and income over a span of about 5.5 years. The total number of on-site workers involved in the modifications phase will peak at about 2,460, and an additional 100 are likely to be located off-site. Modifications could result in some scattered, short-term strain on community services, including police and emergency services, schools and the housing market. Operation of Unit 1 in addition to current operation of Units 2 and 3 will require an increase in employment of about 150 permanent workers, which would be a small addition to the local economy.

With renewed license operation of all three units, decommissioning of the units will be delayed by the 20-year renewed license period, providing an opportunity for decommissioning technology (including more advanced robotics) and the licensing framework to evolve and mature. In addition, it becomes more likely that a permanent spent fuel repository will be available prior to completion of decommissioning. Attachment E-5 is a cross reference showing where consideration of the license renewal NEPA issues listed in Table B-1 of 10 CFR Part 51, Subpart A, has been documented.

2. Describe any new and significant information identified and the associated environmental impacts.

TVA's Final SEIS concluded that BFN Unit 1 can be recovered in a well-controlled modifications effort and all three BFN units can be operated through the 20-year renewed license period with no significant, adverse impacts on the environment.

3. For each impact, describe mitigation measures that were considered and the measures that will be implemented.

The Final SEIS identified appropriate measures to minimize or mitigate environmental impacts which have subsequently been adopted. These measures are generally of two types, i.e., physical changes incorporated during project design, modifications or construction, and programs and environmental controls initiated to meet regulatory standards.

Mitigation measures to minimize potential air pollutant emissions during construction activities for the new Administration Building, the Modifications Fabrication Building, the dry cask storage facility, and the new cooling tower will be the best management practices that TVA uses for construction of any new facilities. These include such measures as wetting ground surfaces as appropriate to reduce fugitive dust, requiring equipment and trucks to be well maintained and tuned for efficient fuel combustion, covering fuels and fueling connections to minimize evaporative losses and requiring contractors to adhere to such policies.

TVA will confirm the expected levels of impingement and entrainment of fish by monitoring under current 2-unit operation and then also following return of Unit 1 to service. Although not expected, if based upon these monitoring studies it is determined that the location, design, construction, and capacity of the cooling water intake structure are causing unacceptable environmental impact, TVA will assess reasonable, available and achievable technologies, operational measures and restoration measures to further minimize the adverse impact at the BFN site and institute those measures which in consultation with the permitting agencies are determined to be appropriate.

The potential archaeological site identified in one of the possible spoils disposal areas, along with an adequate buffer zone, has been set aside from available development by marking it on the site master plan drawings with a note requiring that TVA's archaeological staff be consulted before any disturbance is allowed. If disturbance cannot be avoided, Phase II testing would have to first be completed to confirm the significance of the site.

Finally, TVA will further analyze several options for mitigating the potential noise increase at Paradise Shores (a subdivision development adjacent to the northwest boundary of the site) prior to accepting the final design for the additional cooling tower from the selected vendor. Options include, but are not limited to: using low noise fans on the new cooling tower; instituting operational instructions to reduce noise; and soliciting other noise reduction options from the cooling tower vendor.

Detailed supporting documentation need not be included in the ER, but should be available for review by the NRC. Supporting documentation may include (1) a general description of the participants involved, their organizational affiliations, how they interact among themselves, and the role that they served in the process; (2) a description of consultations with academicians and Federal, State, Tribal, and local environmental natural resource, permitting, and land use agencies; and (3) a description of new information that was identified and the assessment of its significance.

Consultations

Appendix B of the BFN SEIS for License Renewal is a listing of agency correspondence. A copy of the Notice of Intent published in the *Federal Register* on February 15, 2001, which described the action alternatives considered, was sent to the following state and federal agencies:

State of Alabama

Department of Economic and Community Affairs, Alabama Forestry Commission, Alabama Development Office, Alabama Historical Commission, Department of Transportation, Department of Agriculture and Industries, Department of Conservation and Natural Resources, Alabama Department of Environmental Management, Department of Public Health, and Top of Alabama Regional Council of Governments.

Federal Government

U. S. Fish and Wildlife Service, U. S. Army Corps of Engineers, U. S. Environmental Protection Agency, U. S. Nuclear Regulatory Commission (both Headquarters and Region II), and the U. S. Department of the Interior, Office of Environmental Polity and Compliance.

A “no comment” letter was received from the U. S. Department of the Interior. A ten-page comment letter dated January 25, 2002, was received from the U. S. Environmental Protection Agency; responses to this letter and to comments from various individuals are given in Appendix F of the BFN License Renewal Final SEIS.

Post-FSEIS

Although not required, TVA provided 30 days for the public to comment on the FSEIS. During this period, comments regarding the FSEIS were received from the U. S. Environmental Protection Agency (EPA), the Alabama Department of Environmental Management (ADEM), and a member of the public. TVA considered all comments received on both the draft and final SEIS in completing the NEPA process and reaching its decision. Discussed below are a number of the more important comments on the FSEIS.

Based on review of the FSEIS, EPA had five concerns: (1) TVA’s stated preference for recovering and restarting BFN Unit 1 and adding a single 20-cell cooling tower appeared to EPA to be inconclusively presented in the FSEIS; (2) the cooling option selected in the FSEIS was not presented in the Draft SEIS (although EPA correctly noted that this was very similar to the cooling tower option in another non-preferred option); (3) cooling capacity and thermal discharge modeling was preliminary at the Draft SEIS stage and specifically for the chosen option was not included until the FSEIS; (4) the proposed action would likely contribute to the thermal load of the downstream 303(d) segment of the Tennessee River listed as impaired for temperature and other pollutants of concern, and (5) the cooling option chosen provides the lowest capacity of the four presented cooling tower options and therefore would allow the hottest average thermal discharge [this is not correct, as explained below].

ADEM commented that: the proposed action would likely contribute to the thermal loading of the BFN facility near the mouth of the Elk River and above Wheeler Dam. This segment had been identified as impaired on Alabama's 1998 and draft 2000 303(d) lists. One of the listed pollutants of concern for that segment was temperature, ADEM commented that because the segment was listed for temperature impairment, no additional thermal loading could be permitted until such time that a Total Maximum Daily Load (TMDL) analysis could be developed or the stream could be de-listed for temperature.

ADEM additionally noted that the current NPDES permit contains temperature limits based on a 316(a) demonstration that EPA approved in June 1977. This allows the plant to meet a relaxed temperature limit. ADEM commented that the NPDES permit can be re-opened and modified in the event that ADEM determines through biological and/or water quality monitoring that more stringent limitations and/or monitoring requirements are necessary to ensure the protection and propagation of aquatic life in the Tennessee River.

ADEM stated that the impaired segment of the Tennessee River would be re-evaluated to determine whether the segment is impaired due to temperature and if so determined, then a TMDL analysis would be developed. To facilitate that evaluation, ADEM expressed interest in receiving copies of TVA's water quality data, if not previously provided, as well as water quality models conducted as part of the Final SEIS. (Per Table 2, Waterbody/Pollutants Removed from the 2000 List, section of the Final 2002 §303(d) List posted on their website, ADEM subsequently delisted this thermally impaired segment of Wheeler Reservoir.)

With regard to the first EPA comment, the FSEIS stated on page 2-55 under the heading "The Preferred Alternative" that Alternative 2 was preferred by TVA and that sub-alternative 2D was the preferred option for additional cooling tower capacity.

At the time of release, the Draft SEIS presented a summary of preliminary modeling results indicating that opportunities existed to allow a reduced amount of additional cooling capacity and/or cooling tower operation in an environmentally acceptable manner. Given TVA's compliance with current thermal limits of the NPDES permit for BFN, there is no material difference between the potential thermal impacts to the environment among those cooling tower sub-alternatives presented in the Draft SEIS and sub-alternative 2D. In the event that thermal limits could not be maintained by operation of cooling towers (see further discussion below), compliance would typically be maintained by derating the plant.

As indicated in both the Draft SEIS and FSEIS, two-dimensional modeling analyses conducted to assess the potential thermal effects under worst-case scenarios to the reservoir and (formerly listed) 303(d) reach under the current NPDES permit conditions, do indicate a slight increase (0.4 deg. F) in average reservoir water temperature in the (formerly listed) 303(d) reach of Wheeler Reservoir for resuming 3-unit operation (at uprated power levels) relative to the originally approved 3-unit operation. As discussed in the FSEIS, the impact of this projected worst-case change on water resources in Wheeler Reservoir is expected to be insignificant. With the use of cooling towers and plant derates, if necessary, temperature effects are expected to be less in years of more typical hydrology and meteorology. TVA supplied the data and information requested by ADEM and cooperated with ADEM regarding monitoring and evaluation of the (formerly) listed stream reach. ADEM subsequently evaluated new information and determined that the (formerly) listed 303(d) section was not an impaired water body; consequently, development of a TMDL analysis for that section of the river will not be necessary.

Currently, TVA operates cooling towers at BFN only when the water temperature of discharges approaches and presents the potential for exceeding an NPDES thermal limit. When this situation occurs, not all cooling towers are necessarily placed in service. To maximize the net generation of the plant, only those towers necessary to keep the water temperature below the thermal limits are operated. Thus, as long as derating is part of the operational strategy for maintaining the NPDES limits, there is no significant difference in the hottest average thermal discharge for any of the cooling tower options. Additionally, TVA is working towards improving its methods of predicting water temperatures in Wheeler Reservoir and optimizing the operation of the cooling system provided at BFN.

EPA also requested further clarification of the expected increase in intake flows necessary for operating all three BFN units as reported in the Draft SEIS and the FSEIS. Further analyses of flow changes associated with the proposed actions following release of the Draft SEIS were indicated in Section 2.2.2 of the FSEIS. As stated in Section E.4.1 of this Environmental Report, the expected increase in intake flows needed for operating all three units is 11 percent.

EPA requested clarification in the Record of Decision concerning two noise related issues: (1) whether or not the 24-hour DNL for noise is also less than the EPA target of 55 DNL for the chosen cooling tower option, as it was for the other cooling tower options; and (2) whether or not the 24-hour DNLs for the chosen cooling tower option are within FICON guidance (and therefore considered insignificant). If not, EPA suggested further consideration of using cooling fans with reduced noise emissions until consistent with FICON. Table 4.3.19-1 of the FSEIS indicates the selected cooling tower option has a 24-hour DNL of 53 dBA which produces an annual average DNL that is less than both HUD and EPA 24-hour DNL annual average guidelines even with the probably priority-of-use configuration for cooling towers. The 24-hour DNL for the chosen cooling tower option is 1 dBA more than the 24-hour DNL for current operation and the increase is insignificant based on FICON recommendations. There are no significant noise consequences from the selected cooling tower option. However, paragraph 4.3.19.4 of the FSEIS would present a clearer picture if it first stated which options are within FICON guidelines (2A, 2B, 2D) and then discussed 2C which does not meet FICON guidelines for Paradise Shores.

<u>Significance of New Information</u>

TVA's Final SEIS concluded that BFN Unit 1 can be recovered in a well-controlled modifications effort and all three BFN units operated through the 20-year renewed license period with no significant, adverse impacts on the environment.

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E.6.0 SUMMARY OF LICENSE RENEWAL IMPACTS AND MITIGATING ACTIONS

E.6.1 LICENSE RENEWAL IMPACTS

> This section should provide a summary, preferably in tabular form, of the environmental impacts related to license renewal for the plant. The summaries should be descriptive and informative rather than evaluative or comparative. The presentation of material should be organized by environmental resource area, such as the subject areas used in Table B-1.

TVA has reviewed the environmental impacts of renewing the operating licenses for Units 1, 2, and 3. Chapter 4 incorporates, by reference, NRC findings for the Category 1 issues that apply to BFN as well as the "NA" issues (for which NRC came to no generic conclusion). Table E.6-1 identifies the impacts that license renewal would have on resources associated with Category 2 issues.

Table E.6-1 – Environmental Impacts Related to License Renewal at BFN

No.	Issue	Environmental Impact
Surface Water Quality, Hydrology, and Use (for all plants)		
13	Water use conflicts (plants with cooling ponds or cooling towers using make-up water from a small river with low flow)	**Small.** The total BFN intake water flow (4,907 cfs) can at unusual times be a significant fraction of the river flow past the plant (7Q10 of 8,700 cfs in NPDES permit rationale), but consumptive water uses are negligible (<100 cfs) and are expected to remain so throughout the license renewal term. TVA has determined that consumptive and off-stream water uses would not have a significant conflict with aquatic habitats due to the large volume of reservoir water available, the high river flow rate, and the return of most of the water withdrawn.
Aquatic Ecology (for all plants with once-through and cooling pond heat dissipation systems)		
25	Entrainment of fish and shellfish in early life stages	**Small.** TVA's Vital Signs monitoring program reported no obvious decline in the fish and benthic macroinvertebrate communities in Wheeler Reservoir during the period 1993 through 2002 and indicated and there is a balanced indigenous reservoir fish community.

Table E.6-1 (cont.) – Environmental Impacts Related to License Renewal at BFN		
No.	**Issue**	**Environmental Impact**
26	Impingement of fish and shellfish	**Small.** TVA's Vital Signs monitoring program reported no obvious decline in the fish community in Wheeler Reservoir and data support the assumption of a balanced indigenous fish community.
27	Heat shock	**Small.** TVA studies have documented that thermal releases from BFN have not had a significant impact on the aquatic community of Wheeler Reservoir. Discharge temperatures will remain within the NPDES permit limits; thus, heat shock impacts are not anticipated.
	Groundwater Use and Quality	
33	Groundwater use conflicts (potable and service water, and dewatering; plants that use >100 gpm)	**None**. This issue does not apply because BFN uses less than 100 gpm of groundwater.
34	Groundwater use conflicts (plants using cooling towers withdrawing make-up water from a small river)	**Small.** Although shallow groundwater at BFN can occur within unconsolidated terrace deposits of alluvial origin, the terrace deposits are not recognized as an aquifer at the site. This is primarily due to the limited permeability and spatial extent of the terrace deposits. Therefore, there are no groundwater use conflicts associated with surface water withdrawals during low flow conditions which may affect aquifer recharge.
35	Groundwater use conflicts (Ranney wells)	**None.** This issue does not apply because BFN does not use Ranney wells.
39	Groundwater quality degradation (cooling ponds at inland sites)	**Small.** Considering that the plant wastewater lagoons and sedimentation ponds possess clay and Hypalon liners, respectively, no impacts to groundwater resources are anticipated. The changes in pond/lagoon discharges to the river would remain within the bounding conditions established in the NPDES.

Table E.6-1 (cont.) – Environmental Impacts Related to License Renewal at BFN		
No.	**Issue**	**Environmental Impact**
	Terrestrial Resources	
40	Refurbishment impacts	**Small.** Because no uncommon terrestrial communities or otherwise unusual vegetation occur on or immediately adjacent to the lands to be disturbed by refurbishment activities, no adverse impacts to any uncommon wildlife or their habitats would result.
	Threatened or Endangered Species (for all plants)	
49	Threatened or endangered species	**Small.** During the three phases of BFN's thermal variance monitoring (1985-1998) and current Vital Signs Monitoring programs, no threatened or endangered aquatic species were found within the affected area. The seven survey reports cited in section 3.11.1 support the conclusion that there would be no effect on the species listed in Section 3.11.2. No occurrences of rare (i.e., federal- or state-listed) plant species are known to exist on or immediately adjacent to the lands to be disturbed. Therefore, no effects to rare plant species are anticipated.
	Air Quality	
50	Air quality during refurbishment (nonattainment and maintenance areas)	**None.** This issue does not apply because no air quality nonattainment or maintenance areas are designated at or near the BFN site.
	Human Health	
57	Microbiological organisms (public health) (plants using lakes or canals, or cooling towers or cooling ponds that discharge to a small river)	**None.** Correspondence with the Alabama Department of Public Health (ADPH) reveals that the ADPH is not aware of any concerns regarding the potential existence and concentration of thermophilic microorganisms such as *Naegleria fowleri* in the receiving waters for plant cooling water discharge. Refer to Attachment E-2 for actual correspondences.

Table E.6-1 (cont.) – Environmental Impacts Related to License Renewal at BFN		
No.	**Issue**	**Environmental Impact**
59	Electromagnetic fields, acute effects (electric shock)	**Small.** TVA designs transmission lines to exceed the requirements given in the NESC at the time the lines are constructed, thereby ensuring that the impact of shock hazards and EMF exposure are minimal as a result of operation of the BFN plant.
	Socioeconomics	
63	Housing impacts	**Small.** BFN is considered to be in a high population area. Also, the primary labor market area has no growth control measures that would limit housing development. Therefore, in accordance with NRC standards, housing impacts would be small.
65	Public services: public utilities	**Small.** The peak potable water consumption rate of 5 million gallons per month partially represents the current total workforce at BFN, which is at the expected peak number of approximately 3,600. When three-unit operation is resumed in 2007, the total site workforce (TVA plus contractors) is projected to return to less than 1,400 and remain at that level through the renewed operating license period. The potable water consumption at BFN after resumption of three-unit operation will likely return to nearly the pre-Unit-1 recovery rate of less than 50 million gallons per year. For off-site consumptive impacts, it has been found that only a minority of the Unit 1 recovery on-site workers have relocated as a result of employment on the project, greatly mitigating the impact on the local area water supplies. The temporary local population increase from workers and their families associated with Unit 1 recovery is distributed over such a large work force population area that the consumptive impacts on Wheeler Reservoir are negligible. Similarly, off-site consumptive impacts of the permanent workers and their families will be negligible through the 20-year period of renewed operating licenses.

Table E.6-1 (cont.) – Environmental Impacts Related to License Renewal at BFN		
No.	**Issue**	**Environmental Impact**
66	Public services, education (refurbishment)	**Small.** It is anticipated that about 460 additional children of school-age would result from refurbishment. The likely geographic distribution of these children and their relative impact on the school systems in each county indicate that in no case would the impact on school systems be as high as one percent of the school membership. Therefore, the impact on schools would be classified as small.
68	Offsite land use (refurbishment)	**Small.** All three conditions prescribed in the NRC Regulatory Guide 4.2S1, Section 4.17.1 are met and therefore, the impacts can be designated as small. • The projected population growth is approximately 3.2 percent (less than 5 percent) of the population in Limestone County, and approximately three-tenths of one percent of the population in the six-county geographic region from which workers would commute. • Limestone County has developed a Comprehensive Plan which includes goals for land use, community facilities, transportation, and a capital improvements program and budget. The existing Plan was developed to cover the time period from 1985 to 2000. An updated plan is currently being developed for the next two decades. • BFN is not located in an extremely isolated or sparsely populated area. According to GEIS criteria, based on proximity and sparseness, Brown's Ferry is located in a high population area.

Table E.6-1 (cont.) – Environmental Impacts Related to License Renewal at BFN		
No.	**Issue**	**Environmental Impact**
69	Offsite land use (license renewal term)	**Small.** Operation of Unit 1 in addition to Units 2 and 3 would require an increase of about 150 workers above the current operational levels and this increase would be of small significance. Since there are sufficient vacant housing units, 2,209 with 621 available for rent, this action should not promote housing construction. No impacts to land use or infrastructure are expected because of the additional workers. With only about 2 percent of the county urbanized, increased revenue from TVA due to this action might have a small positive impact on land use due to increased funds for development.
70	Public services, Transportation	**Moderate.** Transportation impacts vary in degree by location. During the construction phase minor intersections near the plant are noticeably impacted. Those affected are primarily commuters associated with the project. At the other extreme, on other road segments there is no noticeable impact. The analysis shows a worse case drop to Level of Service D for a few identified road segments during the peak construction phase. A drop to LOS C or D is associated with a Moderate impact finding according to the NUREG. These impacts can be tolerated for a short period of time by the traveling public.
71	Historic and archaeological resources	**Small.** The construction activities included in the proposed action are in previously disturbed locations and would not affect historic properties, but could result in excess spoils disposal in the three designated spoil disposal areas. One potentially eligible archaeological site was identified during the Phase I survey. This site has a potential to have intact deposits that would provide valuable information about the prehistoric period in this region. The site is marked on BFN drawings and would be avoided by any future activities. Therefore, there will be no effect on historic properties.

Table E.6-1 (cont.) – Environmental Impacts Related to License Renewal at BFN		
No.	**Issue**	**Environmental Impact**
Postulated Accidents		
76	Severe accidents	**Small.** The evaluation did not identify any potential SAMAs that are cost effective when the estimated costs are compared to the mean value of the estimated potential savings.

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E.6.2 MITIGATION

This section should provide a summary, preferably in tabular form, of each mitigative action committed to in this ER.

Table E.6-2 – Mitigation Measures

No.	Issue	Mitigation Measure(s)
Surface Water Quality, Hydrology, and Use (for all plants)		
13	Water use conflicts (plants with cooling ponds or cooling towers using make-up water from a small river with low flow)	None.
Aquatic Ecology (for all plants with once-through and cooling pond heat dissipation systems)		
25	Entrainment of fish and shellfish in early life stages	None.
26	Impingement of fish and shellfish	None.
27	Heat shock	None.
Groundwater Use and Quality		
33	Groundwater use conflicts (potable and service water, and dewatering; plants that use >100 gpm)	Not applicable at BFN.
34	Groundwater use conflicts (plants using cooling towers withdrawing make-up water from a small river)	None.
35	Groundwater use conflicts (Ranney wells)	Not applicable at BFN.
39	Groundwater quality degradation (cooling ponds at inland sites)	None.

Table E.6-2 (cont.) – Mitigation Measures		
No.	**Issue**	**Mitigation Measure(s)**
Terrestrial Resources		
40	Refurbishment impacts	None.
Threatened or Endangered Species (for all plants)		
49	Threatened or endangered species	None.
Air Quality		
50	Air quality during refurbishment (nonattainment and maintenance areas)	None.
Human Health		
57	Microbiological organisms (public health) (plants using lakes or canals, or cooling towers or cooling ponds that discharge to a small river)	None.
59	Electromagnetic fields, acute effects (electric shock)	None.
Socioeconomics		
63	Housing impacts	None.
65	Public services: public utilities	None.
66	Public services, education (refurbishment)	None.
68	Offsite land use (refurbishment)	None.
69	Offsite land use (license renewal term)	None.
70	Public services, Transportation	Employee programs that provide flexible working hours; delayed shift changes; restrictions for trucks traveling during peak traffic hours.
71	Historic and archaeological resources	None.
Postulated Accidents		
76	Severe accidents	None.

E.6.3 UNAVOIDABLE ADVERSE IMPACTS

> This section should summarize "Any adverse environmental effects which cannot be avoided should the proposal be implemented," as required by 10 CFR 51.45(b)(2). Unavoidable adverse effects should be identified in Chapters 4 and 5, in detail commensurate with the significance of the effects.

Continued operation of the BFN units through the additional twenty-year renewed license period would result in unavoidable but very minor impacts to air and water quality, sound and visual resources.

Air quality would continue to be affected by routine radioactive and non-radioactive gaseous emissions typical of boiling water reactor operations.

Water resources would continue to be affected in terms of surface use and quality because waste heat discharged to Wheeler Reservoir and the very infrequent slightly radioactive effluent releases. Three-unit operation (at EPU) will result in increased waste heat discharge to Wheeler Reservoir, but all regulatory temperature limits will be met. Three-unit operation (at EPU) will also result in increased entrainment and impingement of aquatic biota, which is not anticipated to be environmentally significant. The routine discharge of water treatment chemicals would continue to have a minor affect on the aquatic biota near the plant discharge pipes.

Irreversible adverse impacts associated with recovery and restart of Unit 1 will be construction and operation of increased cooling tower capacity, minor office and maintenance building changes and additions, and operating equipment refurbishments.

Continued operation will also increase the amount of spent nuclear fuel generated and stored on site until the national repository being developed at Yucca Mountain, Nevada, is completed and becomes available. Also unavoidable for continued operation and Unit 1 recovery is the generation of additional non-radioactive and low-level radioactive waste. During operation of Units 2 and 3 with Unit 1 idle, the amount of general non-radioactive trash (paper and cardboard, plastics, wood, etc.) generated by BFN normally is somewhat greater in weight and volume than the solid radioactive waste stream. However, recovery of Unit 1 is now, as expected, temporarily generating more than double the normal amount of solid wastes, and much of it is slightly radioactively contaminated. The non-radioactive and radioactive waste streams are surprisingly similar in terms of the types of items and materials they contain. Although their unavoidable adverse impact is also similar in requiring landfill disposal, they differ in where they are ultimately reposited. Solid non-radioactive wastes are collected and transported to a licensed local waste disposal company. Low-level radioactive waste, however, must be transported and managed off-site at licensed low-level radioactive waste disposal facilities such as in Clive, Utah and Barnwell, South Carolina.

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E.6.4 IRREVERSIBLE OR IRRETRIEVABLE RESOURCE COMMITMENTS

> This section should summarize "any irreversible or irretrievable commitments of resources which would be involved in the proposed action should it be implemented," as required by 10 CFR 51.45(b)(5). Irreversible or irretrievable commitments of resources include energy and materials consumed, resources and materials committed over the license renewal term, and additional waste materials that will be generated by extended operations. In addition to summarizing irreversible and irretrievable resource commitments discussed in Chapters 4 and 5, this section should briefly describe the magnitude and significance of irreversible or irretrievable commitments of resources that are not addressed in those sections. Discussions should be proportionate to the significance of the resource commitments.

Recovery and restart of Unit 1, plus license renewal and operation of all three units for an additional 20 years after expiration of their current operating licenses, would result in irreversible and irretrievable commitments of resources including land, water, fuels, and other mineral resources over the extended lifetime of the facilities. Human resources (measured in man-years) are also included as a part of the listing of the resource commitments presented in Table E.6-3. Listed values include EPU unless not applicable or otherwise noted.

Continued operation of the plant will result in consumption of nuclear fuel and small amounts of other materials, some of which cannot readily be replaced or recycled. At this time, all constituents of the spent nuclear fuel are considered non-recoverable since no reprocessing of the spent fuel is allowed. Additional temporary spent fuel dry storage at the site will consume construction materials and result in minor increases in worker radiation exposure but would be built on already-disturbed site land.

The values in Table E.6-3 are based on the addition of a single 20-cell cooling tower in (currently vacant) position no. 4, but other changes are being considered. The currently preferred options for additional cooling tower capacity involve building on already-disturbed site land, but future capacity additions could potentially require additional land resource commitments, although probably still within current site boundaries. However, land is not considered to be in short supply in the region, given the large amount of non-industrialized property. Some river water would be evaporated during brief periods of cooling tower operation, typically less than one month per year. Since this water is returned to the earth as vapor, it is not considered to be an irreversible and irretrievable commitment of resources.

Table E.6-3 – Irreversible and Irretrievable Commitments of Resources	
Resource	**Quantity**
Land	no additional
Nuclear Fuel[(1)]	
Uranium oxide	149,130 lb.
Zircaloy	60,324 lb.
Stainless Steel	6,641 lb.
Inconel	777.5 lb.
Fuel Oil[(2)]	385,000 gallons/yr
Industrial Gases	
Hydrogen[(3)]	25,880,000 scf/yr
Oxygen[(4)]	12,300,000 scf/yr
Nitrogen[(5)]	1,538,000 scf/yr
Ion Exchange Resins[(6)]	5,871 ft^3/yr
Construction	
Steel[(7)]	1651 tons
Concrete[(8)]	8,335 cu. Yards
Labor (Man-years)	35,350[(9)]

[1]Per unit per reload (i.e., each reactor refueling batch; two years between refuelings)
[2]The same type of fuel oil is used for auxiliary heating boilers, emergency diesel generators, and various other diesel engines at BFN; annual consumption is essentially independent of Unit 1 restart.
[3]Used for reactor water chemistry control and generator internal atmosphere; in units of standard cubic feet per year.
[4]Predominantly used for reactor water chemistry control; in units of standard cubic feet per year.
[5]Predominantly used in containment atmosphere inerting; in units of standard cubic feet per year.
[6]Used for condensate demineralizers and radwaste processing; in units of cubic feet per year.
[7]Includes concrete reinforcing bars and anchors, framing members (girders, beams, columns), conduit, gratings, etc.
[8]Total concrete for buildings, cooling tower (includes equipment support pads, ducts, etc.), and dry cask spent fuel storage facility.
[9]Total site staff of 1350 for 20 years + U1 restart (avg. 1500 for 5 ½ years) + cooling tower work (~200 workers for ½ year).

E.6.5 SHORT-TERM USE VERSUS LONG-TERM PRODUCTIVITY OF THE ENVIRONMENT

This section should summarize "the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity" as required by 10 CFR 51.45(b)(4). For operational impacts, short-term may be taken to mean the operating life of the plant and long-term should be taken to be the period beginning after the end of its licensed operating life and continuing as long as the past operations of the plant could have discernible impacts. For refurbishment impacts, short-term may be taken to include the refurbishment period and long-term may be taken to be the period beginning with the completion of refurbishment. Long-term should be interpreted in the context of the nature of the affected resource. For some resources, there may be no long-term impacts, such as those affected by refurbishment or operations that return to normal conditions after operations cease). For other resources, there may be only long-term impacts, such as global warming impacts of increasing or reducing combustion of fossil fuels.

The discussion should recognize that license renewal may have both adverse and beneficial impacts on the long-term productivity of the environment. The term "productivity" should be interpreted broadly, to include both the productivity of resources useful for human activity and the productivity and stability of ecological systems, even those that are not used directly by humankind.

The economic and societal returns to the TVA service region would be considerable for license renewal and extended operation of the three BFN units. Those returns include continued stable and dependable electricity, and continued employment covering a wide spectrum of jobs and pay ranges, maintaining BFN as a preferred significant local employer with very minimal consumption of resources. Demands for peaking and baseload energy are projected to increase, and license renewal of the BFN units is one way to help meet the continuing demand for baseload resources.

Cooling tower additions and recovery and restart of Unit 1 will result in small short-term impacts to the environment relative to the long-term maintenance and enhancement of productivity. The short-term impacts are primarily those that occur during the period of construction of increased mechanical draft cooling tower capacity and equipment replacements during Unit 1 refurbishment. The major short-term uses of materials associated with Unit 1 recovery include the concrete, steel (cable conduit, pipe and pipe hangers, reinforcement bars, sheet metal, structural beams, etc.), and fill composition used in constructing the additional cooling tower(s). The use of short-term resources to restore Unit 1 for power production will affect the long-term productivity of the site by providing an additional reliable source for the production of bulk electric power. It will also provide an additional 150 permanent jobs and approximately 3,000 temporary jobs during Unit 1 recovery.

Discontinuing operation of BFN at the end of the licenses, renewed or current, and completion of decommissioning would likely allow some other commercial or industrial use of part of the BFN site in the future, including use of the site for electric power generation. This would ameliorate to some extent the socioeconomic impacts of loss of employment at BFN. However, such uses are not reasonably foreseeable at this time and any such future use would require its own environmental review.

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E.7.0 ALTERNATIVES TO THE PROPOSED ACTION

Regarding alternatives, 10 CFR 51.53(c)(2) states in part that

. . . [T]he applicant shall discuss in this report the environmental impacts of alternatives and any other matters described in § 51.45. The report is not required to include discussion of need for power or economic costs and economic benefits of the proposed action or of alternatives to the proposed action except insofar as such costs and benefits are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation. The environmental report need not discuss other issues not related to the environmental effects of the proposed action and the alternatives.

Requirements for the treatment of alternatives in an EIS are presented in Section 5 of Appendix A to Subpart A of 10 CFR Part 51. These requirements are consistent with the Council on Environmental Quality (CEQ) regulations implementing NEPA (40 CFR 1502.14), which require that an EIS

(a) Rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated.
(b) Devote substantial treatment to each alternative considered in detail including the proposed action so that reviewers may evaluate their comparative merits.
(c) Include reasonable alternatives not within the jurisdiction of the lead agency.
(d) Include the alternative of no action.
(e) Identify the agency's preferred alternative or alternatives, if one or more exists, in the draft statement and identify such alternative in the final statement unless another law prohibits the expression of such a preference.
(f) Include appropriate mitigation measures not already included in the proposed action or alternatives.

In deciding whether or not to approve license renewal, the NRC will consider the environmental impacts of alternatives as well as those of the proposed action. The NRC considers environmental effects of license renewal according to 10 CFR 51.103(a)(5).

In making a final decision on a license renewal action pursuant to Part 54 of this chapter, the Commission shall determine whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable.

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E.7.1 NO- ACTION ALTERNATIVE

> For license renewal, the no-action alternative is defined as the alternative of not renewing the license. At license expiration, plant operations would terminate and decommissioning activities would commence. The environmental impacts of terminating nuclear power plant operations and decommissioning are discussed in Section 8.4 of NUREG-1437. The ER should contain an analysis of the no-action alternative, including impacts on land use, water quality, air quality, ecological resources, human health, social and economic stucture, waste management, aesthetics, and cultural resources. Direct, indirect, and cumulative impacts should be considered. The level of effort expended on impact analyses of alternatives should be commensurate with the significance of the impacts. Material from NUREG-1437 may be summarized and incorporated by reference to the extent it is applicable.

The No Action Alternative would result from a decision to not renew the operating licenses of the BFN units. Since it currently appears economically infeasible to recover Unit 1 without license renewal, such a decision would effectively terminate any further work on recovering and restarting that unit at this time. Operation of Units 2 and 3 would cease upon expiration of their operating licenses in 2014 and 2016, respectively, and the plant would then be required to choose a decommissioning option. Since the Unit 1 license would have expired in 2013, the licenses for Units 2 and 3 would probably have been modified at that time to include interconnecting Unit 1 equipment as necessary. Unit 1 would have been defueled before its license had expired, but decommissioning would most likely be delayed. Unit 1 would probably not enter its chosen decommissioning mode while Units 2 and 3 (with which it is heavily interconnected, including safety systems) are operable or operating. Both TVA and NRC would be cautious about mixing operation with decommissioning of same-site interconnected units

Operation of Units 2 and 3 during their existing license terms is addressed in the plant's original EIS: *Final Environmental Statement, Browns Ferry Nuclear Plant Units 1, 2, and 3* (TVA, 1972). That EIS continues to adequately identify the environmental impacts of operating the BFN units until their existing licenses expire. Other relevant NEPA reviews identify the changes that have occurred in unit operation since the original EIS and the environmental impacts associated with those changes; these include the following:

- "Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement," issued by the U. S. Department of Energy, Office of Fissile Materials Disposition, June 1996. Subsequently re-circulated for review and adopted by TVA, February 2001.

- "Browns Ferry Nuclear Plant Units 2 and 3 Extended Power Uprate Project, Final Environmental Assessment and Finding of No Significant Impact," TVA Environmental Policy and Planning, NEPA Administration, August 2003.

- "TVA Reservoir Operations Study, Draft Environmental Impact Statement," in cooperation with U. S. Army Corps of Engineers and U. S. Fish and Wildlife Service, June 2003. Currently expected to be issued as Final in early 2004.

- "Final Supplemental EIS for Operating License Renewal of the Browns Ferry Nuclear Plant in Athens, Alabama," TVA, March 2002.

In the event that TVA chooses to not seek a renewal of the unit operating licenses or to not complete recovery of BFN Unit 1, the baseload generation that could have been provided by these actions would, presumably, be provided by one of the other generation options identified and described in this Environmental Report. Prior to proposing and implementing one of these options, additional environmental analyses may have to be conducted. Although some of these generating options may be capable of providing the baseload generation that would result from restart of BFN Unit 1 and license renewal of all three BFN units, they would not maximize the use of existing BFN assets, and it is currently projected that the replacement power would be significantly more expensive. Moreover, these options would likely result in more significant environmental impacts than recovering BFN Unit 1 and continuing operation of all three BFN Units, especially those involving construction of new fossil-fuel fired generating facilities on greenfield sites. Additionally, recovering Unit 1 and continuing to operate the three BFN units is considered more cost effective than other power generation options. It is for these reasons that the No Action Alternative has not been identified as preferable by TVA.

E.7.2 ALTERNATIVES THAT MEET SYSTEM GENERATING NEEDS

E.7.2.1 ALTERNATIVES CONSIDERED

The range of alternatives to be considered should be focused by the stated purpose and need for the proposed action. The statement of purpose and need adopted by the NRC and stated in NUREG-1437 and in Chapter 1 of this regulatory guide focuses on meeting future power system generating needs. Alternatives that meet the stated purpose and need are (1) build new generating capacity, (2) purchase the power from outside the system, and (3) reduce power requirements through demand reduction. The ER should demonstrate that the applicant has considered these or similar alternatives. The applicant should identify the criteria used in evaluating the reasonableness of the alternatives and explain which alternatives will not be considered further and why. The ER should identify the alternatives that will be carried forward for comparison with license renewal. The ER should discuss the extent to which these alternatives have been considered by State authorities (e.g., public service commissions and environmental, natural resource, or energy agencies) and how such considerations relate to the applicant's evaluation.

E.7.2.1.1 POWER DEMAND AND CURRENT POWER SOURCES

TVA needs a diverse complement of generating assets to meet customer demands. These assets are called upon as needed to respond to system needs that cycle daily, weekly, and seasonally. TVA defines baseload assets as those which operate at a capacity factor of 70% or greater, and peaking assets as those which operate at a capacity factor of 20% or less ; intermediate assets are those in the middle. TVA's ''swing'' coal and hydro assets are intermediate by this definition, since they cut back production during off-peak hours and increase generation to meet the peak. ''Swing'' coal assets remain running at night, because it is cheaper to avoid start costs and/or to assure reliability. Hydropower assets have minimum flow requirements and the need to move water from one reservoir to another. All power generation assets are operated as needed to meet customer load demands,which fluctuate by as much as 20% on a daily basis and up to 50% seasonally. Consequently, the types of power plants TVA builds must directly respond to the conditions under which they are operated, with the goals of maximizing energy efficiency and minimizing the cost of electricity ($/kWh) across the system.

Nuclear generation is normally operated as much as possible, since the fuel costs of nuclear units are a relatively small component of the overall costs of operation, unlike fossil-fired units. Another consideration is the physical operating constraints of nuclear plants. Nuclear units are not easily cycled – meaning they cannot be brought on line quickly, and continuously adjusting the output of energy rapidly is neither practical nor economically advantageous compared to other power sources. In contrast, hydropower is a resource that can respond almost immediately to changes in demands for power. Therefore, nuclear units are normally operated as "baseload" capacity (i.e., constant full-power operation, not fluctuating in response to changes in hourly load demand as peaking units do).

The current mix of power generation sources in the TVA region provides a good starting point to evaluate feasible power generation alternatives to extending operation of Browns Ferry Nuclear Plant. The most recent period of complete data available for this comparison is from fiscal year 2002.

TVA currently has over 31,000 MW total winter net dependable generating capacity, comprised of coal-fired, nuclear, combustion turbine (normally gas-fired), hydroelectric, purchased power, and pumped storage hydropower plants. Table E.7-1 shows the capacity mix and the percentage of annual generation supplied by each resource type for fiscal year 2002.

Table E.7-1 – Power Generation Resources

Generation Resource	Net Winter Dependable Capacity (MW)	Percent of Total Capacity	Annual Generation (GWhrs)	Percent of Total Energy
Coal	15,023	47.7	94,930	57.5
Pumped Storage[1]	1,624	5.2	-674	-0.4
TVA Hydropower	3,305	10.5	10.879	6.6
Purchased Hydropower[2]	731	2.3	3,175	1.9
Purchased Power[3]	440	1.4	10,424	6.3
Nuclear	5,751	18.2	45,179	27.4
Combustion Turbines	4,643	14.7	1,190	0.7
"Green" Power			18	
Total[4]	**31,517**	**100**	**165,121**	**100**

[1]Racoon Mountain Pumped Storage Project
[2]USACE Hydro Capacity and APGI's Tapoco Project
[3]Red Hills (Includes other purchases in generation)
[4]Fiscal Year 2002 capacity and generation statistics

The coal and nuclear units total over 20,000 MW, or 65% of TVA's total capacity, and generated 140,000 MWhrs, or over 85% of the annual energy in 2002. In contrast, TVA's combustion turbine and hydropower capacity comprised over 25% of TVA's total capacity but generated only 7.3% of the annual energy in 2002. This difference between percent capacity and percent energy indicates that the coal and nuclear units are run almost continuously to meet baseload demand while combustion turbines and hydropower generators are operated far less than continuously to meet peak demand.

E.7.2.1.2 MEETING FUTURE ENERGY NEEDS

TVA's load forecasting indicates that its customers' future electricity needs will exceed TVA's current generating capacity. Additionally, each year TVA provides updated projections of supply and demand for the DOE's Annual Report EIA-411 (SERC, 2003). The net capacity resources needed to meet the growth in demand increases by over 5,339 MWs between 2002 and 2008 (See TVA Subregion section, Capacity Table for Summer, Net Capacity Resources [bottom] line, of the EIA-411 report).

Based on the energy growth seen in the past several years, an annual growth rate of 2 to 3% is anticipated over the next 20 years (TVA, 2001a). Continued growth in electricity demand is principally driven by the forecast economic growth of the Tennessee Valley region.

TVA projects have been scheduled to maintain, restore or increase net dependable capacities for TVA's combustion turbines, fossil plants, hydroelectric plants, and pumped storage units. Four units of gas-fired combustion turbines began operating at both the Gallatin and Johnsonville Fossil Plants in June and July 2000. TVA's natural gas-fired combustion turbine plant at the Lagoon Creek Site near Brownsville, Tennessee, began operation with Units 1 through 8 in June 2001, and Units 9 through 12 began operation in June 2002. Units 1 through 4 of the Kemper County, Mississippi natural gas-fired combustion turbine plant began operation in July 2002. Option purchase agreements have been made to provide part of the peaking capacity needs. For some of the baseload capacity needs, TVA has a contract for delivery of electricity from the Red Hills Power Project, a lignite-fired plant near Ackerman, Mississippi, which began commercial baseload operation in late 2001.

The national energy plan released by the Administration (National Energy Policy, May 2001) calls for a balanced response to meeting increasing public demands for electricity. This includes expeditious development of additional energy sources such as nuclear energy. The energy plan specifically identifies unit uprates and unit license renewal as parts of the strategy for meeting current and future electric power demands.

TVA has continued to evaluate and select the best energy resource alternatives from available options based on the latest proposals and TVA's forecast of power needs. TVA's energy planning process anticipated that existing TVA plants will continue to be the backbone of TVA's power supply in the future. Continued operation of existing units was part of a system-wide evaluation of future energy needs undertaken by TVA. A range of options to meet those needs was evaluated.

Continued energy generation from BFN is a major component of TVA's generating assets, representing 7% of generating capacity and about 11% of annual energy needs in FY2002. Because of its low operating costs, BFN will continue to be a key generating asset even if some TVA customers elect other suppliers for some of their requirements under electricity deregulation.

<u>Recent Power Generation Capacity Addition Experience</u>

Since 1995, TVA has added about 3,700 MWs of generating capacity to meet the increasing power demand in the Tennessee Valley. Incrementally, the 3,700 MW growth in capacity consists of operational efficiencies resulting from better maintenance and capital improvements at existing nuclear and hydro power production facilities, along with additions in capacity at several fossil, nuclear, and hydro power plant locations. Some previous and on-going activities resulting in capacity additions, including purchase agreements, are described in the following:

- Continuing modernization of existing TVA hydroelectric plants (both conventional and pumped storage) added approximately 388 MWs of peaking capacity through 2002.
- The Red Hills Power Project in Ackerman, Mississippi, a 440 MW lignite coal-fired plant, began commercial baseload operation in late 2001. This plant is owned by Choctaw Generation LP, which is owned by Tractebel Power Inc., but TVA has contracted to buy the plant's output (TVA Record of Decision, 63 FR 44944).
- 680 MWs of simple-cycle combustion turbines were constructed at TVA's Gallatin and Johnsonville Fossil Plants (i.e., four 85-MW units at each site) and began operating during June and July 2000 (Final EIS Notice of Availability, 64 FR 27782, TVA Record of Decision, 64 FR 38932).
- 680 MWs of simple-cycle combustion turbines constructed at TVA's Lagoon Creek Combustion Turbine Plant site west of Brownsville, Tennessee, began operation in June 2001; an additional 340 MWs of simple-cycle combustion turbines were constructed at this site for operation beginning June 2002 (Final EIS Notice of Availability, 65 FR 17265, TVA Record of Decision, 65 FR 30469).
- 340 MWs of simple-cycle combustion turbines were constructed at TVA's Kemper County Combustion Turbine Plant east of DeKalb, Mississippi, for operation which began in June and July of 2002 (Final EIS Notice of Availability, 66 FG 15241; TVA Record of Decisions, 66 FR 21189).
- Between Units 2 and 3, the 1998 BFN Integrated Plant Improvement project resulted in a net gain of about 100 MWs.
- The current EPU project at BFN (for Unit 2 in 2007 and Unit 3 in 2008) will add approximately 250 MWs, and similar upgrades at Sequoyah Nuclear Power Plant added about 25 MWs in June 2003.
- Recovery and restart of BFN Unit 1 will add 1,250 MW in late-2006.
- Various power purchase agreements in effect over the period.

In compliance with the National Energy Policy Act of 1992 (PL 102-486), TVA employed a least-cost energy planning process for the addition of new energy resources to its power system. Consistent with the recommendations of that process, numerous other programs have been developed and implemented to ensure the delivery of clean, reliable, and economical power to customers. TVA also initiated a program in July 1998 to install selective catalytic reduction systems (or similar systems) on 25 existing coal-fired generating units to reduce NO_x emissions. This project is expected to cost more than $1 billion and take several years to fully implement, but will substantially reduce NO_x emissions (70 to 75% reduction during the ozone season) which contribute to ozone problems (TVA, 1999). Other activities that have addressed customer demand for electricity include the following:

- Demand-side customer service initiatives (such as *energy right* home electrical efficiency, direct load control, industrial customer products and services, firm buy-back agreements, etc.) continue to be implemented through TVA power distributors with an estimated 154 MWs of capacity added from 1995 through 1999, and an additional 264 MWs from 2000 through 2002. See Attachment E-7 for additional information regarding TVA's demand-side management program.
- Distributed generation initiatives have beenpursued by TVA. These initiatives include operation of the 14 MW emergency diesel generators at the unfinished Bellefonte Nuclear Plant site and the addition of diesel generators at the Meridian (Mississippi) Air Station and Albertville (Alabama) Municipal Water Treatment Plant. TVA also has contracts for power from small diesels owned and operated by three distributors: Bolivar, TN; McMinnville, TN; and Powell Valley, VA.

A Green Power Switch program began April 22. 2000 as a market test of electricity from certain renewable sources, including landfill gas, photovoltaic, and wind. This program provides about five MWs of generating capacity. Though non-hydro renewables currently represent only a small fraction of TVA's generating capacity, the demand for this program has exceeded expectations. During the first 11 months of the program, 3,260 residential and 150 commercial customers signed up to participate. Sixty-five distributors of TVA power currently offer the Green Power Switch program to their customers. TVA plans to increase generation from such sources, including a project that would increase solar capacity to about one MW by 2010.

<u>Recent Power Purchase Agreement Experience</u>

Some activities implemented by TVA have not performed as intended in delivering reliable power to TVA customers. One of these, involving Option Purchase Agreements (OPAs), has made available some new resources to TVA's system. However, some of the OPAs have either not met stated conditions and requirements, or the entities submitting the proposals could not deliver power by the needed dates. Consequently, the projected power hoped for from this alternative has not fully materialized.

During August 2000, TVA released a two-part request for proposals (RFP) with the goal of acquiring additional peaking capacity (TVA, 2000a). The first part involved purchases of summer peaking capacity and the second part involved constructing new generating capacity under Power Purchase Agreements (PPAs). The deadline for submittal of proposals under this RFP was November 8, 2000, but this deadline was extended to April 1, 2001.

Part one solicited offers from TVA power distributors which would allow TVA to purchase up to 600 MWs of summer peaking capacity under a fee arrangement without owning any of the physical plant assets. The new capacity was to have met the June 1, 2003, delivery date and provide TVA exclusive rights during the term of the PPA. Several proposals were received and evaluated; however, due to unfavorable economics, none resulted in a PPA.

Part two solicited offers from TVA power distributors regarding their purchase (from TVA) of two four-unit combustion turbine facilities at sites within the TVA service region, including the four-unit plant in Kemper County, Mississippi. This capacity began operation in June 2002. TVA's goal in this instance is to pay the successful proposer for exclusive rights to the energy produced at the plant, but not to own the physical assets.

A second RFP, also released in August 2000, focused on short-term proposals (two to five years duration) with the ability to extend agreements for longer periods. It solicited proposals for "firm" summer (June-August) peaking capacity for delivery beginning in 2001 (TVA, 2000b). "Firm" in this context means first-call priority for shared generating resources. The RFP stated a need of up to 500 MWs and a minimum amount of 50 MWs, but the energy may be from one or more resources. The RFP was open to independent power producers, exempt wholesale generators, qualifying facilities, power marketers, and utilities within the TVA or Southern Company transmission systems. The original deadline for submittal of proposals under this RFP was October 2, 2000. This RFP resulted in contracts with two independent power producers.

A third RFP, released in January 2001, pertains to long-term (up to 15 years duration) proposals, preferably with options for early termination and/or options to extend for additional periods. The RFP solicits proposals for "firm" baseload and/or summer peaking power supply requirements for delivery beginning 2004 (TVA, 2001b). In this context, "firm" means that TVA must have first-call priority for shared resources. The RFP states a need for up to 600 MW of baseload type capacity and up to 600 MW of summer peaking capacity beginning June 1, 2004. The offers of capacity and energy may be from one or more resources. The RFP is open to all parties, including, but not limited to: TVA power distributors, independent power producers, exempt wholesale generators, qualifying facilities, power marketers, and utilities. The offers must deliver capacity and energy to the TVA transmission system. The deadline for submittal of proposals under this RFP was May 14, 2001. Several proposals were received and evaluated; however, due to unfavorable economics, none resulted in a PPA.

Spot market purchases of power, also an integral part of TVA's least-cost energy planning process, could help meet future peak demands for electricity. However, while TVA would continue to selectively use this option in the future, market purchases during seasonal periods which cause high demand on the generating capacity of the region could be subject to sharp increases in price. Under some circumstances, the needed power might not be available at any price, thereby requiring TVA to interrupt power to industrial customers (whose contracts allow this action) or to reduce voltages in power delivered to both residential and industrial customers. Each of these consequences involves a definite, but frequently difficult to quantify, societal and human cost. Spot market purchases, if substantial and attempted during periods of high regional demand, could not be depended upon to provide reliable and economic peaking power for the long-term.

Outlook for the Future

The bottom line is that none of the activities discussed above, either individually or collectively, replace the need for TVA-owned and -operated new electricity generation as demand, continually spurred by economic growth in the region, increases. The combined impact on available generation capacity of all demand-side management and renewable energy generation projects, in terms of electricity demand delayed or replaced, is much less than the generation alternative of restarting BFN Unit 1 and renewing the licenses for continued operation of all three units. Even with recent power generation capacity additions and PPAs, this combined impact is greatly exceeded by demands projected through 2020 by TVA's energy planning process, and by actual growth experienced in the past several years. This is one of the reasons why renewed licenses for continuing operation of the BFN units are being sought.

It is reasonable to expect that the delivery of reliable and economic power to customers will require TVA to continue to pursue all available options, both demand-side and supply-side. Each of the options being implemented has received an appropriate environmental review before a decision was made to proceed with its implementation. Future projects will receive a similar review.

Effects of Deregulation

Efforts to deregulate the electric power industry began with passage of the National Energy Policy Act of 1992. Provisions of this Act required electric utilities to allow open access to their transmission lines and encouraged development of a competitive wholesale market for electricity. The Act did not mandate competition in the retail market, leaving that decision to the states.

While planning for future load growth, TVA is aware of the potential for deregulation of power generation markets, in the Southeastern United States and Nationally. In a deregulated market, TVA customers could purchase their power from other energy providers, increasing the uncertainty in the load forecast.

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E.7.2.1.3 SCREENING OF UNREASONABLE ALTERNATIVES

Except for maximizing use of BFN's assets, feasible Action Alternatives for meeting TVA's purpose and need include, as detailed above, various supply-side actions (e.g., constructing new power plants, purchasing and exercising call options, purchasing power from independent power producers, renewable energy, improving the existing hydroelectric generating system, converting Bellefonte Nuclear Plant to an alternative fuel); and customer service alternatives (e.g., demand-side management, beneficial electrification). The environmental impacts of these projects and actions are documented in other environmental reviews completed prior to decisions to implement them.

As also explained above, some of these alternatives did not deliver the power promised, and some alternatives pose unacceptable technical and financial risk in TVA's efforts to ensure that sufficient power is available to meet customer needs. In fact, over reliance on option purchase agreements (which have yielded mixed performance to date) and spot market purchases during periods of high electricity use could have led to failure to meet demands in some recent years. Many utilities across the country did not plan for sufficient margin of production and could not meet the demands of their customers on several occasions during recent summers at any cost. Although currently regional reserve margins are estimated to be at 30%, projections are that this surplus will be used up before the current BFN operating licenses expire. Even when it is possible to purchase energy (electricity) on the spot market from other utility systems, this does not avoid the environmental impacts associated with energy generation. The impacts associated with the generation used to produce the purchased electricity would still occur. It is likely that spot market energy would be supplied by coal-fired generation because this is the generation that tends to swing with load or changes in demand (nuclear generation is normally baseloaded; hydro and natural-gas fired generations (combustion turbines) typically are reserved for use during peak periods). (Natural-gas fired combined cycle plants, which operate as intermediate to baseload assets similar to ''swing coal,'' have increased in number and may change this generation profile over time.) Coal-fired and, to a lesser extent, natural-gas fired generation have more significant environmental impacts than nuclear generation (for example, air quality).

Hydropower has by far the lowest operating cost of any form of electricity available on the TVA system. It offers versatility and (except during drought) dependability that cannot be equaled by any other type of capacity and is far more efficient that any other form of power generation. Despite the numerous advantages of hydropower, however, based on past experience obtaining permission to build and finance the construction of new dams would be very difficult. Moreover, there are no remaining undeveloped sites which could produce sufficient power to be economically attractive, and adding units to existing sites would be cost-prohibitive due to high capital costs and limited water availability. For these reasons, TVA does not consider additional hydropower capacity, from either new dams or adding units to existing sites, to be a reasonable alternative.

Converting one or more BFN units to fossil-fired could theoretically make maximum non-nuclear use of BFN facilities, but is probably not practicable for a number of reasons. The steam turbines and condensate systems in a boiling water reactor (BWR) are radioactively contaminated and not designed for the steam temperatures and pressures that maximize efficiency in fossil-fired boilers. Mixing types of generation (e.g., keeping

Unit 2 or 3 reactors operating while feeding the Unit 1 turbine-generator from a fossil-fired boiler) is even less likely because it would require very expensive "hardening" of steam lines and other equipment that could conceivably be accident initiators. Currently there may not be enough unused space at the BFN site to cost-effectively add large new boilers, pipelines, coal yards, etc. Therefore, conversion is not considered to be a reasonable alternative.

In summary, some options are viable for small power quantities but not for the equivalent of one or more gigawatt units at BFN. New gas-fired and coal-fired generation would not be economically attractive compared with BFN Unit 1 recovery and renewing the operating licenses of the three BFN units. Further improvements to the existing hydropower system would not add much power (compared to losing the bulk power production of BFN) and would be useful only for peaking. Combined cycle repowering of existing coal-fired plants can be viable for 100 megawatt plants but is not economically attractive for larger units. Bulk power from independent producers is sometimes available for purchase but in the past it has not generally been considered to be a dependable source in the long run. Currently there may be enough capacity available for purchase from independent power producers to more than replace BFN but this surplus is projected to be used up well before the current operating licenses expire. Moreover, independent power sources increase the risks to TVA by introducing the potential for non-performance, and growing constraints on transmission grids make off-system purchases even less dependable.

Analysis of Mixed Cases

The NRC stated in the GEIS that while many methods are available for generating electricity, and a huge number of combinations or mixes can be assimilated to meet system needs, such expansive consideration would be too unwieldy given the purposes of the alternatives analysis. Therefore, the NRC determined that a reasonable set of alternatives should be limited to analysis of single, discrete electric generation sources and only electric generation technologies that are technically reasonable and commercially viable (Ref. 7.0-1, Section 8.1, page 8-1). Consistent with the NRC determination, TVA has not evaluated mixes of generating sources for this Environmental Report.

E.7.2.1.4 REASONABLE ALTERNATIVES

TVA continues to explore alternatives for meeting (or reducing) power demand as technology choices and market conditions evolve. If for any reason TVA determined that the Browns Ferry operating licenses would not be renewed and the lost power generation capability had to be replaced, the most viable replacement power generation options currently envisioned are (1) natural gas combined cycle; (2) pulverized coal; (3) new nuclear technologies; and (4) coal gasification.

<u>Natural Gas Combined Cycle</u>

TVA considered the option of electrical generation via natural gas combined cycle combustion turbines because it is a technology which is mature and feasible and can be economical (depending on the price of natural gas).

In a simple-cycle combustion turbine, the only useful energy captured for electricity generation originates from the expansion of gases which occurs when natural gas is combusted in air. These combustion gases pass through a turbine attached to a generator, which produces electricity as the turbine shaft turns. In a combined-cycle configuration, the products of combustion, after leaving the combustion turbine, pass through a heat recovery system which converts this useful energy to steam. This steam is used in a steam turbine to produce additional electric power.

For purposes of comparing environmental impacts, TVA has chosen to evaluate a 510 megawatt combined cycle plant, consisting of two GE F-class (model 7241FA, normally producing ~170 MWs each) combustion turbines, each equipped with heat recovery steam generators (HRSGs, constructed by Alstom) which feed a single GE steam turbine (model D11S, ~170 MWs). The HRSGs would be equipped with SCRs and ammonia vaporizers for reducing NO_x emissions. Typical emissions from such a combined cycle unit would be approximately 0.01 lb/mmBTU for NO_x, near-zero SO_2, and very low particulate matter.

Replacing the 3,760 net megawatts electric base load power generated by the three uprated BFN units will require approximately 7½ natural gas combined cycle plants. Normally BFN refueling and major maintenance outages are scheduled in the spring and fall to avoid winter and summer peak demand seasons, and it is assumed that the modular plants will do the same. More than one site would most likely be involved, to achieve both power distribution and dispersal of impacts.

For each NGCC plant, a mechanical draft cooling tower, consisting of 10 induced-draft, film-filled counterflow cells would be constructed to lower the temperature of condenser cooling water. Blowdown wastewater would be released after the cooling cycle to ensure it reaches the lowest possible temperature before being discharged. Typical wastewater discharge would be in the range of 250 gal/min on an annual basis for a 500-MW plant. Towers would be equipped with the requisite fans, motors, pumps, piping, drift eliminators, spray nozzles, control components, and catch basins, and be enclosed in wood framing materials. Type 304 stainless steel, high grade plastics, and galvanized components would be used at water contact points.

Also constructed would be concrete slab foundations for each CT/HRSG unit, steam turbine, switchyard equipment, one gas-fired auxiliary boiler, one aqueous ammonia storage tank, one demineralized-water storage tank, two raw water pumps and storage tank, process water pond, stormwater retention pond, plant access roads, facility roads, various shop and warehouse buildings, one control building, one fuel gas treatment (basically filtering and condensate traps) equipment area, laydown areas, site perimeter fencing, and transmission towers to nearby substations.

Wastewater treatment facilities would be constructed, as needed, to chemically treat and manage wastewater generated during operation. Wastewater generated during periodic compressor washes would be collected and trucked off site to an approved water treatment facility.

The projected construction period is 20 to 22 months to complete an NGCC plant. The maximum projected work force size for this module is 420 people during any one month of construction. This does not reflect the construction work forces needed for pipeline construction or for transmission line upgrades, whose work is not centralized at one location for any significant period of time.

Pulverized Coal

TVA studied the option of constructing 1,200 megawatt pulverized coal power stations, comprised of two 600 megawatt sub-critical units. Each unit would have its own subcritical steam generator (producing steam at 2,535 psia and 1,050 ^{o}F) and condensing steam turbine generator. The subcritical steam generators are balanced-draft pulverized coal furnaces with drum type, single reheat boilers. Each unit has an eight heater cycle design, comprised of four low pressure feedwater heaters, three high pressure feedwater heaters, and a deaerator. Ignition fuel would be No. 2 fuel oil; storage capacity for each unit is 200,000 gallons. Steam soot blowers are used, and one spare in-place pulverizer is included. Each turbine would be a 3,600 rpm, tandem-compound, four-flow, single-reheat machine. The generator is hydrogen cooled.

The condenser circulating water system will include two 50% nominal capacity vertical pumps and concrete piping. A multi-cell, rectangular, fiberglass fill, counterflow, mechanical draft cooling tower with standard drift eliminators is included for each unit. The cooling tower fans are assumed to be single-speed, non-reversing.

Sulfur dioxide emissions would be reduced 98% by two 50%-capacity wet limestone scrubber modules. Nitrogen oxide emissions would be controlled by a Selective Catalytic Reduction system to 0.1 lb/MBtu. Electrostatic precipitators or fabric filter equipment would limit particulate emissions to 0.018 lb/MBtu.

Major structures include the boiler building, turbine and control building, and limestone preparation building. Pre-engineering buildings would be used for the construction facilities, administration building, plant warehouse, maintenance building, and water treatment building. A single common concrete chimney is included, with dual FRP flues for wet stack gas.

Bottom ash is collected by submerged drag chain conveyors and transported to adjacent concrete collection structures. Front-end loaders and trucks would move bottom ash from the concrete collection structures to an onsite storage location. From there, bottom ash and pulverizer rejects would be trucked from the plant area to an ash and scrubber solids disposal area, which has a single membrane liner and monitoring wells. Dewatered sludge ($CaSO_4$) from the wet limestone FGD systems would also be trucked to the permanent onsite waste disposal area, sized initially for ten years of ash and scrubber solids. A pneumatic fly ash transport system would be provided, including fly ash disposal silos.

The projected construction duration is 46 months from the start of construction until full power production of the first unit. The second unit would be completed 8 months later. This does not include time for siting, land and right-of-way purchase and/or condemnation, permitting, etc.

New Nuclear Technologies

Advanced nuclear power plant designs have become increasingly attractive as the industry strives to overcome past problems with operational complexity and high economic investment for new construction. If TVA was to consider building an advanced technology reactor, most likely it would be built at a previously analyzed site such as Bellefonte where much of the preparatory work has already been done for its unfinished reactors and community acceptance of a similar nuclear project is high.

The most likely candidate design is the Advanced Boiling Water Reactor (ABWR) which received design certification from the NRC in 1997. In comparison with a conventional BWR like BFN, the ABWR design has the following features to greatly improve plant operation and maintenance:

Internal reactor recirculation pumps – Whereas previous-design BWRs have recirculation pumps and pipe loops located outside the reactor pressure vessel (RPV), the ABWR has no external recirculation loops, and its 10 recirculation pumps have been installed inside the RPV. This improves reliability and safety, because of the reduced probability of reactor water leakage through use of wet-type motor modules without shaft seals, and the fact that the reactor core remains covered during an accident due to the elimination of external recirculation piping. Eliminating the external recirculation piping also reduces radiation exposure and decreases in-service inspection.

Fine motion control rod drive mechanism (FMCRD) – As an addition to the hydraulic driving force employed for scrams, fine-tunable motor drives for the control rods improve operability, reliability, and diversity for normal operation and accident mitigation. A simplified and optimized hydraulic system eliminates scram discharge system piping and vessels.

Reinforced concrete containment vessel (RCCV) – A compact cylindrically-shaped concrete vessel designed for ease of maintenance and resistance to accident deformation replaces the self-standing steel vessel design of earlier BWRs. The reactor building surrounds the RCCV, acting as a secondary containment.

Integrated digital instrumentation and control system – The I&C system has state-of-the-art digital technology and optical multiplexing signal transmission, greatly reducing the amount of cabling in the plant and permitting increased automation.

High efficiency turbine system – Turbines with 52-inch last-stage blades (enlarged from the 41-inch conventional BWR plant design), moisture separating reheater, and a heater drain pump-up system, together improve the thermal efficiency by more than 1 percent compared with a conventional BWR.

Other major improvements expected from an ABWR are increased electrical output (1,336 MWe/unit, net), increased capacity factor (~95%, based on 24-month cycle and 25-day refueling outage), decreased core damage frequency per reactor year (from $\sim 10^{-6}$ to $\sim 10^{-7}$), shortened construction time (~37 months), radiation exposures decreased by 2/3, and radwaste decreased by 85%. For all postulated design basis accident scenarios, no core uncovery occurs, and no fuel is damaged during a loss of coolant accident.

For two units constructed on the BLN site, the total net power output of 2,672 MWe falls short of the 3,480 of the three BFN units. The remaining 808 MWe would have to be supplied from other sources.

Coal Gasification

Coal gasification is a method of producing relatively clean, burnable gas from almost any type of coal. The basic process involves crushing the coal and partially oxidizing the carbon in the coal. Partial oxidation converts the coal into a gaseous fuel composed primarily of combustible hydrogen and carbon monoxide. The gas can be piped directly into a gas turbine to generate electricity. The exhaust from the gas turbine is ducted into a heat recovery steam generator to produce steam for a conventional steam turbine generator.

To make the overall process both environmentally safe and thermally efficient, a coal gasification plant must integrate a number of different technologies. The integrated gasification combined cycle (IGCC) plant's major systems include fuel preparation, an air separation unit, a gasifier, acid gas removal, sulfur recovery, a combustion turbine-generator (CT), a heat recovery steam generator (HRSG), and a steam turbine-generator.

TVA has analyzed the environmental impacts of converting the unfinished Bellefonte Nuclear Plant site to various fossil-fueled power production technologies, including IGCC. The plant would consist of eight new IGCC modules, each consisting of one coal gasification plant, one CT, and one HRSG, that send steam to a new topping turbine and the two existing low pressure steam turbine generators. Coal is pulverized in grinding equipment, and then fed either dry or slurried with water (depending on the specific process selected) to the gasification unit along with oxygen from the air separation plant and steam if the coal is fed dry. The gasification unit uses an oxygen-blown pressurized slagging gasifier. An air separation plant is constructed for each gasifier to supply the pressurized 95% (by volume) oxygen required for the oxygen-blown gasifiers. The air separation units receive part of their air from the CT compressors and return excess nitrogen to the CTs for power augmentation and NO_x control. The primary products from the gasifier are hydrogen (H_2) and carbon monoxide (CO), with small amounts of carbon dioxide (CO_2), N_2, methane (CH_4), hydrogen sulfide (H_2S) and some trace sulfur and nitrogen-based compounds. The synthesis gas produced in each gasifier is cleaned of impurities and fired in compatible CTs. Steam is generated and superheated in dedicated HRSGs, then expanded through the steam turbine.

The IGCC power plant's net output would be approximately 2,720 MWe, which is somewhat less than the 3,480 MW produced by the three BFN units. If all three BFN units could not be operated, the remaining 760 MW would need to be supplied from other sources.

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E.7.2.2 ENVIRONMENTAL IMPACTS OF ALTERNATIVES

This section should describe the impacts of the alternatives identified for further consideration. The impacts should be described in sufficient detail so that reviewers may compare the adverse and beneficial impacts of the alternatives with those of renewing the operating license. Impact analyses should consider land use, water quality, air quality, ecological resources, human health, social and economic systems, waste management, aesthetics, and cultural resources. The impacts analyses should include direct, indirect, and cumulative impacts. For each alternative, the analysis should identify and, to the extent possible, quantify, unavoidable adverse impacts, irreversible and irretrievable resource commitments, and tradeoffs between short-term use and long-term productivity of the environment. To the extent possible, each alternative should be analyzed on a site- or region-specific basis. Each impact should be analyzed in proportion to its significance. Chapter 8 of NUREG-1437 includes the results of an analysis of the generic environmental impacts of several electricity generating technologies. These results may be utilized to the extent that they are applicable.

E.7.2.2.1 NATURAL GAS COMBINED CYCLE

With all three units at full uprated power, BFN will produce 3,840 megawatts. Taking into account refueling outages and other power reductions, the annual average power level is: 3840 X 92% annual average capacity = 3533 MW; divided by 510 MW per NGCC plant, 7 NGCC plants operating continuously would be required to replace BFN. TVA has analyzed in detail the environmental impacts of siting a 510 MW NGCC plant in Franklin County, Tennessee, and a brief summary of those impacts is presented below, generalized to recognize that multiple site impacts would be involved. The prospective sites analyzed were chosen in part due to ready access to natural gas pipelines and transmission lines. In most cases the impacts may be multiplied by a factor of 7 to be equated with replacing the BFN power generation, but for others there may be economies of scale (such as land use) where more than one 510 MW plant could be built at a given site. Locating another similar plant near the selected Franklin County, TN site has not been analyzed environmentally, but there may be make-up water availability limitations.

<u>Land Use/Soils</u>

Approximately 200 acres would be required to site a 510 megawatt plant. Construction of the plant would permanently change the land use at that site, and would most likely involve an irretrievable but insignificant loss of forest land and/or farmland. Alternative Franklin County sites were evaluated using Natural Resource Conservation Service Form AD 1006, “Farmland Conversion Impact Rating,” which determined that the ratings were significantly below the protection threshold. For construction of transmission lines, natural gas pipeline connections, and water supply and wastewater discharge pipelines, the amount of forest that would be removed would be minimal, and impacts to farmland would be temporary. Because of the use of erosion control practices during and following construction, no significant impacts to soils are anticipated as a result of the natural gas pipeline upgrades.

Transportation

There would be minor impacts to state and county road traffic in the vicinity of the sites due to construction and operation. The construction period spans 20 to 22 months, with a workforce ranging from approximately 40 employees to 420 at its peak. For the Franklin County site the maximum increase in Average Daily Traffic would be 11%, which is easily tolerated for the short construction duration. During operation the workforce would be no more than 40 at each site.

For the Franklin County site there are several possible routes available for plant connections with the Franklin transmission substation, East Tennessee Natural Gas Pipeline, local potable water and sewage treatment utilities, and cooling water supply and blowdown pipelines. The 500-kV transmission line connection would only be 1/3 of a mile long and most of the route would involve existing transmission line right-of-ways, which have been cleared of forested habitat and maintained to limit vegetation growth. Various routes to nearby Woods Reservoir for raw water intake and wastewater discharge lines have been evaluated, ranging from one to 2½ miles in length; most of the line lengths for these routes would be on existing right-of-way corridors. Three to four miles of right-of-way easements, typically 100 feet in width, would need to be acquired for the natural gas buried connector pipeline route chosen. A natural gas metering station, utilizing less than one acre of land, would also be constructed at the point of intersection with the source pipeline. Upgrades to the main supply gas pipeline would be required, accomplished by a construction force of 75 to 100 persons.

Waste Management

There are no solid wastes of any environmental significance associated with construction and operation of a NGCC plant.

Surface and Ground Water Quality

Construction would be expected to increase erosion and stormwater runoff of suspended solids above existing levels, but this would be mitigated by Best Management Practices (BMPs) in accordance with National Pollutant Discharge Elimination System (NPDES) guidelines for erosion control. Completion of a retention pond for the treatment of stormwater runoff early in the construction phase would significantly reduce potential increased solids loading to local surface drainage waterways.

Rigorous application of BMPs to control erosion during construction should make construction impacts of transmission lines and pipelines (natural gas supply, potable water supply, process water supply, and wastewater discharge) minimal and insignificant. Impacts of constructing new intake and discharge structures on nearby waterways and/or reservoirs will be minimized by construction techniques to minimize disturbance of sediments and by the use of mitigation measures such as coffer dams, turbidity curtains, and selection of construction time window.

Approximately 90% of the wastewater discharge flow will be cooling tower blowdown. Other sources of wastewater include steam cycle blowdown, water from inlet fogging, demineralizer rinse water, and miscellaneous low volume wastewater. This water would be treated on site as necessary to meet state requirements before being discharged to local waters.

Storm water runoff, which occurs during operation, would be drained to the retention pond to allow sediments to settle out prior to discharge to local waterways. Rainwater which falls in secondary containment around oil-containing equipment would drain to an oil/water separator where oil would be removed for disposal and the water would subsequently drain to the process water pond. The long-term and cumulative impacts of consumptive water use by the plant will be insignificant.

Excavation and grading associated with construction of the plant or any of the ancillary features, such as the transmission lines, backup power, process and potable water pipelines, wastewater discharge pipelines, and natural gas pipelines, are not expected to cause adverse effects to groundwater. Excavations which penetrate the water table may require temporary construction dewatering. Any groundwater drawdown impacts associated with construction dewatering would be temporary and of negligible magnitude due to limited excavation depths, the relatively short duration of construction, and the distance of neighboring wells from the construction area. The long-term impact of these activities would be insignificant due to the limited depth and relatively small area of disturbance. Structural damage to aquifer areas due to pipeline construction is not anticipated since aquifers are not generally located within excavation depth.

No impacts to groundwater would be expected from plant operations, since process water would be supplied from local reservoirs and waterways. No adverse impacts are anticipated from operation and maintenance of new infrastructure such as the transmission lines, backup power, process and potable water pipelines, wastewater discharge pipelines, and natural gas pipelines.

Ecological Resources

Evaluated sites in Franklin County, Tennessee, do include herbaceous and forested wetlands in and adjacent to site areas, access routes, pipeline (gas, process and potable water intake, wastewater discharge) right-of-ways, and under transmission lines. Wherever possible, wetlands would be avoided and buffer zones of at least 50 feet would be established. Use of BMPs would minimize disturbance from nearby activities. Changes in hydrology and wetland function over time would typically necessitate a 5-Year Wetland Monitoring Program to detect the occurrence of indirect impacts, including changes in federally and state-listed threatened and endangered species. Where unavoidable, portions of these wetlands would be permanently cleared and/or filled or drained, or indirectly impacted due to the proximity of roads and development. These impacts could require development and implementation of a Wetland Mitigation Plan which would replace wetland acreage and functions through wetland restoration or creation. All wetland alternations would be subject to applicable Corps of Engineers and Tennessee Aquatic Resource Alteration Requirements.

