Table of Contents

4.0 ENVIRONMENTAL CONSEQUENCES 4-1

4.1 IMPACTS TO THE ENVIRONMENT ASSOCIATED WITH THE NO ACTION ALTERNATIVE 4-1

4.1.1 DECOMMISSIONING 4-1
4.1.2 POWER REPLACEMENT ALTERNATIVES 4-4
4.1.3 SOCIOECONOMIC IMPACTS OF DISCONTINUING PLANT OPERATIONS AT EXPIRATION OF CURRENT LICENSES 4-4
4.1.3.1 Economic Conditions 4-5
4.1.3.2 Demography 4-6
4.1.3.3 Community Services and Housing 4-6
4.1.3.4 Local Government Revenues 4-6
4.1.3.5 Environmental Justice 4-6

4.2 IMPACTS TO THE ENVIRONMENT ASSOCIATED WITH ALTERNATIVE 1 4-7

4.2.1 AIR RESOURCES 4-7
4.2.1.1 Climate and Meteorology 4-7
4.2.1.2 Ambient Air Quality 4-7
4.2.1.3 Existing Air Emission Sources 4-8
4.2.1.4 Air Quality Impacts 4-9
4.2.2 GEOLOGIC SETTING 4-9
4.2.2.1 Impacts on Geology 4-9
4.2.2.2 Impacts of Construction on Seismicity 4-9
4.2.2.3 Impacts of Operation on Seismicity 4-10
4.2.3 SOLID WASTES MANAGEMENT AND PAST PRACTICES 4-10
4.2.3.1 General Plant Trash 4-10
4.2.3.2 Construction/Demolition Debris 4-10
4.2.3.3 Low Level Radioactive Waste 4-10
4.2.4 HAZARDOUS WASTES MANAGEMENT AND PAST PRACTICES 4-11
4.2.5 SPENT FUEL MANAGEMENT 4-11
4.2.6 SURFACE WATER RESOURCES 4-11
4.2.6.1 Construction Effects 4-11
4.2.6.2 Chemical Effluent Effects 4-12
4.2.6.3 Thermal Effects 4-14
4.2.6.4 Water Use/Water Availability 4-14
4.2.6.5 Microbiological Organisms 4-14
4.2.7 GROUNDWATER RESOURCES 4-14
4.2.7.1 Groundwater Occurrence 4-14
4.2.7.2 Groundwater Use 4-15
4.2.8 FLOODPLAINS AND FLOOD RISK 4-15
4.2.9 TERRESTRIAL ECOLOGY 4-16
4.2.9.1 Vegetation 4-16
4.2.9.2 Wildlife 4-16
4.2.9.3 Introduced Species 4-16
4.2.9.4 Managed Areas and Ecologically Significant Sites 4-17
4.2.9.5 Refurbishment Impacts 4-17
4.2.10 AQUATIC ECOLOGY 4-17
4.2.10.1 Fish 4-17
4.2.10.2 Benthic Organisms 4-19
4.2.10.3 Introduced Species 4-20
4.2.10.4 Entrainment and Impingement of Fish and Shellfish, Heat Shock 4-21

4.2.10.5 Microbiological Organisms *4-21*
4.2.11 THREATENED AND ENDANGERED SPECIES 4-21
4.2.11.1 Animals *4-21*
4.2.11.2 Aquatic *4-21*
4.2.11.3 Plants *4-22*
4.2.12 WETLANDS 4-22
4.2.13 SOCIOECONOMIC CONDITIONS 4-22
4.2.13.1 Demography *4-22*
4.2.13.2 Economic Conditions *4-22*
4.2.13.3 Community Services and Housing *4-22*
4.2.13.4 Local Government Revenues *4-23*
4.2.13.5 Environmental Justice *4-23*
4.2.14 TRANSPORTATION 4-23
4.2.14.1 Highways and Roads *4-23*
4.2.14.2 Railroads *4-24*
4.2.14.3 River Transport *4-24*
4.2.14.4 Pipelines *4-24*
4.2.14.5 Transmission Lines *4-24*
4.2.15 SOILS AND LAND USES 4-24
4.2.16 VISUAL RESOURCES 4-25
4.2.17 RECREATION 4-26
4.2.18 CULTURAL RESOURCES 4-27
4.2.18.1 Archaeological Resources *4-27*
4.2.18.2 Historical Structures *4-27*
4.2.19 ENVIRONMENTAL NOISE 4-27
4.2.20 PUBLIC AND OCCUPATIONAL SAFETY & HEALTH (NON-RADIOLOGICAL) 4-28
4.2.21 RADIOLOGICAL IMPACTS 4-28
4.2.21.1 Normal Operation *4-28*
4.2.21.1.1 Occupational 4-28
4.2.21.1.2 Public 4-28
4.2.21.2 Facility (Design Basis) Accidents *4-29*
4.2.21.3 Severe Accident Mitigation Alternatives *4-29*
4.2.22 DECOMMISSIONING IMPACTS 4-31

4.3 IMPACTS TO THE ENVIRONMENT ASSOCIATED WITH ALTERNATIVE 2 4-32

4.3.1 AIR RESOURCES 4-32
4.3.1.1 Climate and Meteorology *4-32*
4.3.1.2 Ambient Air Quality *4-32*
4.3.1.3 Existing Air Emission Sources *4-33*
4.3.1.4 Air Quality During Refurbishment *4-33*
4.3.2 GEOLOGIC SETTING 4-34
4.3.2.1 Impacts on Geology *4-34*
4.3.2.2 Impacts of Construction on Seismicity *4-34*
4.3.2.3 Local Geology *4-34*
4.3.3 SOLID WASTES MANAGEMENT AND PAST PRACTICES 4-34
4.3.3.1 General Plant Trash *4-34*
4.3.3.2 Construction/Demolition Debris *4-35*
4.3.3.3 Low Level Radioactive Waste *4-35*
4.3.4 HAZARDOUS WASTES MANAGEMENT AND PAST PRACTICES 4-36
4.3.5 SPENT FUEL MANAGEMENT 4-36
4.3.6 SURFACE WATER RESOURCES 4-36
4.3.6.1 Construction Effects *4-36*
4.3.6.2 Chemical Effluent Effects *4-37*
4.3.6.3 Thermal Effects *4-37*
4.3.6.4 Water Use/Water Availability *4-41*

4.3.6.5 Microbiological Organisms *4-42*
4.3.7 GROUNDWATER RESOURCES 4-42
4.3.7.1 Groundwater Occurrence *4-42*
4.3.7.2 Groundwater Use *4-43*
4.3.8 FLOODPLAINS AND FLOOD RISK 4-43
4.3.9 TERRESTRIAL ECOLOGY 4-44
4.3.9.1 Vegetation *4-44*
4.3.9.2 Wildlife *4-44*
4.3.9.3 Introduced Species *4-45*
4.3.9.4 Managed Areas and Ecologically Significant Sites *4-45*
4.3.9.5 Refurbishment Impacts *4-45*
4.3.10 AQUATIC ECOLOGY 4-46
4.3.10.1 Fish *4-46*
4.3.10.2 Benthic Organisms *4-46*
4.3.10.3 Introduced Species *4-46*
4.3.10.4 Entrainment and Impingement of Fish and Shellfish, Heat Shock *4-46*
4.3.10.5 Microbiological Organisms *4-48*
4.3.11 THREATENED AND ENDANGERED SPECIES 4-49
4.3.11.1 Animals *4-49*
4.3.11.2 Aquatic *4-49*
4.3.11.3 Plants *4-49*
4.3.12 WETLANDS 4-49
4.3.13 SOCIOECONOMIC CONDITIONS 4-50
4.3.13.1 Demography *4-50*
4.3.13.2 Economic Conditions *4-50*
4.3.13.3 Community Services and Housing *4-51*
4.3.13.4 Local Government Revenues *4-51*
4.3.13.5 Environmental Justice *4-52*
4.3.14 TRANSPORTATION 4-52
4.3.14.1 Highways and Roads *4-52*
4.3.14.2 Railroads *4-54*
4.3.14.3 River Transport *4-54*
4.3.14.4 Pipelines *4-54*
4.3.14.5 Transmission Lines *4-54*
4.3.15 SOILS AND LAND USES 4-55
4.3.15.1 BFN Environs *4-55*
4.3.15.2 Future Land Uses/Modifications (Including Offsite) *4-56*
4.3.15.3 Land Use Planning and Controls *4-56*
4.3.16 VISUAL RESOURCES 4-56
4.3.17 RECREATION 4-59
4.3.18 CULTURAL RESOURCES 4-60
4.3.18.1 Archaeological Resources *4-60*
4.3.18.2 Historical Structures *4-60*
4.3.19 ENVIRONMENTAL NOISE 4-60
4.3.19.1 Construction Noise *4-61*
4.3.19.2 Intruding Noise *4-62*
4.3.19.3 Effects *4-63*
4.3.19.3.1 Guidelines 4-63
4.3.19.3.2 Hearing Loss 4-63
4.3.19.3.3 Annoyance 4-63
4.3.19.3.4 Communication Interference 4-64
4.3.19.4 Summary *4-64*
4.3.20 SAFETY AND HEALTH (NON-RADIOLOGICAL) 4-64
4.3.21 RADIOLOGICAL IMPACTS 4-64
4.3.21.1 Normal Operation *4-64*

4.3.21.1.1 Occupational 4-64
4.3.21.1.2 Public 4-69
4.3.21.2 Facility (Design Basis) Accidents *4-69*
4.3.21.3 Severe Accident Mitigation Alternatives *4-69*
4.3.22 DECOMMISSIONING IMPACTS 4-69

4.4 IDENTIFICATION OF MITIGATION MEASURES 4-69

4.4.1 AIR RESOURCES 4-70
4.4.2 GEOLOGY 4-70
4.4.3 SOLID WASTES MANAGEMENT AND PAST PRACTICES 4-70
4.4.4 HAZARDOUS WASTES MANAGEMENT AND PAST PRACTICES 4-70
4.4.5 SPENT FUEL MANAGEMENT 4-71
4.4.6 SURFACE WATER RESOURCES 4-71
4.4.7 GROUNDWATER RESOURCES 4-71
4.4.8 FLOODPLAINS AND FLOOD RISK 4-71
4.4.9 TERRESTRIAL ECOLOGY 4-71
4.4.10 AQUATIC ECOLOGY 4-71
4.4.11 THREATENED AND ENDANGERED SPECIES 4-72
4.4.12 WETLANDS 4-72
4.4.13 SOCIOECONOMIC CONDITIONS 4-72
4.4.14 TRANSPORTATION 4-72
4.4.15 SOILS AND LAND USES 4-72
4.4.16 VISUAL RESOURCES 4-72
4.4.17 RECREATION 4-73
4.4.18 CULTURAL RESOURCES 4-73
4.4.19 ENVIRONMENTAL NOISE 4-73
4.4.20 PUBLIC AND OCCUPATIONAL SAFETY & HEALTH (NON-RADIOLOGICAL) 4-73
4.4.21 RADIOLOGICAL IMPACTS 4-74

4.5 IRREVERSIBLE ADVERSE IMPACTS 4-74

4.6 RELATIONSHIP OF SHORT-TERM USES AND LONG-TERM PRODUCTIVITY 4-75

4.7 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES 4-75

4.8 REFERENCES 4-78

4.0 ENVIRONMENTAL CONSEQUENCES

Environmental consequences associated with the proposed alternatives are described in this chapter. Section 4.1 addresses the environmental impacts associated with the No Action Alternative which involves operation of Units 2 and 3 only until their existing license terms expire. Section 4.2 addresses the environmental impacts associated with Alternative 1, which involves operating Browns Ferry Nuclear Plant (BFN) Units 2 and 3 for an additional 20-year period beyond the expiration dates of the current licenses. Section 4.3 discusses the environmental impacts associated with Alternative 2 (A, B, C, and D), which includes the refurbishment and restart of BFN Unit 1 with the additional 20-year operation for all three units. Section 4.4 identifies possible mitigation measures. Section 4.5 discusses the irreversible adverse impacts of the proposed actions. Section 4.6 compares short-term uses of the environment with the long-term productivity enhancements that are expected from the proposed actions. Section 4.7 describes irreversible and irretrievable commitment of resources, and Section 4.8 provides a listing of the references used throughout Chapter 4.

The environmental impacts described in this chapter are based on the affected environment as described in Chapter 3 and on the information describing the proposed actions in Chapter 2. The chapter is formatted to follow the section headings used in Chapter 3. The proposed actions would be carried out in a way which meets all environmental regulations and requirements and this would help ensure that associated impacts are environmentally acceptable.

4.1 Impacts to the Environment Associated with the No Action Alternative

The No Action Alternative would result in TVA not applying for relicensing for any of the three units at BFN at this time. The current operating licenses for Units 1, 2, and 3 would be allowed to expire in 2013, 2014, and 2016, respectively. Existing environmental conditions would remain unchanged or would change through actions other than operation of Units 2 and 3 only until the current licenses expire. The original BFN EIS describes the environmental impacts associated with operating Units 1 through 3. Operation of Units 2 and 3, until the existing licenses expire, is encompassed by the analyses in the original BFN EIS. To the extent that changes affecting environmental impacts have occurred, or that there is new information relevant to environmental impacts since the release of the original EIS, this is addressed either in Chapter 3 in the description of the Affected Environment or is embedded in the discussion of the changes from existing conditions that could occur as a result of the Action Alternatives.

4.1.1 Decommissioning

Under all of the alternatives (No Action and the Action Alternatives), TVA would eventually have to propose a decommissioning option and implement it. It is not proposing a decommissioning option now. The No Action Alternative would be the earliest entry into decommissioning. Therefore, although decommissioning is common to all of the alternatives, it is discussed in the context of the No Action Alternative with references to the action alternatives where appropriate.

Prior to choosing a decommissioning option, TVA would conduct appropriate environmental analyses and reviews. General information about decommissioning is included in this SEIS to update the original BFN EIS in the interim.

Environmental issues associated with decommissioning resulting from continued plant operation during the renewal term of a license have already been discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants* (GEIS), NUREG-1437 (NRC 1996; 1999). The GEIS included a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues were then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

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

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required by the Nuclear Regulatory Commission (NRC), unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria of Category 1; therefore, additional plant-specific review for these issues is required. There are no Category 2 issues related to decommissioning at BFN.

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 that are applicable to BFN Units 1, 2, and 3 decommissioning following the renewal term are listed in Table 4.1-1. For all of those issues, the NRC staff concluded in the GEIS that the impacts are SMALL, and plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 4.1-1 Category 1 Issues Applicable to the Decommissioning of BFN Following the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
DECOMMISSIONING	
Radiation Doses	7.3.1; 7.4
Waste Management	7.3.2; 7.4
Air Quality	7.3.3; 7.4
Water Quality	7.3.4; 7.4
Ecological Resources	7.3.5; 7.4
Socioeconomic Impacts	7.3.7; 7.4

A brief description of the NRC staff's review and the GEIS conclusions, as codified in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, for each of the issues follows. As indicated, the analyses in the original EIS and those done here for the SEIS have not identified anything that leads TVA to conclude that decommissioning impacts are likely to be materially different under any of the alternatives. However, based on past experience, it is possible that decommissioning techniques would continue to be improved over time; therefore, Alternatives 1 and 2 (the Action Alternatives) could result in fewer impacts or impacts of less severity.

- Radiation doses: Based on information in the GEIS, NRC found: "Doses to the public will be well below applicable regulatory standards regardless of which decommissioning method is used. Occupational doses would increase no more than 1 man-rem [0.01 person-Sv] caused by buildup of long-lived radionuclides during the license renewal term." TVA has not identified any significant new information during its review and evaluation that would indicate any additional radiation dose would be experienced by either the public or workers (NRC, 1990). Therefore, TVA concludes that there would be no radiation doses associated with decommissioning following license renewal beyond those discussed in the GEIS.

- Waste management: Based on information in the GEIS, NRC found: "Decommissioning at the end of a 20-year license renewal period would generate no more solid wastes than at the end of the current license term. No increase in the quantities of Class C or greater than Class C wastes would be expected." TVA has not identified any significant new information relevant to environmental concerns during its review and evaluation that leads to a different conclusion. Therefore, TVA concludes that there would be no solid waste impacts associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

- Air quality: Based on information in the GEIS, NRC found: "Air quality impacts of decommissioning are expected to be negligible either at the end of the current operating term or at the end of the license renewal term." TVA has not identified any significant new information relevant to environmental concerns during its review and evaluation that leads to a different conclusion. Therefore, TVA concludes that there would be no air quality impacts from license renewal during decommissioning beyond those discussed in the GEIS.

- Water quality: Based on information in the GEIS, NRC found: "The potential for significant water quality impacts from erosion or spills is no greater whether decommissioning occurs after a 20-year license renewal period or after the original 40-year operation period, and measures are readily available to avoid such impacts." TVA has not identified any significant new information relevant to environmental concerns during its review and evaluation that leads to a different conclusion. Therefore, TVA concludes that there would be no water quality impacts from license renewal term during decommissioning beyond those discussed in the GEIS.

- Ecological resources: Based on information in the GEIS, NRC found: "Decommissioning after either the initial operating period or after a 20-year license renewal period is not expected to have any direct ecological impacts." TVA has not identified any significant new information relevant to environmental concerns during its review and evaluation that leads to a different conclusion. Therefore, TVA concludes that there would be no ecological resources impacts from license renewal during decommissioning beyond those discussed in the GEIS.

- Socioeconomic impacts: Based on information in the GEIS, NRC found: "Decommissioning would have some short-term socioeconomic impacts. The impacts would not be increased by delaying decommissioning until the end of a 20-year relicense period, but they might be decreased by population and economic growth." TVA has not identified any significant new information relevant to environmental concerns during its review and evaluation that leads to a different conclusion. Therefore, TVA concludes that there would be no socioeconomic impacts from license renewal during decommissioning beyond those discussed in the GEIS.

A number of commercial nuclear power plants are currently conducting initial decommissioning efforts, and are developing both the technology and the licensing framework that will allow better understanding of and approaches to decommissioning by others in the future.

- Technology: The decommissioning commercial nuclear power plants, in cooperation with the Electric Power Research Institute (EPRI), the Department of Energy's (DOE) National Energy Technology Laboratory (NETL), and private industry, have developed technologies which are improving the effectiveness and safety of the decommissioning process. The most significant of these technologies are in the areas of site characterization (locating and characterizing radiological contamination), decontamination, dismantlement, disposal (e.g., volume reduction), and worker safety (EPRI, 2001). Commercial robotics technology, although in its infancy, is already contributing in many of these areas.

- Licensing: The NRC, working with commercial licensees through the Nuclear Energy Institute (NEI), has and is continuing to develop a framework of rules and regulations to systematically "de-license" plants in the course of the decommissioning process (NRC, 2000a and 2000b).

In summary, choosing the No Action Alternative or any of the action alternatives would not result in foreclosing any decommissioning options, or result in any environmentally unacceptable conditions. Unlike license renewal under Alternatives 1 and 2, the No Action Alternative would not allow an additional 20-year period for decommissioning technology (including more advanced robotics) and the licensing framework to evolve and mature. Similarly, choosing the No Action Alternative would not allow an additional 20-year period to increase the likelihood that a permanent spent fuel repository would be available prior to the completion of decommissioning. The availability of a spent fuel repository would further reduce the potential for adverse environmental effects from decommissioning.

4.1.2 Power Replacement Alternatives

The range of options available to TVA as sources of replacement power, assuming a decision by the TVA Board of Directors to not seek license renewal of the BFN units, is addressed in *Energy Vision 2020*. The supply-side options include combined-cycle plants, purchasing and exercising call alternatives, purchasing power from independent power producers, developing renewable energy resources, and improving the existing hydroelectric generating systems.

Energy Vision 2020 analyzes the connection between various air pollutants and carbon dioxide emissions with fossil-fired power production, and used carbon dioxide emissions and pollutant levels as one of the measures to differentiate among TVA's energy strategies. For example, coal-based technologies emit over 200 pounds of carbon dioxide per million BTU of heat input; this is in stark contrast with nuclear power, which emits none. TVA has been an active participant in programs to minimize and/or mitigate the effects of utility emissions on global climate, such as the Climate Challenge Memorandum of Understanding signed by the Department of Energy, four utility organizations, and TVA on April 20, 1994. Consistent with these program objectives, *Energy Vision 2020* lists several potential means of lowering the carbon dioxide emitted per unit of electric energy produced by TVA, the first and foremost of which is increased production of nuclear power. The others are (1) hydroelectric power plant modernization, (2) addition of more efficient fossil-fired plants, (3) increased use of renewables, and (4) repowering of existing coal-fired plants with more efficient energy conversion systems. However, compared with a single 1,000 megawatt nuclear unit, these other alternatives either represent a smaller collective contribution to the overall energy production mix (1 and 3), or would still remain as large sources of carbon dioxide (2 and 4). The total power increase from hydro plant modernization is approximately 750 megawatts, and the current total power from other renewable energy sources (bioenergy, solar and wind) is less than 10 megawatts. Since currently about two-thirds of TVA's total power production originates from fossil fuels and further development of new hydroelectric generation is unlikely, any change in nuclear power generation within TVA will affect the overall production of greenhouse gases.

4.1.3 Socioeconomic Impacts of Discontinuing Plant Operations at Expiration of Current Licenses

4.1.3.1 Economic Conditions

According to the analysis by the NRC (NRC Generic EIS, Section 7.3.7), there are no significant socioeconomic impacts from decommissioning, and it is considered to be a Category 1 issue, not requiring additional plant-specific analysis. Nonetheless, should BFN not be relicensed, there would be some loss of jobs as the plant went into the decommissioning process, at license expiration followed by further loss at the end of the decommissioning period. In addition to these direct losses of income and employment, the impacts would be increased by additional indirect income and employment losses in the area as a result of decreased spending due to the direct income losses. The number of jobs lost would be roughly equal to perhaps one percent of the labor force of Limestone County, but would be only a tiny fraction of the labor force in the labor market area. The NRC study (NRC Generic EIS, Section 7.3.7) concludes that, "The impact of license renewal on the socioeconomic impacts of decommissioning are of small significance. Because license renewal does not affect the socioeconomic impacts that will occur at the time of decommissioning, there is no need for the consideration of mitigation as part of the license renewal environmental review."

The need for additional storage for spent fuel will require construction of a dry cask storage facility and replacement of the Modifications Fabrication Building in a different location (see Sections 2.3.2 and 2.3.3). This will be required under any of the alternatives. However, the employment and income impacts of these actions would be small and short-term, and therefore would not be significant.

4.1.3.2 Demography

As shown in Section 3.13.1, the population of Limestone County is expected to be about 80,000 at the time of license expiration, with a labor market area population of close to 750,000. Thus, the population loss that could occur in association with this alternative would be only a small share of the total.

4.1.3.3 Community Services and Housing

Due to the small size of the population impact relative to the total population in the area, no important impacts to community services are expected. Sudden loss of this number of jobs could have a noticeable dampening effect on the housing market; however, this effect would be short-lived if the area continues to grow as expected and is likely to be small.

