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2.0 ALTERNATIVES INCLUDING THE PROPOSED ACTION

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

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

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

2.1 Description of the No Action Alternative

The No Action Alternative would result from a decision to not extend operation of the BFN units. Since it currently appears economically infeasible to recover Unit 1 without license renewal, such a decision would effectively terminate any further consideration of restarting that unit at this time. Operation of Units 2 and 3 would cease upon expiration of their operating licenses in 2014 and 2016, respectively, and the plant would then be required to choose a decommissioning option.

Operation of Units 2 and 3 during their existing license terms is addressed in the plant's original EIS from which this EIS tiers: *Final Environmental Statement, Browns Ferry Nuclear Plant Units 1, 2, and 3* (TVA, 1972). That EIS continues to adequately identify the environmental impacts of operating the BFN units until their existing licenses expire. The other relevant NEPA reviews, identified in Section 1.5.3 of this SEIS, identify the changes that have occurred in unit operation since the original EIS and the environmental impacts associated with those changes. The discussion of the Action Alternatives in this SEIS describes current unit operations.

Figure 2.0-1
Current Facilities at BFN

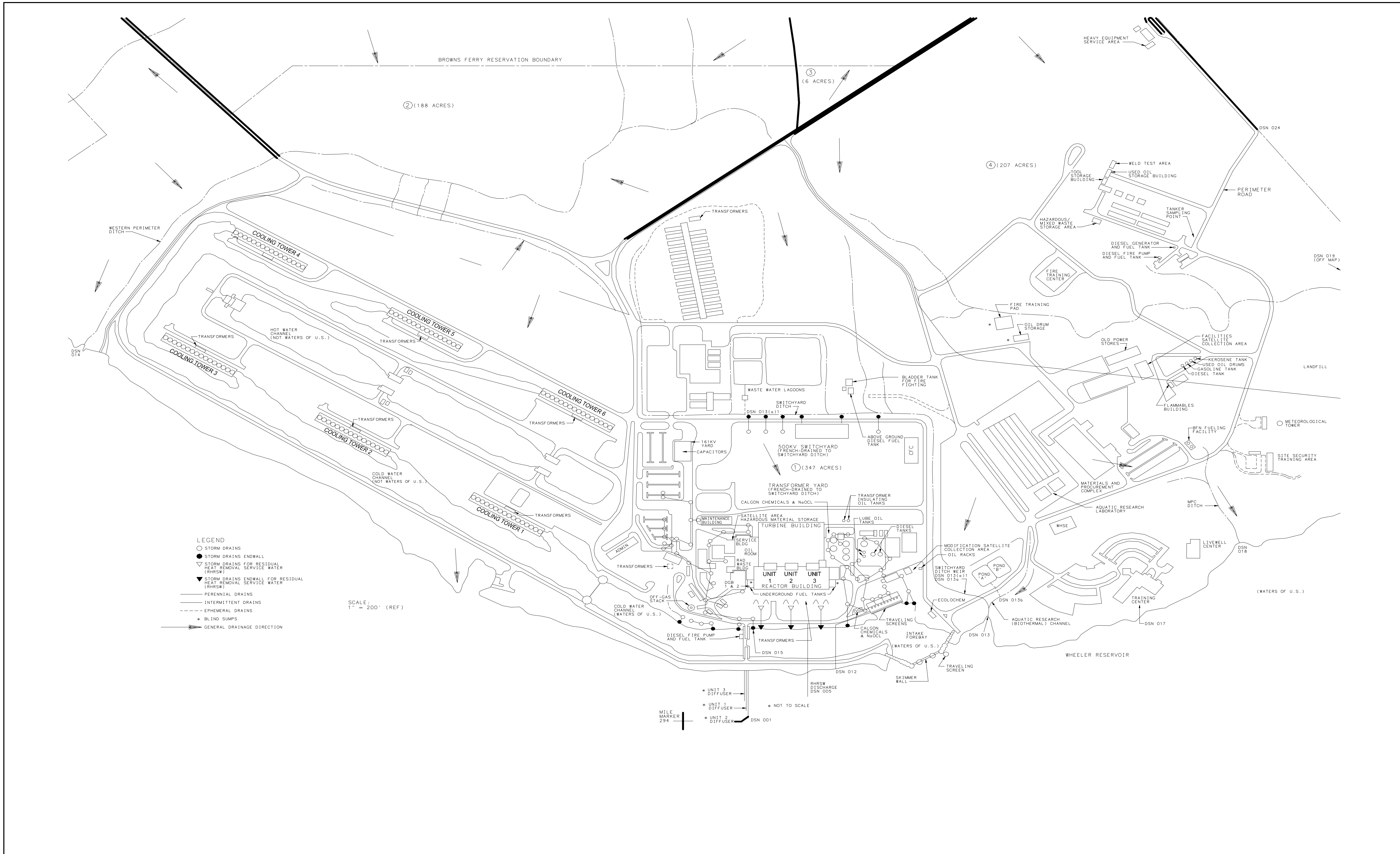
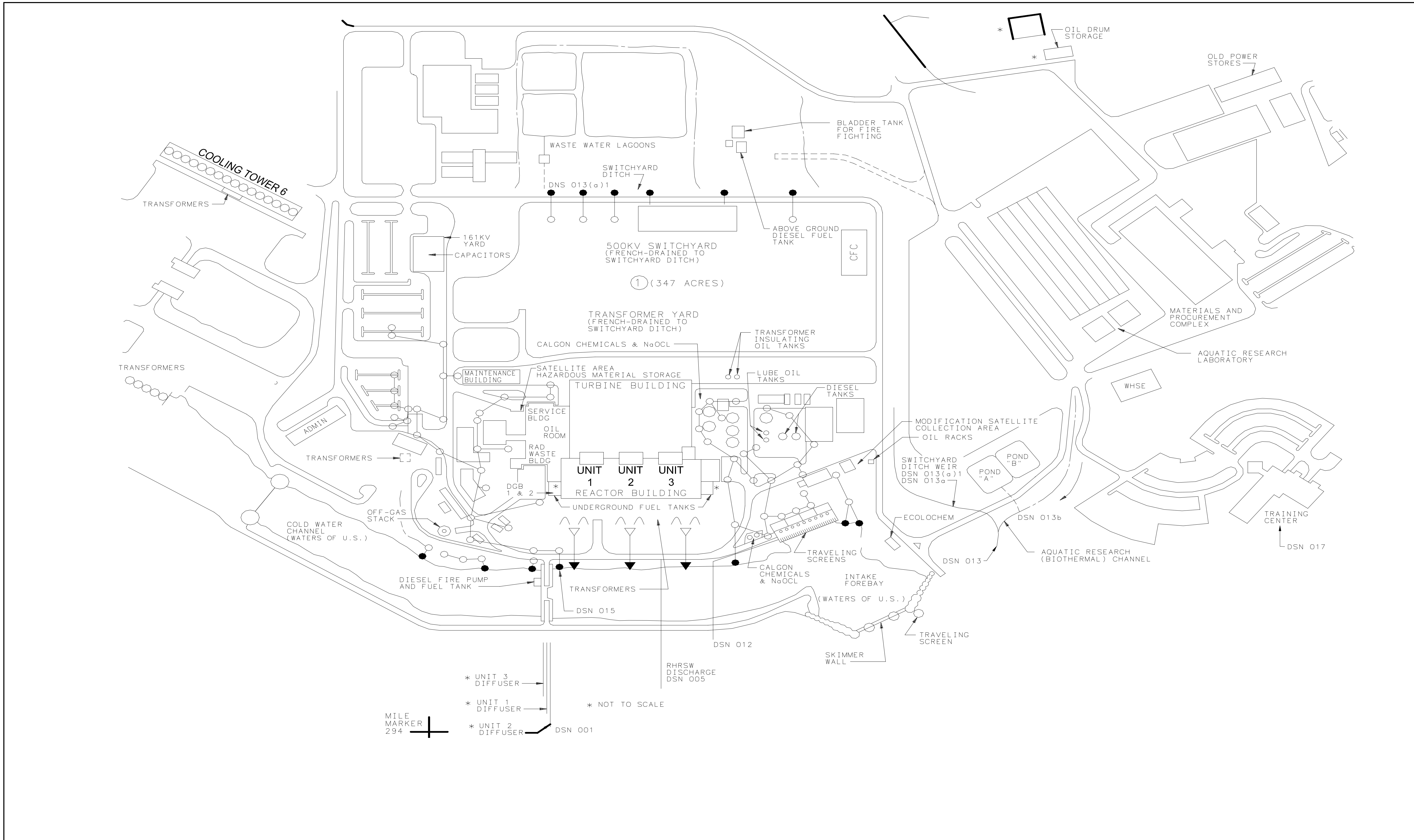


Figure 2.0-2
Current Facilities (Details) at BFN



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

2.2 Screening of Action Alternatives

Except for maximizing use of BFN's assets, feasible Action Alternatives for meeting TVA's purpose and need include the entire portfolio of actions recommended in *Energy Vision 2020*. These actions include, as detailed in Section 1.4.2, various supply-side actions (e.g., constructing new power plants, purchasing and exercising call options, purchasing power from independent power producers, renewable energy, improving the existing hydroelectric generating system, converting Bellefonte Nuclear Plant to an alternative fuel); and customer service alternatives (e.g., demand-side management, beneficial electrification). The environmental impacts of these projects and actions are documented in *Energy Vision 2020* or in other environmental reviews completed prior to decisions to implement them.