Provided that appropriate mitigation measures are successfully implemented, most impacts to terrestrial ecology resources resulting from the disturbance or loss of native plant communities and/or the introduction and spread of invasive plants are expected to be insignificant. However, one of the evaluated Franklin County sites has an example of a plant community that is tentatively designated as critically imperiled globally per rankings established by The Nature Conservancy. Development of this site would destroy this plant community and therefore result in a significant impact to the terrestrial ecology of the region.

Some forested land would be permanently lost as the result of development of either site, but these reductions of contiguous forest area resulting from project-related activities are anticipated to be insignificant.

The evaluated sites and their associated utility routes provide wildlife habitat that is relatively common in the area. Many of the areas along the proposed utility routes have been disturbed by prior land use activities, such as developed right-of-ways. Construction of the plant and its associated utility routes would remove some wildlife habitat and displace wildlife populations that exist in these areas; however, most species would find refuge in similar adjacent habitats. Following construction, many of these species would likely re-colonize in areas surrounding the new facility and utility routes. Thus, construction of the plant would result in significant adverse impacts to terrestrial animal populations in these areas.

Aquatic impacts during construction would result primarily from erosion runoff from areas of exposed soil, which could cause additional sedimentation in receiving waters. Erosion impacts would be reduced to insignificant levels with the implementation of BMPs to control erosion during construction.

Intake effects on aquatic life resulting from entrainment of fish eggs and larvae and other aquatic life would be insignificant because of the relatively low intake flow rate (about 3,500 gpm, or 7.8 cfs) and velocity (0.5 feet per second or less). Additionally, per Section 316(b) of the Clean Water Act and subsequently promulgated regulations, the intake structure will be designed and operated to minimize adverse environmental impacts to aquatic life.

Plant effluent will meet permit requirements for temperature and chemical constituents, so impacts to aquatic life would be insignificant.

Several federal and state-listed species of both plants and animals occur on or adjacent to the evaluated sites and their associated utility corridors. In some cases this would require identification of suitable habitat for transplanting individuals of the species that are currently located within affected properties, enhancing the new habitat, and providing for long term protection of the transplants. In other cases the boundaries of occurrences would be clearly marked with signs and barriers to vehicular traffic prior to construction. To reduce potential impacts of lighting, noise, and human activity on protected species such as gray bats that forage along affected habitats such as creek embayments, a 50-meter wooded buffer zone could be established. Retaining forested tracts near ponds and wetlands and avoiding disturbance to wetlands or wetland mitigation would reduce long-term effects to animals such as amphibians that use these areas. Since BMPs will be employed to minimize impacts of construction-related runoff and bridges will be constructed to span wetland/spawning habitats, no significant impacts to aquatic animals are anticipated for the project at any of the evaluated sites. Based on the proposed combination of avoidance and mitigation activities, impacts to threatened and endangered species are anticipated to be insignificant.

Air Quality

The plant would have associated transient air pollutant emissions during the construction phase of the project. Construction-related air quality impacts are primarily related to land clearing, site preparation, and the operation of internal combustion engines. Air quality impacts from construction activities would be temporary and dependent on both manmade factors (e.g., intensity of activity, control measures, etc.) and natural factors (e.g., wind speed, wind direction, soil moisture, etc.). However, even under unusually adverse conditions, with the use of dust suppression measures, these emissions would have at most a minor, transient impact on off-site air quality. Overall, the air quality impact of construction-related activities for the project would be insignificant.

Annual emission rates given in Table E.7-2 assumed continuous operation during the year of two combined-cycle combustion turbines, operated only with natural gas fuel. The single heat recovery steam turbine is also operated continuously, but its operation does not involve any separate or additional combustion and therefore does not affect emissions. The operating loads and ambient conditions assumed for the modeling were chosen to ensure worst-case air emissions estimates were produced.

Table E.7-2 – Summary of NGCC Air Emissions

Pollutant	Annual Emissions per single 510 MW plant	Annual Emissions for BFN replacement
NO_x (all Oxides of Nitrogen)	204 tons/year	1,428 tons/year
CO (Carbon Monoxide)	778 tons/year	5,446 tons/year
PM_{10} (Particulate Matter <10 micrometers in diameter)	187.2 tons/year	1,310 tons/year
SO_2 (Sulfur Dioxide)	10.6 tons/year	74.2 tons/year
CO_2 (Carbon Dioxide)	2,400,000 tons/year	18,900,000 tons/year

Also shown in Table E.7-2 is the estimated maximum annual production of carbon dioxide (CO_2) emissions, for both the single 510 megawatt plant and the group of plants needed to replace BFN power generation. CO_2 is the predominant greenhouse gas emitted by power plants. The 18.9 million tons per year of CO_2 generated by replacing BFN with the equivalent NGCC power plant production may be compared with 2,150 million tons per year for the total U.S. CO_2 emissions associated with electric power generation in 1997.

Modeling was performed to evaluate the plant's impact on air quality. None of the maximum predicted concentrations for the plant at the evaluated sites exceed the National Ambient Air Quality Standards (NAAQS) or Prevention of Significant Deterioration (PSD) increments.

Maximum estimated ambient concentration levels of each hazardous air pollutant (HAP) were calculated for the evaluated sites and compared with the corresponding time-weighted average Threshold Limit Value divided by 40. The maximum predicted one-hour concentrations (based on short-term emission rates) were well below these threshold values for all of the pollutants. Therefore, the small emissions of HAPs from the evaluated sites would not cause significant adverse effects to human health in the surrounding area.

Socioeconomics

The projected construction period for each 510-MW plant is 20 to 22 months, including site preparation, at the evaluated sites. Associated employment, excluding pipeline construction and transmission line upgrades, would reach a maximum of about 420 workers, but would exceed 200 workers for a period of only about six months. The maximum increase in workers would represent less than a three percent increase in Franklin County jobs. However, because of the temporary nature of the jobs and the proximity to comparable labor forces in Coffee, Bedford, Lincoln, Marion, and Warren Counties, it is anticipated that many of the workers would be drawn from other counties (particularly the immediately adjacent Coffee County) and would commute daily, thereby minimizing the socioeconomic impacts on Franklin County. The remaining workers could be expected to move into the area for a brief duration.

Jobs related to pipeline construction, including upgrading the gas pipeline, or to transmission/distribution line upgrades would not be centralized at one location for any significant period of time and therefore would have no important impact on the local economy or on community and government services. Other construction-related activities would have very small socioeconomic impacts as well.

The operations workforce would consist of around 35 to 40 persons. While this would constitute a positive impact to Franklin County and the labor market area, in the context of total employment and income, it would be only a very small addition to the county and the labor market area. Therefore, there would be no important impacts to the local economy or to community and government services. There would be a small increase in the amount of TVA's in-lieu-of-tax payments that would be redistributed to Franklin County.

Aesthetics

The proposed facilities would permanently alter the visual landscape character of the evaluated sites. Appearance would change adversely from a forested wildlife management area to a moderate-scale industrial facility in a rural setting. The tallest structures include the 150-feet high auxiliary boiler and two HRSG stacks, as well as the 100-foot high steam turbine building. Some portion of these structures would be visible for a mile or more above the tree lines and across the rural landscape. There would be more lighting visible across the night landscape, and sky brightness would increase somewhat. Building a connector transmission line and backup power line to the site would create a relatively minor long-term impact. The visual consequences of building underground utility pipelines would be minor to insignificant. A sufficient buffer of vegetation would be retained where necessary to preserve the current scenic character. Overall, the project construction and operations would not have a significant impact on visual resources, but would contribute to a cumulative reduction of visual harmony and scenic integrity in the rural landscape.

Increased road traffic and use of heavy equipment during construction would bring slightly increased intermittent noise to nearby residences. Although, based on conservative analyses, noise from plant operation could be noticeable at nearby residences and could exceed the TVA guideline of three dBA at times; it is not expected to exceed the 55 dBA threshold level for "outdoor interference." Existing forest buffers will be retained where feasible and fast-growing evergreen trees will be planted where necessary; once the plant is operational, other appropriate and cost-effective mitigation measures would be identified, and if needed, implemented to mitigate unnecessary sound impacts to local residents.

Cultural Resources

A Phase I archaeological and historic structures reconnaissance survey was conducted for the evaluated sites and associated utility corridors. No historic properties eligible for listing in the NRHP were identified, but a few archaeological sites were identified, and the Tennessee SHPO recommended that one of them be avoided by any ground disturbing activities. Based on the proposed avoidance strategy, the project would have no effect on cultural resources.

Human Health

Emergency response procedures would be outlined in the Site Safety and Health Plan for all plant operations. These procedures would address safety training, chemical hazard information, accident reporting and investigation, and medical aspects of construction and operation of the plant.

Potential accidents for plant operations include the possible ruptures of natural gas pipelines on and off site, but the risk of such an accident is considered negligible, and the industry's record for pipeline safety has been improving for more than 20 years. Other potential accidents include various scenarios for ammonia (used in SCRs) releases. However, the use of 19.5% ammonia solution lessens the potential for exposure of nearby residents to harmful levels of ammonia, should a release occur. The 19.5% aqueous ammonia solution is below the concentration level subject to regulation under the EPA Risk Management Plant requirements in 40 CFR 68 (20% or greater aqueous ammonia solution) or under the OSHA Process Safety Management requirements in 20 CFR 1910.119 (greater than 44% aqueous ammonia solution).

TVA's standard for siting new transmission lines has the effect of minimizing public exposures to electric and magnetic fields (EMF) during their operation. The transmission line route selection team used a constraint model that placed a 300-foot radius buffer around occupied buildings. For schools, a 1,200-foot buffer was used. The purpose of these buffers was to reduce potential land use conflicts with yard trees, outbuildings and ancillary facilities, and to reduce potential visual impacts and possible EMF-related controversy. Though not absolute location constraints, these buffers weigh heavily in location decisions, influencing selection of route options and alignments. Because EMF diminishes so quickly with distance, the routing of transmission lines using constraint buffers effectively reduces potential public exposure to EMF.

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E.7.2.2.2 PULVERIZED COAL

TVA has analyzed the cost and schedule associated with constructing a 1,200 MW pulverized coal power station, consisting of two sub-critical 600 MW net units. One option is to locate the plant near the coal supply (i.e., "mine mouth"), to essentially eliminate or at least minimize coal transport expense. The trade-off for locating the plant adjacent to the coal source is that the new transmission lines required to deliver the power can be lengthy. One particular mine-mouth site being considered by an independent power producer is just outside the TVA region on the Green River, NE of Central City, Kentucky. The Central City site would require approximately 110 miles of new power lines; ~20 miles of lines installed by the plant to connect to both TVA and an adjacent power company, and ~90 miles of new lines constructed by TVA to enable its transmission network to accommodate the increased load. However, locating the station on a Greenfield site with barge access on an adjacent river, assumed to be somewhere in the TVA service area, has also been considered.

Replacing the 3,840 MW generated by BFN would require at least three of these pulverized coal power stations. TVA has not completed detailed analyses of the environmental impacts of constructing and operating these stations at specific sites, but has instead extrapolated this information from similar previous analyses such as for converting the unfinished Bellefonte Nuclear Plant to a pulverized coal power station.

<u>Land Use/Soils</u>

One thousand acres would be required for construction and operation of each 1,200 MW facility for a 30-year period. This includes land for a barge unloading facility, coal pile, limestone pile, ash and scrubber solids disposal area, and plant buildings and structures, but does not include land for an associated coal mine, transmission lines, access road, and railroad connector. An adjacent coal mine could add a few thousand acres to the site. For construction of transmission lines, access road, and railroad connector the amount of forest that would be removed would be minimal, and impacts to farmland would largely be temporary. Construction of the plant would permanently change the land use at the site, and would most likely involve an irretrievable but moderate loss of forest land and/or farmland. Because of the use of erosion control practices during and following construction, no significant impacts to plant site soils are anticipated.

The most likely source of coal for the plant would be underground deep mining, whether adjacent to the site or distant. Currently about 59% of TVA's coal is from deep mines, and 41% is from surface mines. In either case, the state Office of Mining will have primary responsibility for environmental compliance, with specific requirements and commitments delineated in the mining permit. For deep mines the overburden is typically left in place, with some settling expected, but no other significant environmental impacts are anticipated.

Surface mining environmental impacts, however, are primarily the result of changes in land use. Past impacts have included acid drainage from exposed sulfur bearing rock, erosion from disturbed mining areas and coal transport roads, loss of wildlife habitat, deforestation, stream siltation, unstable land situations, and fugitive dust. The Surface Mining Control and Reclamation Act now addresses these issues in permitting enforcement. Other land impacts can include the loss of prime farmland, encroachment on threatened or endangered species and loss of cultural and archaeological resources. Surface mining operations usually clash aesthetically with the surrounding landscape. Mine reclamation, which is mandatory, requires restoration to the original contour, and appropriate re-vegetation can mitigate long-term visual aesthetics as well as impacts resulting from changes in land use.

Locating the plant at a Greenfield site would involve considerably greater land disturbance impacts than for the site being considered on the Green River, approximately two miles NE of Central City, Kentucky, which is basically on reclaimed strip mine land. Any new plant site will also involve acquisition of new transmission line corridors, some of which may be lengthy, but for the most part the amount of forest that would be removed would be minimal and the impacts to farmland would be temporary. For example, the NE Central City site would involve at least three new transmission line corridors, two from the plant switchyard to the nearby Paradise Steam Plant (TVA, 500 kV, ~10 miles) and DB Wilson Generating Station (Big Rivers Electric Corp., 345 kV, ~10 miles) and a new 90-mile 500 kV TVA line south from Paradise Steam Plant to the Wilson substation near Montgomery, TN to transmit the new power load to consumers.

Transportation

For a mine-mouth plant, the impacts of coal transport are obviously much less than those of plants sited distant from coal sources, although impacts of new transmission lines can be greater. In either case there would still be the need for barge accessibility and a facility to unload limestone for the scrubbers during operation. The barge slip could be used for unloading major equipment during the construction phase. Sites evaluated generally include ready access to roads and railroads to provide redundant transportation systems for personnel access and shipment of materials and equipment.

During the major construction period of 54 months there will be increased traffic in the area, reaching its maximum when the construction labor and management force peaks at 1100. The construction traffic impact would be temporary, however, dropping to 500 at about 42 months and down to 110 for the permanent operating staff.

Waste Management

The pulverized coal plan would produce solid material streams in significant quantities, including both potential by-products and unusable solid wastes. The potentially marketable material streams include, in tons per year (tpy): 330,000 tpy for fly ash; 82,500 tpy for bottom ash; and 611,000 tpy for flue gas desulfurization sludge (gypsum). The unusable waste streams include raw water treatment sludges (623 tpy) and general water treatment sludges (390 tpy). All of these byproduct and waste streams are classified as non-hazardous, as determined by the Federal Resource Conservation and Recovery Act (RCRA) Toxicity Characteristic Leaching Procedure (TCLP).

Provision would be made to store fly ash, bottom ash, and scrubber byproducts on site indefinitely. If permitted, it may be possible to inject ash into underground mine works in the future. The market potential and economic benefit of selling the ash and scrubber byproducts to wallboard manufacturers will be explored. With barge access, transportation logistics are enhanced for wallboard plants on the river. The water treatment sludges would be disposed at a state-approved landfill, either on-site or off-site.

Surface and Ground Water Quality

Construction of the power plant and overall site (including transmission lines, access road, etc.) would affect surface water hydrology, but sites would be chosen to avoid extensive site excavation, filling or grading. New construction would disturb the land surface, which may temporarily affect surface water quality. Potential water quality impacts would consist of suspended solids from disturbed soils, biochemical oxygen demand, nutrient loading from disturbed vegetation, and oil and grease from construction equipment. New construction activities that disturb five acres or more would require an NPDES permit for storm water discharges from the site to ensure the implementation of BMPs and to minimize impacts to surface waters during construction. To minimize the impacts of storm water flow erosion during construction, onsite retention areas (storm water detention pond) would be designed to detain storm water from the 25-year, 24-hour rainfall event, in compliance with regulatory requirements. Runoff detention ponds would be designed to detain runoff within the containment areas to allow for settling and to reduce peak discharges. Both structural and vegetative BMPs would also be required during construction to minimize water quality impacts. Construction would cause no significant consumption of surface water resources. Sanitary waste water would most likely be routed to a publicly-owned treatment works, if available; if not, a sanitary waste treatment system would be constructed.

During operation, approximately 90.5% of the 14,400 gpm plant intake water requirement is for cooling tower make-up flow, or about 13,040 gpm (~29 cfs). This amount of water consumption is relatively small and is normally obtainable from river intake or wells with a negligible impact on water availability downstream or in the vicinity of the plant. For the Central City, KY site on the Green River, the KY Water Withdrawal Letter of Assurance allows 16,667 gpm on average, 20,833 gpm maximum. Cooling water for the facility's main condensers and miscellaneous components is recirculated through the towers, with the cooling tower blowdown (a portion of the circulated water which is discharged to prevent the buildup of dissolved salts and minerals) and other plant operational wastewater streams subsequently being discharged through diffusers to the river. A biocide would be used to protect the cooling water system from biological growths. At 2600 gpm, cooling tower blowdown is expected to be several times larger than any other wastewater stream, and would not contain any detectable amounts of priority pollutants. Plant process wastewater streams include demineralizer regeneration wastes (180 gpm), steam cycle blowdown (200 gpm), and service water/pre-treatment waste and chemical drains (92 gpm). Plant wastewater outfalls would also require an NPDES permit, with established treatment standards and discharge limits. To prevent leachate in stormwater runoff from entering the surficial aquifer, the coal storage area and the runoff basin would be lined with low-permeability materials. Runoff streams from the coal pile, fly ash and bottom ash piles, and gypsum storage area would be collected in the lined recycle basin for reuse (which would be sized to exceed capacity requirements for the 25-year, 24-hour storm event), with no direct discharge to the surface water.

Ecological Resources

The majority of the site near Central City, KY has been surface mined prior to today's stringent reclamation laws. Vegetation in the plant disturbance area for the most part consists of self-seeded native plants. The site contains locust, pine, and a variety of small trees that have re-grown since the site was logged two years ago. Available data indicate that there are no sensitive botanical areas within the proposed project site and there are no threatened or endangered tree or plant species in the disturbance area.

Limited studies to date have not found any threatened or endangered animal species (including mussels) or unique habitats in the project area. However, as a protection of potential habitat for the Indiana bat, it could be stipulated in the construction permit that tree cutting not take place between March 31 and October 15 in the area proposed for construction of the intake and outfall structures, the barge unloading dock, and the barge fleeting area. There are numerous records of Henslow's sparrow and other grassland species west of the site. If grassland habitat is located on the site, Henslow's sparrow and other state-listed birds that use this habitat would have to be addressed.

In accordance with Clean Water Act §316(b) Track I requirements to minimize impingement and entrainment of aquatic biota by new construction, intake water withdrawal velocities would be designed to be less than 0.5 ft/sec. Similar to the Indiana bat protection described above, it could be stipulated that no construction work is permitted in the Green River and connected slips during the fish spawning season of April 1 through June 30.

National Wetland Inventory data indicate the possible presence of several open water and wetland areas on and adjacent to the site, including excavated ponds, impoundments, and vegetated palustrine emergent, scrub-shrub and forested wetlands. The presence of numerous excavated ponds is a common feature of strip-mine sites. An actual ground survey would be necessary to identify and delineate wetlands on the site, and the U.S. Army Corps of Engineers would need to be consulted to determine the jurisdictional status of onsite wetlands.

Air Quality

Construction-related air quality impacts result from land clearing, site preparation, vehicular traffic over unpaved roads, open burning of cleared land debris, and operation of internal combustion engines. Where necessary, open construction areas and unpaved roads would be sprinkled with water to reduce fugitive dust emissions. All open burning activities would be conducted in compliance with applicable federal, state, and local regulations. The total amount of engine emissions (PM, CO, NO_x, VOCs, and SO_2) is small. Even under unusually adverse conditions, these emissions would have, at most, a minor, transient impact on offsite air quality and should not lead to an exceedence or violation of any applicable ambient air quality standard.

Annual emission rates given in Table E.7-3 assumed full load (100% power) operation and an 80% capacity factor for a single 600 MW pulverized coal plant. These listed values reflect the following target removal or combustion efficiencies and/or emission rates which would be used in preparing the air permit: 98% removal and 0.084 lb/MBtu emission rate for SO_x; 0.1 lb/MBtu emission rate for NO_x; 99.9% removal and 0.018 lb/MBtu for particulate emissions; and 80 to 90% combustion efficiency and 0.10 lb/MBtu emission rate for CO. Replacing the 3,840 MW from BFN at 92% average capacity factor would require approximately seven 600MW PC units at 80% capacity factor.

Table E.7-3 – Summary of PC Air Emissions

Pollutant	Annual Emissions per single 600 MW plant	Annual Emissions for BFN replacement
NO_x (all Oxides of Nitrogen)	2,500 tons/year	17,500 tons/year
CO (Carbon Monoxide)	650 tons/year	4,550 tons/year
PM_{10} (Particulate Matter <10 micrometers in diameter	500 tons/year	3,500 tons/year
SO_x (Sulfur Dioxide)	2,100 tons/year	14,700 tons/year
CO_2 (Carbon Dioxide)	6,325,000 tons/year	44,275,000 tons/year

Also shown in the table below is the estimated production of carbon dioxide, which is a major increase in comparison to the current total TVA CO_2 emissions of about 110 million tons per year. Manmade emissions of greenhouse gases, particularly CO_2, N_2O and methane (CH_4), tend to increase global temperatures by absorbing long-wave radiation. Although the estimated N_2O and CH_4 emissions for the IGCC are minimal, the CO_2 emissions are significant.

Modeling by TVA to evaluate the plant's impact on air quality has not been performed for a specific mine-mouth or TVA service area location, but previous analyses for siting four 600 MW PC units at TVA's Bellefonte site found that none of the maximum predicted concentrations of criteria pollutants exceeded the National Ambient Air Quality Standards (NAAQS) or Prevention of Significant Deterioration (PSD) increments set by the Environmental Protection Agency. If site-specific analyses determine that one or more criteria air pollutant limits are exceeded, additional design and pollution control mitigation measures are available, including use of a different fuel (e.g., low sulfur coal) and more extensive equipment to lower stack gas emissions.

An analysis of stack gas hazardous air pollutants (e.g., Arsenic, Beryllium, Cadmium, Cobalt, Lead, etc.) found that time-weighted averages were well beneath the Threshold Limit Values for direct inhalation developed by the American Conference of Governmental Industrial Hygienists.

For the Central City, KY site, the nearest federally-designated Class I area is Mammoth Cave National Park, approximately 74 km to the East-Southeast (within the 100 km Class I eligibility criterion). The Department of the Interior conducted air quality modeling analyses which determined that with an air emissions permit limit for 24-hour average SO_2 of ≤ 0.23 lbs/MBtu there would be no adverse impacts at the Park.

Socioeconomics

The projected construction period for the plant is 54 months, with the first unit becoming operational at 48 months. The total construction workforce would ramp up to the peak of 1100 over the first 18 months and then remain there until beginning reduction at 30 months to 500 at 42 months. The total number of workers would exceed 500 for approximately 2½ years. The peak number of workers would noticeably affect the local labor force for most available sites, but the jobs would be temporary and many of the workers would commute from surrounding areas. The influx of workers could noticeably affect local school systems and other social services. The socioeconomic impacts for construction are primarily positive, however, because of job creation and the multiplying benefit to the local economy.

For a mine-mouth plant, the mining process preparation would increase the construction employment to a base of 1500 persons for four years, peaking at 2500. A construction force of this size would definitely be a noticeable impact for most prospective sites, including the Green River site near Central City, KY.

The plant permanent operating staff would number between 110 and 120, which would be a favorable but smaller and permanent impact (relative to construction) in terms of job creation, multiplying benefit to the local economy, and effect on government and community services such as schools. If the plant is sited at a mine mouth, the projected employment for the mining operation is 320, which would still be in the range where total economic benefits outweigh the impacts on local social services.

It should be noted that there is a correctional facility located adjacent to the Central City, KY site and within one mile of the potential plant location. However, since there are no significant environmental impacts associated with construction and operation of a coal-fired power plant at the site, there cannot be any disproportionate impacts of concern on the prison population. In addition, due to the isolated nature of a prison, there would be no interaction with the community.

Aesthetics

The plant would have a single common concrete chimney with two flues, approximately 650 feet tall, which would be visible for miles and would have aircraft warning flashing lights. Mechanical draft cooling towers would also be constructed. Depending on weather conditions, the plumes from the chimney and cooling towers could also be visible for several miles from the plant.

Cultural Resources

The majority of the site near Central City, KY was surface mined over the last fifty plus years. As confirmed by pedestrian surveys supplemented by shovel testing, there are no archaeological sites located within the proposed disturbance area. The Mt. Olivet Cemetery, consisting of 110 identifiable burials from 1844 through 1933, is located 1,000 feet outside the study area and the proposed construction activities will have no effect on it. The absence of historic sites listed in or eligible for inclusion in the National Register of Historic Places was confirmed by the Kentucky Heritage Council.

Human Health

The only credible accident associated with construction and operation of a mine-mouth pulverized coal-fired power plant and associated coal mining operations which poses a threat to off-site populations is the potential rupture of a large ammonia tank associated with Selective Catalytic Reduction pollution controls. For the quantity of ammonia involved, the Threshold Planning Quantity as defined in 40 CFR Part 68 would be exceeded, and EPA would require development of a Risk Management Program (RMP). For this accident, liquid ammonia would flow to the secondary containment where it would be recovered and reprocessed. However, if the liquid chemical surface is exposed to the ambient air, evaporation would take place at a rate dependent on ambient temperature, vapor pressure of the liquid, the surface area exposed to ambient air, and a number of other factors. Using toxic endpoint concentrations as defined in RMP guidance developed by the American Industrial Hygiene Association, calculations indicate a range of toxicity of less than 3 kilometers (1.8 miles). The duration of the event would depend on the effectiveness of the spill response effort but it is highly unlikely that an event would last more than a few hours. A chemical response plan is required for new chemical plants built after 1999. Chemical plant design and operating specifications such as concentration limits will be utilized to minimize risks to practicable levels.

For employees of the coal company owning the mining property NE of Central City, KY., many years of effort have led to a consistent and substantial reduction in the injury rate, declining more than a factor of five between 1990 and 2000. Significant effort has been, and will continue to be, applied to lowering the incidence and severity of injuries in what is commonly considered to be an inherently hazardous work environment. Similarly, between 1985 and 2002 the lost time injury rate for TVA fossil plant workers has declined more than a factor of six, and the work environment at a new pulverized coal plant is expected to be designed and operated to be consistent with this trend.

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E.7.2.2.3 NEW NUCLEAR TECHNOLOGY

The feasibility of constructing and operating an Advanced Boiling Water Reactor (ABWR) at the unfinished Bellefonte Nuclear Plant (BLN) has been analyzed. Other candidate sites within the TVA region have been considered, but they do not compare favorably in terms of cooling water availability, local support for nuclear projects, recent environmental characterization, and site infrastructure development.

It is widely recognized within the nuclear industry that successful commercial-scale deployment of new plants requires a stable and predictable regulatory process. Various government and industry initiatives aimed at streamlining the licensing process have been working towards allowing the use of previously-approved characterization information for existing sites such as Bellefonte. A significant regulatory advantage of the ABWR is that it has received pre-approved design certification from the U.S. Nuclear Regulatory Commission. Combined with a site such as BLN which has already been successfully analyzed environmentally, the pre-certified ABWR should have a strong licensing advantage.

Although construction of the original Bellefonte nuclear units has been halted, TVA still retains construction permits issued by the NRC. Construction access routes are completed for this facility, and basic support functions (electric power, potable water, sanitary waste disposal, office buildings, parking lots, railways, barge unloading facility, etc.) are in place to support resumption of construction. Almost all of the basic site preparation work such as grading has been completed, including where the ABWR would be constructed. As a result, the overall environmental impacts of building on a heavily-modified industrial site such as BLN are considerably less than for a Greenfield site.

Construction of two ABWR units at the BLN site would very likely make use of the existing BLN site intake water pumping station, natural draft cooling towers, discharge water diffusers, and electrical transmission lines and switchyards, each with varying degrees of modification. Some existing service facilities such as fire protection, temporary construction power, auxiliary boilers, office buildings and parking lots, environmental monitoring, outside lighting, diesel fuel storage tanks, telecommunications, and potable water and sanitary waste supply lines would be used wherever possible. Almost none of the existing unfinished PWR units and their contiguous support systems would be utilized.

The "base" or lowest expected power output is 1,336 MW per unit during summer, which will likely increase to 1380 MW during winter months as the condenser inlet temperature (and consequently the condenser backpressure) is reduced. An additional power increase for 10 CRF 50 Appendix K (reduction in feedwater flowrate uncertainty via ultrasonic metering) of approximately 1.5% is expected, and experience with Japanese ABWRs indicates potential for extending power uprate an additional 20%.

<u>Land Use/Soils</u>

Twin ABWR units would be constructed adjacent to and directly south of the existing cooling towers. A construction lay-down space is planned for the area bordered by the existing cooling towers, existing 500 kV transmission line and the ABWR plant. Almost all of the ABWR construction activities would take place on land which has already been disturbed for the original BLN construction. Warehouses filled with equipment for BLN Unit 2 currently occupy the land where the reactor plant would be constructed and which would have to be removed. There are several buried cables and piping in and around the ABWR construction area and lay-down space, such as power cables, potable water lines, and fire protection piping and fireplugs for the existing BLN warehouses, but there are no buried structures which cannot be removed or transferred.

Including wind effect, the maximum flood level of the Bellefonte site is 627.7 feet, which is higher than the 620 ft. average grade for the planned construction area. To keep the finished grade above the maximum flood level will require adding about 10 feet of fill soil to the construction area, increasing its elevation to 630 ft. The grading soil would most likely be taken from hills to the east or southwest of the construction area.

To supplement the existing natural draft cooling towers, two additional mechanical draft cooling towers may be built on land immediately adjacent to and just south of the existing cooling towers, between the existing cooling towers and the proposed ABWR plant. A nine-acre cooling spray pond may also be constructed south of the ABWR plant to serve as the emergency core cooling ultimate heat sink for the two units. All of this land has previously been cleared for other uses.

Compared with a fossil-fueled power plant which would involve either long fuel pipelines or large fuel and combustion product storage areas, the impacts on land use and soils are minimal for completing a relatively compact nuclear plant on the previously-disturbed Bellefonte site. With use of erosion control methods and other Best Management Practices, no significant impacts to soils are expected.

<u>Transportation</u>

The peak construction work force of would have a moderate impact on the Level Of Service (LOS) on the local two-lane undivided rural roads near the site, particularly Bellefonte Road and Jackson 33, but relatively insignificant decreases in LOS would occur for U.S. Highway 72. The service decreases, however, are short term during the construction phase. The operations phase has a much smaller work force and would not have quite as large an impact on any of the subject roads. Most of the effect of increased traffic would be felt almost entirely by plant employees, as opposed to the entire public at large. Employee programs that provide flexible hours could reduce road travel during peak hours, and restrictions for trucks traveling during the peak hour could be made. Also, establishing employee programs and incentives for ride-sharing could be encouraged and/or vanpool programs could be initiated.

During operation, the nuclear fuel for an ABWR at Bellefonte would most likely be shipped from one or more of three sources: GNF in Wilmington, Delaware; Westinghouse in Columbia, South Carolina; and Framatome in Richland, Washington. All three would ship by overland truck, with the fuel contained in conventional shipping casks specifically built and licensed for that purpose, just as nuclear fuel is presently shipped to the 103 domestic nuclear units around the nation. Because the volume of new fuel required is very small, very few truck shipments are required and the overall transportation impact of new fuel is minimal.

Spent nuclear fuel would eventually be trucked off site in licensed shipping casks to a permanent repository. The shipping distance could be lengthy, such as to the facility being developed at Yucca Mountain, Nevada, but the spent fuel volume is small and the overall impact would be insignificant.

Waste Management

During construction, some modifications to the existing cooling towers might be necessary to increase their cooling capacity. If the changes include replacing the present asbestos fill, proper disposal in an off-site permitted landfill would be required. Much of the waste generated during construction would be typical construction/demolition waste (e.g., broken concrete, rock, asphalt, scrap lumber and metal, etc.) generated by the modification/removal of existing buildings such as old warehouses and the building of the new plant. There is enough space available on site for a landfill to receive construction/demolition waste, but it may prove more economical to use any of several existing landfills within 50 miles of Bellefonte that have adequate storage capacity and life expectancy.

Similar to conventional BWRs, during operation the ABWR produces spent resins from the condensate filters and demineralizers, and dry active wastes from maintenance operations, typically gloves, plastic sheeting, mops, rags, wood, paper, metal and plastic scraps, etc. Based on experience with low-level radwaste generated at both conventional and advanced BWRs in Japan (averaging <65 drums/unit/year; 200 liter [~53 gallon] drums), it is expected that the radwaste generated at the ABWR units would be less than 15% of the radwaste currently generated at the BFN BWR units. The reasons for the dramatic radwaste reduction for the ABWR include lower regeneration requirements for condensate demineralizers, non-precoat hollow-fiber filters for the condensate filters, and much less required maintenance and inspection overall. As an alternative means of disposal for solid and liquid low level radioactive waste, TVA would explore the feasibility of shipping it to off-site contractors for processing (incineration, compaction, etc.) prior to permanent disposal at a licensed facility such as Envirocare of Utah, Inc., similar to what is currently done for BFN.

Also similar to a conventional BWR such as the BFN units, the ABWR would be on a 24-month cycle, discharging a portion of the core spent fuel assemblies during an approximately 25-day outage. However, the ABWR has somewhat smaller consumption of nuclear fuel than conventional reactors of comparable size. This is because the fine motion control rod drives are used to control excess reactivity changes and are capable of rod pattern adjustment at full power operation; this allows the core flow to be kept constant at the low end, contributing to spectral shift and consequently a higher conversion ratio for greater fuel efficiency. As a result, the volume of spent fuel requiring permanent disposition is reduced. The physical configuration and make-up of the fuel is very similar to that of conventional nuclear plants and requires no separate treatment or disposal considerations. Therefore, spent fuel issues for the ABWR are bounded by those of conventional reactors.

It is expected that either the deep, mined geologic repository for high-level waste being developed at Yucca Mountain, Nevada, by the Department of Energy will be expanded or a similar facility elsewhere would be ready to accept spent nuclear fuel long before the ABWR spent fuel pools would be approaching their capacity limits. If that is not the case, ample room is available to construct an Independent Spent Fuel Storage Installation similar to those constructed at a number of domestic nuclear plants.

Decommissioning impacts are similar to and bounded by those of a conventional BWR such as the units at BFN. The ABWR is designed with the intent of becoming a viable candidate for license renewal, extending the total projected plant life to 60 years (40 years initial license + 20 years for renewed licenses).

Surface and Ground Water Quality

The existing BLN Essential Raw Cooling Water system, which supplies make-up water to the cooling towers and service water systems, has four pumps per unit and two lines per unit. The ABWR, however, would require six pumps and three lines per unit unless the spray pond is constructed for the ultimate heat sink. The intake channel has not been periodically maintained and may require some dredging by ship. New Reactor Service Water and Heat Rejection System lines will need to be built for the ABWR units. No significant impacts are expected from these modifications.

The following ponds currently exist or are planned for the BLN site:

- Yard Drainage Pond
- Diluted Chemical Pond
- Concentrated Chemical Treatment Pond
- Sump Collection Ponds
- Alum Sludge Ponds
- Desilting Pond for Cooling Towers
- possible Ultimate Heat Sink Spray Pond

The purpose of the Yard Drainage Pond is to retain any debris or oil spill which may be collected by the Yard Drainage system and then flow into the pond. Yard drainage from open areas flows into the Yard Drainage Pond via ditches, but several connecting drain pipes are buried in the Switchyard. Two 42-inch ERCW discharge pipes are connected to the Yard Drainage Pond by channels. An area of approximately 10 acres would be diked off to increase pond size and capacity. A deep-level skimming type outflow will be provided so that floating debris and oil cannot escape from the pond. Discharge from the outlet structure of the Yard Drainage Pond flows into Town Creek via piping and channels.

The Chemical Treatment Ponds (Concentrated and Diluted) are temporary and are for the purpose of receiving pipe flushing effluent. The Concentrated Chemical Treatment Pond has a plastic liner; its neutralized effluent is discharged to the Diluted Chemical Treatment Pont through valved connecting piping. The top clear layer of water in the Diluted Chemical Treatment Pond is discharged to the Yard Drainage Pond through valved connecting piping. The maximum capacities of the Concentrated and Diluted Chemical Treatment Ponds are 133,000 and 677,300 cubic feet, respectively.

When completed, the Sump Collection Ponds will serve as a collection point for wastewater from the plant sumps, but because of liner leaks they are currently not being used. Depending on the final footprint of the ABWR these ponds may have to be moved rather than repaired.

The Alum Sludge Ponds are designed to hold waste products from the Water Filtration/Demineralized Water Treatment Plant located in the Turbine Building. The waste is pumped to the ponds where it is de-watered and then transferred to a landfill. Water removed from the Alum Sludge Ponds is pumped to the Sump Collection Ponds and then released to the cooling tower blow-down pipe which discharges to the river. The Alum Sludge Ponds are not currently being used but may have to be moved, depending on the exact location of the ABWR.

The Desilting Pond is used to gravity-drain the cooling tower basin well and to remove silt collected in the desilting channel in the bottom of the cooling tower basin. Water in the Desilting Pond is tested and then pumped from the pond directly to the cooling tower blow-down pipe which discharges into the river. Via temporary piping, the Desilting Pond is currently being used as a collection point for wastewater from the plant sumps. The desilting pond may also have to be moved, depending on the exact placement of the ABWR.

As described above, a large cooling spray pond (1082’ X 350’) may also be constructed south of the ABWR plant to serve as the emergency core cooling ultimate heat sink for the two units. Three 250’ diameter spray rings could be mounted 150’ apart in the pond; each ring would have two halves, and each half-ring could serve one of three cooling trains per unit. Together with additional cooling tower capacity, this could enable the existing intake structure to be used for cooling tower make-up and the service water source without requiring extensive modification.

Potable water is supplied to the site by the City of Hollywood, which receives its water from the City of Scottsboro. The potable water supply is delivered to the site’s water meter through a 6-inch main header. The original on-site sanitary waste treatment system has been taken out of service and the plant has been connected to the Hollywood municipal sewage system treatment plant located adjacent to the south side of the BLN site. The sewage treatment plant serves BLN and residential customers in the area, but currently it does not have sufficient capacity to handle the increased demand of a large construction force and would have to be enlarged.

Ecological Resources

Since no state- or federally-listed plant species are known from the site, no impacts are anticipated. There are no caves at BLN which support the federally-endangered Indiana and gray bats, but they are known to forage along the Guntersville Lake shoreline. However, the immediate area has an extensive network of similar wooded shoreline and shallow lagoon habitats. Therefore, the impacts associated with these facilities are minimal.

The intake channel has not been maintained and will require dredging, both initially and periodically throughout the life of the plant. However, surveys have found no toxic sediments and a low average density of mussels in the area, and it is expected that the dredge material would be disposed on land.

Because intake demand is very small compared to the total water mass flowing past BLN, there is little potential for significant entrainment/impingement impacts. The existing BLN intake structure would be used, which entrains water through a 7.6-m wide trench connected to the original river channel and is designed such that 85% of the intake demand would be withdrawn from the river channel and 15% from the more productive upstream overbank habitat. The greatest impacts of entrainment and impingement from BLN would result from water withdrawn from the upstream productive overbank, although losses to the lake fish community should be minimal due to the large amounts of similar habitat near the plant and in other areas of the lake.

Air Quality

Compared to fossil-fueled power generation options such as NGCC, PC and IGCC, nuclear power has an overwhelming advantage of producing insignificant quantities of greenhouse gases and other air pollutants. For example, coal-based technologies emit over 200 pounds of carbon dioxide per million BTU of heat input; this is in stark contrast with the nuclear steam supply system, which emits none. For the ABWR plant, the only combustion sources to produce carbon dioxide are the small auxiliary heating boilers, emergency power generators (usually diesel-driven but sometimes combustion turbines), service vehicles, some portable self-powered devices such as pumps and generators, and some types of welding and heat treatment gear.

Annual emission rate estimates shown in Table E.7-4 are for a typical BWR nuclear plant complement of four emergency diesel generators and two auxiliary boilers. These estimates (except for carbon dioxide) were taken from the annual BFN Air Emissions Summary, adjusted for the number of diesel generators (four) and heating boilers (two) employed by the ABWR. Some additional particulate emissions would be expected from operation of the natural draft cooling towers. The carbon dioxide emissions were calculated based on the annual consumption of fuel oil at BFN, adjusted for numbers of comparable equipment for a two-unit ABWR plant.

In general, air emissions associated with ABWR construction are bounded by those of fossil-fueled power generation stations because of the shorter duration and greater efficiencies of the modular approach. For operation, the air emissions are dramatically reduced because there is no major combustion source. This contrast is particularly evident in the emission rate of the greenhouse gas carbon dioxide, which for a pulverized coal plant of equivalent size is measured in tens of millions of tons per year.

Table E.7-4 – Summary of BWR Nuclear Plant Air Emissions

Pollutant	Annual Emissions per two-unit 2328 MW plant	Annual Emissions for BFN replacement
NO_x (all Oxides of Nitrogen)	8.4 tons/year	14.0 tons/year
CO (Carbon Monoxide)	2.2 tons/year	3.7 tons/year
PM_{10} (Particulate Matter <10 micrometers in diameter	0.41 tons/year	0.68 tons/year
SO_2 (Sulfur Dioxide)	8.4 tons/year	14.0 tons/year
CO_2 (Carbon Dioxide)	2900 tons/year	4800 tons/year

Socioeconomics

Based on Japanese ABWR construction experience, it is expected that the Bellefonte ABWR construction period, from first concrete poured to fuel load, would be 34 months. This abbreviated schedule reflects a high degree of modularization, requiring the use of large cranes; expansion of the work scope which can proceed in parallel due to the "open top" method; and a number of improvements in field productivity, through innovations such as increased use of automatic welding machines. Peak employment during construction is estimated to be 3115, of which 2885 would be craft and craft supervision. Approximately 230 would be construction and pre-operational turnover engineers and technical advisors supplied by an architectural/engineering (A/E) company with ABWR construction experience. Approximately 1/3 of the crafts persons would move into the area, with the rest commuting, and less than half of those moving would be expected to buy or rent houses. But of the ones that move, more than 2/3 would be expected to bring their families. Very few, if any, of the A/E personnel would be expected to buy houses; almost all of them would rent or live in company-supplied housing, and few would bring their families.

Because of the relatively short duration of the ABWR construction period and the fact that almost none of the A/E personnel are likely to bring families, when compared to other bulk power options the ABWR would result in fewer new students and less of a strain on schools and other public services. Still, the large number of new students (720 total) could strain the Scottsboro and Jackson County school systems regarding transportation and other services and be a noticeable though minor addition for other surrounding counties.

The total projected employment during operation for the two-unit ABWR plant is 906, which is comparable to the current two-unit staffing at Browns Ferry. The total population impact on Jackson County would be expected to be twelve to fourteen hundred. The total annual employment generated in Jackson County would be approximately 1,600, and the total annual income generated would be over 78 million dollars. The impacts on housing, schools and services such as fire protection would be less than those of peak construction and should therefore be easily accommodated.

Aesthetics

The Bellefonte site is seen most frequently by passing motorists from various points along U.S. Highway 72. The on-ground plant facilities such as roads, parking, and administration-type buildings are screened for the most part by low rolling terrain in the foreground. Bellefonte is buffered from the main river channel by a wooded ridgeline which rises approximately 200 feet above the lake surface. Distant views of the 477-foot cooling towers and the reactor domes can be seen in excess of five miles away. The only new ABWR construction that would rise to a height comparable to the existing cooling towers would be an off-gas stack, which would have no associated visible plume. Vapor fog from the cooling towers could be visible from distances of 10 miles or more.

Cultural Resources

A 1972 archaeological survey of the BLN reservation identified five sites, none of which are within proposed construction zones. Just offsite from BLN, the original town site of Bellefonte was determined in 1974 to be eligible for placement on the National Register of Historic Places; prior to construction of BLN the Alabama State Historic Preservation Office determined that no mitigation would be required, and since that time all structures have been removed by landowners.

Human Health

The total worker radiation exposure for the two-unit ABWR is projected to be about 0.62 man-Sieverts/year, based on experience from the first five years of commercial operation for two comparable ABWR unit in Japan and adjusted to projected steady-state conditions.. For comparison, the median U.S. annual exposure for (two-unit) BWRs is 2.88 man-Sieverts/year. The reasons for the reduced occupational exposure include less piping, particularly in containment, and therefore less in-service inspection; larger maneuvering space for maintenance work inside containment; improved design requiring less maintenance of reactor components such as control rod drives; and shortened durations of refueling and maintenance outages due to expanded use of automated systems and design improvements such as split-type control rod drive housings. Approximately half of the radiation exposure is accumulated during outages. Experience with the prototype plants in Japan has shown that radiation exposure during outages has decreased steadily with time, reflecting lessons learned.

The ABWR has a calculated major accident risk ($\sim10^{-7}$ core damage frequency) which is an order of magnitude lower than that of comparable large BWRs or PWRs. Among the reasons for the improved nuclear safety of the ABWR are the simplified reactor pressure vessel boundary (i.e., internal reactor pumps, so no large break Loss of Coolant Accident from external reactor recirculation piping) and lower center of gravity, diversified control rod driving force, and optimized Emergency Core Cooling Systems with enhanced RHR redundancy. In the unlikely event of significant core damage, the off-site consequences (both economic and radiation dose to the public) would be bounded by those of conventional reactors of comparable size.

E.7.2.2.4 COAL GASIFICATION

The Integrated Gasification Combined Cycle (IGCC) plant would most likely be sited at the unfinished BLN site on the Tennessee River in NE Alabama to make maximum use of available resources and avoid the environmental impacts associated with constructing a facility on a Greenfield site. The total power output of the plant would be 2,720 MWe for two units combined. The plant would consume approximately 24,000 tons of fuel per day, shipped via barge.

The integrated gasification combined cycle (IGCC) plant constructed at the unfinished BLN site would consist of eight new IGCC modules, each consisting of one coal gasification plant, one combustion turbine (CT), and one heat recovery steam generator (HRSG). The steam recovered from each module is collected and routed to the two existing BLN low pressure steam turbine generators, four modules per steam turbine. An air separation plant is constructed for each gasifier to supply the pressurized 95% (by volume) oxygen required for the oxygen-blown gasifiers. Coal is gasified in each of the gasification units. The synthesis gas produced in each gasifier is cleaned of impurities and fired in compatible CTs. Steam is generated and superheated in dedicated HRSGs, then expanded through the steam turbine.

Process water from syngas cooling and particulate removal is passed through a steam stripper column to remove the CO_2 and H_2S and through an ammonia stripper column to remove ammonia and trace components. Recycled water is sent as makeup water to the gasifier and the sour gas created in water treatment is processed in sulfur recovery.

Several different types of gasifier reactors have been developed and demonstrated, including moving bed and fluidized bed types. However, consideration has been given to only those gasifiers classified as entrained flow, since the performance of this class of gasifiers offers coproduct compatibility, fuel flexibility, and economic competitiveness, and environmental superiority over competing gasification technologies. Although feedstocks with low ash content are favored, entrained flow reactors have the ability to gasify all coals regardless of coal rank, caking characteristics, or amount of coal fines. In addition, the oxygen-blown, entrained flow gasifiers have operated commercially for over 10 years. For entrained-flow gasifiers, the methods of feeding coal to the gasifier reactor fall into two basic categories: 1) for dry feed types, pulverized coal is transported to the gasifier via entrainment by a gas, generally nitrogen; 2) for slurry feed types, pulverized coal is mixed with water and then pumped to the gasifier. The dry feed technology is favored for applications emphasizing thermal efficiency and the flexibility to feed high ash/high water coal. Slurry feed technology is favored for applications requiring low capital cost, higher pressures, and/or high H_2/CO ratios.

For Integrated Gasification Combined Cycle, it is possible to utilize a variety of fossil fuels to provide the source of energy, with coal and petroleum coke being the most likely fuel choices. To allow either of these fuels or a mixture of them to be used for IGCC, the option has been evaluated so as to define the greatest environmental impacts of this technology regardless of fuel type. For example, coal use would result in the generation of the greatest amount of slag, so the impacts of slag storage have been based on the use of coal. Conversely, the greatest emission of gaseous sulfur dioxide (SO_2) occurs for petroleum coke use, so the air impact evaluations have been based on the use of petroleum coke fuel. The sub-option choices assumed for the impacts analyses are noted where necessary to convey the basis for the impacts evaluation.

Land Use/Soils

Figure E.7-1 is a simplified footprint of an IGCC facility constructed at the BLN site. Approximately 190 acres to the southwest of the existing cooling towers would be used to construct new facilities. Construction in this location would require the demolition or relocation of several existing buildings and underground utilities. After completion of demolition, the area would be cleared and grubbed to remove existing vegetation, then leveled to an elevation above the 500-year flood plain.

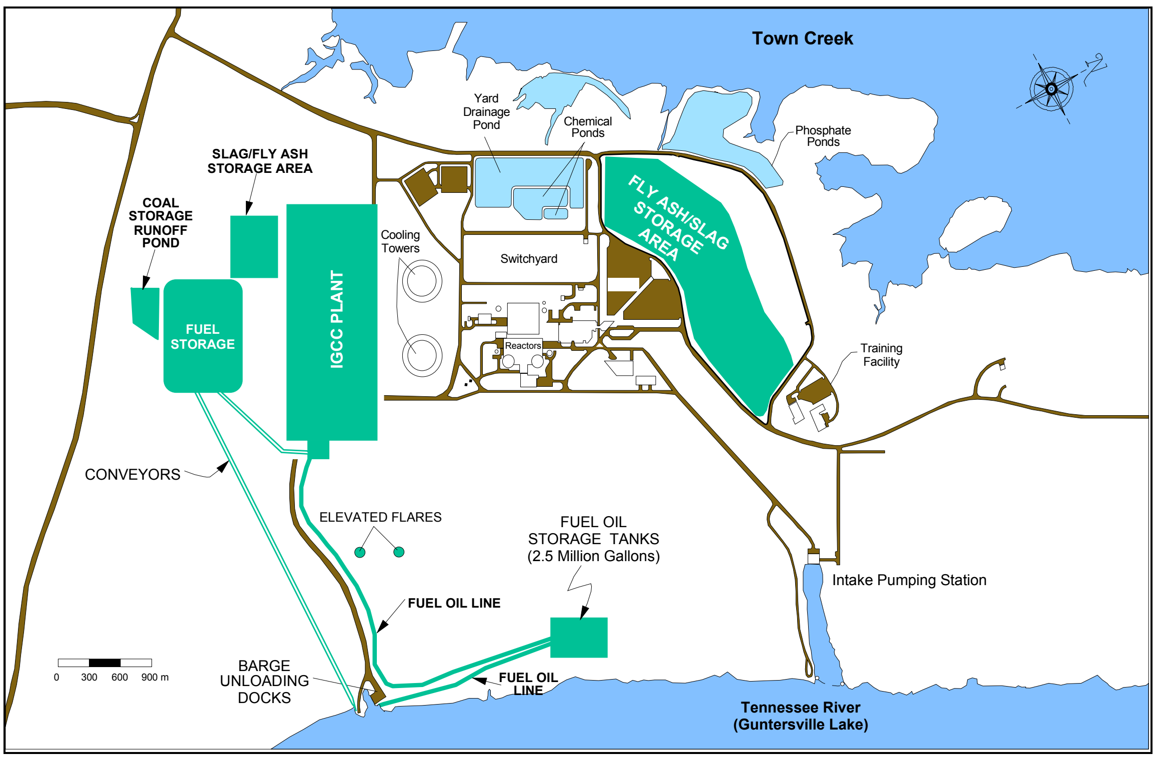

Figure E.7-1 – IGCC Footprint

Cooling tower blowdown diffusers and piping in the Tennessee River would be lowered approximately five feet from their existing position to allow unrestricted barge movement. The barge unloading area would consist of a loading barge storage dock, unloading dock and empty barge dock. The docks would be constructed of cells interconnected with walkways. Cells would be constructed of sheet piles with a granular fill material. Approximately 50 of these 20-foot diameter cells would be needed.

New coal handling facilities would be constructed for barge unloading of coal or petroleum coke. The existing cooling towers and circulating water system would be utilized for cycle heat rejection. The existing substation would be augmented and a new auxiliary power system would be constructed. A new distributed control and information system would also be constructed.

Construction will include the preparation of an area for disposal of unmarketable slag. The area identified is expected to provide at least nine years of storage capacity, even if none of the slag is marketed. It is highly likely that most gasifier slag will be marketed due to its excellent quality and high demand. Conservatively assuming that half is sold, storage area life would be 18 years.

Transportation

Table E.7-5 shows the transportation requirements for an IGCC facility at Bellefonte. Delivery of coal and/or petroleum coke to the BLN site would be required for IGCC. Approximately 24,000 tons of fuel would be shipped in daily, probably via barge. If coal is used, the origin would likely be Southern Illinois, based on the design assumption of Illinois No. 6 coal. If petroleum coke is used, the origin would likely by Texas or Louisiana, states with extensive refining industry. Delivery of a small quantity of limestone may also be required, depending upon the exact technology chosen. Trucking would be used for the limestone. Fuel oil would be required for startup of CTs and gasifiers, but would not be used as a backup fuel.

Table E.7-5 – Transportation Requirements (IGCC)

INCOMING SHIPMENTS					
			UNITS/YEAR		
Material	Daily (tpd)	Annual (tpy)[a]	Barge	Rail Car	Truck
Coal	24,000	7,446,000	4,964	-	-
Limestone	240	74,600		-	2,980
Fuel Oil		10,368,000 gal/yr	6	-	-
Subtotal[b]			4,970	0	2,980
OUTGOING MATERIAL					
Sulfur		240,000	-	2,400	-
Slag		504,000	-	-	20,160
Fly ash		40,800	-	-	1,632
Spent Catalysts		520	-	-	21
Sludges		2,180	-	-	87
Subtotal[b]			-	2,400	21,900
TOTAL[b]			**4,970**	**2,400**	**24,880**

[a] - reflects 85% capacity factor
[b] - at build out

The gasification process produces sizable quantities of slag, fly ash, and sulfur for sale as by-products. Much of the slag and fly ash would be sold in local markets. Table E.7-5 reflects the transportation of these by-products by truck. The likely destination of marketable by-products would be local industries capable of utilizing such materials, probably within a 30-mile radius of Bellefonte. Long hauls would probably not be incurred due to marginal profits of such industries and the significant costs of transporting bulk materials. The sulfur would most likely be shipped to Florida for use in the fertilizer industry located there. Small amounts of catalysts would be returned to manufacturers for reclamation. Sludges would have to be delivered to local landfills.

Waste Management

For IGCC, the major solid waste and by-product streams are generated by the gasifiers. Coal would be utilized at the rate of 24,000 tons per day. Slag, fly ash, and sulfur account for more than 99% of the solids produced by the IGCC systems, with the remaining 1% consisting of spent catalysts and water treatment sludges. The generation rates in tons per year are 504,000 for slag; 40,800 for fly ash; and 200,000 for sulfur. The slag produced is an inert glass-like material that has been found in IGCC demonstrations to be non-leachable. Based on testing at gasification demonstration plants, the slag and fly ash from gasification of eastern bituminous coal is expected to be below the RCRA threshold limits for hazardous designation. Most of the sulfur in the coal is converted to H_2S in the syngas. The H_2S is removed by acid gas removal and then converted to elemental sulfur by-product in sulfur recovery. Elemental sulfur produced in the recovery process is a non-hazardous material and represents no threat to the environment.

Based on the projected fuel characteristics it is expected that the slag, fly ash and sulfur produced would be of sufficient quality to be marketed. However, if different feedstocks are used, the slag generated would have to be tested to verify its non-hazardous characteristics. Any storage or disposal of slag and fly ash when using untested feedstock would be in areas constructed over low-permeability materials and separated from the underlying groundwater so as to minimize any potentially adverse environmental impacts. Any slag or fly ash which tested as hazardous would be disposed off site in an approved facility.

There are three process solid waste streams comprised of sludges from raw water or waste water treatment: raw water treatment sludge (1,280 tpy); general waste water treatment sludge (800 tpy); and sludge from the biotreatment of gasification process waste water (40 tpy). These sludges are typically non-hazardous and would be disposed at nearby state-approved municipal disposal sites. A survey of selected landfills within 50 miles of BLN indicates that there is adequate storage capacity for these wastes within the area. Sanitary waste water currently is sent to the Hollywood Waste Water Treatment Facility located adjacent to BLN, which disposes the sanitary sewage treatment sludge.

Hazardous wastes generated during construction and operation would largely result from maintenance activities associated with service and repair of equipment, cleaning of parts and equipment, and maintenance of the physical plant. These wastes would include materials such as waste oils containing solvent residuals or trace metals, waste paint and paint thinners, and solvents and degreasers. Although TVA would adopt a hazardous waste minimization policy for the IGCC facility, including substituting non-hazardous for hazardous materials wherever feasible, it is expected that sufficient quantities of hazardous wastes would be generated to qualify the site as an EPA Large Quantity Generator, i.e., more than 1,000 kg for any one calendar month. Hazardous wastes would be stored onsite temporarily (<90 days) prior to shipment to the TVA Hazardous Waste Storage Facility in Muscle Shoals, which makes arrangements for disposal at a permitted disposal facility off site.

Surface and Ground Water Quality

Raw water for construction and operation would be obtained from the Tennessee River (Guntersville Lake). The quantities needed would have a negligible effect on the river, which provides average flows of 38,800 cfs (25,100 mgd, or 17.4×10^6 gpm), and 7-day, 10-year ("7Q10")minimum flows of 12,875 cfs (8,320 mgd, or 5.78×10^6 gpm) in the vicinity of BLN. The highest sustained water needs would be during operation: 36,700 gpm, or 0.64% of the 7Q10 flow and 0.21% of the average river flow. Of the 36,700 gpm total, 18,100 gpm would be cooling tower make-up. The IGCC plant would require the use of both existing closed-cycle natural draft cooling towers. The flow through each tower is estimated at 435,000 gpm.

No significant construction-related impacts to surface water resources are expected as a result of this project. The majority of the power plant and associated facilities would be constructed on land that has been previously altered due to the BLN construction. Construction of new facilities and overall site reclamation activities would affect surface hydrology, but extensive site excavation, filling, or grading is not expected. The primary surface water impact during construction would be soil erosion, which would be kept low by the use of BMPs. To minimize the impacts of storm water flow during construction, a storm water detention pond would be designed to detain storm water from the 25-year, 24-hour rainfall event, in compliance with regulatory requirements.

[NPDES] The surface water resources within the areas of the proposed development at BLN are currently monitored under the NPDES Permit AL0024635 issued by ADEM. New construction activities that disturb five acres or more would require an NPDES permit for storm water discharges from the site to ensure the implementation of BMPs and to minimize impacts to surface waters during construction. For plant operation, NPDES Permit AL0024635 also limits in-stream discharge water temperature to $\leq 30^{o}$C. Ambient upstream temperatures typically exceed this limit in July and August, an average of 8.4 days per year (maximum measured upstream temperature is 32.22^{o}C).

To meet the condenser cooling water needs at BLN, and minimize thermal impacts on Guntersville Lake, the existing closed-cycle natural draft hyperbolic cooling towers would be utilized. Make-up water for cooling tower blowdown, evaporation, and drift would be withdrawn from Guntersville Lake. The combined blowdown, storm water, plant drains, and other waste water flows would be discharged to Guntersville Lake through a submerged diffuser to provide dilution with stream flow, consistent with the need to protect the aquatic biota of the lake. Based on past NPDES permitting experience, water pollution regulations do not appear to limit IGCC operational discharges. To accommodate barge traffic, the discharge diffuser would be lowered by five feet.

Effluent dilution characteristics were calculated for the diffuser and channel flow configuration. Based on cross sectional data measured at TRM 391.06, the lake channel is assumed to be rectangular, 23 feet deep and 1735 feet wide, with uniform ambient velocity under steady-state conditions. Using a 3Q20 dependable river ambient flow rate of 9560 cfs, the maximum temperature 10 feet downstream from the diffuser is 32.57^{o}C (compared to an ambient temperature of 32.22^{o}C, most likely in July or August), diluting to 32.31^{o}C at 2,600 feet downstream. Since maximum water temperatures are therefore predicted to exceed permitted levels, a 316(a) variance to the NPDES Permit would be required. The predicted maximum temperature rise (which would normally occur in January or February) at 10 feet downstream is 1.76^{o}C, decreasing to 0.53^{o}C at

1,000 feet downstream and 0.42°C at 10 miles downstream; this is well below the Alabama limit of 2.8°C.

All homes relying on groundwater supplies near the plant site are located on the opposite side of the Town Creek Embayment, which serves as a hydraulic boundary along the western side of the site. The nearest municipal groundwater supply consists of two deep wells for the city of Hollywood, Alabama, located about four km northwest of the site. Considering the hydraulic isolation of the site by Town Creek Embayment and the Tennessee River, and the fact that groundwater occurs in a relatively shallow zone beneath the water table at the site, groundwater availability would not be affected by construction activities such as excavation or dewatering.

Any impacts to groundwater during operation would most likely be associated with storage and handling of feedstocks and the storage, handling, and disposal of wastes generated. Runoff from the coal and petroleum coke storage areas would be collected in a drainage basin and treated as needed. Storm water runoff from gasification demonstration plant fly ash and slag piles easily met existing National Interim Drinking Water Standards; as such, this runoff should not pose any risk to surface or ground water in the event of accumulation of substantial amounts of fly ash and/or slag prior to marketing. Storm water runoff also would be managed through a Storm Water Pollution Prevention plan where appropriate controls would be implemented. Appropriate testing procedures, the use of natural clay barriers and liners, and proper handling and storage/disposal of wastes should prevent any adverse impacts to groundwater quality at the site. The BLN Spill Prevention Control and Countermeasure Plan provides a methodology for mitigating any groundwater releases. The existing monitoring well network would be adequate for monitoring groundwater quality.

Wastewater from the steam cycle contains salts and minerals, but these raw process streams are purified and recycled in the gasification process. Scrubber blowdown is high in dissolved solids and gases, including trace metals, trace organics, and several ionic species; this water can be recycled to the coal feed preparation area, to the scrubber after entrained solids have been removed, to a zero discharge water system, or to wastewater treatment.

Ecological Resources

Since no state- or federally-listed plant species are known from the site, no impacts are anticipated. The construction of barge facilities would result in some reduction in roosting and foraging sites for raptors, bats, waterfowl, and wading birds such as great egrets, green herons, and great blue herons. There are no caves at BLN which support the federally-endangered Indiana and gray bats, but they are known to forage along the Guntersville Lake shoreline. However, the immediate area has an extensive network of similar wooded shoreline and shallow lagoon habitats. Therefore, the impacts associated with these facilities are minimal.

Lowering the diffuser and constructing the barge terminal and mooring cells would require in-stream dredging to remove ~150,000 cubic yards, resulting in hear-field impacts on resident aquatic communities. However, surveys have found no toxic sediments and a low average density of mussels in the area, and it is expected that the dredge material would be disposed on land.

Because intake demand is very small compared to the total water mass flowing past BLN, there is little potential for significant entrainment/impingement impacts. The existing BLN intake structure would be used, which entrains water through a 7.6-m wide trench connected to the original river channel and is designed such that 85% of the intake demand would be withdrawn from the river channel and 15% from the more productive upstream overbank habitat. The greatest impacts of entrainment and impingement from BLN would result from water withdrawn from the upstream productive overbank, although losses to the lake fish community should be minimal due to the large amounts of similar habitat near the plant and in other areas of the lake.

Air Quality

Transient air pollutant emissions would occur throughout the construction phase. Since the BLN site was cleared and prepared for nuclear plant construction, however, site preparation and construction activities and their attendant transient air pollution emissions would be substantially less than for a new site. Construction-related air quality impacts are primarily related to: land clearing, site preparation, and vehicular traffic; open burning of cleared land debris; and operation of internal combustion engines. The air quality impacts related to construction activities would be temporary in nature and dependent on both manmade (e.g., intensity of activity, control measures, etc.) and natural factors (e.g., wind speed and direction, soil moisture, etc.). However, even under unusually adverse conditions, these emissions would have, at most, a minor, transient impact on offsite air quality and should not lead to an exceedence or violation of any applicable ambient air quality standard. Accordingly, the overall air quality impact of construction-related activities would not be significant.

The gasification process generally uses oxygen to only partially oxidize the combustible constituents of coal. Usually the oxygen is supplied via a high-pressure cryogenic process called an Air Separation Unit (ASU). An ASU can produce 99+% pure O_2, but lower purity (e.g., 95%) is more economical in IGCC. The 98+% N_2 produced as a byproduct can also be used in the CT as a diluent (i.e., injected inert gas) to reduce NO_x to 15 ppm levels, possibly to 10 ppm with new combustors. If necessary, SCR and SCONOX can be used for post-combustion NO_x control. The major combustible products are carbon monoxide (CO) and hydrogen (H_2), with a small fraction of the carbon yielding some CO_2. Some methane (CH_2) may also be present. The heat produced provides most of the energy to react the coal. The result is a combustible syngas that must be cleaned prior to entering a combustion turbine in order to produce power. After gasification, the particulates are removed from the syngas in typically hot, dry barrier filters or “warm gas” water scrubbers. A series of heat exchangers are employed to cool the syngas before cleanup. After the syngas is cooled, most of the H_2S and some of the CO_2 is removed via acid gas extraction. Elemental sulfur is also recovered.

Elemental Mercury (Hg) is the prominent chemical form in gasification. Hg can be removed either from the syngas prior to combustion or from the flue gas. Removal prior to combustion is preferred and has been successfully demonstrated with carbon beds, removing typically 90 to 95% and >95% with dual beds. Average Hg flue gas emissions from current IGCC plants ranged from 0.0046 to 0.0121 lb/hr with Hg input ranging from 5.6 to 8.9 lb/10^{12} Btu.

The potential operational air quality impacts were evaluated using EPA-recommended air quality models. Primary air pollutant emissions consist largely of SO_2, NO_x, PM, and

CO. Each of these emissions relates to one or more criteria pollutants for which the EPA has set National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration (PSD) increments. Compliance with two major regulatory programs is required to achieve the NAAQS mandated by the Clean Air Act of 1970: New Source Performance Standards, which specify maximum emission rates for specified air pollutants, and New Source Review, which can supersede NSPS and impose more stringent limits on individual sources such as coal-fired power plants. Compliance may also be required with ozone and PM10 non-attainment, hazardous air pollutant emissions, and aggregate emissions of acid rain precursors. Under the CAAA there is a national cap on SO_2, and a regional cap on NO_x emissions. These and other recent revisions to the ozone and fine particulate air quality standards—and likely future efforts to assure compliance with these standards and the future regulation of mercury emissions —have implications for decisions related to the construction of a fossil-fuel generating facility at BLN. The revised standards should prove considerably more stringent to achieve than the previous standards, and it is likely that a number of nearby areas will become non-attainment even if air quality does not decline. Although the BLN area currently meets ozone and particulate matter standards, historical ozone and particulate matter data suggest that one or more counties in Northeast Alabama and nearby Southern Tennessee and Northwest Georgia are likely to become non-attainment for one or both of the revised standards. If an area near BLN is designated non-attainment, new sources could be required to obtain emission offsets from other sources located in the same airshed in order to receive air permits. Actual permitted levels may be significantly less than NSPS based on requirements to use Best Available Control Technology (BACT) in attainment areas and Lowest Achievable Emissions Reduction (LAER) technology in non-attainment areas. BACT/LAER are determined on a case-by-case basis. NO_x emissions are potentially the most affected by BACT/LAER due to limits on natural gas turbines being as low as 2 or 3 ppm, while gasification cannot achieve these low levels on syngas with either combustion control or flue gas control. Mercury emissions are potentially greatly affected by BACT/LAER. In summary, the more stringent revised ozone and particulate matter standards, in combination with regional secondary pollutant management strategies to achieve attainment (or to address new source review or regional haze requirements), will lead to significantly increased regulatory pressure to minimize NO_x and SO_2, and possibly mercury emissions from new fossil-fuel boilers.

Annual emission rates shown in Table E.7-6 are based on an eight-module IGCC plant producing 2,720 MWe and operated continuously throughout the year. The fuel is conservatively assumed to be petroleum coke, which is consumed at the rate of 24,000 tons per day. Air impact evaluations have been based on petroleum coke because emission of gaseous sulfur dioxide (SO_2) exceeds that of coal. The NO_x emission estimates are based on 10 - 20 ppm NO_x. The SO_2 emission estimates are based on a sulfur removal rate of 98 - 99%. Of the sulfur released to the atmosphere, only a portion is associated with the flue gas stream. Tail gases (containing H_2S and reduced sulfur compounds) from the sulfur recovery step are thermally oxidized to SO_2 and vented following this step. Each sulfur recovery unit has a tail-gas treatment stack for a total of eight stacks.

Also shown in Table E.7-6 below is the estimated production of carbon dioxide, which is a major increase in comparison to the current total TVA CO_2 emissions of about 110 million tons per year. Manmade emissions of greenhouse gases, particularly CO_2, N_2O and methane (CH_4), tend to increase global temperatures by absorbing long-wave radiation. Although the estimated N_2O and CH_4 emissions for the IGCC are minimal, the CO_2 emissions are significant. IGCC does have the potential for carbon removal and sequestration due to the relatively high concentration of CO_2 that can be removed via the acid gas removal system.

Table E.7-6 – Summary of IGCC Air Emissions

Pollutant	Annual Emissions per 8 module 2,720 MW plant	Annual Emissions for BFN replacement
NO_x (all Oxides of Nitrogen)	3,812 tons/year	5,379 tons/year
CO (Carbon Monoxide)	4,420 tons/year	6,240 tons/year
PM_{10} (Particulate Matter <10 micrometers in diameter	1,190 tons/year	1,680 tons/year
SO_2 (Sulfur Dioxide)	8,340 tons/year	11,774 tons/year
CO_2 (Carbon Dioxide)	21,980,000 tons/year	31,000,000 tons/year

All primary and secondary NAAQS concentration limits were met, and all PSD Class II increments except for 24-hour SO_2 were met (95 $\mu g/m^3$ calculated vs. 91 $\mu g/m^3$ limit).

For the IGCC plant, sulfur removal greater than 99.5% is possible, but at increased cost for the syngas clean-up system. Improving removal efficiency to 99.6% would result in lowering ambient SO_2 concentrations to less than 80 $\mu g/m^3$.

In addition to PSD Class II increments which apply to nearly all areas, the Clean Air Act identifies PSD Class I increments which apply to National Parks and Wilderness Areas. Significant emission sources proposing to locate or expand within 100 km of a Class I area must evaluate their potential impact on PSD Class I increments. Although the BLN site is not within 100 km of any Class I area, the impact of an IGCC plant at BLN was conservatively evaluated for the nearest Class I area, which is the Cohutta Wilderness, approximately 120 km distant. No PSD Class I increment was exceeded for the Cohutta Wilderness.

During plant start-up, until the gasification pressure reaches its design value, raw syngas is typically flared. Modeling results for flare stack operation suggest that SO_2 emissions during flaring may cause high ambient concentrations during worst-case meteorological conditions. Sand Mountain, which reaches nearly 220 m (700 feet) above the flair stack base, is located just over 2.5 km (1.5 miles) to the southeast. Since the BLN site is near this elevated terrain, reduction of the sulfur in the flared raw gas during startup or a modification to the flare gas system design would be required to prevent significant environmental impact.

Visibility models were used to determine if the plume from the plant would be visible at the Cohutta Wilderness. It was predicted that, under highly unusual conditions of the worst-case wind direction (towards Cohutta), very low wind speed (1 or 2 mph), and very stable meteorology, a plume could be visible. Plume visibility, however, is also greatly dependent on background visual range. It is possible that a plume could be visible on clear winter days with stable conditions and low wind speeds, and not at all visible during hazy summer months regardless of the stability class and wind speed.

A hazardous air pollutants analysis was performed to assess the potential health effects associated with the direct inhalation of air toxic constituents potentially present in emissions from the IGCC plant at the Bellefonte site. None of the hazardous air pollutant concentrations exceeded the Threshold Limit Value – Time Weighted Averages taken from guidance developed by the American Conference of Governmental Industrial Hygienists. Therefore, direct inhalation of hazardous air pollutant emissions from operation of the plant would not cause significant adverse effects to the health of the human population in the area.

Models were also used to estimate maximum concentrations beyond the property boundary of six chemical compounds which produce odors (benzene, naphthalene, formaldehyde, acetaldehyde, ammonia, and hydrogen sulfide). The maximum concentrations were compared to published odor threshold ranges. The ammonia and acetaldehyde concentrations were above the lower thresholds during continuous operation, indicating that they may cause an odor noticeable to some people during worst-case meteorology. None of the higher odor thresholds were exceeded for any of the chemicals during steady-state operation, but the hydrogen sulfide concentration exceeded the higher odor threshold during flare operation. However, the raw gas flares would operate less than 100 hours per year, and this impact would be intermittent and noticeable only immediately downwind of the plant. These intermittent impacts could be mitigated through the use of various sulfur control strategies.

The maximum cooling tower drift is estimated to be 32.4 gpm, which is less than the 45 gpm estimated in the original BLN EIS. The cooling tower drift impact, based on models for the original plant, is expected to remain within the site boundary and be environmentally inconsequential. Fugitive dust emissions from coal piles, coal slurry, and slag transport may also occur, but based on past experience these are not expected to be a significant problem.

Socioeconomics

Peak employment during construction is estimated to be 2,162, and total construction completion employment in person-years is estimated to be 15,604. About 30 to 35% of the construction workers would be expected to move into the area, of which 50% are likely to buy or rent houses. An additional 25 to 30% are expected to buy or rent mobile homes, and the remaining workers would generally rent apartments or sleeping rooms. Of the workers moving into the area, 70% are expected to bring their families; most of the others would be single or would live in the area during the week and return home on weekends. About 75% of construction workers who move are expected to live in Jackson County, and 2/3 of these can be expected to live in the Scottsboro-Hollywood area.