4.1.3.4 Local Government Revenues

Under this alternative, there would be little impact on the TVA in lieu of tax payments to the state of Alabama or to the share that the state passes on to Limestone County. As long as TVA owns the site, the book value of the property would be used in the formulas that calculate the payments. It is possible that sometime, most likely after decommissioning, ownership of the property would be conveyed to someone else. If so, TVA in lieu of tax payments would stop; however, if ownership were private there should be local tax collections based on the actual property value at that time. Most likely, by the time this might happen, the book value would be very low anyway, and therefore even this impact would be small.

The loss of jobs and income would cause a very small decrease in local sales and property tax collections. However, these would not be significant as a share of the total revenues of local governments.

4.1.3.5 Environmental Justice

TVA is not subject to the executive order requiring some federal agencies to consider environmental justice impacts. However, TVA considers such impacts in its NEPA reviews as a matter of policy. The primary impacts in the local area would be to employees at the plant and their families. Secondary impacts would be diffused throughout the area and would not be significant to any particular population group. Therefore, no disproportionate impacts to disadvantaged populations in the local area are expected.

4.2 Impacts to the Environment Associated with Alternative 1

4.2.1 Air Resources

4.2.1.1 Climate and Meteorology

Alternative 1 would not involve any potential impacts on the local climate and meteorology more severe than was assessed in the original BFN EIS. The potential for fogging and icing from operation of the cooling towers was based on conservative plume modeling and conservative assumptions for operation of the original six mechanical draft towers and should not increase with extended operation of Units 2 and 3 and operation of six mechanical draft cooling towers.

4.2.1.2 Ambient Air Quality

Alternative 1 involves the operation of Units 2 and 3 and operation of six mechanical draft cooling towers. These six towers will be configured as assessed in the original EIS. (As addressed in the environmental assessment that TVA completed for extended power uprate (EPU) for these units, TVA plans to also rebuild the other cooling tower that burned down, returning the total number of cooling towers at the site to six). The primary sources of non-radiological air pollutants are these cooling towers, three auxiliary steam boilers, and eight diesel-powered auxiliary generators. Four of the diesel generators are linked to Units 1 and 2 and four are linked to Unit 3.

In Volume 1, Section 2.5, of the original 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 steam boilers and the diesel generators that was assessed. The auxiliary steam 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.

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. Therefore, for Alternative 1, the potential impacts on ambient air quality from operation of the cooling towers remain within the analyses presented in the original EIS.

4.2.1.3 Existing Air Emission Sources

There have been no material changes in plant emission sources compared to those assessed in the original EIS. Table 4.2.1-1 below contains the emissions calculation results presented in the 1972 EIS, and Table 4.2.1-2 lists other additional emission sources.

Table 4.2.1-1 Emissions Calculation Results Presented in 1972 EIS (tons/yr)

Pollutant	Auxiliary Boilers [1]	Emergency Diesel Generators [2]	Six Mechanical Draft Cooling Towers
Particulates	20.9	0.66	100.0 [3]
Sulfur oxides	205.0	6.4	-
Carbon monoxide	0.1 [4]	0.004 [4]	-
Hydrocarbons	13.1	0.42	-
Nitrogen oxides	274.0	8.6	-

1. The 1972 EIS text states that expectations are that maximum actual operation will consume less than half the maximum possible fuel consumption used for these calculations.
2. The 1972 EIS presented numbers for four generators, but the actual number of these generators installed was eight. Therefore, the magnitudes in this column are double those shown in the 1972 EIS.
3. Operation in helper mode and summer only. This magnitude encompasses all alternatives for the cooling towers.
4. These values appear to be underestimated. The maximum annual CO emissions during the 1996-1999 period were 1.2 tons/yr for the three auxiliary boilers and 6.36 tons/yr for the eight emergency diesel generators.

Table 4.2.1-2 Additional Emission Sources			
Source	**Level of Emissions**	**Purpose**	**Time/Season**
Fuel Storage & Dispensing	Minor (THAP, VOC)	Non-radiological BFN plant fuel supply	Daily
Other Misc. Sources	Minor (PM, THAP, VOC)	Misc. BFN plant operations support	Daily/Intermittent
Construction Equipment	Minor and Intermittent (CO, CO_2, PM, NO_x, SO_x, VOC)	Refurbishment, erection of new facilities, earth moving for cooling tower options	Daily/Intermittent/ Limited Project Length(s)
Increased Work Force Traffic	Minor and Intermittent (CO, CO_2, PM, NO_x, SO_x, VOC)	Work force commuting	Daily/Intermittent

4.2.1.4 Air Quality Impacts

For Alternative 1, emissions of small amounts of fugitive dust may be associated with surface preparation and transport of concrete in mixing trucks for the construction of the proposed dry cask storage facility, and the proposed Modifications Fabrication Building. In addition, minor emissions of combustion exhaust products such as nitrogen oxides, carbon monoxide, carbon dioxide, sulfur oxides, and hydrocarbons can be expected from engines in concrete mixing trucks, other construction-related vehicles, and construction equipment. Some particulates would be emitted from a concrete batch plant in the unlikely event that one should be built instead of trucking in the concrete for the pads of the proposed dry cask storage facility. Trucks would still be used in that event to transport the concrete mixing materials to the batch plant location. Some vapors including hydrocarbons may be emitted from stored fuels and during refueling activities. All of these potential impacts on ambient air quality would be minor, intermittent and transitory during the various periods of construction. Chapter 2 provides details about these construction activities.

4.2.2 Geologic Setting

4.2.2.1 Impacts on Geology

The impacts on geology of continued operation of BFN under any of the options being considered are addressed in section 2.8-2 of the original EIS.

4.2.2.2 Impacts of Construction on Seismicity

Under some circumstances, human activities can change the ambient seismicity of an area. Four types of human activities are known to have the ability to change seismicity levels and patterns:

(1) the creation of large reservoirs; (2) large underground explosions (e.g., nuclear tests); (3) the injection (or withdrawal) of underground fluids; and (4) the excavation of mines (Gough, 1978). These activities can induce earthquakes ranging in size from micro earthquakes to earthquakes with m_b (body wave) magnitudes of six or slightly greater (Yeats, et. al. 1996).

None of these activities will be associated with Alternative 1. Therefore, no impacts are expected.

4.2.2.3 Impacts of Operation on Seismicity

Continued operation of BFN should have no impact on the natural level of seismic activity in the area.

4.2.3 Solid Wastes Management and Past Practices

4.2.3.1 General Plant Trash

Continued operation of BFN through the license extension period should not result in generation of additional volumes of general plant trash above and beyond the levels currently generated annually. Disposal of this material would continue as described in Chapter 3. As mentioned previously, landfill capacity and projections for availability of landfill space in Alabama indicate that sufficient space to accommodate this material from BFN should be available during the duration of operating under renewed licenses.

4.2.3.2 Construction/Demolition Debris

BFN would continue to maintain the license to operate the onsite C/D landfill through the duration of the extended BFN operating licenses. The volume of this type of material disposed should remain with the levels currently experienced (average of 0.04 tons per day) and would not require expansion of the existing landfill space on the site. In the unlikely event that additional materials are generated that exceed the capacity of the onsite landfill, arrangements for disposal in an alternative licensed facility would be made.

4.2.3.3 Low Level Radioactive Waste

Generation rates for this type of material would not be expected to exceed existing rates as a result of extension of the BFN licenses. 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.

4.2.4 Hazardous Wastes Management and Past Practices

As is the case for other types of waste material, annual generation of hazardous waste, universal wastes and used oil would not be expected to increase as a result of the license extensions for BFN. The existing process for managing these wastes within TVA would be expected to continue, and capacities of existing disposal and treatment facilities should be adequate to handle the relatively small volumes of material generated. In addition, ongoing waste reduction efforts would be expected to result in further reduction in the number of waste streams and the volumes of waste generated at BFN. Over the past 15 years, BFN has significantly reduced the generation of hazardous wastes through a combination of source reduction and product substitution. In CY 1987, BFN shipped over 220,000 pounds of hazardous waste for treatment/disposal. In CY 2000, BFN shipped 3,900 pounds for treatment/disposal, and over the last five years the average has been 4,700 pounds per calendar year.

4.2.5 Spent Fuel Management

Environmental consequences of additional spent fuel management resulting from license extension would be minimal. As described in sections 2.2, 2,3, and 3.5, additional spent fuel resulting from license extension would be stored in the spent fuel pool or a dry storage system approved by NRC in accordance with 10 CFR 72. Subsequently, BFN spent fuel would be transferred to the DOE in accordance with the Nuclear Waste Policy Act of 1982 and subsequent amendments. The only component of a dry storage system not transferred to DOE would be the concrete storage overpack provided a modular system is chosen. If used, this component would be disposed as part of the Independent Spent Fuel Storage Installation (ISFSI) decommissioning.

4.2.6 Surface Water Resources

4.2.6.1 Construction Effects

Under continued operation of Units 2 and 3, two additional facilities would be constructed: the dry cast storage pad and the modification fabrication building. Concrete for the pad construction would most likely be trucked in rather than building a batch plant on site. 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. 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. The new modifications fabrication building would be designed as light commercial grade construction. It would be largely prefabricated, involving deliveries of prefabricated items, concrete, and other construction materials. Construction of this new building would involve no more than eight or so truckloads of concrete, six to eight gravel truckloads, and less than four truckloads of various other building materials.

Construction activities could potentially result in adverse water quality impacts. Improper water management or storage and handling of potential contaminants could result in the runoff of pollutants to receiving streams. Erosion, sediment, and accidental spills of fuel or oil could impact streams and threaten aquatic life. However, standard safeguards would be included in the project design, construction, and operation to minimize the risk of adverse impacts. Construction activities would comply with state permit requirements for the control of potential pollutants (e.g., general construction permit, best management practices (BMP) plan, erosion control plan, and spill prevention plan). BMPs sufficient to minimize the risk of and avoid adverse impacts will be followed for all construction activities. Site grading and soil removal would be minimized. For those areas which have grasses and other plants, clearing operations would be staged so that only land that will be developed promptly is stripped of protective vegetation; this is not applicable to the proposed dry cask storage site, which is predominantly gravel. Mulch or temporary cover would be applied whenever possible to reduce sheet erosion. Permanent vegetation, ground cover, and sodding would be installed as soon as possible after site preparation. Surface water runoff would be managed using sediment basins, silt fences, berms, or other control options. These and other similar precautions are expected to minimize potential construction impacts such that no special mitigation measures would be necessary.

4.2.6.2 Chemical Effluent Effects

Chemical treatment is provided for the Emergency Equipment Cooling Water, Raw Cooling Water, and Residual Heat Removal Service Water systems. The flow rates, chemicals, operation, and discharge concentrations are summarized in Table 4.2.6-1.

Under Alternative 1, existing chemical discharges and impacts would continue (as well as under the No Action Alternative). Discharges are regulated under the Clean Water Act (CWA) by the U.S. Environmental Protection Agency (EPA) and the Alabama Department of Environmental Management (ADEM). The National Pollutant Discharge Elimination System (NPDES) permit issued to the plant specifies the discharge standards and monitoring requirements for each discharge. The permit must be renewed every five years and this process helps ensure that no changes have been made to the facility that would alter aquatic impacts and that no unacceptable adverse impacts are occurring. Compliance with the NPDES process, other provisions of the CWA (e.g., Sections 316 (a) and (b), 401, 404), and other regulatory requirements (e.g., Federal Insecticide, Fungicide, and Rodenticide Act) should continue to ensure that potential chemical effluent effects are kept within acceptable levels.

Table 4.2.6-1 Summary of Projected Usage Rates for Chemical Effluents
EMERGENCY EQUIPMENT COOLING WATER
(EECW) SYSTEM (8,000 GPM AVERAGE FLOW)*

PRODUCTS	ACTIVE INGRED.	% ACTIVE INGRED.	PRODUCT FEED RATE (PPM)	ACTIVE FEED RATE (PPM)	FREQUENCY	DISCHARGE CONC. PRODUCT (PPM) (AT DSN001)	DISCHARGE CONC. ACTIVE (PPM) (AT DSN001)
PCL-401	Co-polymer	28.5	2.0	0.6	Continuous	0.01	0.003
CL-50	Poly phosphate	38.5	7.5	2.9	Continuous	0.04	0.016
H-940	NaBr	40	17	6.8	20 hrs/wk	NA	<0.1
NaOCl	NaOCl	10	51	5.1	20 hrs/wk	NA	<0.1
Nalco 1336	Toly-triazole (TTA)	50	2	1	Continuous	0.01	0.005
EVAC	Endothall	53	25	13.3	2/yr (72 hrs each)	<0.075	<0.04

* EECW empties to the intake forebay, mixes with the forebay water and the condenser circulating water (CCW) flow (2300 mgd) and discharges to the Tennessee River through DSN001.

RAW COOLING WATER/RAW SERVICE WATER
HIGH PRESSURE FIRE PROTECTION SYSTEMS*
(50,000 GPM TOTAL AVERAGE FLOW)

PRODUCTS	ACTIVE INGRED.	% ACTIVE INGRED.	PRODUCT FEED RATE (PPM)	ACTIVE FEED RATE (PPM)	FREQUENCY	DISCHARGE CONC. PRODUCT (PPM) (AT DSN001)	DISCHARGE CONC. ACTIVE (PPM) (AT DSN001)
PCL-401	Co-polymer	28.5	2.0	0.6	Continuous	0.07	0.02
CL-50	Poly phosphate	38.5	7.5	2.9	Continuous	0.25	0.10
H-940	NaBr	40	17	6.8	20 hrs/wk	NA	<0.1
NaOCl	NaOCl	10	51	5.1	20 hrs/wk	NA	<0.1
EVAC	Endothall	53	25	13.3	2/yr (72 hrs each)	<0.075	<0.04

*Portions of these systems empty to the intake forebay where they mix with forebay water and CCW before discharge to the Tennessee River through DSN001. The remainder discharges directly into the CCW and is discharged through DSN001.

RHRSW SYSTEM -STAGNANT TREATMENT MODE
(2,000 GPM AVERAGE FLOW)*

PRODUCTS	ACTIVE INGRED.	% ACTIVE INGRED.	PRODUCT FEED RATE (PPM)	ACTIVE FEED RATE (PPM)	FREQUENCY	DISCHARGE CONC. PRODUCT (PPM)	DISCHARGE CONC. ACTIVE (PPM)
PCL-401	Co-polymer	28.5	70	20	2/Quarter	70	20
CL-50	Poly phosphate	38.5	80	30	2/Quarter	80	30
H-940	NaBr	40	17	6.8	2/Quarter	NA	<2.0
NaOCl	NaOCl	10	51	5.1	2/Quarter	NA	<2.0
H-300	Gluter-aldehyde	45	200	90	2/Quarter	200	90

* In the stagnant treatment mode, amounts are based on flushes twice per quarter for each of 10 heat exchangers (80 flushes per year). Each flush consists of 20 minutes at < 2000 gpm. Discharge is through DSN 005.

RHRSW SYSTEM -INTERMITTENT TREATMENT MODE
(4,500 GPM AVERAGE FLOW)*

PRODUCTS	ACTIVE INGRED.	% ACTIVE INGRED.	PRODUCT FEED RATE (PPM)	ACTIVE FEED RATE (PPM)	FREQUENCY	DISCHARGE CONC. PRODUCT (PPM)	DISCHARGE CONC. ACTIVE (PPM)
PCL-401	Co-polymer	28.5	2.0	0.6	Intermittent	2.0	0.6
CL-50	Poly phosphate	38.5	7.5	2.9	Intermittent	7.5	2.9
H-940	NaBr	40	17	6.8	20 hrs/wk	NA	<2.0
NaOCl	NaOCl	10	51	5.1	20 hrs/wk	NA	<2.0
EVAC	Endothall	53	25	13.3	2/Year 72 hrs each	13.0	7.0

* In the intermittent treatment mode, amounts are based on a total duration of treatment equivalent to 120 days per year at 4500 gpm. Discharge is through DSN 005.

4.2.6.3 Thermal Effects

The assessment of thermal effects assumes that sufficient cooling tower capacity will be provided to routinely maintain the instream thermal limits as given in the current NPDES permit. If extreme hot and dry conditions should make it impossible for the cooling towers to meet the thermal limits, the plant would be de-rated to remain in compliance. Thermal impacts from continued operation of Units 2 and 3 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 because of continued operation of BFN.

4.2.6.4 Water Use/Water Availability

No additional water use/water availability impacts are expected from continued operation of Units 2 and 3.

4.2.6.5 Microbiological Organisms

No additional microbiological impacts are expected from continued operation of Units 2 and 3.

4.2.7 Groundwater Resources

4.2.7.1 Groundwater Occurrence

There are no environmental consequences to groundwater resources associated with Alternative 1. Effluent discharges from plant systems such as yard drains, station sumps, and sanitary wastewater would not be expected to change significantly under Alternative 1. Considering that the plant wastewater lagoons and sedimentation ponds possess clay and Hypalon liners, respectively, no impacts to groundwater resources are anticipated. The changes in pond/lagoon discharges to the river would remain within the bounding conditions established in the NPDES. These permits are renewed every five years and this helps to ensure that no changes have been made to the facility that would alter aquatic impacts and that no significant adverse impacts have occurred.

4.2.7.2 Groundwater Use

Currently, groundwater is not used by BFN, and no groundwater use is anticipated for Alternative 1. Therefore, there would be no impacts to groundwater resources under this alternative.

4.2.8 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 considered. For non-repetitive actions, EO 11988 states that all proposed facilities should be located outside the limits of the 100-year floodplain unless alternatives are evaluated which would either identify a better option or support and document a determination of "no practicable alternative" to siting within the floodplain. If this determination can be made, adverse floodplain impacts would be minimized during design of the project. For a "critical action," facilities must be protected to the 500-year flood elevation. A "critical action" is considered to be any activity for which even a slight chance of flooding would be too great. One of the criteria used in determining if an activity is a critical action is whether essential and irreplaceable records, utilities and/or emergency services would be lost or become inoperable if flooded. 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. The PMF (see glossary) is more severe than the 500-year flood and is primarily used to conservatively evaluate dams and nuclear facilities.

Common to all of the alternatives, a dry cask storage facility, and Modifications Fabrication Building would be constructed. 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 Probable Maximum Flood (Reference: Individual Plant Examination of External Events (IPEEE). This includes potential flooding from all sources. For the small stream to the northwest of the plant site, the channel is designed with capacity sufficient to carry the PMF without flooding the plant. For the switchyard drainage channel, the switchyard is higher than the maximum water surface, preventing flow from entering the plant. In the vicinity of the radioactive waste, reactor, and diesel generator buildings, the flood elevations from the surface drainage would not exceed elevation 565.0, which is the plant grade. For the Cooling Tower System, the channels have sufficient capacity to pass the PMF runoff and condenser water without flooding the plant for any mode of plant operation. (Reference: FSAR)

The proposed dry cask storage facility 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 the same 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 flood waters 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 as a result of total development of the drainage basin, 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.

4.2.9 Terrestrial Ecology

4.2.9.1 Vegetation

No uncommon plant communities or otherwise sensitive vegetation exists on the lands to be affected under Alternative 1. With respect to vegetation, any direct, indirect or cumulative impacts to the terrestrial ecology of the region are expected to be insignificant as a result of this Alternative.

4.2.9.2 Wildlife

Under Alternative 1, the operating licenses for Units 2 and 3 at BFN would be renewed at an EPU of 120% of the original operating power levels. Because no rare or uncommon communities of animals exist on the site, the construction and operation activities associated with Alternative 1 would not result in adverse impacts to any uncommon wildlife or their habitats.

4.2.9.3 Introduced Species

Because no intact native plant communities occur on lands to be disturbed by the proposed actions, and because introduced plant species are already present in these areas, any direct, indirect, or cumulative impacts due to the establishment or spread of introduced plant species are anticipated to be insignificant as a result of the actions associated with Alternative 1.

Two introduced species, the European house sparrow and the European starling, are known to exist on the project site. These species are quite common in the project area. Alternative 1 would not result in increased population levels of introduced animal species.

4.2.9.4 Managed Areas and Ecologically Significant Sites

Because the proposed actions would occur within the lands presently utilized for the operation and maintenance of the BFN no impacts to Managed Areas or Ecologically Sensitive Sites are anticipated.

4.2.9.5 Refurbishment Impacts

Alternative 1 involves only Units 2 and 3, which are currently operating successfully without the need for significant equipment replacements. License renewal of BFN Units 2 and 3 for a 20-year period 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 will be necessary outside of what is already periodically scheduled for normal wear.

4.2.10 Aquatic Ecology

4.2.10.1 Fish

In 1985, BFN initiated a three-phase biological monitoring program to evaluate the effects of the thermal discharge on total standing stocks and selected fish species in Wheeler Reservoir, and a sampling program to monitor total standing stocks of fish in Wheeler Reservoir. The results of this monitoring program were reported to the State of Alabama in 1998 (Baxter and Buchanan, 1998), and additional analysis of the data was provided as part of the NPDES Permit Renewal application submitted in September 1999 (TVA, 1999). Both the final report and the additional analyses concluded that the operation of BFN under the current permit limitations has not had a significant impact on the aquatic community of Wheeler Reservoir or on the specific aquatic species studied. In addition to the BFN specific studies, monitoring initiated in Wheeler Reservoir in 1990 as part of TVA's Vital Signs Monitoring Program provided an additional measure of the quality of the ecological health of the aquatic community in the vicinity of BFN (Dycus and Baker, 2000). Results since 1991 indicate no adverse impacts as a result of BFN operation.

Two species of special interest, sauger and yellow perch, were the focus of BFN thermal variance studies because both are considered coolwater species and, theoretically, more susceptible to elevated water temperature. Based on results of studies conducted from 1985 through 1992, operation of BFN had no significant adverse impact on the reproductive success of either species nor the movement of sauger past BFN. However, studies did indicate sauger spawning success was adversely impacted by overfishing in Wheeler Reservoir and drought conditions (e.g., low flows and decreased turbidity) in the Tennessee Valley during 1985 through 1988 (Maceina, et al. 1998, and Baxter and Buchanan, 1998).

No changes to the thermal discharge limitations are necessary to accommodate the EPU under Alternative 1 with extended operating periods. As noted earlier, use of the cooling towers would increase from approximately 1.8% of the time for current operations to approximately 2.3% of the time with EPU. This increase would not result in any impacts to the aquatic community of Wheeler Reservoir. TVA plans to continue an ongoing monitoring program for at least the term of the current permit cycle (five years) to confirm that operation at the uprated power levels does not have an adverse impact on the aquatic community in the vicinity of BFN.

The thermal variance permitted under BFN's current NPDES permit of 90°F is well within the thermal tolerance levels of most reservoir fish species in Wheeler Reservoir. Annual ambient maximum temperatures rarely exceed 89°F in the main channel but often exceed this temperature in the shallow areas in embayments and coves. Mundahl (1990) reported most fishes upper temperature tolerances well exceed temperatures found in their natural habitat. As ambient temperatures rise, fish are able to increase their tolerance of high temperatures. High temperatures increase the fishes metabolic rate and induces frantic behavior which aids in the fishes ability to swim out of the thermally affected mixing zone. Therefore, if any fish happen to drift or swim into the mixing zone they have a natural ability to escape if conditions are not favorable. Larval fish do not have the ability to swim out of the mixing zone, but will drift through with minimal exposure to the elevated temperatures. Juvenile fishes (excluding sauger) possess the ability to tolerate warmer temperatures than adults (Brungs and Bernard, 1977).