Chapter 1 pointed out that some of these alternatives did not deliver the power promised, and that some alternatives pose unacceptable technical and financial risk in TVA's efforts to ensure that sufficient power is available to meet customer needs. In fact, over reliance on options purchase agreements (which have yielded mixed performance to date) and spot market purchases during periods of high electricity use could lead to failure to meet demands. Many utilities across the country did not plan for sufficient margin of production and could not meet the demands of their customers on several occasions during recent summers at any cost. Even when it is possible to purchase energy (electricity) on the spot market from other utility systems, this does not avoid the environmental impacts associated with energy generation. The impacts associated with the generation used to produce the purchased electricity would still occur. It is likely that spot market energy would be supplied by coal-fired generation because this is the generation that tends to swing with load or changes in demand (nuclear generation is normally baseloaded; hydro and natural-gas fired generation (combustion turbines) typically is reserved for use during peak periods). (Natural-gas fired combined cycle plants as they increase in number may change this generation profile over time.) Coal-fired and, to a lesser extent, natural-gas fired generation has more significant environmental impacts than nuclear generation (for example: air quality). The environmental impacts associated with spot market purchases have been addressed in *Energy Vision 2020*.

Converting one or more BFN units to fossil-fired could theoretically make maximum non-nuclear use of BFN facilities, but is probably not practicable for a number of reasons. The steam turbines and condensate systems in a boiling water reactor (BWR) are radioactively contaminated and not designed for the steam temperatures and pressures that maximize efficiency in fossil-fired boilers. Mixing types of generation (e.g., keeping Unit 2 or 3 reactors operating while feeding the Unit 1 turbine-generator from a fossil-fired boiler) is even less likely because it would require very expensive “hardening” of steam lines and other equipment that could conceivably be accident initiators. Currently there may not be enough unused space at the BFN site to cost-effectively add large new boilers, pipelines, coal yards, etc. Therefore, conversion is not considered to be a reasonable alternative for this SEIS.

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

2.2.1 Proposed Action Alternatives for this SEIS

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

ALTERNATIVE 1 – RELICENSING OF UNITS 2 AND 3

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

The reason for the above licensing options to accommodate a non-operating Unit 1 is that a decision to not renew the operating license for Unit 1 would require it to enter a chosen decommissioning mode while Units 2 and 3 (with which it is heavily interconnected, including safety systems) are operable or operating. Both TVA and NRC would be cautious about mixing operation with decommissioning of same-site interconnected units. The facilities and components affected by implementation of Alternative 1 are shown in Figures 2.2-1 and 2.2-2; these are the same as Figures 2.0-1 and 2.0-2 except that they include an additional cooling tower, the proposed dry cask storage facility, and a proposed modifications/fabrication building.

Figure 2.2-1
Facilities Associated with Alternative 1

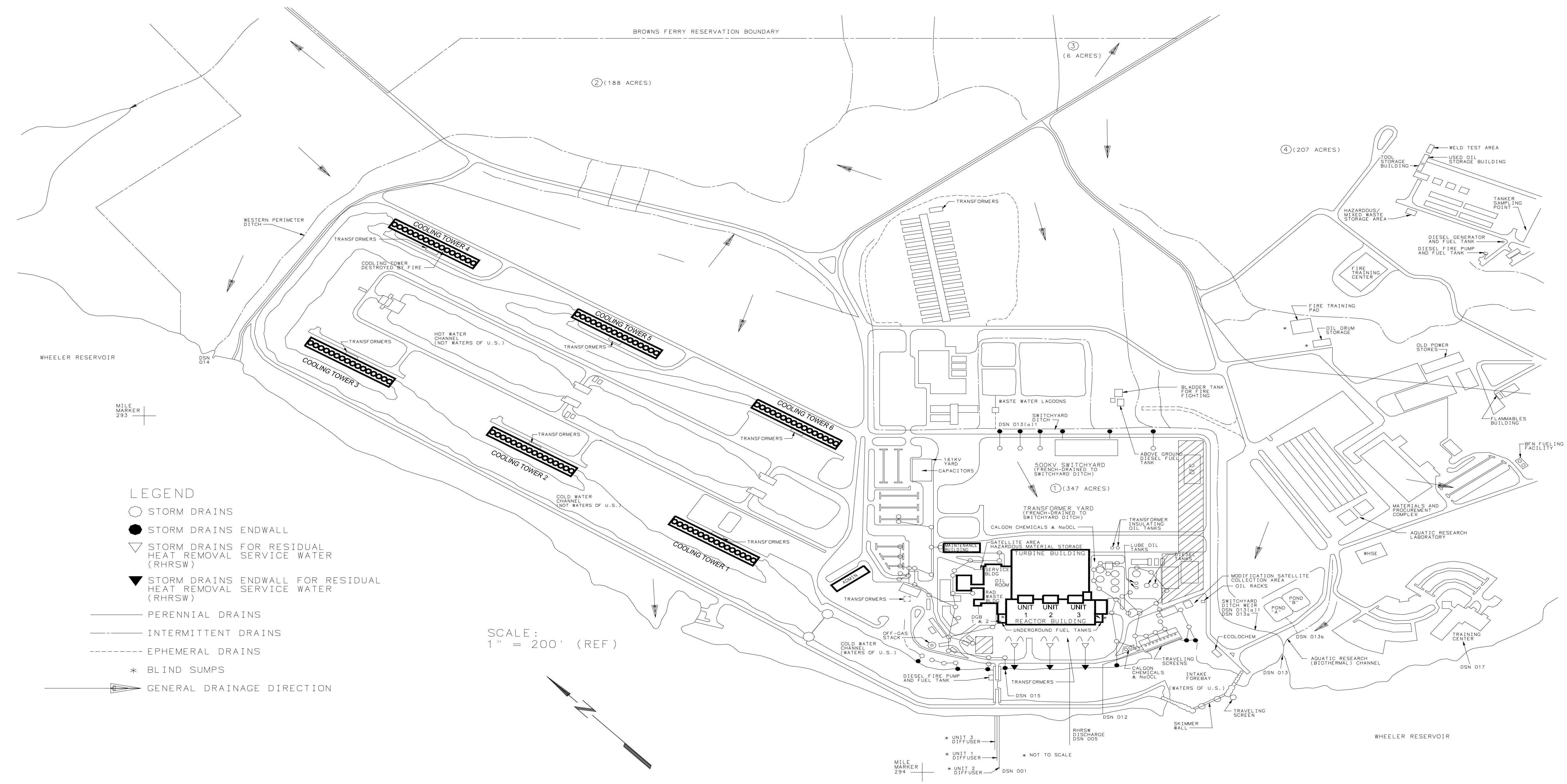
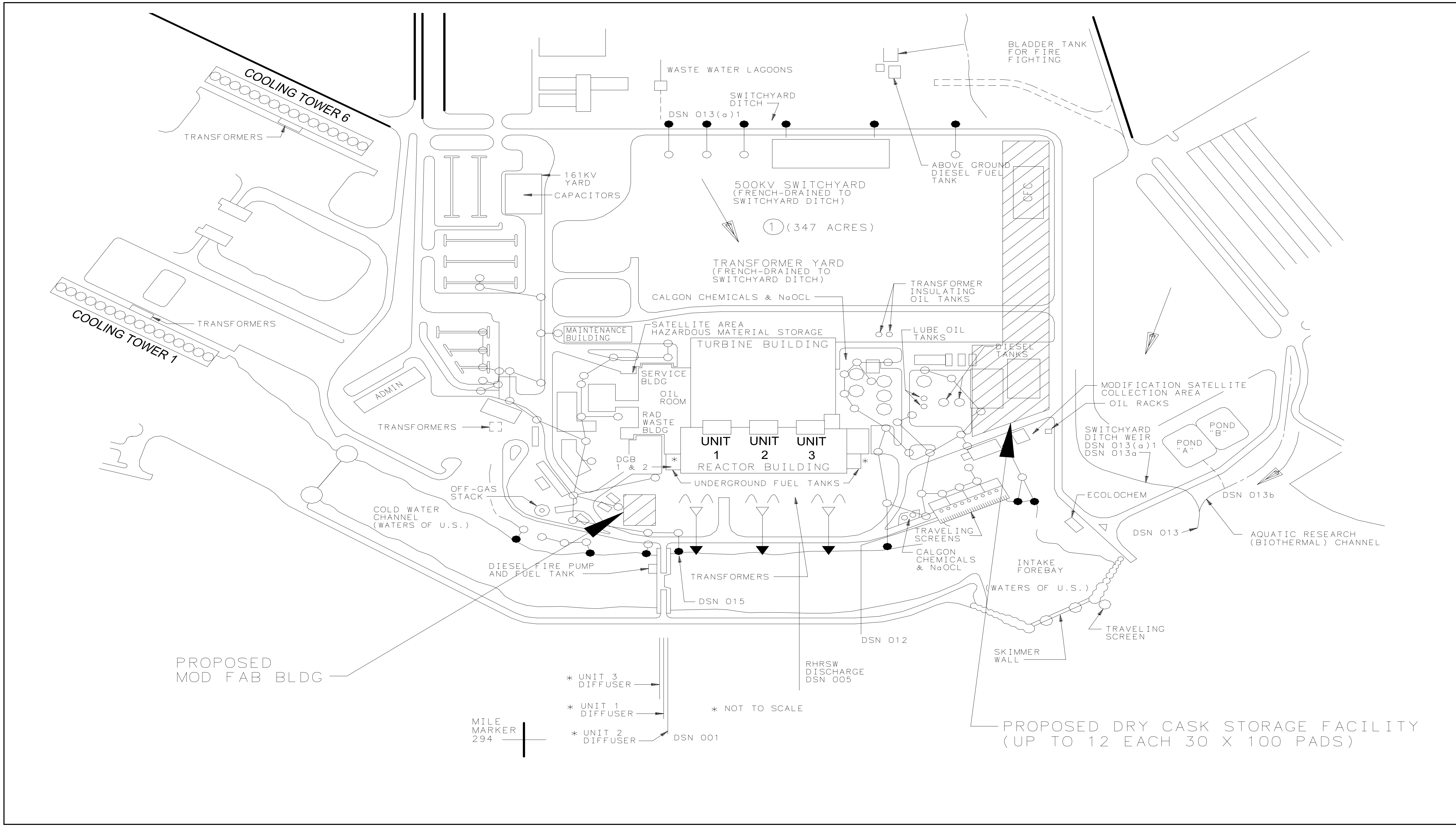