On average, it is expected that construction workers who bring their families would have about 0.9 school-age children per family. The total number of students would be 611, of which 328 can be expected to attend the Scottsboro city schools, 170 in the Jackson County School System, and the remaining 113 in other counties. It is possible that the additional 498 students could strain the transportation capacity and other services of the two Jackson County school systems, which together have approximately 10,000 total students.

There would be about 530 permanent plant employees during operation, of which 265 would be expected to move into the area, and 239 of those would bring families. The total population impact on Jackson County is projected to be an increase of six or seven hundred, which is somewhat higher than the annual average increase in population. The total annual employment generated in Jackson County would be approximately 950, and the total annual income generated would be over 46 million dollars. These impacts on housing, schools and services such as fire protection would be much less than those arising from peak construction and therefore should be easily accommodated.

Aesthetics

Site construction would include 12 stacks 325 feet in height, in addition to two flaring stacks ~200 feet in height. Flaring operations would generally be visible within a 3 mile radius. The 325-foot stacks would not rise to the height of the existing cooling towers and would be visible in distant views from four to six miles away. Vapor fog and stack emissions could be visible from distances of 10 miles or more. The burning of coal would require approximately 17 barges per day and fuel oil storage tank size would be five million gallons. Some recreational impact would result from increased barge traffic.

Cultural Resources

A 1972 archaeological survey of the BLN reservation identified five sites, none of which are within proposed construction zones. Just offsite from BLN, the original town site of Bellefonte was determined in 1974 to be eligible for placement on the National Register of Historic Places; prior to construction of BLN the Alabama State Historic Preservation Office determined that no mitigation would be required, and since that time all structures have been removed by landowners.

Human Health

Although TVA is not subject to OSHA, it is required to have a safety program that is equivalent to OSHA General Industry standards. Emergency response procedures would be outlined in the Site Safety and Health Plan, a comprehensive document required of all work projects.

In addition to the combustion and residue disposal aspects of the fuel cycle which have been addressed above, there are also potential impacts associated with acquisition and transportation. The risks associated with coal mining are a concern, although the rate of coal mining deaths per million production hours has declined from 1.0 in 1970 to 0.2 in the 1990-94 period; this improvement has been brought about by more stringent regulations and monitoring, and the evolution of much safer mining machines and systems. Petroleum coke was until recently a discardable material from the petroleum refining industry; its use would therefore not cause any more oil extraction and not result in incremental impacts over non-use and would provide a means for safely and economically disposing of an unwanted material. The transportation of fuel would have some air quality impact due to emissions resulting from the combustion of fuels in powering the barges, but these emissions would be dispersed along the length of the river.

The production of power at BLN would require energizing 24.8 miles of existing 500 kV transmission line which is currently constructed but de-energized. Other 161 and 500 kV lines to BLN are already energized. Although health impacts of electromagnetic fields are uncertain, TVA's standard for siting transmission lines, which utilizes a 300-foot radius buffer around occupied dwellings (1,200 feet for schools), has the effect of minimizing public exposures to EMF.

E.7.3 REFERENCES

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E.8.0 COMPARISON OF ENVIRONMENTAL IMPACT OF LICENSE RENEWAL WITH THE ALTERNATIVES

This section should present the impacts of the proposed action, the no action alternative, and other reasonable alternatives in comparative form in order to sharply define the issues and provide a clear basis for the NRC to "determine whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable." This comparison may be presented in any of several formats. Often the comparison is presented in a tabular format such as Tables 8.1 and 8.2 of NUREG-1437. The comparison should emphasize the more significant impacts of each alternative.

E.8.1 DISCUSSION

The environment impacts associated with license renewal of BFN Units 1, 2, and 3 are analyzed in Chapter 4. The impacts of alternatives to license renewal are analyzed in Chapter 7. Table E.8-1 summarizes the environmental impacts of the proposed action (license renewal) and the alternatives to license renewal, including the no action alternative. Table E.8-1 provides a means for the reader to easily compare the environmental impacts for each of the considered alternatives. The environmental impacts summarized in Table E.8-1 are those that are either designated as Category 2 issues for the proposed action, or are issues that the *Generic environmental Impact Statement* (GEIS) (NRC 1996) identified as major considerations in an alternatives analysis. Table E.8-2 provides a more detailed comparison of the alternatives.

Table E.8-1 – Impacts Comparison Summary

Impact Category	Proposed Action (License Renewal)	No Action Alternative (Decommissioning)	Natural Gas Combined Cycle	Pulverized Coal	New Nuclear Technologies	Coal Gasification
Land Use	SMALL	SMALL	MODERATE	MODERATE	SMALL	SMALL to MODERATE
Water Quality	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Air Quality	SMALL	SMALL	MODERATE	MODERATE	SMALL	MODERATE
Ecological Resources (including Threatened or endangered Species)	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL

Table E.8-1 (cont.) – Impacts Comparison Summary

Impact Category	Proposed Action (License Renewal)	No Action Alternative (Decommissioning)	Natural Gas Combined Cycle	Pulverized Coal	New Nuclear Technologies	Coal Gasification
Waste Management	SMALL	SMALL	SMALL	MODERATE	SMALL	MODERATE
Human Health	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Socioeconomics	SMALL	MODERATE	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Cultural Resources	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Aesthetics	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL	MODERATE

Table E.8-2 – Impacts Comparison Detail

Proposed Action (License Renewal)	No Action Alternative (Decommissioning)	Natural Gas Combined Cycle	Pulverized Coal	New Nuclear Technologies	Coal Gasification
Alternative Descriptions					
BFN license renewal for 20 years, followed by decommissioning	Decommissioning following expiration of current BFN license	Seven 510 MW NGCC plants similar to one planned for Franklin County, TN, but not completed	Three 1,200 MW Pulverized Coal plants, possibly located at mine mouth sites such as near Central City, KY	Two 1,336 MW Advanced Boiling Water Reactor Units constructed at the unfinished Bellefonte Nuclear Plant site	Eight Integrated Gasification Combined Cycle modules totaling 2,720 MW, constructed at the unfinished Bellefonte Nuclear Plant site
Land Use Impacts					
SMALL – Changes confined to site on previously disturbed land	SMALL – BFN site made ready for other use; some small land commitment in a waste repository for disposal of decontamination materials	MODERATE – Multiple sites and multiple gas pipelines involved	MODERATE – Each site requires 1,000 acres, plus coal mines	SMALL – Can use existing BLN site and blended HEU (avoids mining)	SMALL to MODERATE – Can use existing BLN site but requires land disturbance for coal mining

Table E.8-2 (cont.) – Impacts Comparison Detail

Proposed Action (License Renewal)	No Action Alternative (Decommissioning)	Natural Gas Combined Cycle	Pulverized Coal	New Nuclear Technologies	Coal Gasification
Water Quality Impacts					
SMALL – Minimal water consumption; derates as necessary to meet NPDES discharge temperature limits	SMALL – Possible use of water for soil decontamination if necessary	SMALL – Use of cooling towers minimizes water body impacts	SMALL – Use of cooling towers and runoff retention ponds minimizes water body impacts	SMALL – Use of cooling towers and spray ponds minimizes water body impacts	SMALL – Use of cooling towers minimizes water body impacts, although variance required
Air Quality Impacts					
SMALL – No major source of air pollution; total CO_2 emissions <5 thousand tons/year	SMALL – Activities do not involve any major air pollution potential	MODERATE – CO_2 generation to replace BFN would be ~19 million tons/year	MODERATE – CO_2 generation to replace BFN would be ~44 million tons/year	SMALL – No major combustion source; total CO_2 emissions <5 thousand tons/year	MODERATE – CO_2 generation to replace BFN would be ~31 million tons/year

Table E.8-2 (cont.) – Impacts Comparison Detail

Proposed Action (License Renewal)	No Action Alternative (Decommissioning)	Natural Gas Combined Cycle	Pulverized Coal	New Nuclear Technologies	Coal Gasification
Ecological Resource Impacts (including Threatened or Endangered Species)					
SMALL – Monitoring will confirm increased intake flow from Unit 1 recovery will not result in unacceptable impingement or entrainment of aquatic biota	SMALL – Activities do not involve any potentially significant impacts on ecological resources	SMALL – Habitats with listed species are avoided, and intake structures are designed to meet 316(b) requirements for new construction	SMALL – Reclaimed strip mine land devoid of significant habitats; intake structures designed to meet 316(b) requirements for new construction	SMALL – Existing BLN site has no resident listed species or sensitive habitats; intake demand is very small compared to river flow, will meet 316(b) requirements	SMALL – Existing BLN site has no resident listed species or sensitive habitats; intake demand is small compared to river flow, will meet 316(b) requirements
Waste Management Impacts					
SMALL – Spent fuel will be temporarily held in a dry cask storage facility; existing processes adequate to dispose continuing generation of other waste streams	SMALL – Radioactively contaminated materials dispositioned similarly to those generated during operation; some disposal of hazardous wastes (asbestos, PCBs, etc.) per existing TVA procedures and practices	SMALL – No solid wastes of any significance	MODERATE – Significant quantity of solid waste is produced but most is potentially marketable (330,000 tpy fly ash, 82,500 tpy bottom ash, 611,000 tpy flue gas desulfurization sludge) except water treatment sludges (1,000 tpy)	SMALL – Experience with ABWRs is that radwaste generation is greatly reduced compared with BWRs such as BFN, and spent fuel is slightly less; all other waste streams are comparable to those of existing nuclear plants	MODERATE – Significant quantity of solid waste is produced but most is potentially marketable (504,000 tpy gasifier slag, 40,800 tpy fly ash, 200,000 tpy sulfur) except water treatment sludges (2,100 tpy); plant is also a Large Quantity Generator of hazardous waste (>1,000 kg/mo.)

Table E.8-2 (cont.) – Impacts Comparison Detail

Proposed Action (License Renewal)	No Action Alternative (Decommissioning)	Natural Gas Combined Cycle	Pulverized Coal	New Nuclear Technologies	Coal Gasification
Human Health Impacts					
SMALL – Essentially no change from present operations, which have minimal impacts	SMALL – Will still meet NRC dose limits, same as during operation; industrial safety similar to construction experience	SMALL – Risk of gas pipeline or <20% (low concentration) ammonia tank rupture is negligible; other risks bounded by other types of power plants	SMALL – Potential rupture of large ammonia tank requires Risk Management Program; other risks similar to those of existing power plants	SMALL – Experience with ABWRs is that worker dose is much less than that of conventional nuclear plants, and risk to public is also lower	SMALL – Risks generally similar to those of existing coal-fired power plants, including coal mining and transportation aspects
Socioeconomic Impacts					
SMALL – A large but temporary labor force is needed for Unit 1 recovery and restart, but the permanent additional staff to operate the third unit is only 150 and remains unchanged through the renewed license period.	MODERATE – Less than half the operational staff level is needed temporarily for decommissioning, but this employment reduction, though permanent, is only a small fraction of the local labor force. Alternative source power would be significantly more expensive.	SMALL – Each plant has a relatively small construction staff, for relatively short duration, and the operational staffs are very small; these represent a small fraction of the available labor forces	SMALL to MODERATE – Mining process preparation would increase the construction staff at each plant to a peak of 2500; total impact, though temporary, depends on spacing of the sites (operating staff 440 at each site)	SMALL to MODERATE – Large but temporary construction force peaks at over 3100, with permanent staff less than 1000; this would temporarily strain local schools and other services	SMALL to MODERATE – Construction force peaks at 2200, but operating staff goes down to 530; this could temporarily strain local schools and other services

Table E.8-2 (cont.) – Impacts Comparison Detail

Proposed Action (License Renewal)	No Action Alternative (Decommissioning)	Natural Gas Combined Cycle	Pulverized Coal	New Nuclear Technologies	Coal Gasification
Cultural Resource Impacts					
SMALL – Cemeteries and archaeological sites would be avoided	SMALL – Cemeteries and archaeological sites would be avoided	SMALL – Archaeological sites and any other areas of cultural interest would be avoided	SMALL – No known potential archaeological sites at proposed location; the historic cemetery will be avoided	SMALL – Archaeological sites will be avoided; no impact on off-site historical area	SMALL – Archaeological sites will be avoided; no impact on off-site historical area
Aesthetic Impacts (including Noise)					
SMALL – Slight increase in visual discord with additional cooling tower capacity	SMALL – Slight temporary increase in visual discord due to de-construction cranes	SMALL to MODERATE– Vegetation barriers retained to partially obscure view of plants and stacks; operational noise may be apparent to nearby residents	SMALL to MODERATE – Stack is 650 feet tall with aircraft warning lights and its plume can be visible for miles; plumes from cooling towers may also be visible for miles	SMALL – No significant changes to appearance of site or sounds from site, although cooling tower plume (water vapor) may be visible for miles	MODERATE – Twelve stacks 325 feet high would be added to site, and two 200 feet high flaring stacks would be visible for 3 miles; cooling towers vapor fog and stack emissions visible for 10 miles; heavy river traffic with 17 barges per day
SMALL – Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. MODERATE – Environmental effects are sufficient to alter noticeably, but not to destabilize, any important attribute of the resource. 10 CFR 51, Subpart A, Appendix B, Table B-1, Footnote 3.					

E.8.2 REFERENCES

Nuclear Regulatory Commission. 1996. The *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS: NUREG-1437).

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E.9.0 STATUS OF COMPLIANCE

This section should present the impacts of the proposed action, the no action alternative, and According to 10 CFR 51.45(d), an applicant must discuss the status of compliance in the ER.

The environmental report shall list all Federal permits, licenses, approvals and other entitlements which must be obtained in connection with the proposed action and shall describe the status of compliance with these requirements. The environmental report shall also include a discussion of the status of compliance with applicable environmental quality standards and requirements including, but not limited to, applicable zoning and land-use regulations, and thermal and other water pollution limitations or requirements which have been imposed by Federal, State, regional, and local agencies having responsibility for environmental protection.

Appendix H of Volume 2 of NUREG-1437[2] summarizes the major Federal statutes that may

E.9.1 INTRODUCTION AND BACKGROUND

The major approval action required to permit operation of the Browns Ferry Nuclear Plant (BFN) units to continue after their current operating licenses expire is for the Nuclear Regulatory Commission (NRC) to issue renewed operating licenses for each unit. The current operating licenses for Units 1, 2, and 3 expire at midnight on December 20, 2013, June 28, 2014, and July 2, 2016, respectively. If the NRC approves Tennessee Valley Authority (TVA)'s license renewal application, each unit's renewed license will permit operation for an additional 20-year period beyond these expiration dates, referred to as "continued operation."

Most of the equipment involved in license renewal and continued operation is already in place, having been completed under the various construction and operation permits applicable during initial plant construction approximately 30 years ago. Other than the operating licenses issued by the NRC, no new permits or approvals are required for the cooling tower capacity additions, the dry cask storage facility, or the new site worker facilities (Administration Building, Modifications Fabrication Building) associated with continued operation at Extended Power Uprate conditions. However, continued operation will require BFN to maintain the following permits:

- Air Permits (for the Emergency Diesel Generators, Auxiliary Boilers, and Fueling Facility (i.e., the site gasoline pumping station),
- Construction/Demolition Waste Landfill Permit, and
- NPDES Permit

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E.9.2 AFFECTED COMPLIANCE, INCLUDING PERMITS AND APPROVALS

E.9.2.1 LICENSE RENEWAL DOCUMENTATION

As delineated in 10 CFR Part 54, there are certain regulatory requirements that must be satisfied in order to obtain a renewed operating license that allows continued operation of a nuclear power plant beyond its original license term, including several documents that must be prepared for submittal to the NRC. The license renewal application contains general information, technical information, information regarding technical specifications, and environmental information, each of which is addressed below. The application must be filed no earlier than 20 years prior to the expiration of the operating license currently in effect.

General information concerns the plant site and the plant owner, TVA. This includes administrative information similar to the information filed with the original application for an operating license. The required information is specified in 10 CFR 50.33 (a) through (e), (h) and (I). The application must also include conforming changes to the standard indemnity agreement, 10 CFR 140.92, Appendix B, to account for the expiration term of the proposed renewed license.

In general, required technical information identifies the systems, structures and components within the scope of license renewal and their intended functions that are the basis for their inclusion. It also provides the basis for concluding that the effects of aging can be managed to maintain safe operation during the renewed license terms. Specifically, this includes: (1) the Integrated Plant Assessment (IPA), which is the demonstration that the effects of aging on long-lived, passive structures and components are being adequately managed such that the intended functions are maintained, consistent with the Current Licensing Basis, in the renewed license period; (2) the listing of Structures and Components subject to Aging Management Review; (3) results of the Aging Management Review; (4) the listing and evaluation of Time-Limited Aging Analyses (TLAAs) and any exemptions and justifications in effect which are based on TLAAs; (5) a supplement to the plant's Final Safety Analysis Report (FSAR), which contains a summary description of the programs and activities that are cited as managing the effects of aging and the evaluation of TLAAs; and (6) changes to the Current Licensing Basis of the plant.

Information regarding Technical Specifications must include any changes or additions to the plant's technical specifications that are necessary to manage the effects of aging during the period of renewed license operation.

Pursuant to the requirements of 10 CFR Part 51, the license renewal application will also contain this Environmental Report. This document contains environmental information required by NRC from TVA and which is used by NRC to compose the site-specific supplement to their Generic Environmental Impact Statement for License Renewal of Nuclear Plants. The information comprising this document will largely be excerpted from TVA's own National Environmental Policy Act (NEPA) review

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E.9.2.2 NPDES PERMIT

In accordance with the Clean Water Act (formerly known as the Federal Water Pollution Control Act), the Alabama Water Pollution Control Act, and the Alabama Environmental Management Act, BFN has a permit (number AL0022080) to discharge various plant effluents into the Tennessee River. This permit, which must be renewed every five years, covers the effluents and discharge points listed in Table E.9-1. The permit specifies discharge limitations and monitoring requirements at each discharge point (Discharge Serial Number). The current permit was issued December 29, 2000, by the Alabama Department of Environmental Management (ADEM); it became effective on February 1, 2001, and will expire January 31, 2006. A copy of the NPDES permit is included in Attachment E-8

Table E.9-1 Discharge Points and Effluents of NPDES Permit

Discharge Point	Effluent
Diffuser Outfall (DSN001)	Condenser Circulating Water, Raw Cooling Water, Turbine Building station sump, Liquid Radwaste System effluent, Intake Building sump
DSN005	Residual heat removal service effluent
DSN012	Intake screen backwash
DSN013	Storm water runoff from the Biothermal Facility
DSN013a	Storm water runoff from switchyard drainage ditch
DSN013a(1)	Treated domestic wastewater, medical lab photo developing waste, blowdown from Training Center chiller system, flush water from the Standby Liquid Control System, flush water from cooler/air compressor cleaning, filtered waste from insulator showers (for personnel involved in periodic asbestos stripping and handling operations), and rainwater
DSN013b	Sedimentation pond discharge
DSN014	Storm water runoff from west perimeter drainage ditch
DSN017	Air conditioner condensate and storm water runoff from Training Center and Live Well Center areas
DSN018	Storm water runoff from Materials and Procurement
DSN024	Storm water from the northeast and east permiters (includes adjacent farmland, vehicle service shop and mechanic shop)
DSN019	Storm water from the east side of plant (includes Fire Training Area, Low Level Radwaste storage facility, inert landfill and Hazardous Waste storage area

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E.9.2.3 AIR QUALITY AND AIR POLLUTION CONTROL PERMITS

TVA's BFN is subject to and complies with the Clean Air Act and subsequent amendments, including the National Ambient Air Quality Standards which the original 1970 Act authorized EPA to establish. Compliance with air quality regulations is discussed in Section E.4.11. There are no non-attainment areas near the BFN site.

BFN has Permits To Operate its three Babcock and Wilcox Auxiliary Boilers (Permit No. 708-0003-Z001) and its eight Emergency Diesel Generators (Permit No. 708-0003-Z002). These permits were jointly issued by the Tri-County District Health Service, Air Pollution Control Program, and the Alabama Air Pollution Control Commission, on October 5, 1978; there is no expiration date.

BFN also has an Air Permit for its Gasoline Dispensing Facility (Permit No. 708-0003-Z003). This permit was issued by the ADEM on August 28, 1995; there is no expiration date.

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E.9.2.4 SOLID WASTE DISPOSAL

BFN has a Construction/Demolition Landfill Permit for its solid waste disposal landfill located on the site (Permit No. 42-02, Facility Location: Northwest quarter of the Northwest quarter of Section 18, Township 4 South, Range 5 West, Limestone County). ADEM issued the current permit on March 17, 2000, with an effective date of May 17, 2000, and an expiration date of May 16, 2005. This permit, which must be renewed every five years, allows BFN to dispose of the following materials in its landfill: "Non-hazardous, non-radioactive solid wastes including scrap lumber, bricks, sandblast grit, crushed metal drums, glass, wiring, non-asbestos insulation, roofing materials, building siding, scrap metal, concrete with reinforcing steel, and similar construction and demolition wastes."

The possibility exists that one or more cooling towers might be refurbished or replaced with larger, more efficient cooling towers, in their approximate present locations. To demolish any of the existing cooling towers, a Notice of Demolition to ADEM would be required and would be initiated by the Environmental staff at BFN. The advance notice requirement is that this written notification must be received by ADEM at least ten days before the work is actually started. Also, for the cooling towers that contain asbestos, the workers that remove the asbestos panels will also have to be trained and certified by the State of Alabama in asbestos regulation compliance.

BFN generates a variety of wastes that are classified as hazardous under the Resource Conservation and Recovery Act (RCRA) of 1976, as amended. All hazardous waste generated at BFN is shipped to TVA's Hazardous Waste Storage Facility in Muscle Shoals, Alabama, which holds a RCRA Part B permit for temporary storage of hazardous wastes. Ultimate disposal is through approved and licensed facilities.

As a generator of both low-level and high-level radioactive wastes, BFN is subject to and complies with provisions and requirements of the Low-Level Radioactive Waste Policy Amendment Act of 1985 and the Nuclear Waste Policy Act of 1982, as subsequently amended, and the Nuclear Waste Policy Act of 1982.

The Toxic Substances Control Act (TSCA) of 1976 regulates polychlorinated biphenyls (PCBs) and asbestos, both of which are present at BFN. TVA and BFN are in compliance with the PCB and asbestos regulations applicable to the facility.

TVA is also subject to the hazardous substance release and reporting provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as subsequently amended. Any release of reportable quantities of listed hazardous substances to the environment requires a report to the National Response Center and subsequent written follow-up.

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E.9.3 NEW PERMITS AND APPROVALS NOT REQUIRED, INDIRECTLY OR NOT APPLICABLE, OR COMPLIANCE UNAFFECTED

E.9.3.1 WATER RESOURCES

Since it is located on the Tennessee River, TVA's BFN is not subject to the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972. And since TVA does not have jurisdiction over any public water system in the vicinity of BFN, and BFN does not engage in underground injections or other actions that could endanger drinking water sources, BFN is not subject to the Safe Drinking Water Act of 1974.

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E.9.3.2 LAND USE

The Farmland Protection Policy Act directs federal agencies to identify and take into account the adverse effects of federal programs on the preservation of farmland. The Act requires that Form AD 1006, "Farmland Conversion Impact Rating," be completed with assistance from the USDA-NRCS if prime farmland is to be permanently converted to nonagricultural use as a result of a proposed federal action.

As a federal agency, TVA is not subject to state or local zoning requirements. Land use impacts were assessed in TVA's NEPA review of Unit 1 recovery activities and proposed license renewal for continued operation for an additional 20 years after the current operating licenses expire. Because the new structures associated with Unit 1 recovery and renewed license operation would be located on previously disturbed soils and the plant site is classified as built-up land, their associated impacts would be insignificant. Therefore, no action relative to the Farmland Protection Policy Act is required.

Since it is located inland on the Tennessee River, TVA's BFN is not subject to the Coastal Zone Management Act of 1972.

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E.9.3.3 WETLANDS

If wetland determinations indicate that "jurisdictional" wetlands would be modified or significantly altered to accommodate development of the proposed project, requisite permits must be obtained from both the U. S. Army Corps of Engineers (USACE) and the Alabama Department of Environmental Management. Wetlands are also subject to Executive Order 11990 (Protection of Wetlands), which was issued to avoid direct or indirect support of new construction on wetlands wherever there is a practicable alternative.

It is unlikely that any activity associated with Unit 1 recovery and continued operation through the renewed license period, including the footprint of either the project facilities or related appurtenances, will affect jurisdictional wetlands. Therefore, no action relative to wetlands statutes or EO 11990 is required.

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E.9.3.4 FLOODPLAINS

Executive Order 11988 (Floodplain Management) requires flood hazard assessments of proposed activities and requires consideration of alternatives for actions that would occur within a floodplain or floodway. TVA has conducted a class review of certain repetitive actions that occur in floodplains. See 46 Fed. Reg. 22845 (1981). The use of measures to minimize floodplains impacts as identified in TVA's 1981 class review would ensure that the floodplains are not adversely impacted by these repetitive actions.

All changes to site facilities associated with Unit 1 recovery and continued operation through the renewed license period would be located above the Probable Maximum Flood. Therefore, no identification of preferable options or determination of "no practicable alternative" per Executive Order (EO) 11988 is required.

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E.9.3.5 BIOLOGICAL

Alabama has a list of protected species that overlap and extend beyond those protected by the federal Endangered Species Act (ESA). Potential impacts on federal- and state-listed species were considered in TVA's NEPA review. In addition, per Section 7 of the ESA, a more structured consultation process with the U. S. Fish and Wildlife Service (USFWS) may be required if a "may affect" situation exists. The Fish and Wildlife Coordination Act also requires that aquatic species be considered in project planning and would be a requirement of the U.S. Army Corps of Engineers and state permitting processes. The USFWS usually combines both consultative processes.

There are no impacts to endangered or threatened species that would result from any actions associated with the alternatives associated with Unit 1 recovery and continued operation through the renewed license period. Therefore, no further reviews by state or federal agencies are required.

TVA is also subject to the Fish and Wildlife Conservation Act of 1980, which involves conservation of non-game fish and wildlife and their habitats. However, no specific action by TVA is required relative to BFN because Unit 1 recovery and continued operation through the renewed license period will have no significant biological impacts.

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E.9.3.6 CULTURAL RESOURCES

All federal agencies are mandated under the National Historic Preservation Act of 1966 (NHPA), the Archaeological and Historic Preservation Act of 1974, and the Archaeological Resources Protection Act (ARPA) of 1979 to protect significant archaeological resources and historic properties located on TVA lands or affected by undertakings. These acts supersede or supplement the Antiquities Act of 1906, the Historic Sites Act of 1935, and the Archaeological Recovery Act of 1960. In response to this federal legislation, TVA conducts surveys to record historic properties. A historic property is "any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places."

BFN has no planned future activities which would affect the potentially eligible archaeological site identified (1Li535). The site has been marked on BFN drawings with appropriate contact information and requirements. As discussed in Section E.4.19, a Phase II archaeological survey will be required if the site cannot be avoided by future BFN activities.

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E.9.3.7 AIR NAVIGATION

Coordination with the Federal Aviation Administration (FAA) is required when it becomes necessary to ensure that the highest structures associated with the project do not impair the safety of aviation. Submission of a letter of notification (with accompanying maps and project description) to the FAA would result in a written response from the FAA certifying that no hazard exists or recommending project changes and/or the installation of warning devices such as lighting.

The BFN site facilities elevation is dominated by the 600-foot high Off-Gas Stack, which has quadrant strobe lights near the top and constant red warning lights mid-way up the stack. No new structures associated with Unit 1 recovery and continued operation through the renewed license period would be as high as or higher than existing structures; therefore, no new notifications to the FAA are required.

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E.9.3.8 NOISE

Noise impacts and mitigation plans were addressed in TVA's NEPA review of recovering Unit 1 and continuing operation through the renewed license period. Although federal regulations apply to only certain pieces of construction equipment, any local regulatory requirements on noise would have to be considered and met. However, no applicable local noise ordinances were identified for Limestone County.

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E.9.3.9 EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW

The proposed plant notification and reporting under the Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 goes into effect when the plant becomes operational rather than as a preconstruction process. Provisions of EPCRA flow down to designated Alabama and local officials and to the managers of the plant itself. Being a federal agency, TVA is not subject to EPCRA; however, as a matter of policy and consistent with EO 12856, TVA complies with EPCRA to the same extent as other utilities.

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E.9.3.10 HEALTH AND SAFETY

The federal Occupational Safety and Health Administration (OSHA) governs the occupational safety and health of the construction workers and the operational staffs. As a federal agency, TVA is not directly subject to regulation from OSHA; however, it must comply with OSHA's substantive requirements, as these are incorporated in its occupational health and safety practices. Contractors would continue to be subject to these substantive requirements.

TVA complies with requirements of the National Electric Safety Code. See the discussion in Section E.4.13.

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ATTACHMENT E-1

Wetlands Determination Data Forms

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Browns Ferry Nuclear Plant Site – SEIS	Date:	23 July 2003
Applicant/Owner:	TVA	County:	Limestone
Investigator:	B. Rosensteel	State:	AL
		Quad:	Jones Crossroads
		Watershed:	Tennessee River

Do normal circumstances exist on the site?	Yes	x	No		Community ID:	PEM/SS1
Is the site significantly disturbed (Atypical Situation)?	Yes		No	x	Transect ID:	W1 (NWI)
Is the area a potential problem area? (If needed, explain on reverse)	Yes		No	x	Plot ID:	W1-Wetland

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
Cephalanthus occidentalis	Shrub	Obl	Lycopus virginicus	Herb	Obl
Sambucus canadensis	Shrub	Facw-	Ludwigia alternifolia	Herb	Obl
Salix nigra	Sapling	Obl	Ludwigia palustris	Herb	Obl
Campsis radicans	Vine	Fac	Eleocharis obtusa	Herb	Obl
Carex lupulina	Herb	Obl	Lobelia cardinalis	Herb	Obl
Diodia virginiana	Herb	Facw	Pluchea camphorata	Herb	Facw
Rynchospora corniculata	Herb	Obl			
Juncus effusus	Herb	Facw+			

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-): 100%

Remarks:

HYDROLOGY

____ Recorded Data (Describe in Remarks):
- ____ Stream, Lake, or Tide Gauge
- ____ Aerial Photographs
- ____ Other

x No Recorded Data Available

Field Observations:

Depth of Surface Water:	0-10+	(in.)
Depth to Free Water in Pit:	10	(in.)
Depth to Saturated Soil:	0	(in.)

Remarks:

Wetland Hydrology Indicators:

Primary Indicators:
- x Inundated
- x Saturated in Upper 12 Inches
- ____ Water Marks
- ____ Drift Lines
- x Sediment Deposits
- x Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ____ Oxidized Root Channels in Upper 12 Inches
- ____ Water-Stained Leaves
- x Local Soil Survey Data
- ____ FAC-Neutral Test
- ____ Other (Explain in Remarks)

SOILS

Map Unit Name (Series and Phase):	Guthrie silt loam	Drainage Class:	Poorly drained
Taxonomy (Subgroup):		Field Observations Confirm Mapped Type?	Yes ____ No ____

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast (%)	Texture, Concretions, Structure, etc.
0-3		2.5YR 4/6	5YR 6/2	30%	Silty clay loam
3-6		2.5YR 4/4			Silty clay loam; Concretions
6-9		2.5YR 4/6	N 7/0	20%	Silty clay loam; Concretions
9-13+		N 7/0	7.5YR 5/6 7.5YR 4/6	20% 5%	Silt loam

Hydric Soil Indicators:

____	Histosol	x	Concretions
____	Histic Epipedon	____	High Organic Content in Surface Layer in Sandy Soils
____	Sulfidic Odor	____	Organic Streaking in Sandy Soils
____	Aquic Moisture Regime	x	Listed on Local Hydric Soils List
____	Reducing Conditions	x	Listed on National Hydric Soils List
x	Gleyed or Low-Chroma Colors	____	Other (Explain in Remarks)

Remarks: Top nine inches appears to be accumulated sediments from agricultural erosion.

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	Yes x No ____	Is this Sampling Point Within a Wetland?	Yes x No ____
Wetland Hydrology Present?	Yes x No ____		
Hydric Soils Present?	Yes x No ____		

Remarks: Estimated acreage = 10.56. This wetland extends from the northern property boundary along a channelized stream which empties into the Tennessee River on the west side of the BFN plant. This wetland area is shown on the NWI map (PEM1Ax, PEM1Ad, and PSS/EM1Ad).

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Browns Ferry Nuclear Plant Site – SEIS	Date:	23 July 2003
Applicant/Owner:	TVA	County:	Limestone
Investigator:	B. Rosensteel	State:	AL
		Quad:	Jones Crossroads
		Watershed:	Tennessee River

Do normal circumstances exist on the site?	Yes	x	No		Community ID:	Woody old field
Is the site significantly disturbed (Atypical Situation)?	Yes		No	x	Transect ID:	W1 (NWI)
Is the area a potential problem area? (If needed, explain on reverse)	Yes		No	x	Plot ID:	W1-Upland

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
Liquidambar styraciflua	Sapling	Fac+			
Celtis occidentalis	Sapling	Fac			
Rhus copallina	Shrub	Not listed (upland)			
Rubus sp. (blackberry)	Vine				
Prunus serotina	Shrub	Facu			
Lonicera japonica	Vine	Fac-			
Plantago lanceolata	Herb	Fac			

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-): 43%

Remarks:

HYDROLOGY

____ Recorded Data (Describe in Remarks):

- ____ Stream, Lake, or Tide Gauge
- ____ Aerial Photographs
- ____ Other

____ No Recorded Data Available

Field Observations:

Depth of Surface Water: ____ (in.)

Depth to Free Water in Pit: ____ (in.)

Depth to Saturated Soil: ____ (in.)

Remarks: No hydrologic indicators present

Wetland Hydrology Indicators:

Primary Indicators:

- ____ Inundated
- ____ Saturated in Upper 12 Inches
- ____ Water Marks
- ____ Drift Lines
- ____ Sediment Deposits
- ____ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):

- ____ Oxidized Root Channels in Upper 12 Inches
- ____ Water-Stained Leaves
- ____ Local Soil Survey Data
- ____ FAC-Neutral Test
- ____ Other (Explain in Remarks)

SOILS

Map Unit Name (Series and Phase):	Lindside silt loam	Drainage Class:	Imperfectly drained
Taxonomy (Subgroup):		Field Observations Confirm Mapped Type?	Yes ____ No ____

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast (%)	Texture, Concretions, Structure, etc.
0-6		5YR 4/4			Silt loam
6-9		7.5YR 4/4	7.5YR 6/2	20%	Silt loam
9-12		7.5YR 5/2	7.5YR 4/6	5%	Silt loam

Hydric Soil Indicators:

____	Histosol	____	Concretions
____	Histic Epipedon	____	High Organic Content in Surface Layer in Sandy Soils
____	Sulfidic Odor	____	Organic Streaking in Sandy Soils
____	Aquic Moisture Regime	____	Listed on Local Hydric Soils List
____	Reducing Conditions	____	Listed on National Hydric Soils List
____	Gleyed or Low-Chroma Colors	____	Other (Explain in Remarks)

Remarks: Sampling point is within 40 feet of wetland boundary. This area has been altered in the past for agriculture with the stream being channelized, perhaps leaving this area drier than prior to channelization.

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	Yes	____	No	x	Is this Sampling Point Within a Wetland?	Yes ____ No x
Wetland Hydrology Present?	Yes	____	No	x		
Hydric Soils Present?	Yes	____	No	x		

Remarks:

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Browns Ferry Nuclear Plant Site – SEIS	Date:	23 July 2003
Applicant/Owner:	TVA	County:	Limestone
Investigator:	B. Rosensteel	State:	AL
		Quad:	Jones Crossroads
		Watershed:	Tennessee River

Do normal circumstances exist on the site?	Yes	x	No		Community ID:	PEM1
Is the site significantly disturbed (Atypical Situation)?	Yes		No	x	Transect ID:	W2
Is the area a potential problem area? (If needed, explain on reverse)	Yes		No	x	Plot ID:	W2-Wetland

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
Liquidambar styraciflua	Sapling	Fac+	Juncus effusus	Herb	Facw+
Polygonum hydropiperoides	Herb	Obl	Carex vulpinoidea	Herb	Obl
Galium tinctorium	Herb	Facw	Carex lupulina	Herb	Obl
Conium maculatum	Herb	Facw	Carex lurida	Herb	Obl
Eleocharis obtusa	Herb	Obl	Campsis radicans	Vine	Fac
Juncus brachycarpus	Herb	Facw	Eupatorium perfoliatum	Herb	Obl
Eupatorium serotinum	Herb	Fac	Salix nigra	Shrub	Obl
Sambucus canadensis	Shrub	Facw-			

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-): 100%

Remarks:

HYDROLOGY

___ Recorded Data (Describe in Remarks):
- ___ Stream, Lake, or Tide Gauge
- ___ Aerial Photographs
- ___ Other

___ No Recorded Data Available

Field Observations:

Depth of Surface Water:	0-4+	(in.)
Depth to Free Water in Pit:	-	(in.)
Depth to Saturated Soil:	-	(in.)

Remarks: This form describes two short, parallel, swales that are agricultural field drains ending in the middle of a shrubby transmission line right-of-way. Neither appear to have surface drainage beyond that point.

Wetland Hydrology Indicators:

Primary Indicators:
- ___ Inundated
- x Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- x Sediment Deposits
- x Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ___ Oxidized Root Channels in Upper 12 Inches
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

SOILS

Map Unit Name (Series and Phase):	Lindside silt loam	Drainage Class:	Imperfectly drained
Taxonomy (Subgroup):		Field Observations Confirm Mapped Type?	Yes ____ No ____

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast (%)	Texture, Concretions, Structure, etc.
1-4		2.5YR 4/6	5YR 6/3	20%	Silt loam
4-12		N 6/0	10YR 5/6 7.5YR 4/4	15% 15%	Silty clay loam

Hydric Soil Indicators:

____	Histosol	____	Concretions
____	Histic Epipedon	____	High Organic Content in Surface Layer in Sandy Soils
____	Sulfidic Odor	____	Organic Streaking in Sandy Soils
____	Aquic Moisture Regime	____	Listed on Local Hydric Soils List
____	Reducing Conditions	____	Listed on National Hydric Soils List
x	Gleyed or Low-Chroma Colors	____	Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	Yes x	No ____	Is this Sampling Point Within a Wetland?	Yes x No ____
Wetland Hydrology Present?	Yes x	No ____		
Hydric Soils Present?	Yes x	No ____		

Remarks: Approximate acreage = 0.25 acres.
This wetland, which includes an identical adjacent swale, is a field drainage swale. They begin at the edge of a row-crop field and end in the middle of the transmission line right-of-way. Aerial photographs indicate that these swales may once have continued across the right-of-way to empty into the wetland W1 stream, but there is no indication of this on the ground. The Limstone County soil survey (1953) indicates a stream in this vicinity that used to drain to the wetland W1 stream. No evidence of this stream remains. Not on NWI.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Browns Ferry Nuclear Plant Site – SEIS	Date:	23 July 2003
Applicant/Owner:	TVA	County:	Limestone
Investigator:	B. Rosensteel	State:	AL
		Quad:	Jones Crossroads
		Watershed:	Tennessee River

Do normal circumstances exist on the site?	Yes	x	No		Community ID:	Upland field
Is the site significantly disturbed (Atypical Situation)?	Yes		No	x	Transect ID:	W2
Is the area a potential problem area? (If needed, explain on reverse)	Yes		No	x	Plot ID:	W2 – Upland

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
Rubus sp. (blackberry)	Vine				
Lonicera japonica	Vine	Fac-			
Solidago canadensis	Herb	Facu			
Lactuca canadensis	Herb	Facu-			
Lespedeza cuneata	Herb	Facu			
Dicanthelium sp.	Herb				

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-): 0

Remarks:

HYDROLOGY

____ Recorded Data (Describe in Remarks):
- ____ Stream, Lake, or Tide Gauge
- ____ Aerial Photographs
- ____ Other

____ No Recorded Data Available

Field Observations:
- Depth of Surface Water: ____ (in.)
- Depth to Free Water in Pit: ____ (in.)
- Depth to Saturated Soil: ____ (in.)

Remarks: No hydrologic indicators present

Wetland Hydrology Indicators:

Primary Indicators:
- ____ Inundated
- ____ Saturated in Upper 12 Inches
- ____ Water Marks
- ____ Drift Lines
- ____ Sediment Deposits
- ____ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ____ Oxidized Root Channels in Upper 12 Inches
- ____ Water-Stained Leaves
- ____ Local Soil Survey Data
- ____ FAC-Neutral Test
- ____ Other (Explain in Remarks)

SOILS

Map Unit Name (Series and Phase):	Lindside silt loam	Drainage Class:	Imperfectly drained
Taxonomy (Subgroup):		Field Observations Confirm Mapped Type?	Yes ____ No ____

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast (%)	Texture, Concretions, Structure, etc.
0-10		5YR 4/4			Silt loam
10-12		N 6/0	10YR 5/6 7.5YR 4/4	5% 5%	Silty clay loam; Concretions; Relict oxidized rhizospheres

Hydric Soil Indicators:

____	Histosol	____	Concretions
____	Histic Epipedon	____	High Organic Content in Surface Layer in Sandy Soils
____	Sulfidic Odor	____	Organic Streaking in Sandy Soils
____	Aquic Moisture Regime	____	Listed on Local Hydric Soils List
____	Reducing Conditions	____	Listed on National Hydric Soils List
____	Gleyed or Low-Chroma Colors	____	Other (Explain in Remarks)

Remarks: Soil appears to have been altered to excavate the field drains. Sampling point is just outside of the field drain that contains wetland W2.

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	Yes	____	No	x	Is this Sampling Point Within a Wetland?	Yes ____ No x
Wetland Hydrology Present?	Yes	____	No	x		
Hydric Soils Present?	Yes	____	No	x		

Remarks:

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Browns Ferry Nuclear Plant – SEIS	Date:	23 July 2003
Applicant/Owner:	TVA	County:	Limestone
Investigator:	B. Rosensteel	State:	AL
		Quad:	Jones Crossroads
		Watershed:	Tennessee

Do normal circumstances exist on the site?	Yes	x	No		Community ID:	PEM1
Is the site significantly disturbed (Atypical Situation)?	Yes		No	x	Transect ID:	W3 (NWI)
Is the area a potential problem area? (If needed, explain on reverse)	Yes		No	x	Plot ID:	W3-Wetland

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
Cephalanthus occidentalis	Shrub	Obl	Juncus effusus	Herb	Facw+
Polygonum hydropiperoides	Herb	Obl	Penthorum sedoides	Herb	Obl
Carex lupulina	Herb	Obl			
Galium tinctorium	Herb	Facw			
Juncus effusus	Herb	Facw+			
Juncus marginatus	Herb	Facw			
Diodia virginiana	Herb	Facw			
Carex vulpinoidea	Herb	Obl			

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-): 100%

Remarks:

HYDROLOGY

___ Recorded Data (Describe in Remarks):	
___ Stream, Lake, or Tide Gauge	
___ Aerial Photographs	
___ Other	
x No Recorded Data Available	

Field Observations:

Depth of Surface Water:	0-8+	(in.)
Depth to Free Water in Pit:	10	(in.)
Depth to Saturated Soil:	0	(in.)

Remarks:

Wetland Hydrology Indicators:

Primary Indicators:

- x Inundated
- x Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- ___ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):

- x Oxidized Root Channels in Upper 12 Inches
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

SOILS

Map Unit Name (Series and Phase):	Cumberland clay loam, eroded, undulating phase	Drainage Class:	Good internal and external drainage
Taxonomy (Subgroup):		Field Observations Confirm Mapped Type?	Yes ___ No x

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast (%)	Texture, Concretions, Structure, etc.
0-3		7.5YR 6/2	5YR 4/6	10%	Silt loam
3-10		7.5YR 6/1	7.5YR 4/4	20%	Silt loam; Concretions

Hydric Soil Indicators:

___	Histosol	x	Concretions
___	Histic Epipedon	___	High Organic Content in Surface Layer in Sandy Soils
___	Sulfidic Odor	___	Organic Streaking in Sandy Soils
___	Aquic Moisture Regime	___	Listed on Local Hydric Soils List
___	Reducing Conditions	___	Listed on National Hydric Soils List
x	Gleyed or Low-Chroma Colors	___	Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	Yes x	No ___	Is this Sampling Point Within a Wetland?	Yes x	No ___
Wetland Hydrology Present?	Yes x	No ___			
Hydric Soils Present?	Yes x	No ___			

Remarks: Approximate acreage = 0.85 acres. Shown on NWI as PEM1Ax.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Browns Ferry Nuclear Plant – SEIS	Date:	23 July 2003
Applicant/Owner:	TVA	County:	Limestone
Investigator:	B. Rosensteel	State:	AL
		Quad:	Jones Crossroads
		Watershed:	Tennessee

Do normal circumstances exist on the site?	Yes	x	No		Community ID:	Herbaceous old field
Is the site significantly disturbed (Atypical Situation)?	Yes		No	x	Transect ID:	W3 (NWI)
Is the area a potential problem area? (If needed, explain on reverse)	Yes		No	x	Plot ID:	W3-Upland

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
Lespedeza cuneata	Herb	Upl			
Sorghum halapense	Herb	Not listed (upland)			
Dactylis glomerata	Herb	Facu			
Festuca arundinaceae	Herb	Fac-			
Daucus carota	Herb	Not listed (upland)			
Trifolium pratense	Herb	Facu-			
Lonicera japonica	Vine	Fac-			
Campsis radicans	Vine	Fac			

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-): 12%

Remarks:

HYDROLOGY

____ Recorded Data (Describe in Remarks):
- ____ Stream, Lake, or Tide Gauge
- ____ Aerial Photographs
- ____ Other

____ No Recorded Data Available

Field Observations:
- Depth of Surface Water: ____ (in.)
- Depth to Free Water in Pit: ____ (in.)
- Depth to Saturated Soil: ____ (in.)

Remarks: No hydrologic indicators present

Wetland Hydrology Indicators:

Primary Indicators:
- ____ Inundated
- ____ Saturated in Upper 12 Inches
- ____ Water Marks
- ____ Drift Lines
- ____ Sediment Deposits
- ____ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ____ Oxidized Root Channels in Upper 12 Inches
- ____ Water-Stained Leaves
- ____ Local Soil Survey Data
- ____ FAC-Neutral Test
- ____ Other (Explain in Remarks)

SOILS

Map Unit Name (Series and Phase):	Cumberland clay loam, eroded undulating phase	Drainage Class:	Good internal and external drainage
Taxonomy (Subgroup):		Field Observations Confirm Mapped Type?	Yes ____ No x

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast (%)	Texture, Concretions, Structure, etc.
0-6		7.5YR 4/3			Silt loam
6-8		10YR 6/3	7.5YR 4/6	10%	Silt loam; Concretions
8-10		10YR 6/3	7.5YR 4/6 10YR 6/2	5% 10%	Silt loam; Concretions

Hydric Soil Indicators:

____ Histosol
____ Histic Epipedon
____ Sulfidic Odor
____ Aquic Moisture Regime
____ Reducing Conditions
____ Gleyed or Low-Chroma Colors

____ Concretions
____ High Organic Content in Surface Layer in Sandy Soils
____ Organic Streaking in Sandy Soils
____ Listed on Local Hydric Soils List
____ Listed on National Hydric Soils List
____ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	Yes ____	No x
Wetland Hydrology Present?	Yes ____	No x
Hydric Soils Present?	Yes ____	No x

Is this Sampling Point Within a Wetland? Yes ____ No x

Remarks:

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Browns Ferry Nuclear Plant – SEIS	Date:	23 July 2003
Applicant/Owner:	TVA	County:	Limestone
Investigator:	B. Rosensteel	State:	AL
		Quad:	Jones Crossroads
		Watershed:	Tennessee River

Do normal circumstances exist on the site?	Yes	x	No		Community ID:	Riparian hardwood forest
Is the site significantly disturbed (Atypical Situation)?	Yes		No	x	Transect ID:	NWI-1
Is the area a potential problem area? (If needed, explain on reverse)	Yes		No	x	Plot ID:	NWI-1

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
Platanus occidentalis	Canopy	Facw-	Parthenocissus quinquefolia	Vine	Fac
Liquidambar styraciflua	Sapling	Fac+	Microstegium vimineum	Herb	Fac-
Prunus serotina	Sapling	Facu	Sassafras albidum	Sapling	Facu
Acer negundo	Sapling	Facw	Impatiens capensis	Herb	Facw
Morus rubra	Canopy/Sapling	Fac	Polygonum virginiana	Herb	Fac
Carya sp.	Sapling		Lonicera japonica	Vine	Fac-
Ligustrum sinense	Shrub	Fac	Vitis rotundifolia	Vine	Fac
Aesculus pavia	Shrub	Fac	Toxicodendron radicans	Vine	Fac

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-): 69%

Remarks:

HYDROLOGY

___ Recorded Data (Describe in Remarks):
- ___ Stream, Lake, or Tide Gauge
- ___ Aerial Photographs
- ___ Other

x No Recorded Data Available

Field Observations:
- Depth of Surface Water: ___ (in.)
- Depth to Free Water in Pit: ___ (in.)
- Depth to Saturated Soil: ___ (in.)

Remarks: No hydrologic indicators present

Wetland Hydrology Indicators:

Primary Indicators:
- ___ Inundated
- ___ Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- ___ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ___ Oxidized Root Channels in Upper 12 Inches
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

SOILS

Map Unit Name (Series and Phase):	Cumberland clay loam, eroded undulating phase	Drainage Class:	Good internal and external drainage
Taxonomy (Subgroup):		Field Observations Confirm Mapped Type?	Yes ____ No x

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast (%)	Texture, Concretions, Structure, etc.
0-4		10YR 3/3			Silt loam
4-10		10YR 4/4			Silt loam

Hydric Soil Indicators:

____ Histosol	____ Concretions
____ Histic Epipedon	____ High Organic Content in Surface Layer in Sandy Soils
____ Sulfidic Odor	____ Organic Streaking in Sandy Soils
____ Aquic Moisture Regime	____ Listed on Local Hydric Soils List
____ Reducing Conditions	____ Listed on National Hydric Soils List
____ Gleyed or Low-Chroma Colors	____ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	Yes x	No ____	Is this Sampling Point Within a Wetland? Yes ____ No x
Wetland Hydrology Present?	Yes ____	No x	
Hydric Soils Present?	Yes ____	No x	

Remarks: The National Wetland Inventory data indicates forested wetlands (PFO1A and PF01/4A) on the south and north sides, respectively, of a stream in the southeast corner of the Browns Ferry site. The stream flows into a small Tennessee River embayment. The data indicates that the area is not a federal jurisdictional wetland. Wetland W3, which is an emergent wetland, is associated with this same stream, in an old field upstream.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Browns Ferry Nuclear Plant – SEIS	Date:	23 July 2003
Applicant/Owner:	TVA	County:	Limestone
Investigator:	B. Rosensteel, K. Cole	State:	AL
		Quad:	Jones Crossroads
		Watershed:	Tennessee River

Do normal circumstances exist on the site?	Yes	x	No		Community ID:	Riparian hardwood forest
Is the site significantly disturbed (Atypical Situation)?	Yes		No	x	Transect ID:	
Is the area a potential problem area? (If needed, explain on reverse)	Yes		No	x	Plot ID:	NWI-2

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
Platanus occidentalis	Canopy	Facw-			
Liriodendron tulipifera	Canopy	Facu			
Quercus velutina	Canopy	Upl			
Celtis occidentalis	Canopy	Fac			
Sassafras albidum	Sapling	Facu			
Vitis rotundifolia	Vine	Fac			
Toxicodendron radicans	Vine	Fac-			

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-): 43%

Remarks:

HYDROLOGY

Recorded Data (Describe in Remarks):
- ___ Stream, Lake, or Tide Gauge
- ___ Aerial Photographs
- ___ Other

x No Recorded Data Available

Field Observations:

Depth of Surface Water: ___ (in.)

Depth to Free Water in Pit: ___ (in.)

Depth to Saturated Soil: ___ (in.)

Remarks:

Wetland Hydrology Indicators:

Primary Indicators:
- ___ Inundated
- ___ Saturated in Upper 12 Inches
- ___ Water Marks
- x Drift Lines (Wrack)
- x Sediment Deposits
- x Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ___ Oxidized Root Channels in Upper 12 Inches
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

SOILS

Map Unit Name (Series and Phase):	Melvin silt loam	Drainage Class:	Poorly drained
Taxonomy (Subgroup):		Field Observations Confirm Mapped Type?	Yes ____ No x

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast (%)	Texture, Concretions, Structure, etc.
0-10		7.5YR 4/4			Silt loam

Hydric Soil Indicators:

____	Histosol	____	Concretions
____	Histic Epipedon	____	High Organic Content in Surface Layer in Sandy Soils
____	Sulfidic Odor	____	Organic Streaking in Sandy Soils
____	Aquic Moisture Regime	____	Listed on Local Hydric Soils List
____	Reducing Conditions	____	Listed on National Hydric Soils List
____	Gleyed or Low-Chroma Colors	____	Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	Yes	____	No	x	Is this Sampling Point Within a Wetland?	Yes ____	No	x
Wetland Hydrology Present?	Yes	x	No	____				
Hydric Soils Present?	Yes	____	No	x				

Remarks: The National Wetland Inventory data indicates a forested wetland (PFO1A) in the Douglas Branch riparian zone. The data indicate that this area is not a federal jurisdictional wetland. Douglas Branch is steeply incised in this area.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	Browns Ferry Nuclear Plant – SEIS	Date:	23 July 2003
Applicant/Owner:	TVA	County:	Limestone
Investigator:	B. Rosensteel, K. Cole	State:	AL
		Quad:	Jones Crossroads
		Watershed:	Tennessee River

	Yes	No		
Do normal circumstances exist on the site?	x		Community ID:	Drainage swale
Is the site significantly disturbed (Atypical Situation)?		x	Transect ID:	
Is the area a potential problem area? (If needed, explain on reverse)		x	Plot ID:	NWI-3

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
Festuca arundinacea	Herb	Fac-			
Campsis radicans	Vine	Fac			
Ipomea pandurata	Vine	Not listed (upland)			

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-): <50%

Remarks: The documentation point was in a swale-like drainage channel that crosses a periodically maintained open field. Only species in the swale were listed. These species were also in the adjacent upland field. This area was identified on the NWI as PEM1Ax.

HYDROLOGY

___ Recorded Data (Describe in Remarks):
- ___ Stream, Lake, or Tide Gauge
- ___ Aerial Photographs
- ___ Other

x No Recorded Data Available

Field Observations:

Depth of Surface Water:	0-4	(in.)
Depth to Free Water in Pit:	-	(in.)
Depth to Saturated Soil:	-	(in.)

Remarks: Wet-weather conveyance that drains to the southeast. There was standing water in one part of the conveyance, due all or in part to heavy rainfall on the preceding day. There was no flowing water. The 1953 Limestone County soil survey indicates that the stream where wetland W1 is located previously flowed through here. That stream was apparently re-routed to the west of the plant, apparently leaving a remnant drainage that now functions as a wet-weather conveyance.

Wetland Hydrology Indicators:

Primary Indicators:
- ___ Inundated
- x Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- ___ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ___ Oxidized Root Channels in Upper 12 Inches
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

SOILS

Map Unit Name (Series and Phase):	Ooltewah silt loam	Drainage Class:	Slow surface and internal drainage
Taxonomy (Subgroup):		Field Observations Confirm Mapped Type?	Yes ____ No ____

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast (%)	Texture, Concretions, Structure, etc.
0-10		7.5YR 4/4			Silt loam; Concretions

Hydric Soil Indicators:

____	Histosol	x	Concretions
____	Histic Epipedon	____	High Organic Content in Surface Layer in Sandy Soils
____	Sulfidic Odor	____	Organic Streaking in Sandy Soils
____	Aquic Moisture Regime	____	Listed on Local Hydric Soils List
____	Reducing Conditions	____	Listed on National Hydric Soils List
____	Gleyed or Low-Chroma Colors	____	Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

	Yes	No
Hydrophytic Vegetation Present?		x
Wetland Hydrology Present?	x	
Hydric Soils Present?		x

Is this Sampling Point Within a Wetland? Yes ____ No x

Remarks: This is a wet-weather conveyance that, according to the 1953 Limestone County soil survey, may have previously been the course for a stream that has been diverted to the west side of the plant at an upstream location. There was no flowing water, and the water present in the southern end of the swale was most likely from recent heavy precipitation and runoff. The swale is in a routinely mowed upland field dominated by grasses. This area is identified on the on the NWI as PEM1Ax.

ATTACHMENT E-2

Correspondences with Other Agencies

Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402-2801

September 17, 2003

Mr. J. P. Lofgren, M.D.
Division of Epidemiology
Alabama Department of Public Health
201 Monroe Street,
RSA Tower
Montgomery, AL 36104

Dear Dr. Lofgren:

BROWNS FERRY NUCLEAR PLANT (BFN) LICENSE RENEWAL ENVIRONMENTAL REPORT - REQUEST FOR RESPONSE REGARDING THERMOPHILIC MICROORGANISMS

The Tennessee Valley Authority (TVA) is currently preparing an application to the U.S. Nuclear Regulatory Commission (NRC) for renewal of the operating licenses for BFN Units 1, 2, and 3 located on Wheeler Reservoir near Athens, Alabama.

NRC guidance regarding the license renewal process directs applicants to consult with the state agency responsible for environmental health regarding concerns about the potential existence and concentration of *Naegleria fowleri* in the receiving waters for plant cooling water discharge.

BFN has National Pollutant Discharge Elimination System (NPDES) Permit No. AL0022080, issued by the Alabama Department of Environmental Management, which limits the temperature of the heated effluent to 90°F on a 24-hour average at the downstream end of a 2400 foot mixing zone. TVA understands that temperatures below 91.4°F (33°C) are generally not favorable to the growth of thermophilic microorganisms such as *Naeglaria fowleri*. TVA does not anticipate any operational changes during the license renewal term that would impact our ability to comply with the existing permit limitations.

Please detail any experience or concerns ADPH may have regarding *Naegleria fowleri* or other thermophilic microorganisms in the vicinity of BFN. TVA will include a copy of this letter and your response in the Environmental Report that will be submitted to the NRC as part of the BFN license renewal application.

Should you have any questions concerning this matter, please contact Chuck Wilson at (423) 751-6153.

Sincerely,

Mark Burzynski

Mark Burzynski
Manager
Nuclear Licensing

TVA

Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402-2801

October 2, 2003

Ms. Sheri M. Festoso
Industrial Section, Water Division
Alabama Dept. of Environmental Management
1400 Coliseum Boulevard
Montgomery, Alabama 36110

Dear Ms. Festoso:

BROWNS FERRY NUCLEAR PLANT (BFN) LICENSE RENEWAL ENVIRONMENTAL REPORT – REQUEST FOR RESPONSE REGARDING RIPARIAN ECOLOGICAL COMMUNITIES

The Tennessee Valley Authority (TVA) is currently preparing an application to the U.S. Nuclear Regulatory Commission (NRC) for renewal of the operating licenses for BFN Units 1, 2, and 3 located on Wheeler Reservoir near Athens, Alabama.

As discussed in the September 30, 2003 meeting with TVA to update ADEM on BFN issues, NRC guidance regarding the content of the Environmental Report for license renewal directs applicants to consult with the responsible state agency or agencies regarding the potential for consumptive water use effects on stream-related habitat and ecological communities.

As reported to ADEM in the monthly Discharge Monitoring Report and to the Alabama Department of Economic and Community Affairs in the Annual Certificate of Use Report, BFN withdraws water for various uses (mainly condenser cooling) from Wheeler Reservoir. Except for evaporative and drift losses during cooling tower operation (typically from late July to mid-August) which can approach 2% of the total intake flow, almost all (>99.9%) of the intake water is returned to the river. It should also be noted that there is no consumptive ground water usage at the BFN site. For these reasons, TVA does not expect BFN to have any significant impact on the riparian ecological communities of Wheeler Reservoir.

Please communicate to TVA any experience or concerns (or lack thereof) which the State of Alabama may have regarding the effects of consumptive water use at BFN and its effects on stream-related habitat and riparian ecological communities. TVA will include a copy of this letter and your response in the Environmental Report which will be submitted to the NRC as part of the BFN license renewal application. To help us maintain our schedule for submitting this information to the NRC, we would appreciate a response by October 17, 2003.

If you have any questions concerning this matter, please contact me at (423) 751-6153 or Jack Brellenthin at (423) 751-7270.

Sincerely,

C L Wilson

Chuck L. Wilson
Environmental Licensing Engineer
Nuclear Licensing

STATE OF ALABAMA DEPARTMENT OF
PUBLIC HEALTH

Donald E. Williamson, MD
State Health Officer

November 4, 2003

Mark Burzynski
Manager, Nuclear Licensing
Tennessee Valley Authority
1101 Market Street
Chattanooga, TN 37402-2801

Dear Mr. Burzynski:

Subject: Whether discharge waters from the Browns Ferry Nuclear Plant increase the risk of human disease from thermophilic microorganisms

Both *Naeglaria fowleri* and *Legionella* can cause illness in humans and multiply better in warm water. *N. fowleri* is a free-living ameba that inhabits freshwater ponds, lakes, rivers and hot springs throughout the world. It causes human disease when amebae-contaminated water incidentally enters the nose during swimming or other aquatic activity and amebae migrate to the brain through the olfactory nerve. Approximately 2 such cases occur each year in the United States. *Legionnella* are found throughout the world in water and soil. To cause human illness, the water containing *Legionella* must be made into a mist. In outbreaks, the sources of the organism have been hot water systems (showers), air conditioning cooling towers, evaporative condensers, humidifiers, whirlpool spas, respiratory therapy devices and decorative fountains.

The Alabama Department of Health is not aware of any illness or problems from thermophilic microorganisms associated with the discharge waters from the Browns Ferry Nuclear Plant. Nor are we aware of illness from thermophilic microorganisms related to nuclear plants in other states. Although warm discharge waters could theoretically increase the likelihood of illness, I believe the risk is negligible.

This letter may be used by the TVA as part of its license renewal package for the Browns Ferry Nuclear Plant.

Sincerely,

J.P. Lofgren M.D.

J. P. Lofgren, M.D.
Medical Epidemiologist
Division of Epidemiology
Alabama Department of Public Health

The RSA Tower • 201 Monroe Street • Montgomery, AL 36104
P.O. Box 303017 • Montgomery, AL 36130-3017

ADEM

ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

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Land: 279-3050
Water: 279-3051
Groundwater: 270-5631
Field Operations: 272-8131
Laboratory: 277-6718
Mining: 394-4326
Education/Outreach: 394-4383

November 4, 2003

CHUCK L WILSON
ENVIRONMENTAL LICENSING ENGINEER
TVA
1101 MARKET STREET
CHATTNOOGA TN 37402-2801

RE: Request for response regarding riparian ecological communities

Dear Mr. Wilson:

The Department has reviewed your October 2, 2003, letter concerning the effects of consumptive water use at TVA Browns Ferry Nuclear Plant (NPDES Permit AL 0022080) and its effects on stream-related habitat and riparian ecological communities.

The Department does not have any concerns to convey at this time relating to TVA Browns Ferry Nuclear Plants' consumptive water use.

If you have any additional questions, please do not hesitate to contact me at (334) 271-7945.

Sincerely,

Sheri M. Festoso

Sheri M. Festoso
Industrial Section
Water Division

Birmingham Branch
110 Vulcan Road
Birmingham, Alabama 35209-4702
(205) 942-6168
(205) 941-1603 [Fax]

Decatur Branch
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(256) 340-9359 [Fax]

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OFFICE OF THE GOVERNOR

BOB RILEY
GOVERNOR

STATE OF ALABAMA

ALABAMA DEPARTMENT OF ECONOMIC AND COMMUNITY AFFAIRS

JOHN D. HARRISON
DIRECTOR

November 4, 2003

Mr. Chuck L. Wilson
Environmental Licensing Engineer
Nuclear Licensing
TVA
1101 Market Street
Chattanooga, Tennessee 37402-2801

RE: Browns Ferry Relicensing

Dear Mr. Wilson:

Last week, we received a copy of the attached letter with a request for any statement regarding the renewal of the operating license for Browns Ferry Nuclear Plant.

Currently the Browns Ferry Nuclear Plant has a Certificate of Use (#1058) issued by our office that will expire in January 1, 2006. Under the requirements of that Certificate, TVA is required to annually report the water withdrawals and discharges made at the plant.

Based on the relatively low consumption rate of the water used by the plant (annually less than one percent of the water withdrawn), we do not foresee a significant impact on the riparian hydrology associated with the operation of the plant.

If you have questions or need assistance regarding this request, please feel free to call Tom Littlepage at (334) 242-5697 or e-mail him at toml@adeca.state.al.us.

Respectfully Yours,

Onis "Trey" Glenn, III, Division Director
Office of Water Resources

Enclosures:
E-mail from Chuck Wilson, October 27, 2003
TVA Letter, Dated October 2, 2003

401 ADAMS AVENUE • SUITE 580 • P.O. BOX 5690 • MONTGOMERY, ALABAMA 36103-5690 • (334) 242-5100

ATTACHMENT E-3

Browns Ferry Nuclear Plant
License Renewal Environmental Report
Transmission Line Study

BROWNS FERRY NUCLEAR PLANT
LICENSE RENEWAL ENVIRONMENTAL REPORT
TRANSMISSION LINE STUDY

SCOPE

This report addresses the 500-kV and 161-kV transmission lines constructed to connect TVA's Browns Ferry Nuclear Plant (Browns Ferry) to TVA's power system and compliance with the vertical clearance provisions of the current 2002 Edition of the National Electrical Safety Code (NESC).

TRANSMISSION LINES

In 1968, TVA opened the Madison – West Point 500-kV Transmission Line and looped it into Browns Ferry, creating the Browns Ferry – Madison 500-kV Transmission Line No. 1 and the Browns Ferry – West Point 500-kV Transmission Line. This report considers (a) the 1.14-mile section of line connecting Browns Ferry to the Madison leg of the opened Madison – West Point circuit and (b) the 1.07-mile section of line connecting Browns Ferry to the West Point leg of the opened Madison – West Point circuit. The remaining sections of both transmission lines were originally constructed, not to connect Browns Ferry to the 500-kV transmission system, but to connect together the Madison and West Point substations.

In 1968, TVA opened the Madison – Maury 500-kV Transmission Line and looped it into Browns Ferry, creating the Browns Ferry – Madison 500-kV Transmission Line No. 2 and the Browns Ferry – Maury 500-kV Transmission Line. In 1995, TVA opened the Browns Ferry – Madison 500-kV Transmission Line No. 2 and looped it into Limestone Substation, creating the Browns Ferry – Limestone 500-kV Transmission Line and the Limestone – Madison 500-kV Transmission Line. This report considers (a) the entire length of the 16.56-mile Browns Ferry – Limestone 500-kV Transmission Line, (b) the 6.61-mile section of line connecting Limestone to the Madison leg of the opened Madison – Maury circuit and (c) the 23.11-mile section of line connecting Browns Ferry to the Maury leg of the opened Madison – Maury 500-kV circuit. The remaining sections of both transmission lines were originally constructed, not to connect Browns Ferry to the 500-kV transmission system, but to connect together the Madison and Maury substations.

In 1968, TVA constructed the Browns Ferry – Trinity 500-kV Transmission Line No. 1 and the Browns Ferry – Trinity 500-kV Transmission Line No. 2, both connecting Browns Ferry to the 500-kV transmission system at Trinity Substation. In 1996, TVA opened the Trinity No. 2 line and looped it into Trico Steel Company, creating the Browns Ferry – Trico 500-kV Transmission Line and the Trico – Trinity 500-kV Transmission Line. This report considers (a) the 10.66-mile length of the Browns Ferry – Trinity 500-kV Transmission Line No. 1, (b) the 8.34-mile length of the Browns Ferry – Trico 500-kV Transmission Line, and (c) the 2.74-mile length of the Trico – Trinity 500-kV Transmission Line.

In 1968, TVA completed construction of the Browns Ferry – Athens and Trinity – Browns Ferry 161-kV transmission lines. This report considers (a) the 14.32-mile length of the Browns Ferry – Athens 161-kV Transmission Line and (b) the 10.94-mile length of the Trinity – Browns Ferry 161-kV Transmission Line.

In 1980, TVA and its contractor constructed the Browns Ferry – Union 500-kV Transmission Line, connecting Browns Ferry to the 500-kV transmission system at Union Substation. This report considers the 109.88-mile length of the transmission line.

NESC CLEARANCE REQUIREMENTS

The 2002 Edition of the NESC provides that for transmission lines crossing over roads, streets, driveways, parking lots, alleys, other areas subject to truck traffic, and other land traversed by vehicles, such as cultivated, grazing, forest, orchard, etc., the vertical clearance of conductors above ground and roadway surfaces shall not be less than 28.4 feet for 500-kV phase conductors and 21.1 feet for 161-kV phase conductors, with the conductor sagged to its greatest anticipated value. The NESC allows a reduction for 500-kV circuits with known switching surge factors, and application of this provision allows TVA to reduce the required NESC clearance from 28.4 feet to 26.8 feet. The NESC further provides that these clearances shall be maintained with the conductor at that temperature and under those loading conditions which produce the greatest sag.

The NESC also provides that for 500-kV circuits, the vertical clearance shall be increased or the electric field, or the effects thereof, shall be reduced by other means as required to limit the steady-state current due to electrostatic effects to 5 mA_{rms} if the largest anticipated truck, vehicle, or equipment under the line were short-circuited to ground. For these clearances, the conductor shall be at final unloaded sag and at a conductor temperature of 50^{o}C (120^{o}F).

TVA DESIGN CLEARANCES

The Browns Ferry – Madison No.1, Limestone – Madison, Browns Ferry – West Point, Browns Ferry – Maury, Browns Ferry – Trinity No. 1, Browns Ferry – Trico, and Trico – Trinity 500-kV transmission lines were designed to provide 35 feet of vertical clearance above ground with the phase conductors at a temperature of 120^{o}F. The Browns Ferry – Limestone 500-kV Transmission Line was originally designed to provide 35 feet of clearance at 120^{o}F, but was retensioned in mid-2003 to provide 30 feet of clearance at a conductor temperature of 212^{o}F. The Browns Ferry – Union 500-kV Transmission Line was designed to provide 30 feet of clearance at a conductor temperature of 212^{o}F.

The Trinity – Browns Ferry and the Browns Ferry – Athens 161-kV transmission lines were designed to provide 25 feet of vertical clearance above ground with the phase conductors at a temperature of 120^{o}F. Both circuits have been retensioned to operate at 212^{o}F, the Trinity circuit in 1991 and the Athens circuit in 1992.

PROCEDURES

Drawings for transmission lines were reviewed and wire elevations were noted for 500-kV road crossings. In general, two types of roads were considered - unpaved roads (roads across agricultural fields where planting, cultivating, and harvesting equipment could reasonably be expected and roads through wooded areas) and paved roads (interstate highways; city, county, state and federal highways).

Three reference vehicles were considered in the study: a trailer measuring 57.00 feet in length, 8.50 feet in width, and 13.50 feet in height; a cotton picker measuring 17.50 feet in length, 8.96 feet in width, and 14.00 feet in effective height; and an Chevrolet Suburban measuring 18.28 feet in length, 7.01 feet in width, and 5.26 feet in effective height.

Electric field calculations were made using version 3.1 of ENVIRO, a calculation program for transmission lines fields and effects developed for EPRI's EMF Workstation. In order to obtain accurate E-field intensities, particular attention was paid to determining the exact conductor configuration and the proper phase relationship for each road crossing. Conductor elevations were read from the design drawings and are as accurate as the drawings themselves. It should also be noted that the maximum over-voltage value of 550-kV was used in all calculations.

Short circuit calculations were made using the formulas and procedures provided in section 8.8 of EPRI's Transmission Line Reference Book – 345-kV and Above. Maximum values for the E-field were used unless that value produced a short-circuit current of 5 mA or above, in which case the average E-field was determined across the actual length of the reference vehicle. Since the NESC does not require the 5 mA rule to be applied to transmission lines operating at 161-kV and below, no consideration of field effects for the 161-kV transmission lines was given in this study.

