FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT (SEIS)

for

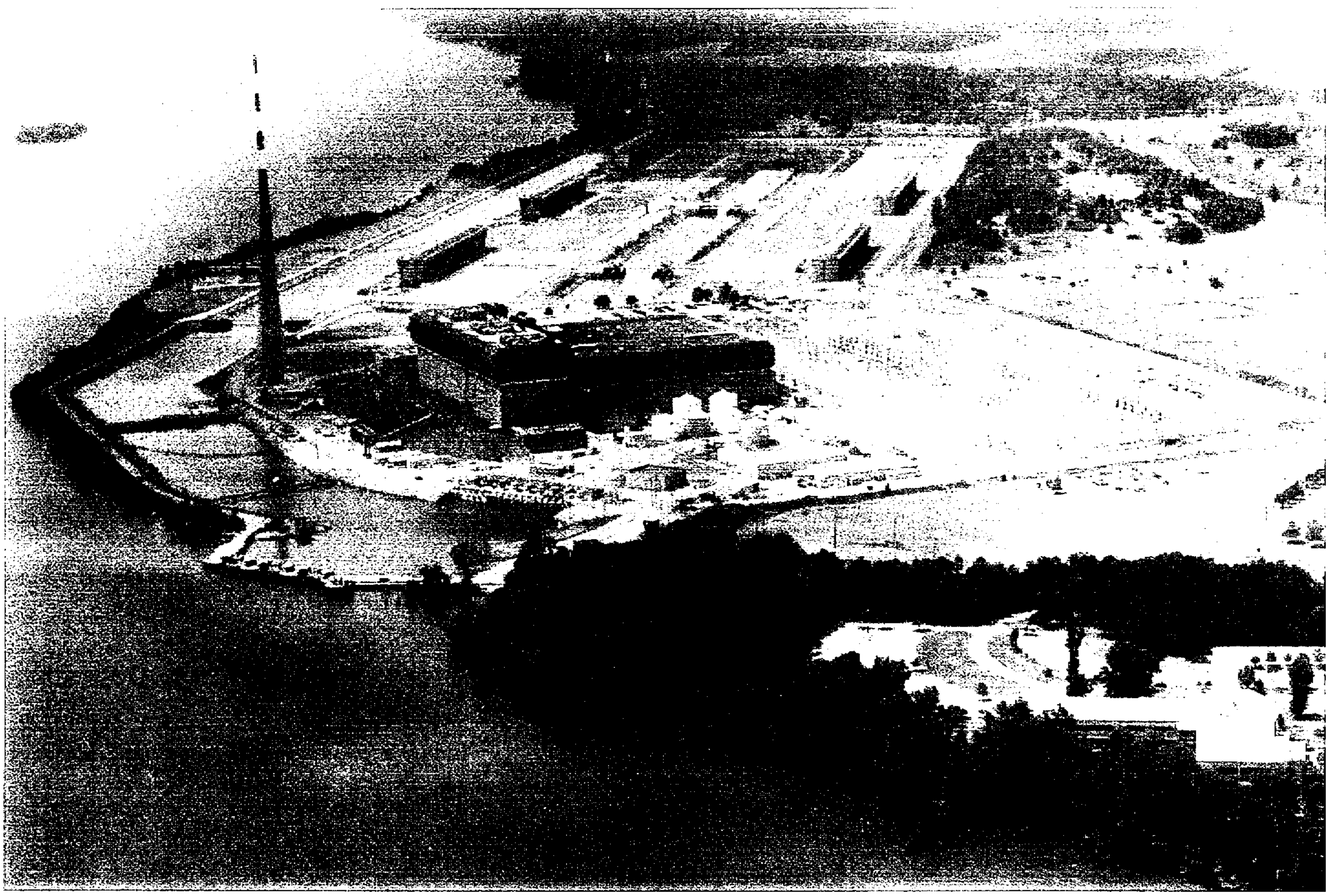
Operating License Renewal

of the

Browns Ferry Nuclear Plant

in

Athens, Alabama



TENNESSEE VALLEY AUTHORITY
March 2002

TVA

Note: Changes made to the Draft SEIS are indicated by a vertical bar in the left margin

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March 2002

Responsible Federal Agency: Tennessee Valley Authority

Title: Final Supplemental Environmental Impact Statement (FSEIS) for Operating License Renewal of the Browns Ferry Nuclear Plant in Athens, Alabama

Abstract: The Tennessee Valley Authority (TVA) proposes to extend operation of Units 1, 2 and 3 at its Browns Ferry Nuclear Plant (BFN) located in Limestone County, Alabama. This would require obtaining a renewal of the units' operating licenses from the Nuclear Regulatory Commission (NRC). Renewal of the licenses would permit operation for an additional 20 years past the current (original) 40-year operating license terms which expire in 2013, 2014, and 2016, for Units 1, 2, and 3, respectively.

This SEIS was prepared to provide the public and TVA decision-makers an assessment of the environmental impacts of extending unit operation. License renewal by itself involves existing BFN facilities, and does not involve any new construction or modifications beyond normal maintenance and minor refurbishment. However, there are other proposed projects not directly related to license renewal. One of these projects is the recovery of Unit 1, which has been in a non-operational status for 15 years. Other projects include the addition of a dry cask storage facility for spent nuclear fuel and a few new office buildings.

Public Involvement: The Notice of Intent was published in the February 15, 2001, *Federal Register*. A public scoping meeting was held on March 6, 2001, in Decatur, Alabama, in the Aerospace Technology Building on the campus of Calhoun Community College. Comments and suggestions received at that meeting and during the scoping period were used to identify the scope of the Draft SEIS. The Notice of Availability of the Draft SEIS was published in the December 14, 2001, *Federal* Register. A second public meeting was held on January 17, 2002, also at Calhoun Community College, to provide the public the opportunity to comment on the Draft SEIS. The public comment period was from December 14, 2001, to January 30, 2002. Comments received from the public were considered in completing this Final SEIS. TVA is also requesting comment on the Final SEIS. Comments on the final must be received on or before May 6, 2002, to ensure consideration.

Electronic and Additional Documents: An electronic version of this SEIS will be available on TVA's website (http://www.tva.gov/environment/reports/index.htm). Requests for hard copies of the original 1972 Environmental Statement should be directed to Don Snodgrass at (256)386-2787, or by e-mail at dwsnodgrass@tva.gov.

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EXECUTIVE SUMMARY
of
FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

for

BROWNS FERRY NUCLEAR PLANT OPERATING LICENSE RENEWAL

ATHENS, ALABAMA

TENNESSEE VALLEY AUTHORITY

March 2002

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S.1 PURPOSE AND NEED FOR THE PROPOSED ACTION

Project Overview

The Tennessee Valley Authority (TVA) proposes to extend operation of Units1, 2, and 3, at its Browns Ferry Nuclear Plant (BFN) located in Limestone County, Alabama. This would require obtaining a renewal of the units' operating licenses from the Nuclear Regulatory Commission (NRC). Renewal of the current operating licenses would permit operation for an additional 20 years past the current (original) 40-year operating license terms which expire in 2013, 2014, and 2016, for Units 1, 2, and 3, respectively.

This Supplemental Environmental Impact Statement (SEIS) is being prepared to provide the public and TVA decision-makers an assessment of the environmental impacts of extending unit operation. Table S.1 shows key milestones for the preparation of the SEIS. License renewal by itself involves existing BFN facilities, and does not involve any new construction or modifications beyond normal maintenance and minor refurbishment. However, there are other proposed projects not directly related to license renewal. One of these projects is the recovery of Unit 1, which has been in a non-operational status for 15 years. Other projects include the addition of a dry cask storage facility for spent nuclear fuel and a few new office buildings. In the interest of completeness, these actions are being included in this SEIS.

Table S.1 Planned Milestones for BFN Operating Licenses Renewal SEIS

Action	Date
Issue Notice of Intent (65 FR 47817)	February 15, 2001
Public Scoping Meeting	March 6, 2001
Close of public scoping period	March 23, 2001
Issue Notice of Availability of Draft SEIS	December 14, 2001
Public meeting on Draft SEIS	January 17, 2002
Close of public comment period	January 30, 2002
Release Final SEIS	March 2002
Issue Record of Decision	May 2002

Tiering from Energy Vision 2020

Tiering from TVA's *Energy Vision 2020* Programmatic EIS incorporates it by reference in this SEIS and allows concise and efficient consideration of the strategies and programmatic issues related to both maintenance of existing generation capacity in TVA's power system and the addition of new geneation capacity. *Energy Vision 2020* evaluated an array of power supply resources, both supply-side and demand-side. These alternatives were ranked using several criteria, including environmental performance. Favorable alternatives were formulated into strategies that would effectively meet baseload energy and peak capacity needs of TVA's customers under a range of future conditions ("futures"). A number of these strategies were then combined to create TVA's short- and long-range energy resource plans, or collectively, TVA's integrated resource plan (IRP).

Nuclear generation is expected to play a vital role in helping TVA meet energy supply demands through the *Energy Vision 2020* study period (1996 through 2020). The *Energy Vision 2020* Resource Integration Strategy Matrices identified five nuclear units, located at three sites, as existing generating assets on the TVA system - BFN Units 2 and 3, Sequoyah Nuclear Plant Units 1 and 2, and Watts Bar Nuclear Plant Unit 1. These five units were determined to contribute 5,517 megawatts, or 20% of the TVA system total projected capacity of 27,995 MW in 2005.

The operating nuclear units at BFN will reach the end of their current operating licenses during the *Energy Vision 2020* study period. *Energy Vision 2020* anticipated that Units 2 and 3 would be excellent candidates for license extensions. *Energy Vision 2020* also discussed both the short-term and the long-term options for BFN Unit 1. For the short-term, the IRP concluded that it was not viable to restart BFN Unit 1 because there were more optimal power supply strategies identified to meet load growth, particularly in consideration of cost, impact on short-term rates, impact on debt, and competitiveness. In order to preserve long-term flexibility, the decision was made to maintain BFN Unit 1 as an inoperative deferred nuclear asset. This enabled TVA to maintain lower rates and debt for the short-term and consider other alternatives for BFN Unit 1 as conditions changed.

Energy Vision 2020 noted that deferring the decision to recover BFN Unit 1 for several years would allow additional time to acquire information regarding nuclear unit performance and economics, TVA's need for power, and the possible role of nuclear power in minimizing total environmental impacts. Moreover, *Energy Vision 2020* concluded that under certain conditions, recovery of BFN Unit 1 could emerge as a low-cost supply option. This set of conditions, referred to as a "high performance" future, consisted of the high load forecast, low cost to complete the nuclear units, low operations and maintenance costs, and a high nuclear capacity factor. Since issuing *Energy Vision 2020*, a number of developments covering each of these areas has made it timely to consider further the recovery of BFN Unit 1 to meet TVA's long-term resource requirements.

- Acknowledging the recent rapid growth in baseload demand, TVA currently estimates that approximately 2,000 GWh annually by 2005, and 5,000 - 15,000 additional GWh annually by 2010 will be needed.
- Adjusted to 2002 dollars, *Energy Vision 2020* projected median Unit 1 completion at nearly \$3.1 billion; current estimates are \$1.64 billion.
- *Energy Vision 2020* projected annual additions and improvements costs to be \$41 million; actual 2001 costs for BFN were \$24 million.
- BFN operations and maintenance costs for 2001 are 17% below the low forecast in the IRP.
- The IRP low forecast estimate for nuclear fuel costs in 2001 was 47.9 cents per million BTU; the actual cost for BFN in 2001 is 47.1 cents per million BTU.
- The IRP assumed 67% annual average capacity factor. BFN has averaged 92% capacity factor over the past five years.

BFN's performance and costs have improved to the point that it is now considered by the Institute of Nuclear Power Operations (INPO) to be among the top performing nuclear plants in the country. It is a Top Quartile performer on Total Production Costs and the INPO Performance Index, and a Top Decile performer on Non-Fuel Production Costs, Net Capacity Factor, and Outage Duration. In conclusion, there is now strong support for the lowered estimates of capital cost, improved operating performance, and high demand case that would bolster recovery of BFN Unit 1 as a low cost power supply option.

Tiering from the BFN Environmental Statement

An earlier Environmental Statement prepared by TVA evaluated the effects on the environment of construction and operation of BFN. The Atomic Energy Commission (AEC), a former regulatory agency of the federal government which has since been superseded by the NRC, participated in the preparation of this statement as a cooperating agency. The AEC concluded on August 28, 1972, that the statement was adequate to support the proposed license to operate the plant.

This SEIS will reference (and not repeat) analyses contained in the original 1972 Environmental Statement wherever possible. However, since methodologies may have changed or additional information may have been obtained over the years, each subject area will be reevaluated in the light of current knowledge and practices. Additional topics are addressed as appropriate.

Unit Uprates

Independent of the matters considered in this SEIS, TVA has reviewed the environmental impacts of, and has approved, an Extended Power Uprate (EPU) project which will increase the maximum operating power level of Units 2 and 3 to 120% of their originally licensed thermal power levels. If Unit 1 is returned to service, it is currently contemplated that it would also be uprated to 120% of its originally licensed thermal power level.

Purpose of the Proposed Action

The purpose of the proposed action (extending unit operation and possibly recovering Unit 1) is to continue to make maximum use of existing power production facilities and the BFN site into the foreseeable future.

Need for the Proposed Action

TVA, in its annual report to the Southeastern Electric Reliability Council, projected continued growth in demand of total net energy (baseload) at about the median level through 2010. These data reflect an average energy growth rate of approximately 2% per year. Acknowledging the recent rapid growth in baseload demand, TVA currently estimates it will need approximately 2,000 GWh annually by 2005, and 5,000 - 15,000 additional GWh annually by 2010.

Continued energy generation from BFN is a major component of TVA's generating assets, representing 8% of generating capacity and about 13% of annual energy generation in FY2000. Because of its low operating costs, BFN will continue to be a key generating asset even if some TVA customers were to elect other suppliers for some of their requirements under electricity deregulation.

S.2 ALTERNATIVES INCLUDING THE PROPOSED ACTION

Description of the No Action Alternative

The No Action Alternative would result from a decision to not extend operation of the BFN units beyond the expiration dates of the current operating licenses. Since it currently appears economically infeasible to recover Unit 1 without license renewal, such a decision would effectively terminate any further consideration of 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.

This No Action Alternative would not help meet the public's demands for more energy from the TVA power system. If TVA took no action at all to meet growing demands, TVA's ability to continue to supply low-cost, reliable power to its customers would be impaired. The impacts of higher priced and undependable electricity supplies would be manifested in customer hardship. Higher costs of electricity could trigger industrial slowdowns or work force outages, and could potentially negatively affect the economic stability of the region served by TVA. Not meeting demand and using less reliable sources of generation could have environmental and health consequences as well if the result was disruption of electric service to the public. For example, if the electricty needed to power air conditioners in the homes of elderly people is disrupted, heat related injuries and death could result.

Consequently, it would be unreasonable for TVA to take no action at all to meet growing demands. Rather, in this context, No Action means that TVA would turn to some other means of responding to energy demands on its power system. These means have been assessed in TVA's Energy Vision 2020 EIS and are identified in the short- and long-term energy resource plan that the TVA Board approved after the completion of that EIS process.

Proposed Action Alternatives

Two Action Alternatives are consistent with the stated project objectives and the updated cost comparison of alternatives previously evaluated in *Energy Vision 2020.*

Alternative 1 is to continue to operate Units 2 and 3 for an additional 20-year period beyond the expiration dates of the current licenses. No major equipment changes are projected to be needed for continuing operation as-is, but some planned upgrades and additions would involve facilities modifications. Due to the planned EPU of Units 2 and 3, a sixth mechanical draft cooling tower would be erected.

Alternative 2 is to add refurbishment and restart of Unit 1 to Alternative 1 (i.e., extended operation of all three BFN units at the EPU level of 120% of the originally licensed power level). Restart of Unit 1 could occur as early as 2007 if a favorable decision is made and recovery efforts are initiated. Unit 1 recovery would necessitate 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.

Restarting Unit 1 would also require additional cooling tower capacity beyond that envisioned for Alternative 1. The additional cooling tower capacity required could be obtained by a combination of constructing new towers, refurbishing the old original cooling towers, or even dismantling and replacing one or more of the old original cooling towers with an updated and more efficient design. The following sub-alternatives to provide the required additional cooling tower capacity are evaluated in this SEIS:

Alternative 2A is to add two new linear mechanical draft cooling towers to the six that would be functional for operation of Units 2 and 3 at EPU, making a total of eight very similar cooling towers. Making room for these new towers would require removal of most of a large hill which was created by excavation of drainage canals associated with construction of the original six cooling towers.

Alternative 2B is similar to Alternative 2A except that the two new cooling towers would be some type other than the current linear mechanical draft cooling towers, such as round mechanical draft or modified hyperbolic design.

Alternative 2C is to demolish the remaining four original cooling towers (two burned down, and only one has been replaced) and to construct 5 new large linear mechanical draft cooling towers, all in roughly the same location as the original six towers. The size of the existing (relatively new) tower 3 would also be increased. This alternative would not require removal of a significant portion of the spoils hill adjacent to the cooling towers, but could involve lowering the height of the hill by several feet to decrease wind resistance.

Alternative 2D is to add a sixth mechanical draft cooling tower in the currently vacant position (4) where a tower that was destroyed by an accidental fire in 1986 has never been replaced. This addition of a sixth cooling tower differs from that proposed for Alternative 1 (see above) in that the tower would be somewhat larger than the recently replaced 16-cell linear mechanical draft cooling tower 3.

For purposes of this SEIS, each of the cooling tower configurations for Alternatives 1, 2A, 2B, and 2C described above represents the maximum expected change in terms of the number and size of required additional towers. Alternative 2D represents the minimum change in the number and size of required additional towers. BFN cooling water discharges comply with a National Pollutant Discharge Elimination System (NPDES) permit issued by the Alabama Department of Environmental Management (ADEM). The impact analyses presented in this SEIS assume that thermal limits in the current BFN discharge permit are unchanged and continue to be met for all alternatives via increased cooling tower capacity or de-rating power operation during periods of extreme weather, or both, with these alternative configurations.

Table S.2 provides a summary and comparison of the proposed action alternatives.

Table S.2 Summary of Proposed Action Alternatives					
Attribute/ Feature	**Alternative 1**	**Alternative 2A**	**Alternative 2B**	**Alternative 2C**	**Alternative 2D**
Units	Units 2 & 3 only	Units 1, 2, & 3	Units 1, 2, & 3	Units 1, 2, & 3	Units 1, 2, & 3
Power Level	EPU[1]	EPU[1]	EPU[1]	EPU[1]	EPU[1]
Cooling Towers	6 Linear Mechanical Draft[2]	8 Linear Mechanical Draft[3]	6 Linear Mechanical Draft + 2 Round[4]	6 Large Linear Mechanical Draft[5]	6 Large Linear Mechanical Draft[6]
Spoils Berm Reconfiguration	Minor (possibly lower hill height)	Major (relocate most of berm)	Major (relocate most of berm)	Minor (possibly lower hill height)	None to minor (possibly lower hill height)
New Buildings	Modifications / Fabrication	Mod/Fab plus Administration	Mod/Fab plus Administration	Mod/Fab plus Administration	Mod/Fab plus Administration
New Spent Fuel Storage	Dry Cask Storage Facility	Larger Dry Cask Storage Facility	Larger Dry Cask Storage Facility	Larger Dry Cask Storage Facility	Larger Dry Cask Storage Facility

[1]Extended Power Uprate = 120% of originally licensed power level.
[2]Four of the original six Ecodyne towers plus the existing Balcke-Durr tower in position 3 plus one new large or expandable tower in currently vacant position 4.
[3]Same as Alternative 1 plus two new large towers located in space currently occupied by spoils berm.
[4]Same as Alternative 1 plus two new round mechanical draft or modified hyperbolic ("hybrid") towers.
[5]Replace the four existing original Ecodyne towers plus one new large tower in position 4 plus expand the existing Balcke-Durr tower in position 3.
[6] Four of the original six Ecodyne towers plus the existing Balcke-Durr tower in position 3 plus one new larger tower in currently vacant position 4.

Associated Cooling Water Intake Flow Rates

Subsequent to issuance of the original three-unit National Pollutant Discharge Elimination System (NPDES) permit in 1984, BFN has made various equipment upgrades and calibration improvements which collectively have resulted in per-unit increases in reported once-through cooling water flow rates of 21.5%. Note that more than half of the increase in reported values is due to improved measurement accuracy; the actual increase in flow is approximately ten percent. For continued operation of Units 2 and 3 the flow rates of once-through cooling water withdrawn from the reservoir remain within the levels evaluated as part of previous studies conducted during three-unit operation at BFN; therefore, impingement of adult fish and entrainment of fish eggs and larvae are expected to remain within levels previously evaluated for Alternative 1. With the return of Unit 1, the total site once-through cooling water flow rate would increase by about ten percent. This increased CCW intake volume would potentially result in increased impingement of adult fish and entrainment of fish eggs and larvae, but it is not expected to result in significant impacts to fish populations of Wheeler Reservoir. TVA will confirm the expected levels of impingement and entrainment by monitoring under current two unit operation and following return of Unit 1 to service. TVA's Vital Signs 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.

The Preferred Alternative

TVA has made no decision with respect to the BFN license renewal Alternatives identified in this SEIS, or the other proposed actions. However, based on TVA's analyses of the environmental aspects and costs to date, Alternative 2D is TVA's currently preferred alternative. This is because there are positive environmental effects to be gained, no significant or insurmountable environmental issues have been identified to date, and the initial cost analysis indicates that recovering Unit 1 for extended operation would be financially feasible and beneficial.

Spent Fuel Storage Options

BFN has been producing power and, consequently, spent nuclear fuel for almost three decades. Considering the Department of Energy (DOE) delay in developing the capability and capacity for receiving utility spent fuel, and assuming current operating conditions, the BFN Unit 3 spent fuel storage pool is projected to lose full core off-load capability in January 2006; therefore, additional spent fuel storage capacity will be required to be developed before then. Thus, spent fuel storage expansion is required significantly before license extension or feasible implementation dates for three-unit operation. However, the addition of spent fuel storage capacity is included in this SEIS as a connected action because license extension and Unit 1 restart would both impact the ultimate size of the facility.

To accommodate the spent fuel storage expansion, TVA has evaluated various options to extend the effective life of the existing BFN spent fuel pools as well as alternatives for separate new spent fuel storage capacity. The preferred spent fuel storage option is construction of a dry cask storage facility, similar to those in use at 18 other U.S. nuclear power plants and planned at others.

S.3 AFFECTED ENVIRONMENT

Air Resources

The local climate and meteorology of the Browns Ferry Nuclear Plant site is characterized in the TVA Environmental Statement, Volume 2, Section 3.3. Variations during the period for which the relicensing is applicable are not expected to be significantly different. Current National Ambient Air Quality Standards for particulate matter, sulfur dioxide, carbon monoxide, ozone, nitrogen dioxide, and lead are essentially unchanged from those considered in the TVA Environmental Statement of the early 1970s, with one exception. The standard for hydrocarbons in effect at that time was later rescinded and a standard for ozone was implemented. There are currently no nonattainment areas for any of these pollutants in the area of the site. Air quality conditions are expected to remain about the same as now with the exception of possible regulatory constraints that may develop in association with future implementation of new EPA standards on ozone and particulates. However, those standards are the subject of legal challenges.

Sources of non-radiological air pollutants at BFN include the mechanical draft cooling towers, the auxiliary steam generators, the emergency diesel generators, and miscellaneous other small sources such as fuel storage facilities. BFN operates as a minor source under air quality permits approved by the Alabama Department of Environmental Management (ADEM).

Geologic Setting

The BFN area is underlain by flat-lying, underformed limestone of Mississippian age. This immediate region has experienced little structural deformation over the past several hundred million years of geologic time. The BFN is located in an area far removed from any centers of significant seismic activity in historic time. The seismic hazard at BFN is low in comparison to most other areas of the United States.

Solid Wastes Management and Past Practices

Solid wastes generated in conjunction with operation of BFN are managed in accordance with applicable NRC and State and Federal environmental regulations, and disposed in approved and licensed disposal facilities.

General plant trash collected as part of routine plant operations is managed through a TVA-wide contract with a licensed disposal company. Waste material is collected in dumpsters and transported to a State-licensed regional landfill. 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.

BFN operates a State-permitted Construction/Demolition landfill 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. The generation rate for this type of material over the past two years is approximately 0.04 tons per day.

BFN generation rates for low level radioactive waste materials are approximately 30-40 cubic meters per month. Spent resins are packaged, de-watered and stored on-site in concrete storage modules, or shipped for burial in a licensed disposal facility. Dry active waste is collected within the plant, and transported to a waste processor for volume reduction and subsequent shipment to a licensed disposal facility. Irradiated non-fuel plant components are stored on-site or processsed for shipment to a licensed disposal facility.

Hazardous Wastes Management and Past Practices

As do many large industrial facilities, BFN generates a variety of wastes that are classified as hazardous. These wastes include paint-related materials, spent solvents used for cleaning and degreasing, spent batteries, fluorescent light tubes, etc. TVA operates a Hazardous Waste Storage Facility (HWSF) in Muscle Shoals, Alabama, that holds a 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. 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. Hazardous waste generation rates for BFN average approximately 4,700 pounds per calendar year over the last five years.

Spent Fuel Management

An Independent Spent Fuel Storage Installation (ISFSI) is proposed for operation beginning in 2005. Expansion of an ISFSI can be accomplished incrementally. This technology can accommodate life-of-plant requirements regardless of DOE repository schedules or plant operation changes.

After implementation of spent fuel dry storage, sufficient capacity would be maintained in the spent fuel pools to accommodate refueling outages. Older spent fuel would be transferred to dual-purpose storage modules (i.e., metal cask or canister with overpack) for storage at the BFN ISFSI. The fuel transfer from pool storage racks to dry storage modules would be performed in the spent fuel pool. The dry storage system would be licensed for both on-site storage and off-site transportation; consequently, these dry storage systems would not require fuel to be repackaged for transport to a DOE repository.

Depending on the dry storage system design chosen for BFN, each storage module could contain up to 68 spent fuel assemblies; five of these modules would typically be loaded before each refueling outage. After loading, the dual-purpose storage module would be drained, dried, decontaminated, sealed, and then transferred by crane to the truck bay for transport to the ISFSI. Storage modules containing spent fuel would be temporarily stored at the ISFSI until a DOE spent fuel repository is available.

Surface Water Resources

BFN is located on Wheeler Reservoir at Tennessee River Mile (TRM) 294. The reservoir was created in 1936 and has an area of 67,070 acres and a volume of 1,050,000 acre-feet at the normal summer pool elevation of 556 feet (msl). Most of Wheeler Reservoir is classified by ADEM for public water supply, swimming and other whole body water-contact sports, and fish and wild life. 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 suitable for most designated uses. The one exception is a 10-mile reach of the river between Wheeler Dam and the Elk River which is on the state 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. Water temperature patterns in Wheeler Reservoir are constantly changing in response to varying meteorological and flow conditions. Natural water temperatures in the reservoir vary from around 35°F in January to near 90°F in July. Temperature patterns upstream of BFN are fully mixed during the fall, winter, and spring with weak thermal stratification from June through September.

There are 8 potable water intakes on Wheeler Reservoir withdrawing a total of approximately 124 million gallons per day (MGD) for municipal and industrial use. Wastewater discharges include 10 municipal plants discharging over 30 MGD and 17 industrial plants discharging over 2,466 MGD. Consumptive and off stream water uses do not currently result 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 NPDES permit limits for return water quality also mitigate potential conflicts. However, potential trade-offs can occur with instream water uses (e.g., instream use conflicts among aquatic life, waste assimilation, navigation, power generation, flood control, and lake levels).

Groundwater Resources

Shallow groundwater at BFN occurs within unconsolidated terrace deposits and residual soils, and along a relatively thin but highly weathered horizon 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 which is a source of water for both wells and springs in the region. Groundwater within this aquifer system is a calcium bicarbonate type and can generally be used without extensive treatment. There is no groundwater use by BFN and site dewatering wells have been inactive since the 1980s.

Groundwater levels at the site are generally highest during the months of January through March. During September and October, water levels are usually at minimum. The Tennessee River and plant surface water features exert some control on local groundwater elevations and hydraulic gradients. The direction of groundwater movement is generally W-SW toward the Tennessee River. 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. 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.

Floodplains and Flood Risk

BFN is located on the right bank of Wheeler Reservoir at TRM 294.0 in Limestone County, Alabama. The proposed project area could possibly be flooded from the Tennessee River, a small stream to the northwest of the plant site and the site drainage system. The site drainage system is broken into three areas: 1) the switchyard, 2) the main plant area, and 3) the cooling tower system. The area impacted by the construction of any of the alternatives extends from about TRM 293.0 to TRM 294.0.

The 100-year floodplain for the Tennessee River would be the area below elevation 557.3. The TVA Flood Risk Profile (FRP) elevation on the Tennessee River would also be elevation 557.3. At this location, the FRP elevation is equal to the 500-year flood elevation. The Probable Maximum Flood (PMF) design level would be 572.5 feet. A maximum flood elevation of 574 at the plant site results from a combination of the PMF and wind wave runup on a vertical wall or 575 as a result of the PMF and wind wave runup on a 3:1 grassed slope.

For the small stream to the northwest of the site and the internal site drainage system, the 100- and 500-year, and PMF flood elevations have been assessed. The maximum possible discharge for this stream is 17,200 cfs. For the switchyard drainage channel, the PMF elevation at the holding pond at the downstream end of the channel would be 574.8 and the PMF elevation at the north corner of the switchyard would be 577.8. The PMF elevation between the office and service buildings would be 566.6. In the vicinity of the radioactive waste, reactor, and diesel generator buildings, PMF elevations for all modes of plant operation would not exceed elevation 564.0. In the cooling tower system of channels there is sufficient capacity to pass the PMF and condenser water.

Flooding conditions during the term of the renewed license (up to year 2036) are expected to remain similar to current conditions. For the Tennessee River, all dams in the TVA system are assumed to be maintained and remain operational for the entire licensing period. For the small stream northwest of the plant site, significant urbanization within the 1.35 square mile drainage area is not expected to occur during the next 35 years. If complete urbanization were to occur, the 100- and 500-year flood discharges could increase as much as 2.5 times the natural discharge. The switchyard drainage channel area, the main plant area, and the cooling tower system area all have some existing impervious area within their drainage basins. Additional impervious area would increase the 100- and 500-year flood discharges by some amount, but should not cause flooding greater than that produced by the PMF event.

Terrestrial Ecology

Little native vegetation remains in the project areas because of the activities associated with the construction and operation of the existing nuclear facilities. The proposed location for the new cooling towers (i.e., the spoils hill that would be removed for Alternatives 2A and 2B) consists of old field vegetation with scattered tree species including black locust, various oaks, loblolly pine, and eastern red cedar. *Sericea lespedeza* and broomsedge are among the dominant herbs. The proposed locations for soil deposition consist of two hayfields and a fallow cotton field now vegetated by a dense thicket of blackberry, Japanese honeysuckle and *Sericea lespedeza*, with scattered saplings of black locust and eastern red cedar. No uncommon communities or otherwise sensitive vegetation occurs on or immediately adjacent to the project areas.

Aquatic Ecology

Extensive TVA sampling of the fish community in the vicinity of BFN and elsewhere in Wheeler Reservoir in recent years has collected a total of 60 species (excluding hybrids); any species known from elsewhere in the reservoir could occur 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 is 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 run-of-the-river reservoirs, the fish assemblage at the Wheeler mid-reservoir transition 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 future 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.

Benthic (i.e., bottom-dwelling) animals common in the vicinity of BFN include Asiatic and fingernail clams, burrowing mayflies, aquatic worms, and midges in the silt-laden overbank areas. Cobble and bedrock areas found primarily in the river channel support Asiatic clams, bryozoa, sponges, caddisflies, snails, and some leeches. Thirty-eight native freshwater mussel species have been documented in Wheeler Reservoir through 1991; more recent surveys have identified up to fourteen species in the area of BFN. Introduced aquatic species known from Wheeler Reservoir include the Asiatic clam, zebra mussel, and grass carp.

Threatened and Endangered Species

No federally listed and four Alabama state-listed plant species are known from Limestone County, Alabama, in which BFN occurs. None of these state-listed plants are known to occur within five miles of the project area. In addition, field inspections of the project area reveal that suitable habitats for these or other rare plant species are not present on lands to be affected by the proposed activities.

Four state-listed animal species (two of which are also federally listed) are known from Limestone County, but none of them are reported within five miles of BFN. Three of these species have no suitable habitat at BFN; there is a limited amount of habitat at BFN for the fourth species but its quality is considered marginal.

Five federally endangered aquatic species are known to occur in the vicinity of BFN. However, their preferred types of habitat do not exist at or downstream of BFN, and it is very unlikely that populations of these species exist in Wheeler Reservoir at or downstream of BFN.

Wetlands

Wetland resources 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. 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.

Wetlands in the vicinity of BFN are a mix of habitat types, including palustrine forested wetlands, scrub-shrub wetlands, and emergent wetlands associated with the mainstem of the Tennessee River/Wheeler Reservoir.

Wetlands in the general project area were identified using United States Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI) maps and topographic maps. A determination of areas subject to jurisdiction by the United States Army Corps of Engineers (USACE) under Section 404 of the Clean Water Act (CWA) on the site was made by TVA wetland biologists pursuant to the regulatory program administered by the USACE. Wetland field surveys indicate that while there are small areas of wetland within the boundaries of BFN, there are no wetlands in the immediate project area. This includes both the area proposed for construction of the new cooling towers, and the spoil disposal area.

Socioeconomic Conditions

Limestone County has experienced rapid growth over the last few decades, with population increasing faster than in the labor market area, the state, or the nation. The population of the county, according to the 2000 Census of Population, is 65,676, an increase of 21.3% since 1990, and 57.5% since 1970. This growth pattern is likely to continue for the next several years, with the population of the county reaching more than 80,000 by 2015, about the time the current BFN licenses expire.

Minority population in Limestone County and in the labor market area is a smaller share of the total than in the state or the nation.

Unemployment in Limestone County and in the labor market area was low in 2000, 3.3% in the county and 3.9% in the labor market area, below both the state and national averages. The number of jobs in the county has grown rapidly, more than doubling since 1970. This growth is expected to continue, reaching about 41,000 in the county by the time the current BFN licenses expire and close to 58,000 by the time a 20-year extension would expire. The county is more dependent on jobs in manufacturing, government, and farming than is the labor market area, the state, or the nation, and less dependent on trade and services employment.

Per capita income in Limestone County in 1999 was just below 75% of the national average, while in the labor market area it was almost 86% of the national average. Poverty levels in the county and the labor market area are below the state average. The county poverty level is about the same as the national average, but the labor market area level is slightly lower.

Transportation, including Electric Power Transmission

The site is located approximately 10 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 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 for approximately 2 months (per unit). Current truck deliveries are minimal (less than 10 per week) and include hydrogen, oxygen, and nitrogen trucks, chemical trucks and occasional gasoline and 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. TVA estimates approximately 1,600 vehicles per day on Shaw Road, Browns Ferry Road, and Nuclear Plant Road.

Although direct rail access does not serve BFN, a spur track and unloading area is located off the CSX mainline in Tanner, Alabama, approximately 8 miles east of BFN. TVA leased this small parcel of land from CSX and used it for offloading during original construction of the plant. This area is currently planned to be used for future off-site removal of dry cask spent fuel storage canisters. There is also a short railroad spur at the plant that runs into the turbine building for short transport into the plant. There are no plans to use it for Unit 1 refurbishment or regular plant operations.

BFN is located downstream from Guntersville Lock and upstream from Wheeler Lock at TRM 294. 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. The facility is used several times per year and requires a temporary crane. Future upgrading is planned and a temporary crane will no longer be required. An upgraded barge facility could eventually be used to transport spent fuel canisters offsite for disposal in a national repository.

BFN is connected into the TVA system network by seven 500-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. Startup power is from the 500-kV system network, but auxiliary power is available through the two common service station transformers that are fed from two 161-kV lines supplying the 161-kV switchyard, one line each from the Athens and Trinity substations.

Soil and Land Uses

Limestone County is part of the Highland Rim section of the Interior Low Pleateaus physiographic province. It is comprised of three physiographic subdivisions: The Limestone Valleys, the Plateau, and the Alluvial Plains. The Limestone Valleys 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. The soils which develop in these areas are inherently productive for growing crops. There are about 279,229 acres of soils in the county classified as prime farmland and/or statewide important farmland. These are soils which have the chemical and physical properties to economically sustain high yields of crop production. 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.

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. Limestone County is ranked first in Alabama for the most cotton grown. Agriculture is, and will continue to be, a major economic component in the county. The remainder of the acreage in the county is used for forest (23.9%), water (7%), and urban/built-up land (2%).

The current trend in population growth will promote a larger portion of the land area to become urbanized. Population trends show an increase by 17.7% from 1980 to 1990, another increase of 17% from 1990 to 1998, and predictions from the Equifax Decision Systems project another increase of 6.6% by 2005. These trends are attributable to the increased employment opportunity in the county as well as in nearby Huntsville and Decatur.

Visual Resources

BFN is located off of County Road 25 (Nuclear Plant Road) approximately twelve miles south of Athens, Alabama. 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. Little traffic is seen along the roadway except at plant shift changes and during deliveries. 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.

There are no homes within foreground viewing distance to the north and east. However, there is a small residential development to the northwest, across Wheeler Reservoir southwest, and Mallard Creek public use area that has partial views of the plant site. The views from the homes northwest off of County Road 25 are of the existing mechanical draft cooling towers (approximately 60 feet in height), a portion of the 500-kV switchyard and the turbine and reactor building. A berm, graded during the initial construction of the plant site and containing approximately 3.3 million cubic yards of earth, lies adjacent to the hot and cool water channels and blocks views of the northern and eastern plant areas. The homes to the southwest and from the Mallard Creek area have views of the off gas stack, the cooling towers, and the turbine and reactor building. These views may be somewhat obscured in the early morning hours, particularly in the fall and winter, as heavy fogs rise from the warmer waters of the reservoir.

Recreation

Approximately 3.5 miles upstream of BFN is Round Island Recreation Area 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 occur within three miles of the BFN site, Swan Creek State Wildlife Management Area and Mallard-Fox Creek State Wildlife Management Area. These areas are owned by TVA and presently managed by the Alabama Department of Conservation.

Cultural Resources

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 area of potential effects (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 ES-1) identified a prehistoric archaeological 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.

Environmental Noise

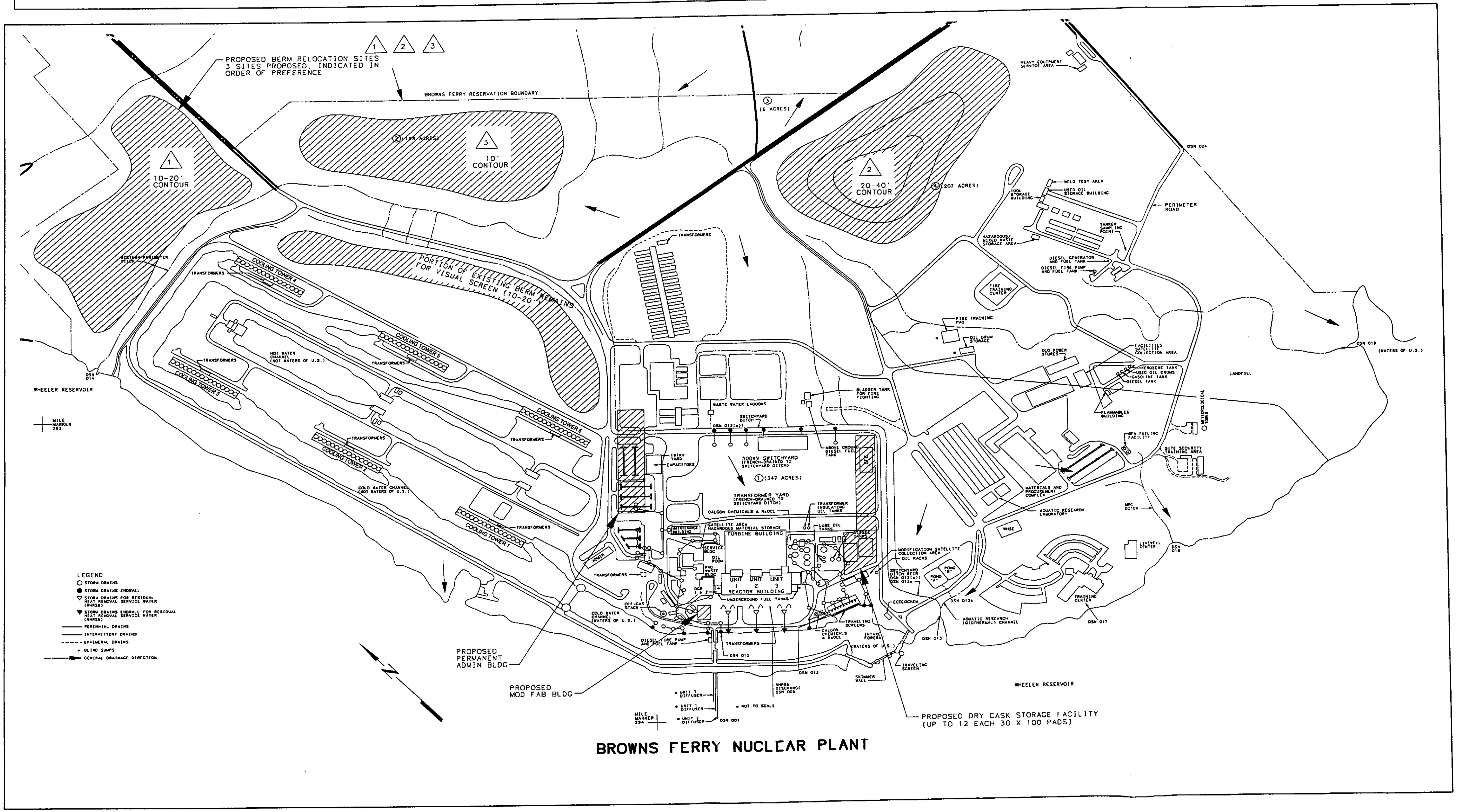
The addition and replacement of cooling towers have the potential to change the noise environment within about a mile of their location. Within this radius there has been a significant increase in residential development since the original construction of the plant. The sensitive noise receptors are in Paradise Shores adjacent to the cooling towers to the northwest and the Lakeview community across the river. Potential noise effects evaluated include hearing loss, speech interference, annoyance, and increased awareness of the intruding noise. During present operations, cooling tower noise is audible in the closest portions of Paradise Shores but not in Lakeview or other residential locations around the plant.

Public and Occupational Safety & Health (Non-Radiological)

The TVA nuclear work force has achieved recordable injury rates that are among the lowest in the utility industry. Operation and construction (i.e., refurbishment and restoration) activities are required to meet or exceed federal regulatory requirements for safety design and inspection, including OSHA regulations. These standards and requirements also apply to TVA contractors and vendors, which are monitored to ensure compliance.

The TVAN Safety and Health Manual contains requirements designed to assure that management administers a strong safety program. BFN has a Fire Protection Plan which is applicable to all activities which could affect the life or health of TVA employees or the public, the probability or severity of potential fires throughout the plant, or the ability to maintain safe plant shutdown, or limit radioactive release to the environment in case of fire. In accordance with state and federal regulations, BFN has developed a Spill Prevention, Control, and Countermeasure Plan that includes Hazardous Materials Response Team assignments and responsibilities, best management practices for controlling and managing oil and chemical storage, and contingency plans in the event of an accidental spill. TVA has also concluded that operation of BFN has not resulted, and is not likely to result, in adverse human health effects as a consequence of the presence of microorganisms associated with cooling towers and thermal discharges.

TVA's standard for siting new transmission lines has the effect of minimizing public exposures to electric and magnetic fields during their operation. TVA's design also ensures that the transmission lines exceed National Electric Safety Code requirements regarding shock hazards.


PROPOSED BERM RELOCATION SITES
3 SITES PROPOSED, INDICATED IN
ORDER OF PREFERENCE
BROWNS FERRY RESERVATION BOUNDARY
10-20' CONTOUR
10' CONTOUR
20-40' CONTOUR
(6 ACRES)
(207 ACRES)
PORTION OF EXISTING BERM REMAINS
FOR VISUAL SCREEN (10-20')
COOLING TOWER 1
COOLING TOWER 2
COOLING TOWER 3
COOLING TOWER 4
COOLING TOWER 5
COOLING TOWER 6
WHEELER RESERVOIR
500KV SWITCHYARD
(347 ACRES)
TRANSFORMER YARD
TURBINE BUILDING
REACTOR BUILDING
PROPOSED
PERMANENT
ADMIN BLDG
PROPOSED
MOD FAB BLDG
PROPOSED DRY CASK STORAGE FACILITY
(UP TO 12 EACH 30 X 100 PADS)
LEGEND
BROWNS FERRY NUCLEAR PLANT

Radiological Impacts

At BFN, occupational radiation doses (to site workers) are consistent with current industry trends for this reactor type (BWR) and worker radiation exposures are controlled to be significantly less than regulatory limits. Similarly, controlled releases of radioactive emissions during normal operations result in radiation doses to the public that are small relative to doses from natural radioactivity. TVA has conducted a Radiological Environmental Monitoring Program (REMP) since 1973 to assess the impact of BFN operations on the surrounding environs and the general public. Data collected via the REMP demonstrate that the small amounts of radiological effluents released to the environment due to the operation of BFN have had no measurable impact on the environs surrounding BFN, and that estimated doses to the maximum exposed member of the public are typically only a small fraction of applicable limits.