Figure 2.2-2
Details Associated with Alternative 1



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

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

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

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

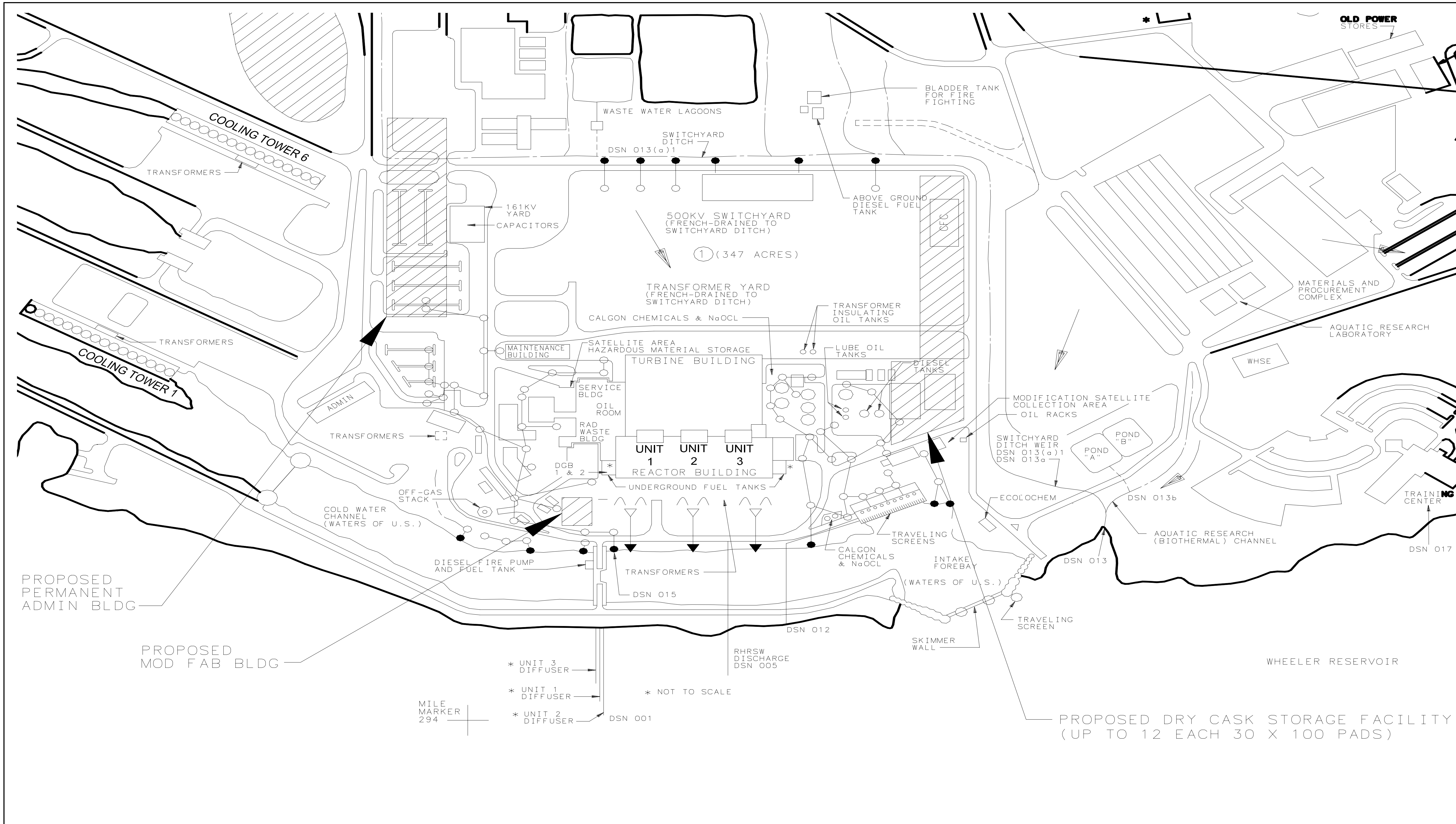
UNIT NOS.	**CURRENT** (prior to EPU)	**AFTER EPU** (Completion Date)	**ALTERNATIVE 1** (begins 2013)	**ALTERNATIVE 2** (begins 2013)
Unit 1	[not operable]	[not operable]	[not operable]	1280
Unit 2	1164	1280 (April ’05)	1280	1280
Unit 3	1164	1280 (April ’04)	1280	1280
Total	2328	2560	2560	3840
Increase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

2.2.2 Associated Condenser Circulating Water Flow Rates

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

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

Figure 2.2-3
Facilities Associated with Alternative 2



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

In recent years, BFN has operated with only Units 2 and 3, but due to a combination of system upgrades and improved flow calibrations the measured total per-unit CCW flow rate in the open mode (with 3 condenser circulating water pumps per unit) has increased. For example, the condensers were re-tubed with stainless steel tubing having a larger internal diameter and decreased flow resistance, which increased flow approximately 6%. The most recent total intake flow reported to the Alabama Department of Environmental Management (ADEM) in the monthly Discharge Monitoring Report is 2,312.1 MGD (approximately 800,000 GPM per unit). With the return of Unit 1 (which will also be re-tubed), the total intake flow would then become approximately 3,468 MGD, which represents an increase over the previous high reported number (2,855) of 21.5%. However, based on extensive recent experience in measuring flows and observing changes due to various modifications, maintenance, and measurement methods and techniques, TVA believes that only about 10% of this represents a real increase in flow; the remainder is due to either changes in flow measuring methods and techniques or differences in how the original values were reported.