RESULTS

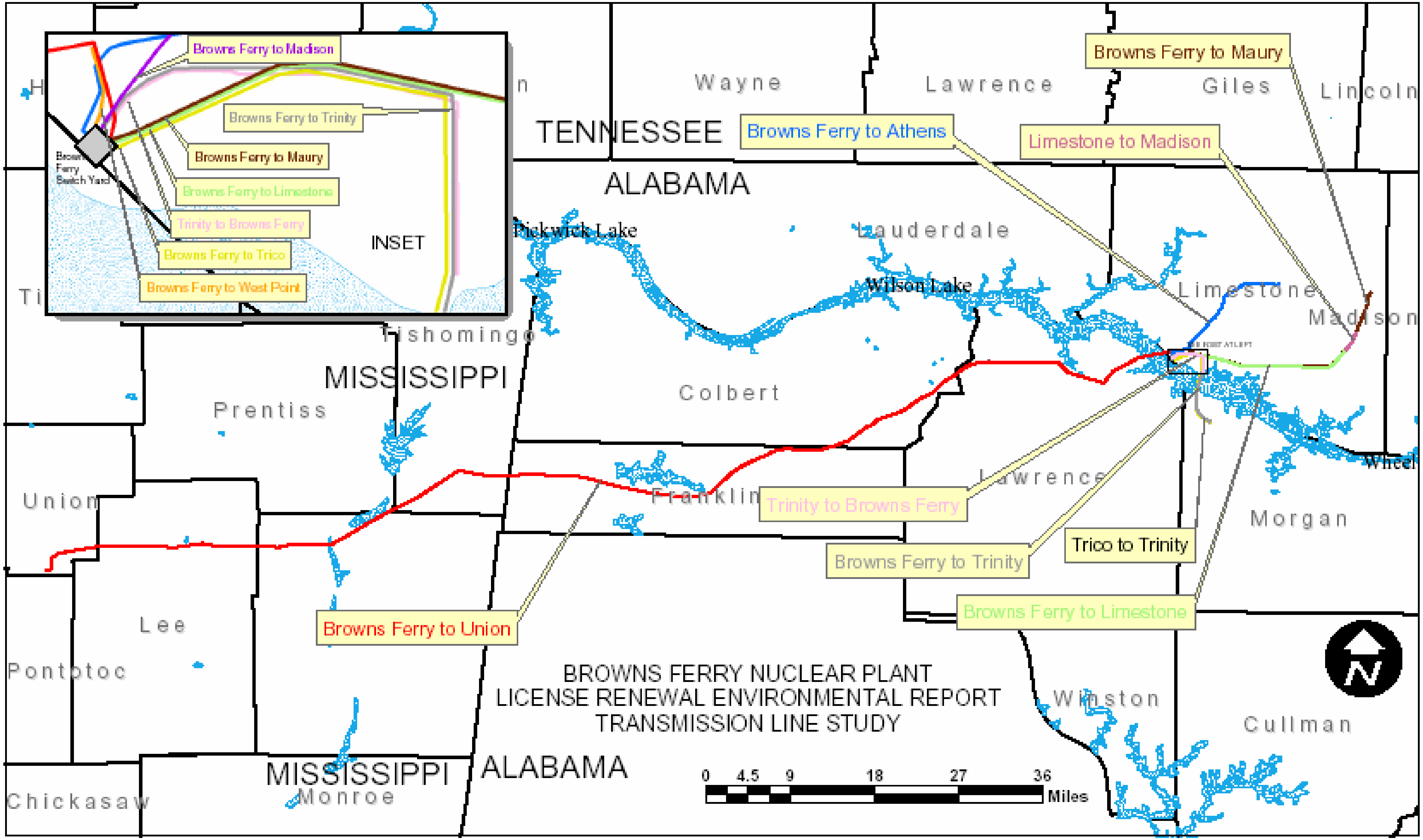
The results of the study are tabulated in the attachment.

CONCLUSIONS

Vertical clearances of all transmission lines built to connect Browns Ferry to TVA's transmission system meet or exceed the vertical clearance requirements of the 2002 Edition of the NESC. All 500-kV transmission lines have sufficient clearance to limit the steady-state current due to electrostatic effects to 5 mA_{rms}, should the largest anticipated truck, vehicle, or equipment under the line be short-circuited to ground.

Transmission Line		line length			crossing	minimum vertical clearance					E-field			Isc	
	crossing over	total miles	this study miles	conductor	station	NESC feet	design $feet_{cond\ temp}$	actual feet	span feet	phasing	max kV/m	avg kV/m	trailer mA	cotton picker mA	Suburban mA
Browns Ferry - Madison 500-kV TL No. 1		37.42	1.14												
	general ground			Rail	n/a	26.8	35_{120}	35	n/a	ABC, l-r	10.0		n/a	3.99	1.59
	unpaved road			Rail	1958+36	26.8	35_{120}	62	1074.7	ABC, l-r	4.3		n/a	1.72	0.68
	paved road			Rail	1970+91	26.8	35_{120}	73	955.3	ABC, l-r	3.1		2.62	1.24	0.49
Browns Ferry - Limestone 500-kV TL		16.56	16.56												
	general ground			Rail	n/a	26.8	30_{212}	36	n/a	CBA, l-r	9.4		n/a	3.75	1.49
	unpaved road			Rail	1116+12	26.8	30_{212}	44	1087.5	CBA, l-r	7.2		n/a	2.88	1.14
	paved road			Rail	631+65	26.8	30_{212}	50	916.1	CBA, l-r	5.6		4.73	2.24	0.89
Limestone - Madison 500-kV TL		23.81	6.61												
	general ground			Rail	n/a	26.8	35_{120}	35	n/a	CBA, l-r	9.8		n/a	3.91	1.56
	unpaved road			Rail	46+64	26.8	35_{120}	41	1130	CBA, l-r	7.7		n/a	3.07	1.22
	paved road			Rail	28+56	26.8	35_{120}	52	1205.2	CBA, l-r	4.7		3.97	1.88	0.75
Browns Ferry - West Point 500-kV TL		118.18	1.07												
	general ground			Rail	n/a	26.8	35_{120}	35	n/a	ABC, l-r	10.0		n/a	3.99	1.59
	unpaved road			Rail	20+68	26.8	35_{120}	57	1031.4	ABC, l-r	5.0		n/a	2.00	0.79
	paved road			Rail	9+74	26.8	35_{120}	77	945.7	ABC, l-r	2.7		2.28	1.08	0.43
Browns Ferry - Maury 500-kV TL		86.57	23.11												
	general ground			Rail	n/a	26.8	35_{120}	35	n/a	CBA, l-r	10.0		n/a	3.99	1.59
	unpaved road			Rail	1434+62	26.8	35_{120}	38	1100	CBA, l-r	8.7		n/a	3.47	1.38
	paved road			Rail	1629+75	26.8	35_{120}	50	970	CBA, l-r	5.6		4.73	2.24	0.89
Browns Ferry - Trinity 500-kV TL No. 1		10.66	10.66												
	general ground			Rail	n/a	26.8	35_{120}	35	n/a	ABC, l-r	9.8		n/a	3.91	1.56
	unpaved road			Rail	1380+05	26.8	35_{120}	40	1089.2	CBA, l-r	8.3		n/a	3.31	1.32
	paved road			Rail	77+72	26.8	35_{120}	46	1040	ABC, l-r	6.4	5.125	4.33*	2.56	1.02
Browns Ferry - Trico 500-kV TL		8.34	8.34												
	general ground			Rail	n/a	26.8	35_{120}	35	n/a	ABC, l-r	9.8		n/a	3.91	1.56
	unpaved road			Mallard	248+09	26.8	35_{120}	40	1544.2	BCA, t-b	7.5		n/a	3.00	1.19
	paved road			Rail	140+81	26.8	35_{120}	78	653.7	ABC, l-r	2.7		2.28	1.08	0.43
Trico - Trinity 500-kV TL		2.74	2.74												
	general ground			Rail	n/a	26.8	35_{120}	35	n/a	CBA, l-r	9.8		n/a	3.95	1.56
	unpaved road			Rail	467+73	26.8	35_{120}	46	1112.9	CBA, l-r	6.7		n/a	2.68	1.06
	paved road			Rail	495+89	26.8	35_{120}	50	759.1	CBA, l-r	5.6		4.73	2.24	0.89
Browns Ferry - Union 500-kV TL		109.88	109.88												
	general ground			Rail	n/a	26.8	30_{212}	35.6	n/a	BAC, l-r	8.7		n/a	3.47	1.38
	unpaved road			Rail	2295+69	26.8	30_{212}	35	480	BAC, l-r	8.9		n/a	3.55	1.41
	paved road			Rail	5404+66	26.8	30_{212}	40	875	CBA, l-r	7.5	5.821	4.92*	3.00	1.19
	paved road			Rail	1666+10	26.8	30_{212}	43	936.4	BAC, l-r	7.3	5.892	4.97*	2.92	1.16
	paved road			Rail	1687+32	26.8	30_{212}	44	1030	BAC, l-r	6.1	4.764	4.02*	2.44	0.97
	paved road			Rail	1923+60	26.8	30_{212}	45	1097.8	BAC, l-r	5.9		4.98	2.36	0.94
Browns Ferry - Athens 161-kV TL		14.32	14.32	Rail	n/a	21.1	25_{212}	25	n/a	n/a	n/a		n/a	n/a	n/a
Trinity - Browns Ferry 161-kV TL		10.94	10.94	Rail	n/a	21.1	25_{212}	25	n/a	n/a	n/a		n/a	n/a	n/a

* Isc based on average E-field


Browns Ferry to Madison
Browns Ferry to Trinity
Browns Ferry to Maury
Browns Ferry to Limestone
Trinity to Browns Ferry
Browns Ferry to Trico
Browns Ferry to West Point
INSET
TENNESSEE
ALABAMA
Wayne
Lawrence
Giles
Lincoln
Browns Ferry to Athens
Limestone to Madison
Pickwick Lake
Lauderdale
Wilson Lake
Limestone
Madison
Tishomingo
MISSISSIPPI
Prentiss
Colbert
Union
Franklin
Lawrence
Morgan
Trico to Trinity
Lee
Pontotoc
Browns Ferry to Union
BROWNS FERRY NUCLEAR PLANT
LICENSE RENEWAL ENVIRONMENTAL REPORT
TRANSMISSION LINE STUDY
Winston
Cullman
Chickasaw
MISSISSIPPI
Monroe
ALABAMA
0 4.5 9 18 27 36
Miles

ATTACHMENT E-4

Severe Accident Mitigation Alternatives (SAMA) at the Browns Ferry Nuclear Plant Volume I of III

and

Reconciliation of Results for Revision 0 (Final Supplemental EIS for Operating License Renewal of BFN, March 2002) versus Revision 1 (NRC License Renewal Environmental Report for BFN)

ABS Consulting

1198189-R-1490

Severe Accident Mitigation Alternatives (SAMA) at the Browns Ferry Nuclear Plant Volume I of III

November 2003

Prepared by:
David H. Johnson
Shobha B. Rao
Shawn R. Rodgers
Brian Olson

Prepared for:
Tennessee Valley Authority
Limestone Co. Road
Intersection 20 and 25
Athens, Alabama 35611

ABSG Consulting Inc. • 300 Commerce Drive, Suite 200 • Irvine, California 92602

EXECUTIVE SUMMARY

The purpose of the present analysis is to provide a consistent framework to facilitate the consideration of the potential benefit of Severe Accident Mitigation Alternatives (SAMAs) for the Browns Ferry Nuclear Plant within the context of extending the current licensing periods of Units 1, 2, and 3.

The framework developed is in the form of a cost/benefit analysis. Costs include the costs of plant modifications and procedure changes needed to implement a mitigation alternative. Benefits are measured in terms of avoided costs, that is, the reduction in costs associated with severe accidents if the mitigation alternative were implemented.

A distinguishing feature of this cost/benefit analysis is a series of screening steps. If the projected benefit associated with a specific SAMA is found to be greater than a specific screening criterion, then the SAMA is retained for further consideration in subsequent, more realistic screening steps. SAMAs that survive all screening steps are retained for future engineering evaluation. Following this strategy, the analysis can be taken to a point where the results form a sound basis for decision-making.

This assessment considers all three Browns Ferry units, each operating at 120% of their original licensed power level. Ideally, this assessment would take advantage of a plant-specific Probabilistic Safety Assessment (PSA) that reflects operation of all three units at 120% of their original licensed power level. Such a PSA is not currently available. Unit-specific PSAs are available for Units 2 and 3 that represent their operation at 120% of their original licensed power level. Because of the progressive, screening nature of the SAMA evaluation, it was possible to use the available PSA information, along with engineering knowledge of the plant, to form a basis for the three-unit cost/benefit analysis.

First, a baseline profile of the costs associated with severe accidents potentially arising from the current design and operation of Units 2 and 3 was formulated. Next, SAMAs were identified, and their impacts on calculated core damage frequency and associated severe accident costs were assessed. SAMAs may consider changes to hardware, procedures, or both. Finally, SAMAs that passed cost/benefit criteria (i.e., if their estimated implementation costs are less than the anticipated avoided costs) were retained for further consideration.

The identification of SAMAs for consideration started with the review of BFNP Units 2 and 3 PSAs. This review formed the basis for the identification of the BFNP-specific SAMAs. In addition, a review was conducted of those SAMAs that had been identified in other industry efforts, including other license renewal applications submitted to the NRC. These generic SAMAs were added to the plant-specific SAMAs to complete the list of SAMAs for consideration.

The current PSAs [August 2003] for Units 2 and 3 were used in this evaluation. These PSAs, however, required some modification for use in evaluating the SAMAs. The current PSAs can be characterized as "level 1+" risk studies; that is, they trace the plant and operator response from a set of initiating events to one of three scenario endstates: success (no core damage), core damage with "large early release," (LERF), or core damage without "large early release," (NLERF). This formulation is consistent with current NRC requirements and guidance for PSAs supporting risk-informed applications. For SAMA evaluations, however, additional information from the PSAs was required.

In the evaluation of SAMAs, it is required that offsite consequences (economic as well as radiation dose to the public) be estimated. A PSA that fully meets these requirements is often referred to as a "level 3" PSA. This necessitated the extension of the current models to address off-site impacts of core damage sequences. Normally, this would require the development of a model that considers the phenomena associated with the in-plant transport of post-core damage fission products (a so called "level 2" PSA). To meet this requirement, the current PSAs were modified to map core damage sequences to the "level 2" endstates that were identified for the 1992 BFNP IPE. Existing analyses that were done in support of the IPE allow for the characterization of the amount and timing of fission product release from the plant for core damage sequences. Offsite consequence analyses were then evaluated using the MACCS2 computer code. This approach satisfies the "level 3" requirement for the SAMA evaluation in an efficient manner.

Evaluation of the offsite impacts of the as-is design of Units 2 and 3 allowed the determination of baseline severe accident costs. The cost evaluation included the consideration of replacement power costs.

Results from the current PSAs for Unit 2 and Unit 3 representing EPU conditions were used to identify plant-specific SAMAs. Scenarios leading to core damage as well as those contributing to LERF were reviewed to identify plant-specific SAMAs.

The list of SAMAs developed from other SAMA submittals was screened to determine those potential changes that required more detailed evaluation. Over 100 “generic” SAMAs were identified. Those SAMAs that did not apply to the BFNP design, were already implemented at BFNP, or whose cost of implementation greatly exceeded the maximum avoided costs were systematically eliminated from further consideration.

The impacts on both the Unit 2 and the Unit 3 PSAs were determined for those SAMAs that passed the initial screening. Often it was appropriate to identify a bounding impact on the PSA that would conservatively overestimate the potential benefit of the SAMA. For several of the SAMAs, information from the PSA (e.g., system importance measures) was used to estimate their potential benefit. For the majority of the Phase II SAMAs, however, new PSA models that incorporate individual SAMAs were developed and quantified. The avoided cost associated with severe accidents was then evaluated for each unit assuming that the specific SAMA was fully implemented. The difference between the baseline avoided costs and the avoided costs with the SAMA implemented was determined for two different future discount rates (3% and 7%) in accordance with Reference 10.

Uncertainties in the PSA calculations were considered by identifying those SAMAs that would not be screened during the cost/benefit comparison if the benefit were to increase by a factor of 3. The factor of three approximates the ratio of the 95^{th} percentile of the core damage frequency to the mean.

Effects on avoided costs due to restart of Unit 1 were also addressed. The operation of Unit 1 increases the calculated core damage frequency of Units 2 and 3. The units share certain equipment (e.g., Diesel Generators, the Residual Heat Removal Service Water System and the Emergency Equipment Cooling Water System) resulting, in selected scenarios, in decreased availability of equipment to a particular unit. Success criteria for selected systems are also impacted. Insights from the Multiple Unit PSA performed in 1995 (Reference 18) were used to bound the effects of three-unit operation.

The evaluation did not identify any SAMAs that are cost effective when the estimated implementation cots are compared to the mean value of the estimated avoided costs. When uncertainty, the operation of Unit 1, and the combination of uncertainty and the operation of Unit 1 are considered, the evaluation did not reveal any cost effective SAMAs.

ABBREVIATIONS AND ACRONYMS

AC	Alternating Current
ADS	Automatic Depressurization System
AFW	Auxiliary Feed Water
ATWS	Anticipated Transient Without Scram
BFNP	Browns Ferry Nuclear Plant
BWR	Boiling Water Reactor
BWROG	Boiling Water Reactor Owners Group
CCDF	Complementary Cumulative Distribution Function
CDF	Core Damage Frequency
CFR	Code of Federal Regulations
CRD	Control Rod Drive
CS	Core Spray
CV	Check Valve
DC	Direct Current
DW	Dry Well
ECCS	Emergency Core Cooling System
EECW	Emergency Equipment Cooling Water
EOP	Emergency Operating Procedure
EPU	Extended Power Uprate
HFO	High Winds, Floods, Transportation and Other External Events
HP	High Pressure
HPCI	High Pressure Coolant Injection
HPGTET	High Pressure General Transient (Event Tree)
HVAC	Heating, Ventilation and Air Conditioning

IPE	Individual Plant Examination
IPEEE	Individual Plant Examination of External Events
ISLOCA	Interfacing System Loss Of Coolant Accident
LERF	Large Early Release Frequency
LLOCA	Large Loss Of Coolant Accident (Event Tree)
LOCA	Loss Of Coolant Accident
LPGTET	Low Pressure General Transient Event Tree
MAAP	Modular Accident Analysis Program
MLOCA	Medium Loss Of Coolant Accident (Event Tree)
MOV	Motor Operated Valve
MSIV	Main Steam Isolation Valve
NLERF	“No” Large Early Release Frequency
NPSH	Net Positive Suction Head
PORV	Power Operated Relief Valve
PSA	Probabilistic Safety Analysis
PSW	Plant Service Water
PWR	Pressurized Water Reactor
RBCCW	Reactor Building Closed Cooling Water
RCP	Reactor Coolant Pump
RCIC	Reactor Core Isolation Cooling
RHR	Residual Heat Removal
RHRSW	Residual Heat Removal Service Water
ROM	Rough Order of Magnitude
RPV	Reactor Pressure Vessel
RWCU	Reactor Water Clean Up
RWST	Reactor Water Storage Tank
SAMA	Severe Accident Mitigation Alternative

SBO	Station Blackout
SG	Steam Generator
SGTR	Steam Generator Tube Rupture
SLC	Standby Liquid Control
SQUG	Seismic Qualification Utility Group
SRV	Safety/Relief Valve
TRANCDBIN	Event Tree for Binning Transient Core Damage Sequences
TVA	Tennessee Valley Authority
UFSAR	Updated Final Safety Analysis Report
USNRC	United States Nuclear Regulatory Commission
UV	Under Voltage

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SECTION I

METHODOLOGY

The methodology selected for this analysis involves identifying those Severe Accident Mitigation Alternatives (SAMAs) that have the most potential for reducing core damage frequency and associated person-rem risk. The phased approach consists of:

1. Extending the Browns Ferry Nuclear Plant (BFNP) Probabilistic Safety Analysis (PSA) results to a Level 3 analysis by determining offsite dose and economic baseline risk values.
2. Determining the maximum averted risk that is possible based on the BFNP baseline risk.
3. Identifying SAMAs based on BFNP PSA results, the USNRC, and industry documents.
4. Screening out SAMAs that are not applicable to the BFNP design or are of low benefit in boiling water reactors.
5. Screening out SAMAs whose estimated implementation cost exceeds the maximum possible avoided cost.
6. Performing a more detailed cost estimate and Level 3 dose and economic risk evaluation of remaining SAMAs to see if any have an avoided cost that exceeds the expected implementation cost.

SECTION II
LEVEL 3 PSA ANALYSIS

The MACCS2 code was used to perform the Level 3 consequence analysis for the BFNP. Plant-specific release data includes the time-nuclide distribution of releases, release frequencies, and release locations. The behavior of the population during a release (evacuation/sheltering parameters) was based on the generic MACCS2 model. This data was used in combination with site-specific meteorology and population data to simulate the impact risks (exposure and economic) to the surrounding (within 50 miles) population from the release accident sequences at the BFNP.

A. Population

Population estimates for the year 2036 within 50 miles of the BFNP (Reference 11) are shown in Tables II-1 and II-2.

B. Meteorological Data Sampling Method

The atmospheric dispersion of radioactive material from a postulated accident depends on the meteorological conditions that exist from the start of the accident through a period of tens to hundreds of hours following the accident. Since the weather that could occur coincident with the accident is diverse, representative meteorological data sequences are selected as input to the dispersion model to reflect the dependence of the transport and dispersion process on the site weather. The selection process is done by means of sampling techniques from a full year of hourly weather data taken from the BFNP on-site meteorological tower. For this analysis, the technique referred to as weather bin sampling in the MACCS2 V1.12 code was used for the 1980 year of data.

This sampling method ensures a complete coverage of diurnal, seasonal, and 4-day cycles without the statistical noise of methods that utilize random sampling and includes the important “rain tails” (deposition due to delayed rain).

The meteorological data assessment is done by sorting the weather sequence into categories that provide a realistic representation of the year's weather without overlooking weather conditions that are instrumental in producing major consequences. A set of 40 weather categories has been selected for the MACCS2 V1.12 model to reflect these requirements. Up to eight meteorological scenarios are selected for each category, limited by the number of meteorological scenarios available for that category.

Table II-1
ESTIMATED POPULATION DISTRIBUTION WITHIN A 10-MILE RADIUS OF BFNP, YEAR 2036

Sector	0-1 mile	1-2 miles	2-3 miles	3-4 miles	4-5 miles	5-10 miles	10 miles total
N	2	18	203	379	501	2,501	3,604
NNE	0	5	33	379	521	1,931	2,869
NE	2	10	65	114	278	8,350	8,819
ENE	6	82	365	289	432	2,273	3,447
E	11	54	25	13	53	5,170	5,326
ESE	5	9	208	0	0	86	308
SE	2	0	0	0	2	7,626	7,630
SSE	0	0	1	0	1	16,037	16,039
S	0	3	29	59	25	1,768	1,884
SSW	0	2	12	235	343	3,708	4,300
SW	0	0	3	90	381	1,523	1,997
WSW	0	0	70	122	79	168	439
W	0	55	200	15	3	69	342
WNW	0	0	1	4	2	85	92
NW	0	2	8	4	33	640	687
NNW	52	467	272	84	104	3,104	4,083
TOTAL	80	707	1,495	1,787	2,758	55,039	61,866

* From Reference 11.

Table II-2
ESTIMATED POPULATION DISTRIBUTION WITHIN A 50-MILE RADIUS OF BFNP, YEAR 2036

Sector	0-10 mile	10-20 miles	20-30 miles	30-40 miles	40-50 miles	50 miles total
N	3,604	2,710	6,269	19,130	8,662	40,375
NNE	2,869	10,929	3,393	3,965	5,432	26,588
NE	8,819	21,034	23,783	16,920	17,488	88,044
ENE	3,447	35,534	69,528	63,014	10,840	182,363
E	5,326	5,731	136,377	105,268	12,263	264,965
ESE	308	1,096	4,229	20,885	17,799	44,317
SE	7,630	40,473	12,373	11,248	36,295	108,019
SSE	16,039	28,541	26,702	36,087	42,023	149,392
S	1,884	7,038	4,083	8,813	15,505	37,323
SSW	4,300	12,873	1,467	2,417	6,519	27,576
SW	1,997	6,376	3,318	4,075	19,955	35,721
WSW	439	3,957	3,895	29,617	4,376	42,284
W	342	3,855	17,460	37,892	4,842	64,391
WNW	92	3,124	28,974	51,789	11,954	95,933
NW	687	11,805	9,717	6,912	4,615	33,736
NNW	4,083	3,232	3,110	24,997	16,467	51,889
TOTAL	61,866	198,308	354,678	443,029	235,035	1,292,916

Given a postulated severe accident, large numbers of early fatalities and injuries are normally associated with relatively low probability weather events such as rainfall or wind speed slowdowns within 50 miles of the plant site or with stable weather and moderate wind speeds at the start of the release. In MACCS2 V1.12, these weather data types have been selected to be among the 40 categories utilized in the assessment process.

With this information, weather sequences can be sampled to reflect the weather data for the full year. This ensures representation of each type of weather sequence, those important to realistic representation of the weather data set, and those important to the occurrence of the most serious accident consequences due to rainout in high population areas.

C. Atmospheric Transport and Dispersion

The dispersion model implemented in MACCS2 V1.12 is described in detail in NUREG/CR-4691, Volume 2 (reference 20). It is a Gaussian, time-dependent, plume segment model that has been in use for consequence assessments since the Reactor Safety Study (RSS) in 1975. The plume is assumed to be transported in a straight line downwind in accordance with the measured wind direction.

For each start hour selected by the meteorological sampling technique, the MAACS2 V1.12 dispersion model uses the subsequent meteorological conditions to predict the dispersion and transport of the released plume of radioactive material. The sequence of hourly recordings is used to account for changing meteorological conditions.

In MACCS2 V1.12, the effects of release duration, mixing layer depth, building wake, plume rise due to sensible heat buoyancy, and dry and wet removal processes are included. The ground concentration is calculated from the air concentration and the deposition rate.

D. Nuclide Release

The current design basis core inventory is provided in Table II-3 (Reference 9). Data from three distinct fuel types each representing Extended Power Uprate (EPU) conditions are provided in the table. Each of the major hypothetical accidents identified in the IPE study (Reference 12) was assigned to one of several release categories based on the primary system and containment responses to the accident conditions calculated by the Modular Accident Analysis Program (MAAP). Each release category has associated release fractions of the initial core radionuclide inventory, which are used as input data to the consequence analysis model. In addition to the release magnitude, the parameters that characterize the various releases due to hypothetical accident sequences are time of release, duration of release, warning time for evacuation, height of release, and energy content of the released radioactive plume.

The time of start of release was taken from MAAP runs and refers to the time interval between the start of the hypothetical accident and the release of radioactive material from the containment building to the atmosphere. This parameter is used to calculate the decay of radioactivity as well as timing used in computing dose accumulated by evacuees in relation to plume location and deposited material. The duration of release is the total time during which radioactive material is emitted into the atmosphere; it is used to account for continuous releases by adjusting for horizontal dispersion due to changes in wind direction.

Release fractions for each MAAP run fission product release category are shown in Table II-4.

Table II-3
BFNP CORE INVENTORY

Isotope Number	Isotope Name	Release Group	Activity, Bq GE Uprated 35 GWD/MTU	Activity, Bq Framatome Commercial 37 GWD/MTU	Activity, Bq Framatome Blended LEU 37 GWD/MTU
1	Cr-51	6	1.733959E+17	1.888302E+17	1.690426E+17
2	Mn-54	6	9.240809E+15	1.419054E+16	1.413400E+16
3	Mn-56	6	3.508059E+17	4.014056E+17	3.618304E+17
4	Fe-55	6	5.283289E+16	6.162424E+16	5.597064E+16
5	Co-58	6	2.133386E+16	2.100312E+16	2.128580E+16
6	Co-60	6	2.124906E+16	1.014821E+16	9.469780E+15
7	As-78	4	2.493803E+16	2.730689E+16	2.725035E+16
8	Ge-78	4	2.430765E+16	2.696767E+16	2.691114E+16
9	Se-81	4	2.229497E+17	2.040950E+17	2.066391E+17
10	Se-81m	4	6.230267E+15	1.452975E+16	1.458629E+16
11	Se-83	4	1.985262E+17	2.326456E+17	2.374512E+17
12	Br-82	2	2.410412E+16	1.215524E+16	1.175949E+16
13	Br-83	2	5.110854E+17	4.946900E+17	5.059972E+17
14	Br-84	2	8.935515E+17	9.215368E+17	9.498048E+17
15	Kr-83m	1	5.119335E+17	4.975168E+17	5.116508E+17
16	Kr-85	1	5.356786E+16	5.286116E+16	5.370920E+16
17	Kr-85m	1	1.093124E+18	1.034609E+18	1.071357E+18
18	Kr-87	1	2.108227E+18	2.080525E+18	2.156848E+18
19	Kr-88	1	2.970967E+18	2.883336E+18	2.996408E+18
20	Rb-86	3	9.503702E+15	6.925660E+15	6.840856E+15
21	Rb-88	3	3.016196E+18	2.968140E+18	3.081212E+18
22	Rb-89	3	3.875543E+18	3.872716E+18	4.042324E+18
23	Sr-89	5	3.997417E+18	4.014169E+18	4.155507E+18
24	Sr-90	5	4.271295E+17	4.635952E+17	4.720756E+17
25	Sr-91	5	4.980885E+18	5.031732E+18	5.201340E+18
26	Sr-92	5	5.359613E+18	5.314384E+18	5.483992E+18
27	Y-90	7	4.533537E+17	4.840330E+17	4.896018E+17
28	Y-91	7	5.122977E+18	5.173762E+18	5.343362E+18
29	Y-91m	7	2.891816E+18	2.911604E+18	3.024676E+18
30	Y-92	7	5.384116E+18	5.371140E+18	5.512477E+18
31	Y-93	7	6.185039E+18	4.070594E+18	4.155398E+18
32	Y-94	7	6.207698E+18	6.416896E+18	6.529967E+18
33	Y-95	7	6.642980E+18	6.671248E+18	6.756052E+18
34	Zr-95	7	7.233216E+18	7.205513E+18	7.279010E+18
35	Nb-95	7	7.262049E+18	7.228128E+18	7.304451E+18
36	Nb-95m	7	5.266046E+16	8.002671E+16	8.076168E+16
37	Zr-97	7	7.387842E+18	7.052866E+18	7.041559E+18
38	Nb-97	7	7.444378E+18	7.081134E+18	7.098095E+18

Table II-3
BFNP CORE INVENTORY

Isotope Number	Isotope Name	Release Group	Activity, Bq		
			GE	Framatome	Framatome
			Uprated	Commercial	Blended LEU
			35 GWD/MTU	37 GWD/MTU	37 GWD/MTU
39	Nb-97m	7	7.004245E+18	6.688209E+18	6.705170E+18
40	Mo-99	6	7.588759E+18	7.519596E+18	7.491320E+18
41	Mo-101	6	6.788063E+18	6.756120E+18	6.699582E+18
42	Tc-99m	6	6.628846E+18	6.642980E+18	6.642980E+18
43	Tc-101	6	6.790889E+18	6.756120E+18	6.699582E+18
44	Tc-104	6	4.921459E+18	4.918632E+18	4.692488E+18
45	Ru-103	6	6.049352E+18	6.105888E+18	5.908012E+18
46	Rh-103m	6	5.450070E+18	6.105888E+18	5.908012E+18
47	Ru-105	6	4.008402E+18	4.042324E+18	3.816180E+18
48	Rh-105	6	3.779432E+18	3.816180E+18	3.618304E+18
49	Ru-106	6	2.176919E+18	2.219038E+18	2.060737E+18
50	Rh-106	6	2.336916E+18	2.385819E+18	2.202077E+18
51	Rh-106m	6	7.194206E+16	7.434484E+16	6.247228E+16
52	Rh-107	6	2.245045E+18	2.303842E+18	2.114446E+18
53	Pd-109	6	1.192344E+18	1.325769E+18	1.207044E+18
54	Ag-109m	6	1.191779E+18	1.325769E+18	1.207044E+18
55	Ag-110m	6	1.578485E+16	1.263580E+16	1.057223E+16
56	Ag-111	6	2.589349E+17	2.202077E+17	2.015508E+17
57	Ag-112	6	1.373825E+17	1.011994E+17	9.384976E+16
58	Cd-115	6	7.198474E+16	3.109480E+16	2.939872E+16
59	Cd-117	6	4.053691E+16	3.081212E+16	2.939872E+16
60	In-113m	6	5.515087E+15	1.158988E+16	1.125066E+16
61	In-115m	6	7.211167E+16	3.109480E+16	2.939872E+16
62	In-116m	6	3.129323E+16	1.984414E+16	1.851554E+16
63	In-117m	6	4.737773E+16	2.823973E+16	2.688287E+16
64	In-117	6	3.742913E+16	2.304144E+16	2.188243E+16
65	Sn-113	4	5.515087E+15	1.156161E+16	1.125066E+16
66	Sn-121	4	8.791065E+16	5.303077E+16	5.113681E+16
67	Sn-123m	4	6.024632E+16	3.280366E+16	3.138964E+16
68	Sn-127	4	2.649842E+17	1.325769E+17	1.263580E+17
69	Sn-128	4	6.456411E+17	5.512260E+17	5.399188E+17
70	Sb-125	4	7.809883E+16	4.576589E+16	4.418288E+16
71	Sb-131	4	3.341278E+18	3.137748E+18	3.137748E+18
72	Sn-125	4	6.875060E+16	1.970280E+16	1.901023E+16
73	Sb-127	4	4.169530E+17	3.307356E+17	3.166016E+17
74	Sb-129	4	1.261318E+18	1.257926E+18	1.232485E+18
75	Sb-130	4	4.079072E+17	4.183664E+17	4.098860E+17
76	Te-125m	4	1.681805E+16	9.995565E+15	9.647868E+15

Table II-3
BFNP CORE INVENTORY

Isotope Number	Isotope Name	Release Group	Activity, Bq		
			GE	Framatome	Framatome
			Uprated	Commercial	Blended LEU
			35 GWD/MTU	37 GWD/MTU	37 GWD/MTU
77	Te-127	4	4.135640E+17	3.279102E+17	3.137761E+17
78	Te-127m	4	5.549027E+16	5.540528E+16	5.314384E+16
79	Te-129	4	1.241813E+18	1.192910E+18	1.167468E+18
80	Te-129m	4	1.856077E+17	2.408434E+17	2.351898E+17
81	Te-131m	4	5.704482E+17	7.688896E+17	7.462752E+17
82	Te-131	4	3.533500E+18	3.363892E+18	3.335624E+18
83	Te-132	4	5.673388E+18	5.710136E+18	5.653600E+18
84	Te-133	4	4.799906E+18	4.466344E+18	4.494612E+18
85	Te-133m	4	3.033156E+18	3.703108E+18	3.703108E+18
86	Te-134	4	6.883258E+18	7.321412E+18	7.406216E+18
87	I-128	2	5.017583E+16	3.505232E+16	3.250820E+16
88	I-130	2	1.324921E+17	8.084648E+16	7.208340E+16
89	I-131	2	3.980134E+18	3.957520E+18	3.900984E+18
90	I-132	2	5.758192E+18	5.794940E+18	5.766672E+18
91	I-133	2	8.189240E+18	8.254256E+18	8.225988E+18
92	I-134	2	9.011838E+18	9.158832E+18	9.158832E+18
93	I-135	2	7.660628E+18	7.830236E+18	7.801968E+18
94	Xe-131m	1	4.449383E+16	5.286116E+16	5.201312E+16
95	Xe-133	1	8.209027E+18	7.915040E+18	7.886772E+18
96	Xe-133m	1	2.545533E+17	2.586522E+17	2.566734E+17
97	Xe-135	1	2.863548E+18	2.660019E+18	2.939872E+18
98	Xe-135m	1	1.589510E+18	1.693253E+18	1.670639E+18
99	Xe-138	1	6.812588E+18	7.067000E+18	7.095268E+18
100	Cs-134	3	8.505841E+17	7.123536E+17	6.586444E+17
101	Cs-134m	3	2.184834E+17	1.537779E+17	1.413400E+17
102	Cs-135m	3	1.007472E+17	1.305982E+17	1.116586E+17
103	Cs-136	3	2.894643E+17	2.374512E+17	2.374512E+17
104	Cs-137	3	5.622505E+17	6.021084E+17	5.992816E+17
105	Cs-138	3	7.536249E+18	7.632360E+18	7.660628E+18
106	Ba-137m	9	5.325691E+17	5.710136E+17	5.681868E+17
107	Ba-139	9	7.352507E+18	7.293144E+18	7.321412E+18
108	Ba-140	9	7.115056E+18	7.321412E+18	7.321412E+18
109	Ba-141	9	6.676902E+18	6.614712E+18	6.642980E+18
110	Ba-142	9	6.348993E+18	6.303764E+18	6.360300E+18
111	La-140	7	7.372294E+18	7.801968E+18	7.801968E+18
112	La-141	7	6.707996E+18	6.671248E+18	6.699516E+18
113	La-142	7	6.495986E+18	6.529908E+18	6.558176E+18
114	La-143	7	6.227440E+18	6.218960E+18	6.303764E+18

Table II-3
BFNP CORE INVENTORY

Isotope Number	Isotope Name	Release Group	Activity, Bq		
			GE	Framatome	Framatome
			Uprated	Commercial	Blended LEU
			35 GWD/MTU	37 GWD/MTU	37 GWD/MTU
115	Ce-141	8	6.764532E+18	6.699516E+18	6.727784E+18
116	Ce-143	8	6.267016E+18	6.275496E+18	6.332032E+18
117	Ce-144	8	5.565969E+18	5.653600E+18	5.681868E+18
118	Pr-142	8	3.106653E+17	2.301015E+17	2.103139E+17
119	Pr-143	7	6.117195E+18	6.077620E+18	6.134156E+18
120	Pr-144	7	5.597064E+18	5.681868E+18	5.710136E+18
121	Pr-144m	7	6.688209E+16	7.915040E+16	7.999844E+16
122	Pr-145	7	4.257161E+18	4.268468E+18	4.296736E+18
123	Pr-147	7	2.673022E+18	2.674153E+18	2.676980E+18
124	Nd-147	7	2.693940E+18	2.693940E+18	2.693940E+18
125	Nd-149	7	1.535518E+18	1.517992E+18	1.498204E+18
126	Nd-151	7	7.765220E+17	7.660628E+17	7.434484E+17
127	Pm-147	7	6.914353E+17	9.469780E+17	9.922068E+17
128	Pm-148	7	1.175666E+18	7.151804E+17	6.784320E+17
129	Pm-148m	7	1.758552E+17	1.438841E+17	1.450148E+17
130	Pm-149	7	2.348505E+18	2.295362E+18	2.219038E+18
131	Pm-150	7	1.885193E+16	1.778057E+16	1.520818E+16
132	Pm-151	7	7.782180E+17	7.745432E+17	7.519288E+17
133	Sm-153	7	1.823569E+18	1.713043E+18	1.597144E+18
134	Sm-155	7	1.447322E+17	1.382310E+17	1.294679E+17
135	Sm-156	7	8.915727E+16	8.593472E+16	7.971576E+16
136	Eu-154	7	4.692347E+16	3.218594E+16	3.162907E+16
137	Eu-155	7	3.293420E+16	1.344002E+16	1.275678E+16
138	Eu-156	7	5.975629E+17	7.840978E+17	6.897957E+17
139	Eu-157	7	7.997017E+16	8.028112E+16	7.123536E+16
140	Eu-158	7	3.386506E+16	3.109480E+16	2.855068E+16
141	Gd-159	7	9.078890E+17	6.689622E+17	6.417401E+17
142	W-187	6	1.594598E+16	1.583008E+16	1.540606E+16
143	Pu-238	8	1.485766E+16	1.274887E+16	4.183664E+16
144	Np-239	8	7.756739E+19	7.293144E+19	6.812588E+19
145	Pu-239	8	1.765619E+15	1.763923E+15	1.840247E+15
146	Pu-240	8	2.288295E+15	2.580868E+15	2.448009E+15
147	Pu-241	8	6.637326E+17	6.303764E+17	6.162424E+17
148	Am-241	7	8.127050E+14	8.112916E+14	8.112916E+14
149	Cm-242	7	1.819328E+17	1.840247E+17	1.648024E+17
150	Cm-244	7	8.497361E+15	7.717164E+15	6.049352E+15

** From Reference 9.*

The warning time for evacuation was estimated based on review of the accident sequences. This time is the interval between awareness of impending core melt and the release of radioactive material from the containment building. Finally, the height of release and the energy content of the released plume affect the manner in which the plume would be dispersed in the atmosphere.

Table II-4
RELEASE FRACTIONS FOR EACH FISSION PRODUCT RELEASE CATEGORY

Release Category (MAAP Case)	Release Group 1	Release Group 2	Release Group 3	Release Group 4	Release Group 5	Release Group 6	Release Group 7	Release Group 8	Release Group 9
MKC	1.000	2.482E-1	2.631E-1	1.711E-1	3.611E-3	1.422E-2	3.244E-4	1.304E-3	3.078E-3
MIA	8.147E-1	3.127E-4	1.387E-3	2.459E-5	7.066E-7	3.949E-6	2.240E-8	4.861E-8	5.868E-6
NIH	8.862E-1	5.241E-3	5.735E-3	2.706E-3	7.245E-5	2.171E-5	7.461E-6	3.090E-5	3.734E-5
OIA	9.472E-1	2.095E-1	2.175E-1	4.699E-2	5.975E-7	2.169E-6	4.343E-8	3.865E-7	2.837E-6
PID	6.065E-1	1.660E-4	1.807E-4	5.538E-4	1.647E-5	2.356E-5	1.886E-6	7.904E-6	1.357E-5
PIH	9.470E-1	1.369E-1	1.248E-1	1.647E-1	6.397E-4	1.378E-5	4.277E-5	4.706E-4	3.384E-4
PJH	7.287E-1	5.060E-4	5.871E-4	3.782E-4	1.310E-6	4.854E-7	1.419E-7	5.750E-7	7.366E-7
PLF	8.817E-1	8.730E-4	1.199E-3	5.257E-3	1.582E-4	1.907E-5	1.487E-5	6.191E-5	6.888E-5

Note: The Release Groups are defined in Table II-3

E. Evacuation and Other Protective Measures

Evacuation and other protective measures (i.e., sheltering and relocation) are taken to avoid or reduce immediate exposure to the passing radioactive plume and ground contamination. Evacuation is potentially the most effective method of avoiding radiation exposure and can provide essentially total protection if completed prior to arrival of the plume.

The evacuation model does not account for actual road networks, road capacity limitations, or lateral travel possibilities (evacuation is assumed to be in a straight-line radially away from the plant). This is a standard model assumption when using MACCS.

F. Results

The results of the Level 3 consequence analysis provide projected offsite radiation doses and offsite economic costs (in 2016 dollars) as a function of accident conditions (Reference 9). This information forms part of the input data to the economic model described in Section III of this analysis. In the exposure and economic cost evaluation of each base case and each SAMA, for each plant damage state, the maximum (as determined by the mean value) dose and offsite cost from the three fuel types was selected.

Complementary Cumulative Distribution Function (CCDF) and summary results are given in Table II-5 and Table II-6, respectively, for the blended low enriched uranium.

Table II-5
PROBABILITY OF EXCEEDANCE, EFFECTIVE WHOLE BODY POPULATION DOSE FROM 0-50 MI, PERSON-REM (PART I)

Population Dose	MKC	MIA	NIH	OIA	PID	PIH	PJH	PLF
1.00E+03	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
2.00E+03	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
3.00E+03	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
5.00E+03	1.00E+00	1.00E+00	1.00E+00	1.00E+00	9.99E-01	1.00E+00	1.00E+00	1.00E+00
7.00E+03	1.00E+00	1.00E+00	1.00E+00	1.00E+00	9.98E-01	1.00E+00	1.00E+00	1.00E+00
1.00E+04	1.00E+00	1.00E+00	1.00E+00	1.00E+00	9.93E-01	1.00E+00	1.00E+00	1.00E+00
2.00E+04	1.00E+00	1.00E+00	1.00E+00	1.00E+00	9.37E-01	1.00E+00	1.00E+00	1.00E+00
3.00E+04	1.00E+00	1.00E+00	1.00E+00	1.00E+00	8.21E-01	1.00E+00	1.00E+00	1.00E+00
5.00E+04	1.00E+00	9.98E-01	1.00E+00	1.00E+00	5.31E-01	1.00E+00	9.89E-01	1.00E+00
7.00E+04	1.00E+00	9.88E-01	1.00E+00	1.00E+00	3.15E-01	1.00E+00	9.48E-01	9.97E-01
1.00E+05	1.00E+00	9.65E-01	9.96E-01	1.00E+00	1.74E-01	1.00E+00	8.07E-01	9.90E-01
2.00E+05	1.00E+00	6.93E-01	9.67E-01	1.00E+00	4.95E-02	1.00E+00	3.33E-01	7.73E-01
3.00E+05	1.00E+00	4.04E-01	8.84E-01	1.00E+00	6.16E-03	1.00E+00	1.93E-01	4.84E-01

Table II-6
PROBABILITY OF EXCEEDANCE, EFFECTIVE WHOLE BODY POPULATION DOSE FROM 0-50 MI, PERSON-REM (PART II)

Population Dose	MKC	MIA	NIH	OIA	PID	PIH	PJH	PLF
5.00E+05	1.00E+00	1.85E-01	5.66E-01	1.00E+00		1.00E+00	5.01E-02	2.09E-01
7.00E+05	1.00E+00	1.15E-01	3.58E-01	9.93E-01		1.00E+00	7.93E-03	8.97E-02
1.00E+06	1.00E+00	4.67E-02	2.09E-01	9.40E-01		9.95E-01	7.42E-04	2.94E-02
2.00E+06	9.92E-01	2.10E-03	5.39E-02	5.79E-01		8.78E-01		2.00E-04
3.00E+06	8.68E-01	1.17E-05	7.47E-03	3.34E-01		6.16E-01		
5.00E+06	4.87E-01			1.23E-01		2.94E-01		
7.00E+06	2.72E-01			5.05E-02		1.03E-01		
1.00E+07	6.92E-02			3.14E-03		1.04E-02		
2.00E+07								
3.00E+07								
5.00E+07								
7.00E+07								
1.00E+08								
2.00E+08								
3.00E+08								
5.00E+08								
7.00E+08								
1.00E+09								
Mean	5.56E+06	3.56E+05	7.57E+05	2.88E+06	6.96E+04	3.59E+06	2.02E+05	3.69E+05

Table II-7
MEAN POPULATION DOSE WITHIN 50 MILES (EFFECTIVE DOSE EQUIVALENT) BROWNS FERRY WITH BLENDED LOW-ENRICHMENT URANIUM (PERSON-REM)

Scenario	Mean
MKC	5.56E+06
MIA	3.56E+05
NIH	7.57E+05
OIA	2.88E+06
PID	6.96E+04
PIH	3.59E+06
PJH	2.02E+05
PLF	3.69E+05

SECTION III

BASE CASE PSA RESULTS

A. Summary of PSA Results

The results of the base case PSAs, as expressed in terms of the contribution to LERF and No LERF are shown in Tables III-1 and III-2 for Unit 2 and Unit 3, respectively. These same results are shown in Tables III-3 and III-4 in terms of contribution to plant damage states as defined in the BFNP IPE (Reference 12.)

Table III-1
UNIT 2 INITIATING EVENT CONTRIBUTION TO LERF AND NLERF

Initiator	Initiator Frequency	LERF	NLERF
Break Outside Containment (BOC)	6.6700E-04	2.3235E-09	3.4752E-08
Excessive LOCA (ELOCA)	9.3900E-09	9.3900E-09	0.0000
Flood in RB-1 (FLRB1)	1.2000E-02	5.4272E-10	2.9098E-09
Flood in RB-2 (FLRB2)	1.7000E-06	0.0000E+00	1.1055E-10
Flood in RB-3C (FLRB3C)	9.8000E-05	7.0272E-11	2.2242E-09
Flood in RB-3S (FLRB3S)	1.3371E-05	1.2308E-09	2.7846E-09
Large Flood in Turbine Building (FLTB)	2.2000E-03	2.9720E-09	1.3226E-08
Small Flood in Turbine Building (FLTB2)	1.4400E-02	5.6401E-09	6.9683E-08
Inadvertent Opening of One SRV (IOOV)	4.3600E-02	1.9913E-08	2.4408E-08
Inadvertent Opening of Two or More SRVs (IOTV)	3.4200E-04	6.6401E-11	2.5496E-09
Inadvertent SCRAM (ISCRAM)	2.5700E-01	3.9291E-09	8.5945E-08
Interfacing System LOCA (ISLOCA)	4.6400E-08	4.6400E-08	0.0000
Loss of 500kV to Plant (L500PA)	9.3200E-03	3.0633E-09	3.6063E-08
Loss of 500kV to Unit 2 (L500U2)	3.4200E-02	1.3829E-08	1.3712E-07
Loss of I&C Bus A (LICA)	4.1000E-03	1.8667E-09	1.9206E-08
Loss of I&C Bus B (LICB)	4.1000E-03	1.8673E-09	1.9215E-08
Core Spray Loop A Break (LLCA)	1.5700E-06	8.4697E-11	2.2329E-09
Core Spray Loop B Break (LLCB)	1.5700E-06	1.5450E-10	3.8959E-09
RHR Discharge Loop A Break (LLDA)	1.1000E-05	1.5932E-10	6.3666E-09
RHR Discharge Loop B Break (LLDB)	1.1000E-05	4.6648E-11	5.1943E-09
Other Large LOCA (LLO)	1.5700E-06	3.1354E-12	7.8491E-10
RHR Suction Loop A Break (LLSA)	7.8500E-07	0.0000E+00	3.5456E-10
RHR Suction Loop B Break (LLSB)	7.8500E-07	0.0000E+00	3.5456E-10
Loss of All Condensate (LOAC)	1.2400E-02	4.6788E-09	5.1072E-08
Loss of Condenser Heat Sink (LOCHS)	1.2000E-01	7.1580E-08	4.9996E-07
Loss of Feedwater (LOFW)	4.8100E-02	1.0539E-08	4.0547E-08

Table III-1
UNIT 2 INITIATING EVENT CONTRIBUTION TO LERF AND NLERF

Initiator	Initiator Frequency	LERF	NLERF
Loss of Plant Air (LOPA)	1.2000E-02	5.7302E-09	4.5988E-08
Loss of Offsite Power (LOSP)	7.1500E-03	1.1454E-08	4.7073E-07
Loss of RBCCW (LRBCCW)	1.1000E-02	5.9685E-09	5.4109E-08
Loss of RCW (LRCW)	7.9500E-03	9.8400E-09	5.7879E-08
Medium LOCA (MLOCA)	4.0000E-05	5.2950E-09	1.6814E-08
Momentary Loss of Offsite Power (MLOSP)	7.5600E-03	3.1174E-10	1.7353E-09
Small LOCA (SLOCA)	5.0000E-04	9.4391E-10	2.0638E-10
General Transient (TRAN)	1.4300E+00	1.5265E-07	5.2211E-07
Very Small LOCA (VLOCA)	3.3800E-03	1.7677E-10	8.7151E-10
Total :	**2.0422E+00**	**3.9272E-07**	**2.2314E-06**

Table III-2
UNIT 3 INITIATING EVENT CONTRIBUTION TO LERF AND NLERF

Initiator	Initiator Frequency	LERF	NLERF
Break Outside Containment (BOC)	6.6700E-04	2.4042E-09	3.4935E-08
Excessive LOCA (ELOCA)	9.3900E-09	9.3900E-09	0.000
Flood in RB-1 (FLRB1)	1.2000E-02	5.6503E-10	3.0240E-09
Flood in RB-2 (FLRB2)	1.7000E-06	3.2237E-10	2.2632E-09
Flood in RB-3C (FLRB3C)	9.8000E-05	9.3115E-11	2.2441E-09
Flood in RB-3S (FLRB3S)	1.3371E-05	8.7919E-09	1.8453E-08
Large Flood in Turbine Building (FLTB)	2.2000E-03	4.1015E-09	1.5381E-08
Small Flood in Turbine Building (FLTB2)	1.4400E-02	1.5430E-08	9.1936E-08
Inadvertent Opening of One SRV (IOOV)	4.3600E-02	2.0367E-08	3.4940E-08
Inadvertent Opening of Two or More SRVs (IOTV)	3.4200E-04	7.9249E-11	2.8616E-09
Inadvertent SCRAM (ISCRAM)	2.5700E-01	4.3536E-09	8.9877E-08
Interfacing System LOCA (ISLOCA)	4.6400E-08	4.6400E-08	0.0000
Loss of 500kV to Plant (L500PA)	9.3200E-03	4.3329E-09	4.0315E-08
Loss of 500kV to Unit 3 (L500U3)	3.4200E-02	1.4141E-08	1.5443E-07
Loss of I&C Bus A (LICA)	4.1000E-03	1.7507E-09	1.9439E-08
Loss of I&C Bus B (LICB)	4.1000E-03	1.7512E-09	1.9448E-08
Core Spray Loop A Break (LLCA)	1.5700E-06	4.7168E-11	2.3921E-09
Core Spray Loop B Break (LLCB)	1.5700E-06	1.0449E-10	3.4438E-09
RHR Discharge Loop A Break (LLDA)	1.1000E-05	4.2487E-11	6.3383E-09
RHR Discharge Loop B Break (LLDB)	1.1000E-05	4.3401E-11	6.3723E-09
Other Large LOCA (LLO)	1.5700E-06	0.0000E+00	7.9686E-10
RHR Suction Loop A Break (LLSA)	7.8500E-07	0.0000E+00	3.6822E-10

Table III-2
UNIT 3 INITIATING EVENT CONTRIBUTION TO LERF AND NLERF

Initiator	Initiator Frequency	LERF	NLERF
RHR Suction Loop B Break (LLSB)	7.8500E-07	0.0000E+00	3.6822E-10
Loss of All Condensate (LOAC)	1.2400E-02	1.3035E-08	6.8310E-08
Loss of Condenser Heat Sink (LOCHS)	1.2000E-01	7.2909E-08	4.9392E-07
Loss of Feedwater (LOFW)	4.8100E-02	1.1020E-08	4.0440E-08
Loss of Plant Air (LOPA)	1.2000E-02	5.3094E-09	4.6221E-08
Loss of Offsite Power (LOSP)	7.1500E-03	3.1812E-08	1.0212E-06
Loss of RBCCW (LRBCCW)	1.1000E-02	5.6555E-09	5.4585E-08
Loss of RCW (LRCW)	7.9500E-03	1.4627E-08	6.5625E-08
Medium LOCA (MLOCA)	4.0000E-05	5.2222E-09	1.7101E-08
Momentary Loss of Offsite Power (MLOSP)	7.5600E-03	3.1715E-10	1.8133E-09
Small LOCA (SLOCA)	5.0000E-04	9.2893E-10	3.3082E-10
General Transient (TRAN)	1.4300E+00	1.5766E-07	5.4756E-07
Very Small LOCA (VLOCA)	3.3800E-03	1.7947E-10	9.1847E-10
Total :	**2.0422E+00**	**4.5319E-07**	**2.9077E-06**

B. Mapping of Plant Damage States

Each sequence that results in core damage is characterized by the status of the containment, the status of key plant systems and other conditions at the time of core damage. The containment is characterized as being either intact, bypassed, not isolated/failing early, or failing late. The early/late distinction is relative to the occurrence of the initiator. The classic BWR sequence “TW,” for example, is one in which that containment fails “late” due to the inability to cool the suppression pool, precipitating the loss of core cooling.

The plant damage state matrix developed in the BFNP IPE (Figure 4.6-1 of the IPE, Reference 12) was used to characterize the degraded core sequences. This formulation was useful because the available MAAP analyses and corresponding MACCS2 calculations followed this framework.

The base case results for Unit 2 and Unit 3 are shown in Tables III-3 and III-4, respectively. Note that some of the plant damage states have no frequency assigned to them. These represent combinations of conditions that either are physically impossible or forbidden by the model.

The key plant damage states are defined in Table III-5.

Common practice in a level 2 PSA is to consolidate the number of individual containment scenario analyses performed. This is analogous to the grouping of initiators into categories for the level 1 analysis. In a level 2 PSA, the reduced set of composite end states chosen are called “key plant damage states.” The eight key plant damage states are shown shaded in Figures III-1 and III-2 with arrows indicating the plant damage state grouping process. Note that the key plant damage states are the same as in the 1992 IPE (Reference 12).

Table III-3
INITIATING EVENT CONTRIBUTION TO KEY PLANT DAMAGE STATE FREQUENCY (UNIT 2)

UNIT 2 - Initiator	MIA	MKC	NIH	OIA	PID	PIH	PJH	PLF	Total
Break Outside Containment (BOC)	3.5214E-08	9.2345E-11	1.3379E-12	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.7677E-09	3.7076E-08
Excessive LOCA (ELOCA)	0.0000E+00	0.0000E+00	0.0000E+00	9.3900E-09	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	9.3900E-09
Flood in RB-1 (FLRB1)	2.5920E-09	3.9295E-10	0.0000E+00	1.2539E-11	0.0000E+00	0.0000E+00	0.0000E+00	4.5500E-10	3.4525E-09
Flood in RB-2 (FLRB2)	7.8304E-11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.2248E-11	1.1055E-10
Flood in RB-3C (FLRB3C)	2.2767E-09	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.7735E-11	2.2944E-09
Flood in RB-3S (FLRB3S)	0.0000E+00	3.8889E-11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.9766E-09	4.0155E-09
Large Flood in Turbine Building (FLTB)	1.1023E-08	2.8484E-10	9.2409E-11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.7976E-09	1.6198E-08
Small Flood in Turbine Building (FLTB2)	5.9063E-08	4.5758E-10	6.6299E-11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.5737E-08	7.5323E-08
Inadvertent Opening of One SRV (IOOV)	2.0222E-08	2.1075E-09	2.1177E-09	1.1770E-08	1.7570E-10	9.2472E-11	0.0000E+00	7.8351E-09	4.4321E-08
Inadvertent Opening of Two or More SRVs (IOTV)	0.0000E+00	1.2080E-11	0.0000E+00	2.0632E-09	0.0000E+00	2.2602E-10	0.0000E+00	3.1464E-10	2.6160E-09
Inadvertent SCRAM (ISCRAM)	7.2829E-08	0.0000E+00	1.6495E-10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.6880E-08	8.9874E-08
Interfacing System LOCA (ISLOCA)	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.6400E-08	0.0000E+00	4.6400E-08
Loss of 500kV to Plant (L500PA)	3.7561E-08	2.9920E-10	4.7815E-11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.2181E-09	3.9126E-08
Loss of 500kV to Unit 2 (L500U2)	1.4387E-07	1.3710E-09	2.5657E-10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	5.4579E-09	1.5095E-07
Loss of I&C Bus A (LICA)	1.6555E-08	5.8957E-10	7.8896E-12	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.9206E-09	2.1073E-08
Loss of I&C Bus B (LICB)	1.6563E-08	5.8957E-10	7.8940E-12	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.9209E-09	2.1082E-08
Core Spray Loop A Break (LLCA)	0.0000E+00	2.5789E-12	0.0000E+00	1.7270E-09	0.0000E+00	0.0000E+00	0.0000E+00	5.8805E-10	2.3176E-09
Core Spray Loop B Break (LLCB)	0.0000E+00	6.8574E-12	0.0000E+00	3.4574E-09	0.0000E+00	0.0000E+00	0.0000E+00	5.8612E-10	4.0504E-09

Table III-3
INITIATING EVENT CONTRIBUTION TO KEY PLANT DAMAGE STATE FREQUENCY (UNIT 2)

UNIT 2 - Initiator	MIA	MKC	NIH	OIA	PID	PIH	PJH	PLF	Total
RHR Discharge Loop A Break (LLDA)	0.0000E+00	2.3581E-11	0.0000E+00	1.9724E-09	0.0000E+00	0.0000E+00	0.0000E+00	4.5300E-09	6.5260E-09
RHR Discharge Loop B Break (LLDB)	0.0000E+00	2.3581E-11	0.0000E+00	6.8424E-10	0.0000E+00	0.0000E+00	0.0000E+00	4.5331E-09	5.2409E-09
Other Large LOCA (LLO)	0.0000E+00	2.7308E-12	0.0000E+00	1.9496E-10	0.0000E+00	0.0000E+00	0.0000E+00	5.9036E-10	7.8805E-10
RHR Suction Loop A Break (LLSA)	0.0000E+00	1.3654E-12	0.0000E+00	7.5110E-11	0.0000E+00	0.0000E+00	0.0000E+00	2.7808E-10	3.5456E-10
RHR Suction Loop B Break (LLSB)	0.0000E+00	1.3654E-12	0.0000E+00	7.5110E-11	0.0000E+00	0.0000E+00	0.0000E+00	2.7808E-10	3.5456E-10
Loss of All Condensate (LOAC)	5.0830E-08	4.1348E-10	1.8223E-11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.4890E-09	5.5751E-08
Loss of Condenser Heat Sink (LOCHS)	5.1860E-07	2.2488E-08	2.2011E-10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.0224E-08	5.7153E-07
Loss of Feedwater (LOFW)	4.7421E-08	1.9464E-09	3.6878E-11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.6807E-09	5.1085E-08
Loss of Plant Air (LOPA)	4.9601E-08	1.8886E-09	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.2861E-10	5.1719E-08
Loss of Offsite Power (LOSP)	4.3662E-07	9.0341E-10	2.1144E-08	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.3513E-08	4.8218E-07
Loss of RBCCW (LRBCCW)	4.6744E-08	1.7597E-09	4.6613E-11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.1527E-08	6.0077E-08
Loss of RCW (LRCW)	4.1054E-08	2.5708E-10	5.4211E-10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.5866E-08	6.7719E-08
Medium LOCA (MLOCA)	0.0000E+00	1.3090E-10	5.1438E-10	1.0723E-08	0.0000E+00	0.0000E+00	0.0000E+00	1.0740E-08	2.2109E-08
Momentary Loss of Offsite Power (MLOSP)	1.5552E-09	2.3969E-10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.5221E-10	2.0471E-09
Small LOCA (SLOCA)	2.2260E-10	1.5523E-11	7.5687E-12	8.5376E-10	1.7231E-11	0.0000E+00	0.0000E+00	3.3619E-11	1.1503E-09
General Transient (TRAN)	4.7925E-07	7.3980E-08	1.7519E-09	4.8412E-09	4.4655E-11	0.0000E+00	0.0000E+00	1.1489E-07	6.7476E-07
Very Small LOCA (VLOCA)	7.8489E-10	1.1862E-10	0.0000E+00	3.6167E-12	0.0000E+00	0.0000E+00	0.0000E+00	1.4115E-10	1.0483E-09
TOTAL	2.0905E-06	1.1044E-07	2.7045E-08	4.7844E-08	2.3759E-10	3.1849E-10	4.6400E-08	3.0130E-07	

Table III-4
INITIATING EVENT CONTRIBUTION TO KEY PLANT DAMAGE STATE FREQUENCY (UNIT 3)

UNIT 3 - Initiator	MIA	MKC	NIH	OIA	PID	PIH	PJH	PLF	Total
Break Outside Containment (BOC)	3.5275E-08	9.2244E-11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.9720E-09	3.7339E-08
Excessive LOCA (ELOCA)	0.0000E+00	0.0000E+00	0.0000E+00	9.3900E-09	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	9.3900E-09
Flood in RB-1 (FLRB1)	2.6124E-09	3.9252E-10	0.0000E+00	1.2525E-11	0.0000E+00	0.0000E+00	0.0000E+00	5.7169E-10	3.5891E-09
Flood in RB-2 (FLRB2)	1.9371E-09	0.0000E+00	2.4232E-11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	6.2426E-10	2.5856E-09
Flood in RB-3C (FLRB3C)	2.3195E-09	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.7716E-11	2.3372E-09
Flood in RB-3S (FLRB3S)	0.0000E+00	5.8324E-10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.6662E-08	2.7245E-08
Large Flood in Turbine Building (FLTB)	1.5570E-08	2.8325E-10	5.8447E-12	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.6235E-09	1.9483E-08
Small Flood in Turbine Building (FLTB2)	8.7448E-08	4.6401E-10	1.3264E-11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.9441E-08	1.0737E-07
Inadvertent Opening of One SRV (IOOV)	2.7272E-08	2.1363E-09	1.2003E-09	1.2163E-08	1.5918E-10	1.0578E-10	0.0000E+00	1.2272E-08	5.5308E-08
Inadvertent Opening of Two or More SRVs (IOTV)	0.0000E+00	2.4803E-11	0.0000E+00	2.4450E-09	0.0000E+00	8.8041E-11	0.0000E+00	3.8302E-10	2.9408E-09
Inadvertent SCRAM (ISCRAM)	7.2906E-08	0.0000E+00	8.2683E-11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.1242E-08	9.4231E-08
Interfacing System LOCA (ISLOCA)	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.6400E-08	0.0000E+00	4.6400E-08
Loss of 500kV to Plant (L500PA)	3.5335E-08	2.9031E-10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	9.0225E-09	4.4648E-08
Loss of 500kV to Unit 2 (L500U2)	1.3821E-07	1.2379E-09	3.0001E-11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.9096E-08	1.6857E-07
Loss of I&C Bus A (LICA)	1.5819E-08	5.8893E-10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.7823E-09	2.1190E-08
Loss of I&C Bus B (LICB)	1.5827E-08	5.8894E-10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.7828E-09	2.1199E-08
Core Spray Loop A Break (LLCA)	0.0000E+00	2.5761E-12	0.0000E+00	1.8316E-09	0.0000E+00	0.0000E+00	0.0000E+00	6.0511E-10	2.4393E-09
Core Spray Loop B Break (LLCB)	0.0000E+00	6.4086E-12	0.0000E+00	2.9375E-09	0.0000E+00	0.0000E+00	0.0000E+00	6.0442E-10	3.5483E-09
RHR Discharge Loop A Break (LLDA)	0.0000E+00	2.4560E-11	0.0000E+00	1.6814E-09	0.0000E+00	0.0000E+00	0.0000E+00	4.6748E-09	6.3808E-09
RHR Discharge Loop B Break (LLDB)	0.0000E+00	2.3555E-11	0.0000E+00	1.7157E-09	0.0000E+00	0.0000E+00	0.0000E+00	4.6764E-09	6.4157E-09

Table III-4
INITIATING EVENT CONTRIBUTION TO KEY PLANT DAMAGE STATE FREQUENCY (UNIT 3)

UNIT 3 - Initiator	MIA	MKC	NIH	OIA	PID	PIH	PJH	PLF	Total
Other Large LOCA (LLO)	0.0000E+00	2.7278E-12	0.0000E+00	1.8561E-10	0.0000E+00	0.0000E+00	0.0000E+00	6.0853E-10	7.9686E-10
RHR Suction Loop A Break (LLSA)	0.0000E+00	1.3639E-12	0.0000E+00	7.9633E-11	0.0000E+00	0.0000E+00	0.0000E+00	2.8722E-10	3.6822E-10
RHR Suction Loop B Break (LLSB)	0.0000E+00	1.3639E-12	0.0000E+00	7.9633E-11	0.0000E+00	0.0000E+00	0.0000E+00	2.8722E-10	3.6822E-10
Loss of All Condensate (LOAC)	7.5386E-08	4.1303E-10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	5.5468E-09	8.1346E-08
Loss of Condenser Heat Sink (LOCHS)	5.0950E-07	2.2488E-08	1.8188E-10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.4665E-08	5.6683E-07
Loss of Feedwater (LOFW)	4.7472E-08	1.9443E-09	3.7457E-11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.0056E-09	5.1459E-08
Loss of Plant Air (LOPA)	4.9317E-08	1.8877E-09	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.2626E-10	5.1531E-08
Loss of Offsite Power (LOSP)	8.9238E-07	7.2059E-10	1.1749E-07	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.2433E-08	1.0530E-06
Loss of RBCCW (LRBCCW)	4.4475E-08	1.7642E-09	1.1296E-11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.3991E-08	6.0241E-08
Loss of RCW (LRCW)	5.6688E-08	2.3819E-10	1.8594E-11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.3306E-08	8.0251E-08
Medium LOCA (MLOCA)	0.0000E+00	1.3207E-10	1.7286E-10	1.1161E-08	0.0000E+00	0.0000E+00	0.0000E+00	1.0857E-08	2.2323E-08
Momentary Loss of Offsite Power (MLOSP)	1.5613E-09	2.3943E-10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.2964E-10	2.1304E-09
Small LOCA (SLOCA)	2.9208E-10	1.5506E-11	1.7003E-12	8.5311E-10	1.7212E-11	0.0000E+00	0.0000E+00	8.0143E-11	1.2598E-09
General Transient (TRAN)	4.8157E-07	7.4019E-08	1.1438E-09	4.9827E-09	4.4606E-11	0.0000E+00	0.0000E+00	1.4346E-07	7.0523E-07
Very Small LOCA (VLOCA)	7.9260E-10	1.1849E-10	0.0000E+00	3.6127E-12	0.0000E+00	0.0000E+00	0.0000E+00	1.8325E-10	1.0979E-09
TOTAL	2.6100E-06	1.1073E-07	1.2041E-07	4.9521E-08	2.2100E-10	1.9382E-10	4.6400E-08	4.2342E-07	

Table III-5
DEFINITION OF KEY PLANT DAMAGE STATES (MAAP CASES) (REFERENCE 12)

MAAP Case	Description	Typical Sequence
MIA	Containment isolated, water available to core debris, drywell spray available, suppression pool cooling available, vessel at high pressure at time of melt with water on drywell floor	Flood in turbine building, failure of HPCI, RCIC and failure to depressurize. CRD is failed
MKC	Containment not isolated or failed early, water available to core debris, drywell spray available.	Transient with failure to scram reactor and failure of SLC
NIH	Containment isolated, water not available to core debris, vessel at high pressure at time of melt with no water on drywell floor	Loss of offsite power with no recovery and limited number of diesels available. RCIC is successful.
OIA	Containment isolated, water available to core debris, drywell spray available, suppression pool cooling available, vessel at low pressure at time of melt with water on drywell floor	Inadvertent opening of three or more SRVs followed by loss of injection
PID	Containment isolated, water not available to core debris, drywell spray not available, suppression pool cooling available, vessel at low pressure at time of melt with no water on drywell floor	MSIV closure followed by failure of battery boards 2 and 3; HPCI, RCIC and Feedwater are not available. One SRV is stuck open.
PIH	Containment isolated, water not available to core debris, drywell spray not available, suppression pool cooling not available, vessel at low pressure at time of melt with no water on drywell floor	Loss of offsite power with no recovery and failure of all onsite AC power sources. HPCI/RCIC run successfully until DC power source fails
PJH	Containment bypassed, water not available to core debris, vessel at low pressure at time of melt with no water on drywell floor	Interfacing system LOCA.
PLF	Containment failed late, water not available to core debris, drywell spray not available, suppression pool cooling not available, vessel at low pressure at time of melt with no water on drywell floor	Transient with loss of RHR function.

	INTACT (I)								BYPASSED (J)		NOT ISOLATED OR FAILED EARLY (K)			FAILED LATE (L)		
	A	B	C	D	E	F	G	H	A	H	C	F	H	C	F	H
M	MIA 1.5593E-006	MIB 4.9510E-007	MIC 5.4488E-009	MID	MIE	MIF	MIG	MIH	MJA	MJH	MKC 1.0746E-007	MKF	MKH	MLC 2.6155E-007	MLF	MLH
N	NIA	NIB	NIC	NID 3.0696E-008	NIE 8.1370E-009	NIF 2.2406E-010	NIG 1.8057E-008	NIH 1.1256E-010	NJA	NJH	NKC	NKF 2.7170E-009	NKH 7.2359E-011	NLC	NLF 4.4560E-009	NLH 1.0013E-008
O	OIA 3.2657E-008	OIB 1.0075E-008	OIC 4.3793E-009	OID 7.3345E-010	OIE	OIF 5.1438E-010	OIG	OIH	OJA	OJH	OKC 5.1336E-011	OKF 5.7780E-011	OKH 8.3839E-011	OLC 2.4579E-008	OLF 6.6991E-010	OLH
P	PIA	PIB	PIC	PID 2.3759E-010	PIE 3.1705E-010	PIF	PIG	PIH 1.4374E-012	PJA 4.6342E-008	PJH 5.8000E-011	PKC	PKF	PKH	PLC	PLF 3.6060E-011	PLH

Figure III-1
Browns Ferry Plant Damage State Matrix – Unit 2

	INTACT (I)								BYPASSED (J)		NOT ISOLATED OR FAILED EARLY (K)			FAILED LATE (L)		
	A	B	C	D	E	F	G	H	A	H	C	F	H	C	F	H
M	MIA 1.7102E-006	MIB 8.7061E-007	MIC 1.1711E-008	MID	MIE	MIF	MIG	MIH	MJA	MJH	MKC 1.0734E-007	MKF	MKH	MLC 3.8558E-007	MLF	MLH
N	NIA	NIB	NIC	NID 1.7477E-008	NIE 2.2507E-008	NIF 1.4273E-010	NIG 9.7134E-008	NIH 4.5474E-010	NJA	NJH	NKC	NKF 3.1457E-009	NKH 4.1790E-011	NLC	NLF 5.4799E-009	NLH 6.4680E-009
O	OIA 3.3911E-008	OIB 1.1002E-008	OIC 4.3782E-009	OID 2.2960E-010	OIE	OIF 1.7286E-010	OIG	OIH	OJA	OJH	OKC 5.7867E-011	OKF 5.7717E-011	OKH 7.9036E-011	OLC 2.5405E-008	OLF 4.5384E-010	OLH
P	PIA	PIB	PIC	PID 2.2100E-010	PIE 1.9382E-010	PIF	PIG	PIH 0.0000 E00	PJA 4.6342E-008	PJH 5.8000E-011	PKC	PKF	PKH	PLC	PLF 3.8046E-011	PLH

Figure III-2
Browns Ferry Plant Damage State Matrix – Unit 3

SECTION IV

DETERMINATION OF PRESENT VALUE

This section explains how the monetized value of the status quo (i.e., accident consequences without SAMA implementation) was calculated. This analysis was also used to establish the maximum benefit that a SAMA could achieve if it eliminated all BFNP risk. The following costs are included in the analysis:

1. Offsite exposure cost
2. Offsite economic cost
3. Onsite exposure cost
4. Onsite cleanup cost
5. Replacement power cost

The cost will be determined independently for both Unit 2 and Unit 3. Two real discount rates will be used in the calculations. A 7% discount rate will be used to reflect a “base case” discount rate and 3% will be used to provide analysis sensitivity to the discount rate, in accordance with Reference 10.

The sum of these costs will be used to screen out SAMAs that are not economically feasible; if the estimated cost of implementing a SAMA exceeds the maximum benefit, then it will be discarded from further analysis. Exceeding this threshold would mean that a SAMA would not have a positive net value even if it could reduce the core damage frequency to zero.

For the purposes of this analysis, the “present” is considered to be the year 2016. All constant dollar values from Reference 10 have been recalculated to the Year 2016 using a 3% inflation rate. Specifics are noted in the text to this section.