BFN has a Radiological Emergency Plan (REP) which provides protective measures for TVA personnel and protects the health and safety of the public in the event of a radiological emergency resulting from an accident at the plant. This plan fulfills federal regulatory requirements and was developed in accordance with the NRC and Federal Emergency Management Agency (FEMA) guidance. Specific implementing procedures ensure that accidents are properly evaluated, rapid notifications are made, and assessment and protective actions are performed. In conjunction with the REP, State Radiological Emergency Plans have been developed to provide integrated response actions of Federal, State and local governments to any emergency caused by an incident at BFN. The REP is also designed to be implemented in a variety of non-radiological emergencies such as chemical spills, toxic gas releases, fires, plant operational problems, natural events, etc., which may pose a threat to the safe operation of the plant and have a potential impact offsite.

Postulated accidents for which the NRC has determined the probability is sufficient to warrant specific inclusion in design basis analyses are documented in the Updated Final Safety Analysis Report (UFSAR). BFN has also completed a systematic and comprehensive analysis of the potential accidents that can occur at the plant, referred to as a Probabilistic Safety Assessment (PSA), which incorporates both system reliability and human intervention. Extremely unlikely (and therefore not part of the design basis), but potentially more severe accidents are also considered via an analysis of Severe Accident Mitigation Alternatives (SAMA).

Decommissioning Impacts

TVA is required to complete decommissioning of the plant within a maximum of 60 years after permanent cessation of operations. To decommission a nuclear power plant, the radioactive material on the site must be reduced to levels that would permit termination of the NRC license; this involves removing the spent nuclear fuel, dismantling any systems or components containing activation products, and cleaning up or dismantling contaminated materials. All activated materials generally have to be removed from the facility and shipped to a waste processing, storage, or disposal facility. Contaminated materials may either be cleaned of contamination on-site, or the contaminated sections may be cut off and removed (leaving most of the component intact in the facility), or they may be removed and shipped to a waste processing, storage or disposal facility.

S.4 ENVIRONMENTAL CONSEQUENCES

Air Resources

For any of the Alternatives, potential and cumulative impacts on local climate and meteorology are expected to be less than the assessment results in the TVA Environmental Statement of the early 1970s. Conservative plume modeling and conservative operating assumptions that were used in the original EIS gave results that encompass (bound) the Alternative 2 options for increased cooling tower capacity because actual cooling tower operations have been and are expected to occur only in the warmer months, generally limited to summer. This is much less time than the 29% annual use assumed in the original EIS.

Based on operating experience, impacts on ambient air quality are all expected to be smaller than the magnitudes given in the original EIS, with the exception of carbon monoxide. Emissions and ambient concentrations for carbon monoxide were about two orders of magnitude too small compared to amounts reported during actual operations. However, the ambient air quality standard for this pollutant is still five orders of magnitude larger than this revised estimate, so the impact is considered negligible. The original EIS's assumption of maximum operation in the helper mode 22% of the time was applied to Alternative 2 with its increased cooling tower capacity options. (The 7% closed mode included in the EIS was not quantified because operation in this mode is now known to be impractical.) In this updated assessment, particulate emissions in the form of drift from the towers would be about 22 pounds/hr compared to an emissions standard for fine particulates of 45 pounds/hr. Total annual emissions would be about 21 tons/yr compared to the 100 tons/yr in the original EIS. Construction and modification impacts on air quality during refurbishment of Unit 1 also would be minor and transitory.

Geologic Setting

Construction of additional water cooling capacity under any of the alternatives considered should result in no significant impacts to the geologic resources and hazards. The changes to crustal loading caused by excavation and movement of materials and the construction of new structures should have negligible effects on the seismicity of the area. The local geology and character of local seismicity would not be impacted by continued operation of BFN.

Solid Wastes Management and Past Practices

Continued operation of BFN Units 2 and 3 through the license extension period should not result in generation of additional volumes of general plant trash which exceed the levels currently generated annually. If Unit 1 is restarted, the amount of general plant trash would be expected to increase in proportion to the increase in site population required for the recovery effort. In addition, there would be additional trash generated as a part of construction activities, but this amount would be significantly less than that generated by construction of a new facility. Once operational, the amount of trash generated would be similar to the other operating units, and the overall amount generated would increase slightly due to the small increase in permanent plant staff necessary to operate three units.

BFN would continue to maintain the license to operate the on-site construction/demolition (C/D) landfill through the duration of the extended BFN operating licenses. In the event Unit 1 is restarted, the on-site C/D landfill has the space and capacity to handle the small amount of additional wastes associated with construction activities. Should the on-site facility prove inadequate, there is sufficient alternative capacity in surrounding off-site C/D landfills.

Generation rates for low level radioactive waste would not be expected to exceed existing rates as a result of extension of the BFN licenses. Should Unit 1 be restarted, generation rates for low level radioactive wastes would be expected to increase during construction activities due to additional asbestos removal operations and the normal increases associated with nuclear construction activities. Once operational, the generation rates for this type of waste activity would increase in proportion to the additional operational activity associated with three unit operation. BFN has provisions in place to either store or ship for processing and disposal the volumes of material generated. Existing storage and disposal facilities have adequate capacity to handle the volumes of material expected to be generated during the extended life of BFN with either two unit or three unit operation.

Hazardous Wastes Management and Past Practices

Generation of hazardous waste would not be expected to increase for BFN as a result of license extension. Existing processes for managing these wastes within TVA would be expected to continue, and capacities for existing disposal and treatment facilities should be adequate to handle the relatively small volumes of material generated. Over the past 15 years, BFN has significantly reduced the generation of hazardous wastes through a combination of source reduction and product substitution. These ongoing waste reduction efforts would be expected to further reduce the number of waste streams and the volumes of waste generated at BFN.

Construction activities associated with Unit 1 restart would temporarily increase rates of hazardous waste generation due to the increased use of solvents and paint related materials necessary for refurbishment. 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.

Spent Fuel Management

Environmental consequences of additional spent fuel management resulting from license extension of either two or three BFN units would be minimal. The additional spent fuel which would accrue during the license extension period would be stored in the spent fuel pool or a dry storage system approved by NRC. Compared with license renewal of only Units 2 and 3, the addition of Unit 1 would simply increase the number of storage casks needed and the required size of the ISFSI. Subsequently, BFN spent fuel would be transferred to the DOE in accordance with the Nuclear Waste Policy Act of 1982 and subsequent amendments.

Surface Water Resources

Under Alternative 1, no significant construction impacts are expected. Best management practices and construction control measures would be employed to control surface runoff and contain potential pollutants. All waste materials will be handled and disposed in accordance with regulatory requirements. There would be no significant changes in current operational impacts. Regulatory requirements will control potential adverse impacts from plant discharges and operations. Thermal impacts from continued operation of Units 2 and 3 will remain within the levels evaluated during the original EIS. No additional thermal impacts to water temperature, reservoir stratification, sediment transport, scouring, dissolved oxygen concentrations, or eutrophication are expected.

Under Alternatives 2A, 2B, 2C, and 2D, potential construction and operational impacts are similar. Construction impacts are expected to be temporary and insignificant using best management practices (BMPs) and pollution control measures. The restart of Unit 1 would require upgrading the cooling tower system and increased flow rates from a maximum flow of approximately 2,312 MGD for Units 2 and 3 to approximately 3,468 MGD with three units operating. The discharge temperature of the cooling system water will be essentially the same for three-unit operation, due to the proportional increase in cooling water flow. However, the total amount of heat added to the river and the water temperatures at the edge of the mixing zone would increase with three units operating. Modeling analyses using historical data indicate that the maximum discharge temperature and the temperature rise between intake and discharge will remain within regulatory limits. Use of the cooling towers would increase, and on rare occasions when the cooling towers are unable to meet the thermal limits, the plant would be derated to remain in compliance. The implications of the thermal effects on reservoir water temperatures, dissolved oxygen concentrations, and eutrophication were also modeled. The results suggest that Alternatives 2A, 2B, 2C, and 2D should have insignificant effects on reservoir stratification, dissolved oxygen concentrations, eutrophication, sediment transport, and scouring.

Groundwater Resources

There are no adverse impacts to groundwater resources associated with Alternative 1. Activities potentially affecting groundwater resources would include foundation treatment, excavation, and grading associated with Alternative 2 facilities. Excavations which penetrate the water table may require temporary construction dewatering. 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 proposed facilities would result in permanent displacement of shallow soils above the water table (e.g., the proposed berm relocation sites). 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. 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 proposed cooling tower configurations given the limited area of disturbance. Potential contaminant releases (e.g., fuels, oils, and solvents) during construction activities would be averted by careful handling and proper disposal of potential contaminants according to BMP guidelines. No adverse impacts to groundwater resources are anticipated from operation and maintenance of new facilities associated with Alternative 2 or the other alternatives.

Floodplains and Flood Risk

The floodplains and flood risk assessment involves ensuring that facilities would be sited to provide a reasonable level of protection from flooding. In doing this, the requirements of Executive Order (EO) 11988 (Floodplain Management) are taken into account. Due to the nature of this facility, it is necessary to evaluate the flood risk associated with the Probable Maximum Flood (PMF) elevations for all alternatives.

Under Alternative 1, all existing and proposed facilities are, or would be, located outside the limits of the 100- and 500-year floodplains. Therefore, the project would be consistent with EO 11988. All safety-related structures are protected against all flood conditions and would not be endangered by the PMF. The proposed dry cask storage facility and permanent administration building would be located on ground above the PMF elevation based on site topography dated 1989. The proposed Modifications Fabrication Building would be located on ground below the PMF elevation, but the site would be raised or the building would be floodproofed consistent with other facilities of this nature on the plant site. Based on site topography, the proposed mechanical draft cooling tower would be located above elevation 570.

During the license renewal period (up to year 2036), the 100- and 500-year flood, and PMF elevations for the Tennessee River would not be expected to change as stated in Section 3.8 of the SEIS. Although the 100- and 500-year flood flows for the small stream to the northwest of the plant site and the site drainage system could increase by as much as 2.5 times what they are now, these flows would not adversely impact existing or proposed development because they would be significantly lower than the PMF flows, and these channels can handle PMF flows without flooding the plant.

Anticipated flood impacts for Alternatives 2A, 2B, 2C, and 2D would be the same as those listed for Alternative 1, except for potential PMF flooding impacts to the new cooling tower(s). Equipment within the cooling towers that could be damaged by floodwaters would be located above or floodproofed to the PMF elevation, as required. The construction of these towers would involve the relocation of material to one of three potential spoil areas. These areas are located outside the limits of the 100-year floodplain which would be consistent with EO 11988.

Terrestrial Ecology

With respect to botanical aspects of Terrestrial Ecology, impacts are anticipated to be the same under all alternatives. No uncommon communities or otherwise significant vegetation types are known from the vicinity and impacts to this resource are anticipated to be insignificant.

Likewise, impacts to terrestrial animal communities would be similar under all alternatives. Due to previous levels of disturbance at the site during construction and operation of existing facilities, little suitable habitat of wildlife exists on site. No populations of rare or uncommon animals exist at the project site. Adoption of the proposed alternatives would not result in adverse impacts to uncommon animals or their habitats.

Aquatic Ecology

If Unit 1 is not returned to operation, but Units 2 and 3 are relicensed under Alternative 1, the total maximum two-unit intake volume, even with past plant modifications that increased Condenser Circulating (i.e., cooling) Water (CCW) flow, would be within the bounds of previously-assessed intake volumes at which fish impingement and entrainment of fish eggs and larvae were determined to not adversely impact Wheeler Reservoir fish populations. With the return of Unit 1 to operation under Alternative 2, the total CCW flow would increase by about ten percent. This increased CCW intake volume would potentially result in increased impingement of adult fish and entrainment of fish eggs and larvae, but is not expected to result in significant impacts to fish populations of Wheeler Reservoir.

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 Vital Signs 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 meaures, and restoration measures that could be undertaken to remedy this, and institute appropriate measures in consultation with appropriate federal and Alabama agencies.

Thermal impacts to aquatic life would be insignificant under any of the proposed action alternatives because the maximum discharge temperature will remain within approved regulatory limits. With implementation of BMPs and other specialized measures as needed to prevent entry of pollutants into surface waters, impacts to aquatic life resulting from construction of new facilities would be insignificant.

Threatened and Endangered Species

For threatened and endangered plants, the impacts are anticipated to be the same under all 5 Action Alternatives. No rare (listed) plants are known from the vicinity and no impacts to this resource are anticipated. No threatened or endangered aquatic animals are presently known from the potentially affected area, and no impacts to this resource are anticipated. Four state-listed terrestrial animal species (two of which are also federally listed) are known from Limestone County, but none of them are reported within five miles of BFN. Adoption of any of the proposed alternatives would have no effect on threatened or endangered terrestrial animals or their habitats.

Wetlands

No wetlands 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 by activities proposed under any of the alternatives.

Socioeconomic Conditions

Discontinuing Plant Operation (upon Expiration of Current Licenses)

Discontinuing operations would require that the plant begin the decommissioning process. There would be some loss of jobs as the plant went into the process, followed by further loss at the end of the decommissioning period. In addition to these direct losses of income and employment, there would be additional indirect income losses as a result of decreased spending associated with the direct job losses. However, the number of jobs lost would be roughly one percent of the labor force of Limestone County and only a small fraction of the labor force in the labor market area. Impacts to community services and housing and to local government revenues would be small. No disproportionate impacts to disadvantaged populations in the local area are expected.

Alternative 1

Under Alternative 1, there would be no significant change in operating employment levels, payroll, or other plant-related expenditures. There would be some construction activity associated with construction of the cooling tower (part of the previously reviewed EPU of BFN Units 2 and 3), modifications/fabrication building, and spent fuel dry cask storage facility, requiring a small number of workers (less than 100 at peak) for a brief period of time. However, impacts to employment and income would be small and temporary.

There would be no important impacts to community services and housing and to local government revenues. No disproportionate impacts to disadvantaged populations in the local area are expected.

Alternative 2

Under any of the variations of Alternative 2, construction activities would result in important impacts on population, employment, and income over a time span of about 5.5 years. The total number of workers involved in the construction phase would peak at about 3,000, although not all of these are likely to be located at the plant site. Operation of Unit 1 in addition to current operation of Units 2 and 3 would require an increase in employment of about 150 permanent workers. This would be a small addition to the local economy.

Construction would result in some short-term strain on community services, including police and emergency services. Schools and the housing market likely would experience short-term strains. These impacts, however, would be scattered throughout the labor market area, not just in Limestone County. The increase in permanent employment associated with operation of Unit 1 in addition to the Units 2 and 3 could have a temporary impact on the local housing market and housing prices. However, the operations impacts would be small. Local government revenues would increase as a result of increases in the in-lieu-of-tax payments by TVA. No disproportionate impacts to disadvantaged populations are expected.

Transportation

Alternative 1 will result in no impacts to the traffic generated by the plant because it would remain at the existing level. However, background traffic growth is expected to continue between now and when the renewed licenses expire. Assuming 15% growth per decade, traffic on the county roads would increase to approximately 2,600 vehicles per day.

Additional traffic would be generated due to refurbishment of Unit 1, and there would be impacts to state and county roads in the vicinity of the site. The Action Alternatives 2A, 2B, 2C, and 2D will have additional traffic generated in the form of operation and construction workforce employee travel and construction and operational material deliveries. During the refurbishment period the workforce rises to peak levels of 3,055; assuming an average ridership of 1.6 persons per vehicle, and one trip in and out each day, about 3,820 vehicles will be added to the road network due to daily commuters during this peak construction period. The average daily traffic on Shaw Road, Nuclear Plant Road, and Browns Ferry Road would increase from the current 1,600 to about 2,900 vehicles per day, which represents a temporary (but not unacceptable) decrease in the level of service. This decrease in level of service from LOS C to LOS D would result in traffic flow conditions that could be tolerated for short periods of time. In this instance, such conditions could occur at shift changes twice during the day and last up to one hour. The county roads are in good condition for access and will be adequate to support the traffic requirements during both construction and operation; however, construction periods are temporary and peak forces only last for approximately six months. There will be some delay turning onto County Road 25 from the plant due to traffic congestion at shift changes and leaving multiple exits simultaneously. Over a long period of time, there is a natural progression to improve the quality of the local roadway network and it can be assumed that the roadway network would be improved in the normal course of events. U.S. Highways 31 and 72 would not be significantly affected.

TVA has completed a transmission study as recently as June 2000 for BFN which assessed the ability of the offsite power system to meet NRC requirements for electric power systems. This study included a 5-year look-ahead to the summer 2005 peak system load of 33,775 megawatts (MW), and assumed BFN Units 2 and 3 were generating at full power with a per-unit power uprate to 1,155 MW gross. The study examined both load flow and transient stability in response to a number of postulated system alignments, contingencies and design basis accident conditions. It was concluded that all the cases studied meet the BFN minimum voltage and design requirements.

TVA has analyzed the transmission line condition and loading in the vicinity of the BFN site, and has determined that restart of Unit 1 at EPU would require additional 500-kV circuit breakers to be installed in the existing 500 kV switchyard, and several 161-kV transmission lines are projected to become overloaded due to single contingency events. Line uprates (i.e., retensioning or increasing tower height or adding towers as necessary to maintain height clearances of conductors which warm and sag under higher power loading), reconductoring (i.e., increasing conductor size), the addition of a second 500-161kV transformer bank at the Madison 500kV substation, or other solutions would be required to correct these overloads. A Static Var Compensator and Capacitors would also be needed for regulating system voltage. These upgrades and equipment additions involve existing facilities with available spaces; any associated environmental impacts would be minimal. There would be no need to obtain new Right of Ways or construction of new transmission lines under any of the alternatives.

The alternatives considered in this SEIS have no impacts on railroads, river transport, or pipelines.

Soil and Land Uses

Activities associated with license renewal and operation of Units 2 and 3 at extended power uprate would have no impact on soils or land use on the plant site. Potential impacts to site soils and land use associated with refurbishing Unit 1 and license renewal for all 3 units, including construction of the additional cooling towers, dry cask storage facility, new administration building, and new modifications/fabrication building, would be insignificant. These construction activities would be located on previously disturbed soils and in built-up areas. Facilities for construction workers would be temporary and at completion of the project the land would revert to prior use.

Operational impacts of any of these activities on land use in the surrounding areas would be insignificant. Current trends in local land use are toward development of more land for residential and commercial use. This is a result of population growth averaging 17% per decade. Any growth associated with either of these proposed activities would be minimal compared to current trends. Existing power line easements are sufficient, no new transmission lines are proposed as part of this license renewal process.

Visual Resources

Impacts under the No Action Alternative would be insignificant. The plant site would remain in its current state and would remain visually unchanged. Under Alternative 1, minor visual impacts would include additional plumes seen by area residents and motorists along adjacent roadways. Alternative 2A will introduce two new cooling towers in the landscape, similar to those that exist now. Alternative 2B, however, will provide two cooling towers that will contrast vertically to the existing towers. Alternative 2C, demolishing the four existing Ecodyne cooling towers, constructing 5 new linear mechanical draft cooling towers and increasing the size of the existing Balcke-Durr cooling tower by 25%, would add to the number of linear elements seen across the plant site. Alternative 2D is the construction of a sixth mechanical draft cooling tower in the currently vacant position (4) where a tower that was destroyed by an accidental fire in 1986, has never been replaced. This addition of a sixth cooling tower differs from that proposed for Alternative 1 (see above) in that the tower would be somewhat larger than the recently replaced 16-cell linear mechanical draft cooling tower 3. The visual impact of Alternative 2D would essentially be the same as that for Alternative 1 since a single mechanical cooling tower of a similar design (but slightly shorter length) would otherwise have been built in the same location for the EPU project. Alternatives 1 and 2D would have the least visual impact for both plant workers, visitors, and motorists along County Road 25 under the Action Alternatives.

Recreation

There are no recreation facilities impacted by either alternative. Under either of the alternatives, there would be insignificant affects on recreation resources, facilities and activities.

Cultural Resources

TVA determined that the project had the potential to affect historic properties within the three areas designated as soil disposal or spoil pile locations. The Area of Potential Effect (APE) for historic structures was determined as those areas from which the disposal locations would be visible. A Phase I cultural resource survey was conducted to identify sites within this APE.

The archaeological survey identified one archaeological site near disposal Area 1 (see Figure ES-1). This site is marked on BFN drawings and it is expected that it would be avoided by any future activities. If avoidance is not possible, or should any future plans result in potential adverse impacts to the site, a Phase II archaeological survey would be required. Cox Cemetery, located near disposal Area 2, would also be avoided. No historic structures were identified within the APE. In consultation with the Alabama State Historic Preservation Office (SHPO), it was determined that no historic properties will be affected by Alternatives 1 and 2 under the commitments that all sites identified during the Phase I survey will be avoided.

Environmental Noise

Routine construction noise from the action alternatives would have an insignificant effect during the duration of construction activities. Some cooling tower and building construction noise would be noticeable above background at times, but it would take place during daylight hours and for a relatively short time period. The highest noise levels during construction would come from the site preparation and foundation work for additional cooling towers. Alternatives 2A and 2B would require two additional towers. Alternative 2C would involve replacement construction of four large towers and the addition of one large tower extending over a period of three to four years. Alternative 2D would require a single additional tower. These heavy construction phases require the largest and most equipment to be in operation, but they are expected to be completed in about three months per tower. The following construction phases of erection and finishing do not require as large or as many pieces of equipment.

The incremental increases in operational noise from the cooling towers for Alternatives 1, 2A, 2B, and 2D are insignificant. These are about a 1 dBA increase over current operational noise. This increase might not be detectable by most of the nearest residents, but it has the potential for a 1 to 2% increase in annoyance. The incremental increase for Alternative 2C is likely to be noticed and has the potential for about a 4% increase in annoyance. None of the alternatives has the potential for causing hearing loss or speech interference.

Although Alternative 2C has the potential to cause an operational noise increase greater than 3dBA, it would be an insignificant effect. The maximum potential effect of Alternative 2C is decreased for several reasons. First, frequently, less than all of the towers are operating; second, the towers operated an average of 17 days per year over the past five years; and third, the cooling tower noise is low frequency and continuous. Also, the towers operate during the hottest part of the summer when residential air-conditioning is used and windows are closed, eliminating any potential noise increase from inside the residences.

Public and Occupational Safety & Health (Non-Radiological)

The site Safety and Health Program will not be impacted or affected by license renewal and continuing to operate Units 2 and 3 for 20 years after the current licenses expire. If Unit 1 recovery and license renewal/extended operation is added to continuing operation of Units 2 and 3, there is still no change to the Safety and Health Program. However, during the construction/modification work in recovering Unit 1 injury rates would be expected to be higher than during periods of operation.

Radiological Impacts

Future occupational radiation exposures from continuing either two-unit or three-unit operation at Extended Power Uprate (EPU) power levels have been analyzed based on extrapolations from past and present data; it was concluded that worker radiation exposures will continue to be significantly less than the limits established by federal regulation. The average annual dose to workers and and the average annual dose per operated reactor will remain consistent with current BWR industry trends. The estimated cancer risk increase associated with the occupational dose forecast for either operational Alternative is bounded by the projected doses for license renewal analyzed in NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants."

TVA does not anticipate any significant changes to the radioactive effluent releases or exposures to the public from continuing two-unit BFN operations through completion of the license renewal period. EPU is projected to increase effluent releases proportionately, as would the addition of Unit 1. However, the refined calculated doses are a small fraction of the applicable radiological dose limits and the total exposures to the public from 3-unit operation at EPU are expected to remain a small fraction of the regulatory dose limits.

The design basis accidents addressed in the BFN UFSAR are independent of the age of the plant and are the same for each unit. Therefore, the extension of the operating lifetime of the plant from 40 to 60 years will not impact the analysis of these accidents. EPU to 120% of the originally licensed maximum thermal power level will affect accident analysis because the power level influences the amount of radioactive isotopes available for release; however, all radioactive releases are projected to remain well within regulatory limits.

Extension of plant life from 40 to 60 years will also proportionately impact the ability of safety related equipment to withstand the effects of accidents; this is because of age-related effects of continuing operational conditions (temperature, humidity, radiation, etc.). However, the BFN equipment qualification program ensures that safety-related equipment will remain qualified to operate as designed in its intended environment so as to perform its intended function. As part of this program, any equipment that cannot withstand the full 60-year life of the plant will be replaced on a predetermined maintenance schedule.

License extension with either two- or three-unit operation would be accommodated as it has in the past by the BFN Radiological Emergency Plan. Based on the BFN SAMA analysis and SAMA analyses completed to date at other nuclear plants similar to BFN, it is not anticipated that either Alternative 1 or Alternative 2 would result in justifying significant modifications.

Decommissioning Impacts

If the decision is made to extend operation of only Units 2 and 3, decommissioning would probably not be initiated for Unit 1 until cessation of all site power operations. Instead, Unit 1 would likely remain in its current non-operable status until any renewed licenses expire or a subsequent decision is made to recover and restart the unit. If Unit 1 is restarted, Unit 1 would join Units 2 and 3 in extended operation for an additional 20 years past expiration of the current licenses. Therefore, under either Action Alternative, decommissioning would be delayed by the 20-year license renewal 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 would be available prior to completion of decommissioning.

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°F	Degrees Fahrenheit
ACHP	Advisory Council on Historic Preservation
AD	After Death
ADEM	Alabama Department of Environmental Management
ADT	Average Daily Traffic
ADOT	Alabama Department of Transportation
AEC	Atomic Energy Commission
ALARA	As Low As Reasonably Achievable
APE	Area of Potential Effect
AREOR	Annual Radiological Environmental Operating Report
ARPA	Archaeological Resources Protection Act
avg	Average
BC	Before Christ
BEIR	Biological Effects of Ionizing Radiation
BGE	Baltimore Gas & Electric
BIBI	Benthic Index of Biotic Integrity
BMP	Best Management Practices
Btu	British Thermal Unit
BFN	Browns Ferry Nuclear Plant
BWR	Boiling Water Reactor
CCNPP	Calvert Cliffs Nuclear Power Plant
CCW	Condenser Circulating Water
C/D	Construction/Demolition
CFD	Computional Fluid Dynamics
CFR	Code of Federal Regulations
cfs	Cubic Feet Per Second
CRD	Control Rod Drive
CRDA	Control Rod Drop Accident
CTC	Chemical Traffic Control
CWA	Clean Water Act
CY	Calendar Year
DASHO	Designated Agency Safety and Health Officials
DAW	Dry Active Waste
dBA	Decibel, A-weighted
DNL	Sound Level Day/Night
DO	Dissolved Oxygen
DOE	U.S. Department of Energy
DSEP	Detailed Scoping, Estimating, and Planning
DSN	Discharge Serial Number
EA	Environmental Assessment
EECW	Emergency Equipment Cooling Water
EIS	Environmental Impact Statement
EMF	Electric and Magnetic Fields
EMT	Emergency Medical Technicians
EO	Executive Order
EPA	United States Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EPIP	Emergency Plan Implementation
EPRI	Electric Power Research Institute
EPU	Extended Power Uprate
EQ	Equipment Qualification

ERAL	Environmental Restriced Awards List
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FHA	Fuel Handling Accident
FICON	Federal Interagency Committee on Noise
FICUN	Federal Interagency Committee on Urban Noise
FLM	Federal Land Manager
FNM	Field Non-Manual
FRP	Flood Risk Profile
FSAR	Final Safety Analysis Report
FSEIS	Final Supplemental Environmental Impact Statement
FTE	Full-time Equivalent
GWh	Total Net Energy
gpd	Gallons Per Day
gpm	Gallons Per Minute
GEIS	Generic Environmental Impact Statement for License Renewal of Nuclear Plants
ha	Fish Per Hectare
HEU	Highly enriched uranium
HUD	United States Housing and Urban Development
HWSF	Hazardous Waste Storage Facility
INPO	Institute of Nuclear Power Operations
IPA	Integrated Plant Assessment
IPEEE	Individual Plant Examination External Events
ISFSI	Independent Spent Fuel Storage Installation
IRP	Integrated Resource Plan
Kg/ha	Kilogram Per Hectare
kV	Kilovolt
KW, kW	Kilowatt
kWh	Kilowatt-hour
LEU	Low Enriched Uranium
lbs	Pounds
Leq	Equivalent Sound Level
LLRW	Low-Level Radioactive Waste
LOCA	Loss of Coolant Accident
LOS	Loss of Service
MACCS2	MELCOR Accident Consequence Code System, version 2
MGD	Million Gallons Per Day
mg/L	Milligrams Per Liter
mph	Miles Per Hour
mrem/yr	Milllirem Per Year
MSDS	Material Safety Data Sheets
MSLB	Main Stream Line Break
mSv/yr	Millisievert Per Year
msl	Mean Sea Level
MW	Megawatts, Electric
MWe	Megawatt, Electrical
MWh	Megawatt, Hour
MWt	Megawatt, Thermal

NEI	Nuclear Energy Institute
NEPA	National Environmental Policy Act
NESC	National Electrical Safety Code
NETL	National Energy Technology Laboratory
NFPA	National Fire Protection Association
NFS	Nuclear Fuel Service
NGCC	Natural Gas-Fired Combined Cycle
NHPA	National Historic Preservation Act
NOI	Notice of Intent
NOx	Nitrogen Oxides, or All Oxides of Nitrogen
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRC	Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NSSS	Nuclear Steam Supply Steam
NUREG-1437	Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants
NWI	National Wetlands Inventory
ODCM	Offsite Dose Calculation Manual
O&M	Operations and Maintenance
OPA	Option Purchase Agreement
OSHA	Occupational Safety and Health Administration
PAME	Primary Aerobic Meningoencephalitis
pH	Negative Logarithm of the Effective Hydrogen Ion Concentration
PMF	Probable Maximum Flood
ppm	Parts per Million by Volume
PSA	Probabilistic Safety Assessment
PSD	Prevention of Significant Deterioration
psi	Pounds Per Square Inch
PWR	Pressurized Water Reactor
RCRA	Resource Conservation and Recovery Act
REMP	Radiological Environmental Monitoring Program
REP	Radiological Emergency Plan
RFAI	Reservoir Fish Assemblage Index
RFP	Requests for Proposals
RHR	Residual Heat Removal
RHRSW	Residual Heat Removal Service Water
ROD	Record of Decision
ROW	Right-of-Way
RWCU	Reactor Water Clean-up System
SAMA	Severe Accident Mitigation Alternative
SEIS	Supplemental Environmental Impact Statement
SERC	Southeastern Electric Reliability Council
SFI	Sport Fishing Index
SHPO	State Historic Preservation Officer
SPC	Siemens Power Corporation
SPCC	Spill Prevention Control and Countermeasure Plan
SR	State Route
SREPs	State Radiological Emergency Plans
SRS	Savannah River Site
TDS	Total Dissolved Solids

T&E	Threatened and Endangered
TLAAs	Time-Limited Aging Analyses
TRM	Tennessee River Mile
TVA	Tennessee Valley Authority
UFSAR	Updated Final Safety Analysis Report
U.S.	United States
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
VISCREEN	Visual Impact Screening
vpd	Vehicles Per Day
VS	Vital Signs
yr	Year

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1.0 PURPOSE AND NEED FOR PROPOSED ACTION

1.1 Project Overview

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 construction of a new power generating facility.

Consistent with the above, TVA proposes to extend operation of Units 1, 2, and 3 of its Browns Ferry Nuclear Plant (BFN) located in Limestone County, Alabama. This would require obtaining a renewal of the units' operating licenses from the Nuclear Regulatory Commission (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.

This Supplemental Environmental Impact Statement (SEIS) is being prepared to provide the public and TVA decision-makers an assessment of the environmental impacts of extending unit operation. License renewal by itself involves existing BFN facilities, and does not involve any new construction or modifications beyond normal maintenance and minor refurbishment. However, there are other proposed projects not directly related to license renewal that are connected to, or could affect, license renewal. One of these projects is the recovery of Unit 1, which has been in a non-operational status for 15 years. Other projects include the addition of a few new office buildings. In the interests of completeness, these actions are being included in this SEIS.

Independent of the matters considered in this SEIS, TVA earlier reviewed the environmental impacts and approved a project which will uprate the maximum operating power level of Units 2 and 3 to 120% of their originally licensed power levels. This increase is known as Extended Power Uprate (EPU). The various alternatives in the SEIS have been modified as appropriate to reflect the higher operating levels. If Unit 1 is returned to service, it is currently contemplated that it would also be operated at EPU.

A connected action also being addressed in this SEIS is the construction at BFN of a dry cask storage facility for storage of spent nuclear fuel. Currently, spent nuclear fuel at BFN is stored under water in pools specially designed for that purpose, but which have a finite capacity. Even without license renewal or Unit 1 restart, BFN requires expansion of its spent fuel storage capacity in 2005 for reasons discussed in Chapter 2. Construction of a dry cask storage facility at BFN is included in this SEIS because license extension and Unit 1 restart would impact the ultimate size of the facility.

1.2 Brief History and Description of BFN

TVA began major construction on BFN in 1967. BFN is an 840-acre tract located on Wheeler Reservoir in Limestone County, Alabama, 10 miles southwest of Athens, Alabama (Figure 1.2-1). 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 generator.

BFN is TVA's first nuclear power plant. Unit 1 began commercial operation in August 1974, Unit 2 in 1975, and Unit 3 in 1977. Unit 1 has been idled since 1983, and extensive work is required to bring the unit up to current standards.

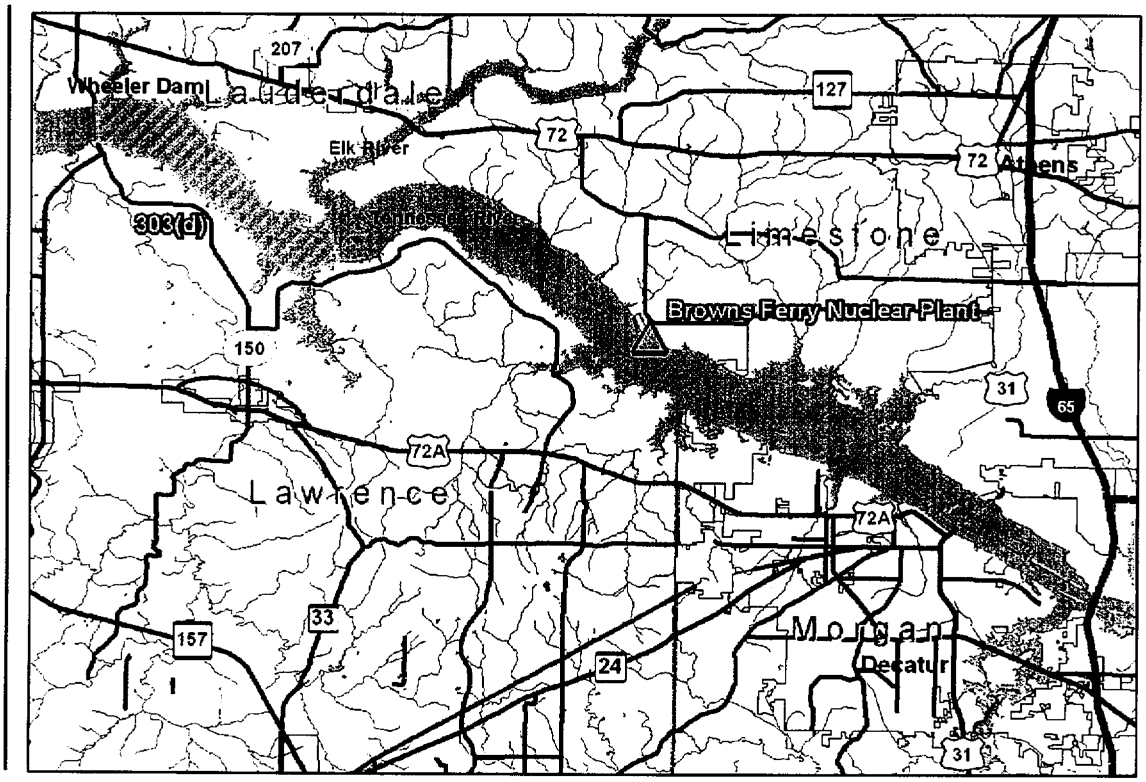
After an extended shutdown in 1985 to review the TVA nuclear power program and to correct significant weaknesses, Unit 2 returned to service in May 1991, and Unit 3 in November 1995. Operating characteristics, since restart from this regulatory outage, are expected to be more representative of future 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.

1.3 The TVA Power System

TVA was established by an Act of Congress in 1933 as a federal corporation to develop and conserve the natural resources of the Tennessee Valley region and to improve the lives of the region's population. From its beginning, TVA's challenge has been to look at economic development and natural resource issues in a comprehensive fashion. TVA has also been expected to demonstrate the unique strengths of "a corporation vested with the power of government with the flexibility and initiative of a private enterprise" (Lilienthal, 1944). TVA is managed by a three-member Board of Directors appointed by the President and approved by the U. S. Senate.

In its first 15 years of existence, TVA built a series of multipurpose dams on the Tennessee River system. One of the by-products of these dams was abundant, inexpensive electricity. The hydroelectric power generated by these dams met most of the rapidly increasing needs of the region through the 1940s. By the early 1950s, however, the growing demand was exceeding the capacity of the dams and the Watts Bar Fossil Plant, which TVA constructed in 1945. During the next 20 years, TVA built 11 large coal-fired generating plants to meet the region's growing needs. Some of these plants were the largest, first-of-their-kind, coal-fired units in the world. The 1960s brought even greater growth to the region. To meet the anticipated need for more power, TVA began an ambitious program of nuclear plant construction.

Figure 1.2-1 Location of Browns Ferry Nuclear Power Plant



Despite this growth program, TVA's electric rates remained among the lowest in the nation throughout the 1960s. However, the 1970s, beginning with the 1973 oil embargo, brought unprecedented change to the entire electric utility industry's ability to control costs and rates charged to customers. Coal costs and the costs of constructing nuclear units rapidly increased, forcing TVA and most other electric utilities to increase their rates. As energy costs across the nation continued to climb in the late 1970s and early 1980s, TVA introduced programs to encourage customers to reduce their demand for electricity. These programs, focusing on energy conservation and reducing peak electric loads, work in concert with TVA's existing generating resources to meet customer energy needs.

TVA's power system in 2000 had generating capacity of about 29,469 MWs (TVA, 2000a). Based on 2000 data, that generating system consisted of 11 coal-fired plants (53% of total generation capacity), five nuclear generating units at three sites (20%), 29 hydroelectric dams (12%), 56 combustion turbines at four sites (10%) and one pumped storage facility (5%). The system is linked by 17,000 miles of transmission lines that distribute power to 750 wholesale delivery points, as well as 57 interconnections to 13 neighboring utilities.

Today, TVA is one of the largest producers of electricity in the United States, generating 4 to 5% of all electricity in the nation. In 2000, TVA generated 152 million MWh of electricity. TVA's power system serves approximately eight million people in a seven state region, encompassing nearly 80,000 square miles (Figure 1.3-1). TVA's electricity is distributed to homes and businesses through a network of 158 power distributors, including 108 municipally-owned utilities and 50 electric cooperatives. TVA also sells power directly to approximately 60 large industrial customers and federal facilities.

1.4 Projecting TVA's Needs for Generating Capacity

1.4.1 The *Energy Vision 2020* Planning Process

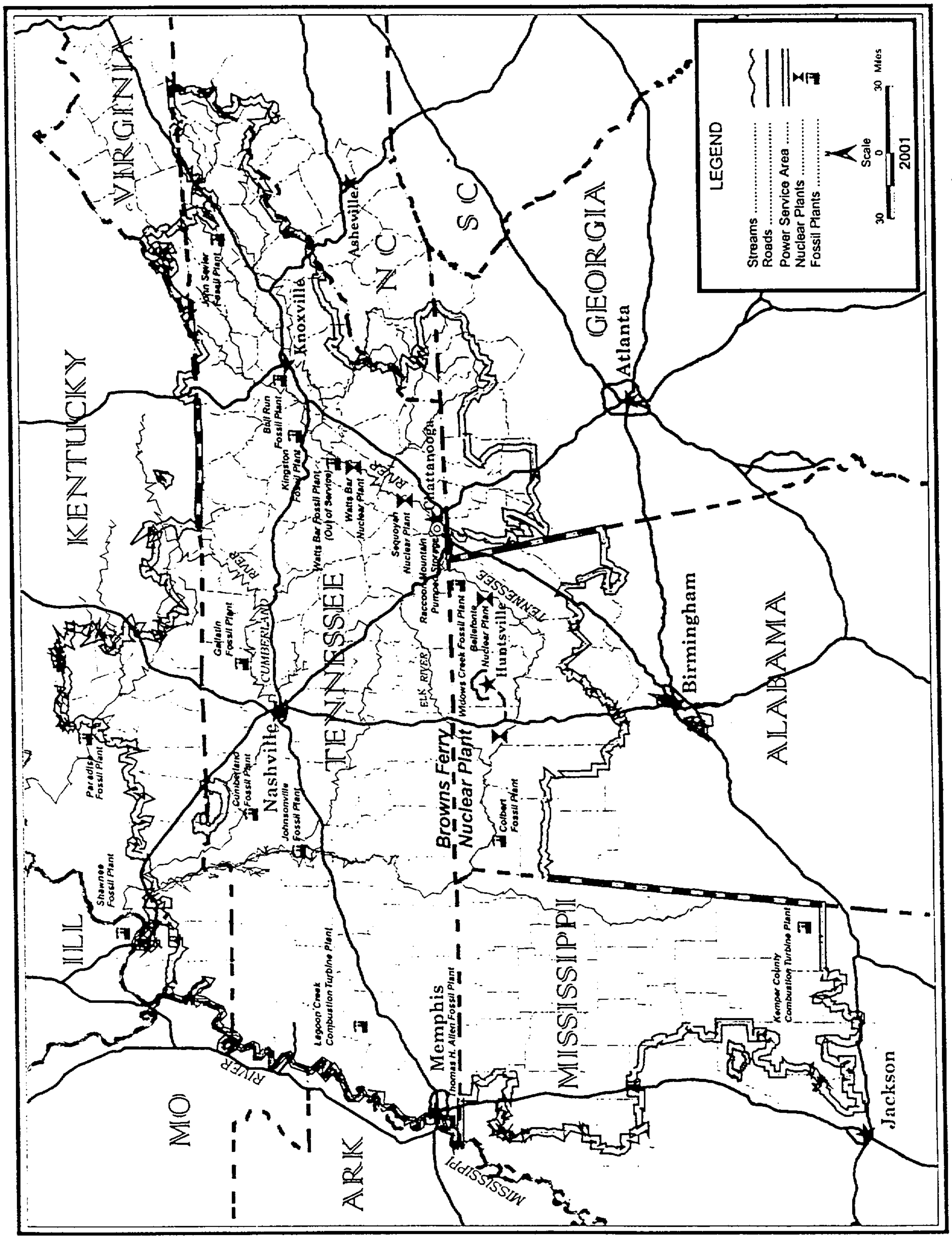
Under the National Energy Policy Act of 1992 (PL 102-486), TVA was directed to employ a least-cost energy-planning process for the addition of new energy resources to its power system. In response to this directive, TVA began work on an Integrated Resource Plan (IRP) in February 1994. An IRP is a plan which broadly identifies the actions that a utility anticipates taking to meet demands for electric service and to achieve its long-term goals and objectives. TVA completed this planning process in December 1995 with the publication of *Energy Vision 2020 - Integrated Resource Plan/Programmatic Environmental Impact Statement* (TVA, 1995).

Because the projected demand for electricity exceeds TVA's current generation capacity, much of *Energy Vision 2020* is an evaluation of ways to meet that demand. This evaluation used the best industry practices in integrated resource planning, included multiple evaluation criteria, considered future uncertainties, and reflected extensive public input. The evaluation criteria used to compare energy resource strategies included:

- Long-run cost and value criteria,
- Short- and mid-term rates,
- Reliability,
- Environmental impacts,
- Economic development,
- Financial requirements,
- Risk management, and
- Equity among rate classes.

