CHAPTER 9

ALTERNATIVES TO THE PROPOSED ACTION

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9.0 ALTERNATIVES TO THE PROPOSED ACTION

The proposed action is the U.S. Nuclear Regulatory Commission (NRC) issuance of a combined construction and operating license (combined license) to Duke Energy for the Lee Nuclear Station, in Cherokee County, South Carolina. This action includes the construction and operation of the Lee Nuclear Station and its associated support facilities, including electric transmission lines to connect the Lee Nuclear Station to the Duke Energy transmission system.

Chapter 9 describes the alternatives to construction and operation of new nuclear units at the Lee Nuclear Site and alternative plant and transmission systems. The descriptions provide sufficient detail for the reader to evaluate the effects of these alternative generation options or plant and transmission systems relative to those of the proposed action.

The chapter is divided into four sections:

- No-Action Alternative (Section 9.1)
- Energy Alternatives (Section 9.2)
- Alternative Sites (Section 9.3)
- Alternative Plant and Transmission Systems (Section 9.4)

9.1 NO-ACTION ALTERNATIVE

9.1.1 INTRODUCTION

The purpose of this section is to examine the consequences should Duke Energy, for whatever reason, not build the Lee Nuclear Station and no other action is taken, hereafter referred to as the "no-action" alternative. To be precise, as directed by NUREG-1555, the no-action alternative means the following:

- the facility is not built and no other generating facility would be built,
- there is no other generation purchase strategy implemented to take the facility's place,
- there are no additional conservation measures that could be enacted to decrease the amount of electrical capacity that would otherwise be required.

Simply put, the output of the proposed generating facility would not become available to either Duke Energy or the region's electrical system. However, as proposed by NUREG-1555, the no action alternative does leave open the potential for either power-reduction measures or purchase power from other suppliers.

This review of the no-action alternative has five components, all discussed in the following subsections of this report. First, there is the initial consideration of exactly what happens to the electric supply/demand balance should the facility not be built and no other action taken. Next, given that Duke Energy is a regulated provider of electric services in North Carolina and South Carolina, there is the consideration of Duke Energy's regulatory and statutory consequences from such an alternative. Third, there is the consideration of what happens, from an energy supply perspective, to the Duke Energy electric system and its customers if the no-action alternative be taken. Fourth, there is the consequence of what should occur to regional energy supplies given the no-action alternative, and finally, what happens with respect to environmental impacts given the no-action alternative.

9.1.2 DUKE ENERGY'S SUPPLY – DEMAND ENERGY BALANCE ASSUMING NO-ACTION ALTERNATIVE

This section presents data relating the consequences of the no-action alternative with respect to Duke Energy's electric supply-demand balance. The need for this facility has been documented and thoroughly demonstrated in Chapter 8. Consequently, based on current and future electric supply and customer demand within Duke Energy's service areas, there is a demonstrated need for the electric output from this or a similar generation source in Duke Energy's franchise service areas. In addition, as discussed in Section 8.4, the demonstrated need for power is for power produced by a baseload facility such as the proposed Lee Nuclear Station.

Given this demand forecast, there are a number of implications should the Lee Nuclear Station not be built and no other actions taken in response. The first and most obvious is that the load projected to be served in the Duke Energy service territory from the unit would not be served and Duke Energy will experience a shortage of energy and capacity.

Referring to Table 8.2-1, Duke Energy's expected peak is forecasted to be approximately 21,000 MW in the 2016-2018 timeframe and its expected energy consumption approximately 107,000 –

110,000 GWh. The output of the Lee Nuclear Station (at an assumed 90 percent capacity factor) would be expected to provide almost 11 percent of the projected capacity need and 16 percent of the projected energy need.

Duke Energy's current future electric service forecasts and the resources necessary to maintain its reserve margin requirement (Section 8.1.4) are reflected in Table 8.2-1. Table 8.4-2 shows the proposed additional generating units. Assuming the proposed 800 MW Cliffside coal unit and the proposed peaking intermediate units shown in Table 8.4-2 are built, and that the Lee Nuclear Station is not built, then Duke Energy would fail to meet its 17 percent planning reserve margin in the summer of 2018. For example, Duke Energy's projected peak demand for the summer of 2018 is 21,643 MWs (Table 8.2-1). A 17 percent reserve margin represents 3700 MWs. To the extent the Lee Nuclear Station was planned as part of the overall resource mix to meet the 17 percent reserve margin but does not materialize, Duke Energy's reserve margin would drop to 7 percent. At this point in time, absent any other alternative, Duke Energy would not have met its 2018 target planning reserve margin. Should this occur without mitigation, Duke Energy would be in danger of being in breach of its statutory obligation to provide adequate and reliable electric service in its North and South Carolina service areas.

9.1.3 STATUTORY AND REGULATORY CONSEQUENCES ASSUMING NO-ACTION ALTERNATIVE

Given the fact that the need for this electric supply in Duke Energy's franchise service area has been demonstrated in Chapter 8, the next question to consider is what are Duke Energy's obligations with respect to the provision of this electric service? As discussed in Section 8.1.2 Duke Energy has both statutory and regulatory responsibilities in both North and South Carolina to provide adequate and reliable electric service in its franchised service areas. For example, the North Carolina General Statutes declare that North Carolina Utilities Commission (NCUC) has the authority to regulate electric utilities in accordance with the policy of the state which provides:

> § 62- 2(a) ... it has been determined that the rates, services and operations of public utilities as defined herein, are affected with the public interest and that the availability of *an adequate and reliable supply of electric power* ….. to the people, economy and government of North Carolina is a matter of public policy. (emphasis added)

Similarly, South Carolina Code of Laws (Reference 1) requires that Duke Energy has an obligation to provide adequate and reliable electric service to all customers in its service area under the following state law:

> Section 58-27-1510. Service shall be adequate, efficient and reasonable. *Every electrical utility shall furnish adequate, efficient and reasonable service.* (emphasis added)

PSCSC rules reiterate this requirement (Reference 2) that Duke Energy provide adequate and reliable electric service to all customers in its service area under the regulatory rules.

Based on these service obligations under the laws governing the states of North Carolina and South Carolina, Duke Energy has an obligation to provide adequate and reliable electric service to its customers in its franchise service areas in both states. If Duke Energy took the no-action alternative, as demonstrated in Subsection 9.1.2, Duke Energy by 2018 would face both energy and capacity shortages. *Therefore, for Duke Energy to retain its franchise service rights in North Carolina and South Carolina, it must provide adequate and reliable electric service to meet its* *future electric demand, and, as will be demonstrated later in this chapter, the only viable option to meet these statutory obligations requires the construction of the Lee Nuclear facility or an equivalent regulatory acceptable electric supply option*.

Given this situation, there are only three alternatives available to the Duke Energy to meet its North Carolina and South Carolina statutory obligations to provide adequate and reliable electric service. The first option would be the construction by Duke Energy of a similar but different baseload facility, an option considered in Subsection 9.2.2 but not an option considered under the "no-action alternative". A second option would be some modifications to Duke Energy's current system or customer demands sufficient to "make-up" for the un-built facility (discussed in Subsection 9.1.4 below). A third option would be for Duke Energy to obtain purchased power from other utilities or suppliers (discussed in Subsection 9.1.5 below). As will be demonstrated in the sections below, these latter two alternatives are also not viable alternatives to the proposed generating facility.

9.1.4 REGIONAL ELECTRIC SUPPLY CONSEQUENCES ASSUMING NO-ACTION ALTERNATIVE

The no-action alternative as defined in Subsection 9.1.1 is taken here to mean that the facility is not built, and no other facility would be built or other strategy implemented to take its place. This would mean that the electrical capacity to be provided by the project would not become available. The no-action alternative also presupposes that no additional conservation measures would be enacted to decrease the amount of electrical capacity that would otherwise be required.