The area thermally affected below BFN does not exceed upper lethal limits of sunfish (bluegill, black and white crappie), bass (largemouth, smallmouth and spotted bass), channel catfish, sauger, or gizzard shad. Their upper thermal tolerances reported by Brungs and Bernard are listed in Table 4.2.10-1. Only yellow perch and juvenile sauger could be affected below BFN's zone of thermal influence. Yellow perch, with a thermal tolerance of 32°C (89.6°F), could be affected by BFN's thermal effluent during annual extreme water temperatures. During June through September, ambient water temperatures would also exceed the upper lethal thermal limit for juvenile sauger of 30°C (86°F) Table 4.2.10-1. Baxter and Buchanan (1998) reported that sauger disperse throughout the reservoir and are not found in the vicinity of BFN during extreme ambient water temperatures.

It is unlikely that sublethal effects would occur from the proposed action. Temperatures below BFN would be within compliance of the permitted thermal variance and the increased discharge would be negligible compared to the releases from Guntersville Dam. Existing predator-prey relationships and other fish behavior patterns should not be affected by the proposed alternatives. Baxter and Buchanan (1998) reported that sauger are not attracted to the BFN thermal plume during seasonal extreme ambient water temperatures. Sauger migrated upstream past BFN during the mid-winter months to spawn in the Guntersville Tailwater and dispersed throughout the reservoir during the mid-summer months. Lowery and Poppe (1992) reported that reproductive success of sauger in Wheeler Reservoir, regardless of their distribution patterns, is not adversely affected by the thermally influenced zone of BFN discharge. All sauger examined during this study appeared to be in excellent physical condition and revealed normal gonadal development. This study also demonstrated that sauger were not concentrated near the BFN thermal discharge. Results of prior operational monitoring at BFN involving egg, larvae and juvenile fishes, do not suggest effects to these life stages from the proposed alternatives.

Table 4.2.10-1 Upper Thermal Temperature Tolerances of Juvenile and Adult Fish Found in Wheeler Reservoir				
SPECIES	**UPPER LIMIT JUVENILE**	**LOWER LIMIT JUVENILE**	**UPPER LIMIT ADULT**	**LOWER LIMIT ADULT**
Black crappie	27-37°C (80.6 – 98.6°F)	3 – 15°C (37.4 – 59°F)	31 – 35°C (87.8 – 95°F)	3 – 11°C (37.4 – 51.8°F)
Bluegill	27-37°C (80.6 – 98.6°F)	3 – 15°C (37.4 – 59°F)	31 – 35°C (87.8 – 95°F)	3 – 11°C (37.4 – 51.8°F)
Common carp	31 – 41°C (87.8 – 105.8°F)			
Channel catfish	30 – 38°C (86 – 100.4°F)			0 – 6°C (32 – 42.8°F)
Emerald shiner	23 – 31°C (73.4 – 87.8°F)	2 – 5°C (35.6 – 41°F)		
Gizzard shad	34 – 36.5°C (Underyearling) (93.2 – 98.2°F)	10.8 – 20°C (Underyearling) (51.44 – 68°F)		
Golden shiner			29.5 – 34.5°C (85.1 – 94.1°F)	1.5 – 11.2°C (34.7 – 52.16°F)
Hybrid striped x white bass		39.2°C (102.5°F)		
Largemouth bass	33 – 36°C (91.4 – 96.8°F)	5 – 12°C (41 – 53.6°F)		
Sauger	27 – 30°C (80.6 – 86.0°F)			
Smallmouth bass	35°C (95°F)	2 – 10°C (35.6 – 50°F)		
Striped bass	35°C (95°F)		38°C (82.4°F)	
Threadfin shad		9°C (48.2°F)		
Walleye	29 – 31°C (84.2 – 87.8°F)	31°C (87.8°F)		
White crappie	33°C (91.4°F)			
White sucker	26 – 31°C (78.8 – 87.8°F)	2 – 6°C (35.6 – 42.8°F)		
Yellow perch		9°C (48.2°F)	21 – 32°C (69.8 – 89.6°F)	

4.2.10.2 Benthic Organisms

As identified in the EPU EA, an increase of approximately 2.3°F in the temperature of the circulating water would occur with the uprate of Units 2 and 3. This increase in discharge temperature would result in increased cooling tower usage during summer periods. However, in order to maintain compliance with the discharge limitations, discharge temperature at the diffusers would not change appreciably (Brellenthin, 2001). Water intake velocity would not change from that which was evaluated during previous studies when all three units were in operation at BFN. Therefore, no additional impacts to benthic macroinvertebrate communities due to discharge temperatures or entrainment are expected in the vicinity of BFN as a result of extending the operating licenses for Units 2 and 3.

4.2.10.3 Introduced Species

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% 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 abundance is not expected to be influenced by BFN operations. Introduced grass carp are normally sterile, so that their numbers can be maintained at desired levels by adjusting any future stocking rates.

Nuisance aquatic plants such as Eurasian water-milfoil (*Myriophyllum spicatum*) and hydrilla (*Hydrilla verticillata*) are established and abundant in several TVA reservoirs including some portions of Wheeler Reservoir. Because of the current abundance of Eurasian water-milfoil on Wheeler Reservoir, the potential of hydrilla to colonize large portions of Wheeler Reservoir in the near future, and published literature on these two species, they were selected to evaluate the potential impacts of thermal enrichment on aquatic plants.

Eurasian watermilfoil and hydrilla grow over a broad temperature range with maximal rates of photosynthesis or biomass accumulation reported in the 32° to 35°C range (Stanley and Naylor, 1972; Van, Haller, and Garrard, 1978; Barko and Smart, 1981; Smith and Barko, 1990). Increases in water temperatures during the growing season (late April through September) theoretically would result in the advancement of phenological events (e.g., onset of growth, flowering, fragmentation, and senescence), an increase in shoot length, and an increase in maximum plant biomass. An increase in maximum biomass of Eurasian water-milfoil might not occur because of sloughing of shoot fragments at the higher temperatures of its growth range (Barko and Smart, 1981). Small changes in temperature within the range (i.e., 0.5°F or less) predicted by the modeling studies for alternative 2 likely will not result in measurable reservoir changes in plant biomass, shoot length, or phenological events. Any effects of thermal enrichment from operation of BFN on aquatic plant populations likely would be insignificant compared to the impacts associated with annual variations in rainfall, reservoir flow, and turbidity (phytoplankton, suspended solids).

In addition, in 2001 most of the estimated 3,600 acres of submersed aquatic plants (including Eurasian water-milfoil, hydrilla, spiny-leaf naiad, coon-tail, southern naiad) in Wheeler Reservoir grew in the broad, shallow over bank habitat (TRM 296 upstream to 305) upstream of Brown's

Ferry Nuclear Plant in areas that would not be impacted by thermal enrichment. During the peak year of aquatic plant coverage on Wheeler Reservoir in 1988 when aquatic plants colonized about 9,840 acres (Burns, Bates, and Webb, 1989), only about five percent of submersed aquatic plants were in areas downstream of Brown's Ferry that potentially would have been impacted by thermal enrichment.

4.2.10.4 Entrainment and Impingement of Fish and Shellfish, Heat Shock

For the continued operation of Units 2 and 3, the volume of water withdrawn from the reservoir remains within the levels evaluated during previous studies of intake effects on fish for three-unit operation at BFN; therefore, as found in the original EIS and in subsequent operational monitoring, entrainment and impingement levels are expected to remain at insignificant levels under Alternative 1. Any increased discharge temperatures would be within the NPDES permit limits; thus, there should be no significant thermal impacts.

4.2.10.5 Microbiological Organisms

Data collected during the 1990-1991 Browns Ferry Thermal Variance monitoring study and the TVA Vital Signs monitoring program did not indicate that the operation of BFN had influenced the phytoplankton community in Wheeler Reservoir (Lowery and Poppe, 1992). Under Alternative 1, no changes to thermal discharge limitations are necessary to accommodate extension of the units' operating licenses. In addition, intake velocity and volume would remain within previously evaluated levels. Therefore, no additional impacts to the plankton communities are anticipated.

4.2.11 Threatened and Endangered Species

4.2.11.1 Animal

Adoption of Alternative 1 is expected to have no effect on federal or state listed terrestrial animal species. Little or no habitat suitable for listed species exists on the project area, and no listed species are known to be on the site.

4.2.11.2 Aquatic

Effects from Alternative 1 are not expected to impact threatened or endangered aquatic species within the area affected by construction or operational changes at BFN as proposed herein. Therefore, these proposed changes and additions to BFN would have no effect on the species listed in Section 3.11.2. No threatened or endangered aquatic animals are presently known to exist within the area potentially affected by Alternative 1; therefore, no impacts to these species are expected to result from adoption of this alternative.

4.2.11.3 Plants

Because no occurrences of rare (federal- or state-listed) plant species are known on or immediately adjacent to BFN, no effects on rare plant species are expected as a result of Alternative 1.

4.2.12 Wetlands

There would be no impacts to wetlands as the result of continuing operation of Units 2 and 3 at BFN for an additional 20 years past the expiration dates of the current operating licenses. There would be no major construction activities scheduled that would impact or affect wetlands in the plant area and construction of the proposed dry cask storage and modification fabrication facilities would not impact any wetlands.

4.2.13 Socioeconomic Conditions

4.2.13.1 Demography

As shown in Section 3.13.1, the population of Limestone County is expected to be about 80,000 at the time of license expiration, with a labor market area population of close to 750,000. Under Alternative 1, the number of construction workers is small enough (less than 100 at peak) that there would be no noticeable impact to population, and any impact would be of very short duration.

4.2.13.2 Economic Conditions

Under Alternative 1, operation of Units 2 and 3 would continue without significant change from that in effect at the end of the current licensing period. Relicensing would result in no changes in operating employment levels at the plant, in payroll, or on other plant-related expenditures. However, a new Modifications Fabrication Building and a dry cask storage facility would be constructed. These construction activities, which are discussed in Sections 2.3.2 and 2.3.3, would add a small number of workers for a brief period of time, providing a positive but very small impact to the local economy. Since operations employment would continue at about the current level, there would be no impact to the local economy from operations under this alternative, as compared to current conditions.

4.2.13.3 Community Services and Housing

Under Alternative 1, there would be no noticeable impact to community services or to housing, due to the small size of the employment impacts and to the short duration of such impacts.

4.2.13.4 Local Government Revenues

Under Alternative 1, there would be no important impact to TVA's in lieu of tax payments paid to the state or received by Limestone County. The new facilities would add a relatively small amount to the book value of the property, and therefore would slightly increase the amounts, but the difference would not be significant.

4.2.13.5 Environmental Justice

As discussed in Section 3.13.4, the disadvantaged population in the immediate area near the site is relatively small. Any negative impacts to persons living near the site would be small and would tend to be dispersed through the area. Therefore, no disproportionate impacts to disadvantaged populations are expected.

4.2.14 Transportation

4.2.14.1 Highways and Roads

In years 2014 and 2016, Units 2 and 3 operating licenses would expire. Alternative 1 involves operating these relicensed units at EPU for an additional 20 years. There would be a minor increase in construction traffic during erection of a sixth mechanical draft cooling tower, the dry cask storage facility, and the modification fabrication facility. This minor traffic increase due to construction workforce and construction deliveries and disposals would be temporary and have no significant traffic impact. Operational traffic generated by the plant would not be affected under this alternative. Current traffic generated by BFN would remain at the existing level. However, traffic growth is expected to occur over this period of time. Assuming general traffic growth occurs along with projected population growth, Average Daily Traffic (ADT) on U.S. Highway 72 will increase to approximately 16,500 vehicles per day (vpd) and ADT on U.S. Highway 31 will increase to approximately 20,000 vpd. The ADT on secondary county roads which provide access to the plant would increase to approximately 2,000 vpd.

Traffic growth will continue during the license period for 20 years following to years 2034 and 2036. During this time, traffic volumes would increase, assuming 15% growth rate per decade, to approximately 21,900 vpd on U.S. Highway 72 and 26,500 vpd on U.S. Highway 31. The county roads would increase to approximately 2,600 vpd.

Under this alternative, there would be no additional impact to the local transportation network. The percentage of vehicles on the road would remain at the current level and decrease as background traffic grows.

4.2.14.2 Railroads

Alternative 1 would result in no impacts to the railway system.

4.2.14.3 River Transport

Alternative 1 would result in no impacts to river transportation.

4.2.14.4 Pipelines

Alternative 1 would result in no impacts to pipelines.

4.2.14.5 Transmission Lines

TVA completed a transmission system study in June 2000 for BFN that assessed the ability of the offsite power system to meet NRC requirements for electric power systems. (These requirements are delineated in 10 CFR 50 Appendix A, General Design Criterion 17.) This study included a five-year look-ahead to the summer 2005 peak (net TVA peak system load of 33,775 megawatts), 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 requirements and satisfy all General Design Criterion 17 requirements relative to safe shutdown of Units 2 and 3 in the event of a design basis accident. Therefore, no additional transmission facilities would be required.

TVA has also recently completed an interim study, excluding transient stability, fault analyses, and off-site power studies of line loading in the vicinity of BFN (with EPU) for the year 2007. This study assumed the units were uprated to 1,280 MW. No transmission lines were identified as exceeding their load limits, although several of them had small margins. TVA is continuing to assess the capabilities of its transmission system, including in the vicinity of BFN.

4.2.15 Soils and Land Uses

Impacts to soils or land use on the site as a result of activities associated with license renewal for operation of Units 2 and 3 at EPU would be insignificant. The construction of the dry cask storage facility and modifications fabrication building would occur on sites previously disturbed or housing other facilities.

4.2.16 Visual Resources

The project area, located within the BFN site, is an industrial setting within the rural countryside. Scenic integrity is moderate, with many transmission lines and associated steel tower structures traversing the countryside and into the switchyard in the plant area. The terrain is gently rolling throughout the plant site and terminates on the west side overlooking the scenic Wheeler Reservoir. Together, the natural and cultural elements provide variety and some scenic attractiveness, which forms a mosaic of rural and industrial setting. This section examines the visual and aesthetic consequences of license renewal of BFN, including construction of facilities common to all alternatives. Visual consequences are examined in terms of visual changes between the existing landscape and proposed actions, sensitivity of viewing points available to the general public, their viewing distances, and visibility of proposed changes. In this assessment, scenic attractiveness is described using the following adjectives: variety, unity, coherence, vividness, harmony, tranquility, and uniqueness. Scenic integrity indicates the degree of intactness or wholeness of the landscape character. These measures help identify changes in visual character based on commonly held perceptions of landscape beauty, and the aesthetic sense of place. The foreground, middleground, and background viewing distances were previously described in Section 3.1.16.

There are common proposed activities for all Action Alternatives 1, 2A, 2B, 2C, and 2D. These include the construction of a dry cask storage facility and a new Modifications Fabrication Building. The proposed facilities would have minor visual impacts on the industrial character of the plant site. However, adding the proposed facilities would increase the number of adversely-contrasting elements seen inside the development from the rural countryside. These incremental changes may not be individually significant, but together with other facilities, they would add to a continuous growth of structures seen in the landscape and a cumulative reduction of visual resources as seen from the countryside.

County Road 25 provides the main access route to both the plant entrances and to homes north of the site. Most views to the site will be from this area and from the homes across Wheelers Lake at Mallard Creek and Mallard Creek public use area. Increasing the number of vertical objects in the landscape would add to the visually discordant contrast between rural countryside and the industrial character of the plant site. The heights and related dimensions of the tallest existing structures in the plant site are shown in Table 4.2.16-1.

Table 4.2.16-1 Summary of Height/Size Information	
Plant Feature (Existing)	**Feature size same for each alternative**
Transmission Towers at Switchyard, Northeast of Plant Site, and crossing Wheeler Reservoir	157 feet height at switchyard; 150 feet entering plant from northeast side; 247 feet mounted on river islands crossing Wheeler reservoir
Plant Reactor/Turbine Building	Roof heights vary from 111 feet-4 inches to 155 feet
Existing Earthen Berm	70 feet, height; 3,000 feet, length
Mechanical Draft Towers (4 existing)	65 feet, height
Off Gas Stack	Nominally 600 feet, height

IMPACTS OF CONSTRUCTION

Operating relicensed Units 2 and 3 at EPU under Alternative 1 will involve minor construction site preparation of a few areas at BFN. Visible construction would include minor grading to construct building pads, new laydown areas for construction equipment and materials, temporary facilities, and trenching for new utilities. As the construction reached completion, it would be seen in the foreground by passing motorists. Scenic integrity in the area would be somewhat low during the construction process. However, the visual discord as a result of construction would be temporary, and would last until site cleanup and reclamation of disturbed areas are complete.

IMPACTS OF OPERATION

The impacts of operation under Alternative 1, while operating Units 2 and 3 at EPU, could include a small increase in the number of plumes, and potentially the duration for which they will be seen, rising from the mechanical draft cooling towers. These plumes could be observed most frequently by area residents and, depending upon atmospheric conditions, by residents much farther away from the plant site.

4.2.17 Recreation

Since the proposed action would be contained within the existing plant site, impacts for Alternative 1 would be insignificant. This includes the construction of the proposed dry cask storage and the modification fabrication facilities. No recreation facilities, resources or activities would be significantly affected.

Cumulative impacts for Alternative 1 would be insignificant. This includes the construction of the proposed dry cask storage and the modification fabrication facilities.

4.2.18 Cultural Resources

4.2.18.1 Archaeological Resources

Alternative 1 proposes to relicense Units 2 and 3 at EPU. This action would have no affect on historic properties because activities will take place within existing facilities. The construction of the proposed dry cask storage facility and Modifications Fabrication Building would not have any direct effects on historic properties. However, historic properties (one prehistoric archaeological site and one historic cemetery) have been identified at BFN. Placement of construction spoil on either of these historic properties would be an adverse effect. These two historic properties encompass small portions of disposal areas 1 and 2. By excluding these two historic properties from potential disposal areas, placement of spoil would not result in an adverse effect to historic properties. The boundaries of these two sites have been adequately demarcated on site-controlled drawings to prevent inadvertent disturbance of these sites. The Cox Cemetery, located in Area 2, would be avoided by all activities.

4.2.18.2 Historical Structures

No historic structures were identified within the visual area of potential effect. Therefore, there would be no effect on historic structures.

4.2.19 Environmental Noise

There would be no environmental noise effects from Alternative 1, the relicensing of Units 2 and 3, that are different from existing noise conditions described in Chapter 3.

Construction of the dry cask storage area and the modification fabrication building has the potential for short-term, insignificant environmental noise effects. Neither construction is a major project. The dry cast storage area consists of a light-commercial building, concrete pads, and fencing; and the modifications fabrication building is a large, light-commercial, prefabricated steel structure. Sections 2.3.2 and 2.3.3 give more details about these facilities.

Earth moving for site preparation and concrete deliveries are the two major noise sources from the construction of the dry cask storage area. The pads for Phase 1 and 2 would probably take a few months to complete, and this work would be done during normal business hours. This area is more than 4,200 feet from the closest residence and there is a small, wooded hill in between. Although concrete truck noise will be noticeable along the delivery route for a few weeks, the overall potential environmental noise effect is insignificant for this construction.

Construction of the modifications fabrication building will take a few weeks and will require about 25 to 30 truck deliveries. The proposed site of this building is tucked-in behind the main plant, and it needs minimal site preparation. Erection of this building has no potential for environmental noise effects.

There will be no operational noise effects from Alternative 1, the relicensing of Units 2 and 3, that are different from existing noise conditions described in Chapter 3.

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

The site Safety and Health Program described in Section 3.20 would not be impacted or affected by license renewal and continuing to operate Units 2 and 3 for 20 years after the current operating licenses expire in 2014 and 2016, respectively.

4.2.21 Radiological Impacts

4.2.21.1 Normal Operation

4.2.21.1.1 Occupational

Occupational radiation dose refers to radiation dose received by individuals as a course of their employment. Parameters considered for the analysis included: baseline occupational dose, projected dose increments, and an estimated cancer risk increase for the projected dose increments. The scope for Alternative 1 (see section 2.2.1) addresses units 2 and 3 EPU with an extended operating license (20 years). EPU has been addressed by a specific environmental assessment (EA). A conservative basis assumption of that EA is that the annual collective dose would increase in direct proportion to the power level. Table 4.3.21.1.B summarizes the current facility dose parameter and forecasts the EPU basis dose assumption. Alternative 1 occupational radiation dose increases are less than those analyzed for Alternative 2 (see section 4.3.21.1). The occupational radiation dose increase in cancer risk associated with the EPU is addressed in Table 4.3.21.1.D. NUREG-1437 Vol. 1 Section 4.6.3.2 postulates that the radiation dose attributable to license extension might result in a five percent increase in the calculated cancer incidence to workers, but there may be no increase. The estimated cancer risks for the proposed Alternative 1 activities are bounded by the NUREG-1437 Vol. 1 Section 4.6.3.2 assumptions.

4.2.21.1.2 Public

Current radioactive effluent releases and associated exposures from BFN operations are not expected to change in adverse ways during a 20-year renewal period. There are no significant changes to the radiological effluent releases anticipated as a result of the proposed action(s) and, therefore, the impacts to the environment or the general public are not expected to change.

4.2.21.2 Facility (Design Basis) Accidents

The design basis accidents addressed in Chapter 14 of the BFN UFSAR are independent of the age of the plant. Therefore, extension of the operating lifetime of the plant from 40 to 60 years would not change the analysis of these accidents.

4.2.21.3 Severe Accident Mitigation Alternatives

A "severe" accident is a potential accident that is considered too unlikely to warrant design controls. A Severe Accident Mitigation Alternative (SAMA) analysis assesses alternative ways of mitigating the impact of such accidents. TVA has conducted a SAMA analysis for BFN. The complete SAMA analysis may be found in Appendix A of this SEIS. The SAMA analysis addresses both Alternatives 1 and 2.

The purpose of the present analysis is to provide a consistent framework to facilitate the consideration of the potential benefit of Severe Accident Mitigation Alternatives (SAMAs) for the Browns Ferry Nuclear Plant within the context of extending the current licensing periods of Units 1, 2 and 3.

The framework developed is in the form of a cost/benefit analysis. A distinguishing feature of this cost/benefit analysis is a series of screening steps. If the projected benefit associated with a specific SAMA is found to be greater than a specific screening criterion, then the SAMA is retained for further consideration in subsequent, more realistic screening steps. SAMAs that survive all screening steps are retained for future engineering evaluation.

This assessment considers all three Browns Ferry units, each operating at 120% of their original licensed power level. Ideally, this assessment would take advantage of unit-specific Probabilistic Safety Assessments (PSAs) for each unit that reflects operation of all three units at 120% of their original licensed power level. That information is not currently available. Unit-specific PSAs are available for Units 2 and 3 that represent operation at 105% of their original licensed power level. Because of the progressive, screening nature of the SAMA evaluation, it was possible to use the available PSA information, along with engineering knowledge of the plant to form a basis for the three-unit cost/benefit analysis.

First, a baseline profile of the costs associated with severe accidents potentially arising from the current design and operation of Units 2 and 3 was formulated. Next, potential SAMAs were identified, and their impact on calculated core damage frequency and associated severe accident costs were assessed. SAMAs may consider changes to hardware, procedures, or both. Finally, SAMAs that passed cost/benefit criteria (i.e., if their estimated implementation costs are less than the anticipated savings) were retained for further consideration.