These criteria and their associated measures became the basis for ranking a large number of supply-side and customer service alternatives. They were later used in an analysis to evaluate and improve TVA's proposed strategies. The results of this analysis showed that customer service alternatives, such as demand-side management and rate restructuring, were not, by themselves, adequate to meet the projected electrical demand increases.

Figure 1.3-1 Tennessee Valley Authority Power System



Energy Vision 2020 considered over 60 customer service alternatives that end-use customers can use to obtain energy efficiencies. These alternatives include traditional demand-side management (i.e., energy efficiency and load management), self-generation, beneficial electrification, and rate alternatives.

The evaluation of supply-side alternatives considered numerous methods of generating electricity, including traditional technologies (e.g., coal-fired plants, combustion turbines), as well as potential renewable and advanced combustion facilities. TVA also evaluated alternatives that would give greater flexibility in planning. These alternatives included purchasing competitively-priced power from other suppliers (e.g., independent power producers, cogenerators), buying alternatives on future power delivery (e.g., alternative purchase agreements), and entering business partnering arrangements. Overall, TVA characterized and evaluated over 100 supply-side alternatives based on performance, cost, and environmental impacts.

1.4.2 *Energy Vision 2020* Recommendations and Power Need Forecast

Energy Vision 2020 projected demands for electricity in the TVA power service area through the year 2020, and evaluated ways of meeting these projected increases. It was concluded that TVA would best be able to respond to future uncertainties by maintaining flexibility to deploy a variety of different demand- and supply-side resources as events unfolded. The resulting recommendations of *Energy Vision 2020*, which were adopted by the TVA Board of Directors in February 1996 (TVA, 1996), included the following portfolio components:

- Supply-side alternatives, including combustion turbines, purchasing and exercising call alternatives for both baseload and peaking power, purchasing power from independent power producers, developing renewable energy resources, improving the existing hydroelectric generating system, and converting the unfinished Bellefonte Nuclear Plant to an alternative fuel source, such as natural gas or gasified coal;
- Customer service alternatives, including demand-side management and beneficial electrification; and
- Resource management alternatives to manage risks, including increased use of natural gas to meet future environmental regulations.

The short-term supply-side action plan, designed to meet the demand through the year 2002, includes most of the supply-side alternatives listed in the long-term plan, along with targeted capacities and completion dates (e.g., implement up to 3,000 MWs of purchase call alternatives by 2002), and the development of additional power generation and storage capacity. Under the medium load forecast, the demand for electricity was projected to exceed TVA's 1996 generating capacity of 28,000 MWs by 800 MWs in 1998, and by 6,250 MWs in 2005. The medium load forecast projected a need for an additional 16,500 MWs by 2020.

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. As discussed further in Chapter 2, TVA runs certain assets almost continually (referred to as baseload assets) and other assets for short periods, typically hours at a time (referred to as peaking assets) to meet customer needs which fluctuate by as much as 20% on a daily basis and up to 50% seasonally. There is a third type which operates for several days or even weeks at a time called "intermediate" load assets. 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). Baseload is the minimal amount of power that must be available around the clock to meet demand.

Over the past several years, TVA has experienced growth in both peaking and baseload demand. Since the construction of baseload generating assets benefits TVA's ability to meet both peaking and baseload demands, it is useful to understand how both are growing and are expected to grow in the future. In the following, peaking demand is discussed in terms of instantaneous power generation (MW), and baseload demand is considered in terms of power generation over time (megawatt hours, although gigawatt hours is used in the figures). Baseload planning must consider the period over which various units can be available to meet demand.

Figure 1.4-1 shows the power need projections along with actual peaking demand since 1985. Focusing on the period immediately following the release of *Energy Vision 2020*, it is apparent that actual growth in demand is higher than projected in 1995, nearly paralleling the highest projected rate of 3.4% per year for this time interval. TVA projections in its annual report to the Southeastern Electric Reliability Council (SERC) (the vertical bars on Figure 1.4-1) shows continued higher growth over the next ten years, eventually slowing to the medium projection by about 2010 (SERC, 2000).

Figure 1.4-2 shows the total net energy (GWh) need projections along with actual baseload demand since 1985. These data project an average energy growth rate of approximately 2% per year from 2001 through 2009 (SERC). Note that for the year 2000, the actual values were slightly greater than the values that had been projected for that year. Acknowledging the recent rapid growth in baseload demand, TVA currently estimates an additional annual need of 2,000 GWh by 2005, and 5,000 to 15,000 GWh by 2010. Slowing growth in electricity demand caused by the 2001 slowdown in the economy is expected to be a short-term phenomenon; electricity demand should be back or close to the long-term forecast by 2005.

Figure 1.4-1 TVA Historic System Peak Loads and Demand Projections

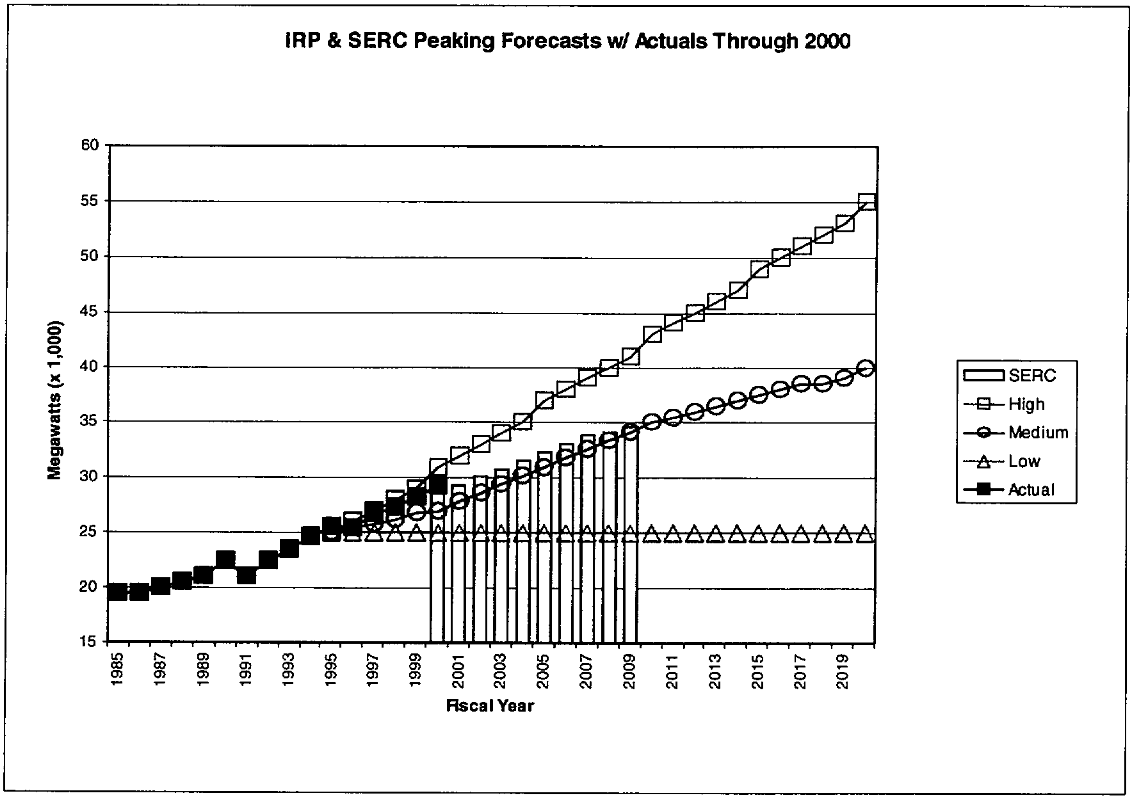
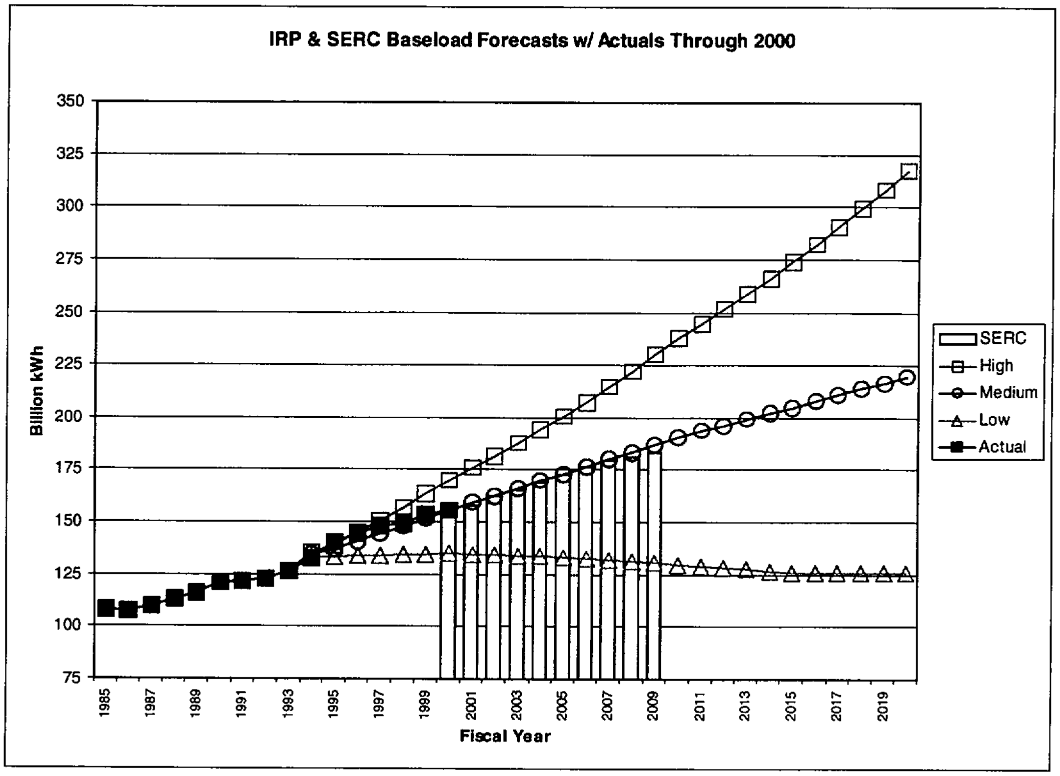


Figure 1.4-2 TVA Historic System BaseLoads and Demand Projections



1.4.3 Experience Since the Release of *Energy Vision 2020*

Since 1995, TVA has added about 3,380 MWs of generating capacity and 1,400 MW in option-purchase agreements to meet the increasing power demand in the Tennessee Valley (TVA, 1999b). Incrementally, the 3,380 MW growth in capacity consists of operational efficiencies resulting from better maintenance and capital improvements at existing fossil, nuclear, and hydro power production facilities, along with additions in capacity at several locations. A list of activities resulting in capacity additions, including option purchase agreements, are described in the following:

- Continuing modernization of existing TVA hydroelectric plants (both conventional and pumped storage) will add approximately 388 MWs of peaking capacity through 2002.
- The Red Hills Power Project in Ackerman, Mississippi, a 440 MW lignite coal-fired plant, is scheduled to begin commercial baseload operation in May 2002. This plant 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 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 will be constructed at this site for operation by June 2002 (Final EIS Notice of Availability, 65 FR 17265, TVA Record of Decision, 65 FR 30469).
- 340 MWs of simple-cycle combustion turbines are being constructed at TVA's Kemper County Combustion Turbine Plant east of DeKalb, Mississippi, for operation by June 2002 (Final EIS Notice of Availability, 66 FG 15241; TVA Record of Decision, 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 will add approximately 232 MWs, and similar planned upgrades at Sequoyah Nuclear Power Plant will add about 25 MWs. A portion of this 275 MWs could reach TVA customers by 2003, and all of the improvements are expected to be completed by mid-2005.
- Various power purchase agreements have been in effect over the period.

Consistent with *Energy Vision 2020*, TVA initiated a program in July 1998 to install selective catalytic reduction systems on 25 existing coal-fired generating units to reduce NO_x emissions. This project is expected to cost approximately $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, 1999c). In 2001, TVA announced that it planned to install five additional scrubbers to further reduce SO_2 emissions at 12 of its coal-fired units. The capital cost of these scrubbers is currently estimated at $1.5 billion.

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.
- Distributed generation initiatives are being pursued 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 began its "Green Power Switch" program on April 22, 2000, as a market test of electricity form certain renewable sources, including landfill gas, photovoltaic, and wind. This program currently provides about five MWs of generating capacity (Table 1.4-1). Though non-hydro renewables currently represent only a small fraction of TVA's generating capacity, the success of this program has exceeded expectations. During the first 11 months of the program, 3,260 residential and 150 commercial customers signed up to participate. Twelve distributors of TVA power currently offer the Green Power Switch program to their customers. TVA plans to increase generation from such sources, including one project to increase wind power capacity by up to 50 MWs by 2003, and a solar project that would increase capacity to about one MW by 2010. TVA has no current plans for repowering any of its conventional units with renewable fuels (TVA, 2001a).

Table 1.4-1 TVA Generation Capacity by Energy Source

	Capacity (MW)	Portion of TVA Total (%)
Conventional Energy[a]		
Coal Fired[b]	17,407.20	53.46
Nuclear	6,053.10	18.59
Hydro	5,157.50	15.84
Natural Gas	3,910.00	12.01
Diesel Generator	27.00	0.08
Subtotal	32,554.80	99.98
Non-hydro Renewable Energy		
Bioenergy[c]	5.60	0.017
Solar	0.25	0.001
Wind	1.98	0.006
Subtotal	7.83	0.024
TVA Total	32,562.63	100.00

a – Based on unit nameplate capacity, which is somewhat higher than the system available capacity discussed in Section 1.2.
b - Includes cogeneration steam to a nearby industrial facility at Johnsonville Fossil Plant.
c - Includes wood waste cofiring at Colbert Fossil Plant and wastewater biogas cofiring at Allen Fossil Plant.

1.4.4 Integrating Supply-Side and Demand-Side Alternatives to Meet Customer Needs

ONGOING EFFORTS TO ACQUIRE SUPPLY

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, 2000b). The first part involved purchases of summer peaking capacity and the second part involved constructing new generating capacity. 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 would need to have a June 1, 2003, delivery date and provide TVA exclusive rights during the term of the OPA.

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, currently under construction. This capacity must begin operation by June 1, 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, 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, 2000c). "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. As a result of the RFP, several contracts were entered into under which TVA committed to purchase in excess of a total of 500 MWs of capacity for the summers of 2002 and 2003.

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. As a result of the RFP, TVA received approximately 80 proposals for summer peaking and baseload energy from more than 20 proposers. After conducting detailed analyses that considered reliability, flexibility, fuel costs, environmental impacts, electricity market prices, and other important factors, TVA has determined there are options that could provide a better value to the Valley for summer peaking energy than the proposals submitted, such as short-term market purchases, unsolicited proposals that TVA could receive in the future, etc. Therefore, TVA has elected not to pursue a power purchase agreement for summer peaking capacity from this RFP. Efforts are continuing to analyze the proposals submitted to supply baseload capacity.

Spot market purchases of power, also recommended by *Energy Vision 2020*, 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 of all demand-side management and renewable energy generation projects, in terms of electricity demand delayed or replaced, is much less than the generation alternatives proposed in this SEIS. This combined impact is also greatly exceeded by demands projected in *Energy Vision 2020*, and by actual growth experienced in the past several years. This is one of the reasons that the proposals for extending operation of the BFN units are being considered.

Exacerbating this complex and fluid planning process is the prospect that, based on peaking and baseload demands recorded in recent years, the medium load capacities targeted in *Energy Vision 2020* may actually be too conservative. Actual peak demands increased by over 4,600 MWs from the winter of 1995 (24,723 MWs) to the summer of 2000 (29,344 MWs), an average annual increase of about 920 MWs (over 3% per year). In fact, peaking demands during the summer of 2000 exceeded by 2,000 MWs the medium load forecast contained in *Energy Vision 2020.* Continued demand increases of this magnitude could, in a few years, exceed TVA's generation capacity and negatively affect TVA's ability to serve its customers.

Over the next few years, TVA plans to further increase capacity through improvements to existing units and the addition of capacity using combustion turbines as peaking units, in combined-cycle baseload plants and in cogeneration configurations with private companies across the service region. However, these increases may not be enough to maintain adequate reserve capacity.

It is reasonable to expect that the delivery of reliable and economic power to customers will require TVA to continue to pursue all of the portfolio options recommended in *Energy Vision*

2020, both demand-side and supply-side. Consistent with *Energy Vision 2020*, from which this SEIS tiers, each of the portfolio 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.

1.5 SEIS Overview/NEPA Approach

This SEIS is being prepared by TVA under the National Environmental Policy Act (NEPA), regulations published by the Council on Environmental Quality (40 CFR Parts 1500-1508), and TVA's procedures implementing NEPA. This SEIS updates and adds to information and analyses in the plant's original environmental impact statement (EIS), and will provide the public and TVA decision-makers a basis for considering the proposed actions.

1.5.1 Tiering from *Energy Vision 2020*

Tiering from the *Energy Vision 2020* Programmatic EIS incorporates it by reference in this SEIS and allows concise and efficient consideration of the strategies and programmatic issues related to both maintenance of existing generation capacity in TVA's power system and the addition of new generation capacity. As discussed in the preceding sections, *Energy Vision 2020* evaluated an array of energy resources, both supply-side and demand-side. These alternatives were ranked using several criteria, including environmental performance. Favorable alternatives were formulated into strategies that would effectively meet baseload energy and peak capacity needs of TVA's customers under a range of conditions ("futures"). A number of these strategies were then combined to create TVA's short- and long-term energy resource plans or, collectively, TVA's Integrated Response Plan (IRP).

Nuclear generation is expected to play a vital role in helping TVA meet energy supply demands through the *Energy Vision 2020* study period (1996 through 2020). The *Energy Vision 2020* Resource Integration Strategy Matrices identified five nuclear units, located at three sites, as existing generating assets on the TVA system – BFN Units 2 and 3, Sequoyah Nuclear Plant Units 1 and 2, and Watts Bar Nuclear Plant Unit 1. These five units were determined to contribute 5,517 megawatts, 20%, of the TVA system total project capacity of 27,995 MW in 2005.

The operating nuclear units at BFN will reach the end of their current operating licenses during the *Energy Vision 2020* study period. *Energy Vision 2020* anticipated that Units 2 and 3 would be excellent candidates for license extension for two reasons. First, boiling water reactors, such as those at BFN, are not very susceptible to reactor vessel age degradation; second, these units have been brought up to current standards. TVA continues to closely follow NRC rule-making and rule interpretation for license renewal, as well as the experiences of other nuclear utilities that have applied for license renewal since the Energy Vision EIS was issued. Accordingly, this SEIS addresses extending BFN unit licenses to provides sources of baseload electric energy in TVA's power system for an additional period of 20 years past expiration of the current operating licenses.

Energy Vision 2020 also discussed both the short-term and the long-term options for BFN Unit 1. That EIS identified strategies that were determined to best optimize the relationship among the inter-related factors of costs, rates, environmental impacts, debt and economic development, while meeting customer needs. For the short-term, the IRP concluded that it was not viable to restart BFN Unit 1 because there were more optimal power supply strategies identified to meet load growth, particularly in consideration of cost, impact on short-term rates, impact on debt and competitiveness.

Since the release of *Energy Vision 2020*, TVA has continued to maintain and improve the efficiency and reliability of its fossil plants, purchased capacity calls in the bulk power markets, and procured additional peaking capacity to meet growth needs that have exceeded the assumptions used in the IRP. The additional peaking capacity consists of gas/oil-fired combustion turbines: 608 MWs by summer 2000, 616 MWs by summer 2001, and 616 MWs by summer 2002. In order to preserve long-term flexibility, BFN Unit 1 has continued to be maintained as an inoperative deferred nuclear asset. This enabled TVA to maintain lower rates and debt for the short-term and consider other alternatives to recovering BFN Unit 1 as conditions changed.

Energy Vision 2020 noted that deferring the decision to recover BFN Unit 1 for several years would allow additional time to acquire information regarding nuclear unit performance and economics and TVA's need for power. Moreover, *Energy Vision 2020* concluded that under certain conditions, recovery of BFN Unit 1 could emerge as a low-cost supply option. This set of conditions, referred to as a "high performance" future, consisted of the high load forecast, low cost to complete the nuclear units, low operations and maintenance costs, and a high nuclear capacity factor. Since issuing *Energy Vision 2020*, a number of developments makes it timely to consider further the recovery of BFN Unit 1 to meet TVA's long-term resource requirements.

Energy vision 2020 – Capital Cost Recovery Estimates for Browns Ferry Unit 1 Restart

At the time *Energy Vision 2020* was issued, the cost of recovery for Unit 1 was expected to be in the range of $1.187 to $3.150 billion with a medium value of $2.374 billion. Adjusting the medium figure to 2002 dollars, the cost today would be nearly $3.1 billion. The cost and schedule estimates made in the IRP assumed a significant degree of uncertainty due to a rapidly changing regulatory climate and difficulty in managing large nuclear construction projects. The detailed engineering costs were taken as the low forecast, and historical forecast error data were used to determine the medium and high forecasts. The IRP EIS conservatively applied adjustments to the detailed engineering cost estimates based on the errors in past cost forecasts, despite the fact that previous forecast errors were considered in the detailed engineering cost estimates. Other nuclear units completed by TVA were constructed in an environment where changes to nuclear unit construction were mandated by the NRC, irrespective of quantifiable impact on the safety of the unit. In this environment, the detailed engineering estimate was doubled when compared with other capacity supply alternatives. Thus, the low cost estimate was not considered as a basis for capacity planning. The report recognized that future forecast error could be reduced if regulations were more stable and construction project management improved.

The current regulatory state is considerably more stable than the "post - Three Mile Island" environment preceding *Energy Vision 2020*. An important regulatory development has been the use of probabilistic risk assessment in the implementation of NRC regulations. Before changes are mandated by the NRC, the cost of the modification and the impact on the probability of associated design basis accidents are considered. This is a significant evolution in regulatory philosophy from the environment that existed at the time recovery of BFN Unit 1 was first considered.

Updated Capital Cost Recovery and Capital Cost Experience

In late 2001 through early 2002, TVA has conducted an assessment and engineering "due diligence" review of the cost estimate to further reduce uncertainty associated with recovery and restart of BFN Unit 1. Detailed engineering estimates (including transmission system impacts) now support a cost of recovery of BFN Unit 1 in the range of $1.56 billion to $1.72 billion with a most likely cost of $1.64 billion in 2002 dollars

TVA now has demonstrated experience in reducing the cost of additions and improvements needed to modify existing nuclear operating units to improve reliability. The IRP projected that TVA's additions and improvement costs would be typical of the industry. Annual costs were assumed to be $20 million per site plus $5 million per unit in 1994 dollars. Escalation was expected to be 4.5%. Accordingly, a two-unit site would have been forecast to have $42.6million in additions and improvements costs in 2002. Actual costs for BFN have averaged $29.7 million over the last five years and were$23.8 million for fiscal year 2001.

The existing management and technical infrastructure at BFN, which currently supports the operation of Units 2 and 3, can also be leveraged to create economies of scale for the operation of Unit 1. In calendar year 2000, the cost of operating Units 2 and 3, as published in *Nucleonics Week*, was $12.22/MWh. Based on continued improvements in operating and fuel costs and increases in the available capacity from the uprates described in this SEIS, the current projected cost for continued operation of Units 2 and 3 is $10.46/MWh. The recovery of Unit 1 would further lower this projection to about $9.37/MWh.

TVA has also materially improved the performance of its nuclear plants above the projections used to review alternatives in *Energy Vision 2020*. The mid-range capacity factor assumption in *Energy Vision 2020* for nuclear units is 67%, with a low of 55% and a high of 86%. Nuclear plant performance has significantly improved beyond even the high case assumptions of the IRP. Capacity factors used in the IRP were based on the 67% average annual capacity factor for Sequoyah Units 1 and 2 and BFN Unit 2 following restoration to service of those units through the date the IRP evaluation was performed. This value was used for the medium estimate for future capacity factors for all nuclear units considered. The high estimate for nuclear capacity factor was 86%. BFN has consistently improved capacity factors since Unit 3 was returned to service in 1995, and has demonstrated the ability to sustain a high level of operation by averaging 92% capacity factor over the past five years. Two key factors in this improvement have been the reduction in refueling outage duration, and improvements in overall plant operating performance. Refueling outages at BFN have been reduced from an average of 89 days in the years immediately prior to the IRP to an average of 24 days since then, with a low of 18 days.

Operating costs for a nuclear unit include operations and maintenance, additions and improvements, fuel, and decommissioning. Decommissioning costs are not adversely impacted by the recovery of BFN Unit 1, since TVA has always funded decommissioning accruals in the same manner in which it funds all of its currently operating units. Operations and maintenance costs were projected in the medium case to be $69 per kilowatt per year, with a low value of $55 per kilowatt per year and a high value of $83 per kilowatt per year. The estimates were escalated at 4.5% annually. At this rate, the low forecast for 2001 would be approximately $74.8 per kilowatt per year. However, operations and maintenance expense for 2001 is $62.3 per kilowatt per year, 17% below the low forecast. Incremental, or replacement, cost of nuclear fuel (in 1994 dollars) was assumed to be 41.7 cents per million British Thermal Unit (Btu). The medium escalation forecast was assumed to be 2.5 %, the low was projected at 2.0%, with a high escalation forecast of 3.5%. The low forecast estimate for nuclear fuel costs in 2001 would be 47.9 cents per million Btu. The actual cost for BFN in 2001 is 47.1 cents per million Btu.

BFN's performance and costs have improved to the point that it is now considered by the Institute of Nuclear Power Operations (INPO) to be among the top performing nuclear plants in the country. It is a Top Quartile performer on Total Production Costs and the INPO Performance Index, and a Top Decile performer on Non-fuel Production Costs, Net Capacity Factor, and Outage Duration.

TVA's load growth since 1994 has exceeded the medium forecast assumed in the IRP. More importantly, a gap between system energy requirements and available generating capacity has occurred as supply side actions implemented by TVA have not performed as expected. For example, the OPA program has added only 1,400 MWs of new capacity to TVA's system versus the 3,000 MWs recommended in *Energy Vision 2020*. Also, there has been no conversion of capacity at Bellefonte that would have supplied additional capacity. Moreover, natural gas prices and the experience of other markets have shown how capacity shortages can impact the cost of power. A more complete discussion of TVA's need for generating capacity can be found in an earlier section.

Comparison With Other Supply Options

In comparison to other power supply options, such as a natural gas-fired combined cycle (NGCC) facility, the cost of BFN is relatively low. A NGCC combined cycle facility operated as a baseload power plant has a capital cost of $550/Kilowatt (kW). With the addition of peaking capacity capabilities, a NGCC facility has a capital cost of $730/kW. The levelized costs of a NGCC plant with peaking capabilities including fuel, fixed and variable O&M, and interest expenses is $51.00/MWh (Reference: Williams Capital Group Equity Research, July 2001). With the economies of a multi-unit site, low capital cost, and low operating cost, the total annual cost of Browns Ferry Unit 1 is expected to be significantly lower with operating and fuel costs at 20% of the level of above referenced NGCC.

While the nuclear option provides lower operating costs relative to the NGCC option, the initial investment in Browns Ferry Unit 1 Restart would cost approximately $1.64 billion in 2002 dollars. In the near term, debt would increase by $1.86 billion in 2007 above a resource plan considering NGCC and market purchases as the principal alternative sources of supply. However, adding more than 1,254 MW net of baseload capacity that operates at or above a 90% capacity would reduce the average cost of power by 0.05 cents/kWh and would ultimately reduce long-term debt. In conclusion, there is now strong support for the lowered expectations of capital cost, improved operating performance, and high demand case that would bolster recovery of BFN Unit 1 as a low cost power supply option.

1.5.2 Tiering from the BFN Environmental Statement

An earlier environmental document was prepared by TVA to evaluate the effects on the environment of construction and operation of BFN. The Atomic Energy Commission (AEC), a former regulatory agency of the Federal government, since superseded by the NRC, participated in the preparation of this three-volume document as a cooperating agency. When the final document was issued in 1972 it was titled as follows: Final Environmental Statement, Browns Ferry Nuclear Plant, Units 1, 2, and 3. The AEC concluded on August 28, 1972, that this Environmental Statement was adequate to support the proposed license to operate the plant. Since this 1972 document is actually what is now commonly designated as an environmental impact statement (EIS) it will be referred to as such throughout this SEIS.

This SEIS will reference (and not repeat) analyses contained in the original EIS wherever possible. However, since methodologies may have changed or additional information may have been obtained over the years, each subject area will be reevaluated in the light of current knowledge and practices. Additional topics will be addressed as appropriate.

1.5.3 Other Relevant NEPA Reviews

1.5.3.1 Complĕted NEPA Actions

1.5.3.1.1 Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG-1437

Anticipating that it would receive applications for renewal of the operating licenses of a significant portion of existing nuclear power plants, the NRC prepared a *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, (NRC 1996) to examine the possible environmental impacts that could occur as a result of renewing licenses of individual nuclear power plants under 10 CFR 54. The GEIS, to the extent possible, establishes the bounds and significance of these potential impacts. The analyses in the GEIS encompass all operating light-water reactors. For each type of environmental impact, the GEIS establishes generic findings covering as many plants as possible. The GEIS makes maximum use of environmental and safety documentation from original licensing proceedings and information from state and federal regulatory agencies, the nuclear utility industry, the open literature, and professional contacts. The GEIS identifies 92 environmental issues and reaches generic conclusions on environmental impacts for 69 of those issues that apply to all plants or to plants with specific design or site characteristics.

Under the NRC's environmental protection regulations in 10 CFR Part 51, renewal of a nuclear power plant operating license is identified as a major federal action significantly affecting the quality of the human environment, and thus an EIS is required for a plant license renewal review. The EIS requirements for a plant-specific license renewal review are specified in 10 CFR Part 51. Operating licenses may be renewed for up to 20 years beyond the 40-year term of the initial license. License renewal applicants (such as TVA) perform evaluations and assessments of their facility to provide sufficient information for the NRC to determine whether continued operation of the facility during the renewal term will endanger public health and safety or the environment.

The assessment in NRC's GEIS is relevant, and applies to the assessment of impacts of the proposed actions at the BFN. TVA has determined that this GEIS is still reasonably available. Copies can be obtained electronically at NRC's Internet website.

TVA may reference, in whole or in part, applicable material covered in the GEIS, wherever appropriate.

1.5.3.1.2 Highly Enriched Uranium FEIS

In accordance with TVA procedures implementing NEPA and consistent with 40 CFR 1506.3, TVA adopted a Final EIS (FEIS) issued by the U. S. Department of Energy (DOE), Office of Fissile Materials Disposition, in June 1996. This FEIS is titled "Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement." Notice of the availability of the FEIS was published by the EPA in the *Federal Register* on June 28, 1996. A separate DOE Notice of Availability, summarizing the Highly Enriched Uranium Final EIS appeared in the *Federal Register* that same day. TVA determined that the FEIS meets the standards for an adequate FEIS. TVA's Notice of adoption was published in the *Federal Register* on February 14, 2001. A Record of Decision (TVA, 2001c) was issued for the project in November 2001.

The FEIS assessed the environmental impacts that may result from the disposition of U. S. origin weapons-usable highly enriched uranium (HEU) that was or may be declared surplus to national defense or defense-related program needs. In addition to the No Action Alternative, this EIS assessed four alternatives that would aid U. S. non-proliferation policies. These alternatives would eliminate the weapons usability of HEU by blending it down with natural uranium, low enriched uranium (LEU) or depleted uranium to create LEU to be used either as commercial reactor fuel feedstock or disposed of as low-level radioactive waste. The EIS assessed the disposition of approximately 200 metric tons of surplus HEU.

The potential blending sites considered in the EIS were: DOE's Y-12 Plant at Oak Ridge, Tennessee; DOE's Savannah River Site (SRS) in Aiken, South Carolina; Babcock and Wilcox Naval Nuclear Fuel Division Facility in Lynchburg, Virginia; and the Nuclear Fuel Services Fuel Fabrication Plant in Erwin, Tennessee. Several domestic commercial nuclear fuel fabrication plants, including Siemens Nuclear Power's plant in Richland, Washington, were identified as potential destinations for the LEU produced. Evaluations of impacts at the potential blending sites on site infrastructure, water resources, air quality, noise, socioeconomic resources, waste management, public and occupational health and environmental justice were included in the EIS. The impact of intersite transportation of nuclear and hazardous materials was also assessed. The preferred alternative was blending down as much of the HEU to LEU as possible while gradually selling the commercially usable LEU for use as reactor fuel. DOE plans to continue the activity over an approximately 15- to 20-year period.

TVA has now entered into contracts with Framatome-Cogema and Siemens for fuel blending and fabrication services, and has executed an Interagency Agreement with the DOE to obtain approximately 33 metric tons of HEU. These 33 metric tons of HEU are a portion of the 200 metric tons identified in the DOE EIS. The HEU for eventual use as blended down LEU fuel in BFN would originate from DOE's Y-12 Plant at Oak Ridge, Tennessee and the Savannah River Site in Aiken, South Carolina. Blending down and processing of the HEU to LEU would occur at the Nuclear Fuel Services (NFS) facility in Erwin, Tennessee, and at DOE's SRS in Aiken, South Carolina. Commercial fuel fabrication would occur at Siemens Power Corporation (SPC) in Richland, Washington.

The first use of HEU in BFN reload fuel is scheduled for the spring of 2005, which is the first of 14 reload fuel batches. For Units 2 and 3, each refueling every other year, the last fuel reload from the 33 metric tons of HEU would occur in 2018, unless additional HEU stocks are dispositioned at BFN. Recovery and restart of Unit 1 could result in earlier consumption of this material.

Facility construction and uranium processing services at NFS would extend over a period of 2002 through 2007. The work would be licensed and regulated by the NRC and the State of Tennessee. Since the work is very similar to the uranium processing work done at NFS since 1958, minimal additional impacts are expected with respect to waste water and air discharges. DOE may potentially surplus additional HEU later that may be processed into commercial reactor fuel for use either by TVA or other utilities.

1.5.3.2 Unit Uprates

EPU will result in approximately 232 MWe of additional electrical output from BFN. An Environmental Assessment has been completed for this proposal (TVA, 2001d). The assessment described the impacts of taking no action (i.e., continuing to operate at the currently licensed level) and undertaking the power uprate. The various alternatives in this SEIS have been modified as appropriate to reflect the higher operating power levels. If Unit 1 is returned to service, it is currently contemplated that it would also be operated at the EPU level. However, the project to uprate Units 2 and 3 is feasible, independent of any future decision TVA may make regarding license renewal for Units 1, 2, and 3, and the recovery and restart of Unit 1.

1.5.3.3 Reservoir Operations Study (ROS)

As mandated by the Congress, TVA manages its integrated system of 49 dams and reservoirs primarily to promote navigation, flood control, and consistent with these purposes, the generation of electric energy. In addition to these main objectives, TVA operates the reservoir system to provide a host of other benefits, including flows for power plant cooling water. Most of TVA's eleven coal-fired plants and three nuclear plants, depend upon these flows in order to operate efficiently.

The purpose of the ROS is to determine if changes in TVA's reservoir operating policies would produce greater overall public value. On February 25, 2002, TVA issued a Notice of Intent to prepare a programmatic environmental impact statement (EIS). Alternatives will address TVA's major reservoir operating objectives of navigation, flood risk reduction, and power production, as well as water quality, water supply, recreation and economic development. TVA is presently in the scoping phase for that study.

1.6 Purpose of the Proposed Action

The purpose of the proposed action (extending unit operation and possibly recovering Unit 1) is to continue to make maximum use of existing power production facilities at the BFN site into the foreseeable future and meeting growing demands on the TVA system in a cost effective and environmentally-sound manner. Obtaining license extensions for BFN Units 2 and 3 would allow the plant to continue to generate electric power for an additional 20 years beyond the expiration dates of the current operating licenses (i.e., 2014 to 2034 for Unit 2, and 2016 to 2036 for Unit 3). Similarly, recovering and restarting Unit 1, which has been in a non-operational status since 1985, with an extended operating license could also significantly increase the electric power production of the BFN during the 20-year renewed license period (2013 - 2033).

1.7 Need for the Proposed Action

Continued operation of the BFN 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 in TVA's *Energy Vision 2020*, released on December 21, 1995.

Energy Vision 2020 anticipated that existing TVA plants will continue to be the backbone of TVA's power supply in the future (*Energy Vision 2020,* p. 7.1). Continued energy generation from BFN is a major component of TVA's generating assets, representing 8% of generating capacity and about 13% of annual energy generation in FY2000. 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.

In *Energy Vision 2020,* 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 (USDOE, 2000). This year's report shows expected energy demand growing at over 2% annually from 2001 through 2008. The net capacity resources needed to meet the growth in demand increases by over 8,000 MWs between 2000 and 2008 (See line item 13 on Table Item 2.1, "Projected Capacity and Demand – Summer," of the EIA-411 report). This trend continues today in the TVA control area. 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.

The short-term action plan of *Energy Vision 2020* identified a need for 3,500 MWs of baseload and peaking additions through the year 2002. Since *Energy Vision 2020* was completed in 1995, TVA has continued to evaluate and select the best energy resource alternatives from its IRP portfolio based on the latest proposals and TVA's forecast of power needs. The total system generation capacity has been increased with the successful completion of Watts Bar Nuclear Plant Unit 1 and the return to service of BFN Units 2 and 3. All three units have operated above expectations and have proven to be very reliable.

TVA projects have been scheduled to maintain, restore, and/or increase net dependable capacities for TVA's combustion turbines, fossil plants, hydroelectric plants, and pumped storage units. OPAs have been entered into 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 is scheduled to begin commercial baseload operation in May 2002. TVA's natural gas-fired combustion turbine plant at the Lagoon Creek Site near Brownsville, Tennessee, began operation in June 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.

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2.0 ALTERNATIVES INCLUDING THE PROPOSED ACTION

The objective of this Supplemental Environmental Impact Statement (SEIS) is to provide information to the public and Tennessee Valley Authority (TVA) decision makers describing the environmental consequences of providing future baseload generation capacity by maximizing utilization of the existing power production facilities at the Browns Ferry Nuclear Plant (BFN) site. This would involve license renewal and extended operation of the units. Reasonable alternatives and related actions are also addressed. Reasonable alternatives range from ceasing operation altogether at BFN (when the current operating licenses expire) to extending operation of all three units. The decision as to how much generating capacity would be continued will take into account environmental considerations together with economic and technical aspects of the project. This decision would be documented in a Record of Decision (ROD) which would be prepared after the issuance of the Final Supplemental Environmental Impact Statement (FSEIS) and TVA's Board of Directors makes the decision.

The current (2001) facilities at BFN are shown in Figures 2.0-1 and 2.0-2. Figure 2.0-1 is a plan view of the site, and Figure 2.0-2 is a close-up view of the central power plant. These current facilities form the reference point or "baseline" from which the alternatives in this SEIS may be described as potential changes.

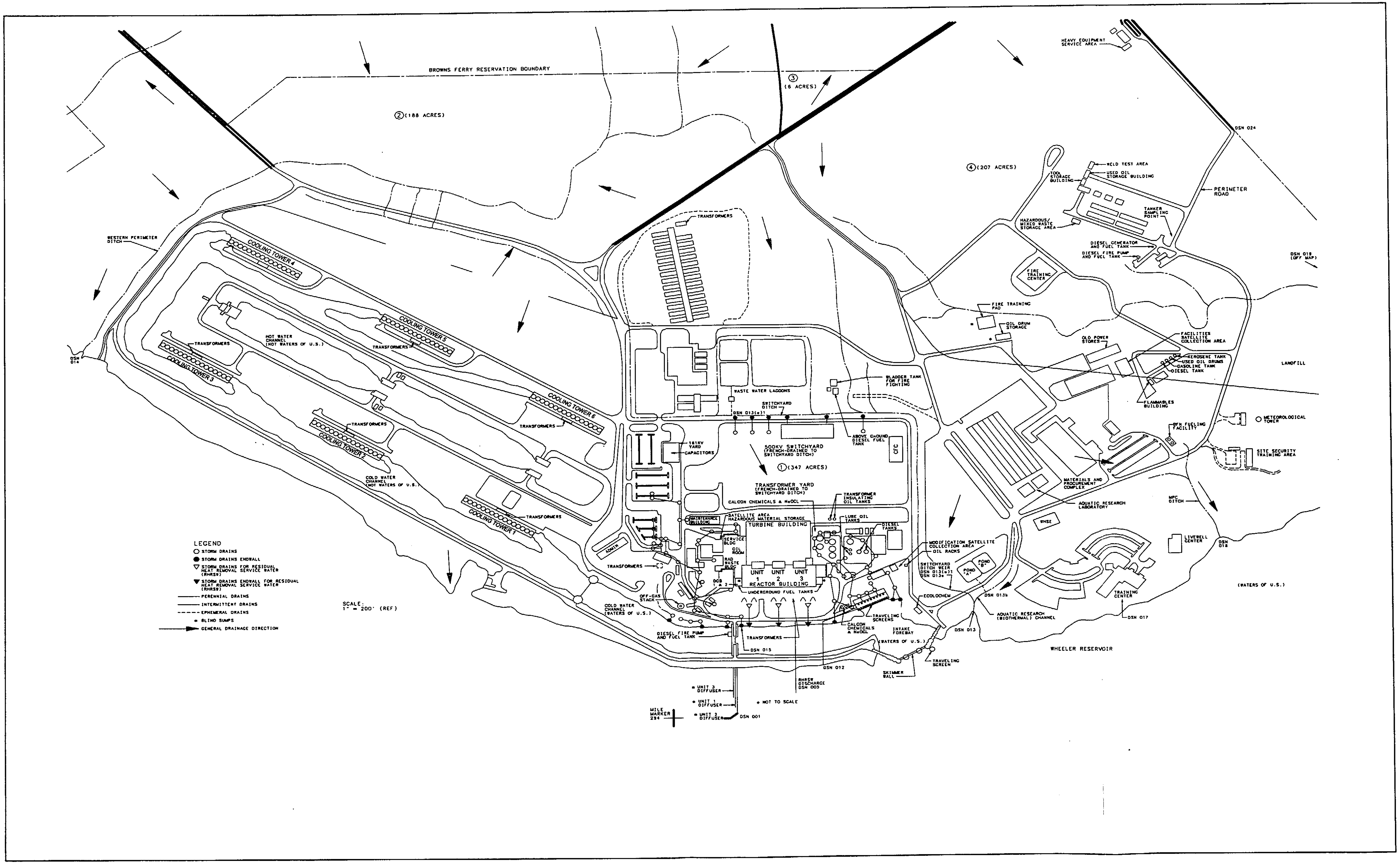
The No Action Alternative is described in Section 2.1. The processes that were followed to identify and screen the other alternatives evaluated in this SEIS are presented in Section 2.2. Additional actions that are common to all action alternatives are defined in Section 2.3. The Proposed Action Alternatives are described in Section 2.4 and summarized in Section 2.5. The environmental consequences of the No Action and Action Alternatives are compared in Section 2.6. A comparison of the costs is presented in Section 2.7, and TVA's Preferred Alternative is described in Section 2.8. References for this chapter are listed in Section 2.9.