As discussed in Subsection 8.3.2, the capacity margin projections include the planned addition of 37,000 MWs of capacity in the Southeast Electric Reliability Council (SERC) Region, indicating a need for additional generation to maintain acceptable capacity reserve margins across the region. In and of itself, assuming other states in the SERC region required similar reserve margin, this level of reserves in the SERC region would indicate that Duke Energy would not likely be able to purchase, on a long-term basis, any baseload capacity from other potential suppliers in the SERC region. Consequently, Duke Energy would have to buy short term power if it is available. Assuming short term power is available in the region, hour to hour, its costs can be $100 to 200 per MWH. The cost to replace all of the nuclear energy based upon an average of $150/MWH could exceed $1 billion per year. Given this situation, as discussed in Subsection 9.1.2, Duke Energy would face energy and capacity shortages and Duke Energy would have no choices other than to buy power at prevailing wholesale market rates or implement rolling blackouts for customers In addition, although Duke Energy has agreements in place with neighboring utilities for emergency power, the provisions are to use this power for true emergencies, not as a remedy for failure to build adequate generating resources. If emergency energy were not available, Duke Energy would have no option other than to face rolling blackouts.

There are additional regional effects. Duke Energy plans generation capacity additions to meet three reserve margin requirements - 1) long term reserve margin requirements, 2) contingency reserve requirements and 3) reactive reserve requirements. The long term planning reserve margin requirement of 17 percent, which is a state regulatory supported requirement, is discussed in Subsection 8.1.4. To the extent the Lee Nuclear Station were planned as part of the overall resource mix to meet the 17 percent reserve margin but does not materialize, Duke Energy's reserve margin would drop to 7 percent. From a long term generation reserves requirement, if another large unit is out of service or if load is above forecast, Duke would not be able to meet its load at times of peak demand. It would need to implement load reductions in some fashion to maintain viable operation.

With respect to the contingency reserve requirement, as a member of the SERC Reliability Region and the VACAR sub-region within SERC, Duke Energy has several reliability agreements with the other VACAR members including an agreement to share generation reserves. (Reference 3) Under the agreement Duke Energy has a commitment under SERC implementation of the Federal Power Act (16 U.S. C. Chapter 12) to provide its proportionate share of 1.5 times the largest generating resource in VACAR. This value changes annually. Presently, Duke's share is 515 MW of contingency reserves to VACAR.

Contingency reserves of this nature serve a different purpose than that of the reserve margin. Contingency reserves are reserves that must be made available within fifteen minutes of a VACAR system need usually brought about by the loss of a large generation unit within VACAR[1]. While nuclear unit capacity would not serve as contingency reserve, it makes other generation available to serve as contingency reserve as that generation is unloaded and available in a capacity emergency. If Duke has insufficient baseload generating reserves, all of its generation capacity will be employed to serve load at times of high system demand and no generation will be available to come on line in the event of the loss of a generation unit within VACAR.

Additionally, not all generating units are suitable to provide contingency reserves. The contingency reserve units must be able to ramp their output quickly. Because of the need for rapid start-up or ramp-up, baseload units, which generally require an extended start-up and ramp-up and are typically operated at full output, are not suitable. If the Lee Station is not built, then more non-baseload units must be utilized to meet load thus depleting the inventory of units suitable for supplying contingency reserves. Absent the construction of the Lee Nuclear Station or similar resources, Duke Energy may not have adequate contingency reserves to meet its VACAR reserve sharing obligations.

Should Duke/VACAR lack sufficient contingency reserves, it puts the reliability of the grid in jeopardy. Any system that cannot supply short term contingency reserves is susceptible to cascading blackouts. If a system loses a large generating unit and cannot replace its output within fifteen minutes, the system becomes highly stressed. Frequency will decline, transmission lines may become overloaded and relays may operate to protect those lines. Under-frequency relays may actuate to remove load from the system. These are the initial steps of every major cascading blackout since 1965. Some systems avert blackouts at this point. Others continue into a chaotic disaggregation of the system. The provision of contingency reserves is critical to system reliability. This is why, on June 18, 2007, the NERC Reliability Standards became mandatory and enforceable under provisions of the Energy Policy Act of 2005. These standards

1. Contingency reserves are reserves that can be brought on line quickly to avoid a cascading blackout. When a system loses a large generation unit, operators must act quickly to replace it. The situation is much different than that of growing load and the potential inability to balance load with generation at a later hour in the day. These load balancing situations allow time to purchase generation, make public appeals or plan rotating blackouts. In the case of the sudden loss of generation, operators must respond within minutes and typically utilize predetermined procedures, one of which is to have in place and call upon contingency reserves.

make the provision of contingency reserves mandatory. The requirements are detailed in NERC Reliability Standard BAL-002-0. (Reference 4)

With respect to reactive reserves, there are reliability ramifications beyond the effects of not serving Duke territorial load or meeting contingency reserves. These reliability implications impact Duke, VACAR and SERC. To explain, all load on an AC power system has two components: real power load (conventional load) and reactive load (VARS). The real power load is addressed in load forecasts. Typically, if one builds generation to meet real power load, the reactive power load will be met as AC generators are an excellent source of reactive power. Reactive power is needed to maintain the proper voltage schedule on the AC system. The danger of not meeting reactive load can be greater than the perils of not meeting real power load. This is exacerbated by the fact that substitute reactive power cannot be shipped effectively over AC transmission lines. In fact, purchased power usually consumes more reactive power than it can provide further exacerbating the situation.

The lack of reactive power to meet reactive load requirements means that voltage profiles will be lower than desired. Lowered voltage profiles coincident with system contingencies (as they do occur daily) can lead to even lower voltage profiles, which eventually lead to more VAR consumption on transmission lines which lead to a downward spiral effect causing cascading blackouts and the domino effect seen in all of the other major blackouts that have occurred since the Northeast Blackout in 1965. The single most important asset in preventing major cascading blackouts is reactive power from generating units on Automatic Voltage Regulation. FERC has implemented through NERC, mandatory and enforceable Reliability Standards effective June 18, 2007, addressing both reactive reserve requirements (Reference 5) and automatic voltage regulation requirements (Reference 6).

If Duke Energy was to not build the Lee Nuclear Station for whatever reason and take no other action, it would likely be in violation of these federally mandated Reliability Standards. Violation of NERC Reliability Standards is subject to a maximum fine of $1,000,000 per day per violation.

Based upon regional system reliability requirements, the no action alternative is not acceptable, in light of the fact that Duke Energy has no alternative but to comply with its contingency and reactive reserve commitments, which, under current load forecasts, will require the construction of the Lee Nuclear Station or resources with equivalent capacity.

9.1.5 ENVIRONMENTAL CONSEQUENCES ASSUMING NO-ACTION ALTERNATIVE

Under the No-Action Alternative the environmental impacts described in Chapters 4 and 5 would not occur. However, the electric demand would have to be met by some other generation source, even if this power was purchased from another utility. This alternative has implications in terms of both environmental and monetary costs. With no marked change in diversity of fuel supply, the regional supply portfolio would remain heavily dependent on coal and natural gas. Under this scenario, the region might be adversely affected by increased air pollutants and increased fuel costs. The environmental impacts of increased electric generation using coal or gas are discussed in Subsection 9.2.3.

9.1.6 REFERENCES

1. South Carolina, Code of Laws, Title 58, Public Utilities, Services and Carriers, http://www.scstatehouse.net/code/titl58.htm

2. South Carolina Code of Regulations, Chapter 103, Public Service Commission, http://www.scstatehouse.net/regs/103.doc

3. Operating Manual for the VACAR Reserve Sharing Agreement

4. NERC Reliability Standard BAL-002-0 http://www.nerc.com/~filez/standards/Reliability_Standards.html

5. NERC Reliability Standard VAR-001 Requirement 2 http://www.nerc.com/~filez/standards/Reliability_Standards.html

6. NERC Reliability Standard VAR-002-1Requirement 1 http://www.nerc.com/~filez/standards/Reliability_Standards.html

9.2 ALTERNATIVE ENERGY SOURCES

The purpose of this section is to explore alternative electric energy sources rather than completing the construction of the proposed nuclear facility. As directed by NUREG-1555, there are essentially three options that can be explored in this alternative. First are alternatives not requiring new generating capacity, examined in Subsection 9.2.1. Second are alternatives requiring new generation, examined in Subsection 9.2.2. Third are competitive market options, considered in Subsection 9.2.3.