The identification of potential SAMAs for consideration started with reviewing those SAMAs that had been identified in other industry efforts, including other SAMA submittals to the NRC. In addition, potential design and/or procedural changes were identified following the review of the BFN Units 2 and 3 PSAs. These plant-specific potential alternatives were added to the generic SAMAs to complete the list of SAMAs for consideration.

The current PSAs for Units 2 and 3 were used in this evaluation. These PSAs, however, required some modification for use in evaluating the SAMAs. The current PSAs can be characterized as "level 1+" risk studies; that is, they trace the plant and operator response from a set of initiating events to one of three scenario end states: success (no core damage), core damage with "large early release," or core damage without "large early release." This formulation is consistent with current NRC requirements and guidance for PSAs supporting risk-informed applications. For SAMA evaluations, however, additional information from the PSAs was required.

In the evaluation of SAMAs, it is required that off-site consequences (economic as well as radiation dose to the public) be estimated. A PSA that fully meets these requirements is often referred to as a "level 3" PSA. This necessitated the extension of the current models to address off-site impacts of core damage sequences. Normally, this would require the development of a model that considers the phenomena associated with the in-plant transport of post-core damage fission products (a so called "level 2" PSA). To meet this requirement, the current PSAs were modified to map core damage sequences to the "level 2" end states that were identified for the 1992 BFN IPE. Existing analyses that were done in support of the IPE allow for the characterization of the amount and timing of fission product release from the plant for core damage sequences. Off-site consequence analyses were then evaluated using the MACCS2 computer code. This approach satisfies the "level 3" requirement for the SAMA evaluation in an efficient manner.

Evaluation of the off-site impacts of the as-is design of Units 2 and 3 allowed the determination of baseline severe accident costs. The cost evaluation included the consideration of replacement power costs.

The list of SAMAs was screened to determine those potential changes that required more detailed evaluation. Over 130 potential SAMAs were identified. Those SAMAs, for example, that did not apply to the BFN design, were already implemented at BFN, or whose cost of implementation greatly exceeded the costs associated with the as-is design severe accident costs were systematically eliminated from further consideration.

The impacts on both the Unit 2 and the Unit 3 PSAs were determined for those potential SAMAs that passed the initial screening. From the original list of SAMAs, 28 "phase II" SAMAs were identified. Often it was appropriate to identify a bounding impact on the PSA that would conservatively (i.e., overestimate) the potential benefit of the SAMA. For several of the SAMAs, information from the PSA (e.g., system importance measures) were used to estimate their potential benefit. For the majority of the phase II SAMAs, however, new PSA models that incorporate individual SAMAs were developed and quantified. The cost associated with severe accidents was then evaluated for each unit assuming that the specific SAMA was fully implemented. The difference between the baseline off-site costs and the off-site costs with the SAMA implemented was determined for two different future discount rates (3% and 7%). This difference is presented as an "avoided cost."

Uncertainties in the PSA calculations were considered by identifying those SAMAs that would not be screened during the cost/benefit comparison if the benefit were to increase by a factor of three. The factor of three approximates the ratio of the 95th percentile of the core damage frequency to the mean.

Effects on avoided costs due to restart of Unit 1 were also addressed. The operation of Unit 1 would increase the calculated core damage frequency of Units 2 and 3. The units share certain equipment (e.g., diesel generators, Residual Heat Removal Service Water and Emergency Equipment Cooling Water) resulting, in selected scenarios, in decreased availability of equipment to a particular unit. Success criteria for selected systems are also impacted. Insights from the Multiple Unit PSA performed in 1995 were used to bound the effects of three-unit operation.

Implementation costs for each SAMA were estimated. The cost/benefit evaluation was based on comparing the implementation costs with the two discounted cost savings for individual SAMAs. The results of this evaluation indicated that one SAMA listed below is potentially cost beneficial. This SAMA is:

- Increase/improve DC bus shedding. This would improve DC power reliability and thus increase the time available to recover power during a station blackout event.

In addition, uncertainties in the PSA calculations were considered by identifying those SAMAs that would not be screened during the cost/benefit comparison if the benefit were to increase by a factor of three. The factor of three approximates the ration of the 95th percentile of the core damage frequency to the mean. Consideration of uncertainty alone did not result in any additional SAMAs surviving the screening process.

When a bounding analysis was used to estimate the potential impact of three-unit operation at Browns Ferry, one additional SAMA was retained:

- Provide additional DC battery capacity.

When bounding analyses were performed to estimate the impact of both uncertainty and three-unit operation on the screening process, two additional SAMAs survive the screening process:

- Use of the fire protection system as a backup source for diesel cooling.
- Develop a procedure to trip unneeded RHR/CS pumps on loss of ventilation.

It should be noted that additional engineering analyses are warranted to further consider the above SAMAs. The analysis documented in Appendix A is bounding in nature.

4.2.22 Decommissioning Impacts

As explained in Chapter 2, under this Alternative (1), decommissioning would probably not be initiated for Unit 1 while operation is extended for Units 2 and 3. 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.

License renewal of BFN Units 2 and 3 would provide an additional 20-year period for decommissioning technology (including more advanced robotics) and the licensing framework to evolve and mature. In addition, it becomes much more likely that a permanent spent fuel repository would be available prior to the completion of decommissioning. Consequently, in comparison with the No Action Alternative, the potential for adverse environmental effects from decommissioning could be further reduced.

4.3 Impacts to the Environment Associated with Alternative 2

4.3.1 Air Resources

4.3.1.1 Climate and Meteorology

Alternative 2 would not involve any potential impacts on the local climate and meteorology greater than was assessed in the original EIS. The potential for fogging and icing from operation of the cooling towers was based on conservative plume modeling and conservative assumptions for operation of the original six mechanical draft towers. The results given in Volume 3, Section 3.4, of the original EIS are greater than would be expected from additional cooling capacities of all variations of Alternative 2. This is because the actual operation of the cooling towers has been and would be expected to occur only in the warmer months, mainly in the summer, and for much less time than the 29% assumed in the original EIS.

4.3.1.2 Ambient Air Quality

Alternative 2 involves restart of Unit 1 and consequent operation of Units 1, 2, and 3. The impacts discussion of the auxiliary steam boilers and diesel generators for Alternative 1 also applies to Alternatives 2A, 2B, 2C, and 2D. Alternative 2A includes the addition of two new rectangular mechanical draft towers; Alternative 2B includes the addition of two round mechanical draft towers instead of rectangular towers; Alternative 2C includes enlargement of existing cooling tower number 3 by 25% and replacing the other five cooling towers with new and larger linear mechanical draft cooling towers; and Alternative 2D includes the construction of a single 20-cell linear mechanical draft cooling tower in the currently vacant position (no. 4) where a tower that was destroyed by an accidental fire in 1986 has never been replaced. The amount of condenser circulating (i.e., cooling) water (CCW) flow would be the same for Alternatives 2A, 2B, and 2C, and the same or less for Alternative 2D. Therefore, the total drift loss from the cooling towers is also expected to be the same for Alternatives 2A, 2B and 2C, and the same or less for Alternative 2D.

The CCW requirement for Alternative 1 is 3,579 cubic feet per second (cfs), which is less than the design rate of about 3,680 cfs for the original six cooling towers. The CCW requirement for each of Alternatives 2A, 2B, 2C, and 2D is 5,368 cfs. In order to estimate PM-10 emissions (particulates in the drift), TVA used this CCW value, the default drift factor of 1.7 pounds/10^3 gallons given in EPA publication AP-42, an estimated 101 parts per million (ppm) total dissolved solids (TDS) content of the intake water which was determined during a source assessment for Title V of the Clean Air Act, and a helper mode concentration factor of 1.03. The current National Ambient Air Quality standard for particulates applies to particles smaller than 10 microns. All of the particles resulting from the TDS in the drift are assumed to be at least this small, and the majority of them are expected to be smaller than the 2.5 micron criterion in a new standard that was promulgated in 1997, but was overturned by court action. Thus, the addition of cooling towers potentially changes the estimate of total particulate emissions identified in the original EIS.

In addition to the values stated above, an expected maximum operation in the helper mode was assumed to be 22% of the time. This amount of time should encompass the increase from two to three units and potentially more adverse conditions in future years than have been encountered in the last six years. It also provides direct comparison of the results with the helper mode results in the original EIS, Volume 1, Section 2.5. For Alternative 2, under any of the options, the estimated emissions would be about 22 pounds/hr compared to an emissions standard of 45 pounds/hr and total emissions would be 21.2 tons/yr compared to the 100 tons/yr stated in Section 2.5. Thus, despite the potential increase in the number of cooling towers, design change, and configuration, particulate emissions are expected to be less than the level identified in the original EIS. As discussed in Section 3.1.3, conservative assumptions about expected emissions and conservative modeling gave the large results in the original EIS. If the future maximum operation of the towers is no more than the eight percent maximum experienced in recent years, the total emissions would be only about 7.7 tons/yr.

4.3.1.3 Existing Air Emission Sources

All existing BFN emission sources for air pollutants are described in the original EIS. The addition of two cooling towers or modification of sizes of cooling towers would result in emissions discussed in Section 4.3.1.2. Construction sources and increased work force traffic would be somewhat more extensive for Alternative 2 than for Alternative 1, but the source types, levels, purpose, and time/season would be the same as listed in Table 4.2.1-2.

4.3.1.4 Air Quality During Refurbishment

For Alternatives 2A, 2B, 2C, and 2D, the same minor construction impacts as for Alternative 1 can be expected, and some additional impacts would be associated with the expected addition of more cooling tower capacity and Unit 1 restart work. These additional impacts may include fugitive dust from earth-moving activities required to reduce the height of the existing soil berm on the northeast side of the current set of cooling towers and to prepare the footprints for the additional cooling tower capacity and associated fuel combustion emissions from construction equipment and trucks. Emissions of small amounts of fugitive dust may be associated with surface preparation and transport of concrete in mixing trucks for the construction of the proposed dry cask storage facility, the proposed modifications fabrication building, and the proposed administration building. Minor emissions of combustion exhaust products such as nitrogen oxides, carbon monoxide, carbon dioxide, sulfur oxides, and hydrocarbons from engines in concrete mixing trucks, other construction-related vehicles, and construction equipment used in construction of the new facilities and in the Unit 1 refurbishment process can also be expected. Some vapors including hydrocarbons may be emitted from stored vehicle fuels and during refueling activities. As concluded for Alternative 1, construction-related impacts on ambient air quality for Alternative 2 would be minor, intermittent, and transitory.

4.3.2 Geologic Setting

4.3.2.1 Impacts on Geology

The impacts on geology of continued operation of BFN under any of the alternatives being considered are encompassed by the analysis in section 2.8-2 of the original EIS.

4.3.2.2 Impacts of Construction on Seismicity

Under some circumstances, human activities can change the ambient seismicity of an area. Four types of human activities are known to have the ability to change seismicity levels and patterns: (1) the creation of large reservoirs; (2) large underground explosions, e.g., nuclear tests; (3) the injection (or withdrawal) of underground fluids; and (4) the excavation of mines (Gough, 1978). These activities can induce earthquakes ranging in size from microearthquakes to earthquakes with m_b magnitudes of six or slightly greater (Yeats, et. al. 1996).

Activities (1), (2), and (4) can be associated with construction. Activities (1) and (2) would not occur at the site under Alternative 2A, 2B, 2C, or 2D. Activity (4), excavation, would occur on a relatively small scale at the site for any of the sub-alternatives of Alternative 2. Alternatives 2A, 2B, and 2C would require removal of some or all of the mound of earth located immediately north of the existing cooling towers. Alternative 2D would not likely require removal of this material. It is very unlikely that moving this material would change the crustal loading enough to trigger earthquakes. Therefore, there is essentially no possibility that any construction associated with re-licensing and refurbishment of Unit 1, including the construction of the three new facilities, would alter the natural level of seismic activity and no construction impacts are expected.

4.3.2.3 Local Geology

Continued operation of BFN and refurbishment activities, including the construction of the three new facilities, should have no impact on the natural level of seismic activity in the area.

4.3.3 Solid Wastes Management and Past Practices

4.3.3.1 General Plant Trash

In the event that 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 reconstruction 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. Together this could be as much as a 30% increase over current levels during the construction period. Once operational, the amount of trash generated would be similar to the other operating units, and the overall amount generated would increase slightly (approximately 12.5 %) from the current 50 ton per month level due to the small increase in permanent plant staff necessary to operate three units. The increase in general plant trash could be offset to some extent by implementation of recycling efforts beyond those currently in place. This would include increasing the amount of white paper, aluminum cans, and special stock paper sent to recycling, and improving recycling of waste wood. The existing contractor is capable of handling the increased volumes anticipated.

4.3.3.2 Construction/Demolition Debris

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

Alternative 2C (six large linear mechanical draft cooling towers) would result in generation of a large amount of construction/demolition debris and asbestos as a result of the need to remove four existing towers and modify the fifth tower to increase its size. Demolition of Towers 1, 2, 5, and 6 would result in approximately 39 to 45 dumpsters (40 cubic yards each) of fiberglass and vinyl, 60 to 70 dumpsters of asbestos, and 16 to 20 dumpsters of scrap lumber. The fiberglass and asbestos would be disposed in off-site permitted landfills, while the majority of the scrap lumber could be recycled. A minor amount of scrap metal (wires, fasteners, etc.) would also be generated and disposed through existing recycling programs. In addition, approximately 1,350 gallons of used oil would be generated as a result of removal of the fan motors and gearboxes; this material would be recycled through the existing BFN program. Discarded motors and gear boxes would also be recycled as scrap metal. Appropriate demolition notifications would be sent to the Alabama Department of Environmental Management.

4.3.3.3 Low Level Radioactive Waste

Should Unit 1 be restarted, generation rates would be expected to increase during construction activities primarily 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 material would increase in proportion to the additional operational activity associated with three-unit operation. This would result in an increase to approximately 45 to 60 cubic meters per month. These increases would be expected to remain within the storage and disposal capacities of existing facilities. The existing contractor(s) is capable of handling the increased volumes anticipated.

4.3.4 Hazardous Wastes Management and Past Practices

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

4.3.5 Spent Fuel Management

Environmental consequences of additional spent fuel management resulting from Unit 1 restart and license extension of the three BFN units would be minimal. As described in sections 2.2, 2.3, and 3.5, additional spent fuel resulting from license extension would be stored in the spent fuel pool or a dry storage system approved by NRC in accordance with 10 CFR 72. Subsequently, BFN spent fuel would be transferred to the DOE in accordance with the Nuclear Waste Policy Act of 1982 and subsequent amendments. The only component of a dry storage system not transferred to DOE would be the concrete storage overpack provided a modular system is chosen. If used, this component would be disposed as part of the ISFSI decommissioning. 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 ISFSI by approximately 33%.

4.3.6 Surface Water Resources

4.3.6.1 Construction Effects

The Unit 1 upgrade, restart, and increased cooling tower capacity involves substantial construction activities. As development occurs, soil disturbances associated with access roads and other construction activities could potentially result in adverse water quality impacts. Improper water management or storage and handling of potential contaminants could result in the runoff of pollutants to receiving streams. Erosion, sediment, and accidental spills of fuel or oil could impact streams and threaten aquatic life.

Standard safeguards would be included in the project design, construction and operation to minimize the risk of adverse impacts. Construction activities would comply with state permit requirements for the control of potential impacts (e.g., general construction permit, best management practices (BMP) plan, erosion control plan, and spill prevention plan). BMPs sufficient to minimize the risk of and avoid adverse impacts would be followed for all construction activities. Site grading and soil removal would be minimized. Clearing operations would be staged so that only land that would be developed promptly is stripped of protective vegetation. Mulch or temporary cover would be applied whenever possible to reduce sheet erosion.

Permanent vegetation, ground cover, and sodding would be installed as soon as possible after site preparation. Surface water runoff would be managed to avoid adverse impacts using sediment basins, silt fences, berms, or other control options. These and other similar precautions are expected to minimize potential construction impacts such that no special mitigation measures would be necessary.

4.3.6.2 Chemical Effluent Effects

Under Alternative 2, the Emergency Equipment Cooling Water, Raw Cooling Water, and Residual Heat Removal Service Water (Intermittent Treatment Mode) systems would have increased flow rates. Conservative estimates indicate that flow would increase by up to one-third as Unit 1 is added to Units 2 and 3 (actual increases may be less due to some commonality among systems). Discharge concentrations would be similar to those shown in Table 4.2.6-1, due to proportional flow increases in the corresponding waste streams. No changes are expected in the flow, concentrations, or treatment frequencies for the Residual Heat Removal (Stagnant Treatment Mode), since the operation of this system would be the same under all sub-alternatives for Alternative 2.

Effluent discharges from other plant systems such as yard drainage, station sumps, and sewage treatment would not be expected to change significantly with the restart of Unit 1. The changes in discharges to the river would remain within the bounding conditions established in the NPDES permit, and therefore should have minimal impact either individually or cumulatively on the environment. The discharges are regulated under the Clean Water Act (CWA) by the U.S. Environmental Protection Agency and the Alabama Department of Environmental Management. The NPDES permit specifies the discharge standards and monitoring requirements for each discharge. The permit is renewed every five years and this helps to ensure that no changes have been made to the facility that would alter aquatic impacts and that no significant adverse impacts have occurred. Compliance with the NPDES process, other provisions of the CWA (e.g., Sections 316 (a) and (b), 401, 404), and other regulatory requirements are expected to adequately control potential chemical effluent effects. In general, under these regulatory programs, TVA treats wastewater effluents, collects and properly disposes potential contaminants, and undertakes pollution prevention activities that comply with regulatory requirements and minimize the risk of adverse environmental impacts.

4.3.6.3 Thermal Effects

The restart of Unit 1 will require upgrading the cooling tower system from the existing Unit 2 and 3 capacity. The following analysis assumes that sufficient cooling tower capacity would be supplied to routinely maintain the instream thermal limits in the current NPDES permit. If extreme hot and dry conditions should make it impossible for the cooling towers to meet the thermal limits, the plant would be de-rated to remain in compliance.

Under Unit 2 and 3 operation, the maximum flow rate for the once through Condenser Circulating Water system is approximately 2,312 MGD (actual annual average flow rates are slightly lower due to outages). Restarting Unit 1 will result in a maximum flow rate for all three units of approximately 3,468 MGD. No changes are expected in the plant intake system to accommodate the flow rate for all three units.

The discharge temperature of the cooling system water would be essentially the same for three-unit operation as for Units 2 and 3 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 mixing zone would increase with the restart of Unit 1. Table 4.3.6-1 summarizes the temperature changes based on a near-field modeling analysis of 29 years of historical data from 1969-1999 (Harper, 2001, 2002). (Years 1989 and 1990 were not included in the analysis due to missing data.) Results are also shown for 1988, one of the driest and hottest years in the period of analysis, and for 1985-1999, recent years that include warmer than normal conditions and changes in the way TVA operates the river system (TVA, 1990).

Table 4.3.6-1 Summary of Projected Thermal Effects on Water Temperatures (°F)*

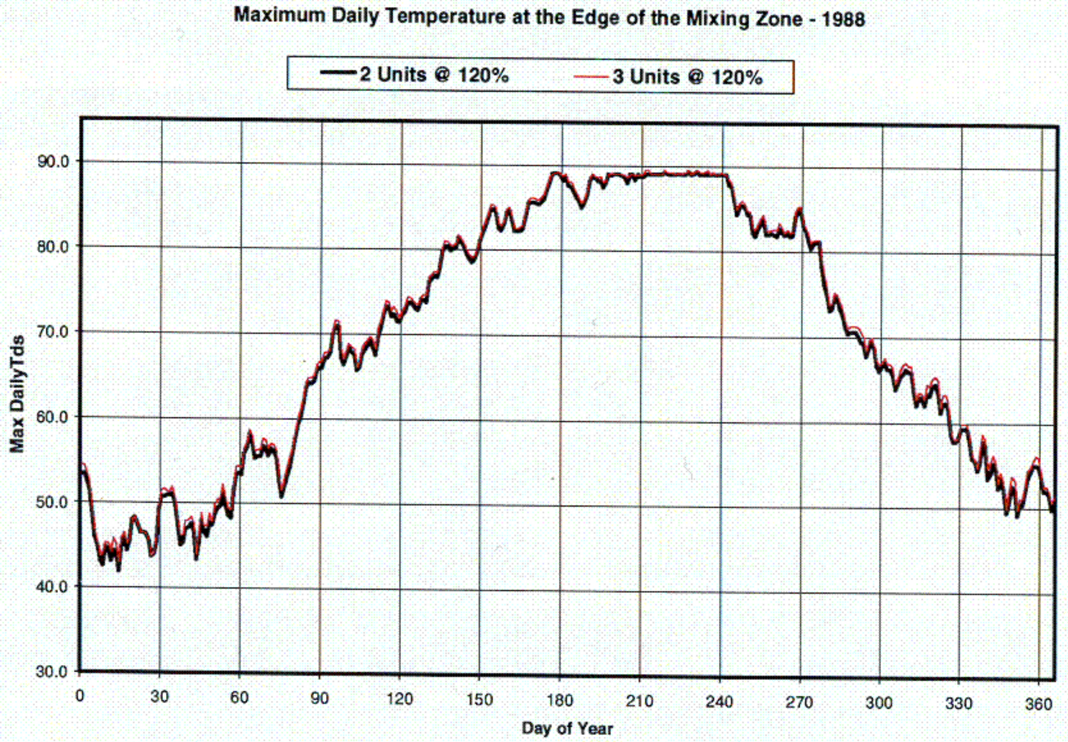
Alternative 1. Units 2 and 3 Operating								
Years	Discharge Point			Edge of Mixing Zone			Percent of Time	
	Min.	Mean	Max.	Min.	Mean	Max.	Towers	De-rate
1969-99	58.8	89.7	116.3	36.1	67.9	89.8	2.8	0.03
1985-99	59.2	90.1	115.9	36.2	68.8	89.8	4.6	0.06
1988	62.1	89.0	114.2	41.5	68.8	89.4	6.3	0.00
Alternative 2. All Three Units Operating **								
Years	Discharge Pont			Edge of Mixing Zone			Percent of Time	
	Min.	Mean	Max.	Min.	Mean	Max.	Towers	De-rate
1969-99	58.8	89.4	115.1	36.3	68.4	90.0	4.6	0.19
1985-99	59.2	89.9	115.1	37.7	69.2	90.0	6.6	0.40
1988	62.1	88.9	113.9	42.4	69.4	89.5	8.9	0.00

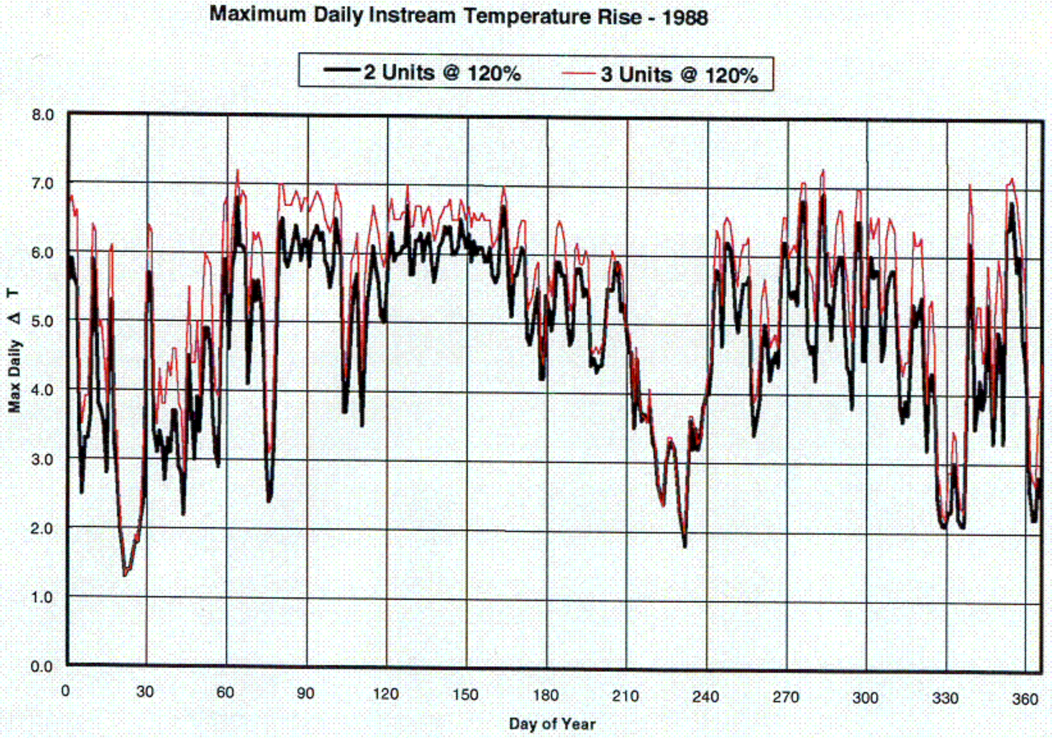
* Based on modeling analysis of hydrological and meteorological conditions for the years indicated (Harper 2001, 2002).