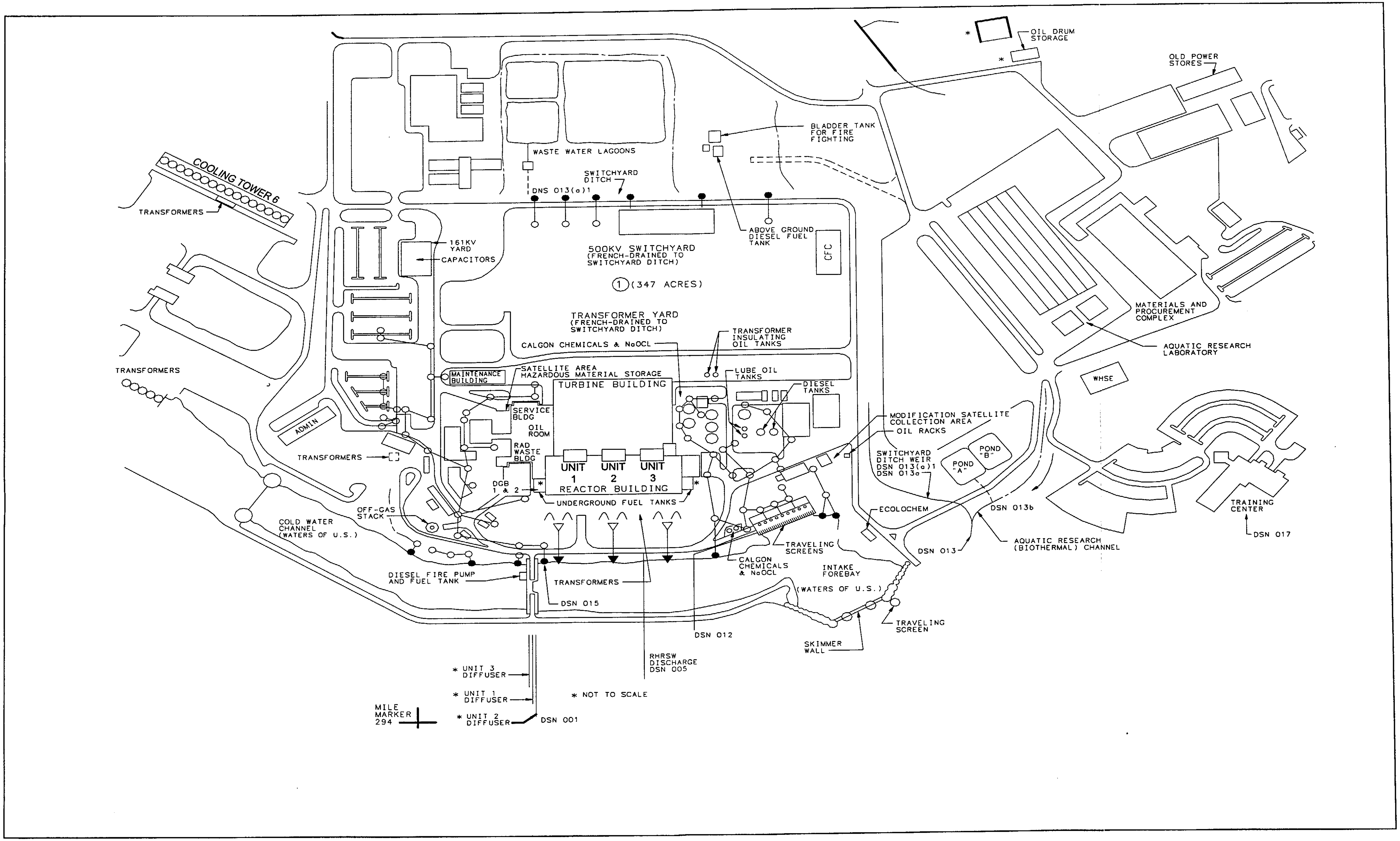
2.1 Description of the No Action Alternative

The No Action Alternative would result from a decision to not extend operation 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 consideration of 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.

Operation of Units 2 and 3 during their existing license terms is addressed in the plant's original EIS from which this EIS tiers: *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. The other relevant NEPA reviews, identified in Section 1.5.3 of this SEIS, identify the changes that have occurred in unit operation since the original EIS and the environmental impacts associated with those changes. The discussion of the Action Alternatives in this SEIS describes current unit operations.

Figure 2.0-1
Current Facilities at BFN




OIL DRUM STORAGE
OLD POWER STORES
BLADDER TANK FOR FIRE FIGHTING
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SWITCHYARD DITCH
DNS 013(a)1
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DIESEL TANKS
WHSE
ADMIN
SERVICE BLDG
OIL ROOM
RAD WASTE BLDG
MODIFICATION SATELLITE COLLECTION AREA
OIL RACKS
SWITCHYARD DITCH WEIR DSN 013(a)1 DSN 013a
POND "A"
POND "B"
TRANSFORMERS
UNIT 1
UNIT 2
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REACTOR BUILDING
DGB 1 & 2
UNDERGROUND FUEL TANKS
OFF-GAS STACK
ECOLOCHEM
DSN 013b
TRAINING CENTER
DSN 017
COLD WATER CHANNEL (WATERS OF U.S.)
AQUATIC RESEARCH (BIOTHERMAL) CHANNEL
DSN 013
TRAVELING SCREENS
CALGON CHEMICALS & NaOCL
INTAKE FOREBAY
DIESEL FIRE PUMP AND FUEL TANK
TRANSFORMERS
(WATERS OF U.S.)
DSN 015
TRAVELING SCREEN
DSN 012
SKIMMER WALL
RHRSW DISCHARGE DSN 005
* UNIT 3 DIFFUSER
* UNIT 1 DIFFUSER
* NOT TO SCALE
MILE MARKER 294
* UNIT 2 DIFFUSER
DSN 001

In the event that TVA chooses to not seek an extension of the unit operating licenses or to restart 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 in TVA's integrated resource plan (IRP) portfolio of options. Those options and their associated environmental impacts have been generally described in the *Energy Vision 2020* EIS. Prior to proposing and implementing one of those options, additional environmental analyses would be conducted. Although some of these generating options may be capable of providing the baseload generation that would result from the Action Alternatives described in this SEIS, they would not maximize the use of existing BFN assets. As addressed in *Energy Vision 2020*, most of these IRP options would likely result in more significant environmental impacts than the BFN Action Alternatives, especially those involving construction of new fossil-fuel fired generating facilities on greenfield sites. Additionally, as discussed in this SEIS, the Action Alternatives here, particularly Alternative 1, are considered more cost effective than other IRP options. It is for these reasons that the No Action Alternative has not been identified as preferable by TVA.

2.2 Screening of Action Alternatives

Except for maximizing use of BFN's assets, feasible Action Alternatives for meeting TVA's purpose and need include the entire portfolio of actions recommended in *Energy Vision 2020*. These actions include, as detailed in Section 1.4.2, 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 *Energy Vision 2020* or in other environmental reviews completed prior to decisions to implement them.

Chapter 1 pointed out that some of these alternatives did not deliver the power promised, and that 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 options purchase agreements (which have yielded mixed performance to date) and spot market purchases during periods of high electricity use could lead to failure to meet demands. 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. 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 generation (combustion turbines) typically is reserved for use during peak periods). (Natural-gas fired combined cycle plants as they increase in number may change this generation profile over time.) Coal-fired and, to a lesser extent, natural-gas fired generation has more significant environmental impacts than nuclear generation (for example: air quality). The environmental impacts associated with spot market purchases have been addressed in *Energy Vision 2020*.

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 for this SEIS.

Continuing operation of BFN, as proposed in this SEIS, would further enhance the flexibility that is an inherent part of the Energy Vision IRP portfolio, and would provide TVA with an important and powerful tool for minimizing future risks, managing costs, and ensuring the delivery of low cost reliable power to its customers for many years to come.

2.2.1 Proposed Action Alternatives for this SEIS

Two alternatives are fully consistent with the stated project objectives and the updated cost comparison of alternatives previously evaluated in *Energy Vision 2020.*

ALTERNATIVE 1 – RELICENSING OF UNITS 2 AND 3

Alternative 1 is to continue to operate Units 2 and 3 for an additional 20-year period beyond the expiration dates of the current licenses. The current operating license expiration dates are 2014 for Unit 2 and 2016 for Unit 3. Units 2 and 3 would be operated at up to the Extended Power Uprate (EPU) level of 120% of their originally licensed power levels. The current Unit 1 operating license expires in 2013. If this occurs, Unit 1 would probably either have its license renewed (with the condition that any future proposal to restart the unit would be approved by the Nuclear Regulatory Commission) or the licenses for Units 2 and 3 would have to be modified to include interconnecting Unit 1 equipment as necessary. Unit 1 would continue in its current non-operable status until either the renewed license expires or a subsequent decision is made to recover and restart the unit.

The reason for the above licensing options to accommodate a non-operating Unit 1 is that a decision to not renew the operating license for Unit 1 would require it to enter a 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. The facilities and components affected by implementation of Alternative 1 are shown in Figures 2.2-1 and 2.2-2; these are the same as Figures 2.0-1 and 2.0-2 except that they include an additional cooling tower, the proposed dry cask storage facility, and a proposed modifications/fabrication building.

Figure 2.2-1
Facilities Associated with Alternative 1

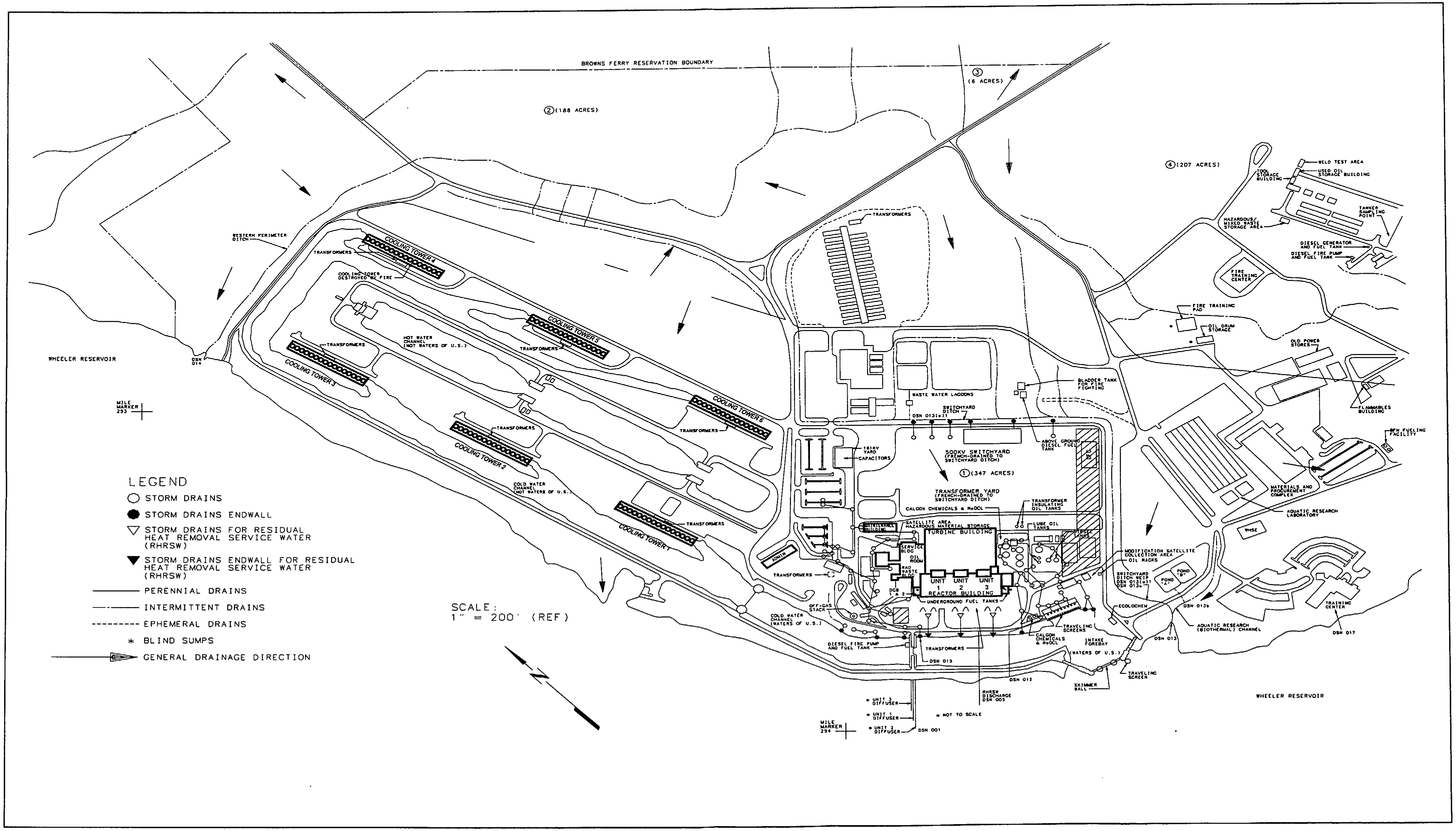
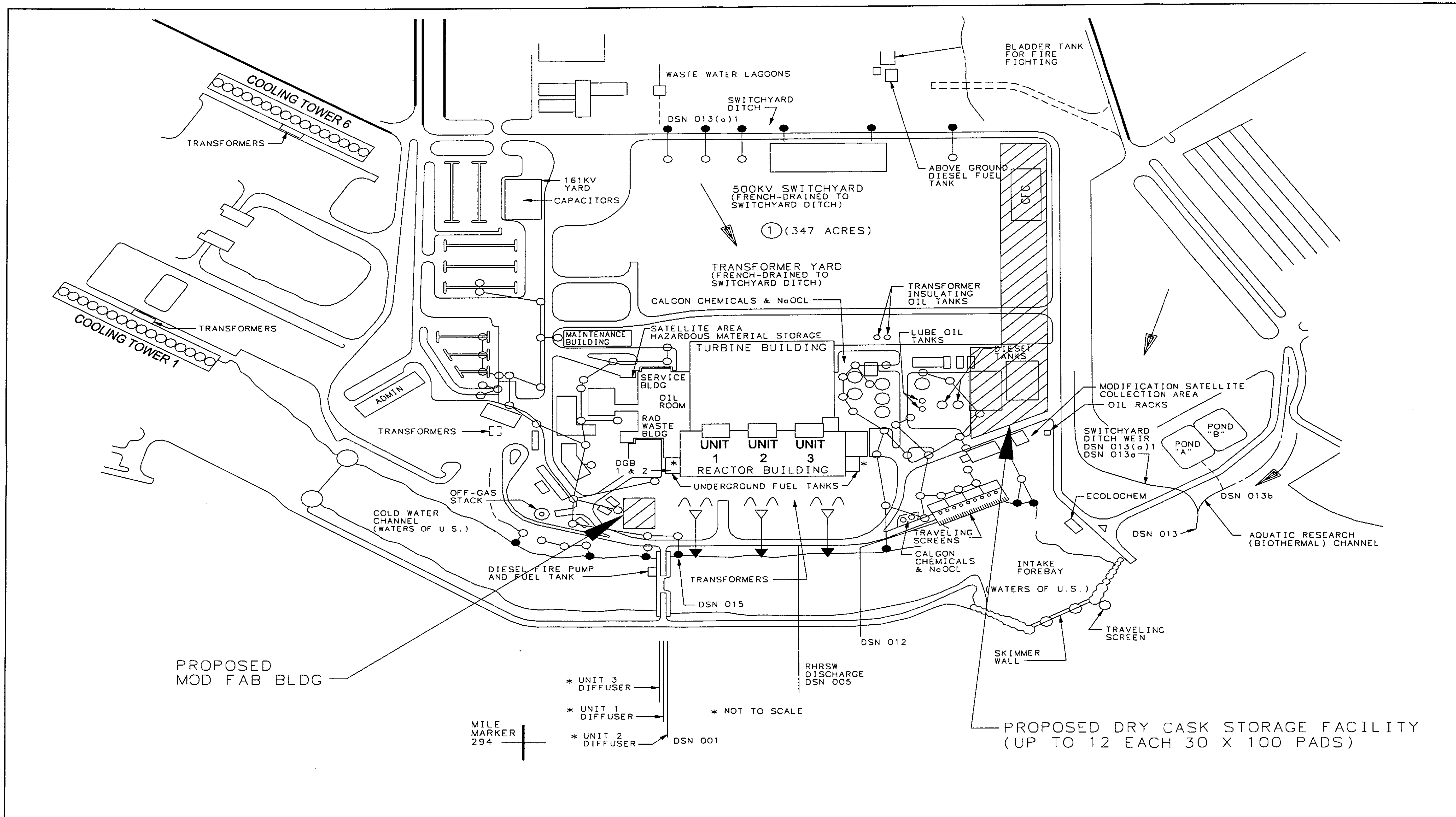


Figure 2.2-2
Details Associated with Alternative 1



ALTERNATIVE 2 - REFURBISHMENT AND RESTART OF UNIT 1 WITH RELICENSING OF ALL UNITS

Alternative 2 is to add refurbishment and restart of Unit 1 to Alternative 1, i.e., extended operation of all three BFN units. Unit 1 would be restarted at the EPU level. Although renewal of the current Unit 1 operating license would allow an additional 20 years of operation after the current license expires in 2013, restart of Unit 1 could occur as early as 2007, if the decision is made to restart the unit and recovery efforts were initiated soon after this SEIS is completed. The central facilities and components (except cooling towers) affected by implementation of Alternative 2 are shown in Figure 2.2-3.

Table 2.2.1-1 below quantifies the additional power that would be generated by each unit as a function of the Extended Power Uprate (EPU) modifications and the alternatives described in this FSEIS.

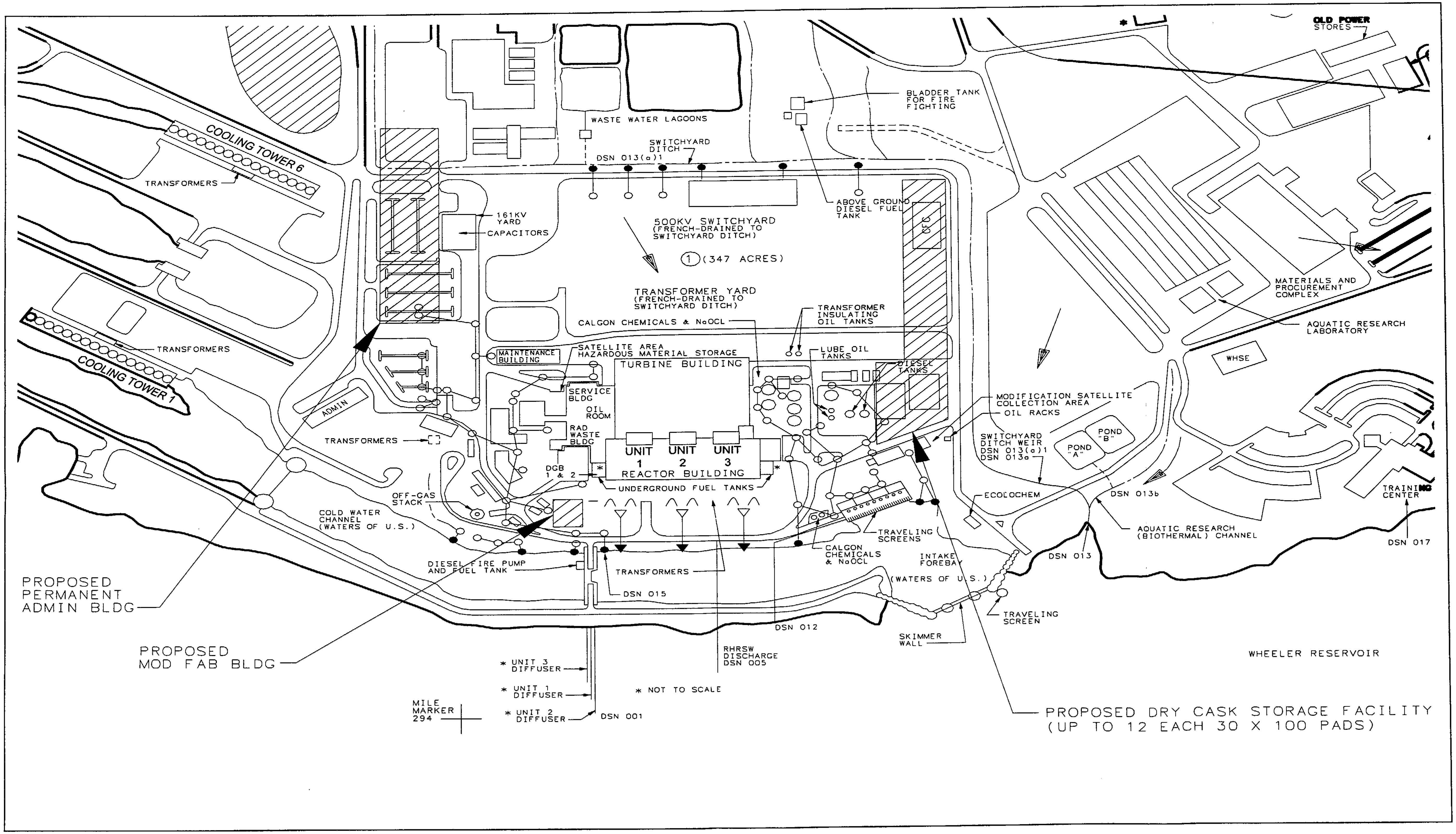
Table 2.2.1-1 Summary of Power Levels (in net megawatts electric)

UNIT NOS.	CURRENT (prior to EPU)	AFTER EPU (Completion Date)	ALTERNATIVE 1 (begins 2013)	ALTERNATIVE 2 (begins 2013)
Unit 1	[not operable]	[not operable]	[not operable]	1280
Unit 2	1164	1280 (April '05)	1280	1280
Unit 3	1164	1280 (April '04)	1280	1280
Total	2328	2560	2560	3840
Increase above current	(N/A)	232	232	1512

2.2.2 Associated Condenser Circulating Water Flow Rates

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, 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.


OLD POWER STORES
COOLING TOWER 6
TRANSFORMERS
COOLING TOWER 1
TRANSFORMERS
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BLADDER TANK FOR FIRE FIGHTING
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161KV YARD
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500KV SWITCHYARD (FRENCH-DRAINED TO SWITCHYARD DITCH)
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CALGON CHEMICALS & NaOCL
INTAKE FOREBAY
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DIESEL FIRE PUMP AND FUEL TANK
TRANSFORMERS
(WATERS OF U.S.)
PROPOSED PERMANENT ADMIN BLDG
DSN 015
TRAVELING SCREEN
DSN 012
SKIMMER WALL
PROPOSED MOD FAB BLDG
RHRSW DISCHARGE DSN 005
WHEELER RESERVOIR
* UNIT 3 DIFFUSER
* UNIT 1 DIFFUSER
* NOT TO SCALE
MILE MARKER 294
* UNIT 2 DIFFUSER
DSN 001
PROPOSED DRY CASK STORAGE FACILITY (UP TO 12 EACH 30 X 100 PADS)

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 is 2,312.1 MGD (approximately 800,000 GPM per unit). With the return of Unit 1 (which will also be re-tubed), the total intake flow would then become approximately 3,468 MGD, which represents an increase over the previous high reported number (2,855) of 21.5%. However, based on extensive recent experience in measuring flows and observing changes due to various modifications, maintenance, and measurement methods and techniques, TVA believes that only about 10% of this represents a real increase in flow; the remainder is due to either changes in flow measuring methods and techniques or differences in how the original values were reported.

2.2.3 Associated Cooling Tower Impacts and Alternatives

ALTERNATIVE 1: COOLING TOWER IMPACTS

During peak hot weather periods, full-load operation of BFN Units 2 and 3 generally requires all five of the mechanical draft cooling towers to be running in order to meet condenser circulating (cooling) water maximum allowable temperature requirements for discharge to the river. Since there is currently little spare cooling capacity to accommodate any additional heat load that would be associated with the power uprate, TVA plans to erect a sixth mechanical draft cooling tower as part of the BFN EPU project (See Figures 2.2-4 and 2.2-5). This was addressed in the Environmental Assessment that TVA prepared for the EPU proposal. The design would most likely be similar to the recently replaced cooling tower number 3 and would be located on the site of the old cooling tower number 4 which was destroyed by fire in 1986 and never replaced (TVA, 2001).

Figure 2.2-4 Location of Sixth Cooling Tower for Alternative 1

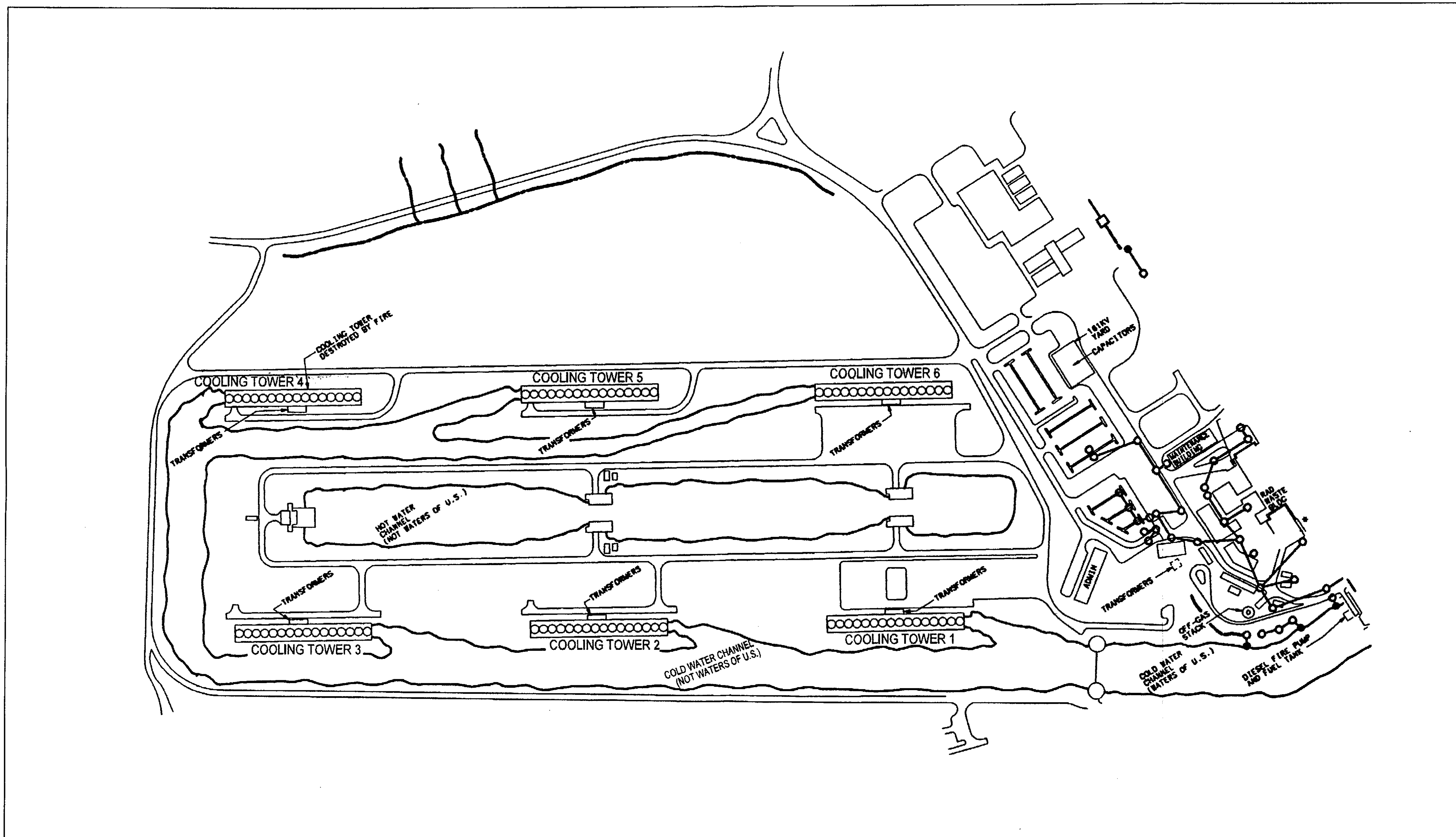
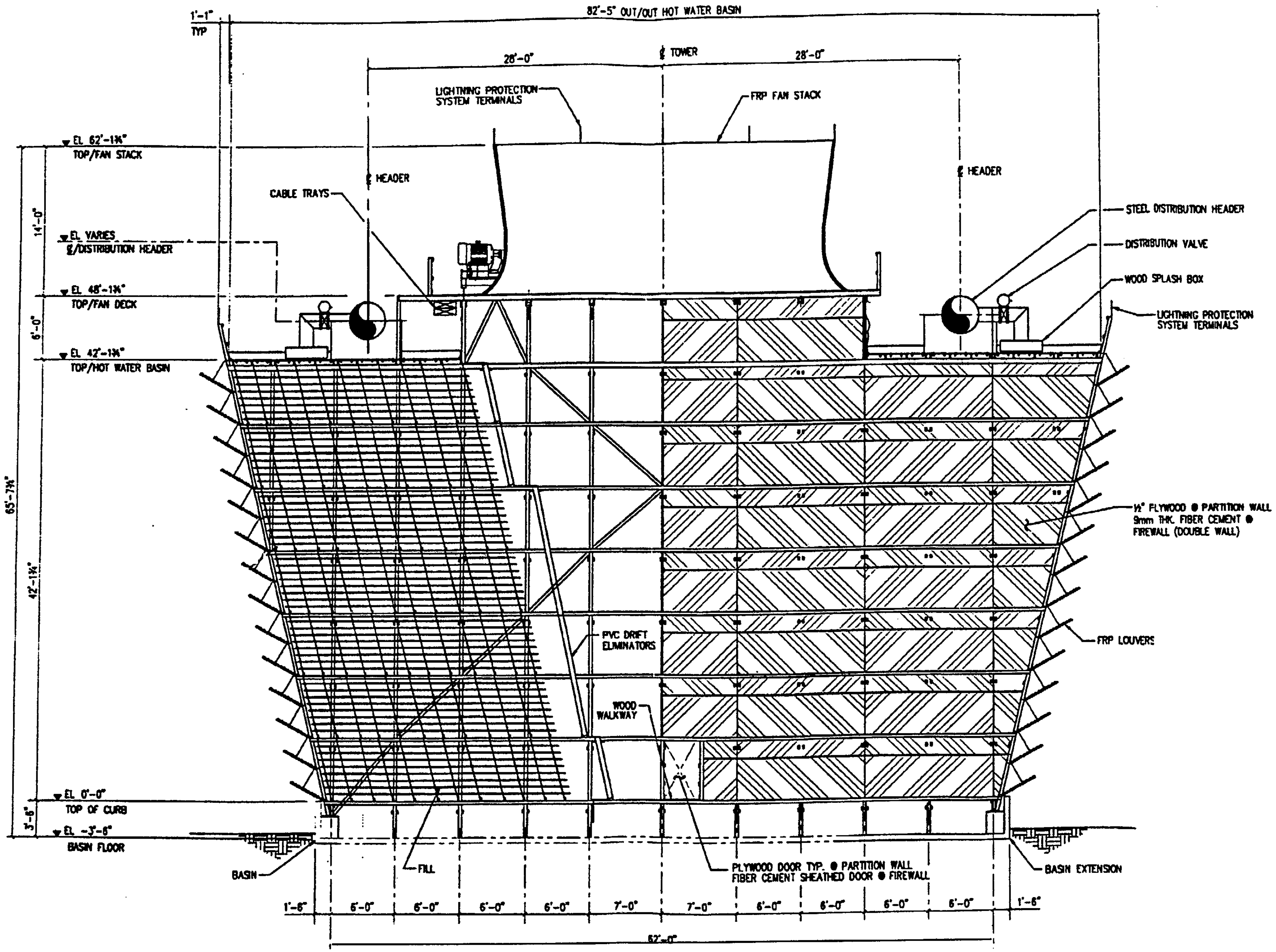


Figure 2.2-5 Diagram of Typical Mechanical Draft Cooling Tower



ALTERNATIVE 2: COOLING TOWER IMPACTS

Restarting Unit 1 would require additional cooling tower capacity beyond that currently envisioned for Units 2 and 3 with EPU. The additional cooling capacity required could be obtained by a combination of constructing new cooling towers, refurbishing the old original cooling towers, or even dismantling and replacing one or more of the original cooling towers with an updated and more efficient design. The environmental impacts of refurbishing or replacing the original towers are minimal. Installation of additional cooling towers could involve movement of a soil berm created during construction of the existing towers. This 70-foot high berm, located northeast of the tower complex, is the preferred location for some cooling tower configurations. The following sub-alternatives are evaluated in the SEIS to bound the additional cooling tower capacity that could be required.

ALTERNATIVE 2A: ADDITIONAL LINEAR MECHANICAL DRAFT COOLING TOWERS OPTION

Alternative 2A is to add two new linear mechanical draft cooling towers (see Figure 2.2-6 for location) which are very nearly identical to the recently replaced cooling tower 3. The two new towers would be in addition to the six that would be functional for operation of Units 2 and 3 at EPU, making a total of eight very similar cooling towers. Installing these new towers would require removal of most of a large existing hill or mound created by excavation of drainage canals associated with construction of the original six cooling towers. As shown in Figure 2.2-7, the displaced spoils would be deposited in three currently vacant regions of the site. The remainder of the hill or mound adjacent to the new towers would be reduced in height to ensure that wind from any direction is unimpeded in flowing across any of the towers, old or new. This will also overcome the shielding effect of the existing hill that contributes to interference between towers (i.e., effluent from one tower being entrained into the intake of another tower).

ALTERNATIVE 2B: ADDITIONAL ROUND MECHANICAL DRAFT OR MODIFIED HYPERBOLIC COOLING TOWER OPTION

Alternative 2B is similar to Alternative 2A, except that the two new cooling towers would be some type other than the current linear mechanical draft cooling towers, such as round mechanical draft or modified hyperbolic design. Approximately the same volume of spoils would be displaced as for Alternative 2A, and the footprint of the new towers would be located similarly to Alternative 2A, but would be somewhat different in size and shape (see Figure 2.2-8). Other characteristics would be different, such as noise and effluent appearance. The type of cooling tower chosen is primarily an economic decision, into which must be factored initial capital costs, operating and maintenance expenses, and the percentage of time the tower would be operating during power usage peaks and off-peak periods.

Figure 2.2-6 Location of Cooling Towers for Alternative 2A

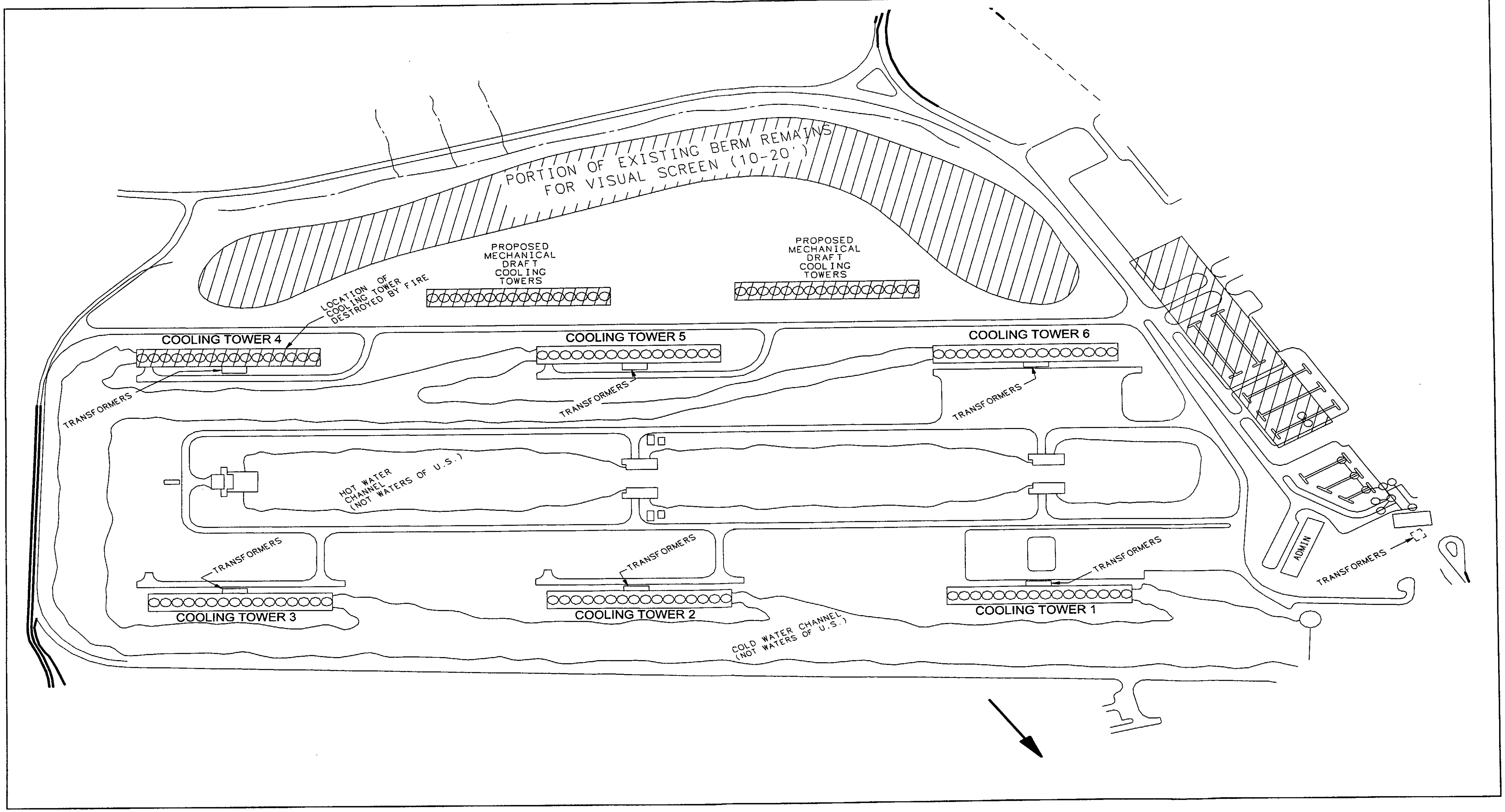


Figure 2.2-7
Location of Areas for Spoils Deposition

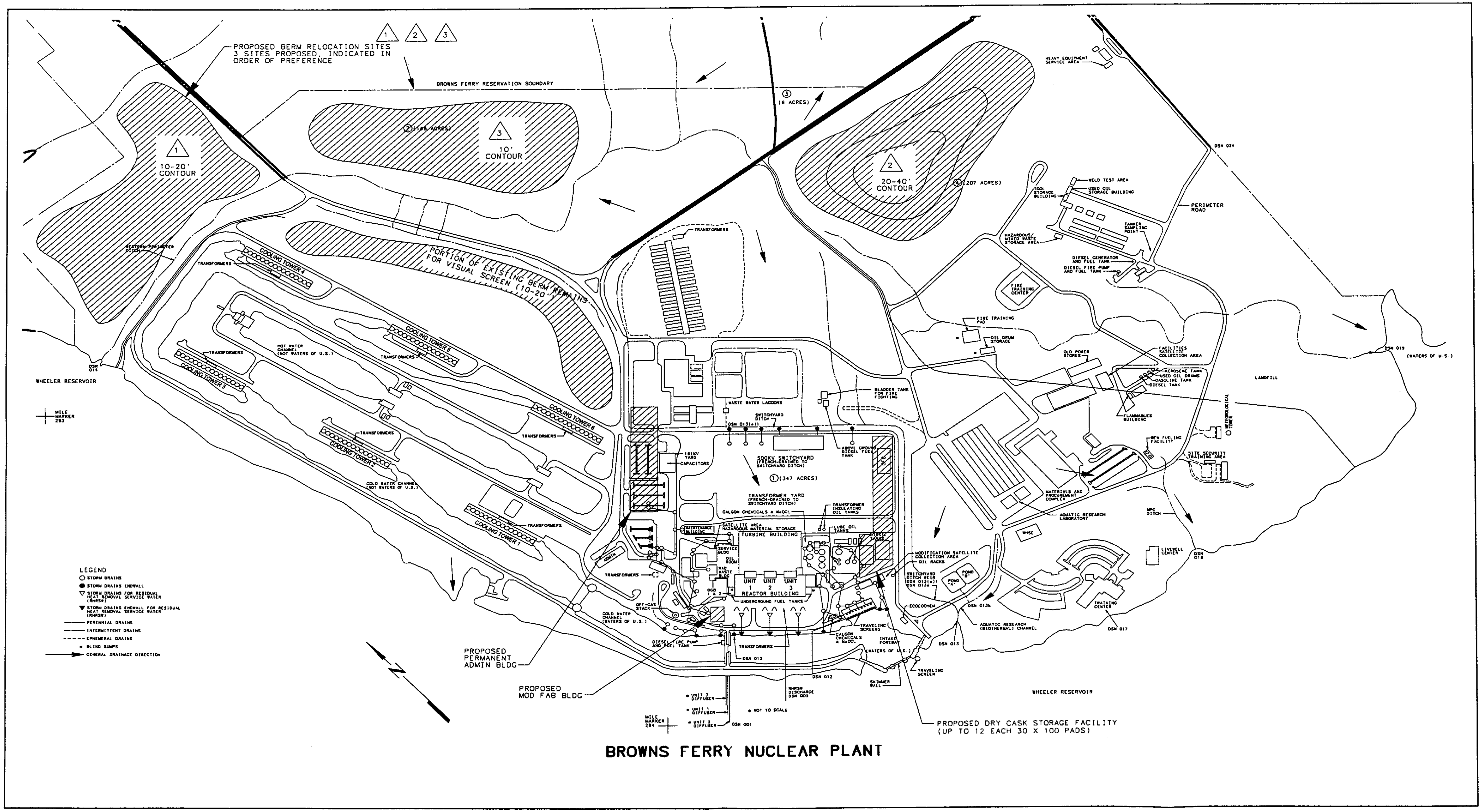
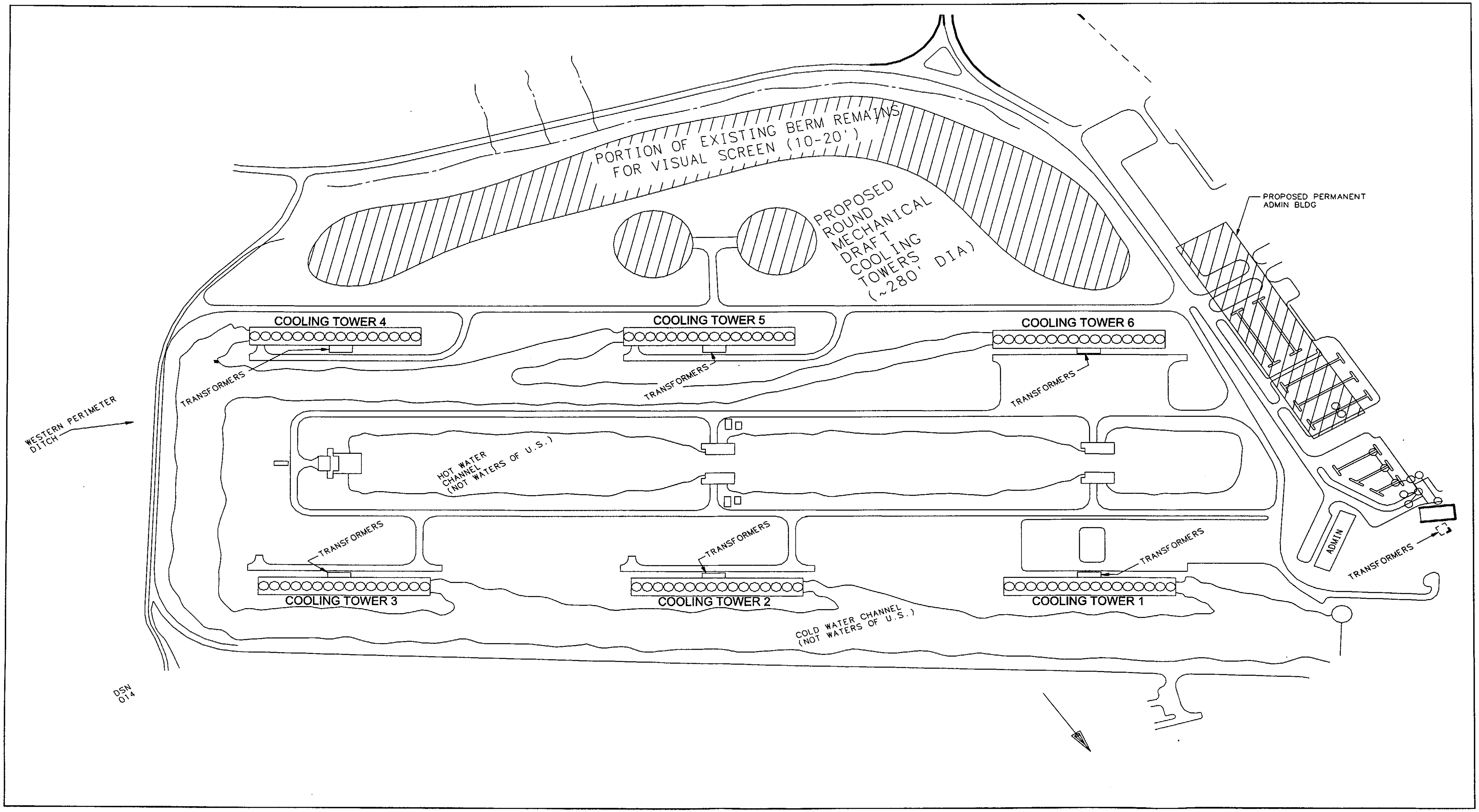


Figure 2.2-8
Location of Cooling Towers for Alternative 2B



ALTERNATIVE 2C: ENLARGED LINEAR MECHANICAL DRAFT COOLING TOWERS OPTION

Alternative 2C is to construct 5 new linear mechanical draft cooling towers and to increase the size of the existing Balcke-Durr cooling tower (tower 3) by 25%. This would be accomplished by demolishing the four existing Ecodyne towers (towers 1, 2, 5, and 6) and replacing them with new and larger linear mechanical draft cooling towers in their approximate locations and in the currently vacant cooling tower location (tower 4), and also by adding cells to cooling tower 3. This alternative would not require removal of a significant portion of the spoils hill adjacent to the cooling towers, but could involve lowering the height of the hill by several feet to decrease wind resistance. Lowering the hill height could be accomplished by recontouring or spoils removal or a combination of the two. Figure 2.2-9 shows the approximate location and footprint of the enlarged cooling towers for Alternative 2C.