While there are several potential sources for electric service in lieu of the proposed generating facility, there are several fundamental decision criteria that these potential sources must meet in order to be equivalent in energy supply to the proposed facility and in order to satisfy the regulatory and statutory obligations under which Duke Energy must plan and build its electric supply resources. These decision criteria include:

1. Regulatory acceptability - The proposed alternative must be acceptable to Duke Energy's utility commissions in North Carolina and South Carolina,

2. Baseload equivalent - The alternative electric resource must be equivalent to a baseload resource in terms of both supply availability (both amount of energy, capacity, and timing of availability) and reliability (the need for this type resource was demonstrated in Subsection 8.4), and

3. Risks avoidance - The alternative must not introduce supply risks, such as marginal or uncertain transmission capability, uncertainty of fuel supplies, insufficient or uncertain financial capabilities of the potential supplier, unknown or uncertain capabilities of the potential supply resource, or any other risk or uncertainty.

These decision criteria will be used, in part, along with criteria established by NUREG-1555, to evaluate the alternative resource options explored in this chapter.

9.2.1 ALTERNATIVES NOT REQUIRING NEW GENERATING CAPACITY

NUREG-1555 directs this subsection of the Environmental Report to examine the "economic and technical feasibility of (1) supplying the electrical energy from the proposed plant without constructing new generating capacity, or (2) initiating energy conservation measures that would avoid the need for the plant." While there are several potential sources for electric service in lieu of the proposed generating facility, any acceptable option must meet the criteria established in the introduction to this section. As directed by NUREG-1555 there are three basic options to consider in this subsection, (1) power purchases, (2) plant reactivation or extended service life, and (3) conservation. All three alternatives are explored below.

Purchased Power

NUREG-1555 directs the analysis of alternatives to the Lee Nuclear Station to evaluate the potential of a purchase power option. As discussed in Chapter 8, projected demand in the SERC Region exceeds current generation capacity. Consequently, there is a low likelihood that baseload power would be available under a purchase agreement. Furthermore, as discussed in Subsection 8.1.4, the risk that purchased power could be terminated for a variety of reasons is not an acceptable business risk to Duke Energy. Therefore, Duke Energy does not rely upon purchase power for baseload needs. This option fails the “baseload equivalent” business criteria established in the introduction to this subsection. It is also likely that such an option would be unacceptable to state utility regulators as it might present risks and uncertainties to the long-term supply of power to Duke Energy’s service area, violating both the “regulatory acceptability” and the “unacceptable risks” criteria established in the introduction.

As noted in Subsection 8.1.4, the NCUC supported Duke Energy’s policy of not using generation sources from outside its service area for baseload generation in the approval of Duke Energy’s Integrated Resource Plan (IRP) (p. 29). In the Order Approving Integrated Resource Plans And Requiring Additional Information In Future Reports, Docket No. E-100, Sub 103, August 31, 2006 (Reference 1), in a discussion about future nuclear and fossil fuel generating plants, the NCUC held;

> *“Using power generated in other states in place of power generated in North Carolina would not result in any major reduction in electric usage or in any meaningful environmental benefits and would have at least one serious adverse affect.* During periods of peak consumption, the state’s utilities might have to pay extremely high rates to purchase power from other utilities; in some case they may be unable to import sufficient power at all because of the limitations of the transmission system or for other reasons. Consequently, a policy prohibiting the construction of all nuclear and fossil-fired plants may create risks of both excessive electric rates and unreliable service. Such a policy would contravene G.S. 62-2(a)(3), which provides that a primary purpose of utility regulation is “[t]o promote adequate, reliable, and economical utility service to all of the citizens and residents of the State.” (emphasis added)

Conclusion: Purchase power is not an acceptable option to replace the need for the Lee Nuclear Station.

Reactivation or Life Extension of Existing Plants

NUREG-1555 directs the analysis of alternatives to the Lee Nuclear Station to evaluate the potential of a plant reactivation option in the “relevant region.” As demonstrated in Subsection 8.1, Duke’s relevant market area is its franchise service territory. Also, as discussed in the introduction to this subsection and in Subsection 8.1.4, (discussion entitled Regional Market Based Considerations), Duke Energy and its state utility commissions are reluctant to rely upon baseload generation from resources outside Duke Energy’s relevant market area. These considerations restrict the analysis, from a geographic perspective, to Duke Energy’s franchise service areas in North and South Carolina.

Duke Energy has received permission from the NRC to extend the life of its three existing nuclear stations, Oconee, McGuire, and Catawba. In addition, Duke Energy is seeking relicensing of the hydroelectric units with FERC licenses that would expire in the planning horizon. All generation listed in Tables 8.3-1, 8.3-2 and 8.3-3, other than those listed as scheduled for potential retirement as shown in Table 8.3-6, are included in Duke Energy’s resource planning process. The units scheduled for retirement are older single-cycle combustion turbines and old coal-fired units that meet intermediate and peaking needs, not baseload needs. Thus, even if these units were to be reactivated or their life extended, it would not impact the need for the Lee Nuclear Station. Reactivation of any of these older coal-fired units would initiate the application of new more stringent air emissions controls, thus adversely affecting the cost competitiveness of the units. No units are anticipated for retirement beyond 2017 at this stage of planning.

Conclusion: Within the relevant market area there is no known additional generating units that might be considered viable candidates for extended service or reactivation and thereby avoiding the need for the Lee Nuclear Station.

Potential for Supplying the Electrical Energy Through Conservation

NUREG-1555 requires the analysis of alternatives to the Lee Nuclear Station to evaluate the potential for conservation to replace the need for the proposed facility. As directed by NUREG-1555, “except for unusual circumstances, no additional review should be required to complete this portion of this ESRP, since the reviewers for ESRP (Subsection 8.2.2 and Section 8.4), in the process of analyzing and evaluating the need for the plant, should make a determination that conservation is or is not a practical alternative to the proposed plant.”

Given this direction, the review and evaluation of Duke Energy’s forecasting process and inclusion of conservation in this forecast was discussed in Subsection 8.2.2. The evaluation concluded that the forecast provided in the Duke Energy Carolinas Annual Plan (Integrated Resource Plan or IRP) properly incorporates demand-side options, energy efficiency, and fuel substitution, which was identified in NUREG-1555 as factors to consider in developing an electric energy forecast.

In addition, the need-for-power analysis presented in Subsection 8.4 concluded that the 2007 IRP suggested that a combination of additional baseload, intermediate and/or peaking generation and energy efficiency and demand response programs is required over the next fifteen years to reliably and cost effectively meet customer demand (Reference 3).

Duke Energy has increased its emphasis and financial commitment to conservation activities with a pledge to spend as much as 1% of its retail electric revenues in new energy efficiency and demand side programs (Reference 2).

The 2007 IRP documents the extensive demand-side and conservation activities (Reference 3). As shown in Table 8.3-12, the 2007 IRP resource plan includes projections of 1800 MWs and 2,237,258 MWHs of EE/DSM in addition to new renewable, coal, gas-fired, and nuclear generation (Reference 3). Despite aggressive efforts on EE/DSM, Duke is only projecting to obtain enough DSM equal to 12% of the Lee Nuclear Station output (Reference 3).

Conclusion: Duke Energy has a strong commitment to energy conservation and has properly accounted for these type activities in its energy resource plan. As such, there are no additional energy conservation activities that could be employed and offset the need for the Lee Nuclear Station.

9.2.2 ALTERNATIVES REQUIRING NEW GENERATING CAPACITY

NUREG-1555 directs this subsection of the Environmental Report to review the potential for alternative generation energy sources that could meet the demonstrated forecast demand from both a load and economic standpoint and thereby obviate the need for the proposed Lee Nuclear Station. As directed by NUREG-1555 there are three basic options to consider in this subsection, alternatives not yet commercially available, fossil fuels, taking into account national policy regarding their use as fuels, and alternatives uniquely available within the region. As directed by NUREG-1555, these options are categorized and evaluated in two distinct categories, (1) competitive -an option that is feasible and compares favorably to the proposed project in terms of environment and health impacts, (2) noncompetitive. Both categories are evaluated in this subsection.