** Mean and minimum temperatures were essentially the same for each of the four cooling tower configurations. Maximum temperatures varied slightly (e.g., 89.8 °F to 90.0 °F during the 1969-99 simulation period). Cooling tower usage and plant de-rating also varied slightly depending on the cooling tower configuration (e.g., during 1969-99, tower usage varied from 3.9 to 4.6 percent of the time and de-rating varied from 0.06 to 0.19 percent of the time).

The mean 1969-1999 water temperature at the edge of the mixing zone increases from 67.9°F to 68.4°F as Unit 1 is added to Units 2 and 3. In 1988, the mean temperature at the edge of the mixing zone increased from 68.8°F to 69.4°F. Figure 4.3.6-1 compares the model results for 1988 under two-unit and three-unit operation. In both cases the maximum temperature at the edge of the mixing zone is maintained below 90°F with the use of cooling towers. In 1988, the instream temperature rise (i.e., between the ambient monitoring station (no. 4) upstream of the intake and downstream edge of the mixing zone) ranged from 1.2°F to 7.6°F. The potential effects of the added heat load are discussed below, based on a far-field modeling analysis.

Figure 4.3.6-1 Water Temperatures for Two-Unit and Three-Unit Operation 1988





C01

With all three units operating, the maximum downstream temperature and temperature rise between upstream and downstream would 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 have to be de-rated to remain in compliance. During the 1969-1999 simulation period, model results showed that with Units 2 and 3 operating, the cooling towers would be used 2.8% of the time and de-rating would be required approximately 0.03% of the time (i.e., de-rated 3.3 days over the 29 year period of analysis). With all three units operating, the cooling towers would be used approximately 4.6% of the time and de-rating would be required approximately 0.19% of the time (i.e., de-rated 20.8 days over the 29 year period of analysis). For the more recent period of analysis (1985-1999), cooling towers would be used approximately 6.6% of the time with de-rates occuring approximately 17.5 days over the 12-year period (1989 and 1990 are not included).

The implications of the thermal effects on reservoir water temperatures, dissolved oxygen concentrations, and eutrophication were evaluated using a far-field two dimensional reservoir model (TVA, 1993). Hydrological and meteorological conditions for 1988 (without cooling tower operation) were assessed as a potential worst-case condition for reservoir water quality (i.e., due to the low flows and warm weather). The potential reservoir effects from the restart of Unit 1 are expected to be less with the use of cooling towers and less in years of more typical hydrology and meteorology than in 1988. Results for 1988 are summarized in Table 4.3.6-2 for three reservoir locations: immediately upstream of BFN, immediately downstream of BFN, and in the reservoir forebay just upstream of Wheeler Dam.

The 1988 mean annual water temperature at the reservoir section downstream of BFN increased from 65.0°F to 66.5°F as Unit 1 is added to Units 2 and 3 (under the EPU operating capacity for all three units) in the modeled scenario. The mean annual water temperature at the downstream reservoir section was 66.0°F for all three units operating at their initial 100% capacities. Thus, the current three-unit operation represents an increase of 0.5°F over the original plant operation with all three units operating. The average daily reservoir temperature at this downstream section on the warmest day in 1988 increased from 87.1°F to 89.0°F as Unit 1 is added to Units 2 and 3 (under the EPU operating capacity for all three units). With all three units operating at their initial 100% capacity the water temperature on the warmest day was 88.6°F. Thus, the proposed three-unit operation is predicted to result in an increase of 0.4°F on the warmest day, over the original plant operation. Similar model results are shown in Table 4.3.6-2 for the upstream and reservoir forebay stations. The model results indicate potentially higher upstream and downstream temperatures due to periodic back flow conditions. The cumulative thermal impact would be insignificant, due to the small increase in reservoir temperatures, the limited effect on temperatures downstream of Wheeler Reservoir, and the lack of other major thermal discharges in the vicinity.

Table 4.3.6-2 Summary of Wheeler Reservoir Modeling Analysis for 1988*

Parameter/Units	Upstream of BFN TRM 294		Downstream of BFN TRM 292		Reservoir Forebay TRM 275	
	Annual Mean	Max. Day	Annual Mean	Max. Day	Annual Mean	Max. Day
Temperature (°F)						
Units 2 and 3 (EPU)	64.5	87.0	65.0	87.1	63.5	85.1
All 3 Units (EPU)	65.8	88.3	66.5	89.0	64.8	86.7
All 3 Units (100%)	65.4	88.0	66.0	88.6	64.4	86.3
Difference (120%-100%)	0.4	0.3	0.5	0.4	0.4	0.4
Algal Biomass (mg/L)	**Annual Mean**	**Max. Day**	**Annual Mean**	**Max. Day**	**Annual Mean**	**Max. Day**
Units 2 and 3	1.7	4.6	1.8	4.5	1.6	3.5
All 3 Units	1.8	4.3	1.9	4.4	1.7	3.5
Difference	0.1	-0.3	0.1	-0.1	0.1	0.0
Dissolved Oxygen (mg/L)	**Annual Mean**	**Min. Day**	**Annual Mean**	**Min. Day**	**Annual Mean**	**Min. Day**
Units 2 and 3	8.8	6.3	8.7	5.8	7.9	4.3
All 3 Units	8.7	6.7	8.7	6.6	7.9	4.5
Difference	-0.1	0.4	0.0	0.8	0.0	0.2

*Based on 1988 modeled reservoir conditions for the period and location indicated (Shiao, 2001).

The 1988 mean annual dissolved oxygen and algal concentrations in the reservoir were essentially unchanged with the addition of Unit 1. On the day of lowest dissolved oxygen concentration in 1988, the model indicted a potential DO decrease of 0.2 mg/L to 0.8 mg/L at the three reservoir sections. Algal concentrations on the day of highest productivity were essentially unchanged. Cumulative impacts of thermal changes on DO and algal concentrations would be insignificant.

Based on these results and the future operation of the plant in compliance with regulatory requirements for thermal effluents, Alternative 2 is expected to have insignificant effects on reservoir stratification, dissolved oxygen concentrations, eutrophication, sediment transport, scouring, and cumulative impacts.

4.3.6.4 Water Use/Water Availability

Restart of Unit 1 is not expected to adversely affect the availability of water or water use by others, as the maximum cooling water withdrawal is approximately 5,368 cfs, compared to an annual average flow at Wheeler Dam of 49,800 cfs. With once-through cooling essentially all of the water is returned to the river. Even during times of minimum river flow sufficient water will be available from reservoir storage for use by others.

4.3.6.5 Microbiological Organisms

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 two 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.

During the 1999 TVA Vital Signs Monitoring, samples were collected at five swimming beaches and four boat ramps throughout the reservoir and analyzed for fecal coliform bacteria. All of the samples were within the State of Alabama guidelines for water contact. Since essentially no microbiological organisms will be discharged by BFN, no microbiological impacts to the reservoir or water uses are expected.

4.3.7 Groundwater Resources

4.3.7.1 Groundwater Occurrence

Activities potentially affecting groundwater resources would include foundation treatment, excavation, and grading associated with Alternative 2 facilities. These facilities might include parabolic or mechanical draft cooling towers, a Dry Cask Storage Facility, a Modifications Fabrication Building, and a permanent Administration Building. Although no groundwater use is anticipated during construction, excavations that penetrate the water table may require temporary construction dewatering. Therefore, transient impacts to groundwater resources from dewatering activities might be expected to produce localized and temporary reductions in the groundwater table. Although several water supplies are known to exist in the area, the only water supply identified close to BFN was Limestone County Water System Well G-1, more than two miles north of the proposed project site. Any groundwater drawdown impacts associated with plant construction dewatering would be temporary and of negligible magnitude due to the limited excavation depths, the relatively short duration of facility construction, and the distance of neighboring wells.

Excavation and grading associated with construction of the proposed facilities would result in permanent displacement of shallow soils above the water table. This includes the proposed berm relocation sites for sub-alternatives 2A, 2B, and 2C under Alternative 2. However, the long-term impact of these activities on groundwater resources would be negligible for all facility configurations given the limited depth and area of disturbance. The areas proposed for the mechanical draft or hyperbolic cooling towers are underlain by weathered Tuscumbia limestone and Fort Payne chert bedrock that might require foundation treatment for stabilization. Although permanent local impacts to groundwater levels and movement might be experienced from foundation treatment, the long-term impacts of these activities on groundwater resources would be negligible for the proposed cooling tower configurations given the limited area of disturbance.

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

No adverse impacts to groundwater resources are anticipated from operation and maintenance of new facilities associated with Alternative 2 for the project.

Effluent discharges from plant systems such as yard drains, station sumps, and sanitary wastewater would not be expected to change significantly under Alternative 2. Considering that the plant wastewater lagoons and sedimentation ponds possess clay and Hypalon liners, respectively, no impacts to groundwater resources are anticipated. The changes in pond/lagoon discharges to the river would remain within the bounding conditions established in the NPDES. These permits are renewed every five years and this helps to ensure that no changes have been made to the facility that would alter aquatic impacts and that no significant adverse impacts have occurred.

4.3.7.2 Groundwater Use

Currently, groundwater is not used by BFN, no groundwater use is anticipated during construction, and site dewatering wells have been inactive since the 1980s. Although excavations that penetrate the water table may require temporary construction dewatering under Alternative 2, drawdowns would be temporary and of negligible magnitude to impact off-site private water supplies. No adverse groundwater use impacts are anticipated from all alternatives considered for the project.

4.3.8 Floodplains and Flood Risk

The floodplains and flood risk assessment for Alternatives 2A and 2B is the same as for Alternative 1.

Under Alternative 2A, Units 2 and 3 would be relicensed at EPU levels, Unit 1 would be refurbished, restarted, and relicensed at EPU levels, and a dry cask storage facility, Modifications Fabrication Building, permanent Administration Building, and two additional mechanical draft cooling towers would be constructed. All anticipated flood impacts would be the same as those listed for Alternative 1 except for potential PMF flooding impacts to the two new towers. The towers would be located above the PMF elevation in a new footprint. 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, consistent with EO 11988.

Under Alternative 2B, Units 2 and 3 would be relicensed at EPU levels, Unit 1 would be refurbished, restarted, and relicensed at EPU levels, and a dry cask storage facility, Modifications Fabrication Building, permanent Administration Building, and two new hybrid cooling towers would be constructed. All anticipated flood impacts would be the same as those associated with Alternative 2A.

Under Alternative 2C, Units 2 and 3 would be relicensed at EPU levels, Unit 1 would be refurbished, restarted, and relicensed at EPU levels, and a dry cask storage facility, Modifications Fabrication Building, Permanent Administration Building, and five new linear mechanical draft cooling towers would be constructed. Based on the site topography dated 1989, the proposed mechanical draft cooling towers would be located at the existing cooling tower footprints above elevation 570. 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 also 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, consistent with EO 11988.

Under Alternative 2D, Units 2 and 3 would be relicensed at EPU levels, Unit 1 would be refurbished, restarted, and relicensed at EPU levels, and a dry cask storage facility, Modifications Fabrication Building, permanent Administrative Building, and one new 20-cell mechanical draft cooling tower would be constructed. All anticipated flood impacts would be the same as those listed for Alternative 1 except for potential PMF flooding impacts to the new cooling tower. The tower would be located above the PMF elevation in a new footprint. Construction of this cooling tower is not anticipated to require relocation of material to one of the three potential spoil areas.

4.3.9 Terrestrial Ecology

4.3.9.1 Vegetation

Alternative 2 would cause some disturbance of existing plant communities in conjunction with the addition of any of the four configurations of new cooling towers and the relocation of soil that would accompany the construction of the towers for Alternatives 2A, 2B and 2C. Alternative 2D may or may not involve recontouring of the existing soil berm. However, no uncommon terrestrial communities or otherwise unusual vegetation occur on the lands to be disturbed under Action Alternative 2. With respect to vegetation, any direct, indirect, or cumulative impacts to the terrestrial ecology resources of the region are expected to be insignificant as a result of the proposed activities.

4.3.9.2 Wildlife

Under Alternative 2, the operating licenses for the three units at BFN would be renewed for up to 20 years, and Unit 1 would be restored to service. Associated with this would be the restoration of several existing cooling towers and/or the construction of new cooling towers, and the construction of three new facilities. These construction activities would result in the removal of some early successional habitats in the vicinity of the existing facilities. Because no rare or uncommon communities of animals exist on the site, this action alternative would not result in adverse impacts to any uncommon wildlife or their habitats.

4.3.9.3 Introduced Species

Because no intact native plant communities occur on lands to be disturbed by the proposed project, and because introduced plant species are already present in these areas, any direct, indirect, or cumulative impacts due to the establishment or spread of introduced plant species are anticipated to be insignificant as a result of the actions associated with Alternative 2.

Two introduced species, the European house sparrow and the European starling, are known to exist on the project site. These species are quite common in the project area. Alternative 2 would not result in increased population levels of introduced animal species.

4.3.9.4 Managed Areas and Ecologically Significant Sites

Because the proposed actions would occur within the lands presently utilized for the operation and maintenance of the BFN, no impacts to Managed Areas or Ecologically Sensitive Sites are anticipated.

4.3.9.5 Refurbishment Impacts

Similar to the experience with recovery of Units 2 and 3, no substantial ecological impacts are expected for the recovery of Unit 1. Site worker population could be temporarily increased to a peak of approximately 3,000 (possibly fewer if some of the workers remain at their parent companies and are not relocated to the BFN site). This influx of workers would require either permanent or temporary new office and shop buildings, and would increase the load on the waste treatment plant. The waste treatment system at BFN is sized to operate with a maximum plant population of approximately 4,500.

As was the case for recovery of Units 2 and 3, equipment being replaced would necessitate the disposal of the original items, which in some cases might involve decontamination and/or eventual shipment to a low-level waste repository. Refurbishment may also result in producing other materials requiring disposal, such as decontamination chemicals and worker C-zone items (booties, gloves, tape, rags, etc.).

Any of the sub-alternatives under Alternative 2 would involve major additions to existing cooling tower capacity. Some of this additional capacity may be accomplished by refurbishment of the existing cooling towers, and this could necessitate the disposal of fill materials (some of which contain non-friable asbestos) and possibly steel and concrete (see Section 4.3.3.2). Disposal of all such materials that cannot be recycled would be in permitted landfills, either on-site or off-site, thus impacts to terrestrial resources would be minimal and insignificant.

4.3.10 Aquatic Ecology

4.3.10.1 Fish

Refer to 4.2.10.1. With implementation of BMPs and other measures as needed, to prevent the entry of pollutants into surface waters potential impacts to aquatic life resulting from construction of new facilities would be insignificant.

Potential impacts from changes in thermal characteristics of CCW discharge from BFN and entrainment and impingement of fish are discussed in section 4.3.10.4.

4.3.10.2 Benthic Organisms

The refurbishment and restart of Unit 1 at EPU is proposed in addition to operating Units 2 and 3 at EPU for Alternative 2. To provide additional heat dissipation capacity for the restart of Unit 1, different cooling tower configurations have been identified. The new cooling towers would either be mechanical draft or new hybrid ("modified parabolic") towers in new or existing footprints. For any of the alternative configurations, discharge temperatures outside of the mixing zone would not exceed the current NPDES thermal limits. The proposed actions would not impact the benthic macroinvertebrate communities in the vicinity of BFN diffuser discharges. As discussed in section 4.2.10, Vital Signs monitoring will be continued to follow any unanticipated changes to the aquatic community in the vicinity of BFN.

4.3.10.3 Introduced Species

The Vital Signs Monitoring program is designed to track introduced species throughout the Tennessee Valley. Actual monitoring will document any increases in zebra mussel reproduction in the vicinity of BFN. Monitoring raw water for zebra mussel larvae inside BFN would allow formulation of treatment plans to prevent biofouling impacts to BFN operations resulting from zebra mussel infestation.

Grass carp abundance is not expected to be influenced by BFN operations. Introduced grass carp are normally sterile, so that their numbers can be maintained at desired levels by adjusting any future stocking rates.

4.3.10.4 Entrainment and Impingement of Fish and Shellfish, Heat Shock

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. Increased discharge temperatures are not planned; thus, heat shock impacts are not anticipated.

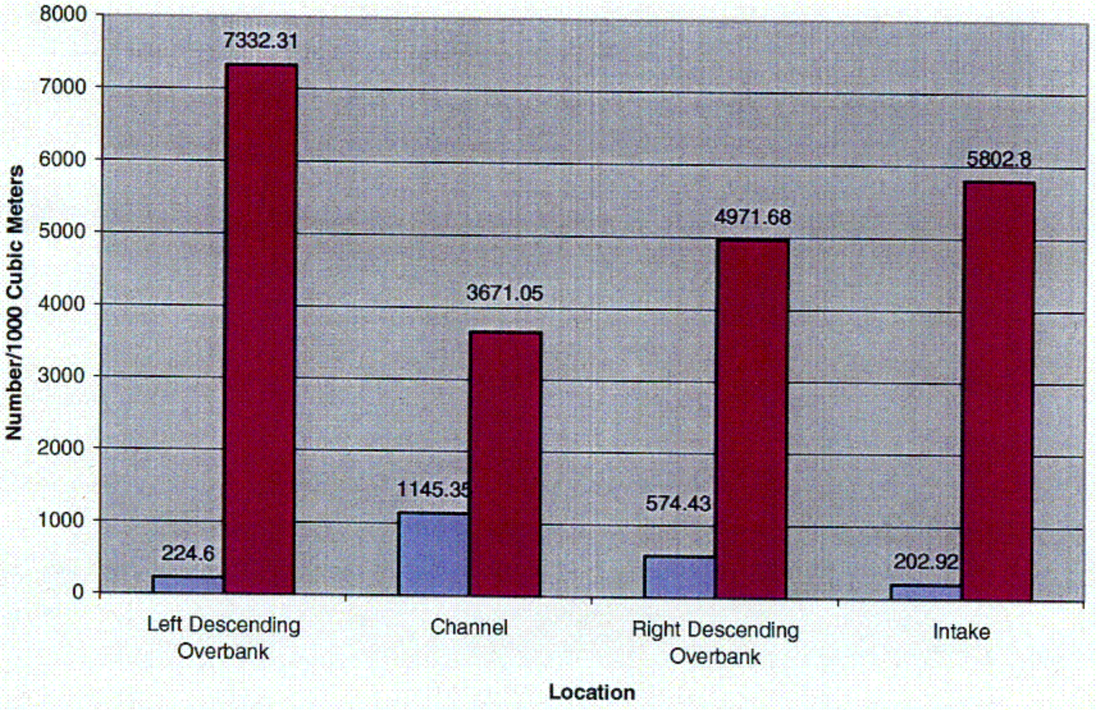
During operational monitoring (1974-1977), with all nine circulating pumps in operation, four species of fish (threadfin shad, gizzard shad, freshwater drum, and skipjack herring) represented 95% of the total fish impinged at BFN. No species other than these four comprised greater than one percent of total fish impinged. It was concluded in TVA (1980) that the operation of BFN has not caused an adverse environmental impact to the balanced indigenous fish community of Wheeler Reservoir. With the return of Unit 1 and associated ten percent increase in CCW flow, impingement rates are expected to slightly increase, but are not expected to result in significant impacts to fish populations of Wheeler Reservoir.

From 1971-1977, larval fish were sampled in the vicinity of BFN to assess any potential adverse impact to the indigenous fish community in Wheeler Reservoir (TVA, 1978b). 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%). These estimates were reported to result in no significant impact to the reservoir population with concurrence from regulatory agencies. Subsequent monitoring of adult populations (TVA, 2000), including gillnetting and electrofishing, have reported no obvious decline in the populations of these families in Wheeler Reservoir. With the return of Unit 1 and associated ten percent increase in CCW flow, entrainment rates would be expected to similarly increase (i.e., to 13 % for Clupeidae, 5% for Catostomidae, and 6.7 % for Scianedae). This estimated change is not expected to result in any significant impact to fish populations in Wheeler Reservoir.

Flow studies conducted by TVA at BFN have indicated that the majority of water entrained originates from the right side of the main river channel. This pelagic area contains significantly lower densities of drifting fish larvae than found in the overbank areas (Figure 4.3.10-1). Higher densities of fish eggs (primarily freshwater drum eggs) are transported in the channel portion of the river, but entrainment of drum eggs (and larvae) has not resulted in noticeable decreased abundance of this species; nor is it expected to, under the increased CCW flow rates.

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 .

Figure 4.3.10-1 Average Density of Fish Eggs and Larvae at Plant Transect (TRM 294.5) and Intake Basin at Browns Ferry Nuclear, 1978 - 1980



4.3.10.5 Microbiological Organisms

With the return of Unit 1 to operation, total CCW flow would increase by about ten percent over previous 3-unit oeration. In 1978, TVA determined that almost all the phytoplankton in the CCW intake is coming from the north bank of the Tennessee River upstream of BFN. The plankton community is dynamic and can reproduce and recolonize rapidly. Therefore, to the extent Wheeler Reservoir plankton serves as a food source for other aquatic life, restart of Unit 1 is not anticipated to have an adverse effect on aquatic life dependent upon plankton as a food source. Operational monitoring during the first year of operation of Unit 1 would help to confirm the level of intake impacts to Wheeler Reservoir fish populations, and possibly to plankton densities. Thus, there would be no impacts to microbiological organisms resulting from any of the proposed action alternatives.