ALTERNATIVE 2D: RESTORATION OF SINGLE LINEAR MECHANICAL DRAFT COOLING TOWER

Alternative 2D is to construct a single 20-cell linear mechanical draft cooling tower in the currently vacant position (tower 4) where a tower that was destroyed by an accidental fire in 1986 has never been replaced. This addition of a sixth cooling tower differs from that proposed for Alternative 1 (see above) in that the tower would be somewhat larger than the recently replaced 16-cell linear mechanical draft cooling tower 3. Other characteristics such as general size, appearance, operating sound and emissions, etc., are very similar to or proportionately larger than those of cooling tower 3. This alternative would not require removal of any of the spoils hill adjacent to the cooling towers, but could involve lowering the height of the hill by several feet to decrease wind resistance. Lowering the hill height could be accomplished by recontouring or spoils removal or a combination of the two. Figure 2.2-10 shows the approximate location and footprint of the enlarged cooling tower for Alternative 2D.

Since Alternative 2D does not add as much heat removal capacity as Alternatives 2A, 2B or 2C, the probability of having to de-rate the operating units to meet NPDES discharge temperature limits would increase during summer periods of unusually hot weather.

Figure 2.2-9
Location of Cooling Towers for Alternative 2C

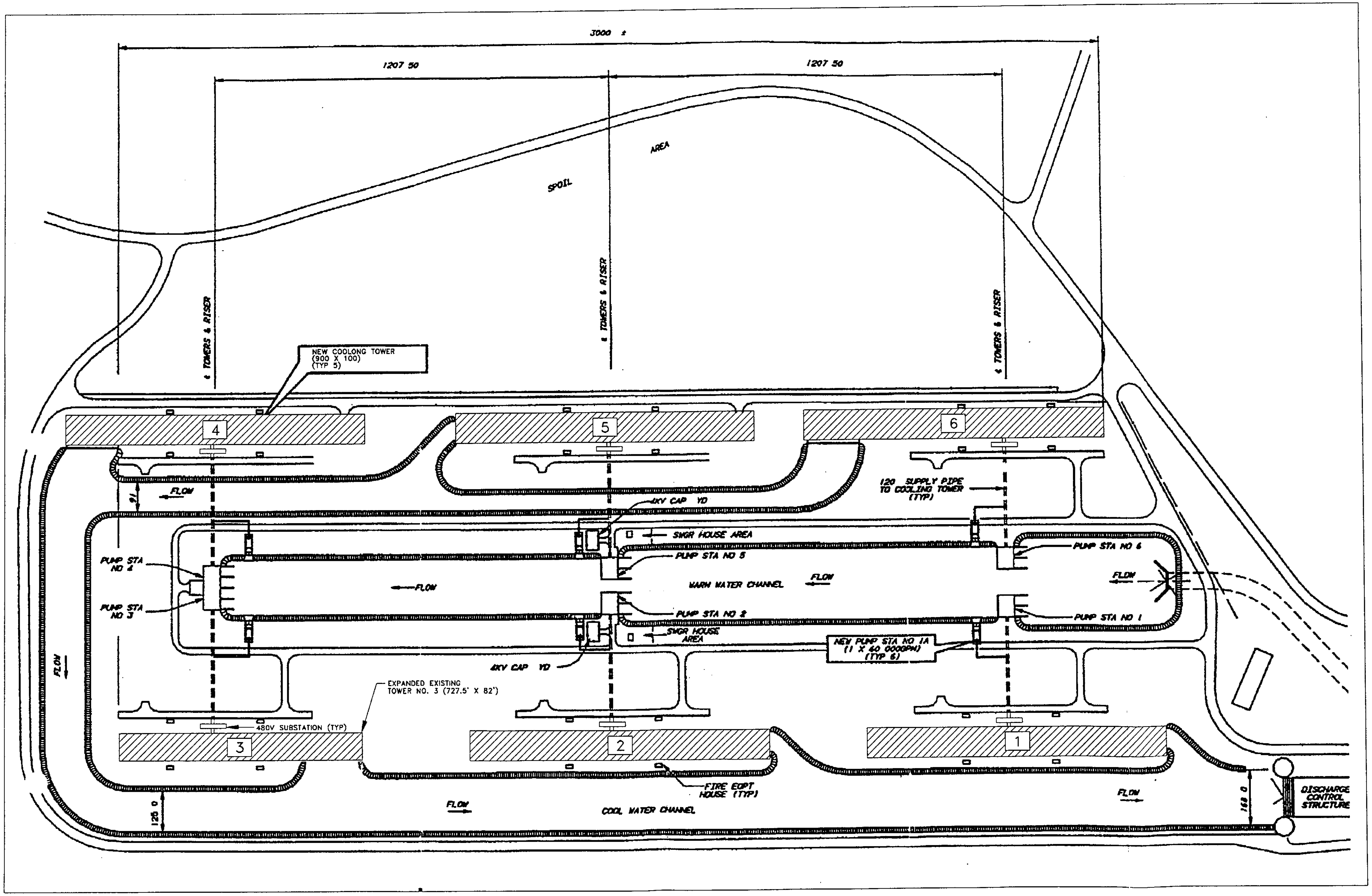
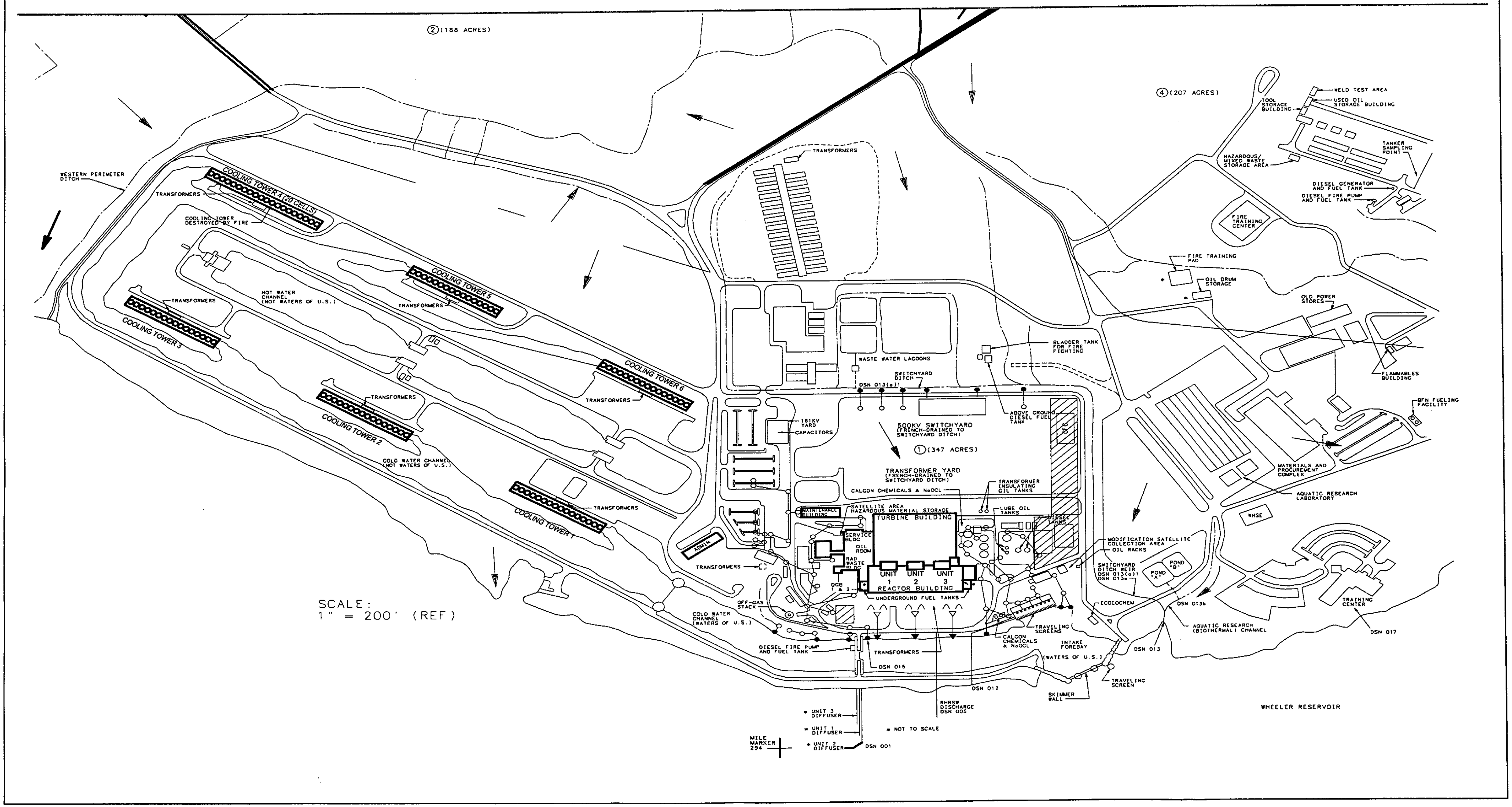


Figure 2.2-10
Location of Cooling Towers for Alternative 2D



ALL ALTERNATIVES: MINIMIZATION OF COOLING TOWER IMPACTS

The primary purpose of cooling towers is to allow BFN to operate during periods of high river temperature in compliance with the NPDES permit limitations which are designed to ensure the protection of a balanced, indigenous population of shellfish, fish and wildlife in Wheeler Reservoir. The cooling towers accomplish this by limiting the temperature of the cooling water returned to the reservoir. In accordance with provisions of section 316 of the Clean Water Act (CWA), BFN currently operates under a permitted thermal limitation set by the ADEM in 1984 which allows thermal discharges up to 90°F (24-hour average), 93°F (1-hour average) with a maximum temperature rise of 10°F. A three-phase biological monitoring program conducted from 1985-1997 evaluated the effect of the thermal discharge on selected species and total standing stocks of fish in Wheeler Reservoir. Baxter and Buchanan (1998) reported results of this work to the State of Alabama as a part of the NPDES permit renewal application, permit number AL0022080, submitted in September 1999. Both the final report and additional analyses submitted with the permit application and request for renewal of the existing permit concluded that the operations of BFN under the current thermal limitations has not had a significant impact on the aquatic community of Wheeler Reservoir, or the specific aquatic species studied.

In addition to BFN specific studies, monitoring initiated in Wheeler Reservoir in 1992 as part of TVA's Vital Signs (VS) Monitoring Program (Dycus and Meinert, 1993) provided an additional measure of quality and health of the ecological community in the vicinity of BFN. The status of existing aquatic communities in Wheeler Reservoir is biennially assessed utilizing three indices, the Reservoir Fish Assemblage Index (RFAI), the Benthic Index of Biotic Integrity (BIBI), and the Sport Fishing Index (SFI). Results since 1992 indicate that the resident ecological community in the vicinity of BFN has been and continues to be of good quality, with no indications of adverse impacts as a result of BFN operation.

For purposes of this SEIS, the cooling tower configurations described above in Alternatives 2A, 2B, and 2C represent the maximum potential change in terms of the number and size of required additional towers. In contrast, Alternative 2D represents the minimum expected additional cooling tower capacity required. The analyses presented in Chapter 4 assume that temperature limits in the current BFN NPDES permit are unchanged and continue to be met for all alternatives via increased cooling tower capacity or de-rating power operation during periods of extreme weather, or both with these alternative configurations.

However, based on ongoing monitoring of the aquatic community in Wheeler Reservoir and hydrothermal characteristics of the reservoir, it may be feasible to provide a reduced amount of additional cooling tower capacity and/or cooling tower operation in an environmentally acceptable manner. The capital and operations & maintenance (O&M) expenses associated with providing additional cooling tower capacity and operation can be very large. If sufficient margin exists in the assimilative capacity of the reservoir to safely discharge a higher level of heat during peak temperature events, opportunities may exist to allow more efficient and cost effective operation of BFN to supply reliable power to TVA customers, while yet effectively protecting aquatic resources. The feasibility of such opportunities requires a detailed evaluation of temperatures, overall water quality, and biological responses in Wheeler Reservoir.

As part of this SEIS, TVA used computational fluid dynamics (CFD) models to assess the potential impact of a reduced amount of additional cooling capacity on water temperatures in the immediate vicinity of BFN. The CFD models were fully three-dimensional and included the full width and depth of the reservoir, the plant intake skimmer wall, and the plant discharge diffusers. The models covered roughly a 3 mile reach of the reservoir, from about 1.5 miles upstream of the plant to 1.5 miles downstream of the plant. The models included steady flow and incorporated the effects of turbulent mixing, reservoir stratification, and fluid buoyancy. The models were calibrated using data from field measurements to allow predictions of water velocity and water temperature throughout the solution domain (TVA, 2002; Alden, 2002).

Two models were used in the CFD evaluations: a "coarse" version with about 270,000 computational nodes, and a "fine" version with about 2 million nodes. The coarse model was used to identify a range of approaches that potentially may safely allow a reduced amount of additional cooling capacity. The fine model was then used to explore a select few of the approaches in detail. The model simulations were performed for a worst case condition derived from water temperature records spanning years 1969 through 2000. The worst case condition contained the highest observed water temperature in the bottom of Wheeler Reservoir immediately upstream of BFN, and included operation of the plant at full power with three units at EPU.

For these conditions and the approaches considered, the CFD evaluations showed that for cooling capacities less than that of Alternative 2D, BFN may not, without other action, be able to satisfy the requirements for instream water temperature specified in the current NPDES permit. These results confirm what TVA predictions show from other models that are used for long-term simulations of the plant. The ramification is that, during occasional peak temperature events in the summer, and for three units at EPU, BFN would likely need to reduce generation to comply with the current NPDES requirements. This is true even for the capacity of the cooling system of Alternative 2D. However, as discussed in section 2.7 *Comparison of Costs Between Alternatives*, evaluation of the projected amounts and levels of de-rate associated with Alternative 2D has shown that this sub-alternative has the highest net present value and monetary internal rate of return when considering initial construction cost, operating power consumption, and the associated de-rates. If the effect of reduced generation creates future problems for operation of the plant, power system, or river system, TVA may need to revisit the balance between the cooling capacity of BFN and any available margin for waste heat in Wheeler Reservoir. In the event that TVA would choose to do so in the future, a proposal to provide additional cooling tower capacity or request a change in the applicable standard would undergo environmental review through both the NEPA and NPDES permitting processes, as appropriate.

2.2.4 Spent Fuel Storage Options

BFN has been producing power, and consequently, spent nuclear fuel for almost three decades. Considering the Department of Energy's (DOE) delay in receiving utility spent fuel and assuming current operating conditions, BFN Unit 3 is projected to require additional spent fuel storage before November 2005. Thus, spent fuel storage expansion is required significantly before license extension or feasible implementation dates for three-unit operation. In addition, the storage expansion technology proposed for BFN is dry storage, which readily accommodates incremental expansion for increased storage requirements. BFN's proposed plans for a dry storage facility include sufficient expansion room to accommodate uncertainty in the DOE schedule for a national repository and additional storage required for license extension and three unit operation.

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. However, the repository is now at least 12 years behind schedule. BFN is currently storing spent fuel in three spent fuel pools which were each 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 projects that BFN must increase spent fuel storage capacity by 2005 to avoid impacting plant availability, regardless of license extension or the operations alternative chosen. TVA would utilize the NRC's General License to store spent fuel at an independent spent fuel storage installation (ISFSI). A General License is an option available to all 10 CFR 50 power licensees to store spent fuel outside of the spent fuel pool at an ISFSI. The General License requires use of a fuel storage system that has been previously approved by NRC as demonstrated by issuance of a Certificate of Compliance in accordance with 10 CFR Part 72, Subpart L.

To accommodate the spent fuel storage expansion, TVA has evaluated alternatives to extend the effective life of the BFN spent fuel pools as well as alternatives for additional spent fuel storage capacity. Alternatives considered to extend pool life were fuel rod consolidation and increasing storage rack capacity. Alternatives evaluated for additional spent fuel storage capacity included dry storage modules, building an additional spent fuel pool, and transshipment of spent fuel to another TVA or private storage facility for temporary storage. None of these alternatives appear to be environmentally advantageous compared to the dry cask storage alternative.

Fuel rod consolidation requires disassembly of the fuel bundles; placing fuel rods in a close packed consolidation canister, compacting the skeleton materials and placing them in a separate canister and disposing of inserts (e.g., control rods, burnable poison, thimble plugs). The amount of storage increase depends on compaction ratios and arrangements that can be made for storing and/or disposing of skeleton materials and fuel inserts. This option is currently not acceptable for receipt as a standard fuel package at a DOE repository, such as Yucca Mountain, and some utilities have already elected to repackage the individual rods back into spacer grids. Also, there is no standard process for rod consolidation currently available for use in the nuclear industry, and there is no practical shipping cask to receive and store consolidated fuel rods for eventual shipment.

Increasing storage rack capacity can be accomplished by re-racking the fuel pool or adding racks in peripheral spaces around the pool. Re-racking adds additional storage spaces when the replacement racks have a higher cell density (closer array). In order to effectively utilize the highest density racks, credit for fuel burnup must be applied to the criticality analysis. However, these options do not significantly increase storage capacity and therefore they only provide a short delay in the eventual need for a larger storage option. Also, refueling risks would be increased by doing these modifications simultaneously with normal plant refueling operations.

Building an additional spent fuel pool was determined to be significantly more expensive than the other options. Also, moving a large quantity of fuel from existing pools to a new pool is very expensive and time consuming because it requires use of a special shipping cask (which is filled and lifted above the existing pool, decontaminated, then moved to where it can enter the new pool to be emptied).

Transshipment within TVA is not currently a viable option because there is not adequate space available at any of the TVA licensed facilities. In addition, this option would involve significant transport expense. Transshipment to a private fuel storage facility is not currently an option because no such facility exists, but it is also projected to be very expensive in terms of both storage costs and transport costs. Furthermore, private fuel storage may only be temporary (20 years or so); afterwards the spent fuel might have to be returned to TVA if a permanent repository or reprocessing facility is not available.

The BFN ISFSI would 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. In addition to being the most economical option, there are several other reasons why dry storage is the most viable alternative. Dry spent fuel storage is a proven technology that is already in use at 18 U. S. nuclear power plants, and additional ISFSIs are in various stages of completion at other sites. The NRC and the utility industry project that dry storage will be in use at more than 55 reactors by the time the BFN ISFSI would be completed. Secondly, dry storage in dual-purpose storage modules minimizes BFN efforts in preparing fuel for shipment when a DOE repository is available. Lastly, procurement of additional storage modules can be accomplished incrementally (i.e., the size can be expanded as needed). Current BFN dry storage plans would provide adequate space for future ISFSI expansion sufficient to assure storage capacity for all action alternatives (i.e., license extension for two- or three-unit operation at EPU) as well as additional delays in the DOE spent fuel repository. Therefore, this technology would assure life-of-plant capability regardless of DOE schedules or plant operations changes.

As a result of these evaluations, the preferred method for assuring adequate spent fuel storage capacity at BFN is dry storage (i.e., an ISFSI).

2.2.5 Decommissioning Options

Under all of the alternatives (No Action and the Action Alternatives), TVA would eventually have to decommission the plant at the end of the units' operating licenses. Decommissioning decisions and actions would have to be made sooner under the No Action Alternative than under the Action Alternatives. When a decommissioning option is proposed in the future, appropriate environmental reviews would be conducted. Because decommissioning is common across all of the alternatives for this SEIS, a general description of decommissioning is provided. TVA currently has no preference among decommissioning options and is not proposing one now.

To decommission a nuclear power plant, the radioactive material on the site must be reduced to levels that would permit termination of the NRC license. This involves removing the spent fuel (the fuel that has been in the reactor vessel), dismantling any systems or components containing activation products (such as the reactor vessel and primary loop), and cleaning up or dismantling contaminated materials. All activated materials generally have to be removed from the facility and shipped to a waste processing, storage or disposal facility. Contaminated materials may either be cleaned of contamination onsite, or the contaminated sections may be cut off and removed (leaving most of the component intact in the facility), or they may be removed and shipped to a waste processing, storage or disposal facility. The licensee decides how to decontaminate material, and the decision is usually based on the amount of contamination, the ease with which it can be removed, and the cost to remove the contamination versus the cost to ship the entire structure or component to a waste-disposal site.

The NRC has evaluated the environmental impacts of three general methods for decommissioning nuclear power facilities: DECON, SAFSTOR, and ENTOMB (see below for definitions). The licensee (TVA) will decide how to decommission the BFN site, but NRC regulations currently state that decommissioning must be completed within 60 years of permanent cessation of operations. The choice of decommissioning options is strongly influenced by potential uncertainties in low-level waste disposal costs and by concerns over the future availability of low-level waste sites.

For the DECON option, the equipment, structures, and portions of the facility and site that contain radioactive contaminants are removed or decontaminated to a level that permits termination of the license shortly after cessation of operations. The DECON option calls for prompt removal of radioactive material to permit restricted or unrestricted access. The advantages of DECON include the following:

- facility license is terminated quickly, and the facility and site become available for other purposes,
- availability of the operating reactor work force that is highly knowledgeable about the facility,
- elimination of the need for long-term security, maintenance, and surveillance of the facility, which would be required for the other decommissioning alternatives,
- greater certainty about the availability of low-level waste facilities that would be willing to accept the low-level radioactive waste, and
- lower estimated costs compared to the alternative of SAFSTOR, largely as a result of future price escalation because most activities that occur during DECON would also occur during the SAFSTOR period, only at a later date. (It is anticipated that the later the date for completion of the decommissioning, the greater the cost.) Some of these increases may well be offset by technological advances during the SAFSTOR period.

The disadvantages of DECON include the following:

- higher worker and public doses (because there is less benefit from radioactive decay such as would occur in the SAFSTOR option),
- a larger potential commitment of disposal-site space than for the SAFSTOR option, and
- the potential for complications if spent fuel must remain on the site until a Federal repository for spent fuel becomes available.

For the SAFSTOR option, the facility is placed in a safe stable condition and maintained in that state until it is subsequently decontaminated and dismantled to levels that permit license termination. During SAFSTOR, a facility is left intact, but the fuel has been removed from the reactor vessel, and radioactive liquids have been drained from systems and components and then processed. Radioactive decay occurs during the SAFSTOR period, thus reducing the quantity of contaminated and radioactive material that must be disposed of during decontamination and dismantlement. The benefits of SAFSTOR include the following:

- a substantial reduction in radioactivity as a result of the radioactive decay that results during the storage period,
- a reduction in worker dose (as compared to the DECON alternative),
- a reduction in public exposure because of fewer shipments of radioactive material to the low-level waste site (as compared to the DECON alternative),

- a potential reduction in the amount of waste disposal space required (as compared to the DECON alternative),
- lower cost during the years immediately following permanent cessation of operations,
- a storage period compatible with the need to store spent fuel onsite, and
- more time to benefit from growth in the decommissioning trust fund.

Disadvantages of SAFSTOR include the following:
- shortage of personnel familiar with the facility at the time of deferred dismantlement and decontamination,
- site unavailable for alternate uses during the extended storage period,
- uncertainties regarding the availability and costs of low-level radioactive waste sites in the future,
- continuing need for maintenance, security, and surveillance, and
- higher total cost for the subsequent decontamination and dismantlement period (assuming typical price escalation during the time the facility is stored), but this will be offset to some extent by reduced disposal volumes resulting from radioactive decay.

For the ENTOMB option, radioactive structures, systems, and components are encased in a structurally long-lived substance, such as concrete. The entombed structure is appropriately maintained, and continued surveillance is carried out until the radioactivity decays to a level that permits termination of the license. The benefits of the ENTOMB process are primarily related to the following:

- reduced amount of work in encasing the facility in a structurally long-lived substance, and
- reducing the worker dose resulting from decontaminating and dismantling the facility.
- In addition, public exposure from waste transported to the low-level waste site would be minimized.

The ENTOMB option may have a relatively low cost.

Disadvantages of ENTOMB include the following:
- Because most power reactors will have radionuclides in concentrations exceeding the limits for unrestricted use even after 100 years, this option may not be feasible under the current regulations. (This option might be acceptable for reactor facilities that can demonstrate that radionuclide levels will decay to levels that will allow restricted use of the site.)
- Although three small demonstration reactors have been entombed, currently no licensees have proposed the ENTOMB option for any of the power reactors undergoing decommissioning.

Discontinuing operation of BFN at the end of the existing licenses and initiation of decommissioning would likely allow some other commercial or industrial use of part of the BFN site in the future. This would ameliorate to some extent the socioeconomic impacts of loss of employment at BFN. This might include use of the site for electric power generation. Such uses are not reasonably foreseeable at this time and any such future use would require its own environmental review.

2.3 Description of Actions Common to All Action Alternatives

2.3.1 Extended Power Uprate

Following completion of an Environmental Assessment (TVA, 2001), the TVA Board approved the EPU project for BFN Units 2 and 3 on April 18, 2001. Using engineering methodology developed by General Electric and approved by the NRC, this project will allow the BFN units to achieve an estimated 10% increase (i.e., 116 more megawatts per unit) in electrical power generation. Both Units 2 and 3 are scheduled to be operating with the increased generation in early 2005. Therefore, for purposes of this SEIS, EPU is assumed to be in place as part of the current baseline for proposed actions to relicense Units 2 and 3. If Unit 1 is recovered and restarted, it would also be operated at EPU conditions and the environmental consequences of this are addressed in the SEIS.

Similar to EPU for BFN Units 2 and 3, EPU of Unit 1 would allow operation at 120% of its originally licensed reactor thermal power level (i.e., 120% of 3,293 Megawatt thermal (MWt) is 3,952 MWt). For EPU, however, preliminary evaluations indicate that, due to generator limitations of no more than 1,280 Megawatt electrical (MWe), the BFN reactors will be operated at slightly less than the full 120% thermal power increase. As for Units 2 and 3, affected Unit 1 plant systems would be further analyzed to determine what modifications would be required to support changes in system operating parameters. Plant equipment, such as the main turbine and associated pumps and valves, will likely require modifications to accommodate the increased power generation, but any such modifications would occur within the plant site and are expected to have no or only minimal environmental impacts.

Also similar to the EPU project for Units 2 and 3, a new Unit 1 operating philosophy would be established whereby reactor power would be adjusted as seasonal changes in river temperature affect the overall efficiency of the turbine to maintain generator output at its present maximum allowable level (approximately 1,280 MWe) throughout the year. This new approach means that at times during the year, reactor steam and feedwater flow could approach levels of 120-122% of the original operating basis. To accommodate the increased reactor steam and feedwater flow and to accommodate the increased heat rejected, the following modifications to plant equipment are expected to be necessary; their exact nature would be determined after more detailed engineering evaluations are completed.

- modifications to the high pressure turbine steam path,
- modifications to the reactor feed pump turbines,
- installation of higher horsepower condensate pump motors,
- modifications to the condensate demineralizer system,
- installation of new heater drain valves,
- increased cooling tower capacity, and
- possibly some miscellaneous safety system setpoint changes.

As was documented in the Environmental Assessment for EPU on Units 2 and 3, minor impacts would occur with implementation of Unit 1 EPU compared to restarting Unit 1 without EPU. Some of the plant modifications required to implement the EPU, and the construction activities associated with cooling tower capacity expansion, may result in the generation of small amounts of hazardous and solid wastes. BFN currently has in place the necessary procedures and contracts for proper disposal of both types of wastes. The capacity of the BFN landfill and the local landfills is adequate to accommodate the additional solid waste.

The increased thermal power proposed for EPU will result in an increase of approximately 2.3 degrees in the temperature of the circulating water leaving the main condenser (for each operating unit) from that currently experienced. This increase in discharge temperature will result in increased cooling tower usage during summer periods to maintain compliance with the discharge limitations. Cumulative impacts to aquatic communities by operation of all three units at uprated power levels are addressed in Chapter 4. No changes are expected to be required to the plant intake system or to the individual unit intake flow rates as a result of the EPU project. However, as previously noted, due to various equipment and system upgrades and improved calibrations since initial operation of the BFN units, the total amount of water withdrawn from the river for three unit operation would no longer remain within the levels evaluated during the original EIS analysis. Therefore, the potential impact of increased total intake flow on the reservoir is addressed in Chapter 4

As compared to past three-unit operations, potential radiological effects from operation of BFN Units 1, 2, and 3 under EPU will not significantly change the maximum projected annual dose or cumulative dose over time to the public resulting from plant radioactive effluents. Radiological doses for extended power uprate conditions will be well below the regulatory limits and should have no effect on human health.

An amendment to the operating licenses for the BFN units from the NRC would be required before EPU can be implemented.

2.3.2 Dry Cask Storage Facility

Even without license extension or Unit 1 restart, BFN requires expansion of spent fuel storage capacity as a result of DOE's delay in receiving utility spent fuel. The site's spent fuel pools are slowly being filled, and as noted in section 2.2.4, Unit 3 will lose full core off-load capability in November 2005. In response, BFN is planning to implement new spent fuel storage capacity during 2005 in order to avoid impacting Unit 3 availability.

Dry Cask Storage at BFN consists of building a secured fenced-in concrete storage pad in phases or sections. The current dry cask storage schedule calls for being able to begin storing fuel in 2005. Putting EPU on a fast track is not expected to impact the current dry cask storage completion schedule. This project would be required with or without EPU, license renewal, or Unit 1 recovery, but there is a strong linkage in that the size requirement for the total pad storage area is directly a function of all three. The pad is being designed to be large enough to accommodate all known requirements, and would be kept functional as a back-up even if the Yucca Mountain or some other DOE repository begins operation.

Concrete for pad construction would most likely be trucked in, rather than building a batch plant on site, because there is probably not enough volume to justify a dedicated facility. There is a nearby batch plant in Athens. (Even with a site batch plant, however, the concrete ingredients (sand, gravel, cement) would still have to be trucked in.) The pad sections would need about 60 concrete truckloads each, or about 360 truck trips for Phases 1 and 2. Phase 3 would involve 180 truck trips, but it may not be completed until 15 years later (2020). It is possible that the access road around the river side of the plant may first have to be "hardened" where it passes over underground pipes, which could add approximately 100 truck trips. The trucks have wide tires to minimize ground loading. Building the pad sections for Phases 1 and 2 would involve approximately 20 workers for one month, near the end of 2003 or the beginning of 2004.

Each pad section would be on the order of 40 feet wide by 120 feet long by 3 feet thick, with each pad section separated by approximately 20 feet. Some amount of soil underneath would probably first be removed and then "re-engineered" (re-formulated and then re-installed and compacted). The underlayment and concrete composition of the pad sections are carefully controlled to meet seismic and energy absorption design requirements; such that tip over of a storage cask can be safely accommodated.

2.3.3 Modifications Fabrication Building

The location for the new dry cask storage facility (Figure 2.2-3) would 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 would be used for Unit 1 recovery. In fact, a decision to recover Unit 1 would essentially require work to begin on the new Modifications Fabrication Building almost immediately. The new building would be completed and occupied within 12 to 18 months after a decision is made to pursue Unit 1 recovery. Compared to the existing Modifications Fabrication Building, this new building would be larger and more flexible in the number and kind of activities it can house.

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

2.4 Description of Actions Specific to Associated Alternatives

2.4.1 Extended Operation of Units 2 and 3

Concurrent with development of this SEIS, initial work scoping and screening of plant components requiring aging management reviews has begun to better determine the feasibility of license renewal for the BFN units. No operational changes or physical work will be performed under the License Renewal process. If the need for any hardware changes, document processes or procedure changes is identified, the changes will be performed and controlled under the appropriate change process.

The work, being largely analytical in nature, will be done primarily by TVA's Nuclear Engineering staff in Chattanooga, with on-site support at BFN. The total staffing is projected to peak at 30 full-time equivalent (FTE) individuals in April of 2002, and thereafter gradually reduce to about 10 FTE in the final year (2005). At any given time, approximately two-thirds of the assigned staff will be Chattanooga and one-third at the site.

BFN is one of several U. S. nuclear plants that have initiated programs to explore the feasibility of license renewal, and some of those programs are much further along than their counterpart efforts at TVA. In fact, as of March 2002, ten utilities have already submitted applications and four of them (Calvert Cliffs Units 1 and 2, Oconee Units 1, 2, and 3, and Arkansas Nuclear One, Unit 1, and Hatch Units 1 and 2) have already been reviewed and approved by the NRC. Using this large body of experience, the following projections can be made regarding the anticipated results of comparable efforts at BFN.

License Renewal of BFN Units 2 and 3 for a 20-year period of extended operation beyond the current operating license expiration dates is not expected to require any replacement of equipment beyond possibly some electrical cables which undergo normal aging at ambient environment conditions. Nor is it expected that any major refurbishment of equipment would be necessary outside of what is already periodically scheduled for normal wear. The only equipment additions that might possibly result from the license renewal effort are those associated with modifications originating from Severe Accident Mitigation Alternatives (SAMA) (i.e., beyond design basis accidents) analyses. Experience to date at other nuclear plants indicates that changes resulting from SAMA analyses are few and relatively minor in nature.

As explained earlier, continued operation of Units 2 and 3 with renewed licenses would be at EPU levels. No transmission facility modifications or additions would be required to extend operation of BFN Units 2 and 3.

2.4.2 Extended Operation of Units 2 and 3 Plus Recovery and Restart of Unit 1

This alternative is the same as that for Extended Operation of Units 2 and 3, except that recovery and restart of Unit 1 is also completed; probably, but not necessarily, prior to expiration of its current operating license in 2013. In any event, the environmental impact of recovering, restarting and operating Unit 1, while Units 2 and 3 are continuing to operate, is analyzed in this SEIS. Operation of any and all BFN units would be at EPU levels.

In order to better understand what would be involved in recovering and restarting Unit 1, the following historical perspective is provided on past problems encountered at BFN and the experience gained in correcting those problems and recovering and restarting Units 2 and 3.

Units 1 and 3 were voluntarily shut down by TVA in March 1985, because of questions about the primary containment isolation leak rate testing for Unit 1 and reactor water level instrumentation for Unit 3. Unit 2 was in a refueling outage at that time. These specific concerns for Units 1 and 3 were resolved, but during this 3-unit shutdown, an expanded approach to resolving questions about the environmental qualification of electrical equipment resulted in extending the outages. Additional questions and concerns were subsequently raised about the overall adequacy of TVA's nuclear program, and BFN Units 2 and 3 remained shutdown until adequate corrective actions were defined and completed to address the root causes of TVA's nuclear program problems. The corrective actions included both managerial improvements and plant hardware changes.

The managerial improvements included organizational changes compatible with corporate level restructuring, improved management control and involvement, revised conduct of design control, and programs to ensure employee confidence. Particularly noteworthy were the design control improvements that addressed a number of problems that had resulted from inadequately analyzed or documented design control and poor coordination between the engineering design and the modification process. The Design Baseline Verification Program was instrumental in re-establishing confidence and continuity between the current design and actual ("as-built") field 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 intergranular 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. These programs resulted in a large number of plant modifications to improve nuclear safety, which were delineated in the Nuclear Performance Plan, Volume III (Browns Ferry); (TVA, 1988).

Unit 2 recovery was accomplished and the unit was restarted on May 24, 1991. In a letter to NRC dated July 10, 1991 (TVA, 1991), TVA proposed the overall regulatory framework for the restart of Units 1 and 3, which was based largely on the work experience of recovering and restarting Unit 2. This letter reiterated the commitment that TVA would not restart BFN Units 1 and 3 without prior NRC approval, and summarized the programmatic and equipment issues and programs requiring satisfactory resolution prior to startup.

Unit 3 was subsequently restarted on November 19, 1995, but as described in *Energy Vision 2020,* the decision was made to not proceed with recovery efforts on Unit 1 because the economic climate had changed, the projected costs and cost uncertainties were large, and there were other more cost-effective means available at that time to meet baseload power demands. Since *Energy Vision 2020* was issued, the overall performance of TVA's nuclear plants has improved dramatically in terms of both production costs and power availability/capacity factor, and relative cost benefit compared to other candidate sources of bulk power.

No substantial ecological impacts were associated with recovery of Units 2 and 3. Site worker population was temporarily increased to a peak of approximately 4,500, requiring placement of temporary office trailers (which were removed after the units were restarted) and increased load on the waste water treatment plant. At the conclusion of the recovery work, some other older existing temporary office buildings were also removed. The large influx of personnel also temporarily impacted local roads and facilities such as schools, and a new off-site office building was constructed in Athens for some of the workers.

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 changeout, 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 would have similar environmental consequences.

2.4.2.1 Restart of Unit 1

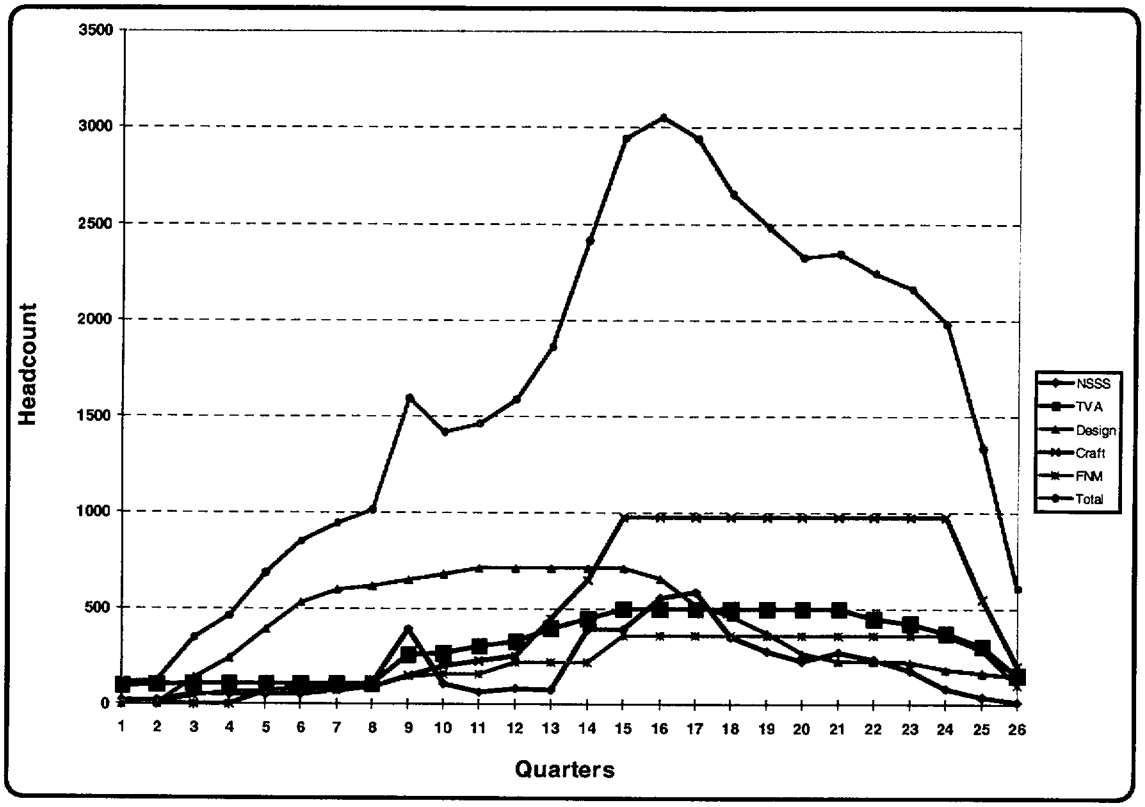
Recovery of Unit 1 for restart would be a substantial operation involving a large workforce over a time span of 5.5 years. The total number of workers (crafts, field supervisors, engineers, and managers) would peak at approximately 3,000, but some of these would remain at their parent company offices and not be re-located to the BFN site. Figure 2.4-2 illustrates how the BFN Unit 1 recovery staffing head count changes over the life of the project. As is typical with large projects, the total number of workers climbs to a peak and then begins to decrease as recovery efforts near completion. If Unit 1 is fully recovered the projected increase in permanent BFN staff required to maintain and operate the unit is 150 individuals.

The Unit 1 recovery project may be described chronologically in terms of the following phases, each with some overlap: planning (including worker facilities); engineering reanalysis; construction/modifications; turnover to operations and testing of restored systems, and commercial operation. Some of the planning and reanalysis work has already been initiated to support this SEIS and to better define the cost estimate.

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. As previously described, considerable reanalysis was involved in updating the Unit 2 and Unit 3 design basis to current standards and re-establishing consistency between design control drawings and actual installed equipment configuration. Similarly, a large amount of this same work for BFN Unit 1 recovery would be analytical in nature and would result in changes to drawings and other design basis documentation. It would also likely result in a large number of modifications and equipment changes internal to the plant, but the impact on the air, land, and water environment surrounding the facility is expected to be negligible.

In addition to the plant changes, which would 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 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. Additional cooling tower capacity is a possible exception and is addressed separately under each specific Alternative 2 subsection.

Figure 2.4-2 Browns Ferry Unit 1 Recovery Staffing Plan



Notes to Figure 2.4-2:
NSSS = Personnel from the Nuclear Steam Supply System (i.e., reactor) vendor, General Electric.
TVA = Tennessee Valley Authority employees assigned to the project.
Design = Design contract personnel, typically from a large architectural engineering firm.
Craft = Predominantly local construction trades craftspersons (electricians, boilermakers, carpenters, etc.)
FNM = Field Non-Manual personnel such as craft supervisors, foremen, work planners, etc.
Time Scale = Calendar quarters, showing both gradual increase prior to start and gradual decrease during completion of pre-operational testing.

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 2.4-1 lists some of the major hardware impacts associated with Unit 1 recovery, together with any disposal considerations involved.

Table 2.4-1 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

Table 2.4-1 (continued) Hardware Impacts Associated with Unit 1 Recovery	
Physical Change	**Disposal Consideration**
Main Steam Tunnel cooling system upgrade	misc. scrap equipment (potentially contaminated)
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 Boiling Water Reactor (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.

2.4.2.2 New Administration Building

Unit 1 is adjacent to buildings that house plant personnel. Operation of Unit 1, especially with the hydrogen injection 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, construction of a new Administration (office) Building located further from Unit 1 is being considered as a possible means of minimizing dose to site workers at BFN.

A decision to recover Unit 1 would require work to begin on a new Administration (office) Building almost immediately (Figure 2.2-3). The new office building would be required to house existing plant staff so that space could be freed up in the existing office buildings to house the incoming Unit 1 team. The new office building would be expected to be completed and occupied within 12 to 18 months after a decision is made to pursue Unit 1 recovery. After completion of Unit 1 recovery, the existing (old) office buildings would be kept for use during outages. The new office building would house almost all site office staff, approximately 514 individuals.

The new two-story office building would consist of light commercial grade construction, and would be largely prefabricated, involving delivery of prefabricated items, concrete and other construction materials. The new office building would require 40 or so truckloads of concrete, 30 to 40 gravel truckloads, less than 20 truckloads of various other building materials (5 of construction steel, 15 for items such as sheetrock, electrical, plumbing, etc.). The number of workers would peak at 60, but no more than 40 would normally ever be on site simultaneously.

2.4.2.3 Power Transmission System Impacts

TVA has analyzed the transmission line condition and loading in the vicinity of the BFN site, and has determined that restart of Unit 1 at EPU would require additional 500-kV circuit breakers to be installed in the existing 500 kV switchyard, and several 161-kV transmission lines are projected to become overloaded due to single contingency events. Line uprates (i.e., retensioning or increasing tower height or adding towers as necessary to maintain height clearances of conductors which warm and sag under higher power loading), reconductoring (i.e., increasing conductor size), the addition of a second 500-161kV transformer bank at the Madison 500kV substation, or other solutions would be required to correct these overloads. A Static Var Compensator and Capacitors will also be needed for regulating system voltage. These upgrades and equipment additions involve existing facilities with available spaces; any associated environmental impacts would be minimal. There would be no need to obtain new right of ways or construction of new transmission lines under any of the alternatives.

2.5 Summary of Proposed Alternatives

Table 2.5-1 summarizes key aspects of the BFN units proposed for life extension in this SEIS.

Table 2.5-1 Summary of BFN Unit Attributes

Attribute	Description
Type of Generation	Nuclear Power
Type of Operation	Base Load (Continuous)
Service Mode	one month refueling outage every two years
Reactor Thermal Power	3952 MWt per unit (with EPU)
Electrical Generation	generator limited to 1280 MWe per unit
Number and Type of Units	3 GE BWR 4 Units w/Mark I Containment
Current Operating License Expiration Dates	2013, 2014, 2016 for Units 1,2,3
Renewed Operating License Expiration Dates	2033, 2034, 2036 for Units 1,2,3
No. of Site Employees (Normal/Outage)	1200/2000
Reactor Fuel Consumption	336 fuel bundles per refueling (with EPU and HEU)
Diesel Fuel Consumption[1]	380,500 gallons per year
Cooling Water Intake Source	Wheeler Reservoir (Tennessee River)
Cooling Water Intake Flow	700,000 gpm per unit
Unit 1 Recovery/Restart	
Expected Capital Cost for Recovery	$1.35 B
Peak Recovery Workforce	3,055
No. of Additional Permanent Employees	150

[1]Note: This same fuel oil is used in all site diesel engines and in the auxiliary steam boilers.