2.2.3 Associated Cooling Tower Impacts and Alternatives

ALTERNATIVE 1: COOLING TOWER IMPACTS

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

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

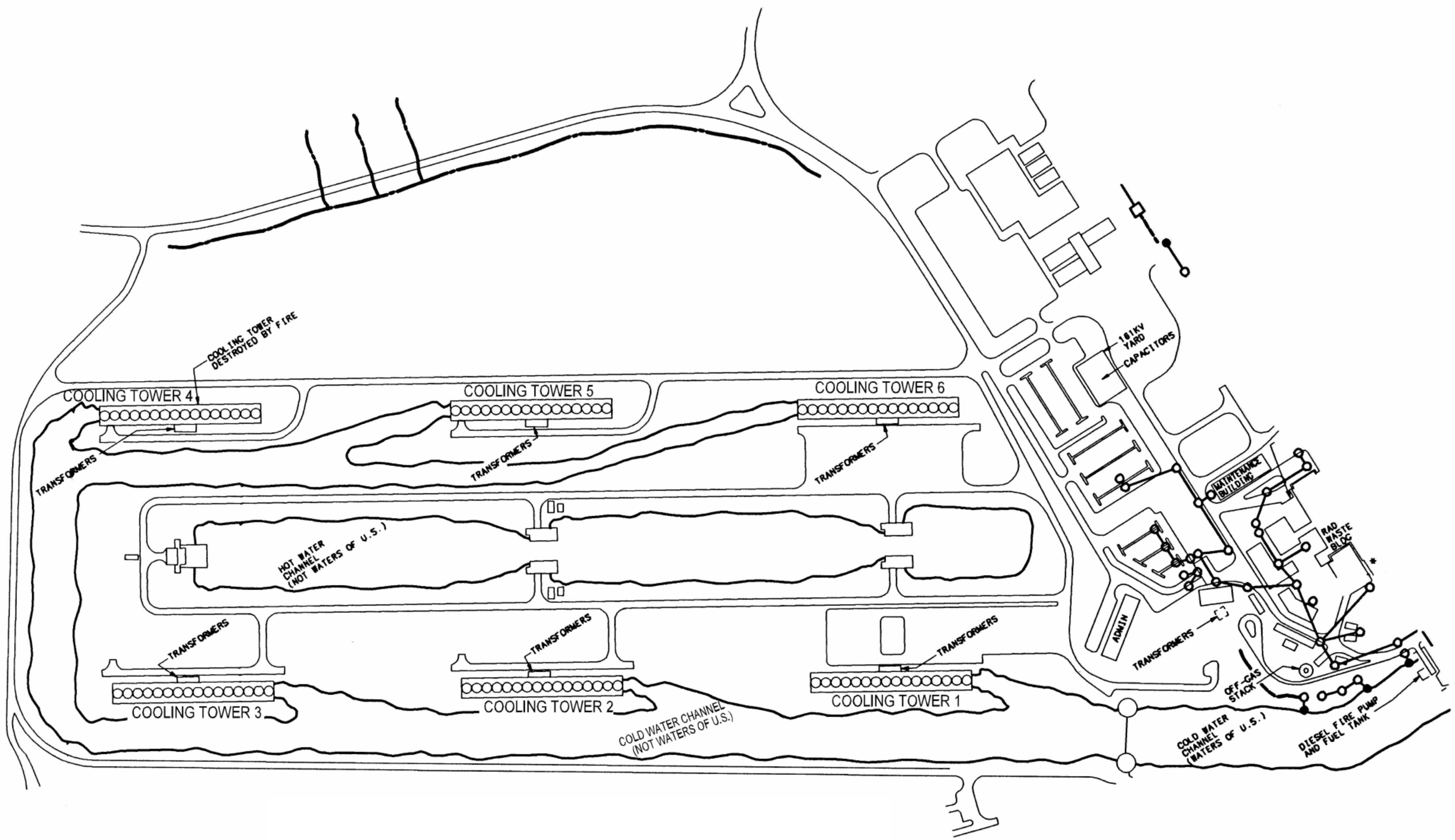
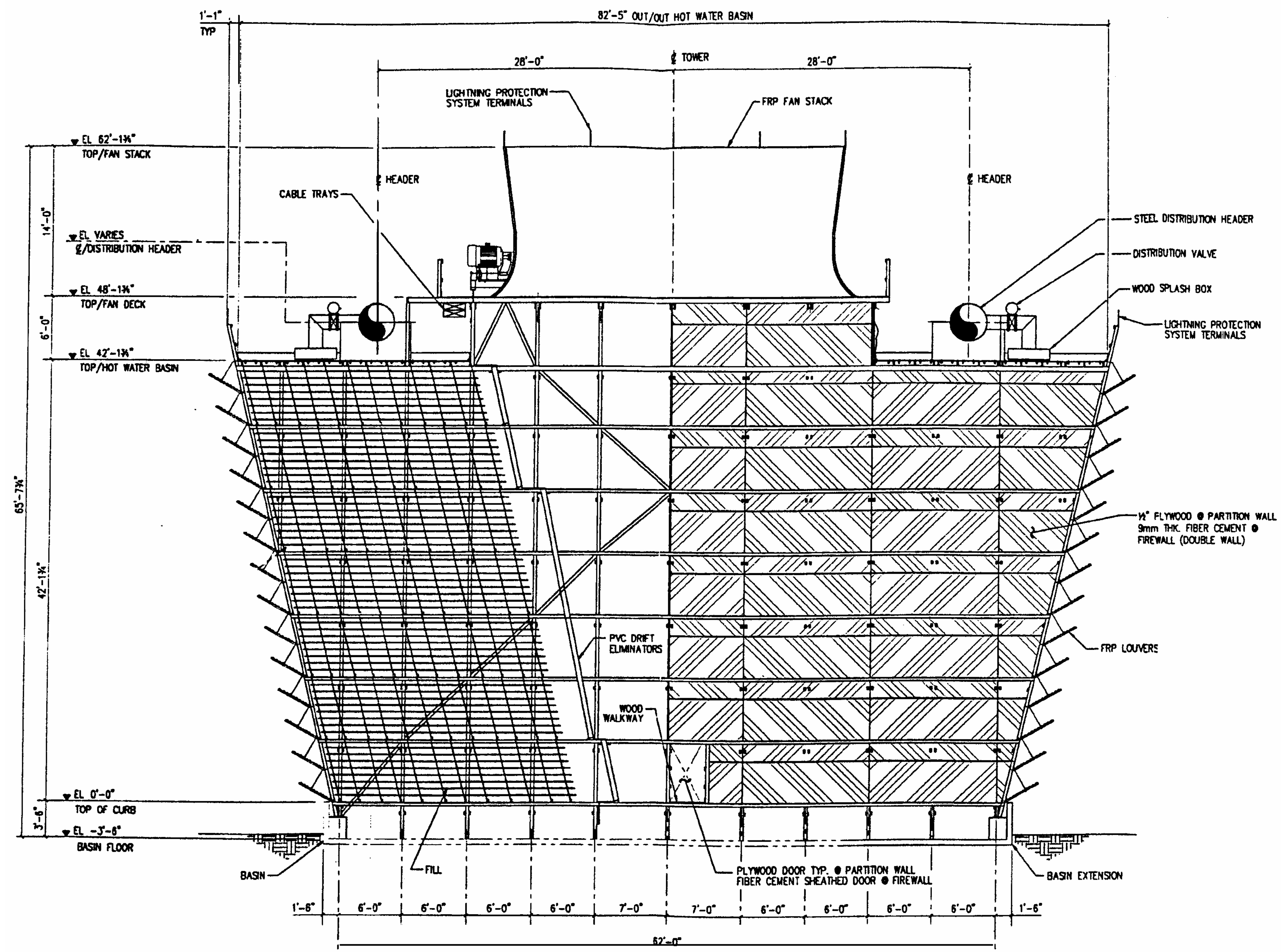