C02

4.3.11 Threatened and Endangered Species

4.3.11.1 Animals

As described in Chapter 3, four listed species of animals are reported from Limestone County. Implementation of Alternative 2 would not result in adverse impacts to federally listed gray or Indiana bats. Gray bats likely forage along the shoreline of the Wheeler Reservoir, adjacent to the nuclear plant. However, renewal of the operating license resulting in the continued operation of the nuclear plant and modifications and construction of the cooling towers would not affect this species because they only forage over aquatic habitats and their foraging areas would not be altered by the proposed project. No suitable habitat for Indiana bats or the Tennessee cave salamander exists on the project site. Some habitat suitable for Appalachian Bewick's wren exists on the site; however, proposed modifications at the site would not eliminate this habitat. Therefore, Alternative 2 is expected to have no effect on listed terrestrial species or their critical habitat.

4.3.11.2 Aquatic

As described in Chapter 3, there are five federally protected aquatic species in Wheeler Reservoir in the vicinity of BFN, but these are found in habitats upstream of the plant. During the three phases of BFN's thermal variance monitoring (1985-1998) and current Vital Signs Monitoring programs, no threatened or endangered aquatic species were found within the area affected by construction or operational changes at BFN as proposed herein. The seven survey reports cited in section 3.11.1 support the conclusion that the proposed changes and additions to BFN would have no effect on the species listed in Section 3.11.2.

4.3.11.3 Plants

No occurrences of rare (i.e., federal- or state-listed) plant species are known on or immediately adjacent to the lands to be disturbed under Alternative 2. Therefore, no effects to rare plant species are anticipated under this Alternative.

4.3.12 Wetlands

Construction activities associated with Alternative 2 would require the excavation and removal of soil for the construction of new cooling tower capacity. None of the excavation or spoil areas would occur in wetlands, thus there would be no impacts to wetlands.

4.3.13 Socioeconomic Conditions

4.3.13.1 Demography

Under Alternative 2, Unit 1 recovery staffing requirements would have an impact on the population of Limestone and surrounding counties. Staffing would reach a peak of approximately 3,000 workers. This peak would only last about six months, while the construction project would last about six years in total. A staffing level of at least 1,500 would be maintained over approximately four years, with a staffing level of at least 2,000 being sustained over almost three years. Not all of these workers would be located at the plant site (e.g., design staff, which would exceed 500 workers for about three years). Furthermore, only a minority of on-site workers would relocate as a result of employment on this project, further mitigating the impact on the local area. Many workers would commute from their homes outside Limestone County. In 1971, at the peak of the original BFN construction, about 25% of the employees at the site changed their residence in order to work at the site. This suggests that no more than 750 workers (25% of 3,000 peak employment) would move into the area to work on this project, and very likely less than this. With families this would mean a maximum population increase of 2,000 to 2,500 persons. The duration of any such population increase would likely be three to four years, coinciding with the sustained staffing levels of 1,500 to 2,000.

This maximum population increase is equivalent to about twice Limestone's annual population growth through the 1990s (or four percent of the current county population). However, because many workers would commute from outside the county, a more meaningful comparison is made with the growth rate of the labor market area. The maximum population increase resulting from the project is equivalent to less than one-third the area's annual population growth (or 0.4% of the current area population). The most likely locations for those moving into the area outside Limestone County to work would include Huntsville, Florence, and Decatur in Alabama, along with possibly Pulaski and Fayetteville in Tennessee. The impact of population growth resulting from this project would be eased as a result of the gradual build-up in staffing. Peak staffing would be the result of almost four years of steady staffing increases.

4.3.13.2 Economic Conditions

Under Alternative 2, recovery of Unit 1 would generate additional income in the area from a large workforce over a time span of approximately six years (see Section 2.4.2.1).

A sustained employment level of 1,500 to 2,000, less at least 500 off-site workers, results in perhaps 1,000-1,500 new jobs over three to four years. This represents 3.5 to 5.2% of Limestone County's current employment level, or 0.3 to 0.4 % of labor market area employment. The income earned by 1,500 on-site workers would represent approximately four percent of annual earnings in Limestone County, but only 0.3% of the labor market area's annual earnings (and many of these workers would reside outside Limestone County). A permanent staff of 150 would be required to operate Unit 1, and their earnings would represent about 0.7% of Limestone County annual earnings and 0.1% of area earnings. Alternative 2 would have a beneficial, albeit relatively minor, effect on income in Limestone County and the broader labor market area.

4.3.13.3 Community Services and Housing

Under Alternative 2, during construction there most likely would be some short-term strain on community services, including police and emergency services. Schools likely would experience noticeable impact. Housing for movers could become a short-term concern. However, many of the movers would seek short-term rental facilities, including motels, or sites for trailers, easing somewhat the strains on the traditional housing market. Housing and the impacts on community services would be spread around geographically within the labor market area, including Huntsville, lessening the extent of the impacts on any one location or governmental jurisdiction. Also, many of the workers would commute on a weekly or other less than daily basis, and would not reside in the area all the time. Residential locations would depend on the availability of suitable facilities or sites, and could be anywhere in the labor market area. These strains on the local and area housing markets most likely would lead to increased prices for at least some types of housing. The impacts on housing prices would begin to diminish after the peak construction employment level is reached and then essentially disappear by the end of the construction period.

The increase in permanent employment associated with operation of Unit 1 in addition to Units 2 and 3 could have a temporary impact on the local housing market and housing prices in Limestone County and, to a lesser extent, the surrounding area. However, given the recent relatively fast growth in population in Limestone County, the impact likely would be minor and not very important. As of 2000, there were 2,209 vacant housing units in Limestone County, which are enough to absorb the peak number of new households that could be expected during the project, even if they all located in Limestone County.

4.3.13.4 Local Government Revenues

Under Alternative 2, in addition to the expenditures that would occur with Alternative 1, there would be significant capital expenditures on Unit 1, estimated to be about $1.24 billion. As a result, TVA in lieu of tax payments to the state would increase. In turn, there would be increases in the amounts redistributed by the state to north Alabama counties located in the TVA service area. The total annual payment to the state of Alabama is estimated to increase by about $4.3 million. Based on the current redistribution formula, about $660,000 would be redistributed to Limestone County. Madison and Morgan Counties would also receive similar increases, estimated to be about $710,000 and close to $560,000, respectively. Other counties in the area would receive smaller increases. In addition, there would be additional tax revenue associated with expenditures made in the area for materials associated with the proposed refurbishment as well as sales tax revenue associated with purchases by individuals employed during construction and subsequently during operation. The magnitude of these increases could vary greatly, depending on the amount of local purchases for construction and on the relocation and buying decisions of workers employed at the site.

4.3.13.5 Environmental Justice

As discussed in Section 3.13.4, the disadvantaged population percentage in the immediate area near the site is relatively small. Any negative impacts to persons living near the site would be small and would tend to be dispersed through the area. Potential impacts of concern would include air quality, transportation, visual, and noise. The use of BMPs and planned mitigation, as discussed in this chapter, would help maintain such impacts at a level of no significance. No disproportionate impacts to disadvantaged populations are expected.

4.3.14 Transportation

4.3.14.1 Highways and Roads

IMPACTS OF CONSTRUCTION

Additional traffic would be generated due to refurbishment of the Unit 1 at EPU and the associated construction of additional cooling tower capacity. No impacts to the state and county roads in the vicinity of the site are expected. The construction period spans almost six years with a construction workforce rising to peak levels of 3,055 employees on-site during the refurbishment period. Assuming an average ridership of 1.6 persons per vehicle, and a 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. Assuming traffic is split equally in three directions on Shaw Road, Nuclear Plant Road, and Browns Ferry Road, the Average Daily Traffic (ADT) on these county roads would increase to approximately 2,900 vehicles per day, or a 180% increase in ADT. U.S. Highways 72 and 31 would not be significantly impacted.

For a more detailed analysis (Highway Capacity Analysis), the assessment of traffic effects for the project is based on the transportation planning and engineering concept of level of service (LOS). This concept addresses the quality of service, or operating conditions, provided by the roadway network, as perceived by motorists during the peak hour of traffic, typically the afternoon rush hour. Six LOS are designated as A through F, with A being the best. With this type of analysis, level of service D is viewed as the minimally acceptable LOS of the roadway because associated conditions can be tolerable for short periods of time, or peak hour conditions. In contrast, an LOS of E or F would be viewed as an unacceptable level. Peak work force levels were calculated using certain assumptions. First, it was assumed that 80% of the peak on-site personnel would work day shift and travel during peak hours. Also, at worst case, peak work force was determined using both peak construction forces and existing work forces common during an outage. As for the broad ADT analysis, an average ridership of 1.6 workers per vehicle was assumed. Current peak traffic was assumed at 12% ADT and the current truck composition is 10% of average daily traffic. Also, for this analysis, an even split was assumed on the three county roads toward U.S. Highway 72 or U.S. Highway 31.

The results of the level of service analysis show a decrease on the county roads from level of service C to D during the construction phase. The county roads would provide traffic flow conditions where tolerable average operating speeds are maintained but would be subject to considerable and sudden variation. These conditions can be tolerable for short periods of time. In this instance, such conditions could occur twice during the day and last for up to one hour.

There will also be additional traffic added to the road network throughout the day in the form of construction material deliveries to the site and disposals from the site. This truck traffic will vary over the length of the refurbishment project. For example, the dry cask storage pad construction may generate up to 25 truck trips per day, but would only last approximately a month. The level of service analysis is based upon peak commuter traffic. This condition would only last approximately six months when the maximum work force would be on site; therefore, the analysis provides a conservative estimate. This conservatism offsets and compensates for unknown construction material truck deliveries and disposals, traffic growth, possibility of fewer sharing rides, and variation of traffic flows during peak hours on the local roads, without altering the final results regarding the significance of future road transportation impacts. The level of service analysis concentrates on peak hours; therefore, there would be no loss of level of service during off-peak hours when trucks will mostly travel.

There will be some additional delay at the various plant exits and the intersections with County Road 25 at shift changes. Those experiencing the delay would primarily be the construction commuters. Such a problem can be easily tolerated for the short duration of the peak construction period. If unacceptable delays routinely occur, which is not expected, delayed shift changes could be instituted to help alleviate the problem. In summary, TVA concludes that the roads in the area are capable of absorbing this additional traffic and stay within an acceptable level of service.

IMPACTS OF OPERATION

Additional commuter traffic generated during operation of the refurbished Unit 1 at EPU would result in an ADT increase on the county roads of less than five percent due to an additional workforce of approximately 150 employees. There would also be approximately 50% additional hydrogen and Calgon water chemistry truck deliveries; or less than ten trucks per week. This minor increase in operational traffic results in an insignificant impact to the transportation system.

Traffic growth would continue during the licensing period for 20 years following to year 2033. During this time, traffic volumes would increase, assuming 15% growth rate per decade, to approximately 22,000 vpd on U.S. Highway 72, and 26,600 vpd on U.S. Highway 31. The county roads would increase to approximately 2,700 vpd.

ANTICIPATED IMPACTS

The county roads are in good condition for access and would be adequate to support the traffic requirements during both construction and operation. Traffic increases during construction are much higher than that during operation; however, construction periods are temporary and peak forces only last for approximately six months. Nevertheless, even the traffic increases associated with the peak construction force levels do not result in any unacceptable service levels. 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. Generally, as distance from the site increases and traffic becomes more disbursed, impacts to the transportation network decrease. The major multi-lane highways U.S. Highway 72 and U.S. Highway 31 would provide higher capacity levels and an increase in traffic would tend to be less noticeable in these areas.

Traffic and ADT predictions are projected over many years. These projections may vary greatly over such a length of time. However, over a long period of time, there is a natural progression to improve the quality of the local roadway network. Therefore, as traffic increases, roadway networks are expected to also improve.

4.3.14.2 Railroads

Alternatives 2A, 2B, 2C, or 2D would result in no impacts to the railway system.

4.3.14.3 River Transport

Alternatives 2A, 2B, 2C, or 2D would result in no impacts to river transportation. The potential for discharges from BFN under Alternative 2 to increase the production of steam fog was examined. Compared to three-unit operation of BFN at the original power levels, TVA estimates that for three-unit extended power uprate, the rate of evaporation during such events will increase approximately two percent on average, and on rare occasions might increase as much as much as seven percent. The original analyses for the impact of fog on local water transportation estimated that river traffic could be affected roughly 147 hours per year by diffuser-related operation at BFN (TVA, 1972). Assuming that fogging would increase in direct proportion to the rate of evaporation, this period would increase, at most, to about 158 hours per year. This increase is small and is not expected to significantly exacerbate any existing diffuser-related fog impairments to navigation in the vicinity of BFN.

4.3.14.4 Pipelines

Alternatives 2A, 2B, 2C or 2D would result in no impacts to pipelines.

4.3.14.5 Transmission Lines

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

1) An additional 500-kV circuit breaker would have to be installed in the existing BFN 500-kV switchyard. Other transient stability improvements may be required.
2) The Madison-Redstone 161-kV transmission line (13.2 miles) becomes overloaded due to a single contingency event and would require reconductoring.

3) The following 161-kV lines would become overloaded due to a single contingency event and would require the addition of a second 500-161kV transformer bank at the Madison 500kV substation.
   - Limestone-Jetport 161-kV transmission line - 8.1 miles
   - Limestone-North Huntsville 161-kV transmission line - 15.9 miles
4) Three 161kV circuit breakers at the Farley 161kV Substation would have to be replaced due to the increased fault currents associated with the addition of the second Madison transformer bank.
5) A Static Var Compensator would have to be installed at an existing TVA substation in order to supply area voltage support.

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

TVA continues to study the capability of its transmission system and analyses will be appropriately updated in the future.

4.3.15 Soils and Land Uses

4.3.15.1 BFN Environs

Potential impacts to site soils and land use associated with refurbishing Unit 1 and relicensing all three units are related to construction of cooling towers, buildings, and a dry cask storage facility. Two building are proposed, a Modifications Fabrication Building, and a new Administration Building. Alternative 2A proposes two new mechanical draft towers and Alternative 2B proposes two new hybrid towers. Alternative 2C proposes construction of five linear mechanical draft cooling towers and expansion of existing cooling tower 3. All of the Alternative 2C towers are to be built in the same location as existing towers. The single Alternative 2D cooling tower would be constructed in the location of the number 4 tower that previously burned and was not replaced. The existing Modifications Fabrication Building would be removed to enable construction of the dry cask storage facility. An Administration Building and a new Modifications Fabrication Building would be erected. Temporary land use would be required for activities when removing old components and constructing new components. In addition, the large number of temporary workers needed to accomplish the major refurbishment activities would require temporary facilities be installed for on-site parking, training, site security access, office space, change areas, fabrication shops, mockups, and related needs. This would require from 2.5 to 10 acres. Because any of these structures, either temporary or permanent, would be located on soil which has previously been disturbed, the impacts would be insignificant. The entire plant site is classified as built-up land; thus, any construction at the plant would have insignificant impact to on-site land use.

4.3.15.2 Future Land Uses/Modifications (Including Offsite)

Land use in the region surrounding a nuclear power plant may change as a result of plant-related population growth. The changes proposed by this action only support about 150 additional permanent employees. Any impacts would be temporary and insignificant.

4.3.15.3 Land Use Planning and Controls

Limestone County receives in lieu of taxes revenue from TVA and this revenue significantly aids the development of the county. This revenue would not be adversely affected by implementation of either of the Action Alternatives. No impacts to land development are expected from any of the proposed actions.

Impacts associated with continued use of transmission line right-of-ways (ROWs) after restart of Unit 1 are largely related to agricultural land use. Buildings cannot be built within the ROWs and the vegetation must be maintained to prevent interference with the lines. These effects would continue during the extended license period. No new ROWs for construction of transmission line are proposed as part of the alternatives addressed in this SEIS.

4.3.16 Visual Resources

In addition to the common proposed activities of constructing a dry cask storage facility and a new Modifications Fabrication Building, Alternative 2 proposes the construction of a permanent Administrative Building. These proposed facilities would have minor visual impacts on the industrial character of the plant site. However, adding the proposed facilities would increase the number of adversely-contrasting elements seen inside the development from the rural countryside. These incremental changes may not be individually significant, but together with other facilities, they would add to a continuous growth of structures seen in the landscape and a cumulative reduction of visual resources as seen from the countryside.

Approximately 514 personnel would occupy the new Administrative Building upon completion of construction. Most of these employees would likely be relocated from other existing plant office buildings, making those buildings available for incoming Unit 1 recovery personnel. Parking would be displaced during the construction of the Administrative Building; therefore, the existing gravel parking lots around and among the mechanical draft cooling towers would be used. Parking in these areas would be visually similar to the nearby parking that is being displaced. An additional parking facility, for approximately 200 automobiles, would be constructed immediately northeast of this area in the foreground of County Road 25. The parking facility would be viewable by motorists and workers on the northeast side of the plant site.

County Road 25 provides the main access route to both the plant entrances and to homes north of the site. Most views to the site will be from this area and from the homes across Wheelers Lake at

Mallard Creek and Mallard Creek public use area. Increasing the number of vertical objects in the landscape would add to the visually discordant contrast between rural countryside and the industrial character of the plant site. The heights and related dimensions of the proposed structures are shown in Table 4.3.16-1.

Table 4.3.16-1 Summary of Height/Size Information

Plant Feature (Proposed)	Feature size same for each alternative
Mechanical Draft Towers (1 or 2 proposed)	60 feet height
Parabolic Cooling Towers	60 feet height; 300 feet base diameter
Proposed Berms (Soil from existing berm)	10 feet to 40 feet height

Alternate 2A includes the same activities as Alternate 1 with the addition of two new mechanical draft cooling towers located on the west side of the existing cooling towers at the base of the existing berm. In order for the towers to be located in this area, the berm would be modified by removing a portion of the existing earth and placing it in one of three alternate sites. These sites are discussed in greater detail in section 3.1.16.

The new cooling towers proposed under this alternative would be architecturally similar to the existing towers. The proposed towers and the existing would be approximately the same height, as shown in Table 4.3.16-1. The new towers would be seen by motorists along Browns Ferry Road in the middleground as the plant site comes into view, and briefly in the foreground traveling north on County Road 25. Motorists traveling south on County Road 25 would see the upper portions of the towers briefly above the remaining berm on the east side. Residents across Wheelers Lake southwest and from Mallard Creek public use area would see additional vertical structures in the landscape that would obscure views to natural areas beyond. These additional towers would add to the continuous growth of visually discordant structures in middleground views for these residents.

Lowering and re-shaping the existing berm would have both positive and negative impacts. Motorists traveling south on County Road 25 would have much broader views of the cooling towers and of other main buildings within the plant site (i.e., the turbine/reactor building and the new Administrative Building). Residents north of the plant could have views of the skyline affected by the appearance of rooflines of industrial facilities. For these residents, the harmonious mosaic of cultural and natural features in the countryside becomes less intimate.

However, for motorists traveling north on County Road 25, and for workers and visitors within the plant site, re-shaping, lowering, and relocating the berms to one of three alternate locations could have a positive or beneficial affect. The topography surrounding BFN is gently rolling with little visual interest achieved through dramatic elevation changes. By creating elevation changes with berms, scenic classification could range from moderately desirable to desirable. Elevation changes, particularly with heights over ten feet, break up forms in the foreground and add visual interest to a viewshed.

Alternate 2B would be the same as Alternate 2A with the exception of two new hybrid "modified parabolic" cooling towers that would be used instead of the mechanical draft towers. These towers would provide a striking contrast when viewed adjacent to the existing mechanical draft towers. Materials, colors, and forms would be quite different. For residents across Wheeler Lake and visitors at Mallard Creek day use area, the towers would increase the number of adversely-contrasting elements as seen in the middleground across the river.

Alternate 2C, demolishing the four existing Ecodyne cooling towers, constructing five new linear mechanical draft cooling towers and increasing the size of the existing Balke-Durr cooling tower by 25%, would add to the number of linear elements seen across the plant site. The new mechanical draft towers would be larger than the existing Ecodyne cooling towers, providing a greater contrast to the broadly horizontal forms seen over the plant site now. Motorists along County Road 25 would have the greatest views of the new towers.

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 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.

In comparison, Alternatives 1 and 2D would have the least visual impact (of the Action Alternatives) for plant workers, visitors, and motorists along County Road 25. These alternatives would require the least amount of grading and earth moving activities, particularly since the berm adjacent to the cooling towers would not be disturbed. The new Administrative Building, modification and fabrication shop, and proposed dry cask storage facility would have little visibility from nearby homes and passing motorists. Development of these alternatives would result in fewer cumulative visual impacts within BFN industrial setting.

IMPACTS OF CONSTRUCTION

As the new Administrative Building reached completion, it would be seen in the foreground by passing motorists. Very little, if any, outdoor work for Alternatives 1 or 2 would take place at night. This is also true for work during the "No-Action Alternative" because it includes the dry cask spent fuel storage facility and the new modifications/fabrication building. Any outdoor night-time work would be minimal and would be the exception, not the general practice. There may be some indoor work scheduled at night, particularly for support tasks such as scaffolding and other job preparations. Scenic integrity in the area would be somewhat low during the construction process. The visual discord of construction would be temporary, and would last until site cleanup and reclamation of disturbed areas are complete.

Alternate 2A would have the same impacts of construction as Alternate 1 with additional grading and the introduction of two new vertical structures in the landscape. There would be a temporary increase in the amount of machinery seen on site from area residents and motorists. Construction activities would include tree removal from the berm area, material stockpiles, and related work seen in the foreground and middleground from the highway and nearby homes. There could potentially be an increase in truck traffic along County Road 25 as dirt is being hauled from the existing berm to one of the three alternate sites. Scaffolding, lift trucks, and other machinery would be seen by area residents during the construction of the two new mechanical draft cooling towers.

Alternate 2B would have similar visual impacts during construction as Alternate 2A. During the construction process, different types of machinery may be utilized to construct the modified parabolic cooling towers than the mechanical draft units, and frequencies for material deliveries may vary. However, visual discord would be temporary and would last until site cleanup is complete.

Alternate 2C would require various pieces of machinery, staging areas, and storage yards for the removal of the existing cooling towers and the construction of the new, larger towers. Some of this equipment, such as cranes, could be readily seen in the foreground by local residents and motorists along County Road 25. Scenic integrity could be low during this period. As with each of the proposed alternates, visual discord as a result of construction will last only until the site has been restored to pre-construction conditions

Alternate 2D would have construction impacts similar to Alternate 1 with additional grading and the introduction of one new vertical structure in the landscape. There would be a temporary increase in the amount of machinery seen on site from area residents and motorists. Construction activities would include material stockpiles, and related work seen in the foreground and middleground from the highway and nearby homes. Scaffolding, lift trucks, and other machinery would be seen by area residents during the construction of the one new mechanical draft cooling tower. Since the berm would not need to be lowered or re-shaped and removed, impacts associated with those activities would not occur

IMPACTS OF OPERATION

Under Alternatives 2A, 2B, 2C, and 2D, the impacts for operation would be identical and similar to those in Alternative 1. In each of these alternatives, additional plumes may be seen as a result of adding either one or two additional cooling towers. The shape, size, and duration of these plumes would vary with operations and atmospheric conditions.