2.6 Comparison of Environmental Consequences

The following summarizes the potential impacts of the Action Alternatives across the various environmental resources. They rely on or benchmark from the environmental conditions that exist under the No Action Alternative, and are as described in the Chapter 3 Affected Environment section of this SEIS. Operation of BFN Units 2 and 3 only until the current licenses expire - which is the No Action Alternative here - is encompassed by and discussed in the plant's original EIS that this document supplements. The impacts of the No Action Alternative are therefore not further discussed in this document except where new information or refinement of the earlier analyses warrants and appears for comparison purposes with the potential impacts of the Action Alternatives.

2.6.1 Comparison by Resource

AIR RESOURCES

Potential impacts on local climate and meteorology are expected to be less than the assessment results in the original EIS. Conservative plume modeling and conservative operating assumptions that were used then gave results that encompass the Alternative 2 options for increased cooling tower capacity because actual cooling tower operations have been and would be expected to occur only in the warmer months, generally limited to summer, and for much less time than the 29% assumed in the original EIS.

Based on operating experience, impacts on ambient air quality are all expected to be smaller than the magnitudes provided in the original EIS, with the exception of carbon monoxide. Emissions and ambient concentrations for carbon monoxide were about two orders of magnitude too small compared to amounts reported during actual operations. However, the ambient air quality standard for this pollutant is still five orders of magnitude larger than this revised estimate, so the impact is still considered negligible. The original EIS assumed maximum operation of the cooling towers in the helper mode 22% of the time. This assumption has been compared to Alternative 2 with its increased cooling towers capacity options for purposes of this SEIS. (The 7% closed mode analysis included in the original EIS has not been similarly refined because operation in this mode is now known to be impractical.) In this updated assessment, particulate emissions in the form of drift from the towers would be about 22 pounds per hour compared to an emissions standard for fine particulates of 45 pounds per hour. Total annual emissions would be about 21 tons per year compared to the 100 tons per year that was the estimate in the original EIS. Construction and modification impacts on air quality during the refurbishment period would be minor and transitory.

GEOLOGIC SETTING

Construction of additional water cooling capacity under any of the alternatives considered should result in no significant impacts to the geologic resources and hazards. The changes to crustal loading caused by excavation and movement of materials and the construction of new structures are expected to have negligible effects on the seismicity of the area.

The local geology and character of local seismicity would not be impacted by continued operation of BFN.

SOLID WASTES MANAGEMENT AND PAST PRACTICES

Continued operation of BFN through the license extension period should not result in generation of additional volumes of general plant trash which exceed the levels currently generated. If Unit 1 is restarted, the amount of general plant trash would be expected to increase in proportion to the increase in site population required for the recovery effort. In addition, there would be additional trash generated as a part of construction activities, but this amount would be significantly less than that generated by construction of a new facility. Once operational, the amount of trash generated would be similar to the other operating units, and the overall amount generated would increase slightly due to the small increase in permanent plant staff necessary to operate three units.

BFN will continue to maintain the license to operate the onsite construction/demolition (C/D) landfill through the duration of the extended BFN operating licenses. In the event Unit 1 is restarted, the onsite C/D landfill has the space and capacity to handle the small amount of additional wastes associated with construction activities. Should the onsite facility prove inadequate, there is sufficient alternative capacity in surrounding off-site C/D landfills.

Generation rates for low level radioactive waste would not be expected to exceed existing rates as a result of extension of the BFN licenses. Should Unit 1 be restarted, generation rates would be expected to increase during construction activities due to additional asbestos removal operations and the normal increases associated with nuclear construction activities. Once operational, the generation rates for this type of waste activity would increase in proportion to the additional operational activity associated with three unit operation. BFN has provisions in place to either store or ship for processing and disposal the volumes of material generated. Existing storage and disposal facilities have adequate capacity to handle the volumes of material expected to be generated during the extended life of BFN with either two-unit or three-unit operation.

HAZARDOUS WASTES MANAGEMENT AND PAST PRACTICES

Generation of hazardous waste would not be expected to increase for BFN as a result of license extension. Existing processes for managing these wastes within TVA would be expected to continue, and capacities for existing disposal and treatment facilities should be adequate to handle the relatively small volumes of material generated. Over the past 15 years, BFN has significantly reduced the generation of hazardous wastes through a combination of source reduction and product substitution. These ongoing waste reduction efforts would be expected to further reduce the number of waste streams and the volumes of waste generated at BFN.

Construction activities associated with Unit 1 restart would temporarily increase rates of hazardous waste generation due to the increased use of solvents and paint related materials necessary for refurbishment. 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.

SPENT FUEL MANAGEMENT

Environmental consequences of additional spent fuel management resulting from license extension of either two or three BFN units would be minimal. The additional spent fuel would be stored in the spent fuel pool or a dry storage system approved by NRC. Compared with license renewal of only Units 2 and 3, the addition of Unit 1 would just increase the number of storage casks needed and the required size of the proposed ISFSI. Subsequently, all BFN spent fuel would be transferred to the DOE in accordance with the Nuclear Waste Policy Act of 1982 and subsequent amendments.

SURFACE WATER RESOURCES

Under Alternative 1, no significant construction impacts are expected. Best Management Practices (BMPs) and construction control measures would be employed to control surface runoff, contain potential pollutants, and dispose of all waste materials in accordance with regulatory requirements. There would be no significant change in current operational impacts. Regulatory requirements would continue to control potential adverse impacts from plant discharges and operations. Thermal impacts from continued operation of Units 2 and 3 would remain within the levels evaluated during the original EIS. No additional thermal impacts to water temperature, reservoir stratification, sediment transport, scouring, dissolved oxygen concentrations, or eutrophication are expected.

Under Alternatives 2A, 2B, and 2C, potential construction and operational impacts are similar; and those for Alternative 2D are slightly less than the other sub-alternatives and similar to those described for Alternative 1. Construction impacts are expected to be temporary and insignificant using BMPs and pollution control measures. The restart of Unit 1 will require upgrading the cooling tower system and increased flow rates from a maximum flow of approximately 2,300 MGD for Units 2 and 3 to approximately 3,450 MGD with three units operating. The discharge temperature of the cooling system water will be essentially the same for three-unit operation, due to the proportional increase in cooling water flow. However, the total amount of heat added to the river and the water temperatures at the edge of the mixing zone would increase with three units operating. With the additional cooling tower capacity installed, modeling analyses using historical data indicate that the maximum discharge temperature and the temperature rise between intake and discharge would remain within regulatory limits that are formulated to protect aquatic life and ecosystems. Use of the cooling towers would increase, however, and on occasion when the cooling towers are unable to meet the thermal limits, the plant may have to be de-rated to remain in compliance. The implications of the thermal effects on reservoir water temperatures, dissolved oxygen concentrations, and eutrophication were also modeled. The results suggest that Alternatives 2A, 2B, 2C, and 2D should have insignificant effects on reservoir stratification, dissolved oxygen concentrations, eutrophication, sediment transport, and scouring.

GROUNDWATER RESOURCES

There are no adverse impacts to groundwater resources associated with the Alternative 1 upgrade scenario. Activities potentially affecting groundwater resources would include foundation treatment, excavation, and grading associated with Alternative 2 facilities. Excavations which penetrate the water table may require temporary construction dewatering. 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 proposed facilities would result in permanent displacement of shallow soils above the water table (e.g., the proposed berm relocation sites). 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. 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 proposed cooling tower configurations given the limited area of disturbance. Potential contaminant releases (e.g., fuels, oils, and solvents), during construction activities, would be averted by careful handling and proper disposal of potential contaminants according to BMP guidelines. No adverse impacts to groundwater resources are anticipated from operation and maintenance of new facilities associated with Alternative 2 for the project. No adverse groundwater use impacts are anticipated from any of the identified alternatives.

FLOODPLAINS AND FLOOD RISK

The floodplains and flood risk assessment involves ensuring that facilities would be sited to provide a reasonable level of protection from flooding. In doing this, the requirements of Executive Order (EO) 11988 (Floodplain Management) would be fulfilled. Due to the nature of this facility, it is necessary to evaluate the flood risk associated with the Probable Maximum Flood (PMF) elevations for all alternatives.

Under Alternative 1, all existing and proposed facilities are, or would be, located outside the limits of the 100- and 500-year floodplains. Therefore, the project would be consistent with EO 11988. All safety-related structures are protected against all flood conditions and would not be endangered by the PMF. The proposed dry cask storage facility and permanent administration building would be located on ground above the PMF elevation based on site topography dated 1989. The proposed Modifications Fabrication Building would be located on ground below the PMF elevation, but the site would be raised or the building would be flood proofed consistent with other facilities of this nature on the plant site. Based on site topography, the proposed mechanical draft cooling tower would be located above elevation 570. All equipment within the cooling tower that could be damaged by floodwaters would be located above or flood proofed to the PMF elevation, as required.

During the license renewal period (up to year 2036), the 100- and 500-year flood, and PMF elevations for the Tennessee River would not be expected to change as stated in Section 3.8. Although the 100- and 500-year flood flows for the small stream to the northwest of the plant site and the site drainage system could increase by as much as 2.5 times what they are now, these flows would not adversely impact existing or proposed development because they would be significantly lower than the PMF flows, and these channels can handle PMF flows without flooding the plant.

All anticipated flood impacts for Alternatives 2A, 2B, 2C, and 2D would be the same as those listed for Alternative 1, except for potential PMF flooding impacts to the new cooling tower(s). However, all equipment within the cooling towers that could be damaged by floodwaters would be located above or flood proofed to the PMF elevation, as required. The construction of these towers would involve the relocation of material to one of three potential spoil areas. These areas are all located outside the limits of the 100-year floodplain which would be consistent with EO 11988.

TERRESTRIAL ECOLOGY

With respect to botanical aspects of Terrestrial Ecology, impacts are anticipated to be the same under all alternatives. No uncommon communities or otherwise significant vegetation types are known from the vicinity and impacts to this resource are anticipated to be insignificant.

Likewise, impacts to terrestrial animal communities would be similar under all alternatives. Due to previous levels of disturbance at the site during construction and operation of existing facilities, little suitable habitat of wildlife exists on site. No populations of rare or uncommon animals exist at the project site. Adoption of the proposed alternatives would not result in adverse impacts to uncommon animals or their habitats.

AQUATIC ECOLOGY

If Unit 1 is not returned to operation, but Units 2 and 3 are relicensed under Alternative 1, the total maximum two-unit intake volume, even with past plant modifications that increased CCW flow, would be within the bounds of previously-assessed intake volumes at which fish impingement and entrainment of fish eggs and larvae were determined to not adversely impact Wheeler Reservoir fish populations. With the return of Unit 1 to operation under Alternative 2, the total CCW flow would increase by about 10 percent. This increased CCW intake volume would potentially result in increased impingement of adult fish and entrainment of fish eggs and larvae but is not expected to result in significant impacts to fish populations of Wheeler Reservoir.

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 Vital Signs 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.

THREATENED AND ENDANGERED SPECIES

For threatened and endangered (T&E) plants, impacts are anticipated to be the same under all alternatives. No rare plants are known from the vicinity, and no impacts to this resource are anticipated. No threatened or endangered aquatic species were found within the area affected by construction or operational changes at BFN as proposed herein. There are no populations of threatened or endangered terrestrial animals or suitable habitat for these species at or near the project site. Adoption of the proposed alternatives would not result in direct or cumulative impacts to threatened or endangered terrestrial animals or their habitats.

WETLANDS

No wetlands 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.

SOCIOECONOMIC CONDITIONS

No Action Alternative

Under the No Action Alternative, discontinuing unit operation when the existing licenses are scheduled to expire would require that TVA choose a decommissioning option and begin plant decommissioning. There would be some loss of jobs if this occurs compared to existing employment levels and additional employment losses when decommissioning was completed. In addition to the direct losses in income and employment that would result there would also be additional income losses in the form of decreased spending in the area by BFN employees. However, the number of jobs lost would only be approximately one percent of the labor force in Limestone County and only a small fraction of the labor force in the entire labor market area. Any resulting impacts to community services and housing from reduced local government revenues would be small and there would be no disproportionate impacts to disadvantaged populations in the area.

Alternative 1

Under Alternative 1, there would be no significant change in operating employment levels, payroll, or other plant-related expenditures. There would be some construction activity, requiring a small number of workers for a brief period of time. However, impacts to employment and income would be small and temporary.

There would be no noticeable affect on community services and housing and local government revenues because of the small and temporary increase in the number of additional workers. No disproportionate impacts to disadvantaged populations in the local area are expected.

Alternative 2

Under any of the variations of Alternative 2, construction activities would have noticeable effects on population, employment, and income over a time span of about 5.5 years. The total number of workers involved in the construction phase would peak at about 3,000, although not all of these are likely to be located at the plant site. Operation of Unit 1, in addition to current operation of Units 2 and 3, would require an increase in employment of about 150 permanent workers. This would be a small addition to the local economy.

Construction would result in some short-term strain on community services, including police and emergency services. Schools and the housing market likely would experience short-term strains. These impacts, however, would be scattered throughout the labor market area, not just in Limestone County. The increase in permanent employment associated with operation of Unit 1 in addition to the Units 2 and 3 could have a temporary impact on the local housing market and housing prices. However, the operations impacts would be small. Local government revenues would increase as a result of increases in the in lieu of tax payments by TVA. No disproportionate impacts to disadvantaged populations are expected.

TRANSPORTATION

Alternative 1 would result in no new impacts to the transportation system. The other action alternatives would have additional traffic generated in the form of operation and construction workforce employee travel and construction and operational material deliveries. The county roads are in good condition for access and would be adequate to support the traffic requirements during both construction and operation; however, construction periods are temporary and peak forces only last for several months. There would be some delay turning onto County Road 25 from the plant due to traffic congestion at shift changes and leaving multiple exits simultaneously. Over a long period of time, there is a natural progression to improve the quality of the local roadway network and any such improvements may help address this potential impact. Therefore, as traffic increases over time, it is reasonable to assume that there will be some improvement in the transportation infrastructure.

SOIL AND LAND USES

Activities associated with license renewal for operation of Units 2 and 3 at EPU would have no impact on soils or land use on the plant site. Potential impacts to site soils and land use associated with refurbishing Unit 1 and license renewal for all 3 units would be insignificant. These construction activities would be located on previously disturbed soils and in built-up areas. Facilities for construction workers would be temporary and at completion of project the land would revert to prior use.

Operational impacts of any of these activities on land use in the surrounding areas would be insignificant. Current trends in local land use are toward development of more land for residential and commercial use. This is a result of population growth averaging 17% per decade. Any growth associated with either of these proposed activities would be minimal compared to current trends. Existing power line easements are sufficient, no new transmission lines are proposed as part of this license renewal action.

VISUAL RESOURCES

Impacts under the No Action Alternative would be insignificant. Under Alternative 1, minor visual impacts would include additional cooling tower plumes seen by area residents and occasionally some additional lighting due to very infrequent night operations may affect night sky brightness. Alternative 2A would introduce two new cooling towers in the landscape, similar to those that exist now. Alternative 2B, however, would provide two cooling towers that would contrast vertically to the existing towers. Alternative 2C, demolishing the four existing Ecodyne cooling towers, constructing 5 new linear mechanical draft cooling towers, and increasing the size of the existing Balcke-Durr cooling tower by 25%, would add to the number of linear elements seen across the plant site. Alternative 2D is the construction of one 20-cell mechanical cell draft cooling tower to replace the one previously in position 4 that had previously burned down and was not replaced. For this alternative a slightly larger (longer) cooling tower (20-cell vs. 16 cell) would be constructed in lieu of the one earlier committed to in the environmental assessment for EPU of Units 2 and 3. The visual impact of this Alternative 2D would essentially be the same as that for Alternative 1 since a single mechanical cooling tower of a similar design (but slightly shorter length) would otherwise have been built in the same location for the EPU project.

Of the Action Alternatives, Alternatives 1 and 2D would have the least visual impact for plant workers, visitors, and motorists along County Road 25.

RECREATION

There are no recreation facilities impacted by Alternative 1 or 2. Under either of the alternatives, there would be insignificant affects on recreation resources, facilities and activities.

CULTURAL RESOURCES

TVA Cultural Resources staff determined that the project had the potential to affect historic properties within the three areas designated as soil disposal or spoil pile locations. The Area of Potential Effect (APE) for historic structures was determined as those areas from which the disposal locations would be visible. A Phase I cultural resource survey was conducted to identify sites within this APE.

The archaeological survey identified one archaeological site near disposal Area 1 (see Figure 2.2-7). The site is marked on BFN drawings and it is expected that it will be avoided by any future activities. If avoidance is not possible, or should any future plans result in potential adverse impacts to the site, a Phase II archaeological survey will be required. Cox Cemetery, located near disposal Area 2, would be avoided. No historic structures were identified within the APE. In consultation with the Alabama State Historic Preservation Office (SHPO), it was determined that no historic properties would be affected by Alternatives 1 and 2 under the commitments that all sites identified during the Phase I survey would be avoided.

ENVIRONMENTAL NOISE

Routine construction noise from the action alternatives would have an insignificant effect for the duration of construction activities. Some cooling tower and building construction noise would be noticeable above background at times, but it would take place during daylight hours and for a relatively short time period. The highest noise levels during construction would come from the site preparation and foundation work for the two additional cooling towers in alternatives 2A and 2B. These heavy construction phases require the largest and most equipment to be in operation, but they are expected to be completed in about three months. The following construction phases of erection and finishing do not require as large or as many pieces of equipment.

The potential construction noise from refurbishing Unit 1 in preparation for restart is also insignificant because the overwhelming majority of the work would be done inside the generation building and containment structure.

The incremental increases in operational noise from the cooling towers for Alternatives 1, 2A, 2B, and 2D are insignificant. These are about a 1 Decibel, A-weighted (dBA) increase over current operational noise. This increase might not be detectable by most of the nearest residents, but it has the potential for a 1 to 2% increase in annoyance. The incremental increase for Alternative 2C without mitigation is likely to be noticed and has the potential for about a 4% increase in annoyed people. None of the alternatives has the potential for causing hearing loss or speech interference.

The maximum potential effect of Alternative 2C is decreased for several reasons. First, frequently less than all of the towers are operating; second, the towers operated an average of only 17 days per year over the past five years; and third, the cooling tower noise is low frequency and continuous when they are operating, and such noise is considered less objectionable by most people than high frequency, intermittent noise. Also, the towers operate during the hottest part of the summer when residential air-conditioning is used and windows are closed, eliminating any potential noise increase from inside the residences. Although Alternative 2C has the potential to cause a noise increase greater than 3 dBA, this is considered an insignificant effect for these reasons.

PUBLIC AND OCCUPATIONAL SAFETY & HEALTH

The site Safety and Health Program would not be impacted or affected by license renewal and continuing to operate Units 2 and 3 for 20 years after the current licenses expire. If Unit 1 recovery and license renewal/extended operation is added to continuing operation of Units 2 and 3, there is still no change to the Safety and Health Program. However, during the construction/modification work in recovering Unit 1, injury rates would be expected to be approximately 20% higher than during periods of operation.

RADIOLOGICAL IMPACTS

Future occupational radiation exposures from continuing either two-unit or three-unit operation at EPU power levels have been analyzed based on extrapolations from past and present data. It was concluded that worker radiation exposures would continue to be significantly less than the limits established by federal regulation. The average annual dose to workers and the average annual dose per operated reactor would remain consistent with current BWR industry trends. The estimated cancer risk increase associated with the occupational dose forecast for either Action Alternative is bounded by the projected doses for license renewal analyzed in NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants."

TVA does not anticipate any significant changes to the radioactive effluent releases or exposures to the public from continuing two-unit BFN operations through completion of the license renewal period. EPU is projected to increase effluent releases proportionately, as would the addition of Unit 1. However, revised calculated doses are a small fraction of the applicable radiological dose limits and the total exposures to the public from 3-unit operation at EPU are expected to remain a small fraction of the regulatory dose limits.

The design basis accidents addressed in the BFN Updated Final Safety Analysis Report (UFSAR) are independent of the age of the plant and are the same for each unit. Therefore, the extension of the operating lifetime of the plant from 40 to 60 years would not impact the analysis of these accidents. EPU will affect accident analysis because the power level influences the amount of radioactive isotopes available for release; however, all radioactive releases are projected to remain well within regulatory limits.

Extension of plant life from 40 to 60 years would also proportionately impact the ability of safety related equipment to withstand the effects of accidents. This is because of age-related effects of continuing operational conditions (temperature, humidity, radiation, etc.). However, the BFN equipment qualification program ensures that all safety-related equipment will remain qualified to operate as designed in its intended environment so as to perform its intended function. As part of this program, any equipment that cannot withstand the full 60-year life of the plant would be replaced on a predetermined maintenance schedule.

License extension with either two or three-unit operation would be accommodated as it has in the past by the BFN Radiological Emergency Plan. The SAMA analysis for BFN, included as Appendix A of this SEIS, addresses restart of Unit 1 and operation of all three units at EPU; and therefore, addresses both Alternatives 1 and 2. Based on the existing BFN SAMA analysis and SAMA analyses completed to date at other nuclear plants similar to BFN, it is not anticipated that either Alternative 1 or Alternative 2 would result in justifying significant modifications.

DECOMMISSIONING IMPACTS

If the decision is made to extend operation of only Units 2 and 3, decommissioning would probably not be initiated for Unit 1 until cessation of all site power operations. Instead, Unit 1 would likely remain in its current non-operable status until any renewed licenses expire or a subsequent decision is made to recover and restart the unit. If Unit 1 is restarted, Unit 1 would join Units 2 and 3 in extended operation for an additional 20 years past expiration of the current licenses. Therefore, under either Action Alternative, decommissioning would be delayed by the 20-year license renewal 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 would be available prior to completion of decommissioning.

2.6.2 Comparison by Alternative

Table 2.6-1 summarizes the impacts of constructing and operating each alternative and sub-alternatives evaluated in this SEIS.

Table 2.6-1 Summary of Environmental Impacts for BFN License Renewal SEIS Action Alternatives

Environmental Resource	Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 2D
Air Resources	***Construction:*** No significant impacts anticipated. BMPs include wetting ground surfaces to reduce fugitive dust, and maintaining trucks and equipment for efficient fuel consumption. ***Operation:*** Expected operation of six cooling towers is bounded by analyses in the original EIS. Other emissions are likewise bounded or (such as CO) are well below regulatory limits. No significant impacts are anticipated.	***Construction:*** No significant impacts anticipated. BMPs include wetting ground surfaces to reduce fugitive dust, and maintaining trucks and equipment for efficient fuel consumption. ***Operation:*** Expected operation of eight cooling towers is bounded by analyses in the original EIS. Other emissions are likewise bounded or (such as CO) are well below regulatory limits. No significant impacts are anticipated.	***Construction:*** No significant impacts anticipated. BMPs include wetting ground surfaces to reduce fugitive dust, and maintaining trucks and equipment for efficient fuel consumption. ***Operation:*** Expected operation of eight cooling towers is bounded by analyses in the original EIS. Other emissions are likewise bounded or (such as CO) are well below regulatory limits. No significant impacts are anticipated.	***Construction:*** No significant impacts anticipated. BMPs include wetting ground surfaces to reduce fugitive dust, and maintaining trucks and equipment for efficient fuel consumption. ***Operation:*** Expected operation of six large cooling towers is bounded by analyses in the original EIS. Other emissions are likewise bounded or (such as CO) are well below regulatory limits. No significant impacts are anticipated.	***Construction:*** No significant impacts anticipated. BMPs include wetting ground surfaces to reduce fugitive dust, and maintaining trucks and equipment for efficient fuel consumption. ***Operation:*** Expected operation of six cooling towers is bounded by analyses in the original EIS. Other emissions are likewise bounded or (such as CO) are well below regulatory limits. No significant impacts are anticipated.
Geologic Setting	***Construction:*** No significant impacts anticipated. Changes to crustal loading are minor. ***Operation:*** Continued operation would have no impact on the natural seismic activity in the area.	***Construction:*** No significant impacts anticipated. Changes to crustal loading are minor. ***Operation:*** Continued operation would have no impact on the natural seismic activity in the area.	***Construction:*** No significant impacts anticipated. Changes to crustal loading are minor. ***Operation:*** Continued operation would have no impact on the natural seismic activity in the area.	***Construction:*** No significant impacts anticipated. Changes to crustal loading are minor. ***Operation:*** Continued operation would have no impact on the natural seismic activity in the area.	***Construction:*** No significant impacts anticipated. Changes to crustal loading are minor. ***Operation:*** Continued operation would have no impact on the natural seismic activity in the area.

Environmental Resource	Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 2D
Solid Wastes Management	***Construction:*** Onsite landfill adequate. No significant impacts are anticipated. ***Operation:*** Generation rates for wastes would not change. No significant impacts are anticipated.	***Construction:*** Onsite landfill adequate. No significant impacts are anticipated. ***Operation:*** Generation rates for wastes would increase slightly. No significant impacts are anticipated.	***Construction:*** Onsite landfill adequate. No significant impacts are anticipated. ***Operation:*** Generation rates for wastes would increase slightly. No significant impacts are anticipated.	***Construction:*** Offsite landfill would be utilized if onsite landfill not adequate. No significant impacts are anticipated. ***Operation:*** Generation rates for wastes would increase slightly. No significant impacts are anticipated.	***Construction:*** Onsite landfill adequate. No significant impacts are anticipated. ***Operation:*** *Generation rates for wastes would increase slightly. No significant impacts are anticipated.*
Hazardous Wastes and Asbestos Management	***Construction:*** Existing processes adequate for minimal quantities expected. ***Operation:*** Generation rates for wastes unchanged. No significant impacts are anticipated.	***Construction:*** Existing processes adequate for minimal quantities expected. ***Operation:*** Generation rates for wastes would increase slightly. No significant impacts are anticipated.	***Construction:*** Existing processes adequate for minimal quantities expected. ***Operation:*** Generation rates for wastes would increase slightly. No significant impacts are anticipated.	***Construction:*** Asbestos from demolished cooling towers would be deposited in a permitted landfill. ***Operation:*** Generation rates for wastes would increase slightly. No significant impacts are anticipated.	***Construction:*** *Existing processes adequate for minimal quantities expected.* ***Operation:*** *Generation rates for wastes would increase slightly. No significant impacts are anticipated.*
Spent Fuel Management	***Construction:*** No significant impacts. BMPs for building ISFSI would be followed. ***Operation:*** Experience with similar ISFSI facilities at other utilities indicates no significant impacts.	***Construction:*** No significant impacts. BMPs for building ISFSI would be followed. ***Operation:*** Experience with similar ISFSI facilities at other utilities indicates no significant impacts.	***Construction:*** No significant impacts. BMPs for building ISFSI would be followed. ***Operation:*** Experience with similar ISFSI facilities at other utilities indicates no significant impacts.	***Construction:*** No significant impacts. BMPs for building ISFSI would be followed. ***Operation:*** Experience with similar ISFSI facilities at other utilities indicates no significant impacts.	***Construction:*** *No significant impacts. BMPs for building ISFSI would be followed.* ***Operation:*** *Experience with similar ISFSI facilities at other utilities indicates no significant impacts.*

Environmental Resource	Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 2D
Surface Water Resources	***Construction:*** No significant impacts; BMPs would be followed for cooling tower, ISFSI, new mod fab building. ***Operation:*** No major change from current operations; no significant impacts.	***Construction:*** No significant impacts; BMPs would be followed for cooling towers, ISFSI, new mod fab building, and new admin building. ***Operation:*** Total cooling water intake flow increased, but no significant impacts expected. Cooling tower capacity increase would ensure no significant impacts from increased heat to reservoir.	***Construction:*** No significant impacts; BMPs would be followed for cooling towers, ISFSI, new mod fab building, and new admin building. ***Operation:*** Total cooling water intake flow increased, but no significant impacts expected. Cooling tower capacity increase would ensure no significant impacts from increased heat to reservoir.	***Construction:*** No significant impacts; BMPs would be followed for cooling towers, ISFSI, new mod fab building, and new admin building. ***Operation:*** Total cooling water intake flow increased, but no significant impacts expected. Cooling tower capacity increase would ensure no significant impacts from increased heat to reservoir.	***Construction:*** No significant impacts; BMPs would be followed for cooling towers, ISFSI, new mod fab building, and new admin building. ***Operation:*** Total cooling water intake flow increased, but no significant impacts expected. Cooling tower capacity increase would ensure no significant impacts from increased heat to reservoir.
Groundwater Resources	***Construction:*** No usage, only limited local dewatering; no significant impacts. ***Operation:*** No usage; no significant impacts.	***Construction:*** No usage, only limited local dewatering; no significant impacts. ***Operation:*** No usage; no significant impacts.	***Construction:*** No usage, only limited local dewatering; no significant impacts. ***Operation:*** No usage; no significant impacts.	***Construction:*** No usage, only limited local dewatering; no significant impacts. ***Operation:*** No usage; no significant impacts.	***Construction:*** No usage, only limited local dewatering; no significant impacts. ***Operation:*** No usage; no significant impacts.

Environmental Resource	Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 2D
Floodplains and Flood Risk	***Construction:*** None within 500-year floodplain; any new features within PMF would be flood-proofed. No significant impacts. ***Operation:*** Site drainage can handle PMF flows. No significant impacts.	***Construction:*** None within 500-year floodplain; any new features within PMF would be flood-proofed. Spoils relocation outside 100-year floodplain. No significant impacts. ***Operation:*** Site drainage can handle PMF flows. No significant impacts.	***Construction:*** None within 500-year floodplain; any new features within PMF would be flood-proofed. Spoils relocation outside 100-year floodplain. No significant impacts. ***Operation:*** Site drainage can handle PMF flows. No significant impacts.	***Construction:*** None within 500-year floodplain; any new features within PMF would be flood-proofed. All cooling tower equipment would be above or flood proofed to PMF. No significant impacts. ***Operation:*** Site drainage can handle PMF flows. No significant impacts.	***Construction:*** None within 500-year floodplain; any new features within PMF would be flood-proofed. All cooling tower equipment would be above or flood proofed to PMF. No significant impacts. ***Operation:*** Site drainage can handle PMF flows. No significant impacts
Terrestrial Ecology	***Construction:*** Actions impact only areas already disturbed. No significant impacts. ***Operation:*** Impacted lands presently utilized. No significant impacts.	***Construction:*** Actions impact only areas already disturbed. Spoils relocation does not impact sensitive areas. No significant impacts. ***Operation:*** Impacted lands presently utilized. No significant impacts.	***Construction:*** Actions impact only areas already disturbed. Spoils relocation does not impact sensitive areas. No significant impacts. ***Operation:*** Impacted lands presently utilized. No significant impacts.	***Construction:*** Actions impact only areas already disturbed. No significant impacts. ***Operation:*** Impacted lands presently utilized. No significant impacts.	***Construction:*** Actions impact only areas already disturbed. No significant impacts. ***Operation:*** Impacted lands presently utilized. No significant impacts

Environmental Resource	Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 2D
Aquatic Ecology	***Construction:*** BMPs would control siltation. No significant impacts. ***Operation:*** Intake flows and discharge temperature limits unchanged. No significant impacts.	***Construction:*** BMPs would control siltation. No significant impacts. ***Operation:*** Total intake flow increased, potential entrainment/impingement increase expected. No significant impacts expected; would be confirmed by aquatic monitoring. Increased cooling tower capacity would ensure discharge temperatures are within permitted limits. No significant thermal impact.	***Construction:*** BMPs would control siltation. No significant impacts. ***Operation:*** Total intake flow increased, potential entrainment/impingement increase expected. No significant impacts expected; would be confirmed by aquatic monitoring. Increased cooling tower capacity would ensure discharge temperatures are within permitted limits. No significant thermal impact.	***Construction:*** BMPs would control siltation. No significant impacts. ***Operation:*** Total intake flow increased, potential entrainment/impingement increase expected. No significant impacts expected; would be confirmed by aquatic monitoring. Increased cooling tower capacity would ensure discharge temperatures are within permitted limits. No significant thermal impact.	***Construction:*** BMPs would control siltation. No significant impacts. *Operation*: Total intake flow increased, potential entrainment/impingement increase expected. No significant impacts expected; would be confirmed by aquatic monitoring. Increased cooling tower capacity would ensure discharge temperatures are within permitted limits. No significant thermal impact.
Threatened and Endangered Species	***Construction/Operation:*** None on or affected by actions. No effects.	***Construction/Operation:*** None on or affected by actions. No effects.	***Construction/Operation:*** None on or affected by actions. No effects.	***Construction/Operation:*** None on or affected by actions. No effects.	***Construction/Operation:*** None on or affected by actions. No effects.
Wetlands	***Construction/Operation:*** None on or adjacent to site. No significant impacts.	***Construction/Operation:*** None on or adjacent to site. No significant impacts.	***Construction/Operation:*** None on or adjacent to site. No significant impacts.	***Construction/Operation:*** None on or adjacent to site. No significant impacts.	***Construction/Operation:*** None on or adjacent to site. No significant impacts.

Environmental Resource	Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 2D
Socioeconomic Conditions	***Construction:*** Temporary small influx of workers. No significant negative impacts. ***Operation:*** No increase in permanent workforce. No significant negative impacts.	***Construction:*** Temporary large influx of workers. No significant negative impacts. ***Operation:*** 12.5% increase in permanent workforce. No significant negative impacts.	***Construction:*** Temporary large influx of workers. No significant negative impacts. ***Operation:*** 12.5% increase in permanent workforce. No significant negative impacts.	***Construction:*** Temporary large influx of workers. No significant negative impacts. ***Operation:*** 12.5% increase in permanent workforce. No significant negative impacts.	***Construction:*** Temporary large influx of workers. No significant negative impacts. ***Operation:*** 12.5% increase in permanent workforce. No significant negative impacts.
Transportation	***Construction:*** Minor changes in vehicular traffic. No significant impacts. ***Operation:*** No changes in vehicular traffic anticipated. No significant impacts.	***Construction:*** Temporary 150% increase in vehicular traffic. Some transmission equipment upgrades necessary. No significant impacts. ***Operation:*** 12.5% increase in plant traffic. No significant impacts.	***Construction:*** Temporary 150% increase in vehicular traffic. Some transmission equipment upgrades necessary. No significant impacts. ***Operation:*** 12.5% increase in plant traffic. No significant impacts.	***Construction:*** Temporary 150% increase in vehicular traffic. Some transmission equipment upgrades necessary. No significant impacts. ***Operation:*** 12.5% increase in plant traffic. No significant impacts.	***Construction:*** Temporary 150% increase in vehicular traffic. Some transmission equipment upgrades necessary. No significant impacts. ***Operation:*** 12.5% increase in plant traffic. No significant impacts.
Soils and Land Uses	***Construction/Operation:*** No changes outside existing plant area. No significant impacts.	***Construction:*** All site construction on previously disturbed soils. No new transmission line ROW required. No significant impacts. ***Operation:*** Existing power line easements sufficient. No significant impacts.	***Construction:*** All site construction on previously disturbed soils. No new transmission line ROW required. No significant impacts. ***Operation:*** Existing power line easements sufficient. No significant impacts.	***Construction:*** All site construction on previously disturbed soils. No new transmission line ROW required. No significant impacts. ***Operation:*** Existing power line easements sufficient. No significant impacts.	***Construction:*** All site construction on previously disturbed soils. No new transmission line ROW required. No significant impacts. ***Operation:*** Existing power line easements sufficient. No significant impacts.

Environmental Resource	Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 2D
Visual Resources	***Construction:*** Visual discord temporary. No significant impacts. ***Operation:*** Slight increase in cooling tower plumes and site lighting. No significant impact.	***Construction:*** Visual discord temporary. No significant impacts. ***Operation:*** Slight increase in visual discord due to berm removal and new towers. No significant impacts.	***Construction:*** Visual discord temporary. No significant impacts. ***Operation:*** Slight increase in visual discord due to berm removal and new towers. No significant impacts.	***Construction:*** Visual discord temporary. No significant impacts. ***Operation:*** Slight increase in visual discord due to larger cooling towers. No significant impacts.	***Construction:*** Visual discord temporary. No significant impacts. ***Operation:*** Slight increase in visual discord due to new cooling tower, plumes and site lighting. No significant impact.
Recreation	***Construction/Operation:*** All actions are on existing site; cumulative effect on nearby recreation resources minor. No significant impacts.	***Construction/Operation:*** All actions except transmission line upgrades are on existing plant site; cumulative effect on nearby recreation resources minor. No significant impacts.	***Construction/Operation:*** All actions except transmission line upgrades are on existing plant site; cumulative effect on nearby recreation resources minor. No significant impacts.	***Construction/Operation:*** All actions except transmission line upgrades are on existing plant site; cumulative effect on nearby recreation resources minor. No significant impacts.	***Construction/Operation:*** All actions except transmission line upgrades are on existing plant site; cumulative effect on nearby recreation resources minor. No significant impacts
Cultural Resources	***Construction/Operation:*** Cemeteries and potential archaeological sites would be avoided. No impacts are anticipated.	***Construction/Operation:*** Cemeteries and potential archaeological sites would be avoided. No impacts are anticipated.	***Construction/Operation:*** Cemeteries and potential archaeological sites would be avoided. No impacts are anticipated.	***Construction/Operation:*** Cemeteries and potential archaeological sites would be avoided. No impacts are anticipated.	***Construction/Operation:*** Cemeteries and potential archaeological sites would be avoided. No impacts are anticipated.
Environmental Noise	***Construction:*** No unusual activities planned. No significant impacts. ***Operation:*** Slight increase in potential annoyance due to cooling tower operation. No significant impacts.	***Construction:*** No unusual activities planned. No significant impacts. ***Operation:*** Slight increase in potential annoyance due to cooling tower operation. No significant impacts.	***Construction:*** No unusual activities planned. No significant impacts. ***Operation:*** Slight increase in potential annoyance due to cooling tower operation. No significant impacts.	***Construction:*** No unusual activities planned. No significant impacts. ***Operation:*** Cooling tower operation exceeds guideline for detectability, but no significant impacts.	*Construction*: No unusual activities planned. No significant impacts. *Operation*: Slight increase in potential annoyance due to cooling tower operation. No significant impacts.

Environmental Resource	Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 2D
Public and Occupational Safety & Health	***Construction:*** Projected work not major. No significant impacts. ***Operation:*** No changes to current program anticipated. No significant impacts.	***Construction:*** Injury rates projected to be temporarily higher, but no significant impacts. ***Operation:*** No changes to current program anticipated. No significant impacts.	***Construction:*** Injury rates projected to be temporarily higher, but no significant impacts. ***Operation:*** No changes to current program anticipated. No significant impacts.	***Construction:*** Injury rates projected to be temporarily higher, but no significant impacts. ***Operation:*** No changes to current program anticipated. No significant impacts.	***Construction:*** Injury rates projected to be temporarily higher, but no significant impacts. ***Operation:*** No changes to current program anticipated. No significant impacts.
Radiological Impacts	***Construction:*** Projected work non-radiological in nature. No significant impacts. ***Operation:*** No major changes and no significant impacts.	***Construction:*** Unit 1 recovery increases site dose but still well within limits. No significant impacts. ***Operation:*** Unit 1 recovery adds to sources, but all projected doses are still well within limits. No significant impacts.	***Construction:*** Unit 1 recovery increases site dose but still well within limits. No significant impacts. ***Operation:*** Unit 1 recovery adds to sources, but all projected doses are still well within limits. No significant impacts.	***Construction:*** Unit 1 recovery increases site dose but still well within limits. No significant impacts. ***Operation:*** Unit 1 recovery adds to sources, but all projected doses are still well within limits. No significant impacts.	***Construction:*** Unit 1 recovery increases site dose but still well within limits. No significant impacts. ***Operation:*** Unit 1 recovery adds to sources, but all projected doses are still well within limits. No significant impacts.
Decommissioning	License renewal allows time for technology improvement and spent fuel repository development. No significant impacts.	License renewal allows time for technology improvement and spent fuel repository development. No significant impacts.	License renewal allows time for technology improvement and spent fuel repository development. No significant impacts.	License renewal allows time for technology improvement and spent fuel repository development. No significant impacts.	License renewal allows time for technology improvement and spent fuel repository development. No significant impacts.

2.7 Comparison of Costs Between Alternatives

TVA has developed information about the costs of renewing the licenses and preparing for extended operation of BFN Units 2 and 3. These costs were estimated based on typical industry experience for the activities and equipment involved. Since Units 2 and 3 are currently operating and no significant equipment upgrades are projected to be required in preparation for or during extended operation, total costs for Alternative 1 are relatively small. The only facilities changes associated with this Alternative are additional dry cask spent fuel storage facility capacity and a new (replacement) modifications/fabrication building. As part of the separate EPU project, the sixth mechanical draft cooling tower will also be restored.

TVA has also developed information about the costs involved in recovering BFN Unit 1, renewing the license, and preparing for extended operation of BFN Unit 1. The Unit 1 recovery costs were estimated based on TVA's previous experience in recovering and restarting BFN Units 2 and 3, including consideration of lessons learned from those recovery efforts and evaluation of issues and work scope unique to Unit 1. Unit 1 recovery work includes substantial engineering reanalysis and equipment upgrades such as new cables, new piping and pipe supports, and replacement of degraded equipment to bring Unit 1 up to the regulatory standards currently met by Units 2 and 3. Much of the license renewal work being completed for Alternative 1 is applicable to BFN Unit 1; therefore, the additional work required would be about one-third of that expended for Units 2 and 3 (rather than one-half). Changes to facilities or additions outside the power plant include those for Alternative 1 (additional dry cask spent fuel storage facility capacity [but proportionately larger for 3 units], the new modifications/fabrication building, and restoration of the sixth mechanical draft cooling tower as part of the EPU project) plus a new Administration Building and whatever additional cooling tower capacity is determined to be required.

Which cooling tower sub-alternative is most cost-effective overall depends upon several factors besides construction and operating costs, including the amount of additional cooling capacity required, the assumed limits on discharge temperature and condenser backpressure, and the accuracy of the calculational models in minimizing conservative assumptions such as those associated with river flow temperature stratification. The amount of additional cooling capacity needed is also a function of acceptable levels for de-rates which most likely would occur during hot weather extremes.

In comparison of the four cooling tower sub-alternatives, the estimated total construction and operational costs are approximately equivalent for Alternatives 2A, 2B and 2C but significantly less for Alternative 2D. Alternatives 2A and 2B have similar equipment costs, and both would require less new equipment than Alternative 2C. Alternative 2C also involves demolition costs of the existing older cooling towers. In contrast, Alternatives 2A and 2B both require removal of most of the spoils berm, adding a warm-water box conduit, and digging a new cold-water discharge channel. Alternatives 2A and 2B probably also would require refurbishment expenses for the existing older cooling towers.

Since it provides less additional cooling capacity, the projected amount of de-rates due to hot weather extremes is larger for Alternative 2D than for 2A, 2B or 2C. Nonetheless, Alternative 2D has the highest net present value and internal rate of return when considering initial construction cost, operating power consumption, and associated de-rates. The larger size of the new cooling tower for Alternative 2D would also provide flexibility for future operations.

The environmental impacts associated with all of the Action Alternatives appear to be relatively insignificant. The costs for license renewal and justifying readiness for extended operation (of either two or three units) are small compared to the cost of recovery of Unit 1. Therefore, the choice of the preferred Alternative depends in large part upon the overall cost of Unit 1 recovery. As explained in Chapter 1, TVA has completed a cost analysis and benefits comparison, which demonstrate that recovering Unit 1 for extended operation (with license renewal) is financially viable.

TVA has completed a Detailed Scoping, Estimating, and Planning (DSEP) review of the proposed recovery of Unit 1. This effort, which incorporated lessons learned from the recovery of Units 2 and 3, developed a detailed work scope, staffing plan, schedule and cost estimate for the BFN Unit 1 recovery project. It was concluded that: the Unit 1 recovery project is technically viable; the project scope is defined and set; sufficient technical resources are available to proceed at this time; and there are no risks which could prevent the project from being completed within the proposed budget and schedule.

2.8 The Preferred Alternative

TVA has not yet made a decision with respect to the BFN license renewal Alternatives identified in this SEIS. However, based on TVA's present analyses of the environmental and cost/benefit aspects involved, Alternative 2 is preferred. With this alternative, there are positive environmental effects to be gained, no significant or unacceptable environmental impacts have been identified, and the initial cost analysis and benefits comparison indicate that recovering Unit 1 for extended operation would be financially viable.

Recovering and extending operation of Unit 1 would have the beneficial environmental effect of generating a significant amount of additional electricity without generating the greenhouse gases that would be produced if that demand was instead met by fossil-fired plants.