A. Offsite Exposure Cost

The baseline annual offsite exposure risk was converted to dollars using the United States Nuclear Regulatory Commission (USNRC) conversion factor of $2,000 per person-rem (Reference 10, Section 5.7.1.2), and discounting to present value using the USNRC standard formula (Reference 10, Section 5.7.1.3):

$$W_{pha} = C \times Z_{pha}$$

Where:

W_{pha}	=	monetary value of public health risk after discounting
C	=	discount factor $[1\text{-}\exp(-rt_f)]/r$
t_f	=	years remaining until end of facility life = 20 years
r	=	real discount rate (as fraction) = either 0.03 or 0.07/year
Z_{pha}	=	monetary value of public health (accident) risk per year before discounting ($/year)

The calculated value for C using 20 years with a 3% discount rate is 15.04 and with a 7% discount rate is 10.76. Therefore, calculating the discounted monetary equivalent of accident risk involves multiplying the dose (person-rem per year) by monetary value of unit dose (1 person/rem) and by the C value (Reference 10 Section 5.7.12). Since the “present” for this analysis is the Year 2016, the future value of $2,000 at a 3% inflation rate was calculated to be $3,097, which was used in this calculation. The calculated offsite exposure cost is for each of the units is presented in Table IV-1.

Table IV-1
CALCULATED OFFSITE EXPOSURE COST FOR UNITS 2 AND 3

Real Discount Rate	Unit 2		Unit 3	
	3%	7%	3%	7%
C	15.04	10.76	15.04	10.76
Z_{pha}	$5,082	$5,082	$6,032	$6,032
W_{pha}	$76,429	$54,695	$90,723	$64,925

B. Offsite Economic Cost

The annual offsite economic risk for the two units and discount rates is presented in Table IV-2. Calculated values for offsite economic costs caused by severe accidents must be discounted to present value as well. This is performed in the same manner as for public health risks and uses the same C value. The resulting values are also presented in Table IV-2.

Table IV-2
CALCULATED OFFSITE ECONOMIC COST FOR UNITS 2 AND 3

Real Discount Rate	Unit 2		Unit 3	
	3%	7%	3%	7%
C	15.04	10.76	15.04	10.76
Sum of Annual Economic Risk	$1,965	$1,965	$2,140	$2,140
Offsite Economic Costs	$29,555	$21,151	$32,137	$22,999

C. Onsite Exposure Cost

Occupational health costs were evaluated using the USNRC methodology in Reference 10, Section 5.7.3, which involves separately evaluating “immediate” and long-term doses.

Immediate Dose - The equation that the USNRC recommends using (Reference 10, Sections 5.7.3 and 5.7.3.3) is:

$$W_{IO} = R\{(FD_{IO})_S - (FD_{IO})_A\} \{[1 - \exp(-rt_f)]/r\}$$

Where:

W_{IO} = monetary value of accident risk avoided due to immediate doses, after discounting
R = monetary equivalent of unit dose ($/person-rem)
F = core damage frequency (events/yr)
D_{IO} = immediate occupational dose (person-rem/event)
S = subscript denoting status quo (current conditions)
A = subscript denoting after implementation of proposed action
r = real discount rate
t_f = years remaining until end of facility life.

The values used in the BFNP analysis are:

R = $3,097/person-rem ($2,000 inflation at 3% to 2016 values)
r = 0.03 and 0.07
D_{IO} = 3,300 person-rem/accident (best estimate)
t_f = 20 years (license extension period)
F = 2.62E-6 for Unit 2 and 3.36E-6 for Unit 3 (total core damage frequency, References 2 and 3)

For the basis discount rate, assuming $(FD_{IO})_A$ is zero, the best estimate of the immediate dose cost is:

$$W_{IO} = R\ (FD_{IO})_S\ \{[1 - \exp(-rt_f)]/r\}$$

The results of the immediate dose cost calculations are presented in Table IV-3.

Table IV-3
IMMEDIATE DOSE COST FOR UNITS 2 AND 3

Real Discount Rate	**Unit 2**		**Unit 3**	
	3%	**7%**	**3%**	**7%**
Core Damage Frequency (per year)	2.62E-6	2.62E-6	3.36E-6	3.36E-6
Immediate Dose Cost	$403	$289	$517	$370

<u>Long-Term Dose</u> - The USNRC equation (Reference 10, Sections 5.7.3 and 5.7.3.3) is:

$$W_{LTO} = R\{(FD_{LTO})_S - (FD_{LTO})_A\}\ \{[1 - \exp(-rt_f)]/r\}\{[1 - \exp(-rm)]/rm\}$$

Where:

W_{LTO} = monetary value of accident risk avoided long-term doses, after discounting, $
m = years over which long-term doses accrue

The values used in the BFNP analysis are:

R = $3,097/person-rem ($2,000 inflated at 3% to 2016 values)
r = 0.03 and 0.07
D_{LTO} = 20,000 person-rem/accident (best estimate)
m = “as long as 10 years”
t_f = 20 years (license extension period)
F = 2.62E-6 for Unit 2 and 3.36E-6 for Unit 3 (total core damage frequency, References 2 and 3)

For the basis discount rate, assuming $(FD_{LTO})_A$ is zero, the best estimate of the long-term dose is:

$$W_{LTO} = R\ (FD_{LTO})_S\ \{[1 - \exp(-rt_f)]/r\}\ \{[1 - \exp(-rm)]/rm\}$$

The results of the long-term dose cost calculations are presented in Table IV-4.

Table IV-4
LONG-TERM DOSE COST FOR UNITS 2 AND 3

Real Discount Rate	Unit 2		Unit 3	
	3%	**7%**	**3%**	**7%**
Core Damage Frequency (per year)	2.62E-6	2.62E-6	3.36E-6	3.36E-6
Long-term Dose Cost	$2,112	$1,258	$2,705	$1,611

Total Occupational Exposure - Combining Equations 1 and 2 above and using the above numerical values, the total accident related on-site (occupational) exposure avoided (W_O) is presented in Table IV-5.

$$W_O = W_{IO} + W_{LTO}$$

Table IV-5
TOTAL OCCUPATIONAL EXPOSURE COST FOR UNITS 2 AND 3

Real Discount Rate	Unit 2		Unit 3	
	3%	**7%**	**3%**	**7%**
Immediate Dose Cost	$403	$289	$517	$370
Long-term Dose Cost	$2,112	$1,258	$2,705	$1,611
Total Occupational Exposure Cost	$2,515	$1,547	$3,221	$1,981

D. Onsite Cleanup and Decontamination Cost

The net present value (year 2001 dollars) that the USNRC provides for cleanup and decontamination for a single event is $1.1 billion, discounted over a 10-year cleanup period (Reference 10, Section 5.7.6.1). The USNRC uses the following equation in integrating the net present value over the average number of remaining service years:

$$U_{CD} = [PV_{CD}/r][1-\exp(-rt_f)]$$

Where:

PV_{CD} = Net present value of a single event
r = real discount rate
t_f = years remaining until end of facility life.

The values used in the BFNP analysis are:

PV_{CD} = \$1.714E+9 (\$1.1E+9 inflated at 3% to 2016 values)
r = 0.03 and 0.07
t_f = 20

The resulting net present value of cleanup integrated over the license renewal term is multiplied by the total core damage frequency to determine the expected value of cleanup and decontamination costs. The resulting monetary equivalent is presented in Table IV-6.

Table IV-6
EXPECTED VALUE OF CLEANUP AND DECONTAINMENT
COSTS FOR UNITS 2 AND 3

Real Discount Rate	Unit 2		Unit 3	
	3%	7%	3%	7%
Net Present Value of Cleanup and Decontamination Costs	2.58+10	1.84E+10	2.58E+10	1.84E+10
Core Damage Frequency (per year, References 2 and 3)	2.62E-6	2.62E-6	3.36E-6	3.36E-6
Expected Value of Cleanup and Decontamination Costs	$67,635	$48,402	$86,625	$61,992

E. Replacement Power Cost

Long-term replacement power costs were determined following the USNRC methodology in Reference 10 Section 5.7.6.2. The net present value of replacement power for a single event, PV_{RP}, was determined using the following equation:

PV_{RP} = [$1.2E + 08/r] * [1 - exp(-rt$_f$)]^2 (2001 dollars)

PV_{RP} = [$1.9E + 08/r] * [1 - exp(-rt$_f$)]^2 (2016 dollars)

Where:

PV_{RP} = net present value of replacement power for a single event, ($). This yields a PV_{RP} for 2016 of $2.18E+9 at 3% and $1.52+9 at 7%.
r = 0.03 and 0.07
t_f = 20 years (license renewal period)

To attain a summation of the single-event costs over the entire license renewal period, the following equation is used:

U_{RP} = [PV_{RP} /$_r$] * [1 - exp(-rt$_f$)]^2 (r > 5%)
U_{RP^2} = 1.9E+10 (r =1%, 2001 dollars)

Where:

U_{RP} = net present value of replacement power over life of facility ($-year). Reference 10, Section 5.6.7.2 provides a recommended discount rate value of between 1.9E+10 at 1% and 1.2E+10 at 5%. A linear interpolation was made to determine the value (2001) of replacement power at a 3% discount rate. This value was inflated to 2016 values. This yields a U_{RP} for 2016 of $2.41E+10 for 3% and $1.23E+10 for 7%.

After applying a correction factor to account for BFNP's size relative to the "generic" reactor described in Reference 10 (i.e., 1190 MWe/910 MWe), the replacement power costs are presented in Table IV-7.

Table IV-7
EXPECTED REPLACEMENT POWER COSTS FOR UNITS 2 AND 3

Real Discount Rate	Unit 2		Unit 3	
	3%	7%	3%	7%
Net Present Value of Replacement Power over the Life of the Facility	2.41E+10	1.23E+10	2.41E+10	1.23E+10
Correction Factor for size	1.31	1.31	1.31	1.31
Replacement Power Cost	3.16E+10	1.61E+10	3.16E+10	1.61E+10
Core Damage Frequency (per year, References 2 and 3)	2.62E-6	2.62E-6	3.36E-6	3.36E-6
Expected Value Replacement Power Costs	$82,867	$42,184	$106,133	$54,027

F. Baseline Screening

The sum of the baseline costs is presented in Table IV-8.

Table IV-8
TOTAL COSTS FOR UNITS 2 AND 3

Real Discount Rate	Unit 2		Unit 3	
	3%	7%	3%	7%
Monetary Value of Public Health Risk After Discounting	$76,429	$54,695	$90,723	$64,925
Offsite Economic Costs	$29,555	$21,151	$32,137	$22,999
Total Accident on-site exposure avoided	$2,515	$1,547	$3,221	$1,981
Expected Value of Cleanup and Decontamination Costs	$67,635	$48,402	$86,625	$61,992
Replacement Power Costs	$82,867	$42,184	$106,133	$54,027
Total	$259,001	$167,979	$318,839*	$205,925

** The largest value in Table IV-8 is $318,839. Including the effects of restart of Unit 1, the maximum value for the three-unit plant is $1.9 million. This value was conservatively rounded to $6 million for initial screening of SAMAs that are not economically feasible; if the estimated cost of implementing a SAMA exceeded $6 million, it was discarded from further analysis. Exceeding this threshold means that a SAMA would not have a positive net value even if it could eliminate all severe accident costs associated with all three units, including the effect of PSA model uncertainty.*

SECTION V

SAMA CANDIDATES AND SCREENING PROCESS

A. Identification of BFNP-Specific SAMA Candidates

Modification options that comprise good SAMA candidates are those that address the major contributors to CDF or LERF. This section identifies BFNP-specific candidate SAMAs (denoted with an identifier "Bxx") as well as "generic" candidate SAMAs (denoted with an identifier "Gxx") adopted from other SAMA-related submittals.

The results of a quantified RISKMAN® model are stored in the form of a database. This database contains all sequences quantified in the model and these sequences are assigned to unique endstates. The model was quantified with each sequence assigned to three possible endstates: success; LERF; or, NLERF ("not LERF").

B. Contributors to Core Damage Frequency

The databases (one for Unit 2 and one for Unit 3) were queried to identify contributors (ranked by relative contribution) to total core damage frequency. The categories were:

1. Failure of MFW/HPCI/RCIC short term and failure of the operator to timely depressurize
2. Failure of MFW/HPCI/RCIC short term and hardware failures preventing timely depressurization.
3. Station Blackout
4. ATWS with failure to control pressure (allowing an uncontrolled injection by low pressure systems)
5. ATWS with failure of the operator to initiate SLC in a timely manner
6. ATWS with hardware failure of SLC
7. Interfacing system LOCA
8. TW (successful operation of HPCI/RCIC for 6 hours but failure of suppression pool cooling)
9. Other failures (operator action) of suppression pool cooling
10. Degraded electrical power conditions (e.g., two Unit 1/2 or two Unit 3 diesel failures)

These categories of sequences represent approximately 88% and 95% of the total core damage frequency for Units 2 and 3, respectively.

C. Contributors to Large Early Release Frequency

In a similar manner, the following categories of scenarios contributing to LERF (ranked by relative contribution) were investigated:

1. ATWS with failure of the operator to initiate SLC in a timely manner
2. Failure of MFW/HPCI/RCIC short term and failure to depressurize (with failed containment)
3. Interfacing system LOCA
4. ATWS with hardware failure of SLC
5. ATWS with failure to control pressure (allowing an uncontrolled injection by low pressure systems)
6. ATWS with failure to control low pressure injection (following successful pressure control)
7. ATWS with failure of suppression pool cooling
8. ATWS with RHR pump failure
9. Excessive LOCA
10. LOCA with loss of level control

These categories contribute approximately 95% of the LERF for both units 2 and 3

Table V-1 provides a list of BFNP-specific SAMA candidates based on the preceding review process.

Table V-1
BFNP-SPECIFIC CANDIDATE SAMAs

SAMA Case Number	Description
B01	Improve Reliability of Automatic Depressurization System (ADS)
B02	Improve Reliability Of HPCI And RCIC
B03	Improve Hardware Reliability Of SRVs
B04	Station Blackout: Improve Reliability Of One Diesel
B05	Control Pressure During ATWS
B06	Automatic Initiation Of SLC (ATWS)
B07	Improve Hardware Reliability Of SLC (ATWS)
B08A	Decrease Frequency Of Interfacing Systems LOCA (hardware modification)
B08B	Decrease Frequency of Interfacing Systems LOCA (operational)
B09	Improve Suppression Pool Cooling Reliability for Transients (Non-ATWS)
B10	Automatic Initiation Of Suppression Pool Cooling
B11	Improve DC Reliability
B12	Improve Level Control (ATWS)
B13	Improve Suppression Pool Cooling (ATWS)
B14	Reduce Frequency Of Excessive LOCA
B15	Add Motor Drive Startup Feedwater Pump
B16	Mitigate Fire Risk
B17	Mitigate Earthquake Effects
B18	Implement Internal Flood Prevention and Mitigation Enhancements
B19	Mitigate Effects of High Winds, Floods, Transportation, and Other External Events

Each BFNP-specific SAMA was assumed to pass the Phase I screening and is explicitly evaluated in Phase II. These SAMAs, along with three SAMAs derived from the BFNP Individual Plant Examination of External Events (IPEEE) (References 4 through 7) are listed in Table V-2.

A list of generic SAMAs is provided in Table V-2. This list was screened to remove those that met any of the criteria footnoted in that table.

This screening process leaves unique SAMAs that are applicable to BFNP and are of potential value in averting the risk of severe accidents. An implementation cost estimate was prepared for each of these candidates based on previous design/procedural modifications of similar scope to focus on those that had the possibility of having a positive benefit and to eliminate those whose costs were clearly beyond the possibility of any corresponding benefit.

The list of generic SAMAs and their initial screening is provided in Table V-2.

Table V-2
INITIAL SCREENING OF GENERIC SAMAs

SAMA ID Number	SAMA Title	Description of Potential Enhancement	Screening Criterion*	Reference Paragraph Number
1	Cap downstream piping of normally closed component cooling water drain and vent valves.	SAMA to reduce the frequency of a loss of component cooling event, a large portion of which was derived from catastrophic failure of one of the many single isolation valves.	N/A	N/A
2	Enhance loss of component cooling procedure to facilitate stopping reactor coolant pumps.	SAMA to reduce the potential for RCP seal damage due to pump bearing failure.	B	N/A
3	Enhance loss of component cooling procedure to present desirability of cooling down RCS prior to seal LOCA.	SAMA would reduce the potential for RCP seal failure.	B	N/A
4	Additional training on the loss of component cooling.	SAMA would potentially improve the success rate of operator actions after a loss of component cooling (to prevent RCP seal damage).	B	N/A
5	Provide hardware connections to allow another essential raw cooling water system to cool charging pump seals.	SAMA would reduce effect of loss of component cooling by providing a means to maintain the centrifugal charging pump seal injection after a loss of component cooling.	B	N/A
5A	Procedure changes to allow cross connection of motor cooling for RHRSW pumps.	SAMA would allow continued operation of both RHRSW pumps on a failure of one train of PSW.	N/A	N/A
6	On loss of essential raw cooling water, proceduralize shedding component cooling water loads to extend component cooling heatup.	SAMA would increase time before the loss of component cooling (and reactor coolant pump seal failure) in the loss of essential raw cooling water sequences.	B	N/A
7	Increase CRD pump lube oil capacity.	SAMA would lengthen the time before control rod drive (CRD) pump failure due to lube oil	None	Phase II Generic SAMA G01
8	Eliminate the RCP thermal barrier dependence on component cooling such that loss of component cooling does not result directly in core damage.	SAMA would prevent the loss of recirculation pump seal integrity after a loss of component cooling. Watts Bar Nuclear Plant IPE said that they could do this with essential raw cooling water connection to charging pump seals.	B	N/A
9	Add redundant DC Control Power for SW Pumps.	SAMA would increase reliability of SW and decrease core damage frequency due to a loss of SW. Relevant, potential concern at BFNP is loss of DC-D	D	SAMA 57

Table V-2
INITIAL SCREENING OF GENERIC SAMAs

SAMA ID Number	SAMA Title	Description of Potential Enhancement	Screening Criterion*	Reference Paragraph Number
10	Create an independent RCP seal injection system, with a dedicated diesel.	SAMA would add redundancy to RCP seal cooling alternatives, reducing CDF from loss of component cooling or service water or from a station blackout event.	B	N/A
11	Use existing hydro test pump for RCP seal injection.	SAMA would provide an independent seal injection source, without the cost of a new system.	B	N/A
12	Replace ECCS pump motor with passively cooled motors.	SAMA would eliminate ECCS dependency on EECW.	None	Phase II Generic SAMA G02
13	Install improved RCS pumps seals.	RCP seal O-ring constructed of improved materials would reduce probability of RCP seal LOCA	B	N/A
14	Install additional component cooling water pump.	SAMA would reduce probability of loss of component cooling leading to RCP seal LOC*A.*	B	N/A
15	Prevent centrifugal charging pump flow diversion from the relief valves.	If relieve valve opening causes a flow diversion large enough to prevent RCP seal injection, then the modification would reduce the frequency of the loss of RCP seal cooling.	B	N/A
16	Change procedures to isolate RCP seal letdown flow on loss of component cooling, and guidance on loss of injection during seal LOCA.	SAMA would reduce CDF from loss of seal cooling.	B	N/A
17	Implement procedures to stagger CRD pump use after a loss of service water.	SAMA would allow injection with CRD to be extended after a loss of service water.	None	Phase II Generic SAMA G03
18	Use fire protection system pumps as a backup seal injection and high pressure make-up.	SAMA would reduce the frequency of the RCP seal LOCA and the SBO CDF.	B	N/A
19	Procedural guidance for use of cross-tied component cooling or service water pumps.	SAMA would reduce the frequency of the loss of component cooling water and service water.	None	Phase II Generic SAMA G04
20	Procedure enhancements and operator training in support system failure sequences, with emphasis on anticipating problems and coping.	SAMA would potentially improve the success rate of operator actions subsequent to support system failures.	None	Phase II Generic SAMA G05

Table V-2
INITIAL SCREENING OF GENERIC SAMAs

SAMA ID Number	SAMA Title	Description of Potential Enhancement	Screening Criterion*	Reference Paragraph Number
21	Improved ability to cool the residual heat removal heat exchangers	SAMA would reduce the probability of a loss of decay heat removal by implementing procedure and hardware modifications to allow manual alignment of the fire protection system or by installing a component cooling water crosstie.	None	Phase II Generic SAMA G06
22	Provide reliable power to Control Building fans	SAMA would increase availability of control room ventilation on a loss of power.	N/A	Control Bay HVAC was not a critical function represented in the BFNP models
23	Provide a redundant train of ventilation.	SAMA would increase the availability of components dependent on room cooling.	None	Phase II Generic SAMA G07
24	Procedures for actions on loss of HVAC.	SAMA would provide for improved electrical equipment reliability upon a loss of Control Building HVAC)	C	N/A
25	Add a diesel building switchgear room high temperature alarm.	SAMA would improve diagnosis of a loss of switchgear room HVAC. Option 1: Install high temp alarm Option 2: Redundant louver and thermostat	None	Phase II Generic SAMA G08
26	Create ability to switch fan power supply to direct current (DC) in an SBO event.	SAMA would allow continued operation in an SBO event. This SAMA was created for reactor core isolation cooling system room at Fitzpatrick Nuclear Power Plant.	N/A	N/A
27	Delay containment spray actuation after large LOCA.	SAMA would lengthen time of RWST availability.	N/A	N/A
28	Install containment spray pump header automatic throttle valves.	SAMA would extend the time over which water remains in the RWST, when full CS flow is not needed	N/A	N/A
29	Install an independent method of suppression pool cooling.	SAMA would decrease the probability of loss of containment heat removal.	D	Phase II BFNP-specific SAMA B09
30	Develop an enhanced drywell spray system.	SAMA would provide a redundant source of water to the containment to control containment pressure, when used in conjunction with containment heat removal.	D	SAMA 46
31	Provide dedicated existing drywell spray system.	SAMA would provide a source of water to the containment to control containment pressure, when used in conjunction with containment heat removal. This would use an existing spray loop instead of developing a new spray system.	C	N/A

Table V-2
INITIAL SCREENING OF GENERIC SAMAs

SAMA ID Number	SAMA Title	Description of Potential Enhancement	Screening Criterion*	Reference Paragraph Number
32	Install an unfiltered hardened containment vent.	SAMA would provide an alternate decay heat removal method for non-ATWS events, with the released fission products not being scrubbed.	C	N/A
33	Install a filtered containment vent to remove decay heat.	SAMA would provide an alternate decay heat removal method for non-ATWS events, with the released fission products being scrubbed. Option 1: Gravel Bed Filter Option 2: Multiple Venturi Scrubber	E	Cost in excess of $6M per plant
34	Install a containment vent large enough to remove ATWS decay heat.	Assuming that injection is available, this SAMA would provide alternate decay heat removal in an ATWS event.	None	Phase II Generic SAMA G09
35	Create/enhance hydrogen recombiners with independent power supply.	SAMA would reduce hydrogen detonation at lower cost, Use either a new, independent power supply, a nonsafety-grade portable generator, existing station batteries, or existing AC/DC independent power supplies.	N/A	N/A
35A	Install hydrogen recombiners.	SAMA would provide a means to reduce the chance of hydrogen detonation.	N/A	N/A
36	Create a passive design hydrogen ignition system.	SAMA would reduce hydrogen denotation system without requiring electric power.	N/A	N/A
37	Create a large concrete crucible with heat removal potential under the basemat to contain molten core debris.	SAMA would ensure that molten core debris escaping form the vessel would be contained within the crucible. The water cooling mechanism would cool the molten core, preventing a melt-through of the basemat.	E	Cost well in excess of $6M per plant
38	Create a water-cooled rubble bed on the pedestal.	SAMA would contain molten core debris dropping on to the pedestal and would allow the debris to be cooled.	E	Cost well in excess of $6M per plant

Table V-2
INITIAL SCREENING OF GENERIC SAMAs

SAMA ID Number	SAMA Title	Description of Potential Enhancement	Screening Criterion*	Reference Paragraph Number
39	Provide modification for flooding the drywell head.	SAMA would help mitigate accidents that result in the leakage through the drywell head seal.	N/A	Containment failure dominated by wet well failure or dry well shell failure other than head region (BFNP IPE NUREG-1150)*
40	Enhance fire protection system and/or standby gas treatment system hardware and procedures.	SAMA would improve fission product scrubbing in severe accidents.	C	N/A
41	Create a reactor cavity flooding system.	SAMA would enhance debris coolability, reduce core concrete interaction, and provide fission product scrubbing.	C	N/A
42	Create other options for reactor cavity flooding.	SAMA would enhance debris coolability, reduce core concrete interaction, and provide fission product scrubbing.	D	SAMA 41
43	Enhance air return fans (ice condenser plants).	SAMA would provide an independent power supply for the air return fans, reducing containment failure in SBO sequences.	N/A	N/A
44	Create a core melt source reduction system.	SAMA would provide cooling and containment of molten core debris. Refractory material would be placed underneath the reactor vessel such that a molten core falling on the material would melt and combine with the material. Subsequent spreading and heat removal from the vitrified compound would be facilitated, and concrete attack would not occur.	E	Cost well in excess of $6M per plant
45	Provide a containment inerting capability.	SAMA would prevent combustion of hydrogen and carbon monoxide gases.	C	N/A

* *Reference 16*

Table V-2
INITIAL SCREENING OF GENERIC SAMAs

SAMA ID Number	SAMA Title	Description of Potential Enhancement	Screening Criterion*	Reference Paragraph Number
46	Use the fire protection system as a back-up source for the containment spray system.	SAMA would provide redundant containment spray function without the cost of installing a new system.	None	Phase II Generic SAMA G10
47	Install a secondary containment filter vent.	SAMA would filter fission products released from primary containment.	C	N/A
48	Install a passive containment spray system.	SAMA would provide redundant containment spray method without high cost.	None	Phase II Generic SAMA G11
49	Strengthen primary/secondary containment.	SAMA would reduce the probability of containment overpressurization to failure.	E	Cost well in excess of $6M per plant
50	Increase the depth of the concrete basemat or use an alternative concrete material to ensure melt-through does not occur.	SAMA would prevent basemat melt-through.	N/A	N/A
51	Provide a reactor vessel exterior cooling system.	SAMA would provide the potential to cool a molten core before it causes vessel failure, if the lower head could be submerged in water.	E	Cost well in excess of $6M per plant
52	Construct a building to be connected to primary/secondary containment that is maintained at a vacuum.	SAMA would provide a method to depressurize containment and reduce fission product release.	E	Cost well in excess of $6M per plant
53	Not Used	None	N/A	N/A
54	Proceduralize alignment of spare diesel to shutdown board after Loss of Offsite Power and failure of the diesel normally supplying it.	SAMA would reduce the SBO frequency.	N/A	N/A
55	Not Used	None	N/A	N/A
56	Provide an additional diesel generator.	SAMA would increase the reliability and availability of onsite emergency AC power sources.	F	N/A
57	Provide additional DC battery capacity	SAMA would ensure longer battery capability during an SBO, reducing the frequency of long-term SBO sequences.	None	Phase II Generic SAMA G12
58	Use fuel cells instead of lead-acid batteries.	SAMA would extend DC power availability in an SBO.	None	Phase II Generic SAMA G12

Table V-2
INITIAL SCREENING OF GENERIC SAMAs

SAMA ID Number	SAMA Title	Description of Potential Enhancement	Screening Criterion*	Reference Paragraph Number
59	Procedure to crosstie high pressure core spray diesel.	SAMA would improve core injection availability by providing a more reliable power supply for the high pressure core spray pumps.	N/A	N/A
60	Improve 4.16 kV bus crosstie ability.	SAMA would improve AC power reliability.	C	N/A
61	Incorporate an alternate battery charging capability.	SAMA would improve DC power reliability by either cross-tying the AC buses, or installing a portable diesel-driven batter charger.	None	Phase II Generic SAMA G13
62	Increase/improve DC bus load shedding.	SAMA would extend battery life in an SBO event.	G	N/A
63	Replace existing batteries with more reliable ones.	SAMA would improve DC power reliability and thus increase available SBO recovery time.	None	Phase II Generic SAMA G13
63A	Mod for DC Bus A reliability Loss of DC Bus A causes a loss of main condenser, prevents transfer from the main transformer to offsite power, and defeats one half of the low vessel pressure permissive for LPCI/CS injection valves.	SAMA would increase the reliability of AC power and injection capability.	N/A	Loss of DC bus does not cause plant trip at BFNP
64	Create AC power crosstie capability with other unit.	SAMA would improve AC power reliability.	C	N/A
65	Create a crosstie for diesel fuel oil.	SAMA would increase diesel fuel oil supply and thus diesel generator, reliability.	C	N/A
66	Develop procedures to repair or replace failed 4 kV breakers.	SAMA would offer a recovery path from a failure of the breakers that perform transfer of 4.16kV non-emergency busses from unit station service transformers, leading to loss of emergency AC power.	None	Phase II Generic SAMA G14
67	Emphasize steps in recovery of offsite power after an SBO.	SAMA would reduce human error probability during offsite power recovery.	C	N/A
68	Develop a severe weather conditions procedure.	For plants that do not already have one, this SAMA would reduce the CDF for external weather-related events.	C	N/A
69	Develop procedures for replenishing diesel fuel oil.	SAMA would allow for long-term diesel operation.	C	N/A

Table V-2
INITIAL SCREENING OF GENERIC SAMAs

SAMA ID Number	SAMA Title	Description of Potential Enhancement	Screening Criterion*	Reference Paragraph Number
70	Install gas turbine generator.	SAMA would improve onsite AC power reliability by providing a redundant and diverse emergency power system.	E	Cost greater than $6M for plant
71	Not Used	None	N/A	N/A
72	Create a back-up source for diesel cooling. (Not from existing system)	This SAMA would provide a redundant and diverse source of cooling for the diesel generators which would contribute to enhanced diesel reliability.	E	Cost greater than $6M for plant
73	Use Fire Protection System as a back-up source for diesel cooling.	This SAMA would provide a redundant and diverse source of cooling for the diesel generators which would contribute to enhanced diesel reliability.	None	Phase II Generic SAMA G15
74	Provide a connection to an alternate source of offsite power.	SAMA would reduce the probability of a loss of offsite power event.	F	N/A
75	Bury offsite power lines.	SAMA could improve offsite power reliability, particularly during severe weather.	E	Cost greater than $6M for plant
76	Replace anchor bolts on diesel generator oil cooler. Millstone Nuclear Power Station found a high seismic SBO risk due to failure of the diesel oil cooler anchor bolts.	For plants with a similar problem, this would reduce seismic risk. Note that these were Fairbanks Morse DGs.	D	SAMA 114
77	Change Undervoltage (UV), Auxiliary Feedwater Actuation Signal (AFAS) Block and High Pressurizer Pressure Actuation Signals to 3-out-of-4, instead of 2-out-of-4 logic.	SAMA would reduce risk of 2/4 inverter failure.	N/A	N/A
78	Provide DC power to the 120/240 V vital AC system from the Class 1E station service battery system instead of its own battery.	SAMA would increase the reliability of the 120 VAC Bus.	N/A	N/A
79	Install a redundant spray system to depressurize the primary system during a steam generator tube rupture (SGTR).	SAMA would enhance depressurization during a SGTR.	N/A	N/A
80	Improve SGTR coping abilities.	SAMA would improve instrumentation to detect SGTR, or additional system to scrub fission product releases.	N/A	N/A
81	Add other SGTR coping abilities.	SAMA would decrease the consequences of an SGTR.	N/A	N/A

Table V-2
INITIAL SCREENING OF GENERIC SAMAs

SAMA ID Number	SAMA Title	Description of Potential Enhancement	Screening Criterion*	Reference Paragraph Number
82	Increase secondary side pressure capacity such that an SGTR would not cause the relief valves to lift.	SAMA would eliminate direct release pathway for SGTR sequences.	N/A	N/A
83	Replace steam generators (SG) with a new design.	SAMA would lower the frequency of an SGTR.	N/A	N/A
84	Revise emergency operating procedures to direct that a faulted SG be isolated.	SAMA would reduce the consequences of an SGTR.	N/A	N/A
85	Direct SG flooding after a SGTR, prior to core damage.	SAMA would provide for improved scrubbing of SGTR releases.	N/A	N/A
86	Implement a maintenance practice that inspects 100% of the tubes in an SG.	SAMA would reduce the potential for an SGTR.	N/A	N/A
87	Locate RHR inside of containment.	SAMA would prevent ISLOCA out the RHR pathway.	E	Cost greater than $6M per plant
88	Not Used.	None	N/A	N/A
89	Install additional instrumentation for ISLOCAs.	Pressure of leak monitoring instruments installed between the first two pressure isolation valves on low-pressure inject lines, RHR suction lines, and HPSI lines would decrease ISLOCA frequency.	D	Phase II BFNP-specific SAMA B08B
90	Increase frequency for valve leak testing.	SAMA could reduce ISLOCA frequency.	D	Phase II BFNP-specific SAMA B08B
91	Improve operator training on ISLOCA coping.	SAMA would decrease ISLOCA effects.	D	Phase II BFNP-specific SAMA B08B
92	Install relief valves in the CC System.	SAMA would relieve pressure buildup from an RCP thermal barrier tube rupture, preventing an ISLOCA.	N/A	N/A
93	Provide leak testing of valves in ISLOCA paths. At Kewaunee Nuclear Power Plant, four MOVs isolating RHR from the RCS were not leak tested.	This SAMA would help reduce ISLOCA frequency.	D	Phase II BFNP-specific SAMA B08B

Table V-2
INITIAL SCREENING OF GENERIC SAMAs

SAMA ID Number	SAMA Title	Description of Potential Enhancement	Screening Criterion*	Reference Paragraph Number
94	Revise EOPs to improve ISLOCA identification. Salem Nuclear Power Plant had a scenario where an RHR ISLOCA could direct initial leakage back to the pressurizer relief tank, giving indication that the LOCA was inside containment.	Procedure enhancements would ensure LOCA outside containment could be identified as such.	D	Phase II BFNP-specific SAMA B08B
95	Ensure all ISLOCA releases are scrubbed.	This SAMA would scrub all ISLOCA releases. One example is to plug drains in the break area so that the break point would cover with water.	D	Phase II BFNP-specific SAMA B08B
96	Add redundant and diverse limit switches to each containment isolation valve.	Enhanced isolation valve position indication could reduce the frequency of containment isolation failure and ISLOCAs.	D	Phase II BFNP-specific SAMA B08B
97	Modify swing direction of doors separating turbine building basement from areas containing safeguards equipment.	SAMA would prevent flood propagation, for a plant where internal flooding from turbine building to safeguards areas is a concern.	N/A	Doors open into turbine building. No flooding scenarios propagating from turbine building to safeguards area (BFNP IPE)
98	Improve inspection of rubber expansion joints on main condenser.	SAMA would reduce the frequency of internal flooding, for a plant where internal flooding due to a failure of circulating water system expansion joints is a concern.	None	Phase II Generic SAMA G16
99	Implement internal flood prevention and mitigation enhancements.	This SAMA would reduce the consequences of internal flooding.	D	Phase II BFNP-specific SAMA B18
100	Implement internal flooding improvements such as those implemented at Fort Calhoun.	This SAMA would reduce flooding risk by preventing or mitigating: a rupture in the RCP seal cooler of the component cooling system an ISLOCA in a shutdown cooling line, an AFW flood involving the need to remove a watertight door.	N/A	N/A
101	Install a digital feedwater upgrade.	This SAMA would reduce the chance of a loss of main feedwater following a plant trip.	C	N/A
102	Perform surveillances on manual valves used for back-up AFW pump suction.	This SAMA would improve success probability for providing alternative water supply to the AFW pumps.	N/A	N/A

Table V-2
INITIAL SCREENING OF GENERIC SAMAs

SAMA ID Number	SAMA Title	Description of Potential Enhancement	Screening Criterion*	Reference Paragraph Number
103	Install manual isolation valves around AFW turbine-driven steam admission valves.	This SAMA would reduce the dual turbine-driven AFW pump maintenance unavailability.	N/A	N/A
104	Install accumulators for turbine-driven AFW pump flow control valves (CVs).	This SAMA would provide control air accumulators for the turbine-driven AFW flow CVs, the motor-driven AFW pressure CVs and SG PORVs. This would eliminate the need for LOCA manual action to align nitrogen bottles for control air during a LOOP.	N/A	N/A
105	Proceduralize intermittent operation of HPCI.	SAMA would allow for extended duration of HPCI availability.	C	If RCIC is available, HPCI used in test mode to control pressure and avoid cycling.
106	Increase the reliability of safety relief valves. (Adding signals to add electrical signal to open automatically).	SAMA reduces the probability of a certain type of medium break LOCA. Hatch evaluates medium LOCA initiated by an MSIV closure transient with a failure of SRVs to open. Reducing the likelihood of the failure for SRVs to open subsequently reduces the occurrence of this medium LOCA.	C	N/A
107	Install motor-driven feedwater pump.	This would increase the availability of injection subsequent to MSIV closure.	D	Phase II BFNP-specific SAMA B15
108	Procedure to instruct operators to trip unneeded RHR/CS pumps on loss of room ventilation.	SAMA increases availability of required RHR/CS pumps. Reduction in room heat load allows continued operation of required RHR/CS pumps, when room cooling is lost.	None	Phase II Generic SAMA G17
109	Increase available NPSH for injection pumps.	SAMA increases the probability that these pumps will be available to inject coolant into the vessel by increasing the available NPSH for the injection pumps.	C	NPSH concerns are not a concern in the dominant BFNP sequences. RHR has been demonstrated to operate satisfactorily at less than “minimum” NPSH. Torus water temperature leading to loss of lube oil cooling rather than NPSH, is a limiting concern for HPCI and RCIC

Table V-2
INITIAL SCREENING OF GENERIC SAMAs

SAMA ID Number	SAMA Title	Description of Potential Enhancement	Screening Criterion*	Reference Paragraph Number
110	Increase the SRV reseat reliability.	SAMA addresses the risk associated with dilution of boron caused by the failure of the SRVs to reseat after SLC injection.	None	Phase II Generic SAMA G18
111	Reduce DC dependency between high pressure injection system and ADS.	SAMA would ensure vessel depressurization and high pressure injection upon a DC failure.	None	Phase II Generic SAMA G19
112	Modify RWCU for use as a decay heat removal system and proceduralize use.	SAMA would provide an additional source of decay heat removal.	C	N/A
113	Use of CRD for alternate boron injection.	SAMA provides an additional system to address ATWS with SLC failure or unavailability.	None	Phase II Generic SAMA G20
114	Increase seismic ruggedness of plant components.	SAMA would increase the availability of necessary plant equipment during and after seismic events.	D	See discussion on external events
115	Allow cross connection of uninterruptable compressed air supply to opposite unit.	SAMA would increase the ability to depressurize containment using the hardened vent.	N/A	N/A
116	Use Fire Protection as a backup source of RPV injection water	SAMA would increase diversity of supplies of RPV injection	C	N/A

**Note:*
None indicates that the proposed SAMA was not screened and is therefore evaluated as a phase II SAMA.
N/A indicates that the proposed SAMA is not applicable to BFNP or the BWR-4/Mark I design.
A reserved.
B indicates that the proposed SAMA is related to RCP seal leakage. A review of NUREG-1560 (Reference 13) indicates that although RCP seal leakage is important for PWRs, recirculation pump leakage does not significantly contribute to CDF in BWRs.
C indicates that the proposed SAMA has already been installed at BFNP.
D indicates that similar item is addressed under other proposed SAMAs.
E indicates that SAMA did not pass initial cost screening and was therefore not examined in detail.
F Primary cause of loss of existing, redundant hardware is due to a common cause event, which another string of hardware would not alleviate.
G The SBO coping time is 4 hours (Section 8.10 of Reference 19). By engineering judgment, it is deemed unlikely that the capacity of the unit batteries can be extended for a significant time.

SECTION VI
SAMA ANALYSIS RESULTS FOR BFNP

A. Summary of Phase II SAMA Analysis

A summary of Phase II SAMAs is shown in Table VI-1 and Table VI-2.

SAMA hardware implementation costs were first estimated in 2003 dollars and are based on costs of previous modifications judged to be similar in scope to the proposed SAMA (Reference 17). New or revised procedures were estimated to cost $50K per unit. These values were then inflated (at 3%/year) to arrive at Year 2016 estimated costs. This step is necessary to make the costs directly comparable to estimate costs averted.

Figure VI-1 presents a sample table of results that summarizes the comparison of the baseline PRA results and the PRA results of each SAMA.

Table VI-1 shows the disposition of the 19 BFNP-specific SAMAs. Table VI-2 shows the disposition of the 20 Phase II Generic SAMAs.

Baseline PRA Results

SAMA PRA Results

MAAP Case	Baseline Case	SAMA B01 Case
MIA	2.09E-06	5.60E-07
MKC	1.10E-07	1.10E-07
NIH	2.70E-08	2.63E-08
OIA	4.78E-08	4.78E-08
PID	2.38E-10	2.38E-10
PIH	3.18E-10	3.18E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	3.01E-07
Person-rem	1.64	1.09
Unit 2 Total Cost (3%)	$259,002	$141,022
Unit 2 Total Cost (7%)	$167,979	$93,683
SAMA 01 Saving (3%)	$ 117,980	
SAMA 01 Saving (7%)	$ 74,296	

Total cost for Baseline Case

Savings = Baseline case – SAMA case, e.g., $259,002 - $141,022 = $117,980

Total cost with SAMA Implemented

Figure VI-1
Sample Table of Results

Table VI-1
SUMMARY OF PHASE II PLANT-SPECIFIC SAMA ANALYSIS

BFNP-specific Candidate SAMA	SAMA Title	Result of Potential Enhancement	Estimated Cost (2003)	Estimated Cost (2016)	Phase II Disposition
B01	Automatic Depressurization	Improve reliability of Automatic Depressurization System (ADS)	$1M/unit	$1.5M/unit	See Section VI.B.1
B02	Improve Reliability Of HPIC And RCIC	Add redundant train	$5M/unit	$7.3M/unit	See Section VI.B.2
B03	Improve Hardware Reliability Of SRVs	Replace valves with more reliable design	$5M/unit	$7.3M/unit	See Section VI.B.3
B04	Station Blackout: Improve Reliability Of One Diesel	Add dedicated blackout diesel	$6M/plant	$8.8M/plant	See Section VI.B.4
B05	Control Pressure During ATWS	Improve procedures and training	$50k/unit	$73k/unit	See Section VI.B.5
B06	Automatic Initiation Of SLC (ATWS)	Automate SLC initiation to mitigate failure of SLC due to operator error during ATWS conditions	$400k/unit	$623k/unit	See Section VI.B.6
B07	Improve Hardware Reliability Of SLC (ATWS)	Add redundant train	$1M/unit	$1.5M/unit	See Section VI.B.7
B08A	Decrease Frequency Of Interfacing Systems LOCA	Major hardware modifications to prevent overpressurization	$5M/unit	$7.3M/unit	See Section VI.B.8
B08B	Decrease Frequency Of Interfacing Systems LOCA	Improve procedures and training or minor hardware modifications	$50k/unit	$73k/unit	See Section VI.B.8
B09	Improve Suppression Pool Cooling Reliability for Transients (Non-ATWS)	Add redundant train or additional cross tie capability	$5M/unit	$7.3M/unit	See Section VI.B.9
B10	Automatic Initiation Of Suppression Pool Cooling	Automate torus cooling on high torus temperature to avoid lack of torus cooling due to operator error	$400k/unit	$623k/unit	See Section VI.B.10

Table VI-1
SUMMARY OF PHASE II PLANT-SPECIFIC SAMA ANALYSIS

BFNP-specific Candidate SAMA	SAMA Title	Result of Potential Enhancement	Estimated Cost (2003)	Estimated Cost (2016)	Phase II Disposition
B11	Improve DC Reliability	Increase/improved procedures to load shed (see also Generic SAMA G12)	$50k/unit	$73k/unit	See Section VI.B.11
B12	Improve Level Control (ATWS)	Improve procedures and training	$50k/unit	$73k/unit	See Section VI.B.12
B13	Improve Suppression Pool Cooling (ATWS)	Add redundant trains	$6M/unit	$8.8M/unit	See Section VI.B.13
B14	Reduce Frequency Of Excessive LOCA	Increase the RPV inspection frequency to reduce probability of Excessive LOCA	$100k/unit	$155k/unit	See Section VI.B.14
B15	Add Motor Drive Startup Feedwater Pump	Install motor driven startup feedwater pump	$5M/unit	$7.3M/unit	See Section VI.B.15
B16	Mitigate Fire Risk	New Fire Barriers, new cable routing, training and procedures	Over $5M/unit	Over $7.3M/unit	See Section VI.B.16
B17	Mitigate Earthquake Effects	Strengthening of structures and equipment	Over $5M/unit	Over $7.3M/unit	See Section VI.B.17
B18	Implement Internal Flood Prevention and Mitigation Enhancements	Reduce the frequency of flooding events (e.g., install barriers)	Over $5M/unit	Over $7.3M/unit	See Section VI.B.18
B19	Mitigate Effects of High Winds, Floods, Transportation, and Other External Events	Construct barriers, strengthen structures	Over $5M/unit	Over $7.3M/unit	See Section VI.B.19

Table VI-2
SUMMARY OF PHASE II GENERIC SAMA ANALYSIS

Phase II SAMA ID No.	Phase I SAMA ID No.	SAMA Title	Result of Potential Enhancement	Estimated Cost (2003)	Estimated Cost (2016)	Phase II Disposition
G01	7	Increase CRD pump lube oil capacity.	SAMA would lengthen the time before control rod drive (CRD) pump failure due to lube oil	N/A	N/A	No significant risk decrease. See Section VI.C.1
G02	12	Replace ECCS pump motor with air-cooled motors.	SAMA would eliminate ECCS dependency on ERCW.	$6M per unit	$8.8M per unit	See Section VI.C.2
G03	17	Implement procedures to stagger CRD pump use after a loss of service water.	SAMA would allow injection with CRD to be extended after a loss of service water.	$50k/unit	$73k/unit	No significant risk decrease. See Section VI.C.3
G04	19	Procedural guidance for use of cross-tied component cooling or service water pumps.	SAMA would reduce the frequency of the loss of component cooling water and service water.	$50k/unit	$73k/unit	See Section VI.C.4
G05	20	Procedure enhancements and operator training in support system failure sequences, with emphasis on anticipating problems and coping.	SAMA would potentially improve the success rate of operator actions subsequent to support system failures.	$50k/unit	$73k/unit	See Section VI.C.5
G06	21	Improved ability to cool the residual heat removal heat exchangers	SAMA would reduce the probability of a loss of decay heat removal by implementing procedure and hardware modifications to allow manual alignment of the fire protection system or by installing a component cooling water crosstie.	$1M/unit	$1.5M/unit	See Section VI.C.6

Table VI-2
SUMMARY OF PHASE II GENERIC SAMA ANALYSIS

Phase II SAMA ID No.	Phase I SAMA ID No.	SAMA Title	Result of Potential Enhancement	Estimated Cost (2003)	Estimated Cost (2016)	Phase II Disposition
G07	23	Provide a redundant train of ventilation.	SAMA would increase the availability of components dependent on room cooling.	$6M/unit.	$8.8M per unit	See Section VI.C.7
G08	25	Add a diesel building switchgear room high temperature alarm.	SAMA would improve diagnosis of a loss of switchgear room HVAC. Option 1: Install high temp alarm Option 2: Redundant louver and thermostat	Option 1: $400k per building Option 2: $6M per building	Option 1: $587K per building. Option 2: $8.8M per building.	See Section VI.C.8
G09	34	Install a containment vent large enough to remove ATWS decay heat.	Assuming that injection is available, this SAMA would provide alternate decay heat removal in an ATWS event.	$2M/unit	$2.9M/unit	See Section VI.C.9
G10	46	Use the fire protection system as a back-up source for the containment spray system.	SAMA would provide redundant containment spray function without the cost of installing a new system.	$500k/unit	$734k/unit	See Section VI.C.10
G11	48	Install a passive containment spray system.	SAMA would provide redundant containment spray method.	$6M/unit	$8.8M/unit	See Section VI.C.11
G12	57	Provide additional DC battery capacity.	SAMA would ensure longer battery capability during an SBO, reducing the frequency of long-term SBO sequences.	$1M/unit	$1.5M/unit	See Section VI.C.12
G12	58	Use fuel cells instead of lead-acid batteries.	SAMA would extend DC power availability in an SBO.	$6M/unit	$8.8M/unit	See Section VI.C.12

Table VI-2
SUMMARY OF PHASE II GENERIC SAMA ANALYSIS

Phase II SAMA ID No.	Phase I SAMA ID No.	SAMA Title	Result of Potential Enhancement	Estimated Cost (2003)	Estimated Cost (2016)	Phase II Disposition
G12	9	Add redundant DC Control Power for SW pumps	SAMA would increase reliability of SW and decrease core damage frequency due to a loss of SW.	$1M/plant	$1.5M/plant	See Section VI.C.12
G13	61	Incorporate an alternate battery charging capability.	SAMA would improve DC power reliability by either cross-tying the AC buses, or installing a portable diesel-driven battery charger.	$1M/unit	1.5M/unit	See Section VI.C.13
G13	63	Replace existing batteries with more reliable ones.	SAMA would improve DC power reliability and thus increase available SBO recovery time.	$6M/unit	$8.8M/unit	See Section VI.C.13
G14	66	Develop procedures to repair or replace failed 4 kV breakers.	SAMA would offer a recovery path from a failure of the breakers that perform transfer of 4.16kV non-emergency busses from unit station service transformers, leading to loss of emergency AC power.	$50k/unit	$73k/unit	See Section VI.C.14
G15	73	Use Fire Protection System as a back-up source for diesel cooling.	This SAMA would provide a redundant and diverse source of cooling for the diesel generators which would contribute to enhanced diesel reliability.	$1M/plant	$1.5M/plant	See Section VI.C.15
G16	98	Improve inspection of rubber expansion joints on main condenser.	SAMA would reduce the frequency of internal flooding, for a plant where internal flooding due to a failure of circulating water system expansion joints is a concern.	$100k/unit	$147k/unit	See Section VI.C.16

Table VI-2
SUMMARY OF PHASE II GENERIC SAMA ANALYSIS

Phase II SAMA ID No.	Phase I SAMA ID No.	SAMA Title	Result of Potential Enhancement	Estimated Cost (2003)	Estimated Cost (2016)	Phase II Disposition
G17	108	Procedure to instruct operators to trip unneeded RHR/CS pumps on loss of room ventilation.	SAMA increases availability of required RHR/CS pumps. Reduction in room heat load allows continued operation of required RHR/CS pumps, when room cooling is lost.	$50k/unit	$73k/unit	See Section VI.C.17
G18	110	Increase the SRV reseat reliability.	SAMA addresses the risk associated with dilution of boron caused by the failure of the SRVs to reseat after SLC injection.	$700k/unit	$1.03M/unit	See Section VI.C.18
G19	111	Reduce DC dependency between high pressure injection system and ADS.	SAMA would ensure vessel depressurization and high pressure injection upon a DC failure.	$500k/unit	$734k/unit	See Section VI.C.19
G20	113	Use of CRD for alternate boron injection.	SAMA provides an additional system to address ATWS with SLC failure or unavailability.	$2M/unit	$2.9M/unit	See Section VI.C.20

B. Evaluation of BFNP-Specific SAMAs

1. Phase II BFNP-Specific SAMA Number B01: Automate Depressurization

This SAMA would automate the opening of selected SRVs in response to the unavailability or failure of high pressure level control.

To represent the potential impact of this SAMA, the operator action associated with the manual depressurization of the vessel is was set to "guaranteed success."

This change was implemented in the high-pressure transient event tree (HPGTET) by setting the value (failure probability) of top event ORVD (operator depressurizes the reactor vessel) to 0.

PSA Model Results

The results from this case indicate about a 58.3% reduction in Unit 2 CDF (CDF_{new}=1.0932E-6). The new end state frequencies are presented in Table VI-3. For Unit 3 there is a 44.8% reduction in CDF (CDF_{new}=1.8563E-6) and the new end state frequencies are presented in Table VI-4.

Table VI-3
UNIT 2 SAMA NUMBER B01 RESULTS

MAAP Case	Baseline Case	SAMA B01 Case
MIA	2.09E-06	5.60E-07
MKC	1.10E-07	1.10E-07
NIH	2.70E-08	2.63E-08
OIA	4.78E-08	4.78E-08
PID	2.38E-10	2.38E-10
PIH	3.18E-10	3.18E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	3.01E-07
Person-rem	1.64	1.09
Unit 2 Total Cost (3%)	$259,002	$141,022
Unit 2 Total Cost (7%)	$167,979	$93,683
SAMA B01 Saving (3%)	$ 117,980	
SAMA B01 Saving (7%)	$ 74,296	

Table VI-4
UNIT 3 SAMA NUMBER B01 RESULTS

MAAP Case	Baseline Case	SAMA B01 Case
MIA	2.61E-06	1.11E-06
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	1.20E-07
OIA	4.95E-08	4.95E-08
PID	2.21E-10	2.21E-10
PIH	1.94E-10	1.94E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	4.23E-07
Person-rem	1.95	1.41
Unit 3 Total Cost (3%)	$318,839	$202,915
Unit 3 Total Cost (7%)	$205,923	$132,924
SAMA B01 Saving (3%)	$ 115,924	
SAMA B01 Saving (7%)	$ 72,999	

2. Phase II BFNP-Specific SAMA Number B02: Improve Reliability of HPCI and RCIC

This SAMA would result in the improved availability of both HPCI and RCIC.

To bound the potential impact of this SAMA, the split fractions representing both HPCI and RCIC availability were set to “guaranteed success.”

This change was implemented in the high pressure transient event tree (HPGTET) by setting the value (failure probability) of top events HPI and RCI (start and short term operation of HPCI and RCIC, respectively) to 0.

PSA Model Results

The results from this case indicate about a 57.2% reduction in Unit 2 CDF (CDF_{new}=1.1243E-6). The new end state frequencies are presented in Table VI-5. For Unit 3 there is a 49.7% reduction in CDF (CDF_{new}=1.6907E-6) and the new end state frequencies are presented in Table VI-6.

Table VI-5
UNIT 2 SAMA NUMBER B02 RESULTS

MAAP Case	Baseline Case	SAMA B02 Case
MIA	2.09E-06	6.19E-07
MKC	1.10E-07	1.11E-07
NIH	2.70E-08	2.68E-08
OIA	4.78E-08	4.79E-08
PID	2.38E-10	2.38E-10
PIH	3.18E-10	3.20E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	2.73E-07
Person-rem	1.64	1.11
Unit 2 Total Cost (3%)	$259,002	$ 143,439
Unit 2 Total Cost (7%)	$167,979	$ 95,208
SAMA B02 Saving (3%)	$ 115,563	
SAMA B02 Saving (7%)	$ 72,771	

Table VI-6
UNIT 3 SAMA NUMBER B02 RESULTS

MAAP Case	Baseline Case	SAMA B02 Case
MIA	2.61E-06	9.68E-07
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	1.15E-07
OIA	4.95E-08	4.95E-08
PID	2.21E-10	2.21E-10
PIH	1.94E-10	1.94E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	4.01E-07
Person-rem	1.95	1.35
Unit 3 Total Cost (3%)	$318,839	$ 190,069
Unit 3 Total Cost (7%)	$205,923	$ 124,827
SAMA B02 Saving (3%)	$ 128,770	
SAMA B02 Saving (7%)	$ 81,096	

3. Phase II BFNP-Specific SAMA Number B03: Improve Hardware Reliability of SRVs

This SAMA would improve the reliability the hardware portion of the depressurization function (i.e., the SRV hardware).

To bound the potential impact of this SAMA, the split fraction representing the SRV hardware was set to “guaranteed success.”

This change was implemented in the high pressure transient event tree (HPGTET) by setting the value (failure probability) of top event RVD (hardware unavailability of SRVs) to 0.

PSA Model Results

The results from this case indicate about a 0.3% reduction in Unit 2 CDF (CDF_{new}=2.6158E-6). The new end state frequencies are presented in Table VI-7. For Unit 3 there is a 0.02% reduction in CDF (CDF_{new}=3.3603E-6) and the new end state frequencies are presented in Table VI-8.

Table VI-7
UNIT 2 SAMA NUMBER B03 RESULTS

MAAP Case	Baseline Case	SAMA B03 Case
MIA	2.09E-06	2.08E-06
MKC	1.10E-07	1.10E-07
NIH	2.70E-08	2.70E-08
OIA	4.78E-08	4.78E-08
PID	2.38E-10	2.38E-10
PIH	3.18E-10	3.18E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	3.00E-07
Person-rem	1.64	1.64
Unit 2 Total Cost (3%)	$259,002	$258,356
Unit 2 Total Cost (7%)	$167,979	$167,572
SAMA B03 Saving (3%)	$ 646	
SAMA B03 Saving (7%)	$ 407	

Table VI-8
UNIT 3 SAMA NUMBER B03 RESULTS

MAAP Case	Baseline Case	SAMA B03 Case
MIA	2.61E-06	2.61E-06
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	1.20E-07
OIA	4.95E-08	4.95E-08
PID	2.21E-10	2.21E-10
PIH	1.94E-10	1.94E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	4.23E-07
Person-rem	1.95	1.95
Unit 3 Total Cost (3%)	$318,839	$ 318,793
Unit 3 Total Cost (7%)	$205,923	$ 205,894
SAMA B03 Saving (3%)	$ 46	
SAMA B03 Saving (7%)	$ 29	

4. Phase II BFNP-Specific SAMA Number B04: Blackout: Improve Reliability of At Least One Diesel Generator

This SAMA would improve the availability of one diesel generator in order to provide power and to avoid a complete station blackout.

To bound the impact of improving the availability of a diesel generator, the split fraction representing the availability for one diesel per unit (B and 3EB, respectively) was set to “guaranteed success.”

This change was implemented in the Unit 1 / 2 or the Unit 3 electric power event tree (ELECT12 or ELECT3, respectively) by setting the value (failure probability) of top event GB or GF (diesel B or 3EB) to 0.

PSA Model Results

The results from this case indicate about a 11.6% reduction in Unit 2 CDF (CDF_{new}=2.3191E-6). The new end state frequencies are presented in Table VI-9. For Unit 3 there is a 24.0% reduction in CDF (CDF_{new}=2.5552E-6) and the new end state frequencies are presented in Table VI-10.

Table VI-9
UNIT 2 SAMA NUMBER B04 RESULTS

MAAP Case	Baseline Case	SAMA B04 Case
MIA	2.09E-06	1.80E-06
MKC	1.10E-07	1.10E-07
NIH	2.70E-08	1.12E-08
OIA	4.78E-08	4.78E-08
PID	2.38E-10	2.38E-10
PIH	3.18E-10	3.18E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	3.00E-07
Person-rem	1.64	1.53
Unit 2 Total Cost (3%)	$259,002	$ 235,073
Unit 2 Total Cost (7%)	$167,979	$ 152,873
SAMA B04 Saving (3%)	$ 23,929	
SAMA B04 Saving (7%)	$ 15,106	

Table VI-10
UNIT 3 SAMA NUMBER B04 RESULTS

MAAP Case	Baseline Case	SAMA B04 Case
MIA	2.61E-06	1.91E-06
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	2.47E-08
OIA	4.95E-08	4.95E-08
PID	2.21E-10	2.21E-10
PIH	1.94E-10	1.94E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	4.13E-07
Person-rem	1.95	1.62
Unit 3 Total Cost (3%)	$318,839	$254,155
Unit 3 Total Cost (7%)	$205,923	$164,967
SAMA B04 Saving (3%)	$ 64,684	
SAMA B04 Saving (7%)	$ 40,956	

5. Phase II BFNP-Specific SAMA Number B05: Improve Pressure Control During ATWS

This SAMA would improve the likelihood of success for the operator action associated with pressure control in response to an ATWS.

To bound the potential impact of this SAMA, the split fraction associated with this operator action was set to “guaranteed success.”

This change was implemented in the high pressure transient event tree (HPGTET) by setting the value (failure probability) of top event OAD (operator depressurizes vessel) to 0.

PSA Model Results

The results from this case indicate about a 0.7% reduction in Unit 2 CDF (CDF_{new}=2.6070E-6). The new end state frequencies are presented in Table VI-11. For Unit 3 there is a 0.5% reduction in CDF (CDF_{new}=3.3439E-6) and the new end state frequencies are presented in Table VI-12.

Table VI-11
UNIT 2 SAMA NUMBER B05 RESULTS

MAAP Case	Baseline Case	SAMA B05 Case
MIA	2.09E-06	2.07E-06
MKC	1.10E-07	1.11E-07
NIH	2.70E-08	2.70E-08
OIA	4.78E-08	4.79E-08
PID	2.38E-10	2.39E-10
PIH	3.18E-10	3.23E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	3.01E-07
Person-rem	1.64	1.64
Unit 2 Total Cost (3%)	$259,002	$257,735
Unit 2 Total Cost (7%)	$167,979	$167,186
SAMA B05 Saving (3%)	$ 1,267	
SAMA B05 Saving (7%)	$ 793	

Table VI-12
UNIT 3 SAMA NUMBER B05 RESULTS

MAAP Case	Baseline Case	SAMA B05 Case
MIA	2.61E-06	2.59E-06
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	1.20E-07
OIA	4.95E-08	4.96E-08
PID	2.21E-10	2.22E-10
PIH	1.94E-10	1.94E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	4.23E-07
Person-rem	1.95	1.94
Unit 3 Total Cost (3%)	$318,839	$317,577
Unit 3 Total Cost (7%)	$205,923	$205,132
SAMA B05 Saving (3%)	$ 1,262	
SAMA B05 Saving (7%)	$ 791	

6. Phase II BFNP-Specific SAMA Number B06: Automate SLC Initiation

This SAMA would eliminate the failure of the SLC system to inject boron solution to the vessel due to operator error.

To represent the potential impact of this SAMA, the operator action associated with the initiation of the SLC system was set to "guaranteed success."

This change was implemented in the high pressure transient event tree (HPGTET) by setting the value (failure probability) of top event OSLC (operator initiates SLC injection) to 0.

The model adopted assumes that the contribution to failure of any necessary sensors, monitors or other actuation devices does not significantly contribute to the likelihood of actuation failure.

PSA Model Results

The results from this case indicate about a 3.3% reduction in Unit 2 CDF (CDF_{new}=2.5385E-6). The new end state frequencies are presented in Table VI-13. For Unit 3 there is a 2.5% reduction in CDF (CDF_{new}=3.2758E-6) and the new end state frequencies are presented in Table VI-14.

Table VI-13
UNIT 2 SAMA NUMBER B06 RESULTS

MAAP Case	Baseline Case	SAMA B06 Case
MIA	2.09E-06	2.09E-06
MKC	1.10E-07	1.99E-08
NIH	2.70E-08	2.71E-08
OIA	4.78E-08	4.81E-08
PID	2.38E-10	2.43E-10
PIH	3.18E-10	3.26E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	3.02E-07
Person-rem	1.64	1.14
Unit 2 Total Cost (3%)	$259,002	$215,463
Unit 2 Total Cost (7%)	$167,979	$137,388
SAMA B06 Saving (3%)	$ 43,539	
SAMA B06 Saving (7%)	$ 30,591	

Table VI-14
UNIT 3 SAMA NUMBER B06 RESULTS

MAAP Case	Baseline Case	SAMA B06 Case
MIA	2.61E-06	2.61E-06
MKC	1.11E-07	2.05E-08
NIH	1.20E-07	1.20E-07
OIA	4.95E-08	4.98E-08
PID	2.21E-10	2.27E-10
PIH	1.94E-10	1.96E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	4.24E-07
Person-rem	1.95	1.45
Unit 3 Total Cost (3%)	$318,839	$275,467
Unit 3 Total Cost (7%)	$205,923	$175,448
SAMA B06 Saving (3%)	$ 43,372	
SAMA B06 Saving (7%)	$ 30,475	

7. Phase II BFNP-Specific SAMA Number B07: Improve Hardware Reliability of SLC

This SAMA would reduce the unavailability of the Standby Liquid Control system hardware.

To bound the potential impact of this SAMA, the split fraction associated with the SLC System unavailability was set to “guaranteed success.”

This change was implemented in the high pressure transient event tree (HPGTET) by setting the value (failure probability) of top event SLC (hardware unavailability of SLC injection) to 0.

PSA Model Results

The results from this case indicate about a 0.7% reduction in Unit 2 CDF (CDF_{new}=2.6058E-6). The new end state frequencies are presented in Table VI-15. For Unit 3 there is a 0.5% reduction in CDF (CDF_{new}=3.3428E-6) and the new end state frequencies are presented in Table VI-16.

Table VI-15
UNIT 2 SAMA NUMBER B07 RESULTS

MAAP Case	Baseline Case	SAMA B07 Case
MIA	2.09E-06	2.09E-06
MKC	1.10E-07	9.14E-08
NIH	2.70E-08	2.70E-08
OIA	4.78E-08	4.79E-08
PID	2.38E-10	2.39E-10
PIH	3.18E-10	3.23E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	3.01E-07
Person-rem	1.64	1.54
Unit 2 Total Cost (3%)	$259,002	$249,830
Unit 2 Total Cost (7%)	$167,979	$161,537
SAMA B07 Saving (3%)	$ 9,172	
SAMA B07 Saving (7%)	$ 6,442	

Table VI-16
UNIT 3 SAMA NUMBER B07 RESULTS

MAAP Case	Baseline Case	SAMA B07 Case
MIA	2.61E-06	2.61E-06
MKC	1.11E-07	9.18E-08
NIH	1.20E-07	1.20E-07
OIA	4.95E-08	4.96E-08
PID	2.21E-10	2.22E-10
PIH	1.94E-10	1.94E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	4.24E-07
Person-rem	1.95	1.84
Unit 3 Total Cost (3%)	$318,839	$309,718
Unit 3 Total Cost (7%)	$205,923	$199,516
SAMA B07 Saving (3%)	$ 9,121	
SAMA B07 Saving (7%)	$ 6,407	

8. Phase II BFNP-Specific SAMA Number B08: Decrease Frequency of Interfacing System LOCA

This SAMA would result in the decrease in the frequency of all interfacing system LOCAs. Two cases are considered: one that involves hardware changes to the plant (i.e., strengthening low pressure piping); and one that involves enhancing current procedures.

SAMA 08A considers strengthening the low pressure piping at BFNP thus eliminating the interfering system low initiating event category entirely. While this SAMA would not significantly affect the CDF, it would reduce LERF. To bound the impact of this SAMA, the interfacing system LOCA initiating event frequency was set to zero.

PSA Model Results (SAMA B08A)

The results from this case indicate about a 1.8% reduction in Unit 2 CDF (CDF_{new}=2.5777E-6). The new end state frequencies are presented in Table VI-17. For Unit 3 there is a 1.4% reduction in CDF (CDF_{new}=3.3145E-6) and the new end state frequencies are presented in Table VI-18.

Table VI-17
UNIT 2 SAMA NUMBER B08A RESULTS

MAAP Case	Baseline Case	SAMA B08A Case
MIA	2.09E-06	2.09E-06
MKC	1.10E-07	1.10E-07
NIH	2.70E-08	2.70E-08
OIA	4.78E-08	4.78E-08
PID	2.38E-10	2.38E-10
PIH	3.18E-10	3.18E-10
PJH	4.64E-08	0.00E+00
PLF	3.01E-07	3.01E-07
Person-rem	1.64	1.63
Unit 2 Total Cost (3%)	$259,002	$255,814
Unit 2 Total Cost (7%)	$167,979	$166,005
SAMA B08A Saving (3%)	$ 3,188	
SAMA B08A Saving (7%)	$ 1,974	

Table VI-18
UNIT 3 SAMA NUMBER B08A RESULTS

MAAP Case	Baseline Case	SAMA B08A Case
MIA	2.61E-06	2.61E-06
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	1.20E-07
OIA	4.95E-08	4.95E-08
PID	2.21E-10	2.21E-10
PIH	1.94E-10	1.94E-10
PJH	4.64E-08	0.00E+00
PLF	4.23E-07	4.23E-07
Person-rem	1.95	1.94
Unit 3 Total Cost (3%)	$318,839	$315,652
Unit 3 Total Cost (7%)	$205,923	$203,949
SAMA B08A Saving (3%)	$ 3,187	
SAMA B08A Saving (7%)	$ 1,974	

SAMA 08B considers the potential improvement of procedures resulting in a decrease in the frequency of occurrence of an interfacing system LOCA. This analysis assumes that procedural changes alone have the potential to reduce the frequency of interfacing system LOCAs by 50%.

PSA Model Results (SAMA B08B)

The results from this case indicate about a 0.9% reduction in Unit 2 CDF (CDF_{new}=2.6009E-6). The new end state frequencies are presented in Table VI-19. For Unit 3 there is a 0.7% reduction in CDF (CDF_{new}=3.3377E-6) and the new end state frequencies are presented in Table VI-20.

Table VI-19
UNIT 2 SAMA NUMBER B08B RESULTS

MAAP Case	Baseline Case	SAMA B08B Case
MIA	2.09E-06	2.09E-06
MKC	1.10E-07	1.10E-07
NIH	2.70E-08	2.70E-08
OIA	4.78E-08	4.78E-08
PID	2.38E-10	2.38E-10
PIH	3.18E-10	3.18E-10
PJH	4.64E-08	2.32E-08
PLF	3.01E-07	3.01E-07
Person-rem	1.64	1.64
Unit 2 Total Cost (3%)	$259,002	$257,408
Unit 2 Total Cost (7%)	$167,979	$166,992
SAMA B08B Saving (3%)	$ 1,594	
SAMA B08B Saving (7%)	$ 987	

Table VI-20
UNIT 3 SAMA NUMBER B08B RESULTS

MAAP Case	Baseline Case	SAMA B08B Case
MIA	2.61E-06	2.61E-06
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	1.20E-07
OIA	4.95E-08	4.95E-08
PID	2.21E-10	2.21E-10
PIH	1.94E-10	1.94E-10
PJH	4.64E-08	2.32E-08
PLF	4.23E-07	4.23E-07
Person-rem	1.95	1.94
Unit 3 Total Cost (3%)	$318,839	$317,245
Unit 3 Total Cost (7%)	$205,923	$204,936
SAMA B08B Saving (3%)	$ 1,594	
SAMA B08B Saving (7%)	$ 987	

9. Phase II BFNP-Specific SAMA Number B09: Improve Suppression Pool Cooling Reliability for Transients (non-ATWS)

This SAMA would result in the increase in the availability of the suppression pool cooling function in all non-ATWS scenarios.

To bound the potential impact of this SAMA, split fractions associated with one heat exchanger and one pump in each division, as well as the split fraction associated with establishing the suppression pool cooling mode, were set to “guaranteed success.”

This change was implemented in the low pressure transient event tree (LPGTET) by setting the value (failure probability) of top events HXA, HXB, RPA, RPB and SP (heat exchangers A and B, RHR pumps A and B, and the alignment to suppression pool cooling, respectively) to 0.

PSA Model Results

The results from this case indicate about a 11.6% increase in Unit 2 CDF (CDF_{new}=2.3202E-6). The new end state frequencies are presented in Table VI-21. For Unit 3 there is a 17.1% reduction in CDF (CDF_{new}=2.7850E-6) and the new end state frequencies are presented in Table VI-22.

Table VI-21
UNIT 2 SAMA NUMBER B09 RESULTS

MAAP Case	Baseline Case	SAMA B09 Case
MIA	2.09E-06	2.03E-06
MKC	1.10E-07	1.10E-07
NIH	2.70E-08	1.88E-08
OIA	4.78E-08	4.58E-08
PID	2.38E-10	2.38-10
PIH	3.18E-10	9.39E-11
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	7.27E-08
Person-rem	1.64	1.52
Unit 2 Total Cost (3%)	$259,002	$234,633
Unit 2 Total Cost (7%)	$167,979	$152,552
SAMA B09 Saving (3%)	$ 24,369	
SAMA B09 Saving (7%)	$ 15,427	

Table VI-22
UNIT 3 SAMA NUMBER B09 RESULTS

MAAP Case	Baseline Case	SAMA B09 Case
MIA	2.61E-06	2.38E-06
MKC	1.11E-07	11.1E-07
NIH	1.20E-07	9.61E-08
OIA	4.95E-08	4.71E-08
PID	2.21E-10	2.21E-10
PIH	1.94E-10	1.06E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	1.07E-07
Person-rem	1.95	1.72
Unit 3 Total Cost (3%)	$318,839	$272,918
Unit 3 Total Cost (7%)	$205,923	$176,873
SAMA B09 Saving (3%)	$ 45,921	
SAMA B09 Saving (7%)	$ 29,050	

10. Phase II BFNP-Specific SAMA Number B10: Automate Torus Cooling

The purpose of this SAMA is to eliminate the possibility of failing to initiate torus cooling because of operator error.

To represent the potential impact of this SAMA, the operator action associated with the initiation of torus cooling was set to “guaranteed success.”

This change was implemented in the low pressure transient event tree (LPGTET), the large LOCA event tree (LLOCA) and the medium LOCA event tree (MLOCA) by setting the value (failure probability) of top event OSP (operator initiates torus cooling) to 0.

The model adopted assumes that the contribution to failure of any necessary sensors, monitors or other actuation devices does not significantly contribute to the likelihood of actuation failure.

PSA Model Results

The results from this case indicate about a 5.3% decrease in Unit 2 CDF (CDF_{new}=2.4850E-6). The new end state frequencies are presented in Table VI-23. For Unit 3 there is a 4.8% reduction in CDF (CDF_{new}=3.2011E-6) and the new end state frequencies are presented in Table VI-24.

Table VI-23
UNIT 2 SAMA NUMBER B10 RESULTS

MAAP Case	Baseline Case	SAMA B10 Case
MIA	2.09E-06	2.07E-06
MKC	1.10E-07	1.11E-07
NIH	2.70E-08	2.60E-08
OIA	4.78E-08	4.67E-08
PID	2.38E-10	2.41E-10
PIH	3.18E-10	2.59E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	1.89E-07
Person-rem	1.64	1.59
Unit 2 Total Cost (3%)	$259,002	$248,025
Unit 2 Total Cost (7%)	$167,979	$161,045
SAMA B10 Saving (3%)	$ 10,977	
SAMA B10 Saving (7%)	$ 6,934	

Table VI-24
UNIT 3 SAMA NUMBER B10 RESULTS

MAAP Case	Baseline Case	SAMA B10 Case
MIA	2.61E-06	2.58E-06
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	1.20E-07
OIA	4.95E-08	4.84E-08
PID	2.21E-10	2.22E-10
PIH	1.94E-10	1.84E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	2.90E-07
Person-rem	1.95	1.89
Unit 3 Total Cost (3%)	$318,839	$306,298
Unit 3 Total Cost (7%)	$205,923	$198,006
SAMA B10 Saving (3%)	$ 12,541	
SAMA B10 Saving (7%)	$ 7,917	

11. Phase II BFNP-Specific SAMA Number B11: Improve DC Reliability

This SAMA would result in the increase in the reliability of DC power at BFNP.