In this evaluation, the capacity and energy requirements developed in Section 8.2 are used as a basis for the need for power. While there are several potential sources for electric service in lieu of the proposed generating facility, any acceptable option must meet the criteria, established in the introduction to Section 9.2. With respect to the “baseload equivalent” criteria, NUREG-1555 specifically agrees with and addresses this criteria in this subsection, stating that “If the proposed project is intended to supply base load power, a competitive alternative would also need to be capable of supplying base load power.” Therefore, any potential alternative generating resource must, as an initial criteria, be comparable to a baseload facility, while at the same time passing the additional business criteria of “regulatory acceptance” and no “unacceptable risks.”

Generation Alternatives Explored

As presented in Duke Energy’s 2007 IRP (Reference 3), data for a wide range of competitive technologies were explored.

The screening results performed in the preparation of the 2006 IRP (Reference 4) were reviewed and incorporated into the 2007 IRP. Of the eighty-eight potential supply-side technologies, some of the similar technology variants such as greenfield/brownfield, single rail/dual rail and single/multiple units were eliminated from those considered for further evaluation. In the 2006 IRP, the largest sizes of each technology were the lowest cost due to economies of scale, and the differences caused by the other variations were minor. The elimination of some of these variations allowed more time to concentrate on ensuring consistency of treatment across the technologies. From this remaining subset, several were eliminated from further consideration. A brief explanation of the technologies excluded and the logic for their exclusion follows:

- Coal fired Circulating Fluidized Bed combustion is a conventional commercially proven technology in utility use. However, boiler size remains generally limited to the 300-350 MW. In addition, the new source performance standards (NSPS) generally dictate that post-boiler clean-up equipment must be installed to meet the standards when burning coal, which effectively eliminates one of the advantages of this technology. Both of these issues cause it to be one of the higher-cost baseload alternatives available on a utility scale.

- Advanced Battery storage technologies remain expensive relative to conventional technologies and are suitable for small scale emergency back-up and/or power quality applications with short-term duty cycles of three hours or less. In addition, the current energy storage capability is 100 MWh or less. Research, development, and demonstration continue, but this technology is generally not commercially available on a larger utility scale.

- Compressed Air Energy Storage (CAES), although demonstrated on a utility scale and generally commercially available, is not a widely applied technology. This is due to the fact that suitable sites that possess the proper geological formations and conditions necessary for the compressed air storage reservoir are relatively scarce. There are no viable sites in the Duke Energy Carolinas service area to support the application of this technology.

- Fuel Cells, although originally envisioned as being a competitor for combustion turbines and central power plants, are now targeted to mostly distributed power generation systems. The size of the distributed generation applications ranges from a few kilowatts to tens of megawatts in the long-term. Cost and performance issues have generally limited their application to niche markets and/or subsidized installations. While a medium level of research and development continues, this technology is not commercially available for utility scale application.

Below is a listing of the technologies screened and placed into general Conventional and Demonstrated category classes:

Conventional Technologies (technologies in common use):

<u>Base Load Technologies</u>

800 MW class Supercritical Coal (Greenfield)

2-1117 MW Nuclear units, AP1000

<u>Peak / Intermediate Technologies</u>

4-160 MW Combustion Turbines – GE 7FA

460 MW Unfired + 120 MW Duct Fired + 40 MW Inlet Chilling Combined Cycle – 7FA

Demonstrated Technologies (technologies with limited acceptance and not in widespread use):

<u>Base Load Technologies</u>

630 MW class IGCC (Brownfield)

In addition, the following renewable options were considered as demonstrated technologies:

- Wind
- Biomass
    - Biomass Firing
    - Poultry Waste Firing
    - Digester Biogas Firing
    - Hog Digester Biogas Firing
- Solar

- Landfill Gas

Additional information on these demonstrated technologies is presented below:

Integrated Gasification Combined Cycle (IGCC)

Integrated Gasification Combined Cycle (IGCC) is an emerging, advanced technology that combines modern coal gasification technology with both gas turbine and steam turbine power generation. Compared to conventional pulverized coal plants, the technology is substantially cleaner because major pollutants can be removed from the gas stream prior to combustion.

The IGCC process generates much less solid waste than the pulverized-coal-fired alternative. The largest solid waste stream produced by IGCC installations is slag, a sand-like marketable byproduct. Slag production is a function of the fuel ash content. The other large-volume byproduct produced by IGCC plants is sulfur, which is extracted during the gasification process and can be marketed rather than placed in a landfill. IGCC units do not produce ash or scrubber wastes.

Today's IGCC technology still needs operating experience for widespread expansion into commercial-scale, utility applications. Each major component of IGCC has been broadly utilized in industrial and power generation applications. But the joining of coal gasification with a combined cycle power block to produce commercial electricity as a primary output is relatively new. This has been demonstrated at only a handful of facilities around the world, including five in the U.S. Experience has been gained with the chemical processes of gasification and the impact of coal properties on the IGCC areas of design, efficiency, economics, etc. Duke Energy Indiana received regulatory approval on November 20, 2007 to construct a 630 MW IGCC facility at its existing Edwardsport coal plant. IGCC was the preferred choice for Indiana based on the proximity to coal and the federal, state, and local incentives to construct the facility in Indiana. Those factors are not available in the Carolinas for IGCC.

Overall, experience with IGCC still shows generation costs more expensive than comparably sized pulverized coal plants, due in part to the coal gasifier and other specialized equipment.

Wind

Wind power systems produce power intermittently, depending upon when the wind is blowing at sufficient velocity and duration. Despite advances in technology and reliability, capacity factors for wind power systems remain relatively low (29 to 32 percent for North Carolina, Reference 14) compared to the 90 to 95 percent industry average for a baseload plant such as a nuclear plant. Therefore, wind power alone is not capable of producing baseload power, and is not a reasonable alternative by itself.

Biomass

Biomass combustion is a current significant energy source for electrical generation. Supplying almost 850 gigawatt hours (GWh) (2.9 quadrillion British thermal units [Btu] [quads]) of energy in 2003 (including municipal solid waste), it has surpassed hydropower as the largest domestic source of renewable energy. Biomass fired facilities generate electricity using available equipment and well-established technology. This energy is dispatchable on demand because it is combustion based.

The energy content of dry biomass ranges from 7000 Btu per pound (Btu/lb) for straws to 8500 Btu/lb for wood. However, the cost of switchgrass and other energy crops currently is almost twice the cost of coal on an energy basis. Furthermore, the lack of adequate infrastructure, along with transportation and handling costs, are primary obstacles when considering the economic and technical feasibility of this renewable energy source.

Most of the biomass fueled generation facilities in the U.S. use steam turbine conversion technology, and can accept a wide variety of biomass fuels. However, at the scale appropriate for biomass (the largest biomass power plants are 40 to 50 MW in size), the technology is expensive and inefficient. Biomass is much less dense than coal, requiring a greater volume of fuel to be handled per megawatt. Greater areas of biomass storage and additional handling are required to accommodate the lower-density materials. Therefore, the technology is relegated to more cost effective applications where there is a readily available supply of low-, zero-, or negative-cost delivered feedstocks.

Solar Technologies

There are currently two practical methods to produce electricity from solar energy: photovoltaic and solar thermal power. Photovoltaics ("solar cells") convert sunlight directly into electricity using semiconducting materials. Solar thermal power systems convert sunlight into electricity using heat as an intermediate step. These systems generate electricity from this heat with various methods. For this discussion, the different methodologies of nonphotovoltaic systems are grouped together.

Some solar thermal systems can also be equipped with a thermal storage tank to store heated transfer fluid. These solar thermal plants can then dispatch electric power on demand using this stored heat.

Solar technologies produce more electricity with more intense and direct sunlight. Cloudy days can significantly reduce output. To work effectively, solar installations require consistent levels of sunlight (solar insolation). The lands with the best solar resources are usually arid or semi-arid.