This SEIS contains the basis for TVA's conclusion that no significant and unacceptable negative environmental impacts would result from Alternative 2. Restarting Unit 1 would increase the waste heat load to Wheeler Reservoir, but the BFN cooling tower capacity would be increased and operated as necessary to ensure that discharge temperature regulatory limits continue to be met. For reasons explained in the previous section, sub-alternative 2D is the preferred option for additional cooling tower capacity. TVA is not proposing any modification to the existing NPDES permit limitations for the plant. For those periods of unusually hot weather where the increased cooling tower capacity is not sufficient, the operating power levels will be decreased (de-rated) as necessary to maintain discharge temperatures below regulatory limits. The total cooling water flow rate would be approximately 10% higher than it had been previously with three-unit operation, but no significant adverse impacts are expected. Monitoring of aquatic biota impingement and entrainment effects during the first year of operation would help to confirm the impact evaluation and identify any unanticipated or unacceptable impacts. All personnel exposures and radioactive effluents would continue to be well within regulatory limits. The addition of a dry cask spent fuel storage facility would safely accommodate all the spent fuel that would be generated by three units with renewed operating licenses.

As explained in Chapter 1, TVA has completed a cost analysis and benefits comparison which demonstrate that recovering Unit 1 for extended operation (with license renewal) is financially viable. However, the TVA decision on Unit 1 will of necessity take into account other relevant factors external to this SEIS, such as available financing options. The decision could be made as early as 30 days after issuance of this (Final) SEIS. It is currently expected that TVA will most likely make a decision on the proposed actions in May of 2002.

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3.0 AFFECTED ENVIRONMENT

The existing environmental conditions at the Browns Ferry Nuclear Plant (BFN) site that would be affected by the proposed alternatives are described in this chapter. Since the current operating licenses for Units 1, 2, and 3 do not expire until 2013, 2014, and 2016, respectively, but work on recovering Unit 1 or constructing a dry cask storage facility for spent fuel could begin as early as 2002, the affected environment addresses projected changes between 2002 and 2016.

In accordance with Council on Environmental Quality regulations, the affected environment is "interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment," (40 CFR 1508.14). The descriptions of the affected environment provide bases for understanding the direct, indirect, and (where applicable) the cumulative effects of the alternatives. The affected environment text is subdivided by subject area and includes human interaction aspects as well as descriptions of the physical and biological topics. Existing environmental conditions are also representative of the conditions that are expected to exist under the No Action Alternative, which is to operate Units 2 and 3 only until the end of their existing licenses.

3.1 Air Resources

3.1.1 Climate and Meteorology

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 warming trend is expected to continue through the renewed license period. 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.

3.1.2 Ambient Air Quality

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, have been challenged in the courts and are unlikely to be implemented until after the year 2003, if they withstand legal challenge. 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 compliance problems 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.

3.1.3 Existing Air Emission Sources

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.

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).

3.1.4 Air Quality During Refurbishment

Air quality conditions are expected to remain about the same as now during the refurbishment 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.

3.2 Geologic Setting

3.2.1 Local and Regional Geology

The local and regional geology are described in section 3.3 of the original EIS.

3.2.2 Geologic Structure and Faulting

The BFN area is underlain by flat-lying, underformed limestone of the Mississippian age. The site lies on the southeastern flank of the Nashville structural dome where it merges into the foreland slope of the Appalachian geosyncline. The Nashville dome controls the regional geologic structure, and the regional dip is a degree or less to the southeast. During its history, this immediate region has been one of little deformation. Major folds and faults are entirely absent. No active faults showing recent surface displacement are known within a 200-mile radius of the site. The nearest known ancient fault is in Lawrence County, Alabama, 16.5 miles to the west-southwest from the BFN site. This fault is one of three apparently related near-vertical faults that cut Mississippian bedrock and have vertical displacements that vary from 0 to 60 feet (BFN UFSAR).

3.2.3 Seismicity

Significant centers of seismic activity are considered to be regions that have produced large earthquakes (magnitude greater than 6.0) in historical time. For BFN the nearest examples of such seismic source zones include the New Madrid Seismic Zone in the central Mississippi Valley in the vicinity of New Madrid, Missouri and the Charleston Seismic Zone near Charleston, South Carolina. BFN is approximately 200 miles from the New Madrid Seismic Zone and approximately 400 miles from the Charleston Seismic Zone. Both of these seismic zones have produced one or more earthquakes that caused damageover a wide area.

The December 7, 2001, magnitude 3.8/3.9 earthquake that occurred west of Scottsboro, Alabama was not associated with a seismic source zone that has generated large earthquakes in historical time. The earthquake's epicenter was about 50 miles from BFN and 17 miles from TVA's unfinished Bellefonte Nuclear Plant site located approximately six miles northeast of Scottsboro. The event was not felt nor noticed in any way at Browns Ferry. BFN staff confirmed that the seismic instruments were operable and that the seismic alarm, set at 0.01 G., did not activate.

The earthquake was not "felt" at Bellefonte. However, TVA staff in the control room did hear a rumble that sounded like something heavy being dragged along the roof. It seemed to last approximately 5 to 6 seconds. No books fell from shelves, nor did any objects topple. Inspections of the site the evening of the earthquake and the following morning revealed no damage and nothing out of place. Bellefonte does not have a seismic instrument.

The December 7, 2001 earthquake occurred in the Southern Appalachian Seismic Zone as defined by Bollinger (1973). The largest earthquake known to have occurred within this zone occurred in Giles County, Virginia in 1897 with a magnitude of approximately 5.8.

Earthquakes of the size (3.8 magnitude) that occurred near Scottsboro, Alabama on December 7, 2001, could be expected to occur somewhere within the southern Appalachians about once every three years (Bollinger, et al, 1989). The southern Appalachian seismic zone extends from central Alabama to western Virginia, and therefore, most earthquakes occurring in this zone are much farther from BFN than the recent one near Scottsboro. Two aftershocks were associated with the Scottsboro earthquake (both quite small), and it appears the aftershock sequence ended in less than a month.

As shown by the U.S. Geological Survey's 1996 national seismic hazard maps, BFN is located in a region of low seismic hazard. Although infrequent, small earthquakes (magnitude less than 4.0) are likely to continue to occur in the area around BFN. However, earthquakes of this size, even if much closer to BFN than the December 7, 2001 earthquake, produce ground motions that are considerably smaller than those for which the plant is designed and thus pose no threat to plant safety.

3.3 Solid Wastes Management and Past Practices

Solid wastes generated in conjunction with operation of BFN can be subdivided into four general categories:

1. General plant trash consisting of paper, metals, garbage and other items;
2. Construction and demolition debris associated with site activities;
3. Low Level radioactive solid wastes which consists of spent resins, and dry active waste (DAW) (contaminated protective clothing, paper, rags, glassware, and trash); and
4. Hazardous Wastes as defined under the Resource Conservation and Recovery Act (RCRA).

All of these solid wastes are managed in accordance with applicable Nuclear Regulatory Commission (NRC), State, and Federal environmental regulations, and disposed in approved and licensed disposal facilities.

3.3.1 General Plant Trash

General plant trash 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. At the current time, Alabama has greater than ten years of remaining landfill capacity. 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.

3.3.2 Construction/Demolition Debris

BFN operates a State permitted Construction/Demolition (C/D) landfill (Permit Number 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 permit cycles, with the current permit set to expire in May 2005.

3.3.3 Low-Level Radioactive Waste

Spent resins are packaged, de-watered and temporarily stored on-site in concrete storage modules until they are shipped for burial offsite in a licensed disposal facility. DAW is collected within the plant, and transported to a waste processor for volume reduction and subsequent shipment to a licensed disposal repository, such as the Envirocare of Utah, Inc. burial facility. Irradiated non-fuel plant components are stored on-site or processed for shipment to a licensed disposal facility. Generation rates for these types of materials are approximately 30-40 cubic meters per month.

3.4 Hazardous Wastes Management and Past Practices

As is the case with any large industrial facility, BFN generates a variety of wastes that are classified as hazardous under 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 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 ERAL. 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.

3.5 Spent Fuel Management

A 20-year extension of the BFN operating licenses including three-unit operation would impact spent fuel management in the quantity of spent fuel storage required. As described in section 2.3, a BFN Independent Spent Fuel Storage Installation (ISFSI) is proposed for operation beginning 2005. Expansion of an ISFSI can be accomplished incrementally, provided adequate space is allotted in the initial design. This technology can accommodate life-of-plant requirements regardless of Department of Energy (DOE) repository schedules or plant operation changes.

After implementation of spent fuel dry storage, sufficient capacity would be maintained in the spent fuel pool to accommodate refueling outages. Older spent fuel would be transferred to dual-purpose storage modules (i.e., metal cask or canister with overpack) for storage at the BFN ISFSI. The fuel transfer from pool storage racks to dry storage modules would be performed in the spent fuel pool. The dry storage system would be licensed for both on-site storage in accordance with 10 CFR 72 and off-site transportation in accordance with 10 CFR 71. Consequently, these dry storage systems do not require fuel to be repackaged for transport to a DOE repository.

Depending on the dry storage system design chosen for BFN, each storage module could contain up to 68 spent fuel assemblies. Assuming a storage module design with a 68-fuel assembly capacity, five modules would typically be loaded before each refueling outage. After loading, the dual-purpose storage module would be drained, dried, decontaminated, sealed, and then transferred by crane to the truck bay for transport to the ISFSI site. The storage module containing spent fuel would be temporarily stored at the ISFSI until a DOE spent fuel repository is available.

Appropriate dual-purpose system components used for fuel storage would also be used for fuel transportation to the DOE repository. Preparation for transport varies depending on design of the dry storage system chosen. Transport preparation typically includes testing of the storage module seal integrity, then addition of impact limiters for metal (non-canister) systems or addition of a transport overpack and impact limiters if modular systems are used. These operations can be completed either at the ISFSI site, provided an appropriate crane system is available, or at a specially constructed transfer facility. The only part of a dry storage module that would remain on site after shipment to DOE is the storage overpack (if a modular canister design is used).

3.6 Surface Water Resources

3.6.1 Wheeler Reservoir Description

BFN is located on Wheeler Reservoir at Tennessee River Mile (TRM) 294. The 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 10.6 days.

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. 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 ADEM for public water supply, swimming and other whole body water-contact sports, and fish and wild life. The area of the reservoir immediately upstream and downstream of BFN is classified for swimming and other whole body water-contact sports and fish and wild life. Reservoir water quality is generally good and suitable for most designated uses. The one exception is a ten-mile reach of the river between Wheeler Dam and the Elk River which is on the state 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. Table 3.6-1 summarizes general water quality conditions in Wheeler Reservoir using 1990 through 1998 data available from EPA STORET.

Table 3.6-1 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.

3.6.2 Water Quality

Using conventional classification methods, Wheeler Reservoir would be considered eutrophic (Higgins and Kim, 1981). TVA 1999 Vital Signs Monitoring rated the overall ecological condition of the reservoir as fair (TVA, 2000). The 1999 rating was lower than previous years, primarily due to less than normal rainfall. Much of the summer of 1999 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 during summer thermal stratification at two of the four sampling sites; at times comprising up to 25% of the water column and 75% of the bottom length. There were no swimming advisories on Wheeler Reservoir in 1999. Fecal coliform bacteria in samples collected at five swimming beaches and four boat ramps were within the State of Alabama guidelines for water contact.

3.6.3 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 one-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 ten 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 five 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.

3.6.4 Water Intakes and Wastewater Discharges

Tables 3.6-2 and 3.6-3 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 ten municipal plants discharging over 30 MGD and 17 industrial plants discharging over 2,466 MGD.

3.6.5 Water Use Conflicts

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.

Table 3.6-2 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 3.6-3 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
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*

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

3.7 Groundwater Resources

3.7.1 Groundwater Occurrence

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.

3.7.2 Groundwater Use

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.

3.8 Floodplains and Flood Risk

The BFN plant site is located on the right bank of Wheeler Reservoir at Tennessee River mile (TRM) 294.0 in Limestone County, Alabama. The affected project area could possibly be flooded from the Tennessee River, a small stream to the northwest of the plant site and the site drainage system. The site drainage system is broken into three areas: 1) the switchyard, 2) the main plant area, and 3) the cooling tower system. The area impacted by the construction of any of the alternatives extends from about Tennessee River mile 293.0 to mile 294.0.

3.8.1 Current Conditions

The 100-year floodplain for the Tennessee River would be the area below elevation 557.3. The TVA Flood Risk Profile (FRP) elevation on the Tennessee River would also be elevation 557.3. The FRP is used to control residential and commercial development on TVA lands. At this location, the FRP elevation is equal to the 500-year flood elevation. Results of studies completed in 1981 give an estimated Probable Maximum Flood (PMF) level of 570 at the BFN site, or 2.5 feet lower than that provided in Appendix 2.4A of the FSAR. However, the PMF design value of 572.5 feet will continue to be used with the 2.5 feet difference as a design margin. Consequent wave run-up above the flood level would be 1.7 feet on a vertical wall and 2.7 feet on a 3:1 grassed slope. A maximum flood elevation of 574 at the plant site results from a combination of the PMF and wind wave run-up on a vertical wall or 575 as a result of the PMF and wind wave run-up on a 3:1 grassed slope.

For the small stream to the northwest of the site and the internal site drainage system, the 100- and 500-year flood elevations have not been determined. No PMF elevations have been computed for the small stream northwest of the plant; however, the maximum possible discharge is 17,200 cfs. For the switchyard drainage channel, the PMF elevation at the holding pond at the downstream end of the channel would be 574.8 and the PMF elevation at the north corner of the switchyard would be 577.8. The PMF elevation between the office and service buildings would be 566.6. In the vicinity of the radioactive waste, reactor, and diesel generator buildings, PMF elevations for all modes of plant operation would not exceed elevation 564.0. In the cooling tower system of channels there is sufficient capacity to pass the PMF and condenser water (Reference: FSAR).

3.8.2 Anticipated Future Conditions

Flooding conditions during the term of the renewed license (up to year 2036) are expected to remain similar to current conditions. For the Tennessee River, all dams in the TVA system are assumed to be maintained and remain operational for the entire licensing period. Existing procedures used for determining the 100- and 500-year flood levels on the Tennessee River are currently being reviewed; however, no major changes are expected to the adopted flood elevations as listed above. In addition, urbanization within the 27,130 square mile drainage area upstream of BFN would not be expected to significantly increase the 100- and 500-year floods. The computation of PMF levels is based on adopted standards and procedures, and no changes to these procedures are expected within the licensing period. If there were a change in these procedures, or if a major flood event occurred during the licensing period, a reevaluation could be necessary.

In regard to the small stream to the northwest of the plant site and the site drainage system, total development of a small drainage basin will increase the 100- and 500-year flood discharges from a small amount up to 2.5 times the natural discharge from the basin, depending on the amount of impervious area associated with the development. For the small stream northwest of the plant site, significant development within the 1.35 square mile drainage area is not expected to occur during the next 35 years. If total development were to occur, the 100- and 500-year flood discharges could increase as much as 2.5 times the natural discharge, as stated above. The switchyard drainage channel area, the main plant area, and the cooling tower system area all have some existing impervious area within their drainage basins. Additional impervious area would increase the 100- and 500-year flood discharges by some amount, but should not cause flooding greater than that produced by the PMF event.

3.9 Terrestrial Ecology

3.9.1 Vegetation

BFN is located within the Highland Rim section of the Interior Low Plateau Physiographic Province as described by Fenneman (1938). Botanically, the project site occurs within the Mississippian Plateau section of the Western Mesophytic Forest Region as recognized by Braun (1950). In this region of northern Alabama, native forest communities generally consist of mixed oak forests varying composition in relation to topography and soils. Historically, upland forests in the project area were characterized by mixtures of southern red oak, black oak, post oak and white oak with dogwood commonly present in the understory. The clearing of forested lands for agriculture has converted many of these forest communities to early successional habitats, allowing representative native plant communities to become replaced by introduced plant species.

The area in and around the BFN has been heavily impacted and altered as a result of the construction and operation of the existing facilities. Field inspections of the areas associated with the proposed action reveal that little native vegetation remains. The proposed location for the new cooling towers consists of old field vegetation with scattered tree species including black locust, various oaks, loblolly pine, and eastern red cedar. *Sericea lespedeza* and broomsedge are among the dominant herbs. The proposed locations for soil deposition (required for the construction of the new cooling towers) consist of two hayfields and a fallow cotton field now vegetated by a dense thicket of blackberry, Japanese honeysuckle and *Sericea lespedeza*, with scattered saplings of black locust and eastern red cedar. No uncommon communities or otherwise sensitive vegetation occurs on or immediately adjacent to the project areas.

3.9.2 Wildlife

The Tennessee River and surrounding terrestrial habitats offer suitable habitat to a wide variety of wildlife species. The river is used extensively by a variety of waterfowl and wading bird species. Wheeler Wildlife Refuge, located upstream from BFN is one of the southern-most wintering areas for ducks and geese in the southeast. In suitable terrestrial habitats, wildlife such as white-tailed deer, coyote, eastern cotton-tailed rabbit and opossum are fairly abundant in the vicinity. Most habitats in the vicinity are used by a many species of mammals, birds, amphibians and reptiles. Numerous caves are reported from Limestone County. These sensitive habitats provide habitat for numerous cave-dwelling species of animals, mostly bats, amphibians and numerous species of invertebrates.

Extensive agricultural practices prior to the construction of the BFN and construction of the existing facility have led to a decrease in the overall diversity of habitats within the project area. Limited available wildlife habitat existing at the nuclear plant site includes early successional, old field habitats, with scattered trees and agricultural fields. Wildlife species most commonly observed in the project area include those species that are less sensitive to human disturbance and are common in the region. Common bird species include song sparrow, eastern meadowlark, eastern bluebird, northern mockingbird, and American robin. Amphibians such as spring peeper and upland chorus frogs are common in the area. Small mammals such as hispid cotton rat, least shrew, and meadow voles may be found in these habitats.

3.9.3 Introduced Species

As described in section 3.9.1, the lands of the BFN site have been heavily impacted and altered as a result of the construction and operation of the existing facilities. As a result of these disturbances, native plant communities have been converted to early successional habitats characterized by introduced (non-native) plant species such as *Sericea lespedeza*, Japanese honeysuckle and multiflora rose. Introduced plant species have the potential to impact terrestrial ecology resources through reductions in native biological diversity because of their potential for rapid establishment and spread in disturbed habitats, and their tendency to displace native vegetation (Tennessee Exotic Plant Council, 1996).

The densities of introduced plant species and the habitats in which they occur on the project lands are characteristic of such disturbed sites in the region. Various native (i.e., indigenous) plants occur in the area; however, no intact native plant communities exist on the lands to be disturbed by the proposed action.

Due to the lack of complexity of habitats and the presence of the facility, several non-native species of wildlife exists on the project lands. Species such as European house sparrow and European starling are common on the site.

3.9.4 Managed Areas and Ecologically Significant Sites

A review of the TVA Regional Natural Heritage database indicates that there are no Managed Areas or Ecologically Significant Sites on or adjacent to the proposed project site. However, two Managed Areas are known to occur within three miles of the BFN. These areas have been recognized and are protected, to varying degrees, because they contain unique natural resources, scenic values, or public use opportunities. The following paragraphs offer brief descriptions of each area including primary use and available facilities.

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 tracks 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. These lands are owned by TVA and presently managed by the Alabama Department of Conservation (ADC).

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. Although the majority of these acres are owned by TVA, the ADC manages these lands for public use.

3.10 Aquatic Ecology

3.10.1 Fish

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 3.10-1).

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 Monitoring program. Vital signs 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 Reservoir Vital Signs monitoring program. Areas sampled included the forebay (area of the reservoir nearest the dam), a mid-reservoir transition station in the vicinity of 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. 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 run-of-the-river reservoirs, the fish assemblage at the Guntersville 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 future 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 3.10-1) (Dycus and Baker, 2001).

Table 3.10-1 Fish Species Collected in the Vicinity of BFN by TVA During BFN 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	-	-

Table 3.10-1 Fish Species Collected in the Vicinity of BFN by TVA During BFN 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
Black redhorse	x	-	-	-
Golden redhorse	-	-	x	x
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

3.10.2 Benthic Organisms

As mentioned, BFN is located on Wheeler Reservoir, which TVA classifies as a Run-of-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, 1972). 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 Vital Signs monitoring to systematically monitor the ecological condition of its reservoirs in 1990. Benthic macroinvertebrates are included in Vital Signs 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, Vital Signs 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 Vital Signs 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 taxa, long-lived taxa, non-chironomid and oligochaete density, percent oligochaete, dominance, 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 Vital Signs 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 Vital Signs 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 fauna are not assessed as part of TVA's Vital Signs program; however, they 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, 1992). 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 Fish and Game identified 14 species upstream of BFN and 12 species downstream (Jeffrey T. Garner, Alabama Game and Fish Division Malacologist, personal communication, 2001). A listing of these species appears in Table 3.10-2.

Table 3.10-2 Mussel Species Collected by Alabama Game and Fish Division 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*
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*
Butterfly*	*Ellipsaria lineolata*
Giant floater*	*Pyganodon grandis*
Pink papershell*	*Potamilus ohiensis*
Flat floater*	*Anodonta suborbiculata*

* = collected as dead shells

3.10.3 Introduced Species

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

Asiatic clam and zebra mussel populations that exist within Wheeler Reservoir would not be prone to exacerbation or extirpation due to BFN's thermal discharge. Thermal discharge limits permitted by 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 their 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 3-10.1).

3.10.4 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). 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. 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%).

Four species of fish (threadfin shad, gizzard shad, freshwater drum, and skipjack herring) represented 95% of the total fish impinged at BFN. No species other than these four comprised greater than 1% of total fish impinged (TVA, 1980).

TVA's Vital Signs monitoring program (TVA 2000) reported no obvious decline in the fish and benthic macroinvertebrate communities in Wheeler Reservoir and there is a balanced indigenous fish community.

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).

3.10.5 Microbiological Organisms

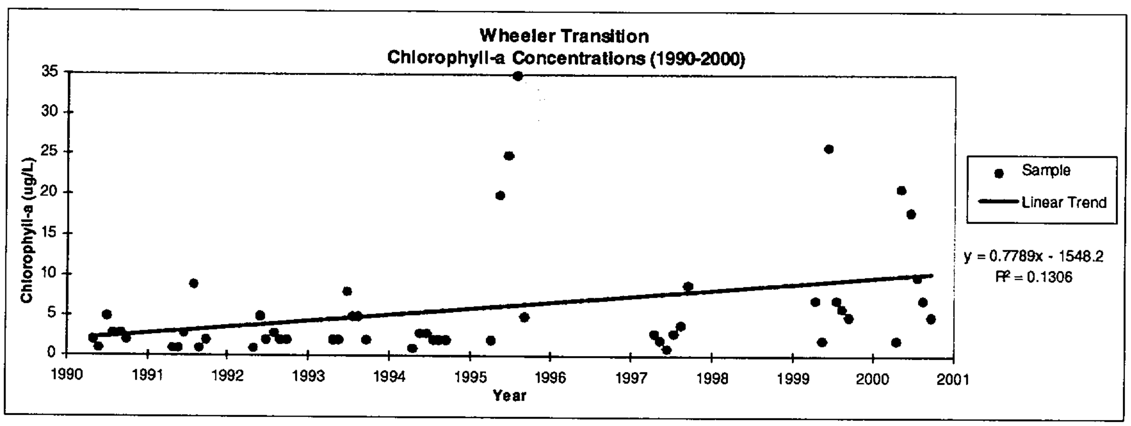
Plankton surveys were conducted during BFN preoperational monitoring in the early 1970s and have been a component of many BFN aquatic community surveys since then. The earliest phytoplankton surveys for Wheeler Reservoir found the assemblage to be quite diverse. As many as 27 Chrysophyta, 52 Chlorophyta, 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 the BFN thermal discharges would have 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.

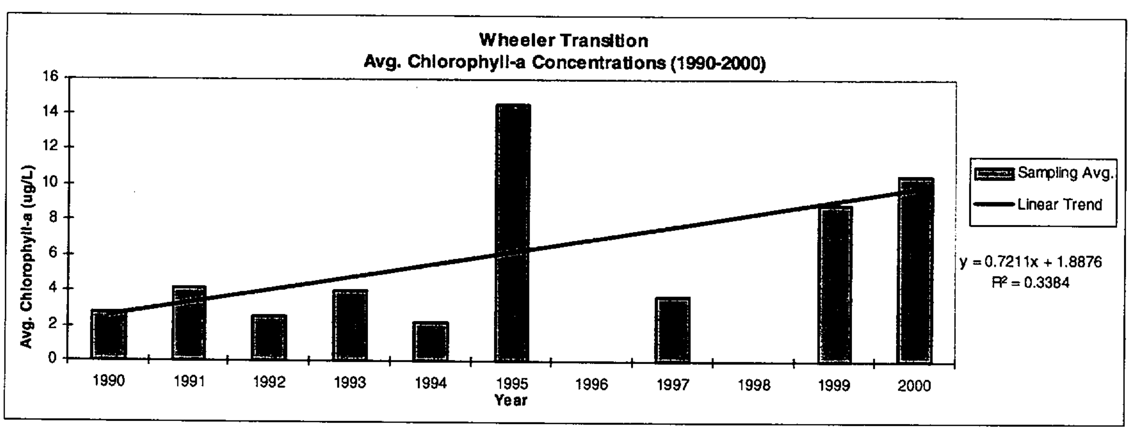
The validity of preoperational and operational BFN algal surveys conducted in the 1970s has been brought into question with advancements in reservoir limnology during the past 18 to 20 years. Considerable research and monitoring, conducted by TVA and others to evaluate phytoplankton/nutrient interactions 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. Vital Signs monitoring is conducted on a monthly schedule, April through September. Plankton data gathered during Vital Signs monitoring is believed to be more reliable. According to Lowery and Poppe (1992), the importance in sampling monthly lays 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 habitats. Examination of the 1989 and 1992 samples and the Vital Signs 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 Vital Signs 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 3.10-1. 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 3.10-1 Chlorophyll *a* Concentrations from Wheeler Reservoir Transition Station, Vital Signs Monitoring 1990-2000





3.11 Threatened and Endangered Species

3.11.1 Animal

A review of TVA Regional Natural Heritage databases indicates that four federally- or state-listed species of animals are reported from Limestone County (Table 3.11-1). No listed species are reported within five miles of the BFN.

Table 3.11-1 Rare Terrestrial Animal Species Known from Limestone County, Alabama

Common Name	Scientific Name	Federal Status	State Status
Gray Bat	*(Myotis grisescens)*	Endangered	Protected
Indiana Bat	*(Myotis sodalis)*	Endangered	Protected
Tennessee Cave Salamander	*(Gyrinophilus palleucus)*	none	Protected
Appalachian Bewick's Wren	*(Thryomanes bewickii altus)*	none	Protected

Federally listed endangered gray and Indiana bats are reported from caves along the Elk River. Gray bats are monitored at these caves annually by ADC Biologists. Gray bat populations appear to be stable at these sites. Indiana bats have not been reported from these caves in recent years. Although there are no suitable habitats for gray or Indiana bats on the BFN, gray bats likely forage along the Tennessee River adjacent to the project area.

State-listed Tennessee cave salamanders and Appalachian Bewick's wren have been reported from northern portions of Limestone County. No caves are known from the project area; therefore, no suitable habitat for Tennessee cave salamanders exists on the site. Appalachian Bewick's wren prefers nesting in hedgerows or slash piles in early successional habitat. Limited amounts of this habitat exist on the site; however, the quality of this habitat is considered marginal.

3.11.2 Aquatic

Five federally listed endangered aquatic species are known to occur in the vicinity of BFN. The rough pigtoe (*Pleurobema plenum*) and the pink mucket (*Lampsilis abrupta*) are freshwater mussels that 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; El-Ashry and Lesene, 1979; Jeffrey T. Garner - State Malacologist - Alabama Game and Fish Division, personal communication 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 downstream of BFN (Koch, 1999).

Two aquatic snails, restricted to streams entering Wheeler Reservoir in Limestone County, Alabama, were recently listed as endangered by the U. S. Fish and Wildlife Service. The armored snail (*Pyrgulopsis pachyta*) and the slender campeloma (*Campeloma decampi*), as well as the previously listed Anthony's river snail (*Leptoxis* [=*Athearnia*] *anthonyi*), are restricted to tributary creeks to Wheeler Reservoir, located upstream from BFN. No evidence exists to suggest that populations of these species exist in Wheeler Reservoir downstream of BFN.

Other federally-listed species, such as the orange-footed pimpleback mussel (*Plethobasus cooperianusi*), the cracking pearly mussel (*Hemistena lata*), the fine-rayed pigtoe mussel (*Fusconaia cuneolus*), the shiny pigtoe mussel (*F. cor*), Snail darter (*Percina tanasi*), the slackwater darter (*Etheostoma boshungi*), 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, Alabama). None of these species are presently known to exist within the area affected by the proposed actions.

3.11.3 Plants

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 (Table 3.11-2). 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 the project area. In addition, field inspections of the project area reveal that suitable habitats for these or other rare plant species are not present on lands to be affected by the proposed activities.

Table 3.11-2 Rare Plant Species Known from Limestone County, Alabama

Common Name	Scientific Name	Federal Status	State Status†
Duck River bladderpod	*Lesquerella densipila*	none	NOST
Snow wreath	*Neviusia alabamensis*	none	NOST
Sweetflag	*Acorus calmus*	none	NOST
Toadshade*	*Trillium sessile*	none	NOST
Waterweed	*Elodea canadensis*	none	NOST

† NOST - Alabama Natural Heritage Program does not assign status codes to state-listed species; this designation indicates the species is tracked by the Alabama Natural Heritage Program due to its rarity in the state.

* This common name is often applied to more than one member of this genus.

3.12 Wetlands

Wetland resources 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 the 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. Overall, Alabama sustained a net loss of 42,000 acres 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, although urbanization and impacts associated with transportation construction projects still impact wetlands in the state (Flynn, 2001).

WETLANDS IN THE PROJECT AREA

Wetlands in the vicinity of BFN are a mix of habitat types, including palustrine forested wetlands, scrub-shrub wetlands, and emergent wetlands associated with the mainstream of the Tennessee River/Wheeler Reservoir. These areas occur primarily along embayments of the main channel. There are also wetlands associated with various tributary streams in the project area, including 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 along the stream channel and many have been reduced both in extent and function due to clearing and channelization associated with agricultural activities.

National Wetland Inventory (NWI) maps indicate small areas of palustrine emergent and scrub-shrub wetlands occur within the boundaries of BFN, and in the areas proposed for disposal of spoil materials associated with construction. A field survey verified the presence of a palustrine emergent wetland within the boundaries of an excavated unnamed stream channel draining agricultural fields at the northeast boundary of the plant boundary. This area is within the plant boundaries, but not within the areas proposed for disturbance. Vegetation consists of soft rush (*Juncus effusus*), blunt spike rush (*Eleocharis obtusa*), and fescue (*Festuca* spp.). The NWI also indicates a palustrine emergent/scrub-shrub wetland in low-lying agricultural area in the northeast boundary of the plant, in an area proposed for spoil disposal. However, a field survey indicated that this area has been excavated and cleared by agricultural activities to the extent that wetland characteristics are absent from this area.

3.13 Socioeconomic Conditions

3.13.1 Demography

Estimated 2000 population in Limestone County is 65,676, an increase of 21.3% since 1990 and 57.5% since 1970. This growth is much faster than the LMA, the state, or the nation. The LMA includes Colbert and Lauderdale Counties (Florence Metropolitan Area), Lawrence County, Madison County (Huntsville), and Morgan County (Decatur). Total population in the LMA in 2000 was 631,193, an increase of 13.5% since 1990 and 40.1% since 1970, higher than the state and slightly higher than the national growth rate.

The population of Limestone County is projected to reach more than 80,000 by 2015, with a labor market population of over 748,000 at that time. These projections are based on a continuation of growth rates experienced over the last three decades, except for Colbert County, which is projected to continue the growth turnaround experienced since 1990.

Table 3.13-1 Population and Population Projections						
	1970	**1980**	**1990**	**2000**	**2010**	**2015**
Limestone Co.	41,699	46,005	54,135	65,676	74,831	80,762
Colbert Co.	49,632	54,519	51,666	54,984	58,515	60,365
Lauderdale Co.	68,111	80,546	79,661	87,966	95,133	98,799
Lawrence Co.	27,281	30,170	31,513	34,803	37,405	38,881
Madison Co.	186,540	196,966	238,912	276,700	313,143	335,444
Morgan Co.	77,306	90,231	100,043	111,064	126,346	134,093
LMA	450,569	498,437	555,930	631,193	705,373	748,344
Alabama (000)	3,444.4	3,894.0	4,040.4	4,447.1	4,816.5	5,014.0
U. S. (000)	203,302.0	226,545.8	248,790.9	281,421.9	311,318.1	328,413.3

Source: Historical data from U. S. Department of Commerce, Bureau of the Census. Projections by TVA.

Table 3.13-2 Population Growth Rates				
	1970-2000	**1990-2000**	**2000-2010**	**2000-2015**
Limestone Co.	57.5	21.3	13.9	23.0
Colbert Co.	10.8	6.4	6.4	9.8
Lauderdale Co.	29.2	10.4	8.1	12.3
Lawrence Co.	27.6	10.4	7.5	11.7
Madison Co.	48.3	15.8	13.2	21.2
Morgan Co.	43.7	11.0	13.8	20.7
LMA	40.1	13.5	11.8	18.6
Alabama (000)	29.1	10.1	8.3	12.7
U. S. (000)	38.4	13.1	10.6	16.7

3.13.2 Economic Conditions

Limestone County had a total labor force of 29,524 persons on average during 2000, while the labor force in the LMA was almost 316,000. The unemployment rate in the LMA was 3.9%, below the state average and slightly below the national average. Limestone County, itself, had a lower rate of unemployment, 3.3%, well below the state average. These rates of unemployment meant that almost 1,000 persons in Limestone County and over 12,000 in the LMA were unemployed.

Table 3.13-3 Labor Force and Unemployment, 2000			
	Civilian Labor Force	**Number Unemployed**	**Unemployment Rate**
Limestone Co.	29,524	971	3.3
Colbert Co.	25,531	1,606	6.3
Lauderdale Co.	41,381	2,258	5.5
Lawrence Co.	16,703	906	5.4
Madison Co.	145,450	4,101	2.8
Morgan Co.	57,195	2,338	4.1
LMA	315,784	12,180	3.9
Alabama	2,154,273	99,092	4.6
U. S. (000)	140,863	5,655	4.0

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 29,035 jobs in 1999. This 1999 level is 6.8% higher than in 1990. Growth since 1970 has been faster than the LMA, the state, and the nation. However, since 1990 the rate of growth was much slower than the LMA, the state, or the nation. 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.

The LMA grew more slowly from 1990 to 1999 than did the state and the nation, although it grew more rapidly than either during the overall time period since 1970.

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. 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.

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 close to 58,000 by the time a 20-year license extension would expire. The LMA is projected to exceed 434,000 jobs and 535,000 jobs, respectively, by these dates.

Table 3.13-4 Total Employment (Full-time and Part-time), by Place of Work						
	1970	1980	1990	1999	Percent Change, 1970-99	Percent Change, 1990-99
Limestone Co.	14,056	18,300	27,188	29,035	106.6	6.8
Colbert Co.	25,045	29,775	28,594	29,039	15.9	1.6
Lauderdale Co.	20,518	29,126	36,579	42,978	109.5	17.5
Lawrence Co.	7,289	8,905	11,445	12,102	66.0	5.7
Madison Co.	93,110	108,507	165,710	192,297	106.5	16.0
Morgan Co.	34,144	42,699	54,151	64,397	88.6	18.9
LMA	194,162	237,312	323,667	369,848	90.5	14.3
Alabama	1,412,924	1,735,999	2,061,914	2,409,612	70.5	16.9
U. S. (000)	91,281.6	114,231.2	139,426.9	163,757.9	79.4	17.5

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

Table 3.13-5 Projected Total Employment, 2015 and 2035					
	1999	2015	2035	Percent Change, 1999-2015	Percent Change, 1999-2035
Limestone Co.	29,035	41,469	58,013	42.8	99.8
Colbert Co.	29,039	32,294	36,931	11.2	27.2
Lauderdale Co.	42,978	51,879	61,519	20.7	43.1
Lawrence Co.	12,102	19,047	23,497	57.4	94.2
Madison Co.	192,297	215,961	262,638	12.3	36.3
Morgan Co.	64,397	73,470	93,004	14.1	44.4
LMA	369,848	434,120	535,602	17.4	44.8

Source: Projections by TVA.

Table 3.13-6 Percent Distribution by Industry Employment (Full-time and Part-time), by Place of Work, 1999						
	Total	Farm	Manufacturing	Trade and Services	Government	Other
Limestone Co.	29,035	7.7	22.4	37.6	20.3	12.1
Colbert Co.	29,039	3.3	15.7	42.6	20.4	18.0
Lauderdale Co.	42,978	5.1	16.8	48.1	16.9	13.1
Lawrence Co.	12,102	16.4	21.1	29.8	14.0	18.7
Madison Co.	192,297	1.7	15.4	51.6	19.3	12.0
Morgan Co.	64,397	3.2	23.6	43.6	11.8	17.8
LMA	369,848	3.4	17.8	47.3	17.7	13.8
Alabama	2,409,612	3.5	15.7	47.2	16.0	17.6
U. S.	163,757.9	3.2	11.8	52.5	13.6	18.9

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 1989 and 1999. In 1989, per capita income in Limestone County was 79.3% of the national average, but in 1999 the percentage had declined to 74.6%; in the meantime, the state had grown slightly relative to the nation. In a similar pattern, per capita income in the LMA was 90.6% of the national average in 1989, but only 85.8% in 1999. None of the counties in the LMA had average income above the national average in 1999, although Madison County did in 1989. Both Madison and Morgan Counties had average incomes higher than the state average in 1999, as well as in 1989.

Table 3.13-7 Per Capita Personal Income

	Per Capita Personal Income, 1989	Per Capita Personal Income, 1999	Percent of Nation, 1989	Percent of Nation 1999
Limestone Co.	14,714	21,294	79.3	74.6
Colbert Co.	14,260	22,550	76.8	79.0
Lauderdale Co.	14,587	21,036	78.6	73.7
Lawrence Co.	11,952	20,691	64.4	72.5
Madison Co.	19,223	27,049	103.5	94.8
Morgan Co.	16,858	24,585	90.8	86.1
LMA	16,812	24,498	90.6	85.8
Alabama	14,899	22,972	80.2	80.5
U. S.	18,566	28,546	100.0	100.0

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

3.13.3 Community Services and Housing

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.

3.13.4 Environmental Justice

Minority population in Limestone County and in the LMA is a smaller share of the total than in the state or the nation. Limestone County has a minority population of 11,534, some 17.6% of the total, while the LMA has a minority population of 139,362, some 22.1% of the total. Poverty levels in both Limestone County and in the LMA as a whole are below the state average. For the LMA as a whole, the poverty rate is also lower than the national average, while the rate in Limestone County is about the same as the national average.

Table 3.13-8 Minority Population, 2000, and Percent Below Poverty Level, 1997				
	Total Population	**Minority Population**	**Percent Minority**	**Percent Below Poverty Level**
Limestone Co.	65,676	11,534	17.6	13.5
Colbert Co.	54,984	10,514	19.1	13.5
Lauderdale Co.	87,966	10,726	12.2	13.3
Lawrence Co.	34,803	7,904	22.7	15.7
Madison Co.	276,700	80,204	29.0	11.0
Morgan Co.	111,064	18,480	16.6	11.4
LMA	631,193	139,362	22.1	12.1
Alabama	4,447,100	1,321,281	29.7	16.2
U. S.	281,421,906	86,869,132	30.9	13.3

Source: U. S. Bureau of the Census.

BFN is located in Census Tract 211, not far from Census Tract 204.01. According to the 2000 Census of Population, 35.0% of the population in Tract 211 and only 8.6% of the population in Tract 204.01 is minority.

3.14 Transportation

3.14.1 Highways and Roads

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 3.14-1 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.

3.14.2 Railroads

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.

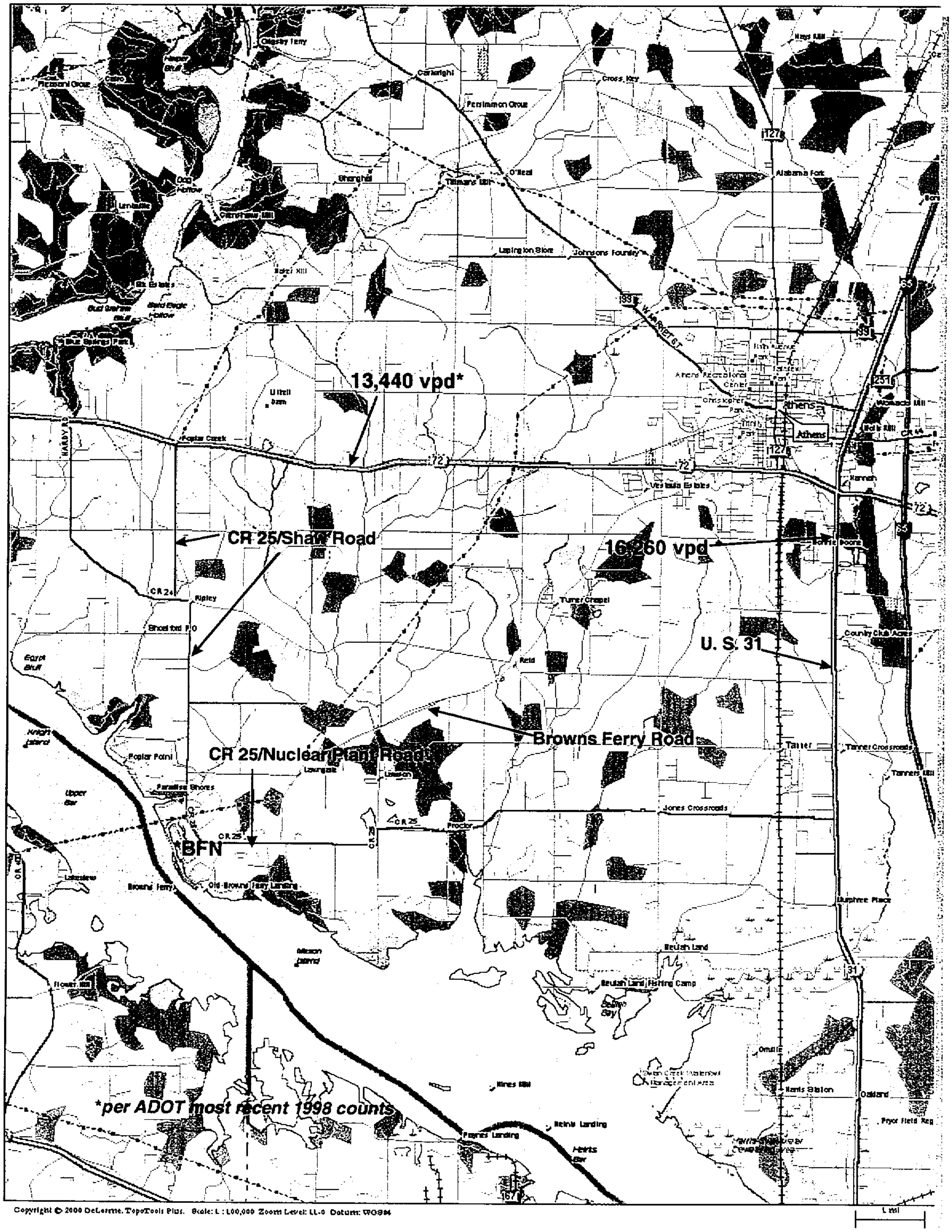
The railroad spur track and unloading area is currently planned for future removal off site of dry cask spent fuel storage canisters. There are no plans to use it for Unit 1 refurbishment or regular plant operations.

3.14.3 River Transport

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 any decision on refurbishing Unit 1. Appropriate environmental analyses would be done if TVA decides to propose upgrading the barge facility.

Figure 3.14-1 Local Road Network for BFN



3.14.4 Pipelines

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.

3.14.5 Transmission Lines

The 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.

3.15 Soil and Land Uses

3.15.1 BFN Environs

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, 1979). 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.