Figure 2.2-5 Diagram of Typical Mechanical Draft Cooling Tower



ALTERNATIVE 2: COOLING TOWER IMPACTS

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

ALTERNATIVE 2A: ADDITIONAL LINEAR MECHANICAL DRAFT COOLING TOWERS OPTION

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

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

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

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

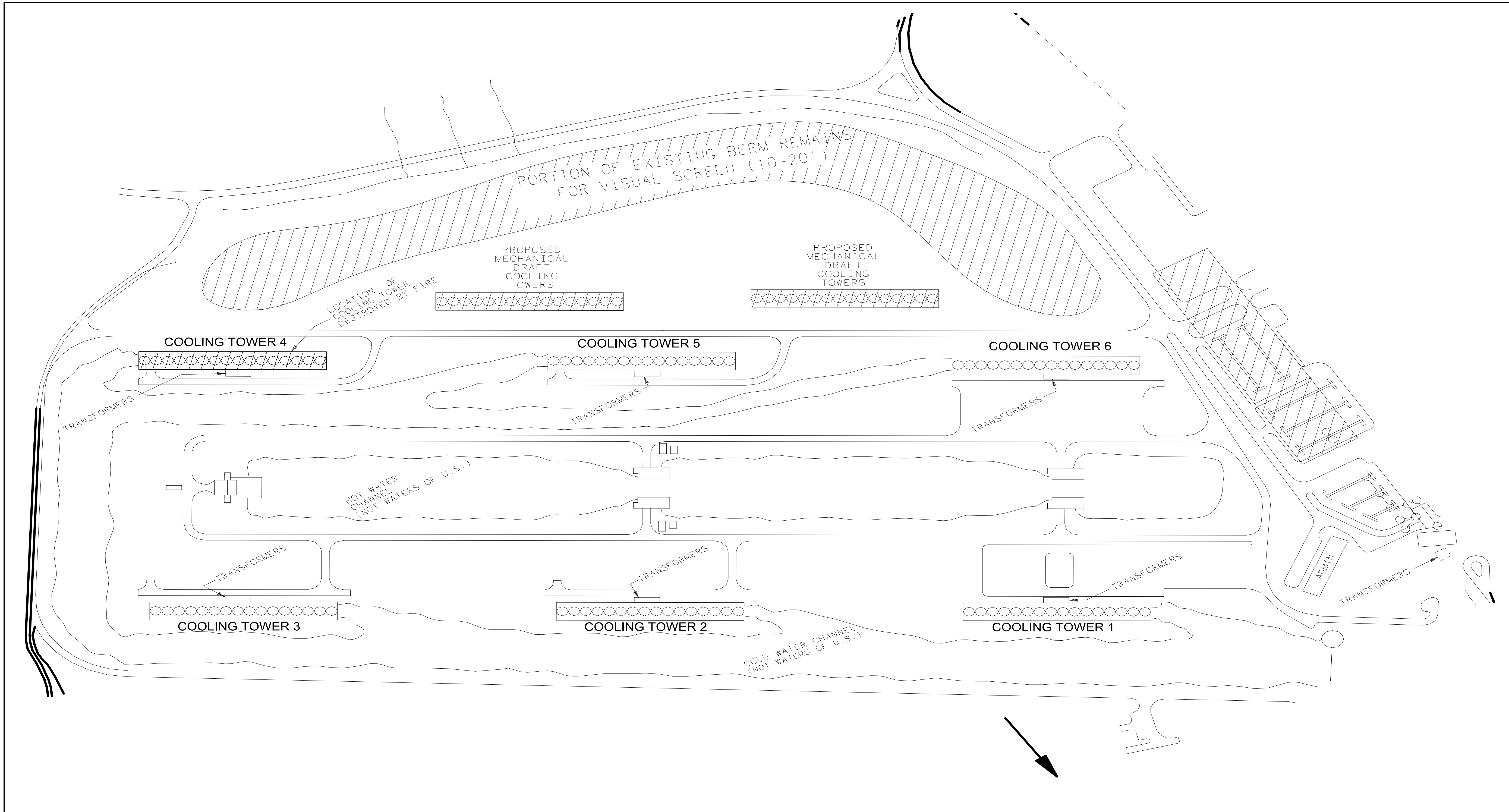


Figure 2.2-7
Location of Areas for Spoils Deposition

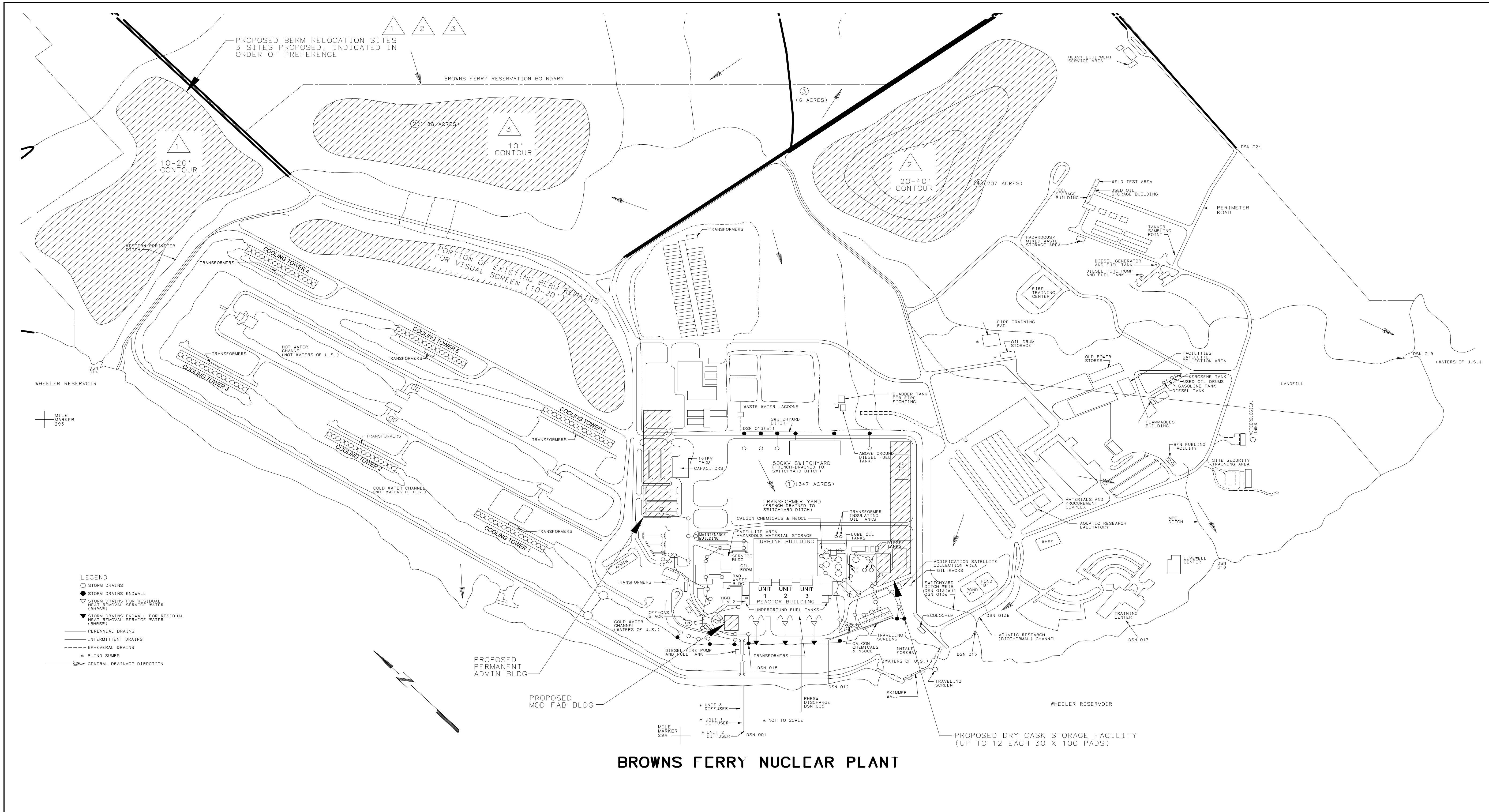
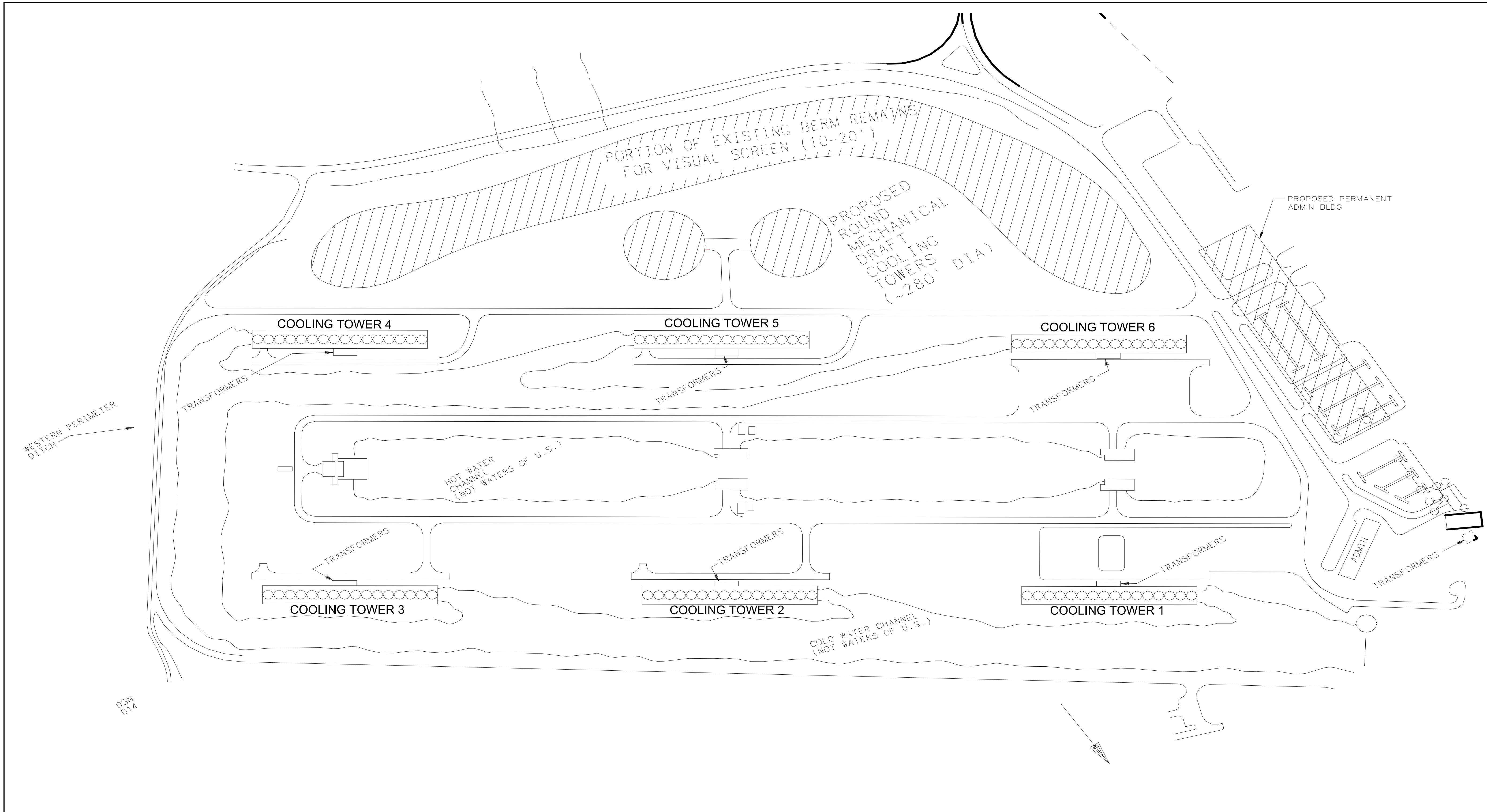