4.3.17 Recreation

Impacts for Alternative 2 (A, B, C, and D) would be insignificant because no recreational facilities, resources, or uses would be affected. This includes activities associated with the construction of the proposed dry cask storage, the modification fabrication facilities, and the permanent Administration Building as well as the restoration and restart of Unit 1. Accordingly, cumulative impacts for Alternative 2 (A, B, C, and D) also would be insignificant.

4.3.18 Cultural Resources

4.3.18.1 Archaeological Resources

Under Alternative 2, TVA is considering refurbishing and restarting Unit 1 in addition to extending the licenses for all three units. The four variations of this alternative, 2A, 2B, 2C, and 2D, proposed the addition or replacement of cooling towers in the vicinity of the present mechanical draft towers. The proposed construction activities included in 2A, 2B, 2C, and 2D are in previously disturbed locations and would not directly affect historic properties, but would result in excess waste disposal in the three designated spoil disposal areas. The construction of the proposed dry cask storage facility, Modifications Fabrication Building, and Administration Building will not have any direct affects on historic properties, but would also result in disposal of material in the three designated spoil disposal areas.

The disposal of materials in these areas may affect historic properties that are listed or have the potential to be listed in the NRHP. One potentially eligible archaeological site was identified during the Phase I survey of Area 1 (see Figure 2.2-7). This site has a potential to have intact deposits that would provide valuable information about the prehistoric period in this region. The site is marked on BFN drawings and it is expected that it would be avoided by any future activities. If avoidance is not possible, a Phase II archaeological survey would be conducted. A Phase II survey would require additional excavation through close interval shovel testing, hand-dug test unit excavation and potentially backhoe trenching in order to delineate site boundaries and establish site significance. Any such investigations would require consultation with the SHPO. The Cox Cemetery, located in Area 2, would be avoided by all disposal activities.

4.3.18.2 Historical Structures

No historic structures were identified within the visual area of potential effect. Therefore, there will be No Affect on historic structures.

4.3.19 Environmental Noise

Additional or larger replacement cooling tower(s) are the only sources of potential noise effects from the action alternatives. The cooling towers for action Alternative 2A include the original cooling towers and two more similar ones located to the northeast of current towers 4, 5, and 6, see Figure 2.2-6. Cooling towers for Alternative 2B also include the original towers and two, circular towers. These round towers are about 300 feet in diameter, 60 feet high, and have 18, 300 horsepower fan-motors. See Figure 2.2-8 for the locations of the additional circular cooling towers. Alternative 2C expands tower 3 by 25%, replaces towers 1, 2, 5, and 6 with larger capacity ones, and erects a similar one on the site of tower 4. A single 20-cell mechanical draft cooling tower similar to, but slightly larger than those towers already at Browns Ferry, would be constructed under Alternative 2D.

4.3.19.1 Construction Noise

Potential construction noise effects for Alternatives 2A, 2B, 2C, and 2D come from sources typically found at medium size industrial construction projects. Construction projects have phases that usually include: clearing and/or demolition; site preparation and excavation; placing supports and foundations; erecting structures or buildings; and finishing and cleanup. Each of these phases has its own combination and number of noise emitting pieces of equipment and processes. For example, clearing and demolition routinely use grubbing hoes and bulldozers; while placing supports and foundations might need pile drivers and cement mixers. In general, equipment with larger engines makes more noise than equipment with smaller engines, and processes that rely on impact action produce higher peak noise than continuous operations. In addition, the condition of the equipment can greatly influence the noise emissions. Noise emissions at 50 feet from construction equipment range from about 75 dBA for a forklift or modern tractor to over 100 dBA for pile driving. Also, the duration of the construction phases impacts the potential noise effects.

Each of the Alternatives would have a slightly different set of equipment and phase durations for their respective construction. Where 2A and 2B would require more earthmoving than 2C, 2C requires demolition of existing cooling towers. Alternatives 2A and 2B might require more foundation work than 2C, but 2C probably requires more actual building of structures. Construction of the one tower for Alternative 2D, would require the least demolition and construction activities among the Alternative 2 options. The total time and equipment for these Alternatives should be about the same.

Predicting the level of intruding noise in the Paradise Shores area from any of the Alternatives would be highly speculative because of the variables discussed above. Based on other construction projects, it is likely that construction noise would be heard in the Paradise Shores area, and impact noise such as pile driving might be heard across the river at the Lakeview community. Although heard, the potential effect of this intruding noise should be insignificant for several reasons, including:

- Very little, if any, outdoor work for Alternatives 1 and 2 would take place at night. This is also true for work during the No-Action Alternative such as the dry cask spent fuel storage facility and the new modifications/fabrication building. Any outdoor night-time work would be minimal and would be the exception, not the general practice. There may be some indoor work scheduled at night, particularly for support tasks such as scaffolding and other job preparations, but this would be limited.
- The great majority of construction work to refurbish Unit 1 for restart will be done inside the generation building and reactor containment.
- Construction is usually a five-day-a-week operation. It follows the normal business week and leaves the weekends free from the intruding noise.
- The cooling towers' construction durations of the Action Alternatives are relatively short, about nine months, and the noisiest phases of the construction, usually site preparation and foundation work, are even shorter. It is expected that, following spoils removal, the site preparation and foundation work for the two additional cooling towers for Alternatives 2A and 2B will be about three months.
- None of the intruding noise from even the peak noise sources would be a hazard to hearing loss or interfere with communications.
- People understand and accept that construction projects use heavy equipment and that the equipment produces noise, and they understand that the construction has an ending point.

Although the construction would probably be heard, potential noise effects can be addressed or ameliorated in several ways if necessary. TVA would include contractual requirements for its construction vendors to only use equipment in good operating condition with factory equivalent muffler systems and to use portable noise barriers where practical. The residents of Paradise Shores would be notified about the cooling tower construction schedule and would be given a contact person and telephone number to respond to questions and concerns.

Overall, residents in the Paradise Shores area should hear construction noise, but this should be of a relatively short duration, and the long-term effect is expected to be insignificant for the reasons given above.

4.3.19.2 Intruding Noise

The intruding noise from the cooling towers for Alternative 2 was calculated using information from two potential vendors and the protocol in the EEI, Electric Power Plant Environmental Noise Guide (EEI, 1984). This guide gives a comprehensive method of estimating the sound power of the noise emitting equipment and calculating the propagated noise at a receiver location. It is assumed that the meteorological conditions are for summer, and no additional noise reducing factors such as ground or foliage attenuation were used.

Table 4.3.19-1 presents the total noise from each action alternative at both Paradise Shores and the Lakeview community.

Table 4.3.19-1 Total Noise at Paradise Shores and Lakeview Community for Alternative 2 (All data in dBA)

Location/Alternative	Total L_{eq} 24 hour	DNL 24 hour	Average annual DNL 17 days op.	Average annual DNL 27 days op.
Paradise Shores/ Current[1]	47	52	50	50
Alternative 2A	47	53	51	51
Alternative 2B	48	53	51	51
Alternative 2C, vendor 1[2]	54	61	53	53
Alternative 2C, vendor 2[3]	50	57	52	52
Alternative 2D	48	53	51	51
Lakeview Community/ Current[1]	44	48	46	46
Alternative 2A	44	48	46	46
Alternative 2B	44	48	46	46
Alternative 2C, vendor 1[2]	45	49	46	46
Alternative 2C, vendor 2[3]	43	47	46	46
Alternative 2D	44	48	46	46

[1]All original cooling towers operating at full capacity.

[2]Cooling tower vendor 1 is Balcke-Durr, which estimated noise values based on empirical handbook data.

[3]Cooling tower vendor 2 is Marley, which supplied noise data based on actual field measurements from similar towers.

4.3.19.3 Effects

4.3.19.3.1 Guidelines

The average annual day-night average sound level (DNL) for Alternatives 2A, 2B, 2C, and 2D are under the EPA guideline of 55 dBA based on 17 days of full capacity operation. At the high end of the operating range of 27 days, the average annual DNL for each alternative is still under EPA guideline. The primary noise source will be large cooling tower fan motors.

Table 4.3.19-1 shows the total noise levels at Paradise Shores and the Lakeview community for all original cooling towers operating at full capacity. Using these values as a baseline for comparison, the total noise level (24 hour DNL) for Alternative 2C (with either of two potential cooling tower vendors) would be above the three dBA incremental increase guideline (FICON, 1992) at Paradise Shores, but not at the Lakeview Community. This level, which calls for additional analysis, occurs only on the days that all of the Alternative 2C cooling towers (either potential vendor) operate and indicates a potential significant effect. Although the potential increase in the 24-hour DNL is above the FICON guidelines for both vendors in Alternative 2C, the potential increase in the average annual DNLs are 3 dBA or less for both vendors, which is not significant at the current DNL of 52 dBA. The additional analysis was completed and included all variations of Alternative 2 described in this document and potential mitigation presented at the end of this section.

As a comparison to the guideline used in the original EIS, none of the Alternatives 2A, 2B, 2C, or 2D causes total 24 hour DNLs above 65 dBA that HUD uses as normally acceptable for residential development (HUD, 1971, 1985).

4.3.19.3.2 Hearing Loss

No residents in any of the adjacent communities would be exposed to noise levels that are hazardous to their hearing from Alternatives 2A, 2B, 2C, or 2D.

4.3.19.3.3 Annoyance

There could be a small percentage of residents of Paradise Shores highly annoyed from the intruding noise associated with the action alternatives. The largest 24 hour DNL from Alternative 2C, vendor 1, could highly annoy as many as six to seven percent of the residents based on equation 3.19-1 or Table 3.19-1. Alternative 2C, vendor 2, has the next highest 24-hour DNL, which could highly annoy four to five percent. The percentage of highly annoyed from Alternatives 2A, 2B, and 2D are about two to three percent. The same techniques show that the current environment could also cause about two to three percent of the residents to be highly annoyed.

Less than two percent of the residents in the Lakeview community should be highly annoyed from the intruding noise associated with Alternatives 2A, 2B, 2C, or 2D.

4.3.19.3.4 Communication Interference

Sentence intelligibility would not be affected by the intruding noise associated with the action alternatives at Paradise Shores or the Lakeview community. The highest 24-hour L_{eq} is 54 dBA at Paradise Shores from Alternative 2C, vendor 1. At this level, EPA estimates sentence intelligibility to be 99% (EPA, 1974). None of the 24 hour DNLs would cause indoor communication interference based on the assumption that normal residential construction provides 20 dBA noise reduction (FICUN, 1980). This reduction would limit the intruding noise to 41 dBA or less inside the residences.

4.3.19.4 Summary

The potential 3 dBA or more increase in the total noise 24 hour DNL would not meet the guideline given by the Federal Interagency Committee on Noise (FICON) for Alternative 2C, vendors 1 and 2. These potential noise effects could be reduced by using a well planned operating procedure for the cooling towers and by using low-noise fan-motors in the design of the new towers. Operating the cooling towers farthest away from Paradise Shores when feasible would also significantly reduce the intruding noise to just a few days per year. This would reduce the percentage of residents who could be highly annoyed.

The EPA guideline of 55 dBA average annual DNL is met with all alternatives at both locations.

There are no noise consequences from Alternatives 2A, 2B, 2C, or 2D in the Lakeview community.

4.3.20 Safety and Health (Non-Radiological)

If Unit 1 recovery and license renewal/extended operation is added to the license renewal and continuing operation of Units 2 and 3, there is still no change to the Safety and Health Program described in Section 3.20. However, during the construction/modification work in recovering Unit 1 injury rates would be expected to be higher than during periods of operation. Based on a review of past performance, these injury rates would be expected to be approximately 20% higher than during periods of operation.

4.3.21 Radiological Impacts

4.3.21.1 Normal Operation

4.3.21.1.1 Occupational

Alternative 2 activities (as described in section 2.2.1) address Unit 1 recovery and operation at an EPU, and a 20-year operating license extension for all three units. This alternative has the most significant occupational radiation dose impact of the identified alternatives. Occupational radiation dose refers to radiation dose received by individuals as a course of their employment. Parameters considered for the analysis included: baseline occupational dose, projected dose increments, and an estimated cancer risk increase for the projected dose increments.

Baseline Occupational Dose

This section contrasts the current industry and facility occupational radiation dose trends against the current limits established by federal regulation. Selected attributes for the comparison are the average annual dose received by a worker, average annual dose per reactor, the collective worker dose, and the percentage of workers that receive radiation dose above a given threshold. Radiation dose attributes are categorized by reactor type. Light water power reactors in use within the United States are either a pressurized water reactor (PWR), or boiling water reactor (BWR) design. BFN reactors are the BWR type. Title Ten of the Code of Federal Regulations Part 20 (10 CFR part 20) establishes occupational radiation dose limits. These limits are designed to minimize the potential health risk to the worker. The annual occupational radiation dose limit for a worker is 5.0 rem. Facility radiation exposure control policies ensure compliance with established federal regulations and incorporate ALARA (as low as reasonably achievable) philosophies. Table 4.3.21-1 summarizes the current occupational radiation dose trend for the BWR industry and BFN.

Table 4.3.21-1 Baseline Occupational Radiation Dose (rem)

	Average Annual Worker Dose	Annual Dose Per Reactor	Collective Worker Dose	Percent of Workers > 2 rem
BWR Industry -1999[1]	0.110	184	6473	0.029
BFN - 1999[2]	0.122	223	447	0
BFN - 2000[2]	0.122	167	333	0
BWR Ind. 1994-1999[1]	0.243	236	51902	0.467
BFN 1994-1999[2]	0.419	250	2999	0.061

[1] NUREG 0713 Vol. 21 (1999)
[2] BFN Radiological Data: 10CFR20.407 Submittals, or Facility Radiological Control Database.

Projected Dose Increments

Projected dose increments are a forecast of dose increase for the proposed activities. Activities that may contribute to a dose increase are EPU, additional facility maintenance or modification needed to support an extended license agenda, and Unit 1 recovery. Each of these topics is addressed in the following paragraphs.

EPU at Units 2 and 3 has been addressed by a specific environmental assessment (EA). A conservative basis assumption of that EA is that the annual collective dose would increase in direct proportion to the power level. Table 4.3.21-2 summarizes the current facility dose parameter and forecasts the EPU basis dose assumption.

Table 4.3.21-2 Extended Power Up-Rate Dose Impact		
	Average Annual Collective Dose (rem)	Average Annual Collective Dose Per Reactor (rem)
BFN 2-Unit (1994-2000)	438	219
Alternative 1	526	263
Alternative 2	789	263

Facility maintenance or modification needed to support a license extension (Alternative 2) for Units 2 and 3 should not be necessary. Unit 2 and 3 systems received repair and modification during the extended outages that concluded May 24, 1991, and November 19, 1995, respectively. Further, Units 2 and 3 will have received extended power up-rate modification prior to license extension. These units should be prepared to operate through the extended license period without additional significant maintenance, modification, or refurbishment.

Unit 1 has been in an extended outage since March 1985. The estimated resources (work within the power house, potential radiation exposure environment) to recover the unit is 7.385 million man-hours protracted over a five year period. An estimated dose rate (rem per hour) was derived from Unit 2 and 3 data. Data was corrected to account for radioactive material decay that has occurred during the Unit 1 extended outage (i.e., 15 years). The decay correction factor is 0.145. The average collective dose (1998 to May 2001) is 395 rem; the average annual man-hours in the power house for the same period is 541,712. The quotient of these values yields the desired dose rate: 0.00073 rem per hour. An estimated dose for the Unit 1 recovery is defined by the product of the man-hours, decay correction factor, and the dose rate; 782 rem (7.385×10^6 hours X 0.145 X 7.3×10^{-4} rem/hour). An estimated collective dose for the Alternative 2 scenario (Unit 1 recovery, 3-unit EPU, and 20-year extended license) is 16,562 rem [782 rem + (263 rem/Reactor-year X 3 Reactors X 20 years)].

Cancer Risk

Health risk associated with radiation dose may be segregated into two general categories, non-stochastic and stochastic. A direct association of cause and effect is representative of the non-stochastic category. An example would be the death of an individual that received a radiation dose of 2,000 rem over a short period of time (a few hours). Stochastic effects are those that occur at random with no direct association to a causative agent. Cancer is an example of a stochastic effect. Cancer occurs spontaneously with no specific association with a causative agent. Hiroshima and Nagasaki bomb survivors who received radiation doses greater than 50 rem have experienced an increased cancer rate when compared with similar populations that only received background radiation dose. Background radiation dose is dose received by members of the public from naturally occurring radioactive materials in the earth's crust and cosmic radiation.

Stochastic Radiation Effects

Stochastic radiation effects are random events whose probability of occurring (rather than the severity of the effect) is a direct function of dose. These effects are normally regarded as having no threshold. Radiation carcinogenesis is generally regarded as stochastic. Cause-effect functions called *Dose Response Models* have been developed to estimate the stochastic effects for radiation exposure. A dose response model hypothetically relates a biological effect to the dose received by either a cell or an individual. It correlates the radiation dose received with the biological effect expected to be observed. There are currently four different hypothetical dose response models that are commonly used to predict radiation induced biological effects. These models are illustrated in Figure 4.3.21-1 and explained as follows:

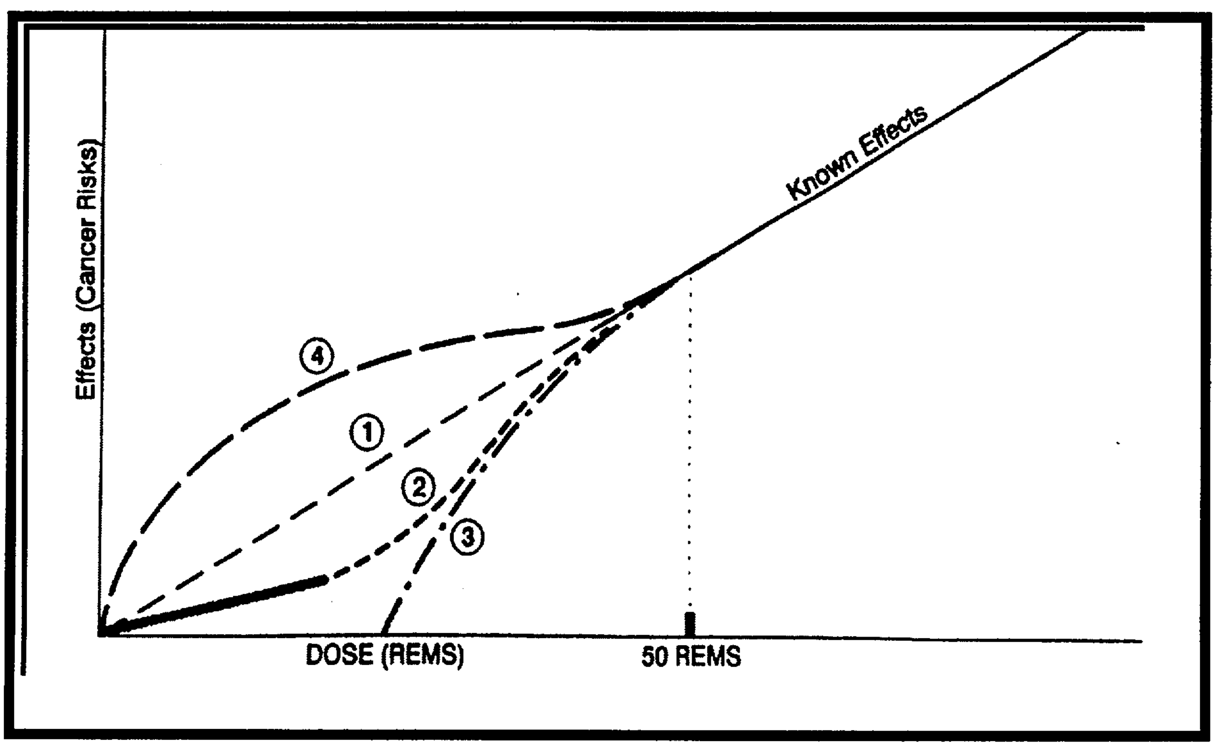
Curve 1: In the linear dose response model, the relationship between the dose received and the biological effect is considered directly proportional. The effect of any one unit of dose would be the same for either a high or a low dose. Thus if 10,000 rem resulted in one additional cancer, 1,000 rem would be predicted to result in 0.1 additional cancers, and 100 rem would be predicted result in 0.01 additional cancers. This is a simple linear proportionality.

Curve 2: The linear quadratic dose response model contains both a linear and a quadratic term. It hypothesizes that the effect is linear for a low dose (as in curve 1) and increases more aggressively as the dose is increased. Therefore, the dose response curve is linear in the low-dose range, becoming quadratic as the dose is increased. The majority of scientists today and the NRC endorse the use of the linear quadratic dose response model. (U.S. Nuclear Regulatory Commission. *Instructions Concerning Risks From Occupational Radiation Exposure.* Regulatory Guide 8.29. Washington, DC)

Curve 3: The third dose response model is known as the threshold model. It postulates that there is a level of dose below which there is no measurable or observable effect. Once that threshold dose is reached, the effect may increase with increasing dose by a linear, linear-quadratic, or quadratic model.

Curve 4: A few scientists believe that radiation effects level off with increasing exposure so that even a small dose implies a significant risk.

Figure 4.3.21-1 Dose Response Models That Predict How The Effects Of Radiation Vary With Dose At Low Levels



Estimated Cancer Risk

NUREG-0713 Vol. 1 Section 4.6.3.2 references the collective background radiation dose to the U.S. population to be on the order of 75 million rem/year. This background radiation dose is presumed to present no discernible health risks. Cancer risk is often assessed in terms of the relative increase with respect to the hypothetical causative agent. A fatal cancer risk coefficient of 4×10^{-4} rem^{-1} has been recommended by BEIR-V 1990. As an example; the possible annual cancer events from the U.S. background dose is 30,000 (75×10^6 rem X 4×10^{-4} rem^{-1}). The increased total BWR industry collective dose for 1999 with respect to the 1999 U.S. background dose is 30,002.59 (75, 006,473 rem X 4×10^{-4} rem^{-1}). This represents a 0.0086% increase {100 X (30,002.59 - 30,000)/30,000}. Table 4.3.21-3 summarizes the relative annual cancer risk with respect to the U.S. background dose. Table 4.3.21-4 summarizes the relative cancer risk for the proposed actions relative to the BWR industry collective dose.

Table 4.3.21-3 Annual Occupational Radiation Dose Increased Cancer Risk Relative to U.S. Population Background Dose

	Average Annual Dose - 1999		
	U.S. Background	BWR Industry	BFN
Collective Dose (rem)	75×10^6	6473	447
Possible Cancer Increase	30,000	2.59	0.179
Percent Increase	0	0.009	0.0006

Table 4.3.21-4 Occupational Radiation Dose Increased Cancer Risk Relative to BWR Industry Collective Dose

	Collective Worker Dose		
	BWR Industry	Alternative 1	Alternative 2
Collective Dose (rem)	418,557	10,520	16,562
Possible Cancer Increase	167.4	4.2	6.6
Percent Increase	0	2.51	3.96

NUREG-1437 Vol. 1 Section 4.6.3.2 postulates the radiation dose attributable to license extension might result in a five percent increase in the calculated cancer incidence to workers, but there may be no increase. The estimated cancer risks for the proposed activities are bounded by the NUREG-1437 Vol. 1 Section 4.6.3.2 assumptions.