To bound the potential impact of this SAMA, the split fractions associated with the availability of the three key battery boards were set to “guaranteed success.”

This change was implemented in the Unit 1 / 2 and Unit 3 electric power event trees (ELECT12 and ELECT3) by setting the value (failure probability) of top events DE, DG and DH (battery boards 1, 2, and 3) to 0.

PSA Model Results

The results from this case indicate about a 1.9% reduction in Unit 2 CDF (CDF_{new}=2.5737E-6). The new end state frequencies are presented in Table VI-25. For Unit 3 there is a 1.4% reduction in CDF (CDF_{new}=3.3149E-6) and the new end state frequencies are presented in Table VI-26.

Table VI-25
UNIT 2 SAMA NUMBER B11 RESULTS

MAAP Case	Baseline Case	SAMA B11 Case
MIA	2.09E-06	2.05E-06
MKC	1.10E-07	1.11E-07
NIH	2.70E-08	2.54E-08
OIA	4.78E-08	4.56E-08
PID	2.38E-10	2.25E-10
PIH	3.18E-10	2.65E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	2.94E-07
Person-rem	1.64	1.62
Unit 2 Total Cost (3%)	$259,002	$254,721
Unit 2 Total Cost (7%)	$167,979	$165,249
SAMA B11 Saving (3%)	$ 4,281	
SAMA B11 Saving (7%)	$ 2,730	

Table VI-26
UNIT 3 SAMA NUMBER B11 RESULTS

MAAP Case	Baseline Case	SAMA B11 Case
MIA	2.61E-06	2.57E-06
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	1.19E-07
OIA	4.95E-08	4.63E-08
PID	2.21E-10	2.25E-10
PIH	1.94E-10	1.89E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	4.20E-07
Person-rem	1.95	1.93
Unit 3 Total Cost (3%)	$318,839	$314,745
Unit 3 Total Cost (7%)	$205,923	$203,298
SAMA B11 Saving (3%)	$ 4,094	
SAMA B11 Saving (7%)	$ 2,625	

12. Phase II BFNP-Specific SAMA Number B12: Improve Level Control (ATWS)

This SAMA would improve the likelihood of success for the operator action associated with level control in response to an ATWS.

To bound the potential impact of this SAMA, the split fraction associated with this operator action was set to “guaranteed success.”

This change was implemented in the low pressure transient event tree (LPGTET) by setting the value (failure probability) of top event OLA (operator controls low pressure injection) to 0.

PSA Model Results

The results from this case indicate about a 0.4% reduction in Unit 2 CDF (CDF_{new}=2.6147E-6). The new end state frequencies are presented in Table VI-27. For Unit 3 there is a 0.3% reduction in CDF (CDF_{new}=3.3514E-6) and the new end state frequencies are presented in Table VI-28.

Table VI-27
UNIT 2 SAMA NUMBER B12 RESULTS

MAAP Case	Baseline Case	SAMA B12 Case
MIA	2.09E-06	2.09E-06
MKC	1.10E-07	1.10E-07
NIH	2.70E-08	2.70E-08
OIA	4.78E-08	3.96E-08
PID	2.38E-10	2.08E-11
PIH	3.18E-10	3.41E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	3.01E-07
Person-rem	1.64	1.62
Unit 2 Total Cost (3%)	$259,002	$256,385
Unit 2 Total Cost (7%)	$167,979	$166,169
SAMA B12 Saving (3%)	$ 2,617	
SAMA B12 Saving (7%)	$ 1,810	

Table VI-28
UNIT 3 SAMA NUMBER B12 RESULTS

MAAP Case	Baseline Case	SAMA B12 Case
MIA	2.61E-06	2.61E-06
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	1.20E-07
OIA	4.95E-08	4.13E-08
PID	2.21E-10	2.08E-11
PIH	1.94E-10	2.11E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	4.24E-07
Person-rem	1.95	1.92
Unit 3 Total Cost (3%)	$318,839	$316,226
Unit 3 Total Cost (7%)	$205,923	$204,117
SAMA B12 Saving (3%)	$ 2,613	
SAMA B12 Saving (7%)	$ 1,806	

13. Phase II BFNP-Specific SAMA Number B13: Improve Suppression Pool Cooling (ATWS)

This SAMA would provide additional capability to remove heat from the suppression pool in response to an ATWS.

To bound the potential impact of this SAMA, the split fractions associated with the availability of all RHR heat exchangers and RHR pumps, as well as the split fraction associated with establishing the suppression pool cooling mode, were set to “guaranteed success” for the condition of failure of the control rods to provide reactivity control.

This change was implemented in the low pressure transient event tree (LPGTET) by setting the value (failure probability) of top events HXA, HXB, HXC, HXD, RPA, RPB, RPC, RPD, OSP and SP) (heat exchangers A, B, C, and D, RHR pumps A, B, C, and D; operator initiates suppression pool cooling mode; and, switch to suppression pool cooling mode) to 0.

PSA Model Results

The results from this case indicate about a 3.0% reduction in Unit 2 CDF (CDF_{new}=2.5466E-6). The new end state frequencies are presented in Table VI-29. For Unit 3 there is a 2.4% reduction in CDF (CDF_{new}=3.2795E-6) and the new end state frequencies are presented in Table VI-30.

Table VI-29
UNIT 2 SAMA NUMBER B13 RESULTS

MAAP Case	Baseline Case	SAMA B13 Case
MIA	2.09E-06	2.03E-06
MKC	1.10E-07	1.16E-07
NIH	2.70E-08	2.66E-08
OIA	4.78E-08	4.09E-08
PID	2.38E-10	2.66E-10
PIH	3.18E-10	2.26E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	2.87E-07
Person-rem	1.64	1.62
Unit 2 Total Cost (3%)	$259,002	$253,714
Unit 2 Total Cost (7%)	$167,979	$164,708
SAMA B13 Saving (3%)	$ 5,288	
SAMA B13 Saving (7%)	$ 3,271	

Table VI-30
UNIT 3 SAMA NUMBER B13 RESULTS

MAAP Case	Baseline Case	SAMA B13 Case
MIA	2.61E-06	2.55E-06
MKC	1.11E-07	1.16E-07
NIH	1.20E-07	1.20E-07
OIA	4.95E-08	4.20E-08
PID	2.21E-10	2.47E-10
PIH	1.94E-10	8.80E-11
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	4.09E-07
Person-rem	1.95	1.93
Unit 3 Total Cost (3%)	$318,839	$313,118
Unit 3 Total Cost (7%)	$205,923	$202,368
SAMA B13 Saving (3%)	$ 5,721	
SAMA B13 Saving (7%)	$ 3,555	

14. Phase II BFNP-Specific SAMA Number B14: Decrease Frequency of Excessive LOCA

This Phase II SAMA addresses increasing the inspection frequency of the Reactor Vessel.

To bound the potential impact of this SAMA, the models were reanalyzed with the initiating event frequency of “Excessive LOCA” set to 0.

PSA Model Results

The results from this case indicate about a 0.4% reduction in Unit 2 CDF (CDF_{new}=2.6147E-6). The new end state frequencies are presented in Table VI-31. For Unit 3 there is about a 0.3% reduction in CDF (CDF_{new}=3.3515E-6) and the new end state frequencies are presented in Table VI-32.

Table VI-31
UNIT 2 SAMA NUMBER B14 RESULTS

MAAP Case	Baseline Case	SAMA B14 Case
MIA	2.09E-06	2.09E-06
MKC	1.10E-07	1.10E-07
NIH	2.70E-08	2.70E-08
OIA	4.78E-08	3.85E-08
PID	2.38E-10	2.38E-10
PIH	3.18E-10	3.18E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	3.01E-07
Person-rem	1.64	1.61
Unit 2 Total Cost (3%)	$259,002	$256,112
Unit 2 Total Cost (7%)	$167,979	$165,975
SAMA B14 Saving (3%)	$ 2,890	
SAMA B14 Saving (7%)	$ 2,004	

Table VI-32
UNIT 3 SAMA NUMBER B14 RESULTS

MAAP Case	Baseline Case	SAMA B14 Case
MIA	2.61E-06	2.61E-06
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	1.20E-07
OIA	4.95E-08	4.01E-08
PID	2.21E-10	2.21E-10
PIH	1.94E-10	1.94E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	4.23E-07
Person-rem	1.95	1.92
Unit 3 Total Cost (3%)	$318,839	$315,963
Unit 3 Total Cost (7%)	$205,923	$203,927
SAMA B14 Saving (3%)	$ 2,876	
SAMA B14 Saving (7%)	$ 1,996	

15. Phase II BFNP-Specific SAMA Number B15: Add Motor Driven Startup Feedwater Pump

This SAMA would add a motor-driven feedwater pump with the approximate pumping capacity of RCIC. This pump would be powered from boards supplied by off-site power sources.

To represent the potential impact of this SAMA, a new top event was inserted in the event model. This top event (SUFW) appears in the LPGTET event tree. A nominal value of 4.2×10^{-3} is taken for the unavailability of SUFW if offsite power is available.

PSA Model Results

The results from this case indicate about a 50% reduction in Unit 2 CDF (CDF_{new}=1.3087E-6). The new end state frequencies are presented in Table VI-33. For Unit 3 there is a 35% reduction in CDF (CDF_{new}=2.1780E-6) and the new end state frequencies are presented in Table VI-34.

Table VI-33
UNIT 2 SAMA NUMBER B15 RESULTS

MAAP Case	Baseline Case	SAMA B15 Case
MIA	2.09E-06	7.85E-07
MKC	1.10E-07	1.10E-07
NIH	2.70E-08	2.35E-08
OIA	4.78E-08	4.77E-08
PID	2.38E-10	2.37E-10
PIH	3.18E-10	3.13E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	2.95E-07
Person-rem	1.64	1.17
Unit 2 Total Cost (3%)	$259,002	$157,411
Unit 2 Total Cost (7%)	$167,979	$103,985
SAMA B15 Saving (3%)	$ 101,591	
SAMA B15 Saving (7%)	$ 63,994	

Table VI-34
UNIT 3 SAMA NUMBER B15 RESULTS

MAAP Case	Baseline Case	SAMA B15 Case
MIA	2.61E-06	1.43E-06
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	1.18E-07
OIA	4.95E-08	4.94E-08
PID	2.21E-10	2.20E-10
PIH	1.94E-10	1.92E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	4.18E-07
Person-rem	1.95	1.52
Unit 3 Total Cost (3%)	$318,839	$227,540
Unit 3 Total Cost (7%)	$205,923	$148,418
SAMA B15 Saving (3%)	$ 91,299	
SAMA B15 Saving (7%)	$ 57,505	

16. Phase II BFNP-Specific SAMA Number B16: Mitigate Fire Risk

Fire scenarios are not a significant contributor to core damage at BFNP. The USNRC noted in their letter to TVA dated June 22, 2000 and the attached SER (Reference 6):

> "No plant modifications were found to be necessary as a result of the fire IPEEE for BFN Units 2 and 3."

No quantitative assessments of fire-related SAMAs were evaluated.

17. Phase II BFNP-Specific SAMA Number B17: Mitigate Earthquake Effects

Seismic events are not a significant contributor to core damage at BFNP. This conclusion is based on a review of the following correspondence between TVA and the USNRC:

In a letter to the USNRC (R08 970411, Reference 14), TVA reported:

> "The outliers identified [in accordance with the Seismic Qualification Utility Group Generic Implementation Procedure criteria] for BFN Unit 3 were resolved during the Cycle 7 refueling outage that was completed March 13, 1997."

That letter went on to say:

> "TVA considers the commitments regarding USI A-46 and the seismic portion of IPEEE to be complete for BFN Unit 3."

Similarly, in a letter to the USNRC from TVA (R08 971118 922, Reference 15):

> "…TVA has completed the resolution of outliers for BFN Unit 2 identified in accordance with the Seismic Qualification Utility Group (SQUG) Generic Implementation Procedure (GIP) criteria."

That letter also indicated:

> "TVA considers the commitments regarding the USI A-46 program not to warrant any further regulatory action under the provisions of 10 CFR 50.54(f)."

In a response from the USNRC to TVA dated March 21, 2000 and the attached USI A-46 SER (Reference 7):

> "The Staff's review of the licensee's actions regarding outliers indicates that identified outliers have been resolved by analysis or corrective actions." "The Staff has also concluded that its findings regarding the USI

A-46 program do not warrant any further regulatory action under the provisions of 10 CFR 50.54(f)."

No quantitative assessments of seismic-related SAMAs were evaluated.

18. Phase II BFNP-Specific SAMA Number B18: Implement Internal Flood Prevention and Mitigation Enhancements

This SAMA involves the implementation of measures to reduce the frequency of internal floods and/or mitigate the plant impact of a flood, if one were to occur.

The BFNP PSAs consider four specific internal flooding initiators in the reactor building and two specific internal flooding initiators in the turbine building.

To bound the impact of such SAMAs, the PSA models were requantified with the frequency of all internal flood initiators set to zero.

PSA Model Results

The results from this case indicates about a 3.9% reduction in Unit 2 CDF (CDF_{new}=2.5227E-6). The new end state frequencies are presented in Table VI-35. For Unit 3 there is a 4.8% reduction in CDF (CDF_{new}=3.1982E-6) and the new end state frequencies are presented in Table VI-36.

Table VI-35
UNIT 2 SAMA NUMBER B18 RESULTS

MAAP Case	Baseline Case	SAMA B01 Case
MIA	2.09E-06	2.02E-06
MKC	1.10E-07	1.09 E- 07
NIH	2.70E-08	2.69 E-08
OIA	4.78E-08	4.78 E-08
PID	2.38E-10	2.38 E-10
PIH	3.18E-10	3.18 E-10
PJH	4.64E-08	4.64 E-08
PLF	3.01E-07	2.76 E-07
Person-rem	1.64	1.60
Unit 2 Total Cost (3%)	$259,002	$250,678
Unit 2 Total Cost (7%)	$167,979	$162,694
SAMA B01 Saving (3%)	$8,324	
SAMA B01 Saving (7%)	$5,285	

Table VI-36
UNIT 3 SAMA NUMBER B18 RESULTS

MAAP Case	Baseline Case	SAMA B18 Case
MIA	2.61 E-06	2.50E-06
MKC	1.11 E-11	1.09E-07
NIH	1.20 E-07	1.20E-07
OIA	4.95 E-08	4.95E-08
PID	2.21 E-10	2.21E-10
PIH	1.94 E-10	1.94E-10
PJH	4.64 E-08	4.64E-08
PLF	4.23 E-07	3.72E-07
Person-rem	1.95	1.88
Unit 3 Total Cost (3%)	$318,839	$305,558
Unit 3 Total Cost (7%)	$205,923	$197,496
SAMA B01 Saving (3%)	$13,281	
SAMA B01 Saving (7%)	$8,427	

19. Phase II BFNP-Specific SAMA Number B19: Mitigate Effects of High Winds, Floods, Transportation, and Other External Events

The USNRC communicated with TVA in a letter dated June 22, 2000 and the attached IPEEE SER (Reference 6):

> "These events were screened out in a manner consistent with the guidance given in NUREG –1407…"

No quantitative assessments of SAMAs related to these events were conducted.

C. Evaluation of Phase II Generic SAMAs

1. Phase II Generic SAMA Number G01: Increase CRD Lube Oil Capacity

This SAMA has the potential to increase the time before CRD pump failure due to failure of lube oil. The original SAMA addressed a PWR concern relating to charging pumps. The closest equivalent in BWRs are the CRD pumps. The risk significance of the CRD pumps in the BFNP models is modest. The fractional importance of the CRD system is much less than 1% for either unit under EPU conditions. In addition the contribution of lube oil failure to CRD system unavailability (BFNP IPE) is approximately 0.2% of the total system unavailability.

It is therefore concluded that there is no significant risk reduction potential associated with this SAMA.

2. Phase II Generic SAMA Number G02: Eliminate ECCS Dependency on EECW

This SAMA would replace ECCS pump motors with passively cooled motors. This would reduce the functional dependency of the RHR and Core Spray pumps on EECW.

To bound the potential impact of this SAMA, the dependency on all RHR and Core Spray pumps on EECW has been eliminated. In addition, the RHR and Core Spray top event models were reviewed. It was determined that failure of the pump coolers contributed approximately 20% to the split fractions representing the RHR pumps and the Core Spray system. All split fractions associated with the RHR pumps and Core Spray system were reduced by 20%. This has the effect of increasing the calculated availability of these pumps.

These changes necessitated changes to be made in the split fraction assignment rules in the low pressure general transient event tree (LPGTET), as well as the large and medium LOCA event trees (LLOCA and MLOCA, respectively). In addition, the split fraction adjustments were made directly to the master frequency file (which is the reference table for the split fractions used in the scenario quantification).

These changes reflect the following bounding assumption: Replacing the pump motors with passively cooled motors completely removes any dependency on EECW.

PSA Model Results

The results from this case indicate about a 7.6% reduction in Unit 2 CDF (CDF_{new}=2.4230E-6). The new end state frequencies are presented in Table VI-37. For Unit 3 there is a 9.1% reduction in CDF (CDF_{new}=3.0541E-6) and the new end state frequencies are presented in Table VI-38.

Table VI-37
UNIT 2 GENERIC SAMA NUMBER G02 RESULTS

MAAP Case	Baseline Case	SAMA G02 Case
MIA	2.09E-06	1.89E-06
MKC	1.10E-07	1.10E-07
NIH	2.70E-08	2.76E-08
OIA	4.78E-08	4.74E-08
PID	2.38E-10	2.38E-10
PIH	3.10E-10	3.18E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	2.99E-07
Person-rem	1.64	1.57
Unit 2 Total Cost (3%)	$259,002	$243,424
Unit 2 Total Cost (7%)	$167,979	$158,162
SAMA G02 Saving (3%)	$15,578	
SAMA G02 Saving (7%)	$9,817	

Table VI-38
UNIT 3 GENERIC SAMA NUMBER G02 RESULTS

MAAP Case	Baseline Case	SAMA G02 Case
MIA	2.61E-06	2.29E-06
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	1.21E-07
OIA	4.95E-08	4.91E-08
PID	2.21E-10	2.21E-10
PIH	1.94E-10	1.94E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	4.33E-07
Person-rem	1.95	1.84
Unit 3 Total Cost (3%)	$318,839	$295,135
Unit 3 Total Cost (7%)	$205,923	$190,990
SAMA G02 Saving (3%)	$23,704	
SAMA G02 Saving (7%)	$14,933	

3. Phase II Generic SAMA Number G03: Implement Procedures to Stagger CRD Pump Use After Loss of Service Water

This SAMA originally was originally associated with the PWR concern of loss of high pressure injection following loss of service water. The CRD system at BFNP can act as a source of high pressure injection and is dependent on RCW. RCW provides oil bearing cooling and thrust bearing cooling. Staggering CRD pump operation would have little benefit on loss of service water.

4. Phase II Generic SAMA Number G04: Enhance Ability to Crosstie Service Water

Several systems at BFNP provide the generic 'service water' systems support function. These systems include RCW, EECW, RHRSW, and RBCCW.

The base case models reflect the capability to realign swing RHRSW pumps to support EECW.

To bound the potential benefit of further enhancing the ability to cross tie service water systems (via hardware and procedural changes), the following assumptions were made:

If insufficient EECW flow occurs and the RHRSW swing pumps are available, the actions necessary to align the swing pumps for EECW service are assumed to occur with a probability of 1.

RBCCW is assumed to be successful if RCW is available. In other words, it is assumed that RCW is cross-tied to RBCCW.

The frequency of the initiator Loss of RBCCW is assumed to be zero.

To reflect these changes, top OEE, alignment of the swing RHRSW to support EECW, is assumed to be successful if the swing pumps are available. Also top RBC representing the availability of the RBCCW system is assumed to be available if RCW is available.

PSA Model Results

The results from this case indicate about a 2.4% reduction in Unit 2 CDF (CDF_{new}=2.5611E-6). The new end state frequencies are presented in Table VI-39. Unit 3 there is a 2.2% reduction in CDF (CDF_{new}=3.2873E-6) and the new end state frequencies are presented in Table VI-40.

Table VI-39
UNIT 2 GENERIC SAMA NUMBER G04 RESULTS

MAAP Case	Baseline Case	SAMA G04 Case
MIA	2.09E-06	2.04E-06
MKC	1.10E-07	1.09E-07
NIH	2.70E-08	2.70E-08
OIA	4.78E-08	4.79E-08
PID	2.38E-10	2.38E-10
PIH	3.18E-10	3.18E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	2.89E-07
Person-rem	1.64	1.61
Unit 2 Total Cost (3%)	$259,002	$253,404
Unit 2 Total Cost (7%)	$167,979	$164,390
SAMA G04 Saving (3%)	$5,598	
SAMA G04 Saving (7%)	$3,589	

Table VI-40
UNIT 3 GENERIC SAMA NUMBER G04 RESULTS

MAAP Case	Baseline Case	SAMA G04 Case
MIA	2.61E-06	2.56E-06
MKC	1.11E-07	1.09E-07
NIH	1.20E-07	1.20E-07
OIA	4.95E-08	4.95E-08
PID	2.21E-10	2.21E-10
PIH	1.94E-10	1.94E-10
PJH	4.64E-08	4.64E-08
PKH	0.00E+00	0.00E+00
PLF	4.23E-07	4.05E-07
Person-rem	1.95	1.91
Unit 3 Total Cost (3%)	$318,839	$312,369
Unit 3 Total Cost (7%)	$205,923	$201,780
SAMA G04 Saving (3%)	$6,470	
SAMA G04 Saving (7%)	$4,143	

5. Phase II Generic SAMA Number G05: Enhanced Recovery of Failed Support Systems

The base case models explicitly consider the recovery of key support systems. Specific recovery actions considered in one or both base case models are:

1. Alignment of RHRSW swing pumps to support EECW operation (top OEE).
2. Restoration of power at a diesel auxiliary board (top ODSB).
3. Restoration of power to support diesel room cooling (top ODSBU3).
4. Restoration of power at a 480V Reactor MOV board (top RMOV).
5. Alignment of spare battery charger (top CPREC).
6. Recovery of power at a 4-kV shutdown board (top SDREC).
7. Alignment of power to a unit board from 161-kV results in a loss of the 500-kV supply (top OUB).
8. Recovery of power at specific unit boards (UBREC).
9. Other electric power recovery actions (top OX).

To estimate a bound for the potential impact of improved procedures, each of the split fractions associated with the above top events were assumed to improve (i.e., be more reliable) by a factor of 3.

The models were then quantified with all of the above operator recovery actions simultaneously improved.

PSA Model Results

The results from this case indicate about a 0.05% reduction in Unit 2 CDF (CDF_{new}=2.6228E-6). The new end state frequencies are presented in Table VI-41. For Unit 3 there is a 0.003% increase in CDF (CDF_{new}=3.3610E-6) and the new end state frequencies are presented in Table VI-42.

For Unit 3, the results are interpreted as indicating that the models are not sufficiently sensitive to the specific changes made to yield a meaningful measure. This is likely due to the effects of truncation during quantification. It is concluded that the postulated SAMA has negligible potential net value for Unit 3.

Table VI-41
UNIT 2 GENERIC SAMA NUMBER G05 RESULTS

MAAP Case	Baseline Case	SAMA G05 Case
MIA	2.09E-06	2.09E-06
MKC	1.10E-07	1.10E-07
NIH	2.70E-08	2.71E-08
OIA	4.78E-08	4.79E-08
PID	2.38E-10	2.38E-10
PIH	3.18E-10	3.19E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	3.01E-07
Person-rem	1.64	1.64
Unit 2 Total Cost (3%)	$259,002	$258,902
Unit 2 Total Cost (7%)	$167,979	$167,916
SAMA G05 Saving (3%)	$100	
SAMA G05 Saving (7%)	$63	

Table VI-42
UNIT 3 GENERIC SAMA NUMBER G05 RESULTS

MAAP Case	Baseline Case	SAMA G05 Case
MIA	2.61E-06	2.61E-06
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	1.21E-07
OIA	4.95E-08	4.95E-08
PID	2.21E-10	2.21E-10
PIH	1.94E-10	1.94E-10
PJH	4.64E-08	4.64E-08
PKH	0.00E+00	0.00E+00
PLF	4.23E-07	4.24E-07
Person-rem	1.95	1.95
Unit 3 Total Cost (3%)	$318,839	$318,862
Unit 3 Total Cost (7%)	$205,923	$205,939
SAMA G05 Saving (3%)	-$23	
SAMA G05 Saving (7%)	-$16	

6. Phase II Generic SAMA Number G06: Fire Water as Backup for RHR Heat Exchanger Cooling

To estimate the potential impact of providing a connection from the fire water system to the RHR heat exchangers, the following assumptions were made:

The fire water system was assumed to be capable of providing adequate cooling water flow to all Unit 2 and 3 RHR heat exchangers

The fire water system was assumed to have a 100% availability.

Any required operator actions associated with aligning the fire water system to provide flow to the RHR heat exchanger was assumed to be successfully completed in a timely manner.

To implement this bounding model, split fractions representing guaranteed success associated with the four RHRSW pumps were used. (In other words, the failure fraction for top events SW2A, SW2C, SW2B, and SW2D were set to zero.)

PSA Model Results

The results from this case indicate about a 0.2% increase in Unit 2 CDF (CDF_{new}=2.6294E-6). The new end state frequencies are presented in Table VI-43. For Unit 3 there is a 5.1% reduction in CDF (CDF_{new}=3.1900E-6) and the new end state frequencies are presented in Table VI-44.

For Unit 2, the results are interpreted as indicating that the models are not sufficiently sensitive to the specific changes made to yield a meaningful measure. This is likely due to the effects of truncation during quantification. It is concluded that the postulated SAMA has negligible potential net value for Unit 2.

Table VI-43
UNIT 2 GENERIC SAMA NUMBER G06 RESULTS

MAAP Case	Baseline Case	SAMA G06 Case
MIA	2.09E-06	2.11E-06
MKC	1.10E-07	1.12E-07
NIH	2.70E-08	1.20E-08
OIA	4.78E-08	4.85E-08
PID	2.38E-10	2.46E-10
PIH	3.18E-10	1.84E-10
PJH	4.64E-08	4.64E-08
PKH	0.00E+00	0.00E+00
PLF	3.01E-07	3.03E-07
Person-rem	1.64	1.65
Unit 2 Total Cost (3%)	$259,002	$259,684
Unit 2 Total Cost (7%)	$167,979	$168,432
SAMA G06 Saving (3%)	-$682	
SAMA G06 Saving (7%)	-$453	

Table VI-44
UNIT 3 GENERIC SAMA NUMBER G06 RESULTS

MAAP Case	Baseline Case	SAMA G06 Case
MIA	2.61E-06	2.48E-06
MKC	1.11E-07	1.12E-07
NIH	1.20E-07	9.88E-08
OIA	4.95E-08	4.97E-08
PID	2.21E-10	2.29E-10
PIH	1.94E-10	1.44E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	4.01E-07
Person-rem	1.95	1.89
Unit 3 Total Cost (3%)	$318,839	$305,660
Unit 3 Total Cost (7%)	$205,923	$197,623
SAMA G06 Saving (3%)	$13,179	
SAMA G06 Saving (7%)	$8,300	

7. Phase II Generic SAMA Number G07: Provide a Redundant Train of Ventilation

A limited number of systems are dependent on room or area cooling at BFNP. The RHR and Core Spray pumps, as modeled, require fan coolers. In addition, room cooling is required for operation of the diesel generators.

A review of the systems analyses for the RHR and Core Spray systems (BFNP IPE) reveals that the contribution (including common cause) to RHR or Core Spray pump unavailability due to fan cooler failure is less than 20%.

To bound the potential impact of a redundant ventilation for the RHR and Core Spray pumps, the split fractions representing these pumps (i.e., RPA, RPB, RPC, RPD and CS) were reduced by 20%.

In addition, the top event representing recovery of diesel generator room cooling was set to guaranteed success.

This bounding modeling approach assumes that the redundant ventilation has an availability of 1.0 (i.e., an unavailability of 0.0) and is independent of any support system such as electric power.

PSA Model Results

The results from this case indicate about a 2.3% reduction in Unit 2 CDF (CDF_{new}=2.5643E-6). The new end state frequencies are presented in Table VI-45. For Unit 3 there is a 8.6% reduction in CDF (CDF_{new}=3.2994E-6) and the new end state frequencies are presented in Table VI-46.

Table VI-45
UNIT 2 GENERIC SAMA NUMBER G07 RESULTS

MAAP Case	Baseline Case	SAMA G07 Case
MIA	2.09E-06	2.07E-06
MKC	1.10E-07	1.11E-07
NIH	2.70E-08	2.69E-08
OIA	4.78E-08	4.31E-08
PID	2.38E-10	2.42E-10
PIH	3.18E-10	3.01E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	2.67E-07
Person-rem	1.64	1.61
Unit 2 Total Cost (3%)	$259,002	$253,475
Unit 2 Total Cost (7%)	$167,979	$164,420
SAMA G07 Saving (3%)	$5,527	
SAMA G07 Saving (7%)	$3,559	

Table VI-46
UNIT 3 GENERIC SAMA NUMBER G07 RESULTS

MAAP Case	Baseline Case	SAMA G07 Case
MIA	2.61E-06	2.58E-06
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	1.20E-07
OIA	4.95E-08	4.48E-08
PID	2.21E-10	2.26E-10
PIH	1.94E-10	1.72E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	3.98E-07
Person-rem	1.95	1.92
Unit 3 Total Cost (3%)	$318,839	$313,194
Unit 3 Total Cost (7%)	$205,923	$202,291
SAMA G07 Saving (3%)	$5,645	
SAMA G07 Saving (7%)	$3,632	

8. Phase II Generic SAMA Number G08: Improve Diagnostics for Diesel Generator Room HVAC

The base case models include the consideration of recovery of a diesel aux board (top ODSB, Unit 2 and Unit 3 models) and recovery of power associated with diesel C room cooling (top ODSBU3, Unit 3).

To bound the potential impact of improved diagnostics for loss of cooling to diesel generator rooms, top events relating to diesel support recovery (ODSB and ODSBU3) were set to guaranteed success.

PSA Model Results

The results from this case indicate about a 0.01% reduction in Unit 2 CDF (CDF_{new}=2.6238E-6). The new end state frequencies are presented in Table VI-47. For Unit 3 there is about a 0.006% reduction in CDF (CDF_{new}=3.3607E-6) and the new end state frequencies are presented in Table VI-48.

Table VI-47
UNIT 2 GENERIC SAMA NUMBER G08 RESULTS

MAAP Case	Baseline Case	SAMA G08 Case
MIA	2.09E-06	2.09E-06
MKC	1.10E-07	1.10E-07
NIH	2.70E-08	2.71E-08
OIA	4.78E-08	4.78E-08
PID	2.38E-10	2.38E-10
PIH	3.18E-10	3.18E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	3.01E-07
Person-rem	1.64	1.64
Unit 2 Total Cost (3%)	$259,002	$258,978
Unit 2 Total Cost (7%)	$167,979	$167,964
SAMA G08 Saving (3%)	$24	
SAMA G08 Saving (7%)	$15	

Table VI-48
UNIT 3 GENERIC SAMA NUMBER G08 RESULTS

MAAP Case	Baseline Case	SAMA G08 Case
MIA	2.61E-06	2.61E-06
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	1.20E-07
OIA	4.95E-08	4.95E-08
PID	2.21E-10	2.21E-10
PIH	1.94E-10	1.94E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	4.23E-07
Person-rem	1.95	1.95
Unit 3 Total Cost (3%)	$318,839	$318,827
Unit 3 Total Cost (7%)	$205,923	$205,916
SAMA G08 Saving (3%)	$ 12	
SAMA G08 Saving (7%)	$ 7	

9. Phase II Generic SAMA Number G09: Install a Containment Vent Large Enough to Remove ATWS Decay Heat

This SAMA would provide redundancy in the ability to remove decay heat and be of sufficient size to successfully handle ATWS decay heat levels.

To estimate the potential effects of this SAMA, the event tree structure (event tree TRANCDBIN) was reviewed along with the logic rules that determine whether a sequence is assigned to core damage or “success.” The relevant logic macro (AHEAT) was modified to reflect the vent (top event VNT) as a potential success path.

PSA Model Results

The results from this case indicate about a 2.8% reduction in Unit 2 CDF (CDF_{new}=2.5517E-6). The new end state frequencies are presented in Table VI-49. For Unit 3 there is a 2.3% reduction in CDF (CDF_{new}=3.2850E-6) and the new end state frequencies are presented in Table VI-50.

Table VI-49
UNIT 2 GENERIC SAMA NUMBER G09 RESULTS

MAAP Case	Baseline Case	SAMA G09 Case
MIA	2.09E-06	2.03E-06
MKC	1.10E-07	1.10E-07
NIH	2.70E-08	2.66E-08
OIA	4.78E-08	4.02E-08
PID	2.38E-10	2.38E-10
PIH	3.18E-10	2.26E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	3.01E-07
Person-rem	1.64	1.60
Unit 2 Total Cost (3%)	$259,002	$251,618
Unit 2 Total Cost (7%)	$167,979	$163,174
SAMA G09 Saving (3%)	$7,384	
SAMA G09 Saving (7%)	$4,805	

Table VI-50
UNIT 3 GENERIC SAMA NUMBER G09 RESULTS

MAAP Case	Baseline Case	SAMA G09 Case
MIA	2.61E-06	2.54E-06
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	1.20E-07
OIA	4.95E-08	4.14E-08
PID	2.21E-10	2.21E-10
PIH	1.94E-10	8.80E-11
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	4.23E-07
Person-rem	1.95	1.90
Unit 3 Total Cost (3%)	$318,839	$311,063
Unit 3 Total Cost (7%)	$205,923	$200,860
SAMA G09 Saving (3%)	$ 7,776	
SAMA G09 Saving (7%)	$ 5,063	

10. Phase II Generic SAMA Number G10: Fire Protection System as Backup Source for Containment Spray

This SAMA considers the use of the Fire Protection water as a backup source for Containment Spray.

To bound the potential impact of this SAMA, the analysis performed for Phase II SAMA G11 (the installation of a passive containment spray system) was used.

11. Phase II Generic SAMA Number G11: Installation of a Passive Containment Spray System

This SAMA would result in the installation of a system capable of providing containment spray and be independent of operator actions.

To bound the potential impact of this SAMA, the top event representing the containment spray function (top event DWS) was set to “success.”

PSA Model Results

The results from this case indicate about a 0.05% increase in Unit 2 CDF (CDF_{new}=2.6254E-6). The new end state frequencies are presented in Table VI-51. For Unit 3 there is a 0.18% increase in CDF (CDF_{new}=3.3669E-6) and the new end state frequencies are presented in Table VI-52.

For Unit 2 and Unit 3, the results are interpreted as indicating that the models are not sufficiently sensitive to the specific changes made to yield a meaningful measure. This is likely due to the effects of truncation during quantification. It is concluded that the postulated SAMA has negligible potential net value for Unit 2 and Unit 3.

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Table VI-51
UNIT 2 GENERIC SAMA NUMBER G11 RESULTS

MAAP Case	Baseline Case	SAMA G11 Case
MIA	2.09E-06	2.13E-06
MKC	1.10E-07	1.10E-07
NIH	2.70E-08	0
OIA	4.78E-08	4.89E-08
PID	2.38E-10	0
PIH	3.18E-10	0
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	2.93E-07
Person-rem	1.64	1.63
Unit 2 Total Cost (3%)	$259,002	$258,504
Unit 2 Total Cost (7%)	$167,979	$167,614
SAMA G11 Saving (3%)	$498	
SAMA G11 Saving (7%)	$365	

Table VI-52
UNIT 3 GENERIC SAMA NUMBER G11 RESULTS

MAAP Case	Baseline Case	SAMA G11 Case
MIA	2.61E-06	2.74E-06
MKC	1.11E-07	1.10E-07
NIH	1.20E-07	0.00E+00
OIA	4.95E-08	5.02E-08
PID	2.21E-10	0.00E+00
PIH	1.94E-10	0.00E+00
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	4.21E-07
Person-rem	1.95	1.90
Unit 3 Total Cost (3%)	$318,839	$315,887
Unit 3 Total Cost (7%)	$205,923	$203,771
SAMA G11 Saving (3%)	$ 2,952	
SAMA G11 Saving (7%)	$ 2,152	

12. Phase II Generic SAMA Number G12: Provide Additional DC Battery Capacity

This SAMA would provide additional functional battery life and be especially beneficial during a Station Blackout event.

To bound the potential impact of this SAMA, the logic associated with determining whether a sequence involves core damage or is “success” was modified. This was done by adding additional statements in the split fraction logic in the TRANCDBIN event tree (specifically for the split fraction assignment logic associated with top event NCD). Any sequence involving successful scram, no stuck open relief valves and successful operation and control of either HPCI or RCIC was considered to be successfully mitigated.

This approach involved making the bounding assumption concerning the reliability of operation of HPCI and RCIC for 24 hours. For the purposes of providing a bounding assessment of this SAMA, representing the operation of HPCI/RCIC for 24 hours with the top event representing 6 hours of operation is conservative.

PSA Model Results

The results from this case indicate about a 17.7% reduction in Unit 2 CDF (CDF_{new}=2.1607E-6). The new end state frequencies are presented in Table VI-53. For Unit 3 there is a 28.9% reduction in CDF (CDF_{new}=2.3903E-6) and the new end state frequencies are presented in Table VI-54.

Table VI-53
UNIT 2 GENERIC SAMA NUMBER G12 RESULTS

MAAP Case	Baseline Case	SAMA G12 Case
MIA	2.09E-06	1.68E-06
MKC	1.10E-07	1.10E-07
NIH	2.70E-08	6.60E-09
OIA	4.78E-08	4.78E-08
PID	2.38E-10	2.38E-10
PIH	3.18E-10	3.18E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	2.67E-07
Person-rem	1.64	1.47
Unit 2 Total Cost (3%)	$259,002	$222,702
Unit 2 Total Cost (7%)	$167,979	$145,070
SAMA G12 Saving (3%)	$36,300	
SAMA G12 Saving (7%)	$22,909	

Table VI-54
UNIT 3 GENERIC SAMA NUMBER G12 RESULTS

MAAP Case	Baseline Case	SAMA G12 Case
MIA	2.61E-06	1.80E-06
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	6.37E-09
OIA	4.95E-08	4.95E-08
PID	2.21E-10	2.21E-10
PIH	1.94E-10	1.94E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	3.74E-07
Person-rem	1.95	1.55
Unit 3 Total Cost (3%)	$318,839	$240,885
Unit 3 Total Cost (7%)	$205,923	$156,562
SAMA G12 Saving (3%)	$ 77,954	
SAMA G12 Saving (7%)	$ 49,271	

13. Phase II Generic SAMA Number G13: Improve DC Power Reliability

Two specific Phase I SAMAs focused on improving DC power reliability. Phase I SAMA 61 would incorporate additional/alternate battery charging capacity. Phase I SAMA 63 would replace station batteries with more reliable ones.

It should be noted that the PSA models already take credit for aligning the spare battery charger.

Reanalyzing the PSA models with “improved” failure probabilities assumed for the station batteries bound the potential impact of improving DC reliability. For the purposes of this analysis, it was assumed that it was possible to improve the unavailability of each of the three station batteries by a factor of 10. This is believed to be a conservative assumption.

PSA Model Results

The results from this case indicate about a 1.8% reduction in Unit 2 CDF (CDF_{new}=2.5756E-6). The new end state frequencies are presented in Table VI-55. For Unit 3 there is a 1.3% reduction in CDF (CDF_{new}=3.3170E-6) and the new end state frequencies are presented in Table VI-56.

Table VI-55
UNIT 2 GENERIC SAMA NUMBER G13 RESULTS

MAAP Case	Baseline Case	SAMA G13 Case
MIA	2.09E-06	2.05E-06
MKC	1.10E-07	1.11E-07
NIH	2.70E-08	2.55E-08
OIA	4.78E-08	4.57E-08
PID	2.38E-10	2.25E-10
PIH	3.18E-10	2.69E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	2.94E-07
Person-rem	1.64	1.62
Unit 2 Total Cost (3%)	$259,002	$254,866
Unit 2 Total Cost (7%)	$167,979	$165,340
SAMA G13 Saving (3%)	$4,136	
SAMA G13 Saving (7%)	$2,639	

Table VI-56
UNIT 3 GENERIC SAMA NUMBER G13 RESULTS

MAAP Case	Baseline Case	SAMA G13 Case
MIA	2.61E-06	2.57E-06
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	1.19E-07
OIA	4.95E-08	4.65E-08
PID	2.21E-10	2.23E-10
PIH	1.94E-10	1.89E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	4.20E-07
Person-rem	1.95	1.93
Unit 3 Total Cost (3%)	$318,839	$314,911
Unit 3 Total Cost (7%)	$205,923	$203,403
SAMA G13 Saving (3%)	$ 3,928	
SAMA G13 Saving (7%)	$ 2,520	

14. Phase II Generic SAMA Number G14: Develop Procedures to Repair or Replace Failed 4-kV Breakers

The specific concern addressed by this SAMA centers on the potential for failure to transfer 4-kV non-emergency busses from the unit station service transformers could lead to the loss of emergency AC power.

To bound the potential impact of this SAMA, the models were reanalyzed with the transfer of power at the unit board level assumed to occur without fault.

PSA Model Results

The results from this case indicate about a 0.004% decrease in Unit 2 calculated CDF (CDF_{new}=2.6240E-6). The new end state frequencies are presented in Table VI-57. For Unit 3 there is a 0.06% increase in the calculated CDF (CDF_{new}=3.3629E-6) and the new end state frequencies are presented in Table VI-58.

For Unit 3, the results are interpreted as indicating that the models are not sufficiently sensitive to the specific changes made to yield a meaningful measure. This is likely due to the effects of truncation during quantification. It is concluded that the postulated SAMA has negligible potential net value for Unit 3.

Table VI-57
UNIT 2 GENERIC SAMA NUMBER G14 RESULTS

MAAP Case	Baseline Case	SAMA G14 Case
MIA	2.09E-06	2.09E-06
MKC	1.10E-07	1.11E-07
NIH	2.70E-08	2.70E-08
OIA	4.78E-08	4.79E-08
PID	2.38E-10	2.38E-10
PIH	3.18E-10	3.19E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	3.01E-07
Person-rem	1.64	1.64
Unit 2 Total Cost (3%)	$259,002	$259,028
Unit 2 Total Cost (7%)	$167,979	$167,999
SAMA G14 Saving (3%)	-$ 26	
SAMA G14 Saving (7%)	-$ 20	

Table VI-58
UNIT 3 GENERIC SAMA NUMBER G14 RESULTS

MAAP Case	Baseline Case	SAMA G14 Case
MIA	2.61E-06	2.61E-06
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	1.20E-07
OIA	4.95E-08	4.95E-08
PID	2.21E-10	2.21E-10
PIH	1.94E-10	1.94E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	4.24E-07
Person-rem	1.95	1.95
Unit 3 Total Cost (3%)	$318,839	$319,038
Unit 3 Total Cost (7%)	$205,923	$206,052
SAMA G14 Saving (3%)	-$ 199	
SAMA G14 Saving (7%)	-$ 129	

15. Phase II Generic SAMA Number G15: Redundant and Diverse Source of Cooling to the Diesel Generators

This SAMA would provide a redundant and diverse source, such as the fire protection system, of cooling water for the diesel generators.

To bound the potential impact of this SAMA, the “logical loop” linking the operation of the diesel generators and their normal cooling water source (EECW) was broken. Three assumptions were made:

It was assumed that the fire protection system has sufficient capacity to service all eight diesel generators.

It was further assumed that the fire protection system is aligned for diesel cooling in a timely manner.

The fire protection system is assumed to be perfectly available (i.e., its unavailability is zero) and the operators align the system (or a passive alignment scheme has been implemented) without failure.

To accomplish this model change, top OEE in the high pressure general transient event tree (HPGTET) was set to “success”. This has the effect of making the generator status macros (e.g., “NOGA” for diesel A) dependent only on the hardware status of the diesel and its associated equipment. In the large LOCA and medium LOCA event trees (LLOCA and MLOCA, respectively), the definition of the generator status macros were modified directly.

PSA Model Results

The results from this case indicate about an 7.7% reduction in Unit 2 CDF (CDF_{new}=2.4230E-6). The new end state frequencies are presented in Table VI-59. For Unit 3 there is a 9.1% reduction in CDF (CDF_{new}=3.0541E-6) and the new end state frequencies are presented in Table VI-60.

Table VI-59
UNIT 2 GENERIC SAMA NUMBER G15 RESULTS

MAAP Case	Baseline Case	SAMA G15 Case
MIA	2.09E-06	1.89E-06
MKC	1.10E-07	1.10E-07
NIH	2.70E-08	2.76E-08
OIA	4.78E-08	4.74E-08
PID	2.38E-10	2.38E-10
PIH	3.18E-10	3.18E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	2.99E-07
Person-rem	1.64	1.57
Unit 2 Total Cost (3%)	$259,002	$243,424
Unit 2 Total Cost (7%)	$167,979	$158,162
SAMA G15 Saving (3%)	$ 15,578	
SAMA G15 Saving (7%)	$ 9,817	

Table VI-60
UNIT 3 GENERIC SAMA NUMBER G15 RESULTS

MAAP Case	Baseline Case	SAMA G15 Case
MIA	2.61E-06	2.29E-06
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	1.21E-07
OIA	4.95E-08	4.91E-08
PID	2.21E-10	2.21E-10
PIH	1.94E-10	1.94E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	4.33E-07
Person-rem	1.95	1.84
Unit 3 Total Cost (3%)	$318,839	$295,135
Unit 3 Total Cost (7%)	$205,923	$190,990
SAMA G15 Saving (3%)	$ 23,704	
SAMA G15 Saving (7%)	$ 14,933	

16. Phase II Generic SAMA Number G16: Improve Inspection of Rubber Expansion Joints on Main Condenser

This SAMA has the potential to decrease the frequency of internal flooding events impacting the turbine building.

To estimate the potential impact of improved inspection of condenser expansion joints, the basis for the turbine building flood frequencies was reviewed. Plant-specific screening of the generic flood database in support of the BFNP IPE determined that 11 events were applicable to BFNP. These 11 events formed the basis for the estimate of the turbine building flooding frequency in the IPE. Two of the eleven events involved failure of expansion joints (of all types). This observation supports the assumption that eliminating expansion joint failure would result in an approximate 20% reduction in the turbine building flooding frequency.

To represent the potential impact of the implementation of this SAMA, the models were reanalyzed with the initiating event flooding frequencies reduced from the base case by 20%. The new flooding frequencies for small and large turbine building floods become 1.152×10^{-2} and 1.760×10^{-3} per year, respectively.

PSA Model Results

The results from this case indicate about a 0.7% reduction in Unit 2 CDF (CDF_{new}=2.6046E-6). The new end state frequencies are presented in Table VI-61. For Unit 3 there is a 0.8% reduction in CDF (CDF_{new}=3.3341E-6) and the new end state frequencies are presented in Table VI-62.

Table VI-61
UNIT 2 GENERIC SAMA NUMBER G16 RESULTS

MAAP Case	Baseline Case	SAMA G16 Case
MIA	2.09E-06	2.08E-06
MKC	1.10E-07	1.10E-07
NIH	2.70E-08	2.70E-08
OIA	4.78E-08	4.78E-08
PID	2.38E-10	2.38E-10
PIH	3.18E-10	3.18E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	2.97E-07
Person-rem	1.64	1.63
Unit 2 Total Cost (3%)	$259,002	$257,430
Unit 2 Total Cost (7%)	$167,979	$166,983
SAMA G16 Saving (3%)	$ 1,572	
SAMA G16 Saving (7%)	$ 996	

Table VI-62
UNIT 3 GENERIC SAMA NUMBER G16 RESULTS

MAAP Case	Baseline Case	SAMA G16 Case
MIA	2.61E-06	2.59E-06
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	1.20E-07
OIA	4.95E-08	4.95E-08
PID	2.21E-10	2.21E-10
PIH	1.94E-10	1.94E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	4.18E-07
Person-rem	1.95	1.94
Unit 3 Total Cost (3%)	$318,839	$316,706
Unit 3 Total Cost (7%)	$205,923	$204,574
SAMA G16 Saving (3%)	$ 2,133	
SAMA G16 Saving (7%)	$ 1,349	

17. Phase II Generic SAMA Number G17: Procedure to Trip Unneeded RHR/CS Pumps on Loss of Room Ventilation

This SAMA would increase the availability of RHR and/or Core Spray pumps by lessening the heat load on the room when area cooling is lost.

This SAMA has common elements to Phase II SAMAs G02 and G07. To bound the potential benefit of implementing Phase II SAMA G18, all requirements for area cooling were removed for the top events representing the RHR and CS pumps by reducing each corresponding split fraction by 20%. It has been determined earlier (see Phase II SAMAs G02 and G07) that ventilation failure contributed less than 20% to RHR and Core Spray failure.

PSA Model Results

The results from this case indicate about a 2.3% reduction in Unit 2 CDF (CDF_{new} = 2.5646E-6). The new end state frequencies are presented in Table VI-63. For Unit 3 there is a 1.8% reduction in CDF (CDF_{new} = 3.2996E-6) and the new end state frequencies are presented in Table VI-64.

Table VI-63
UNIT 2 GENERIC SAMA NUMBER G17 RESULTS

MAAP Case	Baseline Case	SAMA G17 Case
MIA	2.09E-06	2.07E-06
MKC	1.10E-07	1.11E-07
NIH	2.70E-08	2.69E -08
OIA	4.78E-08	4.31E –08
PID	2.38E-10	2.42E-10
PIH	3.18E-10	3.01E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	2.67E-07
Person-rem	1.64	1.61
Unit 2 Total Cost (3%)	$259,002	$253,499
Unit 2 Total Cost (7%)	$167,979	$164,435
SAMA G17 Saving (3%)	$ 5,503	
SAMA G17 Saving (7%)	$ 3,544	

Table VI-64
UNIT 3 GENERIC SAMA NUMBER G17 RESULTS

MAAP Case	Baseline Case	SAMA G17 Case
MIA	2.61E-06	2.58E-06
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	1.20E-07
OIA	4.95E-08	4.48E-08
PID	2.21E-10	2.26E-10
PIH	1.94E-10	1.72E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	3.98E-07
Person-rem	1.95	1.92
Unit 3 Total Cost (3%)	$318,839	$313,208
Unit 3 Total Cost (7%)	$205,923	$202,299
SAMA G17 Saving (3%)	$ 5,631	
SAMA G17 Saving (7%)	$ 3,624	

18. Phase II Generic SAMA Number G18: Increase the SRV Reseat Reliability

This SAMA would reduce the likelihood that an SRV would fail to reseat following a successful lift.

To bound the potential impact of this SAMA, the PSA models were reanalyzed with the assumption that any valves that lift would successfully reseat. The baseline PSA models associated with initiating events involving the inadvertent lifting of relief valves were not altered in the assessment of this SAMA.

PSA Model Results

The results from this case indicate about a 0.4% reduction in Unit 2 CDF (CDF_{new}=2.6139E-6). The new end state frequencies are presented in Table VI-65. For Unit 3 there is a 1.0% reduction in CDF (CDF_{new}= 3.3269E-6) and the new end state frequencies are presented in Table VI-66.

Table VI-65
UNIT 2 GENERIC SAMA NUMBER G18 RESULTS

MAAP Case	Baseline Case	SAMA G18 Case
MIA	2.09E-06	2.09E-06
MKC	1.10E-07	1.11E-07
NIH	2.70E-08	2.54E-08
OIA	4.78E-08	4.30E-08
PID	2.38E-10	1.93E-10
PIH	3.18E-10	3.18E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	3.00E-07
Person-rem	1.64	1.63
Unit 2 Total Cost (3%)	$259,002	$257,119
Unit 2 Total Cost (7%)	$167,979	$166,699
SAMA G18 Saving (3%)	$1,883	
SAMA G18 Saving (7%)	$1,280	

Table VI-66
UNIT 3 GENERIC SAMA NUMBER G18 RESULTS

MAAP Case	Baseline Case	SAMA G18 Case
MIA	2.61E-06	2.59E-06
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	1.19E-07
OIA	4.95E-08	4.45E-08
PID	2.21E-10	1.76E-10
PIH	1.94E-10	1.94E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	4.20E-07
Person-rem	1.95	1.92
Unit 3 Total Cost (3%)	$318,839	$315,084
Unit 3 Total Cost (7%)	$205,923	$203,461
SAMA G18 Saving (3%)	$ 3,755	
SAMA G18 Saving (7%)	$ 2,462	

19. Phase II Generic SAMA Number G19: Reduce the Dependency between the High Pressure Injection System and ADS

This SAMA would reduce the likelihood that failure of the DC power system would significantly impact redundant means of mitigating transients and small LOCAs.

To bound the potential impact of this SAMA, the PSA models were reanalyzed with the DC dependency for HPCI completely removed.

PSA Model Results

The results from this case indicate about a 0.2% reduction in Unit 2 CDF (CDF_{new}=2.6198E-6). The new end state frequencies are presented in Table VI-67. For Unit 3 there is a 1.0% reduction in CDF (CDF_{new}=3.3267E-6) and the new end state frequencies are presented in Table VI-68.

Table VI-67
UNIT 2 GENERIC SAMA NUMBER G19 RESULTS

MAAP Case	Baseline Case	SAMA G19 Case
MIA	2.09E-06	2.09E-06
MKC	1.10E-07	1.10E-07
NIH	2.70E-08	2.68E-08
OIA	4.78E-08	4.78E-08
PID	2.38E-10	2.38E-10
PIH	3.18E-10	3.18E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	3.00E-07
Person-rem	1.64	1.64
Unit 2 Total Cost (3%)	$259,002	$258,655
Unit 2 Total Cost (7%)	$167,979	$167,760
SAMA G19 Saving (3%)	$347	
SAMA G19 Saving (7%)	$219	

Table VI-68
UNIT 3 GENERIC SAMA NUMBER G19 RESULTS

MAAP Case	Baseline Case	SAMA G19 Case
MIA	2.61E-06	2.58E-06
MKC	1.11E-07	1.11E-07
NIH	1.20E-07	1.19E-07
OIA	4.95E-08	4.95E-08
PID	2.21E-10	2.21E-10
PIH	1.94E-10	1.94E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	4.21E-07
Person-rem	1.95	1.94
Unit 3 Total Cost (3%)	$318,839	$316,156
Unit 3 Total Cost (7%)	$205,923	$204,229
SAMA G19 Saving (3%)	$ 2,683	
SAMA G19 Saving (7%)	$ 1,694	

20. Phase II Generic SAMA Number G20: Use of CRD for Alternate Boron Injection

The intent of this SAMA is to provide a second means of injecting a boron solution into the vessel in the event of an ATWS and failure of the SLC System.

The potential benefit of this SAMA was bounded by crediting operation of the CRD hydraulic system as a redundant backup to the SLC system. This was accomplished by modifying the split fraction logic rules that select the value used for top event NCD in the event tree TRANCDBIN. The top event NCD determines whether a sequence involves core damage or is successfully mitigated.

Three assumptions were made:

1. Actions by the operator are assumed to be necessary to initiate boron injection via the CRD system. This assumption completely couples those actions with the actions associated with initiating the SLC system. The implication of this assumption is that the CRD system would provide redundancy for hardware failures of the SLC system.

2. It was assumed that any additional operator actions associated with initiating the CRD are represented by top event OSLC.

3. It was also assumed that any additional failure modes of the CRD system over those analyzed in the base case PSA were not significant contributors to CRD system unavailability in its postulated function of delivering boron solution to the reactor.

PSA Model Results

The results from this case indicate about a 0.6% reduction in Unit 2 CDF (CDF_{new}=2.6087E-6). The new end state frequencies are presented in Table VI-69. For Unit 3 there is a 0.5% reduction in CDF (CDF_{new}=3.3455E-6) and the new end state frequencies are presented in Table VI-70.

Table VI-69
UNIT 2 GENERIC SAMA NUMBER G20 RESULTS

MAAP Case	Baseline Case	SAMA G20 Case
MIA	2.09E-06	2.09E-06
MKC	1.10E-07	9.50E-08
NIH	2.70E-08	2.70E-08
OIA	4.78E-08	4.78E-08
PID	2.38E-10	2.38E-10
PIH	3.18E-10	3.18E-10
PJH	4.64E-08	4.64E-08
PLF	3.01E-07	3.01E-07
Person-rem	1.64	1.56
Unit 2 Total Cost (3%)	$259,002	$251,507
Unit 2 Total Cost (7%)	$167,979	$162,718
SAMA G20 Saving (3%)	$7,495	
SAMA G20 Saving (7%)	$5,261	

Table VI-70
UNIT 3 GENERIC SAMA NUMBER G20 RESULTS

MAAP Case	Baseline Case	SAMA G20 Case
MIA	2.61E-06	2.61E-06
MKC	1.11E-07	9.54E-08
NIH	1.20E-07	1.20E-07
OIA	4.95E-08	4.95E-08
PID	2.21E-10	2.21E-10
PIH	1.94E-10	1.94E-10
PJH	4.64E-08	4.64E-08
PLF	4.23E-07	4.23E-07
Person-rem	1.95	1.86
Unit 3 Total Cost (3%)	$318,839	$311,385
Unit 3 Total Cost (7%)	$205,923	$200,690
SAMA G20 Saving (3%)	$ 7,454	
SAMA G20 Saving (7%)	$ 5,233	

SECTION VII
PSA USE AT BROWNS FERRY

A. Overview

The PSAs are the end products of over 10 years of analysis effort. The Browns Ferry PSA is a living PSA and was updated as recently as early 2003.

TVA procedures provide the details describing the use of the PSA at Browns Ferry to support the Maintenance Rule. The PSA assists in establishing performance criteria, balancing unavailability and reliability for risk significant SSCs and goal setting and provides input to the Expert Panel for the risk significance determination process when revisions to the PSA take place. Functions are potentially considered risk significant if any of the following conditions are satisfied:

- Functions modeled in the level 1 PSA are found to have a risk achievement worth greater than or equal to 2.0;
- Functions modeled in the level 1 PSA are found to have a risk reduction worth of less than or equal to 0.995; or
- Functions modeled in the level 1 PSA are found to have a cumulative contribution of 90% of the CDF.

Because the PSAs are actively used at Browns Ferry, a formal process is in place to evaluate and resolve PSA model-related issues as they are identified. The PSA Update Report is evaluated for updating every other refueling outage. The administrative guidance for this activity is contained in TVA Procedures.

During November 1997, TVA participated in a PSA Peer Review Certification of the Browns Ferry PSA administered under the auspices of the BWROG Peer Certification Committee. The purpose of the PSA peer review process is to establish a method of assessing the technical quality of the PSA for the spectrum of its potential applications.

The evaluation process utilized a tiered approach using standardized checklists allowing for a detailed review of the elements and the sub-elements of the Browns Ferry PSA to identify strengths and areas that needed improvement. The review system used allowed the Peer Review team to focus on technical issues and to issue their assessment results in the form of a "grade" of 1 through 4 on a PSA sub-element level. To reasonably span the spectrum of potential PSA applications, the four grades of certification as defined by the BWROG document "Report to the Industry on PSA Peer Review Certification Process - Pilot Plant Results" were employed. The results of the review are summarized in Table VII-1.

Table VII-1
RESULTS OF BROWNS FERRY PSA PEER REVIEW

PSA ELEMENT	CERTIFICATION GRADE
Initiating Events (IE)	3
Accident Sequence Evaluation (AS)	3
Thermal Hydraulic Analysis (TH)	2
Systems Analysis (SY)	3
Data Analysis (DA)	2
Human Reliability Analysis (HR)	3
Dependency Analysis (DE)	3
Structural Response (ST)	3
Quantification (QU)	3
Containment Performance Analysis (L2)	2
Maintenance and Update Process (MU)	3

Two RISKMAN® models were received from BFNP for use in the SAMA analysis. Model U2EPUSFW represents the base case for the operation of Unit 2 while model U3EPUSFW represents the base case for the operation of Unit 3.

Because multiple computers were used to perform the required analyses, it was first necessary to verify that these computers would reproduce the results of the base cases. For each computer used in the SAMA analysis, models U2EPUSFW and U3EPUSFW were reanalyzed and the results compared to the original base case results. In all cases, the base case results were reproduced exactly.

B. Extrapolation to Operation of All Three Units Operating at EPU Power Level

Browns Ferry Nuclear plant is comprised of three individual units that share certain systems and buildings. In the consideration of the cost/benefit measures of potential SAMAs, therefore, it is important to consider how multiple unit events may impact the evaluation.

The detailed evaluations of the individual SAMAs have utilized the PSAs that are current and available. These PSAs address the operation of Units 2 and 3 operating at 120% of their original licensed power level. Both PSAs assume that Unit 1 is in extended layup and not operating.

The operation of Unit 1 would increase the calculated core damage frequency of Units 2 and 3. The units share certain equipment (e.g., Diesel Generators, the RHR Service Water System and the Emergency Equipment Cooling Water System) resulting, in selected scenarios, in decreased availability of equipment to a particular unit. Success criteria for selected systems are also impacted.

The Multiple Unit PSA (Reference 18) performed in 1995 provides some insight into the potential effect of multiple unit operation. That study provides a basis for the comparison of the core damage frequency of Unit 2 with both other units operating with the IPE results. The IPE assumed that only Unit 2 was operational. The observation is made in the Multiple Unit PSA that the mean core damage frequency of Unit 2 is a factor of 4 greater with all three units operating compared to only Unit 2 operating. For the purpose of the SAMA screening analysis, it is assumed that the baseline core damage frequencies for Unit 1 and Unit 2 are equal with a mean value 4 times the currently calculated Unit 2 core damage frequency mean. This is felt to be a conservative assumption.

Because Unit 1 is more closely associated with Unit 2 than it is with Unit 3, it is expected that the return to service will have a larger impact on Unit 2 than it will on Unit 3. Units 1 and 2 share the electrical system more so than do Units 1 and 3. In addition, RHR System interunit cross connections are possible between Units 1 and 2, as well as Units 2 and 3, but not directly between Units 1 and 3. It is assumed that the maximum impact on the calculated core damage frequency of Unit 3 will be a factor of 2 over the currently calculated value.

Assuming that the potential avoided costs of the individual SAMAs scale by the same factor as the baseline PSA core damage frequency results, then the preceding analyses can be revisited to identify individual SAMAs that warrant further attention. This assumption is felt to be conservative since, for example, ATWS scenarios (which have relatively severe offsite impacts) would be “increased” in frequency in the scaled model but, in fact, not appreciably increased in frequency due to the restart of Unit 1.

C. Uncertainty

An important consideration in any PSA involves the evaluation of uncertainty and its potential impact on the information provided to support management decisions. The uncertainty in the total core damage frequency was calculated for the Unit 2 and Unit 3 base case models. The results are shown in Table VII-2.

Table VII-2
CORE DAMAGE UNCERTAINTY

	Unit 2	**Unit 3**
Mean value	2.6E-6	3.4E-6
5^{th} percentile	4.8E-7	6.9E-7
50^{th} percentile	1.5E-6	2.2E-6
95^{th} percentile	8.2E-6	9.5E-6

Note that the ratio of the 95^{th} percentile to the mean is 3.2 and 2.8 for Units 2 and 3, respectively. The values in Table VII-2 reflect the uncertainty in the data distributions used in the analysis. Each of the Phase II SAMA evaluations were reviewed to determine if a factor of 3 would alter the decision to screen any of them.

SECTION VIII
SAMA ANALYSIS RESULTS

A. SAMA Analysis Results for BFNP

A summary comparison of estimated implementation costs and costs averted is shown in Table VIII-1 for the Phase II SAMAs.

The analysis documented here is bounding in nature. In addition, as noted in the text, potential negative impacts associated with the SAMAs were not considered.

B. Review of Recent Requests for Additional Information

In order to assure that our SAMA analysis response is as complete as practical, recent RAIs were reviewed. Responses to these RAIs are found in Table VIII-2.

Table VIII-1
EVALUATION OF PHASE II SAMAs

Candidate SAMA	SAMA Title	Estimated Cost (2016)	A Maximum Cost Avoidance (Base Case)	B Screening Cost for Impact of Uncertainty	C Screening Cost Avoidance for Impact of Three-Unit Operation	D Screening Cost Avoidance for Impact of both Uncertainty and Three-Unit Operation	Cost Effective?
B01	Automatic Depressurization	$1.5M/unit	$118K/unit	$354K/unit	$1.2M/plant	$3.5M/plant	N
B02	Improve Reliability Of HPCI And RCIC	$7.3M/unit	$129K/unit	$386K/unit	$1.2M/plant	$3.5M/plant	N
B03	Improve Hardware Reliability Of SRVs	$7.3M/unit	$0.65K/unit	$1.9K/unit	$5.3K/plant	$16K/plant	N
B04	Station Blackout: Improve Reliability Of One Diesel	$8.8M/plant	$65K/unit	$194K/unit	$321K/plant	$962K/plant	N
B05	Control Pressure During ATWS	$73K/unit	$1.3K/unit	$3.8K/unit	$12.7K/plant	$38K/plant	N
B06	Automatic Initiation Of SLC (ATWS)	$623K/unit	$44K/unit	$131K/unit	$435K/plant	$1.3M/plant	N
B07	Improve Hardware Reliability Of SLC (ATWS)	$1.5M/unit	$9.2K/unit	$27.5K/unit	$91.6K/plant	$275K/plant	N
B08A	Decrease Frequency Of Interfacing Systems LOCA – Hardware	$7.3M/unit	$3.2K/unit	$9.6K/unit	$32K/plant	$96K/plant	N
B08B	Decrease Frequency Of Interfacing Systems LOCA – Procedures	$73K/unit	$1.6K/unit	$4.8K/unit	$15.9K/plant	$48K/plant	N
B09	Improve Suppression Pool Cooling Reliability for Transients (Non-ATWS)	$7.3M/unit	$45.9K/unit	$138K/unit	$287K/plant	$860K/plant	N
B10	Automatic Initiation Of Suppression Pool Cooling	$623K/unit	$12.5K/unit	$37.6K/unit	$113K/plant	$339K/plant	N
B11	Improve DC Reliability	$73K/unit	$4.3K/unit	$12.8K/unit	$42.4K/plant	$127K/plant	N
B12	Improve Low Pressure Control (ATWS)	$73K/unit	$2.6K/unit	$7.9K/unit	$26.2K/plant	$78K/plant	N
B13	Improve Suppression Pool Cooling (ATWS)	$8.8M/unit	$5.7K/unit	$17.2K/unit	$53.7K/plant	$161K/plant	N
B14	Reduce Frequency Of Excessive LOCA	$155K/unit	$2.9K/unit	$8.6K/unit	$29K/plant	$86K/plant	N
B15	Add Motor Drive Startup Feedwater Pump	$7.3M/unit	$102K/unit	$305K/unit	$1M/plant	$3M/plant	N
B18	Implement Internal Flood Prevention and Mitigation Enhancement	$7.3M/unit	$13.3K/unit	$40K/unit	$93.2K/plant	$279K/plant	N

Table VIII-1
EVALUATION OF PHASE II SAMAs

Candidate SAMA	SAMA Title	Estimated Cost (2016)	A Maximum Cost Avoidance (Base Case)	B Screening Cost for Impact of Uncertainty	C Screening Cost Avoidance for Impact of Three-Unit Operation	D Screening Cost Avoidance for Impact of both Uncertainty and Three-Unit Operation	Cost Effective?
G01	Increase CRD pump lube oil capacity.	N/A	N/A	N/A	N/A	N/A	N
G02	Replace ECCS pump motor with air-cooled motors.	$8.8M per unit	$23.7K/unit	$71K/unit	$172K/plant	$516K/plant	N
G03	Implement procedures to stagger CRD pump use after a loss of service water.	$73K/unit	N/A	N/A	N/A	N/A	N
G04	Procedural guidance for use of cross-tied component cooling or service water pumps.	$73 K/unit	$6.5K/unit	$19.4K/unit	$57.7K/plant	$173K/plant	N
G05	Procedure enhancements and operator training in support system failure sequences, with emphasis on anticipating problems and coping.	$73K/unit	$100/unit	$310/unit	$800/plant	$2.4K/plant	N
G06	Improved ability to cool the residual heat removal heat exchangers	$1.5M/unit	$13.2K/unit	$39.5K/unit	$26.4K/plant	$79K/plant	N
G07	Provide a redundant train of ventilation.	$8.8M/unit	$5.6K/unit	$16.9K/unit	$55.5K/plant	$167K/plant	N
G08	Add a diesel building switchgear room high temperature alarm.	Option 1: $587K per building. Option 2: $8.8M per building.	$24/unit	$72/unit	$218/plant	$654/plant	N
G09	Install a containment vent large enough to remove ATWS decay heat.	$2.9M/unit	$7.8K/unit	$23.3K/unit	$74.6K/plant	$224K/plant	N
G10	Use the fire protection system as a back-up source for the containment spray system.	$734K/unit	N/A	N/A	N/A	N/A	N
G11	Install a passive containment spray system.	$8.8M/unit	$3.0K/unit	$8.9K/unit	$9.9K/plant	$30K/plant	N

Table VIII-1
EVALUATION OF PHASE II SAMAs

Candidate SAMA	SAMA Title	Estimated Cost (2016)	A Maximum Cost Avoidance (Base Case)	B Screening Cost for Impact of Uncertainty	C Screening Cost Avoidance for Impact of Three-Unit Operation	D Screening Cost Avoidance for Impact of both Uncertainty and Three-Unit Operation	Cost Effective?
G12	Provide additional DC battery capacity.	$1.5M/unit	$78K/unit	$234K/unit	$446K/plant	$1.34M/plant	N
	Use fuel cells instead of lead-acid batteries.	$8.8M/unit	--	--	--	--	N
	Add redundant DC Control Power for SW pumps	$1.5M/plant	--	--	--	--	N
G13	Incorporate an alternate battery charging capability.	$1.5M/unit	$4.1K/unit	$12.3K/unit	$41K/plant	$122K/plant	N
	Replace existing batteries with more reliable ones.	$8.8M/unit	--	--	--	--	N
G14	Develop procedures to repair or replace failed 4 kV breakers.	$73K/unit	$0/unit	$0/unit	$0/unit	$0/unit	N
G15	Use Fire Protection System as a back-up source for diesel cooling.	$1.5M/plant	$23.7K/unit	$71.1K/unit	$172K/plant	$516K/plant	N
G16	Improve inspection of rubber expansion joints on main condenser.	$147K/unit	$2.1K/unit	$6.4K/unit	$16.8K/plant	$51K/plant	N
G17	Procedure to instruct operators to trip unneeded RHR/CS pumps on loss of room ventilation.	$73K/unit	$5.6K/unit	$16.9K/unit	$55.3K/plant	$166K/plant	N

Table VIII-2
EVALUATION OF PHASE II SAMAs

Candidate SAMA	SAMA Title	Estimated Cost (2016)	A Maximum Cost Avoidance (Base Case)	B Screening Cost for Impact of Uncertainty	C Screening Cost Avoidance for Impact of Three-Unit Operation	D Screening Cost Avoidance for Impact of both Uncertainty and Three-Unit Operation	Cost Effective?
G18	Increase the SRV reseat reliability.	$1.03M/unit	$3.8K/unit	$11.3K/unit	$22.6K/plant	$68K/plant	N
G19	Reduce DC dependency between high pressure injection system and ADS.	$734K/unit	$2.7K/unit	$8.0K/unit	$8.1K/plant	$24K/plant	N
G20	Use of CRD for alternate boron injection.	$2.9M/unit	$7.5K/unit	$22.5K/unit	$75K/plant	$225K/plant	N

Note : The following relationship was used:

Column A = the maximum of either the U2 or U3 “SAMA cost avoidance at a discount rate of 3%

Column B = 3 X Column A

Column C = 8 X U2 SAMA cost avoidance (3%)” + 2 X U3 SAMA cost avoidance (3%)

Column D = 3 X Column C

Table VIII-3
SUMMARY RESPONSES TO RECENT RAIs

IPE vs. PSA	
1. The SAMA analysis is based on the most recent version of the probabilistic risk assessment (PRA) model for internal events, which is a modification to the original individual plant examination (IPE). Please provide the following information regarding this PRA model:	
a. an identifier or name for the PRA that will positively and uniquely identify it.	Each model in use at the site has a unique name. Its pedigree can be traced from the IPE. Each model revision used to measure the impact of postulated SAMAs also were given unique names.
b. a summary description of the internal and external peer reviews of the level 1, level 2 and level 3 portions of this PRA.	See Section VII.A.
c. a characterization of the findings of these internal and external peer reviews (if any), and the impact of any identified weaknesses on the SAMA identification and evaluation process.	See Section VII.A.
d. additional information regarding the reasons for changes in core damage frequency (CDF) between the IPE model and the PRA model. Please clarify how much of the change in CDF is attributed to PRA model changes and how much is attributed to actual plant changes.	The differences in the IPE results and the current PRA results are due both to changes in the plant and changes made to the model. The IPE reflected the condition of Unit 2 in operation and Units 1 and 3 in extended layup [reflecting the plant configuration at the time.] Model changes to reflect the return to service of Unit 3, EPU conditions and other plant changes [as documented in the various PRA notebook updates] have been made. Model changes made to upgrade model logic [as documented in the TVA corrective action process] have also been made. The current PRAs reflect the operation of Unit 2 and Unit 3 with Unit 1 in layup.
e. a breakdown of the internal event CDF and large early release frequency (LERF) by major contributors or accident classes, such as loss of offsite power (LOOP), station blackout (SBO), transients, anticipated transient without scram (ATWS), loss-of-coolant accident (LOCA), interfacing systems LOCA (ISLOCA).	See Tables III-1 and III-2.
f. a breakdown of the population dose (person-rem per year within 50 miles) by containment release	See Section II.

mode, such as ISLOCA, containment isolation failure, early containment failure, late containment failure, and no containment failure.	
g. for each containment release category (including LERF and non-LERF contributors): the associated release frequency, release magnitude (fission product release fractions), and MACCS-calculated conditional consequence measures. Please identify those release categories that are considered to contribute to LERF, and those categories to which ISLOCA releases are assigned	Release frequencies are given for each SAMA analyzed. Release categories adapted from Reference 12.
h. the definition of LERF used to distinguish a large-early release from a small-early or a large-late release.	Sequences contributed to LERF if they resulted in core damage within 6 hours of occurrence of the initiator and in release of 10% or more of the available CsI.
i. clarification of whether the reported CDF, LERF, and population dose values are per reactor year or per calendar year	The results are expressed in "per calendar year".
j. explain the differences between the units that result in different CDFs.	The primary difference has to do with the electric power system: Unit 2 has more options for crossties than does Unit 3. Unit 2 can also crosstie to both Unit 1 and Unit 3 RHR; whereas Unit 3 can only crosstie to Unit 2.
k. provide justification why the use of plant damage states, as determined by old MAAP runs, provides accurate or conservative modeling of event timing for EPU conditions.	The MAAP runs have been updated to reflect EPU conditions.