While photovoltaic systems use both diffuse and direct radiation, solar thermal power plants can only use the direct component of the sunlight. This makes solar thermal power less suitable for areas like the Southeastern U.S. with high humidity and frequent cloud cover, both of which diffuse solar energy and reduce its intensity. In addition, the average annual amount of solar energy reaching the ground needs to be 64 kWh per square foot per day (kWh/ft^2/day) or higher for solar thermal power systems. The Southeast receives an annual average of 32 to 43 kWh/ft^2/day of solar radiation.

Like wind, capacity factors are too low to meet baseload requirements. Average annual capacity factors for solar power systems are relatively low (24 percent for photovoltaics and 30 to 32 percent for solar thermal power) compared to 90 to 95 percent for a baseload plant such as a nuclear plant.

Land use requirements (and associated construction and ecological impacts) are also much greater for solar technologies than for a nuclear plant. The area of land required depends on the available solar insolation and type of plant, but is about 8 ac/MW for photovoltaic systems and 3.8 ac/MW for solar thermal power plants. Assuming capacity factors of 24 percent for photovoltaics and 32 percent for solar thermal power, facilities having a 2234 MW net capacity are estimated to require 74,467 ac. (116 sq. mi.), if powered by photovoltaic cells, and 26,529 ac. (41 sq. mi.), if powered by solar thermal power.

Landfill Gas

Under the NC GreenPower program, landfill methane projects qualify as a renewable resource. The methane production at waste landfill sites can be a valuable fuel for either direct thermal applications or for electricity generation. North Carolina is part of the EPA's Landfill Methane Outreach Program (LMOP) and is actively promoting the development of landfill gas-to-energy (LGTE) projects (Reference 14).

By way of background, seventeen LGTE projects are currently operating in North Carolina and several more are under consideration. Some of these projects are operating at closed sites while other sites continue to accept waste. North Carolina has six landfill gas projects that are generating electricity, totaling over 15 MW of capacity. Additionally, eleven other landfill projects currently consume the landfill gas directly for thermal applications.

The EPA estimates a total electric generation potential in North Carolina of around 60-70 MW. Reference 14 provides an estimate of 150 MW total generation capacity from 2008 through 2017. This capacity is insufficient to support baseload generation.

The Duke Energy resource model discussed in Subsection 8.4 considers various generating resources. Using decision criteria, similar to the criteria used by Duke Energy to dispatch power, the model selects and designates various resources to be installed and used as either baseload, intermediate, or peaking units. This assignment is based on the decision criteria, rather than a *prima facie* definition of the unit as baseload, intermediate, or peaking. The decision criteria are sensitive to economic and regulatory environments and may change from year to year as the model re-evaluates the appropriateness of the resource mix."

In the above list of generating alternatives Duke Energy considered, the only technologically feasible, baseload comparable alternative to the Lee Nuclear Station is the coal-fired facilities.

Conclusion: Duke Energy identified and evaluated a comprehensive set of alternative generation technologies, both fossil fuel and renewables, and properly concluded that only a coal-fired facility is a potential alternative to the Lee Nuclear Station that is acceptable from a regulatory and risk standpoint and can serve baseload needs. Therefore, Subsection 9.2.3 will assess this alternative resource.

9.2.3 ASSESSMENT OF COMPETITIVE ALTERNATIVE ENERGY SOURCES AND SYSTEMS

As discussed in Subsection 9.2.2, the only technologically feasible, baseload comparable alternative to the Lee Nuclear Station is the coal-fired facilities.

Duke Energy reviewed the NRC analysis of environmental effects from coal-fired generation alternatives in NUREG-1437 (Reference 5) and found it to be a reasonable description of impacts associated with this alternative energy source. Construction effects are substantial, due in part to the large land area required (which can result in natural habitat loss) and the large workforce needed. NRC pointed out that siting a new coal-fired plant where an existing nuclear plant is located reduces many construction effects. NRC identified major adverse effects from operations as human health concerns associated with air emissions, waste generation, and losses of aquatic biota due to cooling water withdrawals and discharges.

For purposes of this analysis, Duke Energy defined the pulverized coal-fired alternative as consisting of four conventional boiler units, each with a net capacity of 530 MW for a combined capacity of 2120 MW. This coal-fired alternative, for purposes of this analysis, is located at the proposed project site. Table 9.2-1 presents the assumed basic operational characteristics of the coal-fired units.

In a pulverized coal-fired generation system, pieces of coal are crushed between balls or cylindrical rollers. The crushed coal is then fed into the pulverizer along with air heated to about 650°F from the boiler. As the coal is pulverized to the consistency of talcum powder by the rolling action, the hot air both dries it and moves the usable fine coal powder to a burner in the boiler, where it is combusted.

The overall effects associated with the construction and operation of the coal-fired alternative using closed-cycle cooling are discussed in the following subsections and compared to the Lee Nuclear Station in Table 9.2-3.

9.2.3.1 Air Quality

The air quality effects of coal-fired generation vary considerably from those of nuclear generation due to emissions of SO2, NOX, particulates, carbon dioxide (CO2), hazardous air pollutants such as mercury, and naturally occurring radioactive materials.

Duke Energy assumed a plant design that minimizes air emissions through a combination of boiler technology and post-combustion pollutant removal. Duke Energy estimated the 2120-MW coal-fired alternative emissions as summarized in Table 9.2-2.

A new coal-fired generating plant needs to meet the new source review requirements in Title I of the Clean Air Act (Reference 6). The plant also needs to comply with the new source performance standards for new generating plants in 40 CFR 60, Subpart Da. The standards establish limits for particulate matter and opacity (40 CFR 60.42(a)), SO2 (40 CFR 60.43(a)), NOX (40 CFR 60.44(a)), and mercury (40 CFR 60.45Da). More stringent control for these and other criteria pollutants may be required under the BACT or LAER provisions as part of the New Source Review analysis, unless the project will net out of review through other reductions at the same facility.

EPA has various regulatory requirements for visibility protection in 40 CFR 51, Subpart P, including a specific requirement for review of any new major stationary source in an area designated as attainment or unclassified under the Clean Air Act. Section 169A of the Clean Air Act establishes a national goal of preventing future and remedying existing impairment of visibility in mandatory Class I federal areas when impairment results from air pollution caused by human activities. In addition, EPA issued new regional haze requirements in 1999 (64 FR 35713-35774). The requirements specify that state agencies must establish goals for reasonable progress toward achieving natural visibility conditions for each mandatory Class I federal area located within a state. The reasonable progress goals must provide for an improvement in visibility for the most-impaired days over the period of the implementation plan and ensure no degradation in visibility for the least-impaired days over the same period (40 CFR 51.308(d)(1)).

If a new coal-fired power plant is located close to a mandatory Class I federal area and is determined to have a significant impact, additional air pollution control requirements may be imposed.

A new coal-fired power plant is subject to the requirements in Title IV of the Clean Air Act. Title IV was enacted to reduce emissions of SO2 and NOX, the two principal precursors of acid rain, by restricting emissions of these pollutants from power plants. Title IV caps aggregate annual power plant SO2 emissions and imposes control on SO2 emissions through a system of marketable allowances. EPA issues an allowance for each ton of SO2 that a generating unit is allowed to emit: new units do not receive allowances but are required to have allowances to cover their SO2 emissions. Owners of new units must therefore acquire allowances from owners of other power plants by purchase or reduce SO2 emissions at other power plants they own. Allowances can be banked for use in future years. Thus, a new coal-fired power plant does not add to net regional SO2 emissions, although it might do so locally. Regardless, SO2 emissions are greater for the coal alternative than the proposed project alternative because a nuclear power plant releases almost no SO2 during normal operations.

EPA issued the Clean Air Interstate Rule (CAIR) in 2005 (70 FR 25162-25405). CAIR provides a federal framework requiring certain states to reduce emissions of SO2 and NOX. EPA anticipates that states achieve this reduction primarily by limiting emissions from the power generation sector. CAIR covers 28 eastern states, including South Carolina, and the District of Columbia. Any new fossil fuel fired power plant sited in South Carolina is subject to the CAIR limitations.