Figure 2.2-8
Location of Cooling Towers for Alternative 2B



ALTERNATIVE 2C: ENLARGED LINEAR MECHANICAL DRAFT COOLING TOWERS OPTION

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

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

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

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

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

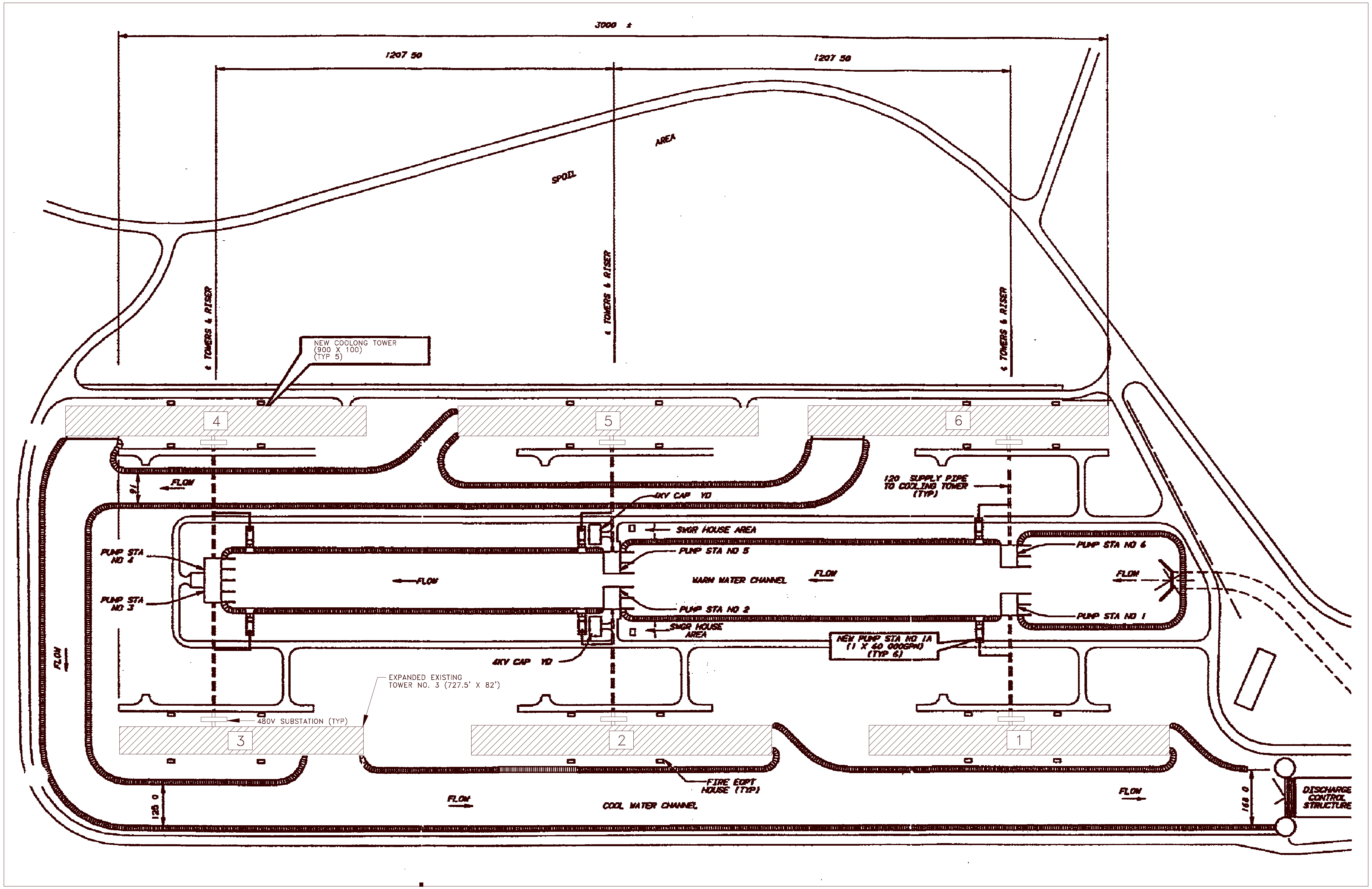
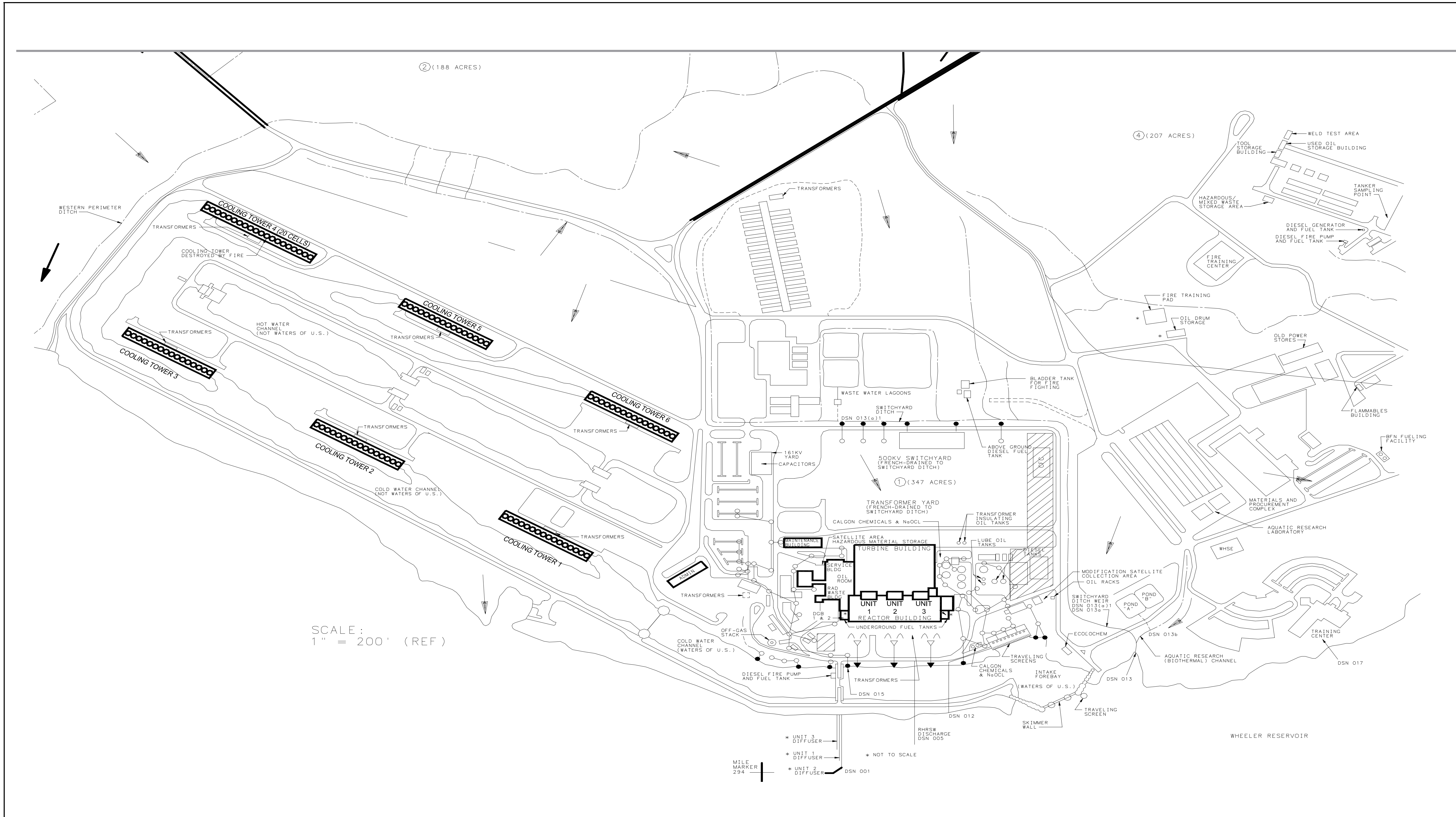