DOMINANT RISK CONTRIBUTORS

2. It is not clear that the set of SAMAs evaluated in ER addresses the major risk contributors. In this regard, please provide the following:	
a. a description of how the dominant risk contributors, including dominant sequences and cut sets from the current PRA and equipment failures and operator actions identified through importance analyses, were used to identify potential plant-specific SAMAs. Indicate how many sequences and cut sets were considered and what percentage of the total CDF they represent.	See Section V.

Table VIII-3
SUMMARY RESPONSES TO RECENT RAIs

b. a listing of equipment failures and human actions that have the greatest potential for reducing risk based on importance analysis and cut set screening.	See Section V.
c. for each dominant contributor identified in (b), provide a cross-reference to the SAMA(s) evaluated in the ER that addresses that contributor.	See Sections V and VI.
d. a list of the subset of SAMAs that are considered unique/specific.	See Section V.

EXTERNAL EVENTS

3. The SAMA analysis did not include an assessment of SAMAs for external events. The risk analyses at other commercial nuclear power plants indicate that external events could be large contributors to CDF and the overall risk to the public. In this regard, the following additional information is needed.	
a. NUREG-1742 ("Perspectives Gained from the IPEEE Program," Final Report, April 2002), lists the significant fire area CDFs. While these fire-related CDF estimates may be conservative, they are still large relative to the internal events CDF. For each fire area, please explain what measures were taken to further reduce risk, and explain why these CDFs cannot be further reduced in a cost effective manner.	See Section VI.16.
b. NUREG-1742 lists seismic outliers and improvements. Please confirm that all of the "plant improvements" that address the "anomalies & outliers" have been implemented. If not, please explain why, within the context of this SAMA study.	See Section VI.17.

Table VIII-3
SUMMARY RESPONSES TO RECENT RAIs

UNCERTAINTY	
4. The SAMA analysis did not include an assessment of the impact that PRA uncertainties and external event risk considerations would have on the conclusions of the study. Some license renewal applicants have opted to double the estimated benefits (for internal events) to accommodate any contributions for other initiators when sound reasons exist to support such a numerical adjustment, and to incorporate additional margin in the SAMA screening criteria to address uncertainties in other parts of the analysis (e.g., an additional factor of two in comparing costs and benefits of each SAMA). Please provide the following information to address these concerns:	
a. an estimate of the uncertainties associated with the calculated CDF (e.g., the mean and median CDF estimates and the 5th and 95th percentile values of the uncertainty distribution).	See Section VII.C.
b. an assessment of the impact on the Phase I screening if risk reduction estimates are increased to account for uncertainties in the risk assessment, and the additional benefits associated with external events (if any).	See Section VII.C.
c. an assessment of the impact on the Phase II evaluation if risk reduction estimates are increased to account for uncertainties in the risk assessment, and the additional benefits associated with external events (if any). Please consider the uncertainties due to both the averted cost-risk and the cost of implementation to determine changes in the net value estimate for these SAMAs. (Note that some of the SAMA candidates could potentially become cost beneficial).	See Sections VII.B and VII.C.

MACCS	
5. Please provide the following information concerning the MACCS analyses:	
a. for the evacuation input, discuss any assumptions used for delayed start after declaration of an emergency and sheltering.	A two-hour delay was assumed which is a common assumption when a detailed analysis of the evacuation has not been done

Table VIII-3
SUMMARY RESPONSES TO RECENT RAIs

b. for meteorology input, clarify the source from which the annual data sets were obtained, e.g., the plant meteorological tower.	Plant meteorological tower
c. the MACCS analysis assumes all releases occur at ground-level and have a thermal content that is the same as ambient. These assumptions could be non-conservative when estimating offsite consequences. Please provide an assessment of the impact that alternative assumptions might have on the estimated offsite consequences (doses to the population within 50 miles) and the conclusions of the SAMA evaluation.	To investigate the potential impact of elevated releases, the MAACS analyses were reanalyzed assuming the releases occurred at 300 feet. This is the elevation of the plant stack. No credit was taken for fission product scrubbing by the SBGT system or other removal mechanisms that might be associated with transport to the stack. The resulting mean population doses (effective dose equivalent within 50 miles) can be compared to those presented in Table II-6 are: <u>Scenario</u> <u>Mean</u> MKC 6.00E+06 MIA 4.04E+05 NIH 8.64E+05 OIA 3.03E+06 PID 8.83E+04 PIH 3.94E+06 PJH 2.61E+05 PLF 4.56E+05 The sensitivity study shows that the average increase in mean dose using the blended low-enrichment uranium fuel increases by 9% if the release is assumed to occur at 300 feet rather than at ground level. Mean doses associated with individual release categories increase from 5% (OIA) to 27% (PID). Note that the release category associated with ATWS scenario (MKC) increases 8% in this sensitivity analysis. Given the relatively small increase in dose, along with the conservative assumption of no credit taken for any additional fission product removal, the results of the SAMA are not affected.

d. For completeness, please provide the source terms used (release fractions for each radionuclide, release categories, release timing, etc.) and the corresponding population doses.	See Section II.

LOW COST SAMAs	
6. For certain SAMAs considered in the ER, there may be lower-cost alternatives that could achieve much of the risk reduction at a lower cost. In this regard, please provide the following:	
a. for the subset of plant-specific SAMAs identified, discuss whether any lower-cost alternatives to those considered in the ER would be viable and potentially cost-beneficial.	Systematic consideration was given for each SAMA to identify low cost options (e.g., procedural changes)
b. SAMAs address added DC capability with high costs. Please provide the averted-risk benefit from these SAMAs, and address whether less costly alternatives to the SAMAs suggested might make these alternatives viable. Specifically, consider and provide estimated costs and benefits for diesel-driven battery chargers, and cross-connects to the existing non-safety station batteries as two potential alternatives.	Alternatives were considered, including additional battery chargers. The results of the assessment of SAMA G13 indicate that the cost of such an alternative would have to be less than $122 for the plant (including the consideration of Unit 1 restart and uncertainty) to be cost effective.
c. a plant has recently installed a direct-drive diesel to power an auxiliary feed water (AFW) pump for under $200K. Please provide the averted-risk benefit of supplemental HPCI/RCIC, and an assessment of whether such a SAMA could be a cost-beneficial alternative to a motor-driven pump.	The maximum cost avoidance (SAMA B15) is estimated to be on the order of $100K/unit.

SECTION IX

REFERENCES

1. Reserved.

2. Browns Ferry Nuclear Plant Probabilistic Safety Assessment, Unit 2 Summary Report, R1.

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6. Letter from the USNRC to TVA, Browns Ferry Units 1, 2, and 3, Individual Plant Examination of External Events (IPEEE) and Related Generic Safety Issues. Issuance of Staff Evaluation (TAC Nos. M83595, M83596, M83597). 6/22/2000.

7. Letter from the USNRC to TVA, Browns Ferry, Units 1, 2, and 3 RE: Completion of Licensing Action for Generic Letter 87-02 (TAC Nos. M83595, M83596, M83597). 3/21/2000.

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10. Regulatory Analysis Technical Evaluation Handbook, NUREG/BR-0184.

11. TVA calculation CN-BFNP-MEB-MDN0-999-2001-0016, Revision 0

12. Browns Ferry Nuclear Plant, Unit 2 Probabilistic Risk Assessment Individual Plant Examination, September 1992.

13. NUREG-1560, “Individual Plant Examination Program: Perspectives on Reactor Safety and Plant Performance,” Volume 2, NRC, December 1987.

14. Letter from TVA to USNRC, RO8 970411 803.

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19. Browns Ferry Nuclear Plant, “Updated Final Safety Analysis Report,” Revision 20.

20. Jow, H-N, et al, “MELCOR Accident Consequence Code System (MACCS),” Volume 2, NUREG/CR-4691, SAND86-1562, February 1990.

Reconciliation of Revision 0 (Final Supplemental EIS for Operating License Renewal of BFN, March 2002)

versus

Revision 1 (this Environmental Report) Results

Reconciliation of Revision 0 (Final Supplemental EIS for Operating License Renewal of BFN, March 2002) vs. Revision 1 (this Environmental Report) Results

A summary of the mean core damage frequency and LERF for the two units are given below for the R0 and R1 analyses.

Model Comparison				
Model Number	Unit 2 (events/year)		Unit 3 (events/year)	
	CDF	LERF	CDF	LERF
R0	1.05E-06	1.35E-07	1.90E-06	2.08E-07
R1	2.62E-06	3.93E-07	3.36E-06	4.53E-07

There are two significant differences between the R0 and R1 analyses. The first is that the PSAs used in the R1 analyses represent EPU conditions. The PSAs used in the R0 analyses represented operation of units 2 and 3 at 105% of their original licensed thermal power level. EPU conditions changed the core damage and LERF frequencies as well as the risk contributors. EPU conditions result in a higher level of decay heat. In the PSA models, this has the impact of decreasing the time available to perform operator actions early in the event sequence and the removal of enhanced control rod drive as a successful means of controlling vessel level at high pressure.

The second difference is how the level 1 results are linked to the offsite consequence calculations. In the R0 analyses, the level 1 end states were expressed in terms of a set of BWR accident classes. These were then linked using engineering judgment to the key plant damage states used in the original unit 2 IPE. Level 3 calculations were only available for the IPE key plant damage states. The R0 process therefore included a mapping of the PSA scenarios to the BWR accident classes and a second mapping of the BWR accident classes to the IPE key plant damage states. In the R1 analyses, the level 1 plant scenarios are assigned to a unique IPE key plant damage state. The R1 method of linking the level 1 and level 3 analyses provides a more accurate representation of the scenarios.

A summary of the mean offsite consequences as measured in person rem is given in the table below for the two analyses.

Mean Offsite Consequences For Base Case Models (person rem/year)			
Unit 2		Unit 3	
R0	R1	R0	R1
3.03	1.64	6.28	1.95

So while the mean core damage and large early release frequencies increase for both units between R0 and R1, the mean values of the offsite consequence as measured in person rem decrease between R0 and R1. Since all calculations used the EPU inventory of fission products as in the source terms, the difference must be in assignment of plant damage states to individual core damage scenarios.

A comparison of the plant damage state frequencies for the unit 2 base case for R0 and R1 is shown below.

Unit 2 Base Case Plant Damage State Frequencies			
MAAP Case	R0	R1	Comment
MIA	1.36E-07	2.09E-06	R0 called this case MIALF
MKC	7.39E-08	1.10E-07	R0 called this case ENMKCTT. These are ATWS sequences.
NIH	2.95E-08	2.70E-08	
OIA	9.83E-08	4.78E-08	These are OIA and OIALF in R0.
PID	2.88E-08	2.38E-10	
PIH	6.18E-07	3.18E-10	These are PIHDEP, PIHDEPV and PIHDLV in R0.
PJH	6.14E-08	4.64E-08	
PLF	4.07E-09	3.10E-07	

Note that the largest relative change is for MAAP case PIH, which from table II-7 results in the second highest mean offsite exposure. There is a relatively small increase in the frequency MKC and an increase in the frequency of PLF, but the net effect is a decrease in the mean annual offsite dose.

A similar conclusion can be reached upon review of the unit 3 results.

Unit 3 Base Case Plant Damage State Frequencies			
MAAP Case	R0	R1	Comment
MIA	1.32E-07	2.61E-06	R0 called this case MIALF
MKC	1.52E-07	1.11E-07	R0 called this case ENMKCTT. These are ATWS sequences.
NIH	3.75E-09	1.20E-07	
OIA	1.71E-07	4.95E-08	These are OIA and OIALF in R0.
PID	9.67E-09	2.21E-10	
PIH	1.28E-06	1.94E-10	These are PIHDEP, PIHDEPV and PIHDLV in R0.
PJH	1.28E-07	4.64E-08	
PLF	2.11E-08	4.23E-07	

Once again the largest impact in offsite dose calculation is due to the change in the frequency of PIH.

R0 of this analysis identified five SAMAs for further consideration. These SAMAs passed the screening process that compared the implementation costs to the maximum costs avoided.

The two SAMAs that were not screened in the R0 analysis were:

- Increase/improve dc bus shedding.

This would increase the time available to recover ac power during a station blackout event. Per the BFN UFSAR, the SBO coping time is four hours. It is considered very unlikely that the battery capacity could be extended such that a significant effect could be realized. Therefore, this SAMA was rejected for further evaluation in R1 of this calculation.

- Provide low pressure vessel injection using existing diesel-driven fire pump.

This SAMA would provide an additional diverse source of vessel injection that would particularly be valuable in station blackout scenarios. In R0, this SAMA was identified for further consideration. This capability is acknowledged in the EOIs. Therefore, in R1, it is more appropriately described as “already implemented at BFNP.”

In addition, uncertainties in the PSA calculations were considered by identifying those SAMAs that would not be screened during the cost/benefit comparison if the avoided costs were to increase by a factor of 3. The factor of three approximates the ratio of the 95th percentile of the core damage frequency to the mean. Consideration of uncertainty alone did not result in any additional SAMAs surviving the screening process.

When a bounding analysis was used to estimate the potential impact of three-unit operation at Browns Ferry, one additional SAMA was retained in R0:

- Provide additional DC battery capacity.

The same SAMA-specific modeling assumption was used in R1 and in R0. This SAMA would involve the provision of new or additional batteries to increase capacity. The baseline model used to represent the impact of the return to power of unit 1 resulted in a cost avoidance of \$446k/plant in R1 as compared to \$1.9M/plant in R0. When the combined impact of the return to service of unit 1 and uncertainty are considered, the cost avoided estimate in R1 is \$1.34M/plant (compared to \$5.6M/plant in R0). Thus, even in the most limiting case (considering the return to service of unit 1 and uncertainty), this SAMA is now screened from further consideration. Since the same SAMA-specific modeling assumptions were used in R1 as R0, the difference in results is due to the PSA modeling differences discussed above. In the R0 mapping of core damage scenarios, the SAMA resulted in a decrease in the frequency of plant damage state PIH and therefore a relatively large decrease in offsite consequences; whereas, in the more accurately mapped plant damage state process in R1, no decrease in the frequency of PIH resulted from this SAMA.

When bounding analyses were performed to estimate the impact of both uncertainty and three-unit operation on the screening process, two additional SAMAs survive the R0 screening process:

- Use of fire protection system as backup source for diesel cooling

This SAMA would remove the dependency of the diesels on EECW for cooling. In R1, the cost avoidance estimate for this SAMA was \$516k/plant, significantly lower than the \$1.5M/plant implementation cost. In R0, the cost avoidance estimate considering the return to service of unit 1 and uncertainty was \$2.1M/plant. The same SAMA-specific modeling assumptions were used in both cases; therefore, the analysis differences are due to the PSA modeling differences discussed above. The primary difference is due to the assignment of core damage sequences associated with plant damage state PIH.

- Develop a procedure to trip unneeded RHR/CS pumps on loss of ventilation.

In this SAMA, the RHR and CS pumps would no longer be dependent on active ventilation for long-term operation. In R1, the estimated avoided cost was $166k/plant (for three unit operation, considering uncertainty) as compared to a $73k/unit implementation cost. The corresponding avoided cost from R0 was $136k/unit. The R0 averted cost estimate was revised to provide a more accurate assessment and to be compatible with other industry estimates. The analysis differences between R0 and R1 are due to both the PSA modeling differences discussed above and a revised cost estimate. The treatment of the assignment of a single plant damage state does not appear to explain the differences in the results of R0 verses R1. Since RHR has both a level control and a heat removal function, several plant damage states are impacted. The net result is that the modeling changes along with the improved cost estimate results in the screening of this SAMA.

ATTACHMENT E-5

Cross-Reference to License Renewal NEPA Issues

ATTACHMENT E-5

CROSS REFERENCE OF 10 CFR PART 51, SUBPART A, TABLE B-1 LICENSE RENEWAL NEPA ISSUES TO TVA'S SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT (SEIS) FOR OPERATING LICENSE RENEWAL OF THE BROWNS FERRY NUCLEAR PLANT AND THIS ENVIRONMENTAL REPORT (ER)

For each issue the sections of the SEIS and/or ER that generally or specifically address the item are listed in the Location column. In some cases the item may be indirectly addressed, by the nature of the general subject matter documented. Additional pertinent information may be footnoted. Note that listed locations include the references at the end of those specific sections.

No.	Issue	Category	Location
Surface Water Quality, Hydrology, and Use for all plants			
1	Impacts of refurbishment on surface water quality	1	SEIS 3.6, 4.3.6
2	Impacts of refurbishment on surface water use[2]	1	SEIS 3.6, 4.3.6
3	Altered current patterns at intake and discharge structures	1	SEIS 3.6, 4.3.6, 4.3.10
4	Altered salinity gradients[4]	1	N/A
5	Altered thermal stratification of lakes	1	SEIS 2.2.3, 3.6, 4.3.6
6	Temperature effects on sediment transport capacity[6]	1	SEIS 3.6, 4.3.6, 4.3.10
7	Scouring caused by discharged cooling water	1	SEIS 3.6, 4.3.6, 4.3.10
8	Eutrophication	1	SEIS 3.6, 4.3.6
9	Discharge of Chlorine or other biocides	1	SEIS 4.2.6, 4.3.6
10	Discharge of sanitary wastes and minor chemical spills	1	SEIS 3.7, 3.20, 4.2.6, 4.3.6
11	Discharge of other metals in wastewater	1	SEIS 3.6, 3.7, 3.20, 4.2.6
12	Water use conflicts (plants with once-through cooling systems)	1	SEIS 3.6, 4.2.6, 4.3.6
13	Water use conflicts (plants with cooling ponds or cooling towers using make-up water from a small river with low flow)	2	SEIS 3.6.5, 4.2.6.4, 4.3.6.3; ER E.4.6
Aquatic Ecology for all plants			
14	Refurbishment effects on aquatic biota	1	SEIS 4.2.10, 4.3.6, 4.3.7, 4.3.10, 4.3.11
15	Accumulation of contaminants in sediments or biota[15]	1	SEIS 3.10, 4.2.10, 4.3.10
16	Entrainment of phytoplankton and zooplankton	1	SEIS 3.10, 4.2.10, 4.3.10
17	Cold Shock	1	SEIS 3.6.3, 3.10.4, 4.3.6.3; ER E.4.4
18	Thermal plume barrier to migrating fish	1	SEIS 2.2.3, 3.10, 4.2.10, 4.3.6, 4.3.10
19	Distribution of aquatic organisms	1	SEIS 3.10, 4.2.10, 4.3.10
20	Premature emergence of aquatic insects	1	SEIS 3.10, 4.2.10, 4.3.10
21	Gas supersaturation (gas bubble disease)[21]	1	SEIS 3.10, 4.2.10, 4.3.6, 4.3.10
22	Low dissolved oxygen in the discharge	1	SEIS 3.6, 4.3.6

23	Losses from predation, parasitism, and disease among organisms exposed to sub-lethal stresses	1	SEIS 3.10, 4.2.10, 4.3.10
24	Stimulation of nuisance organisms (e.g., shipworms)	1	SEIS 3.10, 4.2.10, 4.3.10
Aquatic Ecology for plants with once-through and cooling pond heat dissipation systems			
25	Entrainment of fish and shellfish in early life stages	2	SEIS 3.10, 4.2.10, 4.3.10; ER E.4.2
26	Impingement of fish and shellfish	2	SEIS 3.10, 4.2.10, 4.3.10; ER E.4.3
27	Heat Shock	2	SEIS 2.2.3, 3.6.3, 4.3.6.3; ER E.4.4
Aquatic Ecology for plants with cooling tower-based heat dissipation systems			
28	Entrainment of fish and shellfish in early life stages	1	SEIS 3.10, 4.2.10, 4.3.10; ER E.4.2
29	Impingement of fish and shellfish	1	SEIS 3.10, 4.2.10, 4.3.10, ER E.4.3
30	Heat Shock	1	SEIS 2.2.3, 3.6.3, 4.3.6.3; ER E.4.4
Ground Water Use and Quality			
31	Impacts of refurbishment on ground water use and quality	1	SEIS 3.7, 4.3.7; ER E.2.3, E.4.6, E.4.8
32	Groundwater use conflicts (potable and service water, and dewatering; plants that use <100 gpm)	1	SEIS 3.7, 4.3.7; ER E.2.3, E.4.5
33	Groundwater use conflicts (potable and service water; plants that use >100 gpm)	2	SEIS 3.7, 4.3.7; ER E.2.3, E.4.5
34	Groundwater use conflicts (plants using cooling towers withdrawing make-up water from a small river)	2	SEIS 3.7, 4.3.7; ER E.2.3, E.4.6
35	Groundwater use conflicts (Ranney wells)	2	SEIS 3.7, 4.3.7; ER E.2.3, E.4.7
36	Groundwater quality degradation (Ranney wells)	1	SEIS 3.7, 4.3.7; ER E.2.3, E.4.7
37	Groundwater quality degradation (saltwater intrusion)[37]	1	SEIS 3.7, 4.3.7; ER E.2.3
38	Groundwater quality degradation (cooling ponds in salt marshes)[38]	1	SEIS 3.7, 4.3.7; ER E.2.3, E.4.8
39	Groundwater quality degradation (cooling ponds at inland sites)	2	SEIS 3.7, 4.3.7; ER E.2.3, E.4.8
Terrestrial Resources			
40	Refurbishment impacts	2	SEIS 3.9, 4.2.9, 4.3.9; ER E.4.9
41	Cooling tower impacts on crops and ornamental vegetation	1	SEIS 3.1, 4.2.1, 4.3.1; ER E.2.14
42	Cooling tower impacts on native plants	1	SEIS 3.1, 3.9, 4.2.1, 4.2.9, 4.3.1, 4.3.9; ER E.2.14
43	Bird collisions with cooling towers[43]	1	SEIS 3.9, 3.11, 4.2.9, 4.3.9, 4.3.11
44	Cooling pond impacts on terrestrial resources[44]	1	N/A (no cooling ponds)
45	Power line right-of-way management (cutting and herbicide application)	1	SEIS 4.3.14; ER Attachment E-6
46	Bird collision with power lines	1	ER Attachment E-6

47	Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)	1	SEIS 3.20.4; ER Attachment E-6
48	Floodplains and wetlands on power line right of way	1	SEIS 4.3.14; ER Attachment E-6
Threatened or Endangered Species (for all plants)			
49	Threatened or endangered species	2	SEIS 3.11, 4.2.11, 4.3.11; ER E.4.10
Air Quality			
50	Air quality during refurbishment (non-attainment and maintenance areas)	2	SEIS 3.1, 4.2.1, 4.3.1; ER E.4.11
51	Air quality effects of transmission lines	1	SEIS 3.1, 4.2.1, 4.3.1; ER Attachment E-6
Land Use			
52	Onsite land use	1	SEIS 3.15, 4.2.15, 4.3.15
53	Power line right of way	1	SEIS 3.14, 4.2.14, 4.3.14
Human Health			
54	Radiation exposures to the public during refurbishment	1	SEIS 3.21, 4.2.21, 4.3.21
55	Occupational radiation exposures during refurbishment	1	SEIS 3.21, 4.2.21, 4.3.21
56	Microbiological organisms (occupational health)	1	SEIS 3.20, 4.2.20, 4.3.20; ER E.4.12
57	Microbiological organisms (public health)(plants using lakes or canals, or cooling towers or cooling ponds that discharge to a small river)	2	SEIS 3.20, 4.2.20, 4.3.20; ER E.4.12
58	Noise	1	SEIS 3.19, 4.2.19, 4.3.19
59	Electromagnetic fields, acute effects (electric shock)	2	SEIS 3.20; ER E.4.13
60	Electromagnetic fields, chronic effects	N/A	SEIS 3.20
61	Radiation exposures to the public (license renewal term)	1	SEIS 3.21, 4.2.21, 4.3.21
62	Occupational radiation exposures (license renewal term)	1	SEIS 3.21, 4.2.21, 4.3.21
Socioeconomics			
63	Housing impacts	2	SEIS 3.13, 4.2.13, 4.3.13; ER E.4.14
64	Public services: public safety, social services, and tourism and recreation	1	SEIS 3.13, 3.17, 3.20, 4.2.13, 4.2.17, 4.2.20, 4.3.13, 4.3.17, 4.3.20
65	Public services: public utilities	2	SEIS 3.6, 4.3.6; ER E.4.15
66	Public services, education (refurbishment)	2	SEIS 3.13, 4.2.13, 4.3.13; ER E.3.4, E.4.16
67	Public services, education (license renewal term)	1	SEIS 3.13, 4.2.13, 4.3.13; ER E.3.4
68	Offsite land use (refurbishment)	2	SEIS 3.15, 4.3.15; ER E.4.17
69	Offsite land use (license renewal term)	2	SEIS 3.15, 4.3.15; ER E.4.17
70	Public services, Transportation	2	SEIS 3.14, 4.2.14, 4.3.14; ER E.4.18
71	Historic and archaeological resources	2	SEIS 3.18, 4.2.18, 4.3.18; ER E.4.19
72	Aesthetic impacts (refurbishment)	1	SEIS 3.16, 4.2.16, 4.3.16
73	Aesthetic impacts (license renewal term)	1	SEIS 3.16, 4.2.16, 4.3.16
74	Aesthetic impacts of transmission lines (license renewal term)	1	SEIS 3.14, 3.16, 4.2.14, 4.2.16, 4.3.14

Postulated Accidents			
75	Design basis accidents	1	SEIS 3.21, 4.2.21, 4.3.21
76	Severe accidents[76]	2	ER E.4.20 (Attachment 1)
Uranium Fuel Cycle and Waste Management			
77	Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high level waste)	1	SEIS 3.21, 4.2.21, 4.3.21
78	Offsite radiological impacts (collective effects)	1	SEIS 3.21, 4.2.21, 4.3.21
79	Offsite radiological impacts (spent fuel and high level waste disposal)	1	SEIS 2.2.4, 2.3.2, 3.5, 4.2.5, 4.3.5, 4.4.5
80	Non-radiological impacts of the uranium fuel cycle	1	SEIS 4.7
81	Low-level waste storage and disposal	1	SEIS 3.3, 4.2.3, 4.3.3
82	Mixed waste storage and disposal[82]	1	SEIS 3.4, 4.2.4, 4.3.4
83	On-site spent fuel	1	SEIS 2.2.4, 2.3.2, 3.5, 4.2.5, 4.3.5
84	Non-radiological waste	1	SEIS 3.3, 4.2.3, 4.2.6, 4.3.3, 4.3.6
85	Transportation (including spent fuel)	1	SEIS 2.2.4, 2.3.2, 3.3, 3.5, 3.14, 4.2.3, 4.2.4, 4.2.5, 4.2.14, 4.3.3, 4.3.4, 4.3.5, 4.3.14; ER E.4.21
Decommissioning			
86	Radiation doses	1	SEIS 2.2.5
87	Waste management	1	SEIS 2.2.5
88	Air quality	1	SEIS 2.2.5
89	Water quality	1	SEIS 2.2.5
90	Ecological resources	1	SEIS 2.2.5
91	Socioeconomic impacts	1	SEIS 2.2.5
Environmental Justice			
92	Environmental justice	N/A	SEIS 3.13, 4.2.13, 4.3.13; ER E.2.6, E.4.22

[2] There is no significant usage of water during refurbishment.
[4] BFN is located on interior non-saline (fresh) waters, not near estuaries.
[6] Operation of BFN has not noticeably altered benthic topography or required dredging. The only noticeable sediment accumulation has been inside the diffuser pipes.
[7] The discharge diffusers at BFN direct the flow upward.
[15] BFN has replaced its copper-bearing condenser tubes on Units 2 & 3 and will do so on Unit 1 prior to restart. The Unit 2 & Unit 3 condenser tubes are now stainless steel but titanium is being considered for Unit 1.
[21] BFN has discharge diffusers to promote rapid mixing in the river and does not have discharge canals with resident fish populations.
[37] BFN is located on interior non-saline (fresh) waters, not near coastal saltwater sources.
[38] BFN is located on interior non-saline (fresh) waters, not near coastal saltwater marshes.
[43] BFN has not experienced bird kills due to the cooling towers, ostensibly because they are relatively short (~65 feet above ground) and the adjacent spoils berm is higher (~70 feet).
[44] BFN does not have cooling ponds.
[76] The Severe Accidents Mitigation Analysis (SAMA) in Attachment E-4 has evolved from the preliminary bounding version presented in the SEIS. The differences from the SEIS version are also explained in Attachment E-4.
[82] The State of Alabama has elected to exempt mixed waste from RCRA. BFN typically has very little mixed waste but when it does generate some it typically will ship it to the Hazardous Waste Storage Facility in Muscle Shoals, which holds a permit to receive and disposition mixed waste.

ATTACHMENT E-6

Transmission Line Corridor Environmental Analysis

and

Transmission Line Ozone Production and Avian Mortality

TRANSMISSION LINE CORRIDOR ENVIRONMENTAL ANALYSIS

This attachment briefly summarizes the environmental compliance review process TVA uses for maintenance and modifications of transmission lines and presents the results of this process, by subject matter area, for the area surrounding Browns Ferry. Also included at the end of this attachment are summary discussions of other miscellaneous transmission line environmental issues (ozone production, bird collisions and electrocutions).

Since the detailed environmental records for the entire 210 miles of BFN transmission lines would be prohibitively voluminous, TVA has elected to provide the information in this attachment for the areas within a 5-mile radius of the plant. Each transmission line subject matter area is described separately in this attachment, including the methodology description and the results of the 5-mile illustrative survey.

Overview of Environmental Compliance Process for Transmission Line Maintenance and Modifications

The TVA Transmission and Power Supply – Transmission Operations and Maintenance (TPS-TOM) organization routinely conducts maintenance activities on transmission lines in the TVA system (TVA Power Service Area). These activities include, but are not restricted to, right-of-way reclearing (removal of vegetation), pole replacements, installation of lightning arrestors and counterpoise, and upgrading of existing equipment. Regular maintenance activities are conducted on a cycle of 3-5 years.

Prior to these activities, the transmission line area (including the right-of-way) is reviewed by technical specialists in the TVA Regional Natural Heritage and Cultural Resources programs, to identify any resource issues that may occur along that transmission line. These reviews are conducted on a recurring basis that coincides with the maintenance cycle, to ensure that the most current information is provided to the organizations conducting maintenance on these transmission lines. Experts in the Regional Natural Heritage program evaluate issues involving sensitive natural resources such as wetlands and protected species. Experts in the Cultural Resources program evaluate issues involving archaeological and historic sites and structures.

The transmission lines originating at BFN are currently reviewed under this procedure. The area (as defined by the project manager) that is potentially impacted by maintenance activities on transmission lines originating at BFN covers parts of 23 counties in Alabama, Mississippi, and Tennessee. The TVA Regional Natural Heritage program maintains a database of some 27,000+ occurrence records for protected plants, animals, caves, heronries, eagle nests, and natural areas for the entire TVA Power Service Area (PSA), including these 23 counties. Wetland information is maintained by TVA Resource Services and includes NWI wetland maps for the entire TVA Power Service Area (PSA). Soil survey maps are also used to identify potential wetland areas.

TVA's Natural Heritage Resource program also maintains a list of species currently considered to be either rare nationally or rare in a particular state. The national or federal list of threatened and endangered species is overseen by the U.S. Fish and Wildlife Service (USFWS), and updates to this list are made by either notification from the local field office of the USFWS or through notices in the U.S. Federal Register. In addition, the TVA Heritage Resource program receives annually from each of the seven states in the TVA power service area or in the Tennessee Valley Watershed a list of species considered to be rare or in need of protection in that particular state. Through this process, TVA Heritage Resources is able to maintain an updated list of rare species for the Tennessee Valley.

TVA Heritage Resources also updates, adds, or deletes occurrence records of rare species on a daily basis. TVA's Heritage program also twice annually exchanges data with the seven state Heritage programs and the U.S. Fish and Wildlife Service so that all programs mutually benefit from the data, and TVA can maintain the most up to date database of known locations of rare species possible.

The TVA Cultural Resources program maintains records of known archaeological sites and historic structures, and routinely gathers information from the seven-state TVA Power Service Area.

The 23 county area associated with BFN transmission lines includes over 6100 individual records for sensitive resources (including 1700+ plant records, 800+ animal records, 1800+ invertebrate records, and 1600+ cave records). All records that are present, or are potentially present, in transmission line right-of-ways are taken into consideration when conducting these transmission line reviews. However, if the information is restricted (e.g., archaeological sites, which are subject to theft), in compliance with applicable laws it may be omitted from documents such as this that are intended to be made publicly available.

Also included in this document is the explanation of Sensitive Area Review (SAR) Class Definitions and associated table of mapping polygon colors, and the restrictions indicated by those designations.

(Managed Areas) - Managed Areas, Ecologically Significant Sites, and National Rivers Inventory for Maintenance Activities in TVA Transmission Line Rights-of-Way

Managed Areas (MA) are lands held in public ownership that are managed to protect and maintain certain ecological features. Ecologically Significant Sites (ESS) are tracts of privately owned land that are identified by resource biologists as containing significant environmental resources. National River Inventory (NRI) streams are free-flowing river segments that are recognized by the National Park Service as possessing remarkable natural or cultural values. The TVA Natural Heritage program maintains a database of all such lands and streams occurring within the seven-state TVA power service area.

Sensitive area reviews for MA's, ESS's, and NRI streams are completed by utilizing computerized mapping graphics software known as ArcMap. If a MA, ESS, and/or NRI stream is located within the 0.5-mile buffer of the subject transmission line, a polygon is drawn that represents the area's boundaries within the buffer. A description of the area that includes contact information, restrictions, and the subject transmission line name is listed in the corresponding attribute table.

Right-of-way (ROW) maintenance and/or clearing and pole replacement activities are the two areas that are reviewed for the presence of sensitive resources in SARs. If all or any portion of a MA, ESS, and/or NRI stream lies within the buffer of the subject transmission line, a polygon is drawn depicting the boundary of such areas. Restrictions on proposed activities (Class 0, 1, 2, or 3 below) are determined by the type and location of the MA, ESS, and/or NRI streams as well as consultation with the area manager or resource specialist. The class and contact restrictions, definitions, and polygon color for both activities are listed in the included table.

After determining the particular class restriction associated with the area, special instructions or comments are added to indicate the importance of the restriction and why it was assigned. For example, when a portion of a national forest is within the 0.5-mile buffer or crossed by the subject transmission line, a Class 3 restriction is assigned and a comment is added indicating the area manager must be contacted and herbicide use is restricted.

Transmission line projects such as lightning mitigation, counterpoise activities, conveyances, line relocations for state highway department work, and providing delivery points and switches for substations are reviewed for potential impacts to MA's, ESS's, and NRI streams. A three mile radius of the project site(s) is reviewed for MA's, ESS's, and NRI streams that might be affected by the proposed activity.

(Botany) - State and Federal listed plant restrictions for Maintenance Activities in TVA Transmission Line Rights-of-Way

Botanical assessments are completed for Sensitive Area Reviews (SARs) in order to identify state and federally listed plants that occur within a five mile radius of the transmission line. Identifying the occurrences gives us the ability to identify habitats within a proposed project area that are sensitive and potentially require restrictions from activities. To identify rare plant and sensitive habitat locations we utilize the TVA Natural Heritage database, aerial photographs and USGS topographical maps.

Transmission line SAR activities include right-of-way (ROW) maintenance/re-clearing and pole replacements. The review process for the two activities is different since they potentially impact vegetation in different ways. ROW maintenance consists of vegetation clearing with herbicides or mechanical methods, depending on the natural resources and topography associated with particular line segments. Only EPA-labeled herbicides are used and licensed and trained personnel apply them in accordance with label instructions. Herbicides kill all vegetation that is sprayed. Mechanical clearing has less of an impact since many plants can tolerate being cut. Pole replacements potentially impact vegetation when vehicles and equipment drive on and in the vicinity of the ROW and the soil and the vegetation are disturbed. If there are sensitive plants in the vicinity we recommend different access routes to be taken and personnel are apprised of sensitive areas to avoid. Restrictions are determined by our knowledge of the habitat requirements for rare plants and rare plant communities that occur within the vicinity of the ROW. Once a sensitive area is located a polygon designating the known or likely extent of that occurrence is drawn on an ArcMap electronic topographic map, and appropriate class restrictions are applied (see table of Class Definitions and Associated Polygon Colors of Sensitive Areas).

A review of the TVA Regional Natural Heritage database indicates that no federally listed and five Alabama state-listed plant species are known from Limestone County, Alabama. A more detailed review of TVA Heritage records indicates that none of these species, or any other rare plant species known from adjacent counties, are known to occur within five miles of BFN. In addition, field inspections of the BFN area reveal that suitable habitats for these or other rare plant species are not present.

<u>(Terrestrial Animals) - State and Federal Protected Terrestrial Animal restrictions for Sensitive Area Reviews (SARs) conducted in support of Maintenance Activities in TVA Transmission Line Rights-of-Way</u>

The TVA Regional Natural Heritage Program keeps track of state and federal protected species reported from the seven-state region. The terrestrial animal portion of the data base includes all listed birds (breeding and large wintering aggregations), mammals, reptiles, and amphibians. In addition to specific species of animals, the terrestrial portion of the database also includes records of heronries and caves as they often are used by multiple species.

Each SAR project is reviewed for the presence of protected terrestrial animals. A 1-mile radius of the project site(s) is typically reviewed for each proposed activity along transmission lines. Once an occurrence is located a polygon designating the known or likely extent of that occurrence is drawn on an ArcMap electronic topographic map (see included maps), and appropriate class restrictions are applied (see included table of Class Definitions and Associated Polygon Colors of Sensitive Areas). Special comments or instructions accompany each entry as appropriate. For instance, if a cave is located along a powerline corridor scheduled for vegetative maintenance, a 200-foot buffer is indicated around the opening of the cave and a “Hand Clearing Only” restriction is applied within the buffer. If the cave is used by a summer or hibernating colony of bats, appropriate time restrictions, as designated in specific recovery plans for each species, are also applied.

For Browns Ferry Nuclear Plant, no state or federally listed terrestrial animal occurrences are known within a five-mile radius. Likewise, no heronries, caves, or eagle nests are present within a five-mile radius of Browns Ferry Nuclear Plant.

<u>(Aquatic Animals) - State and Federal Protected Aquatic Animal restrictions for Maintenance Activities in TVA Transmission Line Rights-of-Way</u>

The TVA Regional Natural Heritage Program keeps track of state and federal protected species reported from the seven-state region. Aquatic animal occurrence records are maintained and updated by TVA Heritage staff on a regular basis.

Each SAR project is reviewed for the known or likely occurrence of protected aquatic animals in streams in or adjacent to the transmission line right-of-way. A 10 mile buffer around the transmission line being reviewed is examined to determine the likely occurrence of protected aquatic animals. Once an occurrence is located, appropriate class restrictions are applied and the appropriate colored polygon is drawn around the resource area on an ArcMap electronic topographic map (see included maps and table of Class Definitions and Associated Polygon Colors of Sensitive Areas). Transmission line maintenance activities are currently conducted using Best Management Practices as outlined in Muncy (1999). Special comments or instructions (including designation of specific Streamside Management Zones) accompany each entry as appropriate.

A five-mile radius search around Browns Ferry Nuclear Plant indicated the known or likely occurrence of several protected aquatic animal species (see Section E.2.5, Threatened or Endangered Species). Sensitive areas are marked on the quadrangle maps included in this attachment.

(Wetlands) - Wetlands Review for Maintenance Activities in TVA Transmission Line Rights-of-Way

Prior to the performance of any maintenance activities in TVA transmission line ROWs, office-level reviews are conducted by Natural Heritage wetland biologists. This review includes review of the National Wetland Inventory (NWI) map, county soil surveys, and TVA photos of transmission line structures. Potential wetland areas, not indicated on the NWI map, are identified based on interpretation of topographic features, water bodies, soils information, TVA photos and proximity to NWI features. NWI wetlands or potential wetland areas are superimposed as layers on an ArcMap electronic topographic map (see included maps). These ArcMap images are sent to the client accompanied by the Wetlands ROW and Pole Replacement Guidelines and an Excel spread sheet which lists areas that have been included with the NWI data as areas of potential wetlands and what guidelines are to be used.

The NWI wetlands are indicated (in dark blue outline) on the ArcMap drawings for both the ROW and a 1-mile diameter buffer area around the ROW. Potential wetland areas are identified (in dark pink outline) in the ROW, but are not identified in the buffer area, parts of which may be used for ROW access. If the access route follows an existing road that does not require any repair or upgrading, no further wetland reviews are needed. Repair and upgrading includes, but is not limited to grading, fill addition, new or upgraded stream crossings, and vegetation removal. If a new or upgraded access route is necessary, environmental reviews of those particular access areas are conducted as required by the National Environmental Policy Act (NEPA).

The National Wetland Inventory (NWI) data was compiled using high-altitude aerial photography, some of which is now over 15 years old, with limited field verification. However, the limitations of the NWI data are considered in the performance of ROW maintenance and pole replacement to avoid accidental wetland impacts. Since there could be wetlands present for which no map evidence or other data currently exists, maintenance crews remain alert to such things as water on the surface of the ground, soil saturation, the type of vegetation growing in an area, and evidence of present, seasonal or temporary flooding.

Best Management Practices, as described in Muncy (1999), and TPS Environmental Quality Specifications for ROW Construction and Maintenance are implemented to avoid and minimize potential impacts (see attached Wetlands Guidelines for ROW and Pole Replacement). These techniques would be implemented in all locations where NWI wetlands and potential wetland areas are indicated on the project maps submitted by the TVA Natural Heritage staff.

Site-specific recommendations for ROW reclearing include the following:

- Depending on site conditions, either generic tree-cutting guidelines for protection of important permanent streams, wetlands, springs or sinkholes, or one of six specific wetland clearing methods may be used for tree clearing on TVA transmission line ROWs (Muncy 1999). These methods specify techniques for tree clearing and removal that are selected based on wetland hydrology and condition in order to avoid and minimize wetland impacts.
- According to wetland clearing method CM-6 (Muncy 1999), if the wetland is a scrub-shrub, emergent, or grazed wetland, there should be no equipment entry, and minimal intrusion by all mechanized equipment.
- For aerial or ground herbicide application, use is restricted to those herbicides that are EPA-approved for use in aquatic areas.
- If possible, mechanical clearing should be conducted when the ground is dry or minimally saturated. Ruts should be minimized to avoid altered hydrologic patterns, soil compaction, and disruptions in vegetation regeneration.

Specific recommendations for pole replacement activities include the following:

- Entry of vehicles or heavy equipment in wetlands should be avoided when possible.
- If entry is unavoidable, appropriate measures such as mats and low-ground pressure equipment should be used.
- Impacts to vegetation should be avoided or minimized.

In addition, certain activities that may occur during pole replacement in wetlands may be regulated under Sections 404 and 401 of the Clean Water Act. U.S. Army Corps of Engineers (USACE) Nationwide General Permit (NWP) #12 authorizes certain activities related to utility line construction and contains conditions to ensure that impacts to wetlands are minimal. Section 401 gives states the authority to certify whether activities permitted under Section 404 are in accordance with state water quality standards (Strand, 1997). A qualified TVA or TVA contract wetlands specialist would be required to delineate the wetland(s) and provide the wetland determination data forms which are included in the permit application. TVA also follows Executive Order 11990 which requires all federal agencies to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands, in carrying out the agency's responsibilities involving new construction in wetlands.

Wetlands in Transmission Line ROWs in the Vicinity of the Browns Ferry Nuclear Plant

National Wetland Inventory (NWI) data were reviewed for TVA transmission line ROWs within a 10-mile radius of the Browns Ferry Nuclear Plant. This review provided a representation of the class, size, and typical locations of wetlands that are in, or may be crossed by, TVA transmission line ROWs that originate at the Browns Ferry plant. The NWI indicated that ROWs cross wetlands in 32 locations. The wetlands include narrow (60-100 ft) wetlands in riparian zones, wetlands in depressions, and large areas of wetland in stream bottoms. Two of the wetland areas had multiple ROW crossings. The NWI classified the wetlands in the ROW as palustrine emergent (PEM1), scrub-shrub

(PSS1), and forested (PFO1). Because of ROW clearing, the areas indicated as forested wetlands would have been converted to scrub-shrub and emergent wetlands. The wetland hydrologic regimes include temporarily flooded (A) and seasonally flooded (C). These wetlands are marked on the included quadrangle maps.

Six of the wetlands crossed by ROWs are linear features, ranging from approximately 60-100 ft wide, in stream riparian zones. The remaining wetlands range in total size from <1.0 acres for some small depressional wetlands to 2,188 ac for a large area of forested wetlands in the Dry Creek bottomland. The length of the ROW crossings of the wetlands ranges from approximately 60 ft in the linear wetland crossings to over 4,000 ft in the Dry Creek bottomland.

Potential impacts to wetlands resulting from right-of-way maintenance activities include vegetation damage, soil compaction and erosion, sedimentation, and hydrologic alterations. These impacts are avoided or minimized during TVA maintenance operations by following the recommendations of the guidelines presented above and implementing all relevant Best Management Practices. In addition, the appropriate permits are obtained if required for the specific activity.

(Cultural) - Cultural Resource Reviews Related to Operations and Maintenance Activities in TVA Transmission Line Rights-of-Way

Regulatory Background

The National Historic Preservation Act of 1979 (NHPA) made historic preservation a statutory and regulatory responsibility of federal government agencies and established procedures to be followed for historic preservation. Generally speaking, any TVA action involving construction and/or ground disturbing activity may be subject to NHPA. The concepts "historic property" and "undertaking" are critical underpinnings of the Act. The NHPA defines historic property as "any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places." The Secretary of the Interior is the Keeper of the National Register of Historic Places ("the National Register"), which is maintained by the National Park Service. Much of the regulatory language of the Act describes the processes by which districts, sites, buildings, or structures are assessed for listing in the National Register. An undertaking is "a project, activity, or program funded in whole or in part under the direst or indirect jurisdiction of a Federal Agency."

Section 106 of the NHPA requires TVA to 1) consider the effect of its actions on historic properties and 2) allow the Advisory Council on Historic Preservation an opportunity to comment on the action. Section 106 involves four steps: 1) initiate the process; 2) identify historic properties; 3) assess adverse effects; and 4) resolve adverse effects. One of the main responsibilities of the TVA Cultural Resources staff is to carry out these four steps. In brief, the process involves documentary research and field reconnaissance for identifying cultural resources (such as artifacts, sites, or historic structures); determining whether any identified cultural resources are eligible for listing on the National Register, and therefore should be considered "historic properties"; assessing whether a proposed undertaking will cause adverse affects to any historic properties; and recommending ways to resolve adverse effects, namely avoidance or mitigation. This process is carried out in consultation with the State Historic

Preservation Officer of the state in which the undertaking takes place and with any other interested consulting parties including federally recognized Indian tribes.

The construction, maintenance, and operation of TVA transmission lines constitute undertakings and as such are subject to the NHPA and its implementing regulations at 36 CFR part 800. Examples of maintenance activities associated with transmission lines are spraying herbicides and replacing individual poles. Such activities are reviewed by TVA Cultural Resources staff on a case-by-case basis using the Sensitive Area Review (SAR) procedure. The purpose of an SAR Cultural Resources review is to identify whether the undertaking has any potential for adverse effects on cultural resources such as historic structures or buried prehistoric sites. If the undertaking does have potential for adverse effects, then procedures for avoidance or mitigation of the effects are put into place.

<u>How TVA Cultural Resources Conducts SARs for Transmission Operations and Maintenance Projects</u>

TVA Cultural Resources staff examine topographic maps of the project site for (a) previously recorded archaeological sites in the vicinity of the transmission line corridor; and (b) conditions that suggest high potential for archaeological sites including low slope (< 10%), proximity to major water sources, and lack of modern disturbance. ArcView GIS is used to identify areas with potential for cultural resources. For example, maps generated with this software show areas with slope < 10% (peach) and the distribution of streams (blue). The decision to do a field review is based on such information along with any information the staff can glean from videos of the transmission line corridors and from still photographs of the project site.

Field reviews are conducted by Cultural Resources staff or by consulting archaeologists, who look for signs of intact, buried prehistoric deposits using surface survey and sub-surface probes (when appropriate). The project is cleared if no artifacts or features are identified and if the project site appears to have a low potential for cultural resources. If intact buried deposits containing cultural resources are discovered, an attempt is made to discern whether the site may be potentially eligible for the National Register. A formal assessment of eligibility would not be undertaken during a field review, however. If the site may be eligible, then a Phase I investigation is called for. A Phase I might also be initiated if there is a high potential for intact buried deposits, even if no artifacts or features were identified during field review. The purposes of a Phase I investigation are to delimit the boundaries of a site, gather additional information relating to the site's eligibility (such as integrity), and assess possible effects to the site from the undertaking.

Avoidance is generally feasible for transmission line maintenance projects when cultural resources are present. ArcView GIS is used to generate a map showing polygons around those cultural resources, representing sensitive areas. Areas that are sensitive from the standpoint of cultural resources are coded Level 2, which indicates restrictions on methods of clearing (no mechanized equipment). These maps are provided to TPS prior to any maintenance activities on the line, so that crew supervisors will be aware of the necessary restrictions. Restrictions are typically called for when a previously recorded cemetery, prehistoric mound, or earthwork occurs within 0.25 miles of the transmission line.

Areas having potential for archaeological sites within five-mile radius of BFN

In order to estimate the number of archaeological sites that might be affected by transmission lines associated with BFN, a circle with a five-mile radius was drawn around the plant, and then a count was made of the number of recorded sites falling within the transmission line corridors within that area. The total number of archaeological sites in transmission line corridors within a five-mile radius of BFN, excluding sites that were inundated by the reservoir, is ten. All ten are within the L6074/6078 corridor. New maintenance work undergoes a SAR review. Many of these transmission lines were not surveyed by archaeologists because they were built before Section 106 of the National Historic Preservation Act went into effect.

There are seven TL corridors within a 5-mile radius of BFN (L5055, L6062, L6060/L6077, L5672, L5054/L6078 and related lines, L5837, and L6052/L6091). In the opinion of TVA Cultural Resources staff, virtually 100% of the land in these corridors would need to be field checked prior to any maintenance or new transmission line activity, based on the low slopes and abundance of streams in this area.

Two proposed maintenance projects on transmission lines associated with BFN have been sent to Cultural Resources for review, for FY 2004. Trinity-Browns Ferry Nuclear Plant (L5054) was reviewed for effects from vegetation re-clearing; Athens- Browns Ferry Nuclear Plant (L5055) was reviewed once for vegetation re-clearing and once for pole replacements. Neither transmission line requires Level 2 restrictions on vegetation re-clearing. However, 160 proposed pole replacements have been identified for field reviews along L5055. TPS is not likely to pursue pole replacements in all 160 cases.

Reference:

Muncy, J.A. 1999. A Guide for Environmental Protection and Best Management Practices for Tennessee Valley Authority Transmission Construction and Maintenance Activities. TVA Transmission/Power Supply Group, Technical Note TVA/LR/NRM 92/1, December 1999.

Class Definitions and Associated Polygon Colors of Sensitive Areas for RIGHT-OF-WAY RECLEARING Sensitive Area Reviews

<table>
<tr><td colspan="5">Terrestrial Plants (A), Terrestrial Animals (D), and Aquatic Animals (E)</td></tr>
<tr><td>Class</td><td colspan="2">Restriction if Sensitive area in ROW</td><td>Restriction for Sensitive Areas Potentially Affected when <u>Accessing</u> ROW</td><td>Polygon Color</td></tr>
<tr><td>1</td><td colspan="2">No broadcast spraying. Use one of the three following alternatives: 1) Hand or mechanical clearing, 2) Request field surveys by TVA Heritage staff to determine if suitable habitat for these species exists in the subject area, 3) Selective spraying of herbicides to shrubs or tree saplings less than 12 feet in height.</td><td>Not Applicable</td><td>Yellow</td></tr>
<tr><td>2</td><td colspan="2">Hand-clearing only. Vehicles and equipment restricted from area unless confined to existing access road.</td><td>Vehicles and equipment restricted from area unless confined to existing access road.</td><td>Red</td></tr>
<tr><td>0</td><td colspan="3">Special circumstance.</td><td>Green</td></tr>
<tr><td colspan="5">Wetlands* (C)</td></tr>
<tr><td>-</td><td colspan="3">Wetlands obtained from National Wetland Inventory data. Refer to “Wetlands ROW and Pole Replacement Guidelines” for restrictions.</td><td>Blue Outline</td></tr>
<tr><td>1</td><td colspan="3">Potential wetlands identified by Natural Heritage wetland biologists based on interpretation of topographic features, water bodies, soil surveys and proximity to NWI features. Refer to “Wetlands ROW and Pole Replacement Guidelines” for restrictions.</td><td>Pink Outline</td></tr>
<tr><td colspan="5">Natural Areas (B)</td></tr>
<tr><td>Class</td><td>Call**</td><td colspan="2">Definition</td><td>Color</td></tr>
<tr><td>1</td><td>No</td><td colspan="2">Same as Class 1 definition above.</td><td>Yellow</td></tr>
<tr><td>2</td><td>No</td><td colspan="2">Same as Class 2 definition above.</td><td>Red</td></tr>
<tr><td>1</td><td>Yes</td><td colspan="2">Same as Class 1 definition above, and must contact area manager prior to entering or conducting maintenance in subject area</td><td>Yellow hatching</td></tr>
<tr><td>2</td><td>Yes</td><td colspan="2">Same as Class 2 definition above, and must contact area manager prior to entering or conducting maintenance in subject area.</td><td>Red hatching</td></tr>
<tr><td>3</td><td>Yes</td><td colspan="2">Must contact area manager prior to entering or conducting maintenance in subject area.</td><td>Neon Green</td></tr>
<tr><td>none</td><td></td><td colspan="2">Special circumstance.</td><td>Green</td></tr>
<tr><td colspan="5">Archaeology (F)</td></tr>
<tr><td>Class</td><td colspan="2">Restriction if Sensitive area in ROW</td><td>Restriction for Sensitive Areas Potentially Affected when <u>Accessing</u> ROW</td><td>Color</td></tr>
<tr><td>2</td><td colspan="2">No Mechanical Clearing. Vehicles and equipment restricted from area unless confined to existing access road.</td><td>Vehicles and equipment restricted from area unless confined to existing access road.</td><td>Red</td></tr>
</table>

* Refer to Wetlands Statement included in this package.

** The “Call” column on the accompanying datasheets is used by Natural Area specialists only. A blank in the column indicates no call is necessary.

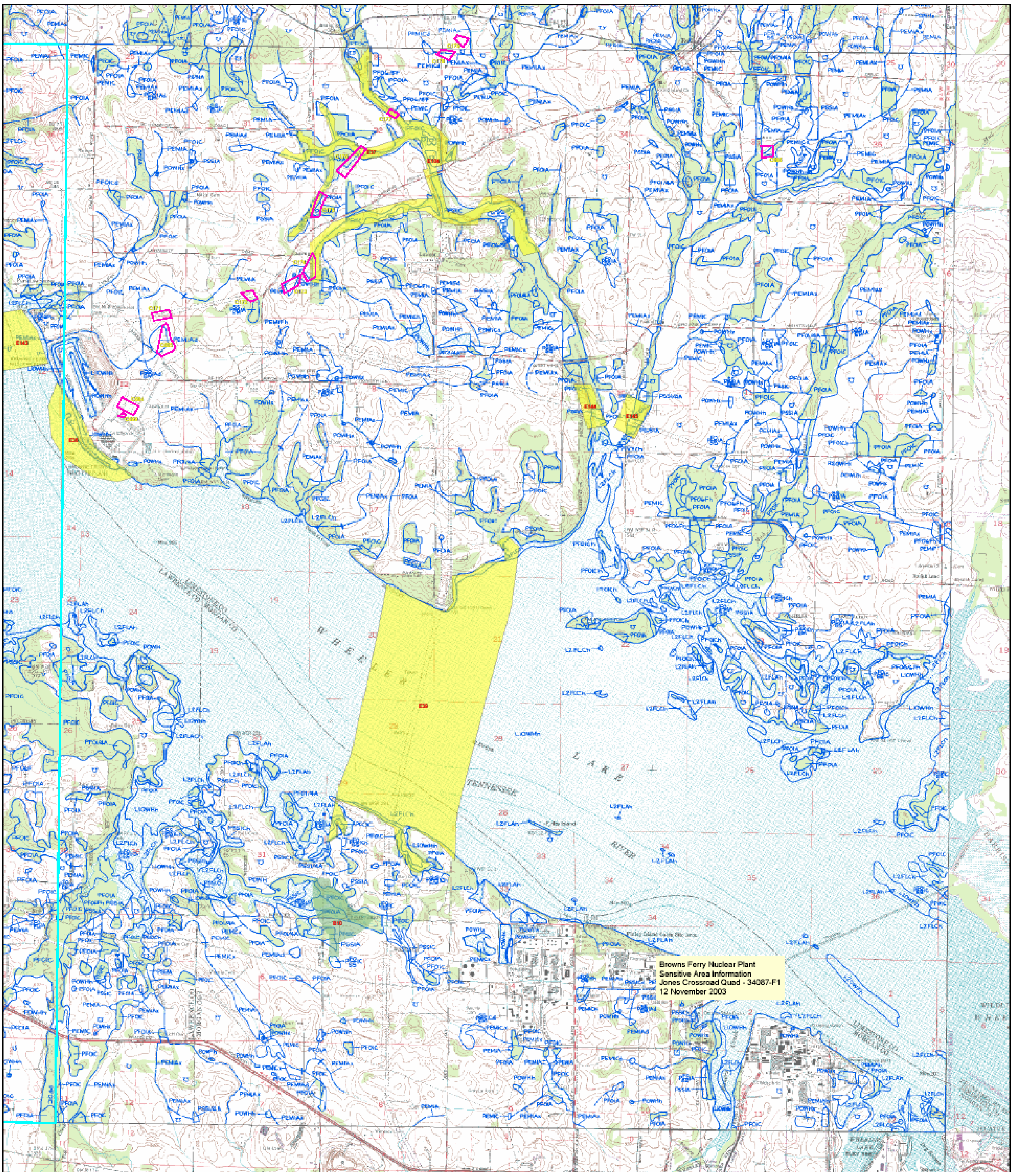
Class Definitions and Associated Polygon Colors of Sensitive Areas for POLE REPLACEMENT Sensitive Area Reviews

All Resources Areas (Plants, Natural Areas, Wetlands, Terrestrial Animals, and Aquatic Animals)		
Class	**Restriction**	**Pink**
1	**Botany**: Sensitive Botanical resources are known from the area. Details of proposed activities should be submitted to TVA Heritage staff to determine if the proposed activities require restrictions. **Natural Areas**: Refer to table accompanying project for restrictions. **Wetlands**: Potential wetlands identified by Natural Heritage wetland biologists based on interpretation of topographic features, water bodies, soil surveys and proximity to NWI features. Refer to "Wetlands ROW and Pole Replacement Guidelines" for restrictions. **Terrestrial Animals**: Refer to table accompanying project for restrictions. **Aquatic Animals**: Refer to table accompanying project for restrictions.	Pink
Wetlands		
-	Wetlands obtained from National Wetland Inventory data. Refer to "Wetlands ROW and Pole Replacement Guidelines" for restrictions.	Blue Outline

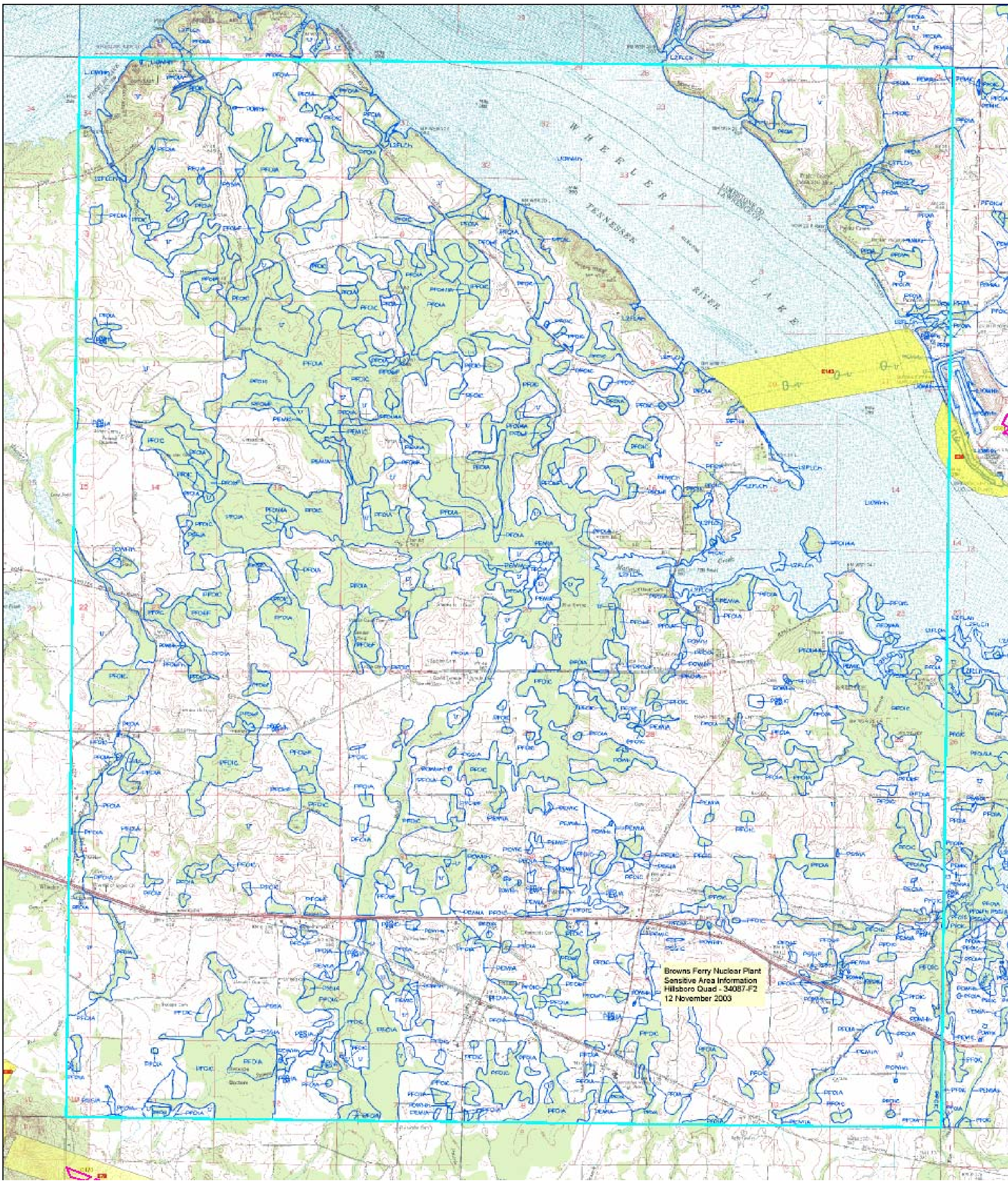
Delineated Electronic Topographical Maps

The following four pages are 8.5"x11" prints of the four topographical quadrangle maps immediately surrounding BFN, delineated via ArcMap to illustrate how sensitive areas are marked in the TVA transmission line environmental compliance review process. BFN is located in the northwest corner of the Jones Crossroad Quad; part of the cooling tower complex lies in the Hillsboro Quad to the west; the Cairo Quad is northwest of the site; and the Ripley Quad is northeast of the site.

These concentrated quadrangle map images are included here to illustrate the degree of detail and volume of information involved in the environmental compliance review process. The electronic versions of the maps can be enlarged for more accurate viewing.



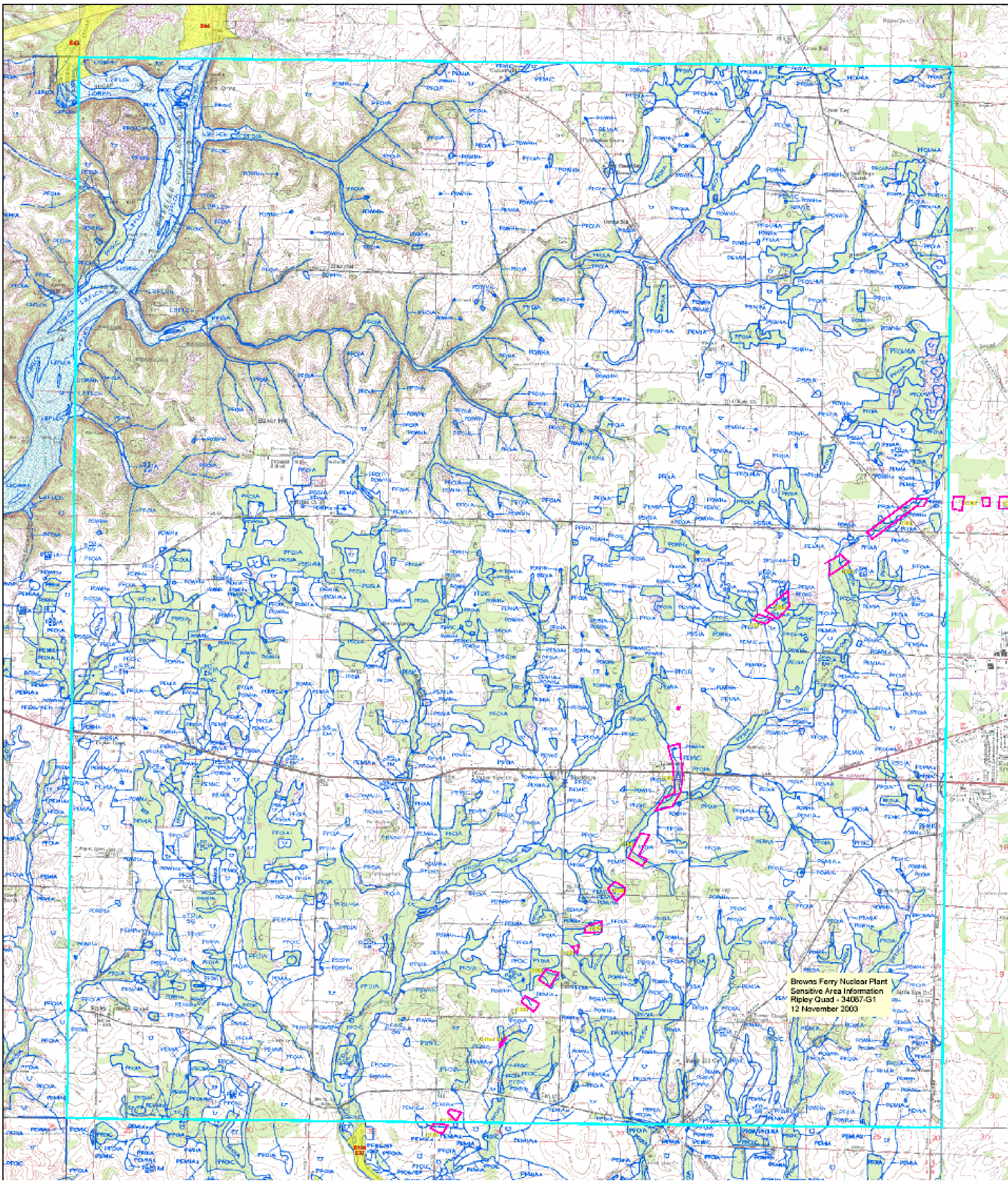
Jones Crossroad Quad



Hillsboro Quad


Browns Ferry Nuclear Plant
Sensitive Area Information
Cairo Quad - 34087-G2
12 November 2003

Cairo Quad


Browns Ferry Nuclear Plant
Sensitive Area Information
Ripley Quad - 34087-G1
12 November 2003

Ripley Quad

TRANSMISSION LINE OZONE PRODUCTION AND AVIAN MORTALITY

Ozone

Under some conditions ozone may be produced in small amounts from corona discharges (ionization of the air) in the operation of transmission lines and substations, particularly at the higher voltages. Such corona discharges can result from abrasions, foreign particles, or sharp points on electrical conductors and electrical equipment.

Extensive field tests concerning ozone were conducted over a 19-month period during 1971 and 1972 by the Illinois Institute of Technology Research for the Commonwealth Edison Company. These tests were made to determine if measurable quantities of ozone are generated by high voltage transmission lines. Continuous ozone measurements made adjacent to a 345-kV switchyard with a high concentration of 345-kV and 128-kV transmission lines and adjacent to a 765-kV line were compared with continuous ambient measurements made at locations in the same areas but remote from the transmission lines. From this investigation it was concluded that high voltage transmission lines up to 765-kV do not generate ozone measurable above the ambient at ground level adjacent to the lines under tested weather conditions (IEEE 1973).

In view of the design and construction standards employed by TVA in building its transmission facilities, corona discharges are minimal or nonexistent. TVA specifications require that transmission line hardware and electric equipment for operation at 500,000 volts be factory tested to assure corona-free performance up to maximum operating voltage levels. Accordingly, any ozone which could possibly be generated by the proposed transmission line (500-kV nominal voltage) would be environmentally inconsequential and harmless to vegetation, animals, and humans.

Bird Collisions and Electrocutions

TVA has not observed significant problems with bird electrocutions or collisions with transmission line structures or conductors within the TVA service area.

Considerable work has been done in the Western U.S. regarding electrocution hazards for large birds, raptors in particular, on distribution-voltage lines, but this is not normally a problem on transmission lines due to the relatively large phase-to-ground and phase-to-phase spacing. In fact, vultures roost in large numbers on TVA structures in some areas, to the point that fecal contamination of the structure is a problem. Typical spacings for TVA transmission line towers are as follows:

Electrical Separation	**161 kV Towers**	**500 kV Towers**
Conductor Phase Wire Spacing	12 feet or more	30 feet or more
Conductor to Ground Distance	6.1 feet minimum	13.3 feet minimum

ATTACHMENT E-7

TVA’s Demand-Side Management Program

Demand-Side Management

Demand-side management (DSM) refers to actions by utilities to manage energy consumption patterns, including the timing and/or amount of energy used. DSM can benefit utilities through lower operations and maintenance costs, deferral of capital requirements, and improved utilization of power system assets. Environmental benefits associated with DSM include less fuel consumption and reduced emissions. DSM can have multiple forms, including load leveling and energy efficiency. Load leveling activities are those that limit or shift load from on-peak to off-peak time periods. Energy efficiency activities are those aimed at reducing the energy used by end-use devices and systems, typically without affecting the benefits from the services provided. These activities reduce overall electricity consumption, often with no explicit consideration for the timing of program-induced energy use reductions.

HISTORICAL PERSPECTIVE AND OVERVIEW

DSM programs have been part of TVA's energy portfolio since the 1970s. They were initiated in response to the rising cost of energy and the rising cost of building new electric generating units that began in the mid 1970s. By 1988, TVA DSM programs were credited with saving more than 2.3 billion kilowatt-hours per year and cutting system demand by 1,200 megawatts (MW). Of these savings, 960 MW came from the residential sector after weatherization measures were installed in 631,000 homes in the Valley. Later in the 1980s and through the 1990s, TVA's energy efficiency efforts continued to focus on the residential market with *energy right*® and TVA's "Cycle and Save" direct load control program for water heaters and air conditioners.

For non-residential customer segments, a program using interruptible Time-Of-Use (TOU) rates was created for the large commercial and industrial consumers to encourage peak load reduction. This highly successful program grew from several hundred megawatts to nearly 6,000 MW of interruptible load at its peak. Today, there are approximately 4,000 MW of load under contract, and TVA relies on approximately half of the available contract load for operations planning. To further assist during periods of critical peak demand, TVA has approximately 230 MW of economy buyback power under contract with 10 industrial customers and 350 MW of call rights for peak demand reduction with five very large industrial facilities.

In total, TVA's residential load control and large volume DSM programs may yield up to 2,600 MW of demand reduction during a critical event.

CURRENT PROGRAMS

Residential and Small Commercial Products and Services

About 150 power distributors participate in the various initiatives from the *energy right* Program. These initiatives are described below:

<u>New Homes Plan</u> promotes all-electric, energy-efficient new homes. All homes built *energy right* must meet a minimum rating in overall energy efficiency. Since 1998 more than 56,000 homes have been built that meet *energy right* guidelines.

Heat Pump Plan promotes the installation of high-efficiency heat pumps in homes and small businesses. Installation, performance, and weatherization standards have been established to ensure the comfort of the customer and the proper operation of the system. A Quality Contractor Network has been established to maintain high installation standards. Through a third-party lender, TVA provides 10-year financing for residential heat pumps with repayment through the consumer's electric bill. Since 1998 more than 43,000 heat pumps have been installed through the program, and 75% of these have a Seasonal Energy Efficiency Rating (SEER) of 12 or higher; the Department of Energy (DOE) minimum efficiency standard is 10 SEER.