In 2005, EPA issued a final rule limiting mercury emissions from coal-fired power plants. Emissions are capped at specified, nationwide levels. A first-phase cap of 38 tons per year (Tpy) becomes effective in 2010 and a second-phase cap of 15 Tpy becomes effective in 2018. Plant owners must demonstrate compliance with the standard by holding one “allowance” for each ounce of mercury emitted in any given year. Allowances are transferable among regulated plants. Any new coal-fired power plant sited in South Carolina is subject to this rule. The new facility also has to meet regulatory levels under the latest EPA regulations.

Coal contains uranium and thorium. Uranium concentrations are generally in the range of 1 to 10 parts per million (ppm). Thorium concentrations are generally about 2.5 times greater than uranium concentrations. One estimate is that a 1000 megawatts electric (MWe) coal-fired plant had an annual release of approximately 5.2 T. of uranium and 12.8 T. of thorium in 1982. The population dose equivalent from the uranium and thorium releases and daughter products produced by the decay of these isotopes has been calculated to be significantly higher than that from nuclear power plants (Reference 7).

A coal-fired plant also has unregulated carbon dioxide emissions. Duke Energy Carolinas estimates that pulverized coal-fired plants sufficient to substitute for the power that is generated by the proposed project emit approximately 19 million Tpy of carbon dioxide (Reference 8).

During the construction of a coal-fired plant, temporary fugitive dust is generated. Exhaust emissions come from vehicles and motorized equipment used during the construction process. In addition, coal-handling equipment introduces fugitive particulate emissions.

The NUREG-1437 analysis did not quantify emissions from coal-fired power plants but implied that air quality effects are substantial. NUREG-1437 also identifies global warming from unregulated carbon dioxide emissions and acid rain from SOX and NOX emissions as potential effects. Adverse human health effects, such as cancer and emphysema, have been associated with the products of coal combustion.

Overall, the air quality effects associated with the 2120-MW coal-fired alternative are MODERATE.

9.2.3.2 Waste Management

Coal combustion generates waste in the form of ash, and equipment for controlling air pollution generates additional ash, spent selective catalytic reduction (SCR) catalyst, and scrubber sludge.

This coal-fired alternative facility, using coal having an ash content of 9.84 percent, consumes approximately 6,633,000 Tpy of coal. Particulate control equipment collects ±99.9 percent of this ash, approximately 652,000 Tpy.

Other types and amounts of waste include:

- Flue gas desulfurization sludge (gypsum): 1,137,478 Tpy.
- Raw water treatment sludges: 1160 Tpy.
- General water treatment sludges: 726 Tpy.

Portions of the ash and gypsum may be recycled. These by-product and waste streams are classified as non-hazardous, as determined by the Resource Conservation and Recovery Act (RCRA) toxicity characteristic leaching procedure.

Provision is made to store fly ash, bottom ash, and scrubber by-products on-site indefinitely. Duke Energy currently markets much of the ash and scrubber by-products to building product manufacturers and as makeup products for the construction industry. Water treatment sludges are disposed at a state-approved landfill, either on-site or off-site. Spent SCR catalyst is regenerated or disposed off-site. Waste effects to groundwater and surface water extend beyond the operating life of the plant if leachate and runoff from the waste storage area occur. Disposal of the waste noticeably affects land use and groundwater quality, but with appropriate management and monitoring, it does not destabilize any resources. After closure of the waste site and revegetation, the land is available for other uses.

In May 2000, EPA issued a “Notice of Regulatory Determination on Wastes from the Combustion of Fossil Fuels" (65 FR 32213-32237). EPA concluded that some form of national regulation is warranted to address coal combustion waste products. Accordingly, EPA announced its intention to issue regulations for disposal of coal-combustion wastes under Subtitle D of RCRA.

Debris is generated during construction activities on the coal-fired alternative units. Such debris is disposed of in landfills.

For the preceding reasons, the appropriate characterization of effects from waste generated from the coal-fired alternative is MODERATE.

9.2.3.3 Other Effects

Land - In NUREG-1437, the NRC staff estimated that approximately 1700 ac. are needed for a 1000-MW coal-fired plant. Duke Energy experience indicates that a 2120-MWe coal-fired plant requires approximately 2000 ac. This area includes land for the coal pile, a limestone pile, an ash and scrubber solids disposal area, and plant buildings and structures, but it does not include land for an associated coal mine, access road, and railroad spur.

NUREG-1437 estimated that approximately 22,000 ac. of land are affected for mining the coal and disposing of the waste to support a 1000-MW coal-fired plant during its operational life. A replacement 2120-MWe coal-fired plant to substitute for the proposed project affects approximately 46,640 ac. of land.

Construction of the alternative permanently changes the land use at the site, and most likely involves an irretrievable but moderate loss of forest land and/or farmland. No significant effects to plant site soils are anticipated because of the use of erosion control practices during and following construction.

The effect of the coal-fired alternative on land use is best characterized as SMALL, similar to the proposed project.

Ecology - The coal-fired generation alternative introduces construction effects and new incremental operational effects. Even assuming siting at a previously disturbed area, the effects alter the ecology. Ecological effects to a plant site and utility easements include effects on threatened or endangered species, wildlife habitat loss, reduced wildlife reproduction, habitat fragmentation, and a local reduction in biological diversity. Use of cooling makeup water from a nearby surface water body has adverse aquatic resource effects. If needed, maintenance of a transmission line and a rail spur has ecological effects. There are effects to terrestrial ecology from cooling tower drift. Overall, the ecological effects are SMALL, similar to the proposed project.

Water Use and Quality - Construction of each power station (including access roads) affects surface water hydrology, but sites are chosen to avoid extensive site excavation, filling, or grading. New construction disturbs the land surface, which may temporarily affect surface water quality. Potential water quality effects consist of suspended solids from disturbed soils, biochemical oxygen demand, nutrient loading from disturbed vegetation, and oil and grease from construction equipment. New construction activities that disturb 1 ac. or more require a National Pollutant Discharge Elimination System (NPDES) permit for stormwater discharges from the site to ensure the implementation of best management practices and to minimize effects to surface waters during construction. To minimize the effects of stormwater flow erosion during construction, on-site retention areas (stormwater detention ponds) are designed to detain storm water from the 25-year, 24-hour rainfall event. Runoff detention ponds are designed to detain runoff within the containment areas to allow for settling and to reduce peak discharges. Best management practices are also required during construction to minimize water quality effects. Construction causes no significant consumption of surface water resources. Sanitary waste water is most likely routed to a publicly owned treatment works, if available. If a sanitary waste treatment system is not available, one is constructed.

During operation, a fraction of the plant intake water requirement for each station is for cooling tower makeup water flow. Consumptive water use through evaporation is small. If the amount of water consumption is moderated through the use of a local reservoir, effect on water availability downstream or in the vicinity of the plant would be negligible. Cooling water for the main condensers and miscellaneous components is recirculated through the cooling towers, with the blowdown (i.e.; the fraction of circulated water that is discharged to prevent the buildup of dissolved salts and minerals) and other plant operational wastewater streams subsequently being discharged through diffusers.

A biocide is used to protect the cooling water system from biological growths. Cooling tower blowdown is expected to be several times larger than any other wastewater stream, but it does not contain any detectable amounts of priority pollutants. Plant process wastewater streams include demineralizer regeneration wastes, steam cycle blowdown, and service water/ pretreatment waste and chemical drains. Plant wastewater outfalls also require a NPDES permit, with established treatment standards and discharge limits. To prevent leachate in stormwater runoff from entering the surficial aquifer, the coal storage area and the runoff basin are lined with low-permeability materials. Runoff streams from the coal pile, fly ash and bottom ash piles, and gypsum storage area is collected in the lined recycle basin for reuse (which is sized to exceed capacity requirements for the 25-year, 24-hour storm event), with no direct discharge to the surface water.

Overall, water use and quality effects can be characterized as SMALL, similar to the proposed project.