Figure 2.2-10
Location of Cooling Towers for Alternative 2D



ALL ALTERNATIVES: MINIMIZATION OF COOLING TOWER IMPACTS

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

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

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

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

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

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

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

2.2.4 Spent Fuel Storage Options

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

In response to the Nuclear Waste Policy Act of 1982 and subsequent amendments, DOE was required to develop a deep, mined geological repository for high-level waste and spent nuclear fuel. The repository was to begin receiving utility spent fuel by January 31, 1998, and based on DOE's last published Acceptance Priority Ranking (DOE/RW0457), was to begin receiving TVA's spent nuclear fuel during the fifth year of repository operation. However, the repository is now at least 12 years behind schedule. BFN is currently storing spent fuel in three spent fuel pools which were each re-racked to a capacity of 3,471 spent fuel assemblies. As a result of the DOE repository delay, Unit 3 is expected to lose full core off-load capability in November 2005.

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

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

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

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

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

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

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

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

2.2.5 Decommissioning Options

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

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

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

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

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

The disadvantages of DECON include the following:

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

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

- a substantial reduction in radioactivity as a result of the radioactive decay that results during the storage period,
- a reduction in worker dose (as compared to the DECON alternative),
- a reduction in public exposure because of fewer shipments of radioactive material to the low-level waste site (as compared to the DECON alternative),
- a potential reduction in the amount of waste disposal space required (as compared to the DECON alternative),
- lower cost during the years immediately following permanent cessation of operations,

- a storage period compatible with the need to store spent fuel onsite, and
- more time to benefit from growth in the decommissioning trust fund.

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

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

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

The ENTOMB option may have a relatively low cost.

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

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

2.3 Description of Actions Common to All Action Alternatives

2.3.1 Extended Power Uprate

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

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

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

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

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

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

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

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

2.3.2 Dry Cask Storage Facility

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

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

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

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

2.3.3 Modifications Fabrication Building

The location for the new dry cask storage facility (Figure 2.2-3) would require tearing down the existing Modifications Fabrication Building. However, the old building would not have to be displaced until approximately 2008, which is expected to be well after the new Modifications Fabrication Building would be operational. Although the primary motivation for erecting a new Modifications Fabrication Building is to make room for the new dry cask storage facility, initially it would be used for Unit 1 recovery. In fact, a decision to recover Unit 1 would essentially require work to begin on the new Modifications Fabrication Building almost immediately. The new building would be completed and occupied within 12 to 18 months after a decision is made to pursue Unit 1 recovery. Compared to the existing Modifications Fabrication Building, this new building would be larger and more flexible in the number and kind of activities it can house.

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

2.4 Description of Actions Specific to Associated Alternatives

2.4.1 Extended Operation of Units 2 and 3

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

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

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

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

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

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

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

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

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

The managerial improvements included organizational changes compatible with corporate level restructuring, improved management control and involvement, revised conduct of design control, and programs to ensure employee confidence. Particularly noteworthy were the design control improvements that addressed a number of problems that had resulted from inadequately analyzed or documented design control and poor coordination between the engineering design and the modification process. The Design Baseline Verification Program was instrumental in re-establishing confidence and continuity between the current design and actual ("as-built") field configuration.

Special programs were defined and carried out to resolve a number of plant hardware issues for Units 2 and 3, including environmental qualification of electrical equipment, seismic design basis adequacy of suspended components, fire protection compliance with current industry standards, adequacy of past welding practices and installed welds, primary system pressure boundary susceptibility to intergranular stress corrosion cracking, safety-related instrument sensing line installation (i.e., slope, separation, material, fabrication, etc.), piping wall loss due to erosion-corrosion, safety-related qualification of past and present piece part procurements, and capability of electrical switchgear to mitigate safe shutdown design basis events. These programs resulted in a large number of plant modifications to improve nuclear safety, which were delineated in the Nuclear Performance Plan, Volume III (Browns Ferry); (TVA, 1988).

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

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

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

No substantial non-radioactive waste was generated as a result of recovery of Units 2 and 3, although at the conclusion of the work, one site temporary office building was demolished and placed in the site land fill. Radioactively contaminated waste generated during the recovery work was shipped to the permanent low-level waste repository in Barnwell, South Carolina; these materials (predominantly steel and other fabricated metals) resulted from control rod drive changeout, reactor recirculation piping replacement, cleanout of miscellaneous parts and pieces stored in the spent fuel pool, and various C-zone activities (booties, gloves, tape, rags, etc.). It is anticipated that recovery and restart of Unit 1 would have similar environmental consequences.

2.4.2.1 Restart of Unit 1

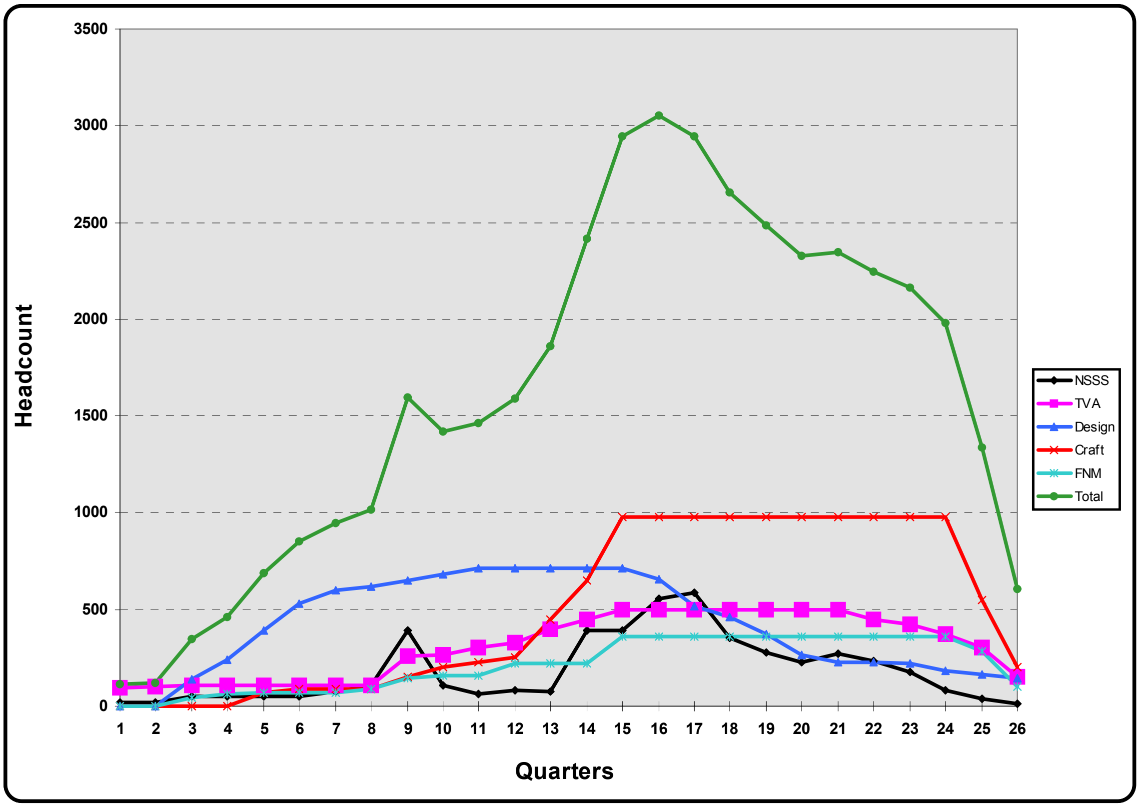
Recovery of Unit 1 for restart would be a substantial operation involving a large workforce over a time span of 5.5 years. The total number of workers (crafts, field supervisors, engineers, and managers) would peak at approximately 3,000, but some of these would remain at their parent company offices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