Water Heater Plan promotes the installation of energy-efficient electric water heaters in homes and small businesses. The *energy right* Program encourages the installation of electric water heaters with higher energy factors and lifetime warranties. More than 72,000 electric water heaters have been installed through the program since 1998.

New Manufactured Homes Plan promotes the installation of electric heat pumps in new manufactured homes. Since 1998 more than 15,000 new manufactured homes have been equipped with heat pumps instead of conventional air conditioning. This reduces heating energy use, and therefore the customer's heating bill, by as much as 50%, and provides the customer with a comfortable and more affordable home. In 2002 TVA worked with 17 plants that build manufactured homes to assist them in obtaining the Energy Star label.

In Concert With The Environment (in partnership with Nexus Energyguide) is a comprehensive environmental and energy education program directed to middle school and junior high school students. Student participants receive an energy survey to complete for their households. The results indicate the home's estimated annual and monthly energy usage by appliance and give a number of energy, environmental, and water recommendations for the student and their family to implement. Approximately 23,000 home energy surveys have been completed through this schools-based program since 1998.

energy right Home e-Valuation® (in partnership with Nexus Energyguide) allows residential customers to play an active role in saving energy in their homes. After completing an energy survey, customers receive a personalized report that breaks down the home's annual and monthly energy usage by appliance and gives a number of energy recommendations as well as information about distributor products and services. Approximately 9,000 home energy surveys have been completed since 1998.

More information is available at the *energy right* website (www.energyright.com).

Another effort, unrelated to *energy right*, which targets this market sector is:

Direct Load Control (Water Heaters). TVA's direct load control program gives participating distributors the option of cycling water heater loads for their own system needs and provides TVA with the option to interrupt these loads in a peak situation.

Industrial and Large Commercial Products and Services

On-site Operations Support. In the Industrial and Large Commercial area, several DSM initiatives are underway. At two of TVA's direct-served industries – Saturn in

Tennessee, and Delphi in Alabama –employees are stationed on-site to co-lead teams toward more efficient plant operations and utility savings. Opportunities identified and implemented at Saturn have resulted in over $3 million in actual savings since 2000. Since 2001, TVA helped identify over $1 million in savings opportunities at the Delphi plant, many of which have already been implemented.

End-Use Industrial Support. Even TVA's energy sales efforts are focused on replacing older, less efficient technologies with those processes using less energy and/or demand than other processes. TVA staff working with these end-use industrial customers help: 1) increase the efficiency of operations that result in less energy and demand per unit of production; 2) enable a better competitive position; and 3) achieve environmental benefits due to less waste of energy and raw materials.

Geothermal Initiatives. TVA has one of the nation's leading geothermal heat pump initiatives. Using heat from the earth, these "green" heating/cooling systems use only about half the energy of a conventional air source heat pump. TVA has actively promoted these systems in schools, public buildings, and prisons with considerable success. The Association of Tennessee Valley Governments (ATVG) has adopted a resolution that all government facilities should consider geothermal in the design process of new and remodeled buildings. At least one county in Tennessee, Sumner, has adopted a policy that all new schools be built geothermal if feasible. TVA also promotes the use of other energy-efficient, load leveling, and demand reducing technologies for large commercial facilities, including other HVAC systems, lighting, and building design.

Green Power Switch

Green Power Switch is a renewable energy initiative that offers consumers in the Tennessee Valley a choice in the type of power they buy. TVA and local public power companies, working in cooperation with the environmental community, developed Green Power Switch as a way to bring green power – electricity that is generated by cleaner, renewable resources – to Valley consumers. Participating public power companies in the TVA service area are selling energy generated by solar, wind, and methane gas resources. Currently, 64 distributors of TVA power offer Green Power Switch to their residential and business customers.

Energy Services

Since 1997, TVA's Energy Services Company has achieved 18,000,000 kilowatt-hours of energy efficiency savings and 8 megawatts of cumulative peak demand reduction through performance contracting in which capital equipment is purchased using utility savings. More than $20 million in improvements have been made at two military installations in the Valley; at one base the energy savings now exceed $1 million per year.

NEW INITIATIVES

Sustainable Building Construction

A growing area of DSM is in sustainable building construction. Sustainable building construction promotes the most efficient use of construction resources, focusing on energy efficiency, water conservation, water pollution prevention, indoor and outdoor air quality, building materials and solid waste, and community development. This reduces energy usage and peak demand in new and remodeled homes and commercial structures.

Uptown Memphis. TVA has partnered with Memphis Light, Gas & Water Division in a demonstration at the Uptown Memphis project. This initiative involves the redevelopment of an approximate one hundred block area of Memphis around St. Jude Children's Research Hospital. Additionally, plans are to build a Green Power Switch solar generation site as part of this redevelopment effort.

Net Zero Energy Building. TVA has partnered with DOE, Oak Ridge National Laboratory, and the Loudon County Habitat for Humanity in a research and development demonstration for future energy-efficient construction and renewable energy. Five houses will be built using energy-efficient home construction. The homes will test and demonstrate innovative technologies such as advanced low-cost power sensors and controls, roofs that change their reflectivity according to the temperature, self-sealing caulks and flashings, indoor air quality enhancements, and advanced space conditioning and water heating. The first house includes a 2-kW photovoltaic system connected to the power grid that will provide any excess power generation to the Green Power Switch Resource Acquisition Pilot. The goal is to have a Net Zero Energy Building (ZEB) that on an annual average is designed and built to produce as much energy as it uses.

Education Initiatives

Tennessee Energy Education Committee. TVA is a partner with the State of Tennessee and co-chairs the committee made up of other stakeholders charged with implementing the Governor's Policy on Energy Efficiency Education. As part of this effort, TVA is making an electronic version of the Energy Sourcebook available to all schools in TVA's service territory.

Performance Contracting for Schools. TVA has developed a performance ally network of energy services consultants, designers, installers, and financers to implement energy efficiency projects in schools. Since 1999, walk-through audits have been conducted at 28 school systems, and project implementation is underway for 8 of these. TVA is also working with the State of Tennessee Energy Services Coalition to streamline their performance contracting process and make it easier for school officials to evaluate opportunities and implement projects.

Educational Website for Children. TVA has a new addition to its educational outreach activities. A new website, www.tvakids.com, is geared toward children in the fourth through the eighth grades and provides information on the generation of electricity, the Tennessee River system, and TVA's dedication to a clean environment. Users are given explanations of TVA operations, tips for water and electrical safety, and information on energy conservation. The site also shares information about the current and future mission of TVA and the nearly 70-year history of the agency. The teachers' section of the site provides information about educational programs offered by TVA and has energy related curriculum plans that can be downloaded for classroom use.

ATTACHMENT E-8

National Pollutant Discharge Elimination System Permit for BFN

ADEM

ALABAMA
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT

PERMITTEE:	TENNESSEE VALLEY AUTHORITY BROWN'S FERRY NUCLEAR PLANT
FACILITY LOCATION:	SHAW ROAD AT NUCLEAR PLANT ROAD ATHENS, ALABAMA (LIMESTONE COUNTY)
PERMIT NUMBER:	AL0022080
RECEIVING WATERS:	TENNESSEE RIVER

In accordance with and subject to the provisions of the Federal Water Pollution Control Act, as amended, 33 U.S.C. §§1251-1378 (the "FWPCA"), the Alabama Water Pollution Control Act, as amended, Code of Alabama 1975, §§ 22-22-1 to 22-22-14 (the "AWPCA"), the Alabama Environmental Management Act, as amended, Code of Alabama 1975, §§22-22A-1 to 22-22A-15, and rules and regulations adopted thereunder, and subject further to the terms and conditions set forth in this permit, the Permittee is hereby authorized to discharge into the above-named receiving waters.

ISSUANCE DATE:	DECEMBER 29, 2000
EFFECTIVE DATE:	FEBRUARY 1, 2001
EXPIRATION DATE:	JANUARY 31, 2006

Alabama Department of Environmental Management

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT

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PART I

A. DISCHARGE LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning the effective date of this permit and lasting through the expiration date of this permit, the permittee is authorized to discharge from the following point source(s) outfall(s), described more fully in the permittee’s application:

DSN001: Once-through cooling water from the Condenser Circulating Water (CCW), Raw Cooling Water (RCW), Units 1-3 Turbine Building station sump effluent, the Liquid Radwaste System effluent, and the Intake Building sump effluent through the diffuser outfall to the Tennessee River.

Such discharge shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	UNITS	DISCHARGE LIMITATIONS				MONITORING REQUIREMENTS 1/	
		Daily Minimum	Daily Maximum	Daily Average	Monthly Average 2/	Measurement Frequency	Sample Type
Flow	MGD	-	Monitor	-	Monitor	1/day	Pump Log 3/
pH 10/	s. u.	6.0	8.5	-	-	1/week	Grab
Ambient Upstream River Temp. 4/	°F	-	-	Monitor	-	1/day	Recorder
Downstream River Temperature 5/	°F	-	93 7/	90 8/	Monitor	1/day	Recorder
Downstream Temperature Rise 5/ 6/	°F	-	Monitor	10	-	1/day	Recorder
Effluent Temperature	°F	-	Monitor	Monitor	-	1/day	Recorder
Chronic Biomonitoring 9/	%	-	IC25	-	-	1/year	Composite
Total Residual Chlorine	mg/l	-	0.064	-	0.045	1/quarter	Grab

1/ Samples collected to comply with the monitoring requirements specified above shall be collected at the locations described in Part I.B. of this permit. Unless otherwise specified, composite samples shall be time composite samples collected using automatic sampling equipment or a minimum of eight (8) equal volume grab samples collected over equal time intervals. All composite samples shall be collected for the total period of discharge not to exceed 24 hours.
2/ Monthly average limits apply only when a parameter is monitored more than once in a month.
3/ Pump log verified by annual dye testing or diffuser head measurement.

4/ The ambient river temperature shall be determined by an upstream monitor located in the main channel at about river mile 297.8. In the event of a failure of this monitor, the five-foot depth temperature at the monitor located at river mile 296.1 will serve as the measured ambient temperature. Measurements shall be every 15 minutes at 3, 5, and 7 foot depths and averaged to obtain a 5 foot depth measurement. The temperatures shall be averaged using the current temperature and the last ninety-five 15-minute readings to produce the 24-hour average.

5/ Compliance with downstream river temperature and temperature rise limitations shall be applicable at the edge of the mixing zone which shall not exceed the following dimensions:

(1) A maximum length of 2400 feet downstream of the diffusers, (2) a maximum width of 2,000 feet, and (3) a maximum length of 150 feet upstream of the diffusers to the top of the diffuser pipes and extends to the bottom downstream of the diffusers.

Downstream river temperature measurements shall be made by three monitors located in a line across the reservoir at approximate river mile 293.45. Temperature data shall be measured every 15 minutes at 3, 5, and 7 foot depths and averaged to obtain a 5 foot depth measurement. Temperatures at each monitor will be temporally averaged using the current temperature and the last ninety-five 15-minute readings to produce a 24-hour running average. The temperatures from the monitors corresponding to the diffusers in operation will then be averaged to obtain a representative spatial mean.

6/ Temperature rise shall be determined by subtracting the ambient temperature values monitored in 4/ from the downstream river temperature monitored in 5/.

7/ The hourly average of any of the three downstream temperature monitors.

8/ When the 24-hour ambient average temperature exceeds 90°F, the downstream temperature may equal but not exceed the upstream value.

9/ See Part IV.B. for other requirements.

10/ The pH shall not be less than 6.0 s.u. nor greater than 8.5 s.u. unless ambient river conditions prevent compliance at that range. Upstream monitoring by the permittee within one hour of a non-complying pH value will serve to demonstrate that ambient river conditions are preventing compliance.

PART I

A. DISCHARGE LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning the effective date of this permit and lasting through the expiration date of this permit, the permittee is authorized to discharge from the following point source(s) outfall(s), described more fully in the permittee's application:

DSN005: Residual heat removal service effluent.

Such discharge shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	UNITS	DISCHARGE LIMITATIONS			MONITORING REQUIREMENTS 1/	
		Daily Minimum	Daily Maximum	Monthly Average 2/	Measurement Frequency	Sample Type
Flow	MGD	-	-	Monitor	1/week	Estimate
pH	s.u.	6.0	8.5	-	1/week	Grab
Temperature	°F	-	Monitor	Monitor	1/week	Grab

1/ Samples collected to comply with the monitoring requirements specified above shall be collected at the locations described in Part I.B. of this permit. Unless otherwise specified, composite samples shall be time composite samples collected using automatic sampling equipment or a minimum of eight (8) equal volume grab samples collected over equal time intervals. All composite samples shall be collected for the total period of discharge not to exceed 24 hours.

2/ Monthly average limits apply only when a parameter is monitored more than once in a month.

PART I

A. DISCHARGE LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning the effective date of this permit and lasting through the expiration date of this permit, the permittee is authorized to discharge from the following point source(s) outfall(s), described more fully in the permittee's application:

DSN012: Intake screen backwash.

Such discharge shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	UNITS	DISCHARGE LIMITATIONS			MONITORING REQUIREMENTS 1/	
		Daily Minimum	Daily Maximum	Monthly Average 2/	Measurement Frequency	Sample Type

NO MONITORING REQUIREMENTS ARE IMPOSED PROVIDED THE PERMITTEE ADDS NO POLLUTANTS TO THE DISCHARGE.

THE DISCHARGE SHALL HAVE NO SHEEN, AND THERE SHALL BE NO DISCHARGE OF VISIBLE OIL, FLOATING SOLIDS OR FOAM IN OTHER THAN TRACE AMOUNTS.

1/ Samples collected to comply with the monitoring requirements specified above shall be collected at the locations described in Part I.B. of this permit. Unless otherwise specified, composite samples shall be time composite samples collected using automatic sampling equipment or a minimum of eight (8) equal volume grab samples collected over equal time intervals. All composite samples shall be collected for the total period of discharge not to exceed 24 hours.
2/ Monthly average limits apply only when a parameter is monitored more than once in a month.

PART I

A. DISCHARGE LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning the effective date of this permit and lasting through the expiration date of this permit, the permittee is authorized to discharge from the following point source(s) outfall(s), described more fully in the permittee's application:

DSN013: Storm water from the Toxicity Testing Laboratory parking lot, northwest corner of Training Center's parking lot, storm drain at sedimentation pond, area south of the Toxicity Testing Lab,
DSN013a, DSN013(a)(1) and DSN013b.

Such discharge shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	UNITS	DISCHARGE LIMITATIONS			MONITORING REQUIREMENTS 1/	
		Daily Minimum	Daily Maximum	Monthly Average 2/	Measurement Frequency	Sample Type
Flow	MGD	-	Monitor	-	1/year	3/
pH	s. u.	Monitor	Monitor	-	1/year	Grab
Total Suspended Solids	mg/l	-	Monitor	-	1/year	Grab
Oil and Grease	mg/l	-	15.0	-	1/year	Grab

THE DISCHARGE SHALL HAVE NO SHEEN, AND THERE SHALL BE NO DISCHARGE OF VISIBLE OIL, FLOATING SOLIDS OR FOAM IN OTHER THAN TRACE AMOUNTS.

THERE SHALL BE NO DISCHARGE OF POLYCHLORINATED BIPHENYL COMPOUNDS, SUCH AS THOSE COMMONLY USED FOR TRANSFORMER FLUID.

1/ Samples collected to comply with the monitoring requirements specified above shall be collected at the locations described in Part I.B. of this permit. Unless otherwise specified, composite samples shall be time composite samples collected using automatic sampling equipment or a minimum of eight (8) equal volume grab samples collected over equal time intervals. All composite samples shall be collected for the total period of discharge not to exceed 24 hours.
2/ Monthly average limits apply only when a parameter is monitored more than once in a month.
3/ See Part IV.C. for storm water flow measurements.

PART I

A. DISCHARGE LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning the effective date of this permit and lasting through the expiration date of this permit, the permittee is authorized to discharge from the following point source(s) outfall(s), described more fully in the permittee's application:

DSN013a: Storm water runoff from the switchyard drainage ditch which includes the 4 kV capacitor yard, the main plant transformer yard, the switchyard, the east parking lot, and the grassland north of the east parking lot.

Such discharge shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	UNITS	DISCHARGE LIMITATIONS			MONITORING REQUIREMENTS 1/	
		Daily Minimum	Daily Maximum	Monthly Average 2/	Measurement Frequency	Sample Type
Flow	MGD	-	Monitor	-	1/year	3/
pH	s. u.	Monitor	Monitor	-	1/year	Grab
Total Suspended Solids	mg/l	-	Monitor	-	1/year	Grab
Oil and Grease	mg/l	-	15.0	-	1/year	Grab

THE DISCHARGE SHALL HAVE NO SHEEN, AND THERE SHALL BE NO DISCHARGE OF VISIBLE OIL, FLOATING SOLIDS OR FOAM IN OTHER THAN TRACE AMOUNTS.

THERE SHALL BE NO DISCHARGE OF POLYCHLORINATED BIPHENYL COMPOUNDS, SUCH AS THOSE COMMONLY USED FOR TRANSFORMER FLUID.

1/ Samples collected to comply with the monitoring requirements specified above shall be collected at the locations described in Part I.B. of this permit. Unless otherwise specified, composite samples shall be time composite samples collected using automatic sampling equipment or a minimum of eight (8) equal volume grab samples collected over equal time intervals. All composite samples shall be collected for the total period of discharge not to exceed 24 hours.
2/ Monthly average limits apply only when a parameter is monitored more than once in a month.
3/ See Part IV.C. for storm water flow measurements.

PART I

A. DISCHARGE LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning the effective date of this permit and lasting through the expiration date of this permit, the permittee is authorized to discharge from the following point source(s) outfall(s), described more fully in the permittee's application:

DSN013a(1): Treated domestic wastewater, medical lab photo developing waste, blowdown from the Training Center's chiller system, flush water from the stand-by liquid control system, flush water from cooler/air compressor cleaning, filtered waste from insulator showers used by personnel involved in the periodic asbestos stripping and handling operations, and rainwater. 3/

Such discharge shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	UNITS	DISCHARGE LIMITATIONS			MONITORING REQUIREMENTS 1/	
		Daily Minimum	Daily Maximum	Monthly Average 2/	Measurement Frequency	Sample Type
Flow	MGD	-	Monitor	Monitor	5/week	Instantaneous
pH	s. u.	6.0	9.0	-	1/2weeks	Grab
Biochemical Oxygen Demand, 5-day	mg/l	-	45.0	30.0	1/2weeks	Grab
Total Suspended Solids	mg/l	-	45.0	30.0	1/2weeks	Grab
Fecal Coliform	org/100 ml	-	400.0	-	1/month	Grab

1/ Samples collected to comply with the monitoring requirements specified above shall be collected at the locations described in Part I.B. of this permit. Unless otherwise specified, composite samples shall be time composite samples collected using automatic sampling equipment or a minimum of eight (8) equal volume grab samples collected over equal time intervals. All composite samples shall be collected for the total period of discharge not to exceed 24 hours.
2/ Monthly average limits apply only when a parameter is monitored more than once in a month.
3/ Sampling location for BOD, TSS, and pH is at the end of DSN013a and samples must be taken during dry weather with no storm water runoff.

PART I

A. DISCHARGE LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning the effective date of this permit and lasting through the expiration date of this permit, the permittee is authorized to discharge from the following point source(s) outfall(s), described more fully in the permittee's application:

DSN013b: Sedimentation pond discharge.

Such discharge shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	UNITS	DISCHARGE LIMITATIONS			MONITORING REQUIREMENTS 1/	
		Daily Minimum	Daily Maximum	Monthly Average 2/	Measurement Frequency	Sample Type
Flow	MGD	-	Monitor	Monitor	1/batch	Staff Gage
pH	s. u.	6.0	9.0	-	1/batch	Grab
Total Suspended Solids	mg/l	-	100.0	30.0	1/batch	Grab
Oil and Grease	mg/l	-	20.0	15.0	1/batch	Grab

1/ Samples collected to comply with the monitoring requirements specified above shall be collected at the locations described in Part I.B. of this permit. Unless otherwise specified, composite samples shall be time composite samples collected using automatic sampling equipment or a minimum of eight (8) equal volume grab samples collected over equal time intervals. All composite samples shall be collected for the total period of discharge not to exceed 24 hours.

2/ Monthly average limits apply only when a parameter is monitored more than once in a month.

PART I

A. DISCHARGE LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning the effective date of this permit and lasting through the expiration date of this permit, the permittee is authorized to discharge from the following point source(s) outfall(s), described more fully in the permittee's application:

DSN014: Storm water runoff from non-industrial activities (west perimeter drainage ditch).

Such discharge shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	UNITS	DISCHARGE LIMITATIONS			MONITORING REQUIREMENTS 1/	
		Daily Minimum	Daily Maximum	Monthly Average 2/	Measurement Frequency	Sample Type

NO MONITORING REQUIREMENTS ARE IMPOSED PROVIDED

THE DISCHARGE SHALL HAVE NO SHEEN, AND THERE SHALL BE NO DISCHARGE OF VISIBLE OIL, FLOATING SOLIDS OR FOAM IN OTHER THAN TRACE AMOUNTS.

1/ Samples collected to comply with the monitoring requirements specified above shall be collected at the locations described in Part I.B. of this permit. Unless otherwise specified, composite samples shall be time composite samples collected using automatic sampling equipment or a minimum of eight (8) equal volume grab samples collected over equal time intervals. All composite samples shall be collected for the total period of discharge not to exceed 24 hours.
2/ Monthly average limits apply only when a parameter is monitored more than once in a month.

PART I

A. DISCHARGE LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning the effective date of this permit and lasting through the expiration date of this permit, the permittee is authorized to discharge from the following point source(s) outfall(s), described more fully in the permittee's application:

DSN017: Air conditioner condensate and storm water runoff from the Training Center and Live Well Center areas.

EFFLUENT CHARACTERISTIC	UNITS	DISCHARGE LIMITATIONS			MONITORING REQUIREMENTS 1/	
		Daily Minimum	Daily Maximum	Monthly Average 2/	Measurement Frequency	Sample Type

NO MONITORING REQUIREMENTS ARE IMPOSED PROVIDED

THE DISCHARGE SHALL HAVE NO SHEEN, AND THERE SHALL BE NO DISCHARGE OF VISIBLE OIL, FLOATING SOLIDS OR FOAM IN OTHER THAN TRACE AMOUNTS.

1/ Samples collected to comply with the monitoring requirements specified above shall be collected at the locations described in Part I.B. of this permit. Unless otherwise specified, composite samples shall be time composite samples collected using automatic sampling equipment or a minimum of eight (8) equal volume grab samples collected over equal time intervals. All composite samples shall be collected for the total period of discharge not to exceed 24 hours.

2/ Monthly average limits apply only when a parameter is monitored more than once in a month.

PART I

A. DISCHARGE LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning the effective date of this permit and lasting through the expiration date of this permit, the permittee is authorized to discharge from the following point source(s) outfall(s), described more fully in the permittee's application:

DSN024: Storm water from the northeast and east perimeters which include adjacent farmland, vehicle service shop and mechanic shop

Such discharge shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	UNITS	DISCHARGE LIMITATIONS			MONITORING REQUIREMENTS 1/	
		Daily Minimum	Daily Maximum	Monthly Average 2/	Measurement Frequency	Sample Type
Flow	MGD	-	Monitor	-	1/year	3/
pH	s. u.	Monitor	Monitor	-	1/year	Grab
Total Suspended Solids	mg/l	-	Monitor	-	1/year	Grab
Oil and Grease	mg/l	-	15.0	-	1/year	Grab

THE DISCHARGE SHALL HAVE NO SHEEN, AND THERE SHALL BE NO DISCHARGE OF VISIBLE OIL, FLOATING SOLIDS OR FOAM IN OTHER THAN TRACE AMOUNTS.

1/ Samples collected to comply with the monitoring requirements specified above shall be collected at the locations described in Part I.B. of this permit. Unless otherwise specified, composite samples shall be time composite samples collected using automatic sampling equipment or a minimum of eight (8) equal volume grab samples collected over equal time intervals. All composite samples shall be collected for the total period of discharge not to exceed 24 hours.
2/ Monthly average limits apply only when a parameter is monitored more than once in a month.
3/ See Part IV.B.8 for storm water flow measurements.

PART I

A. DISCHARGE LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning the effective date of this permit and lasting through the expiration date of this permit, the permittee is authorized to discharge from the following point source(s) outfall(s), described more fully in the permittee's application:

DSN018: Storm water from the Materials and Procurement Complex parking lot, the firing range parking lot, the Facilities Maintenance area, the vehicle fuel dispensing area and adjacent grass area.

Such discharge shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	UNITS	DISCHARGE LIMITATIONS			MONITORING REQUIREMENTS 1/	
		Daily Minimum	Daily Maximum	Monthly Average 2/	Measurement Frequency	Sample Type
Flow	MGD	-	Monitor	-	1/year	3/
pH	s. u.	Monitor	Monitor	-	1/year	Grab
Total Suspended Solids	mg/l	-	Monitor	-	1/year	Grab
Oil and Grease	mg/l	-	15.0	-	1/year	Grab
BETX	µg/l	-	200.0	-	1/year	Grab
Napthalene	µg/l	-	600.0	-	1/year	Grab

THE DISCHARGE SHALL HAVE NO SHEEN, AND THERE SHALL BE NO DISCHARGE OF VISIBLE OIL, FLOATING SOLIDS OR FOAM IN OTHER THAN TRACE AMOUNTS.

1/ Samples collected to comply with the monitoring requirements specified above shall be collected at the locations described in Part I.B. of this permit. Unless otherwise specified, composite samples shall be time composite samples collected using automatic sampling equipment or a minimum of eight (8) equal volume grab samples collected over equal time intervals. All composite samples shall be collected for the total period of discharge not to exceed 24 hours.
2/ Monthly average limits apply only when a parameter is monitored more than once in a month.
3/ See Part IV.C. for storm water flow measurements.

PART I

A. DISCHARGE LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning the effective date of this permit and lasting through the expiration date of this permit, the permittee is authorized to discharge from the following point source(s) outfall(s), described more fully in the permittee's application:

DSN019: Storm water from the east side of plant which includes the Fire Training area, the Low Level Radwaste storage facility, the inert landfill and the Hazardous Waste storage area.

Such discharge shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	UNITS	DISCHARGE LIMITATIONS			MONITORING REQUIREMENTS 1/	
		Daily Minimum	Daily Maximum	Monthly Average 2/	Measurement Frequency	Sample Type
Flow	MGD	-	Monitor	-	1/year	3/
pH	s. u.	Monitor	Monitor	-	1/year	Grab
Total Suspended Solids	mg/l	-	Monitor	-	1/year	Grab
Oil and Grease	mg/l	-	15.0	-	1/year	Grab
Chemical Oxygen Demand	mg/l	-	Monitor	-	1/year	Grab

THE DISCHARGE SHALL HAVE NO SHEEN, AND THERE SHALL BE NO DISCHARGE OF VISIBLE OIL, FLOATING SOLIDS OR FOAM IN OTHER THAN TRACE AMOUNTS.

1/ Samples collected to comply with the monitoring requirements specified above shall be collected at the locations described in Part I.B. of this permit. Unless otherwise specified, composite samples shall be time composite samples collected using automatic sampling equipment or a minimum of eight (8) equal volume grab samples collected over equal time intervals. All composite samples shall be collected for the total period of discharge not to exceed 24 hours.
2/ Monthly average limits apply only when a parameter is monitored more than once in a month.
3/ See Part IV.C. for storm water flow measurements.

B. DISCHARGE MONITORING AND RECORD KEEPING REQUIREMENTS

1. Representative Sampling

Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge and shall be in accordance with the provisions of this permit.

2. Test Procedures

For the purpose of reporting and compliance, permittees shall use one of the following procedures:

a. For parameters with an EPA established Minimum Level (ML), report the measured value if the analytical result is at or above the ML and report “0” for values below the ML. Test procedures for the analysis of pollutants shall conform to 40 CFR Part 136 and guidelines published pursuant to Section 304(h) of the FWPCA, 33 U.S.C. Section 1314(h). If more than one method for analysis of a substance is approved for use, a method having a minimum level lower than the permit limit shall be used. If the minimum level of all methods is higher than the permit limit, the method having the lowest minimum level shall be used and a report of less than the minimum level shall be reported as zero and will constitute compliance, however should EPA approve a method with a lower minimum level during the term of this permit the permittee shall use the newly approved method.

b. For pollutants parameters without an established ML, an interim ML may be utilized. The interim ML shall be calculated as 3.18 times the Method Detection Level (MDL) calculated pursuant to 40 CFR Part 136, Appendix B.

Permittees may develop an effluent matrix-specific ML, where an effluent matrix prevents attainment of the established ML. However, a matrix specific ML shall be based upon proper laboratory method and technique. Matrix-specific MLs must be approved by the Department, and may be developed by the permittee during permit issuance, reissuance, modification, or during compliance schedule.

In either case the measured value should be reported if the analytical result is at or above the ML and “0” reported for values below the ML.

c. For parameters without an EPA established ML, interim ML, or matrix-specific ML, a report of less than the detection limit shall constitute compliance if the detection limit of all analytical methods is higher than the permit limit. For the purpose of calculating a monthly average, “0” shall be used for values reported less than the detection limit.

The Minimum Level utilized for procedures A and B above shall be reported on the permittee’s DMR. When an EPA approved test procedure for analysis of a pollutant does not exist, the Director shall approve the procedure to be used.

3. Recording of Results

For each measurement or sample taken pursuant to the requirements of this permit, the permittee shall record the following information:

a. The facility name and location, point source number, date, time and exact place of sampling;

b. The name(s) of person(s) who obtained the samples or measurements;

c. The dates and times the analyses were performed;

d. The name(s) of the person(s) who performed the analyses;

e. The analytical techniques or methods used, including source of method and method number; and

f. The results of all required analyses.

4. Records Retention and Production

   a. The permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by the permit, and records of all data used to complete the above reports or the application for this permit, for a period of at least three years from the date of the sample measurement, report or application. This period may be extended by request of the Director at any time. If litigation or other enforcement action, under the AWPCA and/or the FWPCA, is ongoing which involves any of the above records, the records shall be kept until the litigation is resolved. Upon the written request of the Director or his designee, the permittee shall provide the Director with a copy of any record required to be retained by this paragraph. Copies of these records shall not be submitted unless requested.

   b. All records required to be kept for a period of three years shall be kept at the permitted facility or an alternate location approved by the Department in writing and shall be available for inspection.

5. Monitoring Equipment and Instrumentation

   All equipment and instrumentation used to determine compliance with the requirements of this permit shall be installed, maintained, and calibrated in accordance with the manufacturer's instructions or, in the absence of manufacturer's instructions, in accordance with accepted practices. At a minimum, flow measurement devices shall be calibrated at least once every 12 months.

C. DISCHARGE REPORTING REQUIREMENTS

1. Reporting of Monitoring Requirements

   a. The permittee shall conduct the required monitoring in accordance with the following schedule:

      MONITORING REQUIRED MORE FREQUENTLY THAN MONTHLY AND MONTHLY shall be conducted during the first full month following the effective date of coverage under this permit and every month thereafter.

      QUARTERLY MONITORING shall be conducted at least once during each calendar quarter. Calendar quarters are the periods of January through March, April through June, July through September, and October through December. The permittee shall conduct the quarterly monitoring during the first complete calendar quarter following the effective date of this permit and is then required to monitor once during each quarter thereafter. Quarterly monitoring may be done anytime during the quarter, unless restricted elsewhere in this permit, but it should be reported on the last DMR due for the quarter, i.e. (March, June, September and December DMRs).

      SEMIANNUAL MONITORING shall be conducted at least once during the period of January through June and at least once during the period of July through December. The permittee shall conduct the semiannual monitoring during the first complete calendar semiannual period following the effective date of this permit and is then required to monitor once during each semiannual period thereafter. Semiannual monitoring may be done anytime during the semiannual period, unless restricted elsewhere in this permit, but it should be reported on the last DMR due for the month of the semiannual period, i.e. (June and December DMRs).

      ANNUAL MONITORING shall be conducted at least once during the period of January through December. The permittee shall conduct the annual monitoring during the first complete calendar annual period following the effective date of this permit and is then required to monitor once during each annual period thereafter. Annual monitoring may be done anytime during the year, unless restricted elsewhere in this permit, but it should be reported on the December DMR.

b. The permittee shall submit discharge monitoring reports (DMRs) on the forms provided by the Department and in accordance with the following schedule:

REPORTS OF MORE FREQUENTLY THAN MONTHLY AND MONTHLY TESTING shall be submitted on a **monthly** basis. The first report is due on the **28th day of March 2001.** The reports shall be submitted so that they are received by the Department no later than the 28th day of the month following the reporting period.

REPORTS OF QUARTERLY TESTING shall be submitted on a [quarterly] basis. The first report is due on the 28th day of [ ]. The reports shall be submitted so that they are received by the Department no later than the 28th day of the month following the reporting period.

REPORTS OF SEMIANNUAL TESTING shall be submitted on a [semiannual] basis. The reports are due on the 28th day of JANUARY and the 28th day of JULY. The reports shall be submitted so that they are received by the Department no later than the 28th day of the month following the reporting period.

REPORTS OF ANNUAL TESTING shall be submitted on an [annual] basis. The first report is due on the 28th day of JANUARY . The reports shall be submitted so that they are received by the Department no later than the 28th day of the month following the reporting period.

c. The DMR must be legible and bear an original signature. Photo and electronic copies of the signature are not acceptable and shall not satisfy the reporting requirements of this permit. If the permittee, using approved analytical methods as specified in Provision I. B. 2. monitors any discharge from a point source for a limited substance identified in Provision I. A. of this permit more frequently than required by this permit, the results of such monitoring shall be included in the calculation and reporting of values on the DMR Form and the increased frequency shall be indicated on the DMR Form. In the event no discharge from a point source identified in Provision I. A of this permit and described more fully in the permittee's application occurs during a monitoring period, the permittee shall report "No Discharge" for such period on the appropriate DMR Form.

d. All reports and forms required to be submitted by this permit, the AWPCA and the Department's Rules and regulations, shall be signed by a "responsible official" of the permittee as defined in ADEM Administrative Code Rule 335-6-6-.09 or a "duly authorized representative" of such official as defined in ADEM Administrative Code Rule 335-6-6-.09 and shall bear the following certification:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

e. The permittee may certify in writing that a discharge will not occur for an extended period of time and after such certification shall not be required to submit monitoring reports. Written notification of a planned resumption of discharge shall be submitted at least 30 days prior to resumption of the discharge. If an unplanned resumption of discharge occurs, written notification shall be submitted within 7 days of the resumption. In any case, all discharges shall comply with all provisions of this permit.

f. All reports and forms required to be submitted by this permit, the AWPCA and the Department's Rules, shall be addressed to:

Alabama Department of Environmental Management
Industrial Section, Water Division
Post Office Box 301463

Montgomery, Alabama 36130-1463

2. Noncompliance Notification

   a. If for any reason, the permittee's discharge (1) does not comply with any daily minimum or maximum discharge limitation for an effluent characteristic specified in Provision I. A. of this permit which is denoted by an "(X)", (2) threatens human health or welfare, fish or aquatic life, or water quality standards, (3) does not comply with an applicable toxic pollutant effluent standard or prohibition established under Section 307(a) of the FWPCA, 33 U.S.C. Section 1317(a), (4) contains a quantity of a hazardous substance which has been determined may be harmful to public health or welfare under Section 311(b)(4) of the FWPCA, 33 U.S.C. Section 1321(b)(4), (5) exceeds any discharge limitation for an effluent characteristic as a result of an unanticipated bypass or upset, or (6) is an unpermitted direct or indirect discharge of a pollutant to a water of the state (unpermitted discharges properly reported to the Department under any other requirement are not required to be reported under this provision), the permittee shall orally report the occurrence and circumstances of such discharge to the Director within 24-hours after the permittee becomes aware of the occurrence of such discharge. In addition to the oral report, the permittee shall submit to the Director or Designee a written report as provided in Provision I. C. 2. c. no later than five (5) days after becoming aware of the occurrence of such discharge.

   b. If for any reason, the permittee's discharge does not comply with any limitation of this permit, the permittee shall submit to the Director or Designee a written report as provided in Provision I. C. 2. c. below, such report shall be submitted with the next Discharge Monitoring Report required to be submitted by Provision I. C. 1. of this permit after becoming aware of the occurrence of such noncompliance.

   c. Any written report required to be submitted to the Director or Designee by Provision I. C. 2 a. or b. shall be submitted using a copy of the Noncompliance Notification Form provided with this permit and shall include the following information:

      (1) A description of the discharge and cause of noncompliance;
      (2) The period of noncompliance, including exact dates and times or, if not corrected, the anticipated time the noncompliance is expected to continue; and
      (3) A description of the steps taken and/or being taken to reduce or eliminate the noncomplying discharge and to prevent its recurrence.

D. OTHER REPORTING AND NOTIFICATION REQUIREMENTS

1. Anticipated Noncompliance

   The permittee shall give the Director written advance notice of any planned changes or other circumstances regarding a facility which may result in noncompliance with permit requirements.

2. Termination of Discharge

   The permittee shall notify the Director, in writing, when all discharges from any point source(s) identified in Provision I. A. of this permit have permanently ceased. This notification shall serve as sufficient cause for instituting procedures for modification or termination of the permit.

3. Updating Information

   a. The permittee shall inform the Director of any change in the permittee's mailing address or telephone number or in the permittee's designation of a facility contact or office having the authority and responsibility to prevent and abate violations of the AWPCA, the Department's Rules and the terms and conditions of this permit, in writing, no later than ten (10) days after such change. Upon request of the Director or his designee, the permittee shall furnish the Director with an update of any information provided in the permit application.

   b. If the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the Director, it shall promptly submit such facts or information with a written explanation for the mistake and/or omission.

4. Duty to Provide Information

The permittee shall furnish to the Director, within a reasonable time, any information which the Director or his designee may request to determine whether cause exists for modifying, revoking and re-issuing, suspending, or terminating this permit, in whole or in part, or to determine compliance with this permit.

5. Cooling Water and Boiler Water Additives

a. The permittee shall notify the Director in writing not later than thirty (30) days prior to instituting the use of any biocide corrosion inhibitor or chemical additive in a cooling or boiler system, not identified in the application for this permit, from which discharge is allowed by this permit. Notification is not required for additives that do not contain a heavy metal(s) as an active ingredient and that pass through a wastewater treatment system prior to discharge nor is notification required for additives that should not reasonably be expected to cause the cooling water or boiler water to exhibit toxicity as determined by analysis of manufacturer's data or testing by the permittee. Such notification shall include:

(1) name and general composition of biocide or chemical,
(2) 96-hour median tolerance limit data for organisms representative of the biota of the waterway into which the discharge will ultimately reach,
(3) quantities to be used,
(4) frequencies of use,
(5) proposed discharge concentrations, and
(6) EPA registration number, if applicable.

b. The use of a biocide or additive containing tributyl; tin, tributyl tin oxide, zinc, chromium or related compounds in cooling or boiler system(s), from which a discharge regulated by this permit occurs, is prohibited except as exempted below. The use of a biocide or additive containing zinc, chromium or related compounds may be used in special circumstances if (1) the permit contains limits for these substances, or (2) the applicant demonstrates during the application process that the use of zinc, chromium or related compounds as a biocide or additive will not pose a reasonable potential to violate the applicable State water quality standards for these substances. The use of any additive, not identified in this permit or in the application for this permit or not exempted from notification under this permit is prohibited, prior to a determination by the Department that permit modification to control discharge of the additive is not required or prior to issuance of a permit modification controlling discharge of the additive.

6. Permit Issued Based On Estimated Characteristics

a. If this permit was issued based on estimates of the characteristics of a process discharge reported on an EPA NPDES Application Form 2D (EPA Form 3510-2D), the permittee shall complete and submit an EPA NPDES Application Form 2C (EPA Form 3510-2C) no later than two years after the date that discharge begins. Sampling required for completion of the Form 2C shall occur when a discharge(s) from the process(s) causing the new or increased discharge is occurring. If this permit was issued based on estimates concerning the composition of a storm water discharge(s), the permittee shall perform the sampling required by EPA NPDES Application Form 2F (EPA Form 3510-2F) no later than one year after the industrial activity generating the storm water discharge has been fully initiated.

b. This permit shall be reopened if required to address any new information resulting from the completion and submittal of the Form 2C and or 2F.

E. SCHEDULE OF COMPLIANCE

1. The permittee shall achieve compliance with the discharge limitations specified in Provision I. A. in accordance with the following schedule:

   COMPLIANCE SHALL BE ATTAINED ON THE EFFECTIVE DATE OF THIS PERMIT

2. No later than 14 calendar days following a date identified in the above schedule of compliance, the permittee shall submit either a report of progress or, in the case of specific actions being required by identified dates, a written notice of compliance or noncompliance. In the latter case, the notice shall include the cause of noncompliance, any remedial actions taken, and the probability of meeting the next scheduled requirement.

PART II

A. OPERATIONAL AND MANAGEMENT REQUIREMENTS

1. Facilities Operation and Maintenance

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of the permit. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of backup or auxiliary facilities only when necessary to achieve compliance with the conditions of the permit.

2. Best Management Practices

a. Dilution water shall not be added to achieve compliance with discharge limitations except when the Director or his designee has granted prior written authorization for dilution to meet water quality requirements.

b. The permittee shall prepare, implement, and maintain a Spill Prevention, Control and Countermeasures (SPCC) Plan in accordance with 40 C.F.R. Section 112 if required thereby.

c. The permittee shall prepare, submit for approval and implement a Best Management Practices (BMP) Plan for containment of any or all process liquids or solids, in a manner such that these materials do not present a significant potential for discharge, if so required by the Director or his designee. When submitted and approved, the BMP Plan shall become a part of this permit and all requirements of the BMP Plan shall become requirements of this permit.

3. Spill Prevention, Control, and Management

The permittee shall provide spill prevention, control, and/or management sufficient to prevent any spills of pollutants from entering a water of the state or a publicly or privately owned treatment works. Any containment system used to implement this requirement shall be constructed of materials compatible with the substance(s) contained and which shall prevent the contamination of groundwater and such containment system shall be capable of retaining a volume equal to 110 percent of the capacity of the largest tank for which containment is provided.

B. OTHER RESPONSIBILITIES

1. Duty to Mitigate Adverse Impacts

The permittee shall promptly take all reasonable steps to mitigate and minimize or prevent any adverse impact on human health or the environment resulting from noncompliance with any discharge limitation specified in Provision I. A. of this permit, including such accelerated or additional monitoring of the discharge and/or the receiving waterbody as necessary to determine the nature and impact of the noncomplying discharge.

2. Right of Entry and Inspection

The permittee shall allow the Director, or an authorized representative, upon the presentation of proper credentials and other documents as may be required by law to:

a. enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of the permit;

b. have access to and copy, at reasonable times, any records that must be kept under the conditions of the permit;

c. inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under the permit; and

d. sample or monitor at reasonable times, for the purposes of assuring permit compliance or as otherwise authorized by the AWPCA, any substances or parameters at any location.

C. BYPASS AND UPSET

1. Bypass

a. Any bypass is prohibited except as provided in b. and c. below:

b. A bypass is not prohibited if:

(1) It does not cause any discharge limitation specified in Provision I. A. of this permit to be exceeded; and

(2) It is necessary for essential maintenance of a treatment or control facility or system to assure efficient operation of such facility or system.

c. A bypass is not prohibited and need not meet the discharge limitations specified in Provision I. A. of this permit if:

(1) It is unavoidable to prevent loss of life, personal injury, or severe property damage;

(2) There are no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime (this condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance); and

(3) The permittee submits a written request for authorization to bypass to the Director at least ten (10) days prior to the anticipated bypass (if possible), the permittee is granted such authorization, and the permittee complies with any conditions imposed by the Director to minimize any adverse impact on human health or the environment resulting from the bypass.

d. The permittee has the burden of establishing that each of the conditions of Provision II. C. 1. b. or c. have been met to qualify for an exception to the general prohibition against bypassing contained in a. and an exemption, where applicable, from the discharge limitations specified in Provision I. A. of this permit.

2. Upset

a. A discharge which results from an upset need not meet the discharge limitations specified in Provision I. A. of this permit if:

(1) No later than 24-hours after becoming aware of the occurrence of the upset, the permittee orally reports the occurrence and circumstances of the upset to the Director or his designee; and

(2) No later than five (5) days after becoming aware of the occurrence of the upset, the permittee furnishes the Director with evidence, including properly signed, contemporaneous operating logs, or other relevant evidence, demonstrating that (i) an upset occurred; (ii) the permittee can identify the specific cause(s) of the upset; (iii) the permittee's facility was being properly operated at the time of the upset; and (iv) the permittee promptly took all reasonable steps to minimize any adverse impact on human health or the environment resulting from the upset.

b. The permittee has the burden of establishing that each of the conditions of Provision II C. 2. a. of this permit have been met to qualify for an exemption from the discharge limitations specified in Provision I. A. of this permit.

D. DUTY TO COMPLY WITH PERMIT, RULES, AND STATUTES

1. Duty to Comply

   a. The permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the AWPCA and the FWPCA and is grounds for enforcement action, for permit termination, revocation and reissuance, suspension, modification; or denial of a permit renewal application.

   b. The necessity to halt or reduce production or other activities in order to maintain compliance with the conditions of the permit shall not be a defense for a permittee in an enforcement action.

   c. The discharge of a pollutant from a source not specifically identified in the permit application for this permit and not specifically included in the description of an outfall in this permit is not authorized and shall constitute noncompliance with this permit.

   d. The permittee shall take all reasonable steps, including cessation of production or other activities, to minimize or prevent any violation of this permit or to minimize or prevent any adverse impact of any permit violation.

2. Removed Substances

   Solids, sludges, filter backwash, or any other pollutant or other waste removed in the course of treatment or control of wastewaters shall be disposed of in a manner that complies with all applicable Department Rules.

3. Loss or Failure of Treatment Facilities

   Upon the loss or failure of any treatment facility, including but not limited to the loss or failure of the primary source of power of the treatment facility, the permittee shall, where necessary to maintain compliance with the discharge limitations specified in Provision I. A. of this permit, or any other terms or conditions of this permit, cease, reduce, or otherwise control production and/or all discharges until treatment is restored.

4. Compliance With Statutes and Rules

   a. This permit has been issued under ADEM Administrative Code, Chapter 335-6-6. All provisions of this chapter, that are applicable to this permit, are hereby made a part of this permit. A copy of this chapter may be obtained for a small charge from the Office of General Counsel, Alabama Department of Environmental Management, 1751 Congressman Dickinson Drive, Montgomery, AL 36130.

   b. This permit does not authorize the noncompliance with or violation of any Laws of the State of Alabama or the United States of America or any regulations or rules implementing such laws. FWPCA, 33 U.S.C. Section 1319, and Code of Alabama 1975, Section 22-22-14.

E. PERMIT TRANSFER, MODIFICATION, SUSPENSION, REVOCATION, AND REISSUANCE

1. Duty to Reapply or Notify of Intent to Cease Discharge

   a. If the permittee intends to continue to discharge beyond the expiration date of this permit, the permittee shall file a complete permit application for reissuance of this permit at least 180 days prior to its expiration. If the permittee does not intend to continue discharge beyond the expiration of this permit, the permittee shall submit written notification of this intent which shall be signed by an individual meeting the signatory requirements for a permit application as set forth in ADEM Administrative Code Rule 335-6-6-.09.

   b. Failure of the permittee to apply for reissuance at least 180 days prior to permit expiration will void the automatic continuation of the expiring permit provided by ADEM Administrative Code Rule 335-6-6-.06 and should the permit not be reissued for any reason any discharge after expiration of this permit will be an unpermitted discharge.

2. Change in Discharge

a. The permittee shall apply for a permit modification at least 180 days in advance of any facility expansion, production increase, process change, or other action that could result in the discharge of additional pollutants or increase the quantity of a discharged pollutant such that existing permit limitations would be exceeded or that could result in an additional discharge point. This requirement applies to pollutants that are or that are not subject to discharge limitations in this permit. No new or increased discharge may begin until the Director has authorized it by issuance of a permit modification or a reissued permit.

b. The permittee shall notify the Director as soon as it is known or there is reason to believe:

(1) That any activity has occurred or will occur which would result in the discharge on a routine or frequent basis, of any toxic pollutant which is not limited in this permit, if that discharge will exceed the highest of the following notification levels:

(a) one hundred micrograms per liter;

(b) two hundred micrograms per liter for acrolein and acrylonitrile; five hundred micrograms per liter for 2,4-dinitrophenol and for 2-methyl-4,6-dini-trophenol; and one milligram per liter for antimony;

(c) five times the maximum concentration value reported for that pollutant in the permit application; or

(2) That any activity has occurred or will occur which would result in any discharge, on a non-routine or infrequent basis, of a toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following notification levels:

(a) five hundred micrograms per liter;

(b) one milligram per liter for antimony;

(c) ten times the maximum concentration value reported for that pollutant in the permit application.

3. Transfer of Permit

This permit may not be transferred or the name of the permittee changed without notice to the Director and subsequent modification or revocation and reissuance of the permit to identify the new permittee and to incorporate any other changes as may be required under the FWPCA or AWPCA. In the case of a change in name, ownership or control of the permittee's premises only, a request for permit modification in a format acceptable to the Director is required at least 30 days prior to the change. In the case of a change in name, ownership or control of the permittee's premises accompanied by a change or proposed change in effluent characteristics, a complete permit application is required to be submitted to the Director at least 180 days prior to the change. Whenever the Director is notified of a change in name, ownership or control, he may decide not to modify the existing permit and require the submission of a new permit application.

4. Permit Modification and Revocation

a. This permit may be modified or revoked and reissued, in whole or in part, during its term for cause, including but not limited to, the following:

(1) If cause for termination under Provision II. E. 5. of this permit exists, the Director may choose to revoke and reissue this permit instead of terminating the permit;

(2) If a request to transfer this permit has been received, the Director may decide to revoke and reissue or to modify the permit; or

(3) If modification or revocation and reissuance is requested by the permittee and cause exists, the Director may grant the request.

b. This permit may be modified during its term for cause, including but not limited to, the following:

(1) If cause for termination under Provision II. E. 5. of this permit exists, the Director may choose to modify this permit instead of terminating this permit;

(2) There are material and substantial alterations or additions to the facility or activity generating wastewater which occurred after permit issuance which justify the application of permit conditions that are different or absent in the existing permit;

(3) The Director has received new information that was not available at the time of permit issuance and that would have justified the application of different permit conditions at the time of issuance;

(4) A new or revised requirement(s) of any applicable standard or limitation is promulgated under Sections 301(b)(2)(C), (D), (E), and (F), and 307(a)(2) of the FWPCA;

(5) Errors in calculation of discharge limitations or typographical or clerical errors were made;

(6) To the extent allowed by ADEM Administrative Code, Rule 335-6-6-.17, when the standards or regulations on which the permit was based have been changed by promulgation of amended standards or regulations or by judicial decision after the permit was issued;

(7) To the extent allowed by ADEM Administrative Code, Rule 335-6-6-.17, permits may be modified to change compliance schedules;

(8) To agree with a granted variance under 30l(c), 30l(g), 30l(h), 30l(k), or 3l6(a) of the FWPCA or for fundamentally different factors;

(9) To incorporate an applicable 307(a) FWPCA toxic effluent standard or prohibition;

(10) When required by the reopener conditions in this permit;

(11) When required under 40 CFR 403.8(e) (compliance schedule for development of pretreatment program);

(12) Upon failure of the state to notify, as required by Section 402(b)(3) of the FWPCA, another state whose waters may be affected by a discharge permitted by this permit;

(13) When required to correct technical mistakes, such as errors in calculation, or mistaken interpretations of law made in determining permit conditions; or

(14) When requested by the permittee and the Director determines that the modification has cause and will not result in a violation of federal or state law, regulations or rules; or

5. This permit may be terminated during its term for cause, including but not limited to, the following:

a. Violation of any term or condition of this permit;

b. The permittee's misrepresentation or failure to disclose fully all relevant facts in the permit application or during the permit issuance process or the permittee's misrepresentation of any relevant facts at any time;

c. Materially false or inaccurate statements or information in the permit application or the permit;

d. A change in any condition that requires either a temporary or permanent reduction or elimination of the permitted discharge;

e. The permittee's discharge threatens human life or welfare or the maintenance of water quality standards;

f. Permanent closure of the facility generating the wastewater permitted to be discharged by this permit or permanent cessation of wastewater discharge;

g. New or revised requirements of any applicable standard or limitation that is promulgated under Sections 301(b)(2)(C), (D), (E), and (F), and 307(a)(2) of the FWPCA that the Director determines cannot be complied with by the permittee.

h. Any other cause allowed by the ADEM Administrative Code, Chapter 335-6-6.

6. This permit may be suspended during its term for noncompliance until the permittee has taken action(s) necessary to achieve compliance.

7. The filing of a request by the permittee for modification, suspension or revocation of this permit, in whole or in part, does not stay any permit term or condition.

F. COMPLIANCE WITH TOXIC POLLUTANT STANDARD OR PROHIBITION

If any applicable effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under Section 307(a) of the FWPCA, 33 U.S.C. Section 1317(a), for a toxic pollutant discharged by the permittee and such standard or prohibition is more stringent than any discharge limitation on the pollutant specified in Provision I. A. of this permit, or controls a pollutant not limited in Provision I. A. of this permit, this permit shall be modified to conform to the toxic pollutant effluent standard or prohibition and the permittee shall be notified of such modification. If this permit has not been modified to conform to the toxic pollutant effluent standard or prohibition before the effective date of such standard or prohibition, the permittee shall attain compliance with the requirements of the standard or prohibition within the time period required by the standard or prohibition and shall continue to comply with the standard or prohibition until this permit is modified or reissued.

G. DISCHARGE OF WASTEWATER GENERATED BY OTHERS

The discharge of wastewater, generated by any process, facility, or by any other means not under the operational control of the permittee or not identified in the application for this permit or not identified specifically in the description of an outfall in this permit is not authorized by this permit.

PART III

A. CIVIL AND CRIMINAL LIABILITY

1. Tampering

   Any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained or performed under the permit shall, upon conviction, be subject to penalties as provided by the AWPCA.

2. False Statements

   Any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or noncompliance shall, upon conviction, be subject to penalties as provided by the AWPCA.

3. Permit Enforcement

   a. Any NPDES permit issued or reissued by the Department is a permit for the purpose of the AWPCA and the FWPCA and as such any terms, conditions, or limitations of the permit are enforceable under state and federal law.

   b. Any person required to have a NPDES permit pursuant to ADEM Administrative Code Chapter 335-6-6 and who discharges pollutants without said permit, who violates the conditions of said permit, who discharges pollutants in a manner not authorized by the permit, or who violates applicable orders of the Department or any applicable rule or standard of the Department, is subject to any one or combination of the following enforcement actions under applicable state statutes.

      (1) An administrative order requiring abatement, compliance, mitigation, cessation, clean-up, and/or penalties;

      (2) An action for damages;

      (3) An action for injunctive relief; or

      (4) An action for penalties.

4. Relief from Liability

   Except as provided in Provision II. C. 1. (Bypass) and Provision II. C. 2. (Upset), nothing in this permit shall be construed to relieve the permittee of civil or criminal liability under the AWPCA or FWPCA for noncompliance with any term or condition of this permit.

B. OIL AND HAZARDOUS SUBSTANCE LIABILITY

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities or penalties to which the permittee is or may be subject under Section 311 of the FWPCA, 33 U.S.C. Section 1321.

C. PROPERTY AND OTHER RIGHTS

This permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to persons or property or invasion of other private rights, or any infringement of federal, state, or local laws or regulations, nor does it authorize or approve the construction of any physical structures or facilities or the undertaking of any work in any waters of the state or of the United States.

D. AVAILABILITY OF REPORTS

Except for data determined to be confidential under Code of Alabama 1975, Section 22-22-9(c), all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Department. Effluent data shall not be considered confidential.

E. EXPIRATION OF PERMITS FOR NEW OR INCREASED DISCHARGES

1. If this permit was issued for a new discharger or new source, this permit shall expire eighteen months after the issuance date if construction of the facility has not begun during the eighteen-month period.

2. If this permit was issued or modified to allow the discharge of increased quantities of pollutants to accommodate the modification of an existing facility and if construction of this modification has not begun during the eighteen month period after issuance of this permit or permit modification, this permit shall be modified to reduce the quantities of pollutants allowed to be discharged to those levels that would have been allowed if the modification of the facility had not been planned.

3. Construction has begun when the owner or operator has:

    a. begun, or caused to begin as part of a continuous on-site construction program:

        (1) any placement, assembly, or installation of facilities or equipment; or

        (2) significant site preparation work including clearing, excavation, or removal of existing buildings, structures, or facilities which is necessary for the placement, assembly, or installation of new source facilities or equipment; or

    b. entered into a binding contractual obligation for the purpose of placement, assembly, or installation of facilities or equipment which are intended to be used in its operation within a reasonable time. Options to purchase or contracts which can be terminated or modified without substantial loss, and contracts for feasibility, engineering, and design studies do not constitute a contractual obligation under the paragraph. The entering into a lease with the State of Alabama for exploration and production of hydrocarbons shall also be considered beginning construction.

F. COMPLIANCE WITH WATER QUALITY STANDARDS

1. On the basis of the permittee's application, plans, or other available information, the Department has determined that compliance with the terms and conditions of this permit should assure compliance with the applicable water quality standards.

2. Compliance with permit terms and conditions notwithstanding, if the permittee's discharge(s) from point sources identified in Provision I. A. of this permit cause or contribute to a condition in contravention of state water quality standards, the Department may require abatement action to be taken by the permittee in emergency situations or modify the permit pursuant to the Department's Rules, or both.

3. If the Department determines, on the basis of a notice provided pursuant to this permit or any investigation, inspection or sampling, that a modification of this permit is necessary to assure maintenance of water quality standards or compliance with other provisions of the AWPCA or FWPCA, the Department may require such modification and, in cases of emergency, the Director may prohibit the discharge until the permit has been modified.

G. GROUNDWATER

Unless specifically authorized by a permit issued by the Department, the discharge of pollutants to groundwater is prohibited. Should a threat of groundwater contamination occur, the Director may require groundwater monitoring to properly assess the degree of the problem and the Director may require that the permittee undertake measures to abate any such discharge and/or contamination.

H. DEFINITIONS

1. Average monthly discharge limitation - means the highest allowable average of "daily discharges" over a calendar month, calculated as the sum of all "daily discharges" measured during a calendar month divided by the number of "daily discharges" measured during that month (zero discharge days shall not be included in the number of "daily discharges" measured and a less than detectable test result shall be treated as a concentration of zero if the most sensitive EPA approved method was used).

2. Average weekly discharge limitation - means the highest allowable average of "daily discharges" over a calendar week, calculated as the sum of all "daily discharges" measured during a calendar week divided by the number of "daily discharges" measured during that week (zero discharge days shall not be included in the number of "daily discharges" measured and a less than detectable test result shall be treated as a concentration of zero if the most sensitive EPA approved method was used).

3. AWPCA - means the Alabama Water Pollution Control Act.

4. Bypass - means the intentional diversion of waste streams from any portion of a treatment facility.

5. Daily discharge - means the discharge of a pollutant measured during any consecutive 24-hour period in accordance with the sample type and analytical methodology specified by the discharge permit.

6. Daily maximum - means the highest value of any individual sample result obtained during a day.

7. Daily minimum - means the lowest value of any individual sample result obtained during a day.

8. Day - means any consecutive 24-hour period.

9. Department - means the Alabama Department of Environmental Management.

10. Director - means the Director of the Department.

11. Discharge - means "[t]he addition, introduction, leaking, spilling or emitting of any sewage, industrial waste, pollutant or other waste into waters of the state". Code of Alabama 1975, Section 22-22-1(b)(9).

12. Discharge monitoring report (DMR) - means the form approved by the Director to accomplish reporting requirements of an NPDES permit.

13. EPA - means the United States Environmental Protection Agency.

14. FWPCA - means the Federal Water Pollution Control Act.

15. Permit application - means forms and additional information that is required by ADEM Administrative Code Rule 335-6-6-.08 and applicable permit fees.

16. Point source - means "any discernible, confined and discrete conveyance, including but not limited to any pipe, channel, ditch, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, . . . from which pollutants are or may be discharged." Section 502(14) of the FWPCA, 33 U.S.C. Section 1362(14).

17. Pollutant - includes for purposes of this permit, but is not limited to, those pollutants specified in Code of Alabama 1975, Section 22-22-1(b)(3) and those effluent characteristics specified in Provision I. A. of this permit.

18. Severe property damage - means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

19. Upset - means an exceptional incident in which there is an unintentional and temporary noncompliance with technology-based permit discharge limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

20. Waters - means "[a]ll waters of any river, stream, watercourse, pond, lake, coastal, ground or surface water, wholly or partially within the state, natural or artificial. This does not include waters which are entirely confined and retained completely upon the property of a single individual, partnership or corporation unless such waters are used in interstate commerce." Code of Alabama 1975, Section 22-22-1(b)(2). Waters "include all navigable waters" as defined in Section 502(7) of the FWPCA, 22 U.S.C. Section 1362(7), which are within the State of Alabama.

21. Week - means the period beginning at twelve midnight Saturday and ending at twelve midnight the following Saturday.

I. SEVERABILITY

The provisions of this permit are severable, and if any provision of this permit or the application of any provision of this permit to any circumstance is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

PART IV

A. BEST MANAGEMENT PRACTICES CONDITIONS

1. **BMP PLAN**

The permittee shall develop and implement a Best Management Practices (BMP) plan which prevents, or minimizes the potential for, the release of pollutants from ancillary activities, including material storage areas; plant site runoff; in-plant transfer, process and material handling areas; loading and unloading operations, and sludge and waste disposal areas, to the waters of the State through plant site runoff; spillage or leaks; sludge or waste disposal; or drainage from raw material storage.

2. **IMPLEMENTATION**

The permittee shall prepare and fully implement the BMP as soon as practicable but not later than 6 months after the effective date of this permit.

3. **GENERAL REQUIREMENTS**

The BMP plan shall:

a. Be documented in narrative form, and shall include any necessary plot plans, drawings or maps;

b. Establish specific objectives for the control of pollutants:

(1) Each facility component or system shall be examined for its potential for causing a release of significant amounts of pollutants to waters of the State due to equipment failure, improper operation, natural phenomena such as rain or snowfall, etc.

(2) Where experience indicates a reasonable potential for equipment failure (e.g., a tank overflow or leakage), natural condition (e.g., precipitation), or other circumstances to result in significant amounts of pollutants reaching surface waters, the plan should include a prediction of the direction, rate of flow, and total quantity of pollutants which could be discharged from the facility as a result of each condition or circumstance.

c. Establish specific best management practices to meet the objectives identified under paragraph b. of this section, addressing each component or system capable of causing a release of significant amounts of pollutants to the waters of the State, and identifying specific preventative or remedial measures to be implemented;

d. Reviewed by plant engineering staff and the plant manager;

e. Provide control sufficient to prevent or control pollution of storm water by soil particles to the degree required to maintain compliance with this permit;

f. Prevent the spillage or loss of fluids, oil, grease, gasoline, etc. from vehicle and equipment maintenance activities and thereby prevent the contamination of storm water from these substances;

g. Prevent or minimize storm water contact with material stored on site;

h. Designate by position or name the person or persons responsible for the day to day implementation of the BMP;

i. Provide for routine inspection, on days during which the facility is manned, of any structures that function to prevent storm water pollution or to remove pollutants from storm water and of the facility in general to ensure that the BMP is continually implemented and effective;

j. Provide for the use and disposal of any material used to absorb spilled fluids that could contaminate storm water;

k. Provide for the proper disposal of all used oils, hydraulic fluids, solvent degreasing material, etc. in accordance with good management practices and any applicable state or federal regulations;

l. Include a diagram of the facility showing the locations where storm water exits the facility, the locations of any structures or other mechanisms intended to prevent pollution of storm water or to remove pollutants from storm water, the locations of any collection and handling systems; and

m. Bear the signature of the plant manager.

4. **DEPARTMENT REVIEW**

a. When requested by the Director or his designee, the permittee shall make the BMP available for Department review.

b. The Director or his designee may notify the permittee at any time that the BMP is deficient and require correction of the deficiency.

c. The permittee shall correct any BMP deficiency identified by the Director or his designee within 30 days of receipt of notification and shall certify to the Department that the correction has been made and implemented.

5. **ADMINISTRATIVE PROCEDURES**

a. A copy of the BMP shall be maintained at the facility and shall be available for inspection by representatives of the Department.

b. A log of the routine inspections required by Item 3.i. of this section shall be maintained at the facility and shall be available for inspection by representatives of the Department. The log shall contain records of all inspections performed for the last three years and each entry shall be signed by the person performing the inspection.

c. The permittee shall provide training for any personnel required to implement the BMP and shall retain documentation of such training at the facility. This documentation shall be available for inspection by representatives of the Department. Training shall be performed prior to the date that implementation of the BMP is required.

d. BMP Plan Modification. The permittee shall amend the BMP plan whenever there is a change in the facility or change in operation of the facility which materially increases the potential for the ancillary activities to result in a discharge of significant amounts of pollutants.

e. BMP Plan Review. The permittee shall complete a review and evaluation of the BMP plan at least once every three years from the date of preparation of the BMP plan.

B. EFFLUENT TOXICITY LIMITATIONS AND BIOMONITORING REQUIREMENTS

The permittee shall perform short-term chronic toxicity tests on the wastewater discharges required to be tested for chronic toxicity by Part I of this permit.

Test Requirements

The effluent shall be tested with appropriate replicates of 32 percent effluent, a control and a minimum of four approximately even-spaced serial dilutions of 8, 16, 32, 64, and 100 percent effluent.

Noncompliance with the toxicity limit will be demonstrated if the IC_{25} (Inhibition Concentration) for reproduction or growth is less than 32 percent effluent. However, if intake samples (tested concurrently with the effluent) are shown to be toxic enough to represent a test failure ($IC25<32$ percent) and if effluent toxicity is not statistically greater than the intake toxicity, the effluent toxicity test in question will be considered invalid. In the event the two above described conditions occur, the toxicity test shall be repeated according to the schedule requirements for test failure. Effluent toxicity which is not consistent with the intake toxicity conditions specified above constitutes a violation of this permit.

The average reproduction for *Ceriodaphnia* shall be calculated by dividing the total number of live *Ceriodaphnia* young in each concentration by the total number of organisms used to initiate that concentration; the average growth for the fathead minnows shall be calculated by dividing the total weight of surviving minnow larvae in each replicate by the total number of organisms used to initiate the replicate. The use of alternate statistical methods (e.g., hypothesis testing) is allowed in cases where atypical or anomalous dose response makes the IC25 inappropriate for analysis of the test data according to current EPA guidance.

General Test Requirements:

A minimum of three (3) 24-hour composite samples shall be obtained for use in each of the above biomonitoring tests. The holding time for each composite sample shall not exceed 36 hours. The control water shall be a water prepared in the laboratory in accordance with the EPA procedure referenced above or another control water selected by the permittee and approved by the Department.

Effluent toxicity tests in which the control survival is less than 80% or in which the other requirements of the EPA Test Procedure are not met shall be unacceptable and the permittee shall rerun the tests as soon as practical within the monitoring period.

Reporting Requirements:

Biomonitoring test results obtained during each monitoring period shall be summarized and reported using the appropriate report form approved by the Department and shall be submitted so that the report is received by the Department no later than 28 days following the last day of the monitoring period.

Additional Testing Requirements:

If chronic toxicity is indicated (noncompliance with permit limit), the permittee shall perform two additional chronic toxicity tests in accordance with these procedures to determine the extent and duration of the toxic condition. The toxicity tests shall be performed once per week and shall be performed during the first two calendar weeks following the date on which the permittee became aware of the permit noncompliance and the results of these tests shall be submitted no later than 28 days following the month in which the tests were performed.

After evaluation of the results of the follow-up tests, the Department will determine if additional action is appropriate and may require additional testing and/or toxicity reduction measures.

Test Methods:

The tests shall be performed in accordance with the latest edition of the “EPA Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms.” The Larval Survival and Growth Test, Methods 1000.0, shall be used for the fathead minnow (*Pimephales promelas*) test and the Survival and Reproduction Test, Method 1002.0, shall be used for the cladoceran (*Ceriodaphnia dubia*) test.

After evaluation of the results of the follow-up tests, the Department will determine if additional action is appropriate and may require additional testing and/or toxicity reduction measures.

EFFLUENT TOXICITY TESTING REPORTS

The following information shall be submitted with each discharge monitoring report. The Department may at any time suspend or reinstate this requirement or may decrease or increase the frequency of submittals.

1. Facility name and location
2. Permit number
3. Toxicity testing requirements of permit
4. Name of receiving water body

Source of Effluent and Dilution Water

1. Effluent samples

    a. Sampling point
    b. Collection dates and times
    c. Sample collection method
    d. Physical and chemical data
    (volume of waste flow, dissolved oxygen, water temperature, pH, alkalinity, hardness, specific conductance)

2. Dilution Water

    a. Source
    b. Collection/preparation date(s) and time(s)
    c. Pretreatment (if applicable)
    d. Physical and chemical characteristics
    (dissolved oxygen, water temperature, pH, alkalinity, hardness, specific conductance)

Test Methods

1. Toxicity test method utilized
2. End point(s) of test
3. Deviations from referenced method, if any, and reasons
4. Date and time test started
5. Date and time test terminated
6. Type and volume of test chambers
7. Volume of solution per chamber
8. Number of organisms per test chamber
9. Number of replicate test chambers per treatment
10. Test temperature (mean and range)

Test Organisms

1. Scientific name
2. Life stage and age
3. Source
4. Disease treatment (if applicable)

Quality Assurance

1. Standard toxicant utilized and source
2. Date and time of most recent test
3. Dilution water utilized in test
4. Results (LC50, NOEC, etc.)
5. Physical and chemical methods utilized

Results

1. Provide copies of laboratory bench sheets of all raw data

    a. Physical/chemical data for test concentrations
    b. Biological data – daily records on organisms

2. Indicate statistical methods utilized to calculate endpoints and provide copies of calculations.
3. Provide summary tables of calculations (LC50, NOEC, etc.) and physical/chemical data.

Adapted from "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms", Third Edition, Lewis, Philip, et al., July 1994 (EPA/600/4-91/002), Section 10, Report Preparation

C. STORM WATER FLOW MEASUREMENT AND SAMPLING REQUIREMENTS

STORM WATER FLOW MEASUREMENT

All storm water samples shall be collected from the discharge resulting from a storm event that is greater than 0.1 inches.

The total volume of storm water discharged for the event must be monitored, including the date and duration (in hours) and rainfall (in inches) for the storm event(s) sampled. The duration between the storm event sampled and the end of the previous measurable (greater than 0.1 inch rainfall) storm event must be a minimum of 72 hours. This information must be recorded as part of the sampling procedure and records retained according to Part I.B.4.b. of this permit.

The volume may be measured using flow measuring devices, or estimated based on a modification of the Rational Method using total depth of rainfall, the size of the drainage area serving a storm water outfall, and an estimate of the runoff coefficient of the drainage area. This information must be recorded as part of the sampling procedure and records retained according to Part I.B.4.b. of this permit.

STORM WATER SAMPLING

A grab sample, if required by this permit, shall be taken during the first thirty minutes of the discharge (or as soon thereafter as practicable); and a flow-weighted composite sample, if required by this permit, shall be taken for the entire event or for the first three hours of the event.

All test procedures will be in accordance with Part I.B.2. of this permit.

D. 316(b) REQUIREMENTS APPLICABLE TO THE COOLING WATER INTAKE STRUCTURE

In accordance with Section 316(b) of the Act, the permittee shall upon promulgation and implementation of regulations pursuant to Section 316(b) of the Federal Water Pollution Control Act, as amended, comply with schedules and requirements in accordance with 316(b).

E. 316(a) DEMONSTRATION REQUIREMENTS

Permit Monitoring Program

Re-application Monitoring Program: Should the permittee wish a continuance of its 316(a) request beyond the term of this permit, re-application for such a continuance shall be submitted in accordance with 40 CFR Part 125.70 *Subpart H-Criteria for Determining Alternative Effluent Limitations Under Section 316(a)of the Act* and 40 CFR Part 122.21 (m)(6) *Subpart B-Permit Application and Special NPDES Program Requirements, Variance Requests by Non-POTWs*. Re-application must be received 180 days prior to permit expiration. Re-application shall include necessary technical data and relevant information to include data collected within the life of the permit to support a continuation of the variance.

Re-Opener Clause

This permit shall be modified, or revoked and re-issued in the event that the Department determines through biological and/or water quality monitoring that more stringent limitations and/or monitoring requirements are necessary to assure the protection and propagation of a balanced, indigenous population of shellfish, fish and wildlife in and on the Tennessee River.

ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
WATER DIVISION - INDUSTRIAL SECTION
NONCOMPLIANCE NOTIFICATION FORM

PERMITTEE NAME: ______________________________

PERMIT NUMBER: ______________________________

FACILITY LOCATION: ______________________________

DMR REPORTING PERIOD: ______________________________

1. DESCRIPTION OF DISCHARGE:

   NONCOMPLIANCE PARAMETER(S):

   CAUSE OF NONCOMPLIANCE: (Attach additional pages if necessary)

2. PERIOD OF NONCOMPLIANCE: (Include exact date(s) and time(s) or, if not corrected, the anticipated time the noncompliance is expected to continue):

3. DESCRIPTION OF STEPS TAKEN AND/OR BEING TAKEN TO REDUCE OR ELIMINATE THE NONCOMPLYING DISCHARGE AND TO PREVENT ITS RECURRENCE (attach additional pages if necessary):

____
NAME OF RESPONSIBLE OFFICIAL (type or print)

____
TITLE OF RESPONSIBLE OFFICIAL

______________________________ ______________
SIGNATURE OF RESPONSIBLE OFFICIAL DATE SIGNED