3.15.2 Past and Existing Land Uses (Including Offsite)

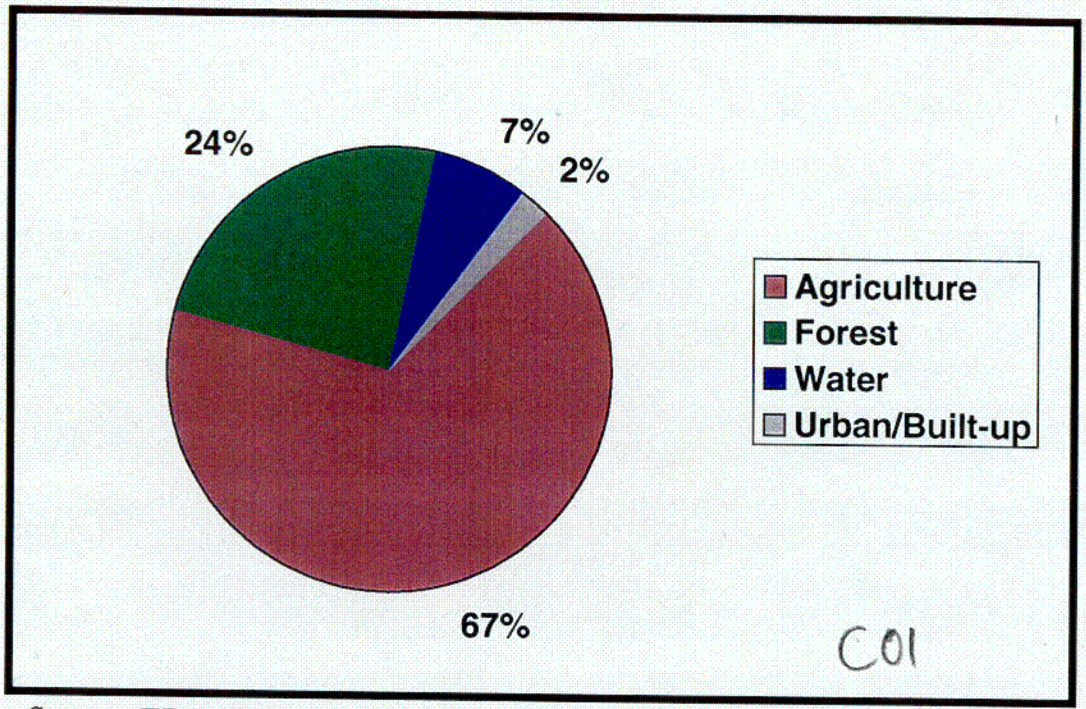
BFN is located in an agricultural area, surrounded by cropland planted with cotton. About 66.8% of the total acreage in the county is used for agriculture, the highest in Alabama (Figure 3.15-1). There are an estimated 78,900 acres (23.9%) of land in forest. The majority of the forestland is located 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, 1985). 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 3.15-1), 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, 1985). 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 3.15-1 Land Use in Limestone County



Source: EPA 1994

3.15.3 Land Use Planning and Controls

Limestone County, as part of Top of Alabama Regional Council of Governments, developed a Comprehensive Plan in 1985 to cover the period to year 2000 (Limestone County Comprehensive Plan, 1985). 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.

3.16 Visual Resources

The physical, biological, and cultural features seen in the landscape give a geographic area its distinct visual character and sense of place. Varied combinations of these elements make the visual resources of an area identifiable and unique. Scenic integrity indicates the degree of intactness, unity, or wholeness of the visible landscape. Aesthetic considerations include scenic beauty, scale, contrast, harmony, color, density, noise, and other qualities that affect the sense of place. Views of the affected landscape are described in terms of foreground, middleground, and background distances. Foreground is considered the area within a half-mile of the observer where details of objects are easily distinguished in the landscape. Middleground is the zone between foreground and background, normally between a mile and four miles from the observer. The objects may be distinguishable, but their details are weak and they tend to merge into larger patterns. Background is the distant part of the landscape, where objects are not normally discernible unless they are especially large and standing alone. Details are generally not visible and colors are lighter.

BFN is located off of County Road 25 (Nuclear Plant Road) approximately twelve miles south of Athens, Alabama. 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. Little traffic is seen along the roadway except at plant shift changes and during deliveries. 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. Elevations across the plant site and in the surrounding areas rise gradually from 558 feet above sea level at the north shore of Wheeler Lake to around 800 feet above sea level ten miles north in the vicinity of Athens. The average elevation of the plant site is 575 feet above sea level. Scenic integrity is moderate, contrasting occasionally with homes that have lake views from across the river.

Access to the plant site is from Browns Ferry Road to County Road 25 from State Route (SR) 72 in Athens. The 600-foot high off gas stack comes into view over existing tree lines while traveling along Browns Ferry Road. Closer to the plant site, near County Road 25, the plant site comes into view. The site has remarkable contrast to the mostly rural countryside that surrounds it. From this viewpoint, clusters of transmission lines and associated steel pole and tower structures can be seen in the foreground and near middleground. These features identify the power plant and its associated architecture and infrastructure as predominately industrial facilities with little transition from rural countryside.

There are no homes within foreground viewing distance to the north and east. However, there is a small residential development to the northwest, across Wheeler Reservoir southwest, and Mallard Creek public use area that has partial views of the plant site. The views from the homes northwest off of County Road 25 are of the existing mechanical draft cooling towers (approximately 60 feet in height), a portion of the 500-kV switchyard and the turbine and reactor building. A berm, graded during the initial construction of the plant site and containing approximately 3.3 million cubic yards of earth, lies adjacent to the hot and cool water channels and blocks views of the northern and eastern plant areas. The homes to the southwest and from the Mallard Creek area have views of the off gas stack, the cooling towers, and the turbine and reactor building. These views may be somewhat obscured in the early morning hours, particularly in the fall and winter, as heavy fogs rise from the warmer waters of the lake.

3.17 Recreation

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.

3.18 Cultural Resources

3.18.1 Archeological 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 (Walthall, 1980; McNutt and Weaver, 1985). 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 16^{th}, 17^{th}, and 18^{th} 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 19^{th} 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 20^{th} century. Industrialization and urbanization has characterized the region in the late 20th century.

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 and consultation has been initiated with the Tennessee SHPO 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.

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 2.2-7) identified a prehistoric archaeological 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.

3.18.2 Historical Structures

An architectural survey was conducted within the visual APE of the proposed project area. No historic structures were identified.

3.19 Environmental Noise

3.19.1 Introduction

Areas that are potentially affected by environmental noise from typical industrial operations are usually within a mile radius of the noise source(s). Sometimes effected areas can reach to two miles under special conditions that are favorable to outdoor sound propagation. This evaluation is primarily concerned with the potential environmental noise effects of the addition and replacement of cooling towers in Alternative 2. Although there are only a couple of residences within the one-mile radius of the center of the main-plant building, there are many residences within a mile of the cooling tower area. Also, within two miles is the Lakeview Community across the river. The open path across water is favorable to sound propagation toward Lakeview. The following sections present a more detailed description of the potentially affected areas; the regulations, standards, and guidelines concerning environmental noise; the possible effects that environmental noise might have on people; and the current noise environment in the area.

3.19.2 Potentially Affected Areas

As anticipated, there has been substantial change in the character of some of the areas surrounding BFN subsequent to the release of the original EIS. Generally, the number of residences and population along the waterfront have increased and the industrial activity on and along the river has also increased.

Upstream and adjacent to the BFN property are new developments of waterfront homes. (Pointe Westmoreland and Lookingbill subdivisions). There are about 40 residences along approximately 4,400 feet of riverfront. The nearest house is within 100 feet of the BFN property line on the east side. These residences are more than a mile from the closest cooling towers 1 and 6, and there is a small hill and the main plant in between this residential area and the cooling towers. Also, there are no favorable conditions for sound propagation in this direction. For these reasons, this residential area is not considered sensitive to environmental noise.

Downstream and adjacent to the BFN property and adjacent to cooling tower area is an older waterfront community, Paradise Shores. This area had few residences in-place when the plant was built, and it is currently a mix of year-around and recreational homes. There are about 100 residences within one mile of the closest cooling towers, and some are as close as 1,500 feet. Paradise Shores is a medium to high density suburban area. This is an area that could be sensitive to environmental noise.

The Lakeview Community is across the river and approximately 8,500 feet from the center of the cooling tower area. It is primarily year-around homes with a few recreation residences. Most of these were built after BFN was constructed. As mentioned in the Introduction, this area could be sensitive to environmental noise because of the favorable sound propagation characteristics across water.

The areas northeast of BFN are still agricultural as they were when the plant was built. There are no residential developments within a mile of the cooling tower, and these areas are not considered sensitive to environmental noise.

3.19.3 Noise Regulations, Ordinances, Guidelines, and Other Useful Criteria

Generally, environmental noise regulations, ordinances, guidelines, and other criteria are set for two reasons. First, to protect the existing residents from the potential impact of new noise sources; and second, to protect new residents from the existing noise sources. The guidelines from the U. S. EPA found in its "levels" document (EPA, 1974) and most municipal noise ordinances (Gatley, 1979) address the first reason. Also, the Federal Interagency Committee on Noise (FICON, 1992) recommends using potential noise impact analysis as a criterion in possible mitigation of sensitive areas when siting airports. Whereas, guidelines from the U. S. Department of Housing and Urban Development (HUD, 1983) and the Federal Interagency Committee on Urban Noise (FICUN), a predecessor to Federal Interagency Committee on Noise (FICON), (FICUN, 1980) concentrate on the second reason to protect new residents from moving into an incompatible noise environment.

The guideline from EPA recommends an average annual equivalent sound level day/night (DNL) of 55 dBA to protect the health and well being of the public with an adequate margin of safety. Guidelines and recommendations from HUD and FICUN also use DNL as their measurement metric and give tables of compatible use categories based on the existing DNL levels. For example, both HUD and FICUN use 65 DNL as their upper limit for acceptable residential development without added noise reduction construction. FICON also uses DNL as its metric.

There are no Federal, State of Alabama, or local municipal noise standards, regulations, or ordinances that apply to the action alternatives evaluated in this SEIS.

TVA uses the EPA guideline of 55 dBA DNL as a design goal when feasible if the nearest receptor is residential, and the equivalent sound level (L_{eq}) of 60 dBA at the property line in industrial and commercial areas. In addition, TVA uses the FICON (FICON, 1992) recommendation that a 3 dB increase indicates possible impact and the need for further analysis when the background DNL is 60 dBA or less. These guidelines were developed and published since the original BFN EIS. At that time, TVA used the HUD guideline of 65 dBA DNL (HUD, 1971) as normally acceptable for adjacent residential areas.

3.19.4 Potential Effects of Environmental Noise

3.19.4.1 Hearing Loss

Exposure to high noise and sound levels can cause hearing loss. The Occupational Safety and Health Administration (OSHA) regulates noise exposure in the workplace and EPA gives guidance for exposure to environmental noise to prevent hearing loss. For environmental noise, EPA recommends an average annual exposure limit of 70 dBA equivalent sound level for 24 hours

[$L_{eq}(24)$] over 40 years to prevent hearing loss (EPA, 1974). The Occupational Safety and Health Administration (OSHA) exposure standard is 90 dBA for eight-hour exposure over a working lifetime (OSHA, 1984).

3.19.4.2 Annoyance and Complaints

Along with the physical, hearing loss response from exposure to prolonged, high levels of environmental noise, there can be annoyance and complaints from the disturbance of social and personal activities caused by moderate levels of environmental noise exposure. Noise can interfere with communications, relaxation and sleep, and concentration. In the FICON analysis of noise effects, annoyance was identified as the summary of the general adverse reactions that people have to noise. Specifically, it states that the best measure of this adverse response is the percentage of the effected population that is characterized as "highly annoyed" as a function of DNL (FICON, 1992). FICON recommends using the updated "Schultz curve" to define the relationship between highly annoyed and DNL. The Schultz curve relationship was originally recommended by EPA in its 1982 guidance document (EPA, 1982), and it was updated by the U. S. Air Force Armstrong Laboratory (FICON, 1992). The updated relationship is:

$$\%\ \text{Highly Annoyed} = \frac{100}{1 + e^{[11.13-0.141(\text{DNL})]}}$$

Eq. 3.19-1

This relationship is shown in Table 3.19-1 in tabular form below.

Table 3.19-1 Percentage Highly Annoyed Based on DNL

DNL, dBA	40	45	50	55	60	65	70	75	80	85	90
Percent Highly Annoyed	0.4	0.8	2	3	6	12	22	36	54	70	83

The discussion in the FICON document goes on to state that complaints are not an absolute measure of the impact of environmental noise on a community. It explains that annoyance can exist without complaints and the converse is also possible.

3.19.4.3 Communication Interference

Sentence intelligibility is one method of determining communication interference when background or intruding noise is broad spectrum. This is usually the case when there are multiple noise sources. In the EPA "levels" document (EPA, 1974), it estimates that there is 99% sentence intelligibility for normal voice communications when the background noise is 54 dBA or less and 100% at 45 dBA or less. This correlates very well with another presentation found in Harris (Harris, 1991) that shows that "just-reliable" normal voice communication can occur at background noise levels as high as 58 dBA when the speaker and listener are one meter apart.

Typical residential construction provides about 20 dB of noise reduction from the outside to the inside with the windows closed. This is factored into the FICUN category of "compatible" at 65 dBA DNL to give an indoor level of 45 dBA or less (FICUN, 1980) in the minimal or moderate noise exposure zones. A 20 dB noise reduction for residential construction also falls within the range of noise reduction given by EPA (EPA, 1974). The HUD guidelines state that common building construction will make the indoor noise environment acceptable when the DNL is 65 dBA or less. In higher noise exposure zones, residential structures need to be constructed with higher noise reduction to prevent potential communication interference.

3.19.5 Current Noise Environment

The current noise environment is different than prior to the construction and operation of BFN. Since that time, the residential population adjacent to BFN has grown (see section 3.19.2), the industrial park about two miles upstream and across the river has expanded, and barge traffic has increased. All of these have some effect on the noise environment. The background noise measurements presented in the original BFN EIS are not applicable to the action alternatives evaluated in this SEIS. The environmental noise evaluation of these action alternatives is concerned with the potential effects of additional cooling tower(s) and the replacement of the current cooling towers which operate during the peak of the summer. The original background noise was measured in November, 1971. A 24-hour background noise survey was conducted June 11-12, 2001, in the Paradise Shores and Lakeview communities. The survey location at Paradise Shores was about 1,500 feet from cooling tower 3 along its major axis. In Lakeview, the survey location was in a vacant lot in the center of the community. The 15 hour daytime (0700-2200) average noise was 45.7 dBA, and the nine hour nighttime average was 43.1 dBA at Paradise Shores and 44.1 dBA and 38.7 dBA at Lakeview. Predominant noise sources were typical of suburban life, and included traffic, lawn mowing, home air-conditioning units, and children. At night, insects, frogs, air-conditioning, and traffic were dominant, although Lakeview had less traffic because of a posted restriction.

A daytime noise survey of three of the current operating cooling towers was conducted July 30, 2001. Towers 2, 3, and 5 were operating, and these are the towers closest to Paradise Shores. The noise from the towers was audible at 1,500 feet in the Paradise Shores area, but it was not audible in the Lakeview Community. Measurements were taken at the same location in Paradise Shores as the background measurements, and another set of measurements was taken at 520 feet off the northwest end of tower 3 inline with the Paradise Shores measurement location. The total noise in Paradise Shores was 45.8 dBA, and at 520 feet it was 47.6 dBA. Based on the 520-foot measurements, the calculated intruding noise from the cooling towers at the 1,500-foot location in Paradise Shores is 38.4 dBA. By adding this calculated intruding noise to the daytime background noise level measured in June, the calculated total noise level is 46.4 dBA, which is similar to the total noise measurement of 45.8 dBA. The operation of towers 1 and 6 would cause a negligible increase, less than 1 dB to the total noise in Paradise Shores because the towers are an additional 1,800 feet away and partially blocked by other towers. Also, operating a cooling tower of similar design at the number 4 tower location would add about 3 dBA to the intruding noise and about 1 dBA to the total noise Leq (24 hrs.) in Paradise Shores to 47 dBA.

Noise from the three operating cooling towers was not detectable in the Lakeview Community on the day of the survey. The calculated intruding noise from the current towers would be 38 dBA based on measured data taken broadside to the towers on July 30. This intruding noise is about 6 dBA less than the daytime background noise level taken in June.

These measured and calculated noise levels, along with the number of operating days of the cooling towers, can be used to calculate the average annual DNL. In the past five years when both BFN units 2 and 3 operated, the cooling towers ran an average of 17 days per year. The range of operating days was from 7 to 27 during this time and included 12-hour start-up and 12-hour shutdown periods. The measured and calculated intruding noise at Paradise Shores, 1,500 feet from the current cooling towers, is about 42 dBA, and the 24-hour and average annual DNLs are 52 and 50 dBA, respectively. At the Lakeview Community across the river, the intruding noise from the cooling towers is not detectable, but the calculated intruding noise is 38 dBA and the 24-hour and average annual DNLs are 48 and 46 dBA, respectively. The maximum average annual DNL for the largest number of operating days, 27, is 50 dBA at Paradise Shores, and 46 dBA at Lakeview. These levels assume that all cooling towers operated the entire periods. Frequently, fewer towers operated which makes these calculated levels the maximum. Table 3.19-2 presents the current noise levels at Paradise Shores and Lakeview communities.

Table 3.19-2 Current Noise Environment*

Location	Background Leq (24 hrs.)	Total Leq (24 hrs.)	DNL 24 hrs	Average Annual DNL 17 days op.	Ave. Annual DNL 27 days op.
Paradise Shores	45	47	52	50	50
Lakeview	43	44**	48**	46**	46**

*All data are dBA.

**Noise from current operating cooling towers was not detectable; these are calculated values.

3.20 Public and Occupational Safety & Health (Non-Radiological)

3.20.1 Site Safety and Health Plan

The TVA nuclear work force has achieved recordable injury rates that are among the lowest in the utility industry. Employees are required to be trained in the safe handling of chemicals that they use in the work environment. Additionally, numerous other safety-related training courses are conducted to respond to OSHA requirements for workers. Operation and construction (i.e., refurbishment and restoration) activities are required to meet or exceed Federal regulatory requirements for safety design, inspection and OSHA regulations. BFN has a 24-hour fire and rescue staff that is Certified Emergency Medical Technicians (EMTs). Emergency medical response procedures are outlined in various Rad/Chem and Emergency Preparedness procedures. Professional medical treatment and testing is available on site with a permanent medical staff that includes a physician. The TVAN Safety and Health Manual contains requirements designed to assure that management administers a strong safety program.

Included in the Safety and Health Manual are provisions for:

Personal protective equipment use,
Safety training requirements for workers,
Accident reporting and investigative requirements,
Hazard communication and right to know,
Heat stress management,
Confined spaces,
Electrical work practices,
Use of chemicals,
Industrial hygiene,
Lead and asbestos abatement,
Fall protection, and
Job safety planning

Employees are trained in applicable safety procedures and methods prior to the start of work at the facility.

3.20.2 TVA's Employee Safety Program

There exists the potential for workers to be exposed to health and safety hazards while constructing and operating the facilities. Construction activities are conducted in accordance with OSHA Construction Industry Standards (29 CFR 1926). All other activities are conducted in accordance with OSHA General Industry Standards (29 CFR 1910) and OSHA Federal Safety and Health Program Requirements (29 CFR 1960). These standards establish practices, chemical and physical exposure limits, and equipment specifications to preserve employees' health and safety. Standards and requirements also apply to TVA contractors and vendors. Contractor operations are monitored to ensure operations are conducted in a safe and healthful manner and that they meet contract requirements.

The TVA Hazard Communication Program ensures that Material Safety Data Sheets (MSDSs) are available and appropriate labels are visible to employees for all products to which they might be exposed in the course of their workday.

TVA's Safety and Occupational Hygiene Program is designed to help the agency conduct its operations in a manner which protects the safety and health of employees. The Safety and Occupational Hygiene Program, headed by a Designated Agency Safety and Health Official (DASHO), defines the activities necessary to prevent on-the-job accidents and occupational illnesses and diseases. This program is implemented by a joint effort among TVA's managers, labor organizations, and employees with guidance and assistance from the DASHO and a professional staff. The program's highlights include:

Workplace Standards - Standards, work rules, and other practices developed by regulatory agencies and by TVA provide employees direction on safe work practices and working conditions.

Job Safety Planning - All jobs undertaken are planned by those involved in sufficient detail to ensure that hazards are identified and eliminated or controlled to an acceptable level.

Training - Each organization provides for job training to improve the safety knowledge and skills of employees and enable them to perform their jobs in a safe and healthful manner.

Employee Involvement - TVA's success in protecting people and property from accidental harm depends on the involvement of all employees in its safety program. Employees are actively involved in the development and implementation of workplace standards and other program activities to minimize unsafe acts and conditions through participation on safety and health committees and through interaction with management and fellow employees.

Workplace Inspection Monitoring and Audits - Workplaces are regularly inspected and monitored to ensure that they meet regulatory and agency requirements. Regular audits assess the effectiveness of inspection and monitoring programs as well as activities to prevent accidents and illnesses. These audits provide the feedback necessary to ensure control of workplace hazards and keep efforts focused on continuous improvement.

Accident Reporting and Investigation - All accidents are reported and investigated by management. Investigations address the following elements:

- Root causes are identified,
- Corrective action to prevent future accidents is recommended,
- Accident data is analyzed for trends to help direct future safety program efforts, and
- Information is shared throughout TVA to support the accident prevention efforts to other organizations.

3.20.3 Fire Protection

BFN has a Fire Protection Plan which is applicable to all activities at or related to BFN which could affect the life or health of TVA employees or the public, the probability or severity of potential fires throughout the plant, or the ability to maintain safe plant shutdown, or limit radioactive release to the environment in case of fire. To assure that the program functions properly and to meet the requirements of 10 CFR 50.48, a Fire Protection Plan has been developed for BFN. The Fire Protection Plan is incorporated into the UFSAR by reference as recommended in NRC Generic Letter 86-10. This document is the sole source for fire protection program commitments at BFN. The Fire Protection Plan contains the current fire protection commitments that affect the Fire Protection Program. The Fire Protection Plan is revised, as required, to reflect all new commitments that affect the BFN Fire Protection Program.

The objectives of the Fire Protection Plan are achieved through the integration of fire protection into the design, construction, operation, and maintenance of the plant and equipment; by fire prevention techniques; and by providing appropriate fire detection and suppression features and fire rated compartmentation. This is known as a defense-in-depth concept, which employs multiple levels of safety measures to attain the required high degree of safety. In addition, the defense-in-depth approach includes the proper administrative controls necessary to maintain program integrity.

The BFN fire protection systems are designed to provide automatic fire protection for known hazardous areas where it is practical to do so, to provide adequate warning of fire in hazardous areas where automatic protection is not feasible, to provide adequate manually-actuated fire protection systems for the entire plant and yard areas (i.e., hose stations, hydrants, etc.), and to ensure the maintenance of divisional integrity of safety-related systems to the extent that the capability for safe shutdown of the reactors is assured during and after a fire. The common parts of the BFN fire protection systems are the high pressure water subsystem (supplies sprinkler/spray systems and fire hose stations), the low pressure carbon dioxide subsystems (used in plant areas with flammable oil and electrical hazards), the fire detection/annunciation and protective action initiation systems, and the compartmentation and fire retardant systems.

Fire prevention is an important part of the overall BFN Fire Protection Plan. The primary objective of the fire protection activities is to prevent fire from occurring. The plant fire prevention program consists of identification, evaluation, and control of fire hazards. Administrative controls have been established to control both combustibles and ignition sources to the greatest extent possible. Procedures have been established to minimize fire hazards and fire protection impairments in areas containing structures, systems, and components important to safety and to maintain the performance of the fire protection systems and personnel. NFPA guidelines have been used as a basis for these procedures.

Effective handling of fire emergencies is an important aspect of the BFN defense-in-depth Fire Protection Program. This is accomplished by the provision of a trained and qualified emergency response organization, the fire safety awareness of all plant employees, a comprehensive pre-fire plan, safe shutdown procedures, and the ability of the operations personnel to perform such procedures.

3.20.4 Electric and Magnetic Fields

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

Studies, interpretations, and research to date are not conclusive about potential associations between electric or magnetic fields and possible health impacts. A few studies have been interpreted by some as suggesting a weak statistical relationship between magnetic or electric fields and some form of rare cancer. However, equal numbers of similar studies show no association. The present weight of this type of evidence does not allow any conclusion and does not indicate a cause and effect relationship between fields and health effects. No laboratory research has found such a cause and effect adverse health impact from EMF, and no concept of how these fields could cause health effects has achieved scientific consensus.

TVA's standard for siting new transmission lines has the effect of minimizing public exposures to EMF during their operation.

3.20.5 Shock Hazards

Shock hazards are produced mainly through direct contact with conductors and have effects ranging from a mild tingling sensation to death (NRC, 1991). 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 (NRC, 1991). TVA's design ensures that the transmission lines meet the requirement given in NESC (TVA, 1994b). Therefore, the impact of shock hazards and EMF exposure are minimal, as a result of operation of the BFN Plant.

3.20.6 Airborne Pathogenic Microorganisms

Some thermophilic microorganisms associated with cooling towers and thermal discharges can have deleterious impacts on human health. These microorganisms include the enteric pathogens *Salmonella* sp. and *Shigella* sp., as well as *Pseudomonas aeruginosa* and thermophilic fungi. Methods of testing for these microorganisms are known and their presence in aquatic environments is often controllable. Other microorganisms normally present in surface water, but not as easily detected or controlled, include the bacteria *Legionella* sp. (which causes Legionnaires' disease) and the amoebae of the genera *Naegleria* and *Acanthamoeba*, which causes a rare but very serious human infection, primary aerobic meningoencephalitis (PAME) (NRC, 1991).

Legionella sp. has been found in the aerosols in the vicinity of condensers or cooling tower basins that were in the process of being cleaned. Two reported cases of infections related to *Naegleria* sp. that were associated with the cleaning of cooling towers have been reported (NRC, 1991). For this reason, utilities that identify microorganisms that are responsible for PAME in the cooling tower often require respiratory protection for workers in the vicinity of the cooling towers and condensers.

The potential health effects from *Naegleria* sp. at sites such as the BFN site, located on rivers with average flow rates less than 2,830 cubic meters per second (100,000 cubic feet per second), are a public health concern (NRC, 1991). These microorganisms occur in surface water where the risk of infection is always present. Increases in average water temperature due to weather or climatic conditions, or from the discharge of heat, may cause an increase in the levels of the microorganisms. Information obtained by TVA in discussions with the Centers for Disease Control and Prevention indicated that to contract primary amoebic meningoencephalitis from *Naegleria* sp., large doses of cyst-contaminated water must enter the nasal mucosa area. A few cases have been reported in swimmers from Texas and the Carolinas during the past few years; however, these were not associated with aerosol cysts from power plant cooling towers (TVA, 1994g). The Tennessee Department of Health was not aware of any cases for which either *Legionella* sp. or *Naegleria* sp. was associated with cooling towers in Tennessee (TVA, 1994b).

TVA concludes that the operation of the BFN plant has not resulted, and is not likely to result, in adverse effects to human health as a result of the presence of these microorganisms.

3.20.7 Hazardous Chemicals

Table 3.20-1 lists the hazardous chemicals in storage for use at BFN, along with their storage location. All of the hazardous chemicals at BFN are either stored inside plant buildings, or are equipped with secondary containment to contain the chemicals in the event of a spill. None of the chemicals stored on-site exceeds the quantity limitations that would require preparation of a Risk Management Plan under 40 CFR Part 68.

In accordance with State and Federal Regulations, BFN has developed a Spill Prevention, Control and Countermeasure (SPCC) Plan that includes spill response assignments and responsibilities, best management practices for controlling and managing oil and chemical storage, and contingency plans in the event of an incident.

BFN has an on-site Hazardous Materials Response Team that is trained and certified to respond to, contain, and clean up oil and hazardous chemicals that may be released. In addition, BFN has the necessary supplies and equipment on-site to control chemical releases, and has arrangements in place for outside assistance in the event of a serious incident.

BFN maintains Material Safety Data Sheets for all hazardous chemicals on-site, and operates a Chemical Traffic Control (CTC) Program to control the use and distribution of chemicals on the site.

Implementation of the alternatives discussed in this EIS would not result in significant differences in the amounts or types of hazardous chemicals stored or used at BFN on an annual basis. All chemicals proposed for use on-site are reviewed and approved for use through the CTC program.

Table 3.20-1 Chemical Storage by Area

Drainage[a] Area	Location	Substance	Physical State	Maximum Storage[b]	Storage Vessels	Secondary Confinement: Type	Secondary Confinement: Percent of Maximum Storage Capacity
4	Hazardous Waste Storage Building	waste solvents, waste acid, and waste caustic, spent fluorescent lighting	liquid	825	drums (15)	Floor drain sump	91
1	Intake	sodium hypochlorite	liquid	5,700	tank (1)	Concrete wall and floor	>100
		Calgon H-940 (sodium bromide)	liquid	5,700	tank (1)	Concrete wall and floor	>100
		Calgon CL-50 (sodium hexametaphosphate)	liquid	1,600	tank (1)	Double-walled tank	100
		Calgon PCL-401 (anionic copolymer)	liquid	1,600	tank (1)	Double-walled tank	100
		Calgon H-300 (glutaraldehyde)	liquid	300	bin (1)	Plastic pan	>100
		Calgon EVAC (molluscicide)	liquid	300	bin (1)	Plastic pan	>100
1	Offgas Building	ethylene glycol	liquid	15,000	tanks (3)	Building sump	>100
1	Modifications Area • Oil Rack	methyl ethyl ketone	liquid	165	drums (3)	Metal pans	>100
		mineral spirits	liquid	385	drums (7)	Metal pans	>100
		ethylene glycol	liquid	110	drums (2)	Metal pans	>100
	• Paint Shop	paints, epoxies, and resins	liquid	1,500-2,000	1- and 5-gallon cans	None	-
1	• Materials Procurement Complex (MPC-B3B (BFN-1) (MPCJ)	hydrazine (35%)	liquid	165	drums (3)	None	-
		paint thinners	liquid	770	drums (14)	None	-
		boric acid	granular	3,425 lbs.	bags (35)	Not applicable	-
1	Reactor Building	aqueous film-forming foam	liquid	900	tank (3)	Floor drain sump	>100
		sodium nitrite (30%)	liquid	5	tank (1)	Floor drain sump	>100
		sodium pentaborate (9.2%)	liquid	4,850	tank (2)	Floor drain sump	>100

Table 3.20-1 Chemical Storage by Area

Drainage[a] Area	Location	Substance	Physical State	Maximum Storage[b]	Storage Vessels	Secondary Confinement	
						Type	Percent of Maximum Storage Capacity
4	Mixed Waste Storage Area	waste solvents, waste acids, and waste caustic, waste lead paint chips	liquid solid	3,465	drums (63)	Floor drain sump	65
1	• Service Building • • Paint Room • Power Stores	paint	liquid	100	cans (40)	None	
		ethylene glycol	liquid	165	drums (3)	None	
		mineral spirits	liquid	660	drums (12)	None	
		thinner	liquid	330	drums (6)	None	-
		sodium nitrite	solid	360 lbs.	plastic bags or jars	Not applicable	-
	Thinner Rack (near Service Building)	thinners	liquid	330	drums (6)	None	-
1	Turbine Building	sodium hypochlorite	liquid	8,530	tank (1)	Containment diking	>100
		Calgon PCL 401 (anionic copolymer)	liquid	1550	tank (1)	dike	>100
		Calgon CL 50	liquid	4400	tank (1)	dike	>100
		Calgon EVAC	liquid	300	bin (1)	plastic pan	>100
		Calgon H-300	liquid	300	bin (1)	plastic pan	>100
		Calgon H-940	liquid	1550	tank (1)	dike	>100
							>100
		hydrazine (0.1%)	liquid	125	reservoirs (1)	Floor drain collector tank	>100
		hydrazine (35%)	liquid	55	drum (1)	Metal pan	>100
		ammonium hydroxide (50 ppm)	liquid	125	tank (1)	Floor drain collector tank	>100

[a]There are no chemicals of concern stored in drainage areas 2 and 3.
[b]Units are gallons unless otherwise stated.

3.20.8 Site Emergency Response Plan

BFN has a Radiological Emergency Plan (REP) which addresses organizational responsibilities, capabilities, actions and guidelines for TVA during a radiological emergency. However, the REP is also designed to be implemented based on a variety of situations that could potentially adversely affect the operations of a TVA nuclear plant such as BFN. In addition to radiological emergencies, these include natural events, chemical spills, toxic gas releases, fires, plant operational problems, etc., which may pose a threat to the safe operation of the plant and have a potential impact offsite. The REP is described in Section 3.21.3.

3.21 Radiological Impacts Baseline

3.21.1 Normal Operations

3.21.1.1 Occupational

Occupational radiological impacts refer to radiation dose received by individuals in the course of their employment. Section 4.3.21.1.1 contrasts the current industry and facility occupational radiation dose trends against the current limits established by federal regulation to minimize the potential health risk to individual workers. At BFN, the average annual dose to workers and the average collective worker dose per reactor are consistent with current industry trends for this type of reactor (boiling water reactor) and worker radiation exposures are controlled to be significantly less than regulatory limits.

3.21.1.2 Public

Commercial nuclear power reactors, under controlled conditions, release small amounts of radioactive materials to the environment during normal operation. These releases result in radiation doses to humans that are small relative to doses from natural radioactivity. Nuclear power plant licensees must comply with NRC regulations (e.g., 10 CFR Part 20, Appendix I to 10 CFR Part 50, 10 CFR Part 50.36a, and 40 CFR Part 190) and conditions specified in the operating license.

The BFN Off-site Dose Calculation Manual (ODCM) provides the methodology used to calculate offsite doses based on gaseous and liquid effluent releases from the plant. These releases are reported in BFN's annual radioactive effluent release report. The ODCM specifies the parameters used to calculate potential off-site doses due to radioactive liquid and gaseous effluents and to ensure compliance with the following limits:

- The concentration of radioactive liquid effluents released from the site to the unrestricted area will be limited to levels that meet regulatory requirements.
- The exposure to any individual member of the public from radioactive liquid effluents will not result in doses greater than the design objectives of 10 CFR Part 50, Appendix I.

- The exposure to any individual member of the public from radioactive gaseous effluents will not result in doses greater than the design objectives of 10 CFR Part 50, Appendix I.
- The dose to any individual member of the public from the nuclear fuel cycle will not exceed the limits in 40 CFR Part 190 and 10 CFR Part 20.
- The dose rate from radioactive gaseous effluents at any time at the site boundary will be limited to:
  (a) less than or equal to 5 mSv/yr (500 millirem per year (mrem/yr) to the whole body and less than or equal to 30 mSv/yr (3,000 mrem/yr) to the skin for noble gases, and
  (b) less than or equal to 15 mSv/yr (1,500 mrem/yr) to any organ for iodine-131 and -133, tritium, and for all radioactive materials in particulate form with half-lives greater than eight days.

BFN's recent operating experience has shown that doses from gas and liquid effluents are a small fraction of the applicable radiological dose limits.

TVA has conducted a Radiological Environmental Monitoring Program (REMP) since 1973 to assess the impact of BFN operations on the surrounding environs and the general public. The purpose of the REMP is to:

- Provide verification that radioactive material released to the environment as a result of plant operations and the ambient environmental radiation levels attributable to plant operations are within the NRC regulatory limits and the EPA environmental radiation standards in 40 CFR Part 190.
- Provide for the assessment of any measurable buildup of long-lived radionuclides in the environment.
- Monitor and evaluate ambient environmental radiation levels.
- Determine if plant operations results in any statistically significant increase in the concentration of radionuclides in the environs of the plant site.

The REMP conducted for BFN is designed to monitor the primary pathways for exposure to humans. The BFN REMP includes measurement of direct radiation levels and collection and analysis of various sample types. Monitoring for the liquid pathway includes samples of fish, shoreline sediment and water from the Tennessee River. The airborne pathway is monitored by direct sampling for air particulates and gaseous radioiodine and sampling of milk, soil, and food crops that could be affected by the deposition of airborne radionuclides.

The results from the REMP are reported in the Annual Radiological Environmental Operating Report (AREOR). The data reported in the BFN AREOR demonstrate that the small amounts of radiological effluents released to the environment due to the operation of BFN have had no measurable impact on the environs around BFN.

Estimated doses to the maximum exposed member of the public due to radiological effluent releases from BFN are calculated on an annual basis. These dose values have consistently been very low, typically only a small fraction of applicable limits. For example, the maximum calculated whole body dose for liquid releases in 1999 was 0.037 mrem/year, or 1.2% of the applicable limit (10 CFR 50 App. I, 3mrem/year). The maximum organ dose equivalent from gaseous effluents in 1999 was 0.04 mrem/year which represented 0.3% of the limit (10 CFR 50 App. I, 15 mrem/year). The calculated whole body or other organ (other than thyroid) dose was 0.12 mrem (0.5% of the 40 CFR 190 limit, 25 mrad/year) for 1999. The calculated thyroid dose was 0.082 mrem (0.1% of the 40 CFR 190 limit, 75 mrad/year) for 1999.

There are also no significant changes to the radiological effluent releases anticipated as a result of BFN operations over the current license period.

3.21.2 Facility (Design Basis) Accidents

The BFN Updated Final Safety Analysis Report (UFSAR) Chapter 14 addresses several design basis accidents such as Loss of Coolant Accident (LOCA), Main Steam Line Break (MSLB), Control Rod Drop Accident (CRDA), and Fuel Handling Accident (FHA). Since the design basis accidents are independent of the age of the plant, the extension of the lifetime operation of the plant from 40 years to 60 years will not impact the analysis of these accidents. This conclusion applies to all BFN units.

The originally licensed maximum thermal power level for the BFN units was 3293 megawatt thermal (MWt). The current analyses in Chapter 14 address BFN operation at the present 5% uprated power level of 3458 MWt. EPU at 120% of the originally licensed maximum thermal power level will affect accident analysis because the power level influences the radioactive isotope inventories and releases. The analyses will be re-performed at EPU power levels, and the plant will conform to regulatory requirements prior to implementation of EPU.

Extension of the plant life from 40 years to 60 years will impact equipment qualification (EQ) of safety related equipment. The total integrated radiation doses will generally increase by 50%. However, the BFN 10 CFR 50.49 (EQ) program will ensure that all safety related equipment will be qualified to operate in its intended environment so as to perform its intended function. Any equipment that cannot withstand the full 60-year life of the plant will be replaced on a predetermined maintenance schedule as part of the 10 CFR 50.49 program. At any time during the life of the plant, the equipment will be qualified for its environment, and will be on a regular maintenance/replacement schedule as needed. Therefore, life extension will not negatively impact the safety of the public following an accident.

3.21.3 Site Radiological Emergency Response Plan

The following discussions detail how the BFN REP fulfills Federal (10 CFR 50) and State and Local (44 CFR 350) requirements.

10 CFR PART 50 DOMESTIC LICENSING OF PRODUCTION AND UTILIZATION FACILITIES

The REP has been developed to provide protective measures for TVA personnel, and to protect the health and safety of the public in the event of a radiological emergency resulting from an accident at a TVA nuclear plant. This plan, which has been approved by the NRC, fulfills the requirements set forth in Part 50, Title 10 of the Code of Federal Regulations, and was developed in accordance with the NRC and Federal Emergency Management Agency (FEMA) guidance. As specified in NUREG-0654, Criteria for Preparation and Evaluation of Radiological Emergency Response Plans in Support of Nuclear Power Plants and REG Guide 1.101, the REP provides for the following:

- Adequate measures are taken to protect employees and the public.
- Individuals having responsibilities during an accident are properly trained.

- Procedures exist to provide the capability to cope with a spectrum of accidents ranging from those of little consequence to major core melt.
- Equipment is available to detect, assess, and mitigate the consequences of such occurrences.
- Emergency action levels and procedures are established to assist in making decisions.

The REP, together with the appendices, describes the methods TVA will use to:

- Detect an emergency condition.
- Evaluate the severity of the problems and conduct environmental monitoring.
- Notify Federal, State, and local agencies of the condition.
- Activate the TVA emergency organizations.
- Evaluate the possible off-site consequences by performing dose assessments.
- Recommend protective actions for the protection of the public.
- Mitigate the consequences of the accident.
- Maintain a drill and exercise program.

Since TVA authority is limited to TVA-owned and -controlled property, State and local agencies are responsible for ordering and implementing actions offsite to protect the health and safety of the public.

Specific procedures are developed to ensure that the plan is implemented as designed. These implementing procedures are designed to ensure that accidents are properly evaluated, rapid notifications made, and assessment and protective actions performed. These procedures are compiled in the EPIPs. Site specific procedures for abnormal and emergency operation and control exist but are not included in the EPIPs. These plant-operating procedures are designed to ensure the implementation of the EPIPs.

44 CFR PART 350 REVIEW AND APPROVAL OF STATE AND LOCAL RADIOLOGICAL EMERGENCY PLANS AND PREPAREDNESS

State Radiological Emergency Plans (SREPs) have been developed to provide a guide for the response of the State Government to any emergency caused by an incident at a TVA operated Nuclear Plant. The plan also provides integrated response actions of Federal, State, and local governments to an emergency that causes, or has the potential for causing, a release of a significant amount of radioactive material into the environment. In accordance with this plan, the State, in coordination with each concerned agency, will provide timely warning and protection for those citizens who may be threatened by an accident or incident at the plant. This plan fulfills the requirements set forth in Part 350, Title 44 of the Code of Federal Regulations, and was developed in accordance with the NRC and FEMA guidance.

As specified in NUREG-0654, Criteria for Preparation and Evaluation of Radiological Emergency Response Plans in Support of Nuclear Power Plants, the SREPs address State and local concepts of operation, organization, administration and logistics, communications, execution, authority and reference, and supporting plans. In addition, plans include annexes to provide guidelines for more specific planning and response information used to protect the public during a radiological emergency. The SREPs has been evaluated and approved by the FEMA which has the responsibility to ensure the adequacy for off-site planning.

The plan, to include annexes, describes the methods the involved agencies use relating to:

- Direction and Control,
- Alert , Warning, and Notification,
- Communications,
- Public Information and Education,
- Radiological Protection Measures for public and emergency workers, to include utilization of radiological and environmental monitoring for the assessment and minimization radiological health hazards,
- Medical and Public Health,
- Plume Exposure Emergency Planning Zone/Ingestion Pathway Zone, to include protective actions decision making for controlling the distribution and use of food and water and consumption of radio-protective drugs, and advising the agriculture community concerning livestock and farm products,
- Evacuation,
- Security,
- Reentry, Recovery, and Return,
- Radiological Emergency Response Training, and
- Exercises.

Since State and local agencies are responsible for ordering and implementing off-site actions for the protection of the health and safety of the public, county implementation procedures are also included.

3.21.4 Severe Accident Mitigation Alternatives

For purposes of this SEIS, the term "accident" refers to any unintentional event (i.e., outside normal or expected plant operations) that result in the release or potential release of radioactive material to the environment. Generally, the nuclear industry and the NRC categorize accidents as "design basis" or "severe." Design basis accidents are those for which the risk is great enough that a nuclear plant is required to be designed and constructed to prevent unacceptable accident consequences. Severe accidents are those considered too unlikely to warrant design controls.

The NRC has concluded in its generic license renewal rulemaking that unmitigated environmental impacts from severe accidents met the criteria for exclusion from requiring additional plant-specific analyses. Nonetheless, the NRC, noting that 1) ongoing regulatory programs related to severe accident mitigation have not been completed for all plants, and 2) these programs have identified plant programmatic and procedural improvements (and in a few cases, minor modifications) as cost-effective in reducing severe accident risks and consequences, elected to require that alternatives to mitigate severe accidents be considered for all plants that have not considered such alternatives. Site-specific information to be presented includes: 1) potential SAMAs; 2) benefits, costs, and net value of implementing potential SAMAs; and 3) sensitivity of analysis to changes to key underlying assumptions.

BFN has previously completed a Probabilistic Safety Assessment (PSA), which is a systematic and comprehensive analysis of the potential accidents that can occur at the plant. The PSA is a thorough description of the frequency and consequences of potential accidents; it incorporates both system reliability and human involvement in plant safety. The BFN PSA evaluates the potential for core damage during power operation (i.e., "Level I" analysis) and also includes containment failure and radionuclide source term estimations following core damage (i.e., "Level II" analysis). It does not, however, evaluate the effects of radionuclide release to the surrounding environment (i.e., "Level III" analysis); this is an integral part of a SAMA analysis.

In response to NRC requirements, BFN has also previously completed an Individual Plant Examination (IPE) which addresses internal events, and an IPE for External Events (IPEEE) such as flood, earthquake, fires, etc. The IPE and IPEEE are less comprehensive than the current PSA, but they utilize standardized methodology which allows some degree of comparison of results between plants. Like the PSA, they involve Level I and II analyses which have been used to identify plant programmatic and procedural improvements (and in some cases, minor modifications) which are effective in reducing severe accident and risk consequences.

A SAMA analysis has been prepared for BFN that addresses operation during the 20-year license renewal period and relates the costs of potential programmatic, procedural, and physical changes to benefits associated with reducing the radiological damage to the surrounding environment (Level III). This analysis is included as Appendix A of this SEIS.

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