Human Health - Coal-fired power generation introduces worker risks from coal and limestone mining, worker and public risks from coal and lime/limestone transportation, worker and public risks from disposal of coal combustion wastes, and public risks from inhalation of stack emissions.

Emission effects can be widespread and health risks are difficult to quantify. The NRC staff stated in NUREG-1437 that there are human health effects (cancer and emphysema) from inhalation of toxins and particulates from a coal-fired plant, but did not identify the significance of these effects.

Regulatory agencies, including EPA and state agencies, set air emissions standards and requirements based on human health effects. These agencies also impose site-specific emissions limits as needed to protect human health. EPA has recently concluded that mercury emissions of power plants should be controlled (under the Clean Air Mercury Rule). Certain segments of the U.S. population (e.g., the developing fetus and subsistence fish-eating populations) may be at potential risk of adverse health effects at high levels of consumption of fish containing methyl mercury accumulated from the aquatic food chain. However, human health effects from radiological doses and inhaling toxins and particulates generated by burning coal at a newly constructed coal-fired plant are characterized as SMALL.

Socioeconomics –During the four-year construction period of the coal-fired Big Stone II Power Plant near Milbank, South Dakota, this single 500-580 MW plant is estimated to employ an average of 625 construction workers, with a peak workforce of 1500. Once online, it is likely to employ 30 to 40 operational workers at the site (Reference 9). Construction of the Duke Energy 800 MW Cliffside unit is expected to peak at 1800 workers. The 2120-MW coal-fired alternative, if constructed on a staggered timeline, could be expected to employ more workers, with an average of 1250 construction workers and a peak workforce of 2000. The peak number of workers noticeably affects the local workforce for most sites, but the jobs are temporary and many of the workers commute from surrounding areas. The influx of workers noticeably affects local school systems and other social services.

The coal-fired plants provide a new tax base for the local communities in which they are sited through the in-lieu-of-tax payments made by Duke Energy Carolinas. For these reasons, the non-transportation socioeconomic effects for new pulverized coal-fired plants are noticeable, but are unlikely to destabilize the area.

For transportation related to commuting of plant operating personnel for the coal- fired alternative, the effects are considered negligible. Transportation effects are temporary, noticeable, but not destabilizing during plant construction.

In NUREG-1437, the NRC states that socioeconomic effects at a rural site are greater than at an urban site, because more of the peak construction workforce need to move to the area to work.

Coal and lime/limestone are likely delivered by rail to each power plant, although barge delivery is feasible for a site located on a navigable body of water. Socioeconomic effects associated with rail transportation likely have some effect to the community. Barge delivery of coal and lime/ limestone likely have minor socioeconomic effects.

Overall, Duke Energy concludes that the socioeconomic effects associated with constructing and operating the 2120-MW coal-fired alternative are SMALL (Adverse) to LARGE (Beneficial), similar to the proposed project.

Aesthetics - The coal-fired power block is as much as 200-ft. tall and is visible off-site during daylight hours. The exhaust stack is as high as 650 ft. Also present are 100-ft. high mechanical draft cooling towers or 600-ft. high natural-draft cooling towers, if required. The stack and cooling towers would likely be highly visible in daylight hours for distances greater than 10 mi. These structures are also visible at night because of outside lighting. The Federal Aviation Administration (FAA) generally requires that structures exceeding an overall height of 200 ft. above ground level have markings and/or lighting so as not to impair aviation safety. Visual effects of a new coal-fired plant are mitigated by landscaping and color selection for buildings that are consistent with the environment. Visual effects at night are mitigated by reduced use of lighting, provided the lighting meets FAA requirements, and appropriate use of shielding. Overall, the addition of the coal-fired unit likely has some aesthetic effect. There is a significant aesthetic effect if construction of a new rail spur is needed.

Coal-fired generation introduces mechanical sources of noise that are audible off-site. Sources contributing to total noise produced by plant operation are classified as continuous or intermittent. Continuous sources include the mechanical equipment associated with normal plant operations. Intermittent sources include the equipment related to coal handling, solid waste disposal, transportation related to coal and lime/limestone delivery, use of outside loudspeakers, and the commuting of plant employees. The noise effects of a coal-fired plant are slightly greater than those of expected operation of the proposed project. Noise effects associated with rail delivery of coal and lime/limestone are most significant for residents living in the vicinity of the facility and along the rail route. Although noise from passing trains significantly raises noise levels near the rail line, the short duration of the noise reduces the effect. Nevertheless, given the frequency of train transport and the fact that many people are likely to be within hearing distance of the rail route, the effects of noise on residents in the vicinity of the facility and the rail line are noticeable. Noise associated with barge transportation of coal and lime/limestone are minimal. Noise and light from the pulverized coal-fired power plants are detectable off-site.

Aesthetic effects at the plant site are mitigated if the plant is located in an industrial area adjacent to other power plants.

Overall, the aesthetic effects associated with new pulverized coal-fired power plants can be categorized as SMALL, but substantially greater than the proposed project.

Cultural Resources - Studies likely are needed to identify, evaluate, and address mitigation of the potential effects of new plant construction on historic and archaeological resources before construction begins at any site. The studies likely are needed for areas of potential disturbance at the proposed plant site and along associated corridors where new construction occurs (e.g., roads, rail lines, or other rights-of-way). Historic and archaeological resource effects can generally be effectively managed and as such are considered SMALL.

Environmental Justice - Environmental justice effects depend upon the nearby population distribution. Construction activities offer new employment possibilities, but have negative effects on the availability and cost of housing, which disproportionately affect low-income populations. Overall, environmental justice effects are likely to be SMALL, similar to the proposed project.

Conclusion: Duke Energy identified and evaluated a coal-fired facility as an alternative to the Lee Nuclear Station and concludes that it is not an environmentally superior alternative to the chosen resource, the Lee Nuclear Station.

9.2.4 REFERENCES

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TABLE 9.2-1 (Sheet 1 of 2)
COAL FIRED ALTERNATIVE

Characteristic	Basis
Unit size - 530 MW ISO rating net [a]	Assumed
Unit size - 562 MW ISO rating gross [a]	Calculated based on 6 percent onsite power
Number of Units - 4	Assumed
Boiler Type - tangentially fired, dry bottom	Minimizes NOX emissions (Reference 10)
Fuel Type - bituminous, pulverized coal	Typical for coal used in South Carolina
Fuel Heating Value - 12,617 Btu/lb	2005 value for coal used in South Carolina (Reference 11)
Fuel Ash Content by weight - 9.84%	2005 value for coal used in South Carolina (Reference 11)
Fuel Sulfur content by weight - 1.24%	2005 value for coal used in South Carolina (Reference 11)
Uncontrolled NOX emission - 10 lb/T	Typical for pulverized coal, tangentially fired dry bottom NSPS (Reference 10)
Uncontrolled CO emission - 0.5 lb/T	Typical for pulverized coal. Tangentially fired dry bottom NSPS (Reference 10)
Heat rate - 10,000 Btu/kWh	Typical for pulverized coal. Tangentially fired dry bottom NSPS (Reference 12)
Capacity factor - 0.85	Typical large coal-fired units (Reference 13)
Fuel Consumption - 6,633,000 Tpy	Calculated from the above values
NOX control - Low NOX burners, overfire air and selective catalytic reduction (95% reduction)	Best available for minimizing particulate emissions (Reference 10)
Particulate control - fabric filters (baghouse-99.9% removal efficiency)	Best available for minimizing particulate emissions (Reference 10)
SOX control - Wet scrubber-limestone (95% removal efficiency)	Best available for minimizing SOX emissions (Reference 10)

TABLE 9.2-1 (Sheet 2 of 2)
COAL FIRED ALTERNATIVE

Notes:

Btu = British thermal unit

ISO rating = International Standards Organization rating at standard atmospheric conditions of 59°F, 60 percent relative humidity and 14.696 pounds of atmospheric pressure per square inch

Heat Rate (a measure of efficiency) = the reciprocal of thermal efficiency, units of Btu/kWh.