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

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

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

Figure 2.4-2 Browns Ferry Unit 1 Recovery Staffing Plan



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

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

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

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

Table 2.4-1 Hardware Impacts Associated with Unit 1 Recovery	
Physical Change	**Disposal Consideration**
[1]Pipe replacement	scrap steel (some contaminated)
Piping hangars and supports	scrap steel (some contaminated)
[2]Control Rod Drive (CRD) replacement	contaminated scrap steel (from drywell)
[3]CRD Hydraulic Control Unit refurbishment	scrap metal
RHR pump impeller replacement	contaminated scrap steel
RHR Service Water pipe loop replacement	scrap steel
Possible Rx Vessel Internals repair/replace.	scrap metal (low level radioactive waste)
Possible Shroud Head Bolt replacement	contaminated scrap steel
Turbine Generator refurbishment	contaminated misc. maintenance materials
Miscellaneous valve replacements	scrap steel (some contaminated)
Generator Field upgrade	misc. wiring & conductor supports
Ampacity Study cable replacements	scrap cable (some abandoned in place)
Shutdown Buswork Cabling upgrade	scrap cable
Bus Tie Board/Cooling Tower cable replace.	scrap cable
Inter-Unit DG Bus Tie cable replacement	scrap cable
Chemical decontamination of piping	mixed chemical waste
Low Power Range Monitor upgrade	scrap contaminated cables and connectors
Power Range Neutron Monitor upgrade	scrap detectors (low level radioactive waste)
High Pressure Coolant Injection upgrade	scrap instruments & controls, piping & hangars
Traveling In-core Probe logic upgrade	scrap switches & controls (possibly contaminated)
Control Rod Blade (possible) changeout	scrap metal components (high level rad waste)
Feedwater Nozzle Thermal Monitor upgrade	contaminated scrap steel, wiring & connectors
Feedwater Control upgrade to digital	scrap instruments & controls
Rx Fdwtr Pump min. flow valve replacement	contaminated scrap steel and connectors
Refueling bridge control replacement	scrap instruments & controls
Recirculation Flow Control upgrade to digital	scrap instruments & controls
ECCS Suction Strainer replacement	contaminated scrap steel
Main Steam Ruggedness upgrades	scrap steel

Table 2.4-1 (continued) Hardware Impacts Associated with Unit 1 Recovery	
Physical Change	**Disposal Consideration**
Main Steam Tunnel cooling system upgrade	misc. scrap equipment (potentially contaminated)
Moisture Separator Level Control upgrade	misc. scrap equipment (potentially contaminated)
Electrohydraulic Control electronics upgrade	scrap instruments & controls
Possible Main Bank Transformer replacement	scrap steel and conductors (mineral oil insulated)
4kV Breaker replacement (new Siemens units)	scrap steel and conductors
Load Sequence Timer replacement	scrap controls
Load Shed Logic upgrade	scrap controls
Generator Breaker upgrade	scrap steel and conductors

[1]Pipe replacement involves those portions of various plant systems which are susceptible to inter-granular stress corrosion cracking, including the suction, discharge, risers, and ring header of the reactor recirculation piping; reactor water clean-up system (RWCU); core spray system; and residual heat removal (RHR) system. Included in this effort is re-routing of the RWCU piping to allow the RWCU pumps to operate at lower temperatures.
[2]CRD replacement scope includes replacement of the existing 185 Boiling Water Reactor (BWR)-4 drives with new upgraded BWR-6 drives.
[3]For the CRD Hydraulic Control Unit refurbishment, the scram valves and scram pilot valves will need to have rubber parts replaced because of shelf life considerations and some accumulators will need to be replaced due to pitting corrosion.

2.4.2.2 New Administration Building

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

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

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

2.4.2.3 Power Transmission System Impacts

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

2.5 Summary of Proposed Alternatives

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

Table 2.5-1 Summary of BFN Unit Attributes

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

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

2.6 Comparison of Environmental Consequences

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

2.6.1 Comparison by Resource

AIR RESOURCES

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

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

GEOLOGIC SETTING

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

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

SOLID WASTES MANAGEMENT AND PAST PRACTICES

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

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

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

HAZARDOUS WASTES MANAGEMENT AND PAST PRACTICES

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

Construction activities associated with Unit 1 restart would temporarily increase rates of hazardous waste generation due to the increased use of solvents and paint related materials necessary for refurbishment. The existing TVA process for management of this type of waste is adequate to handle the expected increase. Once operational, hazardous waste generated as a result of operation of Unit 1 would be within the normal year to year variation currently experienced.

SPENT FUEL MANAGEMENT

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

SURFACE WATER RESOURCES

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

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

GROUNDWATER RESOURCES

There are no adverse impacts to groundwater resources associated with the Alternative 1 upgrade scenario. Activities potentially affecting groundwater resources would include foundation treatment, excavation, and grading associated with Alternative 2 facilities. Excavations which penetrate the water table may require temporary construction dewatering. Any groundwater drawdown impacts associated with plant construction dewatering would be temporary and of negligible magnitude due to the limited excavation depths, the relatively short duration of facility construction, and the distance of neighboring wells.

Excavation and grading associated with construction of the proposed facilities would result in permanent displacement of shallow soils above the water table (e.g., the proposed berm relocation sites). However, the long-term impact of these activities on groundwater resources would be negligible for all facility configurations given the limited depth and area of disturbance. Although permanent local impacts to groundwater levels and movement might be experienced from foundation treatment, the long-term impacts of these activities on groundwater resources would be negligible for the proposed cooling tower configurations given the limited area of disturbance. Potential contaminant releases (e.g., fuels, oils, and solvents), during construction activities, would be averted by careful handling and proper disposal of potential contaminants according to BMP guidelines. No adverse impacts to groundwater resources are anticipated from operation and maintenance of new facilities associated with Alternative 2 for the project. No adverse groundwater use impacts are anticipated from any of the identified alternatives.

FLOODPLAINS AND FLOOD RISK

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

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

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

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

TERRESTRIAL ECOLOGY

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

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

AQUATIC ECOLOGY

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

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

THREATENED AND ENDANGERED SPECIES

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

WETLANDS

No wetlands occur on any portion of the sites proposed for construction and excavation or disposal of spoil materials. Therefore there would be no impacts or effects upon wetlands in the proposed project area.

SOCIOECONOMIC CONDITIONS

No Action Alternative

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

Alternative 1

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

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

Alternative 2

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

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

TRANSPORTATION

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

SOIL AND LAND USES

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

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

VISUAL RESOURCES

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

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

RECREATION

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

CULTURAL RESOURCES

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

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

ENVIRONMENTAL NOISE

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

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

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

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

PUBLIC AND OCCUPATIONAL SAFETY & HEALTH

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

RADIOLOGICAL IMPACTS

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

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

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

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

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

DECOMMISSIONING IMPACTS

If the decision is made to extend operation of only Units 2 and 3, decommissioning would probably not be initiated for Unit 1 until cessation of all site power operations. Instead, Unit 1 would likely remain in its current non-operable status until any renewed licenses expire or a subsequent decision is made to recover and restart the unit. If Unit 1 is restarted, Unit 1 would join Units 2 and 3 in extended operation for an additional 20 years past expiration of the current licenses. Therefore, under either Action Alternative, decommissioning would be delayed by the 20-year license renewal period, providing an opportunity for decommissioning technology (including more advanced robotics) and the licensing framework to evolve and mature. In addition, it becomes more likely that a permanent spent fuel repository would be available prior to completion of decommissioning.

2.6.2 Comparison by Alternative

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

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

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

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

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

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

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

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

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

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

2.7 Comparison of Costs Between Alternatives

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

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

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

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

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

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

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

2.8 The Preferred Alternative

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

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

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

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

2.9 References

Baxter, D. S. and J. P. Buchanan. 1998. Browns Ferry Nuclear Plant thermal variance monitoring program final report. Tennessee Valley Authority, Resource Group, Water Management, Norris, TN. 54pp.

Dycus, D. L. and D. L. Meinert. 1993. Reservoir monitoring, monitoring and evaluation of aquatic resource health and use suitability in Tennessee Valley Authority reservoirs. Tennessee Valley Authority, Water Resources, Chattanooga, Tennessee, TVA/WM-93/15.

Lin, F. and G. E. Hecker. "3-D Numerical Model of Thermal Discharge from Browns Ferry Nuclear Plant." Alden Research Laboratory, Inc., Holden, Massachusetts, to be published 2002.

NRC 1996; 1999.

Smith, B T. and P. N. Hopping. "2001 Hydrothermal Survey for Browns Ferry Nuclear Plant." Report No. WR202-4-67-134, Tennessee Valley Authority, River System Operations & Environment, River Operations, to be published 2002.

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