Conclusions

Occupational radiation dose attributed to the recovery of Unit 1, and normal three-unit operation to the conclusion of the current license and into an extended license period has been examined from multiple perspectives. Average annual dose to the worker and the average annual dose per operated reactors are consistent with current BWR industry trends. Worker radiation exposures are controlled to be significantly less than the limits established by federal regulation, 10 CFR part 20. The estimated cancer risk increase associated with the occupational dose forecast for Alternative 2 activities is demonstrated to be bounded by the assumptions stated by NUREG-1437 Section 4.6.3.2. In that the No Action Alternative (discontinue operation of Units 2 and 3 when their current licenses expire) and Alternative 1 have less occupational radiation dose significance than those analyzed for Alternative 2, these scenarios are similarly bounded.

4.3.21.1.2 Public

The radioactive effluent releases or exposures from BFN operations are expected to increase no more than 1.8 times (see following note) recently reported values after a restart of Unit 1. The recently calculated doses are a small fraction of the applicable radiological dose limits and are expected to remain a small fraction of dose limits. The impacts to the environment are expected to have negligible impact due to restart of Unit 1.

NOTE: Recent dose and release data reflect 2 reactors operating at 100% of initial rated power. The two operating reactors have been re-licensed to operate at EPU and it is assumed that Unit 1 would be re-licensed to operate at EPU before restart (i.e., three reactors at 120% vs. data for two reactors operated at 100%; 360% / 200%; hence 1.8).

4.3.21.2 Facility (Design Basis) Accidents

The design basis accidents addressed in Chapter 14 of the BFN UFSAR are independent of the age of the plant. Therefore, extension of the operating lifetime of the plant from 40 to 60 years will not impact these accidents. This applies to all three units.

4.3.21.3 Severe Accident Mitigation Alternatives

The BFN Severe Accident Mitigation Alternatives (SAMA) analysis is summarized in Section 4.2.21.3 and included as Appendix A of this SEIS. The SAMA analysis addresses restart of Unit 1 and operation of all three units at EPU, and therefore addresses both Alternatives 1 and 2.

4.3.22 Decommissioning Impacts

Under Alternative 2, Unit 1 would join Units 2 and 3 in extending operation for an additional 20 years past expiration of the current licenses. Similarly to Alternative 1, decommissioning would be delayed by this 20 year period under Alternative 2, 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 the completion of decommissioning. Consequently, in comparison with the No Action Alternative, the potential for adverse environmental effects from decommissioning could be reduced under either of the action alternatives.

4.4 Identification of Mitigation Measures

Mitigation includes avoiding, minimizing, rectifying, reducing, or compensating for the impacts. Some potential mitigation measures were identified in the discussions of environmental consequences earlier in Chapter 4. These measures are generally of two types:

- physical changes incorporated during project design and construction, and
- programs and environmental controls initiated to meet regulatory standards.

These potential mitigation measures are assumed to be implemented as part of the actions proposed in Chapter 2 and provide part of the basis for the identification of environmental impacts in Chapter 4. In other words, these measures would be integrated into the action and would be conducted as part of the project.

4.4.1 Air Resources

Mitigation measures to minimize potential air pollutant emissions during construction activities for the new Administration Building, the new Modifications Fabrication Building, the dry cask storage facility, and any new cooling towers would be the best management practices that TVA uses for construction of any new facilities. This would include such measures as wetting ground surfaces as appropriate to reduce fugitive dust, requiring equipment and trucks to be well-maintained and tuned for efficient fuel combustion, covering fuels and fueling connections to minimize evaporative losses, and requiring contractors to adhere to such policies.

No specific mitigation measures are expected to be required during operational use of the new facilities.

4.4.2 Geology

No mitigation is identified for Alternatives 1 or 2.

4.4.3 Solid Wastes Management and Past Practices

No mitigation is identified for Alternatives 1 or 2.

4.4.4 Hazardous Wastes Management and Past Practices

No mitigation is identified for Alternatives 1 or 2.

4.4.5 Spent Fuel Management

No adverse environmental impacts that require mitigation have been experienced or are expected from spent fuel management at BFN. This is because similar facilities (spent fuel pools at TVA nuclear plants and dry cask storage facilities at other utilities) have been in successful operation for years. Should an unexpected problem develop regarding the handling or storage of spent fuel, a number of options are available to the BFN staff. These range from minimizing worker dose (by decreased exposure time, increased distance to the source, and/or intervention of shielding) to modifying or selecting a different storage cask design. No mitigation measures are identified at this time for either alternative.

4.4.6 Surface Water Resources

No mitigation is identified for Alternatives 1 or 2.

4.4.7 Groundwater Resources

No mitigation is identified for Alternatives 1 or 2.

4.4.8 Floodplains and Flood Risk

No mitigation is identified for Alternatives 1 or 2.

4.4.9 Terrestrial Ecology

No mitigation is identified for Alternatives 1 or 2.

4.4.10 Aquatic Ecology

No mitigation has been identified as necessary for Alternatives 1 or 2. TVA will confirm the expected levels of impingement and entrainment of fish 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 the location, design, construction, and capacity of the cooling water structure were causing adverse environmental impact, TVA would undertake an assessment of reasonably available/achievable technologies, operational measures, and restoration measures to minimize that adverse impact at the BFN site, and institute that or those measures which in consultation with the permitting agencies are determined to be the appropriate.

4.4.11 Threatened and Endangered Species

No mitigation is identified for Alternatives 1 or 2. None of the alternatives are expected to affect any listed species.

4.4.12 Wetlands

No mitigation is identified for Alternatives 1 or 2, as there are no wetlands present in any of the areas proposed for spoil disposal or excavation.

4.4.13 Socioeconomic Conditions

No mitigation is identified for Alternatives 1 or 2.

4.4.14 Transportation

Specific site mitigation measures to improve the local roadways could include employee programs that provide flexible working hours. This would reduce road travel during peak hours. Delayed shift changes would also help alleviate the congestion at the plant entrances/exits. Restrictions for trucks traveling during the peak hour could also be made. None of these measures are being committed to at this time, but would be implemented if transportation delays become intolerable.

If very heavy loads are to be transported on the plant site, TVA would assess the impact of these loads over or adjacent to underground structures (e.g., a pipe or a concrete cable tunnel that could be damaged). Ground loadings in these critical areas would be minimized by constructing temporary "bridges" over the underground structures and/or using transport vehicles with increased axles and wheels to minimize load pressures. When heavy loads are hauled on public roadways, it is normal engineering practice for the transport company to define the route and obtain necessary permits for hauling heavy loads. In addition, trucks would meet all safety standards and hauling would comply with all federal, state, and local ordinances.

4.4.15 Soils and Land Uses

No mitigation is identified for Alternatives 1 or 2.

4.4.16 Visual Resources

No mitigation is identified for Alternatives 1 or 2.

4.4.17 Recreation

No mitigation is identified for Alternatives 1 or 2.

4.4.18 Cultural Resources

The archaeological site identified in Spoils Disposal Area 1, along with an adequate buffer zone, would be excluded from the disposal area or Phase II testing would be conducted to confirm the significance of the site. If the site is determined by Phase II testing not to be significant, no further consideration of the site would be required.

Cox Cemetery, along with an adequate buffer zone, would be excluded from Spoils Disposal Area 2.

4.4.19 Environmental Noise

The potential 3 dBA or greater increase in the 24 hour DNL for action Alternative 2C, vendors 1 and 2, at Paradise Shores would be reduced much of the time. Frequently, the intruding noise would have less than a 3-dBA increase when fewer than all of the cooling towers are running or when they run at reduced capacity. This would be especially noticeable if towers 3 and 4, which are closest to Paradise Shores, are the last to be operated and the first to be shut-down. The 24-hour L_{eq} drops by 6 dBA for both alternatives when towers 3 and 4 are not operating.

Using low-noise fans that operate at reduced speeds are effective when included as part of the cooling tower design. Low-noise fan-motors are 7 to 8 dBA less than standard ones. This reduction would lower the total noise at Paradise Shores to about background noise levels.

TVA would further analyze several options for mitigating the potential noise increase at Paradise Shores prior to accepting the final design for the cooling towers from the selected vendor. Some of the options include, but are not limited to: using low noise fans on all cooling towers for Alternative 2C; using low noise fans only on towers 3 and 4; instituting operating instructions to minimize the use of towers 3 and 4; and soliciting other noise reduction options from the cooling tower vendor.

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

No work activities associated with license renewal and possible Unit 1 recovery are projected to require mitigation regarding health and safety. Any plant process or activity that results in harm to individuals, on site or off site, would be suspended (i.e., "stop work") until it could be re-evaluated and the problem corrected.

4.4.21 Radiological Impacts

BFN has been carefully designed, built, and is operated to minimize all releases of radiation emissions to the environment. To ensure public and worker safety, the plant is monitored to strict safety standards set by the regulator on a 24-hour a day, seven days a week basis. Nuclear plant emissions for TVA have always been at or below the safe levels permitted by federal standards. TVA has demonstrated and continues to demonstrate an excellent safety record in this area for its two operating units at BFN and at its other nuclear stations. TVA aggressively conducts a sustained effort to ensure that collective worker radiation doses, as well as annual and cumulative lifetime individual worker radiation doses, are maintained as low as reasonably achievable (ALARA).

Unexpected radiation dose problems are rare, but are mitigated in exactly the same manner as expected or anticipated problems, in keeping with the ALARA concept. This can involve a wide range of dose minimization strategies in the detailed work planning, including use of least exposure pathways, minimizing the time to complete the task, practicing the activity with mock-ups, etc. Additional shielding or the use of respirators may be adopted if it is determined that the total integrated dose is reduced (i.e., the dose increase from placement and removal of the shielding or due to the increased dwell time from being slowed down by the respirator is more than offset by the decrease in worker task dose). Although no activities associated with the Alternatives in this SEIS are projected to have associated radiological impacts requiring mitigation, any unexpected problems would be remedied accordingly.

4.5 Irreversible Adverse Impacts

Continued operation of the BFN units would result in unavoidable but very minor impacts to air and water quality, sound and visual resources. Air quality would continue to be affected by routine radioactive gaseous emissions typical of boiling water reactor operations. Water resources would continue to be affected in terms of surface use and quality because of routine radioactive effluent releases and the need for cooling water. Unit 1 operation (at EPU) would result in increased waste heat discharge to Wheeler Reservoir, but all regulatory temperature limits would be met. Unit 1 operation (at EPU) would also result in increased entrainment and impingement of aquatic biota, which is not anticipated to be environmentally significant. The routine discharge of chemicals would continue to have a minor affect on the aquatic biota near the plant discharge pipes. Also unavoidable would be the generation of additional low-level radioactive waste, which would be transported and managed off-site at a low-level radioactive waste disposal facility such as the one in Barnwell, South Carolina.

Alternative 1 essentially involves no change from the present day operation of BFN except that additional on-site storage capacity for spent fuel would be needed unless a national repository (such as the one being developed at Yucca Mountain, Nevada) is competed and becomes available before the current operating licenses for Units 2 and 3 expire (2014 and 2016, respectively). The irreversible adverse impacts are therefore limited to the continued generation of various types of wastes, including spent nuclear fuel, and a larger temporary facility to store that spent nuclear fuel.

Irreversible adverse impacts for Alternative 2 would be the same as those for Alternative 1; except for the addition of significant cooling tower capacity, some minor building changes and additions, and operating equipment refurbishments.

4.6 Relationship of Short-Term uses and Long-Term Productivity

The economic and societal returns to the TVA service region would be considerable for either Alternative 1 or 2, including continued stable and dependable electricity, and continued employment covering a wide spectrum of jobs and pay ranges. Demands for peaking and baseload energy are projected to increase, and license renewal of the BFN units is one way to help meet the continuing demand for baseload resources. Alternative 1 would maintain BFN as a preferred significant local employer with very minimal consumption of resources.

The construction of additional cooling tower capacity associated with Alternative 2 would result in small short-term impacts to the environment relative to the long-term maintenance and enhancement of productivity. The short-term impacts are primarily those that occur during the period of construction activities, including relocation of excavated spoils associated with increasing cooling tower capacity and equipment replacements during Unit 1 refurbishment. The major short-term uses of materials associated with Alternative 2 include the concrete, steel (reinforcement bars, sheet metal, structural beams, etc.), and fill composition used in constructing the additional cooling tower capacity. The use of short-term resources to restore Unit 1 for power production would affect the long-term productivity of the site by providing an additional reliable source for the production of bulk electric power. Alternative 2 would also provide an additional 150 permanent jobs and around 3,000 temporary jobs during Unit 1 recovery.

4.7 Irreversible and Irretrievable Commitment of Resources

The proposed action alternatives would result in irreversible and irretrievable commitments of resources including land, water, fuels, and other mineral resources over the 20-year extended lifetime of the facilities. Human resources (measured in man-years) are also included as a part of the comparison of the resource commitment by alternatives. This comparison is presented in Table 4.7-1. Listed values include EPU unless otherwise noted.

Depending on the alternative selected, cooling tower capacity addition could result in the removal of up to 106 acres of site land from most future uses. Continued operation of the plant would result in consumption of nuclear fuel and small amounts of fossil fuels, water, metals, and a number of other materials, some of which cannot readily be replaced or recycled. At this time, all constituents of the spent nuclear fuel are considered non-recoverable since no reprocessing of the spent fuel is allowed. Additional temporary spent fuel dry storage at the site would consume construction materials and result in minor increases in worker radiation exposure but would be built on already-disturbed site land.

The potential additional land resource commitment is irretrievable, but land is not considered to be in short supply in the region, given the large amount of non-industrialized property. Some river water would be evaporated during brief periods of cooling tower operation, typically less than one month per year. Since this water is returned to the earth as vapor, however, it is not considered to be an irreversible and irretrievable commitment of resources.

Table 4.7-1 Irreversible and Irretrievable Commitments of Resources

Resource	Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 2D
Land (acres)	no additional	up to 106	up to 106	no additional	no additional
Nuclear Fuel(1)					
Uranium oxide (lb.)	149,130	149,130	149,130	149,130	149,130
Zircaloy (lb.)	60,324	60,324	60,324	60,324	60,324
Stainless Steel (lb.)	6,641	6,641	6,641	6,641	6,641
Inconel (lb.)	777.5	777.5	777.5	777.5	777.5
Fuel Oil(2) (gal./yr)	385,000	385,000	385,000	385,000	385,000
Industrial Gases					
Hydrogen(3) (scf/yr)	16,850,000	25,880,000	25,880,000	25,880,000	25,880,000
Oxygen(4) (scf/yr)	7,995,000	12,300,000	12,300,000	12,300,000	12,300,000
Nitrogen(5) (scf/yr)	1,025,000	1,538,000	1,538,000	1,538,000	1,538,000
Ion Exchange Resins(6) (ft^3/yr)	3,914	5,871	5,871	5,871	5,871
Construction					
Steel(7) (tons)	1,058	1,764	1,854	1,845	1,651
Concrete(8) (cu. yds)	6,480	11,422	14,764	16,906	8,335
Labor (Man-years)	24,000(9)	35,750(10)	35,800(11)	35,700(12)	35,350(13)

(1) Per unit per reload (i.e., each reactor refueling batch; two years between refuelings).

(2) The same type of fuel oil is used for auxiliary heating boilers, emergency diesel generators, and various other diesel engines at BFN; annual consumption is essentially independent of Unit 1 restart.

(3) Used for reactor water chemistry control and generator internal atmosphere; in units of standard cubic feet per year.

(4) Predominantly used for reactor water chemistry control; in units of standard cubic feet per year.

(5) Predominantly used in containment atmosphere inerting; in units of standard cubic feet per year.

(6) Used for condensate demineralizers and radwaste processing; in units of cubic feet per year.

(7) Includes concrete reinforcing bars and anchors, framing members (girders, beams, columns), conduit, gratings, etc.

(8) Total concrete for buildings, cooling towers (includes equipment support pads, ducts, etc.), and dry cask storage facility.

(9) Total site staff of 1200 for 20 years.

(10) Total site staff of 1350 for 20 years + Unit 1 restart (avg. 1500 for 5 ½ years) + cooling tower work (~200 workers for 2 years) + spoils hill relocation (~100 workers for 1 year).

(11) Same as (10) except additional 50 man-years for construction of round cooling towers.

(12) Same as (10) except no spoils hill relocation and additional 50 man-years for construction of very large cooling towers.

(13) Same as (10) except cooling tower work is approximately 200 workers for ½ year and no spoils hill relocation.

4.8 References

10 CFR Part 51, Subpart A, Appendix B, "Environmental effect of renewing the operating license of a nuclear power plant."

Alabama Department of Environmental Management. (2001) Personal Correspondence.

Alabama Department of Transportation. Traffic Flow Maps showing 1998 Average Daily Traffic, reported by ADOT.

Barko, John W. and R. Michael Smart. 1981. Comparative Influences of Light and Temperature on the Growth and Metabolism of Selected Submersed Freshwater Macrophytes. Ecological Monographs 51:210-235.

Baxter, D. S. and J. P. Buchanan. 1998. Browns Ferry Nuclear Plant Thermal Variance Monitoring Program - Final Report. Tennessee Valley Authority, Water Management, Environmental Compliance.

Boston, W. Terry. 2000. "Electricity: Lifeline or Bottom Line?" Forum for Applied Research and Public Policy, Summer 2000, pp. 56-60.

Browns Ferry Nuclear Plant (BFN) - Units 1, 2, and 3 - Updated Final Safety Analysis Report (UFSAR), Amendment 18, dated November 16, 1999.

Brungs, W. A., Bernard R. Jones. 1977. Temperature Criteria for Freshwater Fish: Protocol and Procedures. U. S. Environmental Protection Agency, Office of Research and Development. EPA-600/3-77-061.

Burns, Earl R., A. Leon Bates, and David H. Webb. 1989. Aquatic Plant Management Program – Current Status and Season Workplan. Tennessee Valley Authority, Muscle Shoals, Alabama.

Dycus, D. L. and T. F. Baker. 2000. Aquatic Ecological Health Determinations for TVA Reservoirs - 1999. Tennessee Valley Authority, Water Management, Chattanooga.

Dycus, D. L. and T. F. Baker. 2001. Aquatic Ecological Health Determinations for TVA Reservoirs - 2000. Tennessee Valley Authority, Water Management, Chattanooga.

EPRI/NEI 2001. Proceedings: 2001 Electric Power Research Institute/Nuclear Energy Institute Decommissioning Technology Workshop, April 30 to May 1, 2001, New Orleans, LA.

Gough, D. I. 1978. "Induced Seismicity", Monograph Chapter from the Intergovernmental Conference on the Assessment and Mitigation of Earthquake Risks, 1978 version of a paper submitted to February, 1976 conference, pp. 91-117.

Harper, W. L. 2001. Browns Ferry Nuclear Plant Tower Usage and Load Reductions Under Proposed Increase in Reactor Power Levels and Unit 1 Restart. TVA Internal Memorandum.

Harper, W. L. 2002. Addendum to Browns Ferry Nuclear Plant Tower Usage and Load Reductions Under Proposed Increase in Reactor Power Levels and Unit 1 Restart. TVA Internal Memorandum, May 1, 2001.

Higgins, J. M. and Kim, B. R. 1981. "Phosphorus Retention Models for Tennessee Valley Authority Reservoirs." Water Resources Research, Vol. 17, No. 3, pp. 571-576.

Maceina, M. J., P. W. Bettoli, S. D. Finely, and V. J. DiCenzo. 1998. Analyses of the sauger fishery with simulated effects of a minimum size limit in the Tennessee River of Alabama. North American Journal of Fisheries Management 18: 104-113.

Mundahl, N. D. 1990. Heat Death of Fish in Shrinking Stream Pools. Amer. Midl. Nat. 123:40-46.

Report–Operating License Renewal Stage, Edwin I. Hatch Nuclear Plant. Appendix D, Applicant's Environmental Report–Operating License Renewal Stage Edwin I. Hatch Nuclear Plant.

Shiao, M. C. 2001. Browns Ferry Nuclear Plant—Model Analysis of Wheeler Reservoir for 1988. TVA Internal Memorandum.

Smith, C. S. and J. W. Barko. 1990. Ecology of Eurasian Watermilfoil. Journal of Aquatic Plant Management 28:55-64.

Stanley, R. A. and A. W. Naylor. 1972. Photosynthesis in Eurasian Watermilfoil (*Myriophyllum spicatum* L.). Plant Physiology 50:149-151.

TVA calculation ND-Q0999-980016, R3, R14-000207-104

Tennessee Valley Authority. 1978b. Biological Effects of Intake – Browns Ferry Nuclear Plant. Voluem 4: Effects of the Browns Ferry Nuclear Plant Cooling Water Intake on the Fish Populations of Wheeler Reservoir. Division of Forestry, Fisheries, and Wildlife Development, Norris, Tennessee.

Tennessee Valley Authority. 1983. "A Supplemental 316(a) Demonstration for Alternative Thermal Discharge Limits for Browns Ferry Nuclear Plant, Wheeler Reservoir, Alabama."

Tennessee Valley Authority 1990. "Tennessee River and Reservoir System Operation and Planning Review." Final Environmental Impact Statement. TVA/RDG/EOS-91/1.

TVA. 1990. "Water Resources Issues Analysis: Wheeler Reservoir Watershed Region." TVA/WR/WQ-90/6.

Tennessee Valley Authority. (1993) "Two-Dimensional Water Quality Modeling of Wheeler Reservoir." Report No. WR28-1-3-105.

TVA. 1999. "Response to Request for Additional Information on Individual Plant Examination for External Events." Revision 1.

Tennessee Valley Authority. 1999. Browns Ferry Nuclear Plant - National Pollutant Discharge Elimination System Permit Number AL 0022080 - Renewal Application.

Tennessee Valley Authority. (2000) "Aquatic Ecological Health Determinations for TVA Reservoirs—1999."

Transportation Research Board. *Highway Capacity Manual, Special Report 209.* 3rd ed. Washington: Transportation Research Board. 1994.

U.S. Department of Commerce, Bureau of the Census. www.census.gov/hhes/www/saipe/.

U.S. Nuclear Regulatory Commission. 1990. Technology, Safety and Costs of Decommissioning a Reference Boiling Water Reactor Power Station. NUREG/CR-0672 and Addenda 3 and 4, Washington, D.C.

U.S. Nuclear Regulatory Commission. 1996. Generic Environmental Impact Statement for License Renewal of Nuclear Plant. NUREG-1437, Washington, D.C.

U.S. Nuclear Regulatory Commission. 1999. Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report, Section 6.3 - Transportation, Table 9.1, Summary of findings on NEPA issues for license renewal of nuclear power plants. NUREG-1437, Vol. 1, Addendum 1, Washington, D.C.

U.S. Nuclear Regulatory Commission. 2000a. Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans, dated April 2000. NUREG 1700, Washington, D.C.

U.S. Nuclear Regulatory Commission. 2000b. Integrated Rulemaking Plan for Nuclear Power Plant Decommissioning, dated June 28, 2000. SECY-00-145, Washington, D.C.

Van, T. K., W. T. Haller, and L. A. Garrard. 1978. The Effect of Day Length and Temperature on Hydrilla Growth and Tuber Production. Journal of Aquatic Plant Management 16:57-59.

Yeats, R. S., K. Sieh and C. R. Allen. 1996. The Geology of Earthquakes, Oxford University Press, 576p.