kWh = kilowatt hour

NSPS = New Source Performance Standard

lb = pound

MW = megawatt

NOX = nitrogen oxides

SOX = sulfur oxides

T = ton

Tpy = Tons per year

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a) The difference between “net” and “gross” is electricity consumed on-site

TABLE 9.2-2
AIR EMISSIONS FROM THE 2120-MW COAL-FIRED ALTERNATIVE

Pollutant	Tons/Year
Annual Coal Consumption	6,633,000
SO_X	7,814
NO_X	1658
CO	1658
Particulate Matter	64
Particulate Matter <10 microns in diameter	17

Calculated from data in Table 9.2-1

TABLE 9.2-3
COMPARISON OF THE ENVIRONMENTAL IMPACTS OF THE COAL-FIRED ALTERNATIVE TO THE LEE NUCLEAR STATION

Attribute	Environmental Impacts	
	Lee Nuclear Station	Coal-Fired Alternative
Air Quality	SMALL	MODERATE
Waste Management	SMALL	MODERATE
Land	SMALL	SMALL
Ecology	SMALL	SMALL
Water Use & Quality	SMALL	SMALL
Human Health	SMALL	SMALL
Socioeconomics	SMALL	SMALL
Aesthetics	SMALL	SMALL
Cultural Resources	SMALL	SMALL
Environmental Justice	SMALL	SMALL

9.3 ALTERNATIVE SITES

As directed by 10 CFR 51.45(b)(3), the ER should present, “appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources.” The NRC, in Regulatory Guide 4.2, “Preparation of Environmental Reports for Nuclear Power Stations,” directs license applicants to include a discussion of the site selection process, the purpose of which is to, “provide a condensed description of the major considerations that led to the final selection … ” The Regulatory Guide also directs that, “The applicant is not expected to conduct detailed environmental studies at alternative sites; only preliminary reconnaissance-type investigations need be conducted.”

The Duke Energy site selection process utilized the guidance provided in NUREG-1555 and the Electric Power Research Institute's (EPRI) Siting Guide and site suitability considerations set forth in NRC Regulatory Guide 4.7, Revision 2, “General Site Suitability Criteria for Nuclear Power Stations.”

The Duke Energy site selection process for the Lee Nuclear Station broadly considered potential sites for future nuclear and fossil-fired power generating stations. Consequently, specific descriptions for many of the potential sites are proprietary. The following description of the site selection process describes the process without providing specifics for any sites except the final four candidate sites.

In addition to the guidance previously noted, Duke Energy applied the following business goals to the site selection process:

- Site a proposed nuclear plant to provide baseload power for the Duke Energy Carolinas Service Area.
- Identify sites in both North Carolina and South Carolina that are suitable for nuclear power plants.
- Select only sites capable of being acquired and characterized in time to meet the schedule of submitting a combined license application by the end of 2007.
- Minimize transmission line energy losses.
- Minimize capital and operating costs.

Subsection 9.3.1 describes the site selection process utilized by Duke Energy to select the following four candidate sites:

- Lee Site (Cherokee County, South Carolina)
- Keowee Site (Oconee County, South Carolina)
- Perkins Site (Davie County, North Carolina)
- Middleton Shoals Site (Anderson County, South Carolina)

Subsection 9.3.2 provides a comparison of the potential environmental impacts of constructing and operating a nuclear plant at each of these four candidate sites.

9.3.1 SITE SELECTION PROCESS

Site selection was conducted in accordance with the general process outlined in the Electric Power Research Institute's (EPRI) Siting Guide and site suitability considerations set forth in NRC Regulatory Guide 4.7, Revision 2, "General Site Suitability Criteria for Nuclear Power Stations." The general site selection process is depicted in Figure 9.3-1. The site selection process began by screening the Region of Interest (ROI) (defined in Subsection 9.3.1.1) and then reducing the number of sites under consideration in successive steps. This process proceeded through the following steps which successively reduced the number of sites down to a final proposed site:

- Identifying the Region of Interest
- Identifying candidate areas
- Identifying potential sites
- Identifying candidate sites (coarse screen)
- Identifying candidate sites (fine screen)
- Selecting the final proposed site

Site suitability criteria listed in Chapter 3 of the EPRI Siting Guide were used as the overall framework for these evaluations.

Evaluations of potential and candidate sites using the screening criteria and general siting criteria (described in Subsection 9.3.1.4) were based on publicly available data sources only. Evaluation of the final four candidate sites also had the advantage of first-hand observations.

9.3.1.1 Defining the Region of Interest

As discussed in Chapter 8, Duke Energy is an electric power company operating under franchises from the North Carolina Utilities Commission (NCUC) and the Public Service Commission of South Carolina (PSCSC). Under their statutory authority, the two utility commissions have granted Duke Energy a franchised area in each respective state to serve. These two franchised service areas combined are the Duke Energy Carolinas Service Area.

As also discussed in Chapter 8, the underlying need for the proposed plant is to provide baseload power for the Duke Energy Carolinas Service Area. Consequently, the plant should be located as close as possible to the Duke Energy load centers so as to minimize energy losses from transmission over long distances. Additionally, it is unlikely that the two utility commissions would approve construction of a plant located outside the service area as a financially prudent decision. Consequently, the Region of Interest (ROI) identified for site selection is the Duke Energy Carolinas Service Area as depicted in Figure 9.3-2. Prospective sites were reviewed based on the assumption that a twin-unit plant, using the Westinghouse AP1000 certified design, would be built and operated.

9.3.1.1.1 Description of the Region of Interest

As discussed above, the ROI is the Duke Energy Carolinas Service Area illustrated in Figure 9.3-2. Areas of high population are also shown in Figure 9.3-2. These high population centers also represent the major electric load centers.

The ROI is geographically part of the Piedmont, characterized by rolling hills with a gradual increase in elevation from southeast to northwest. The northwestern portion of the ROI encompasses part of Blue Ridge Mountains and eastern slope of the Appalachian Mountains. East of the ROI is the Atlantic Coastal Plain. Interstate 85 runs from the southwestern edge of the ROI to the northeastern edge connecting the major population centers shown on Figure 9.3-2. Duke Energy maintains two 525 kV transmission lines, one north and one south of, and parallel to, the Interstate 85 corridor. There are four major rivers flowing generally from the north-northwest to south through the ROI. The Yadkin-Pee Dee River basin is in the eastern part of the ROI. The Catawba River and Broad River basins cover the central portion of the ROI and the Savannah River basin is along the western edge of the ROI. The ROI is rural and population density is generally less than 300 individuals per square mile except in the high population centers noted on Figure 9.3-2.

9.3.1.2 Process for Identifying Candidate Areas

The first step in the site selection process was to screen the ROI to eliminate those areas of the Duke Energy service area that were either unsuitable or significantly less suitable than other potential siting areas. Exclusionary and avoidance criteria identified in the EPRI Siting Guide were reviewed to identify applicable criteria and related physical features within the ROI that would provide insight into site suitability.

Criteria applied to initial screening of the ROI are listed in Table 9.3-1. Specific screening criteria for each category are provided in the second column. Explanations/rationales for the use of these criteria are provided in the third column of Table 9.3-1. Information pertaining to the aforementioned initial screening criteria listed in Table 9.3-1 was displayed on separate maps of the Duke Energy service area. These maps were combined using a simple overlaying technique to produce a composite screening map of the ROI.

Areas that remained eligible on the composite map (i.e., those not affected by any of the screening criteria) were reviewed to verify that the area remaining provided:

- Adequate land acreage for a reasonable number of potential sites.
- Reasonable diversity in potential sites, in terms of alternative settings within the ROI.
- Potential sites capable of satisfying Duke Energy's business objectives for the proposed nuclear plant.

Once this process was completed, the final composite screening result formed the basis for identification of candidate areas for potential sites. This regional screening effort yielded six general candidate areas across the Duke Energy service area that were subsequently examined for potential site locations (Figure 9.3-3). The six areas span across most of the Duke Energy service area. Two of the areas are located in North Carolina, three are located in South Carolina, and one, located near the center of the service area, extends across both North and South

Carolina. These candidate areas generally take the form of land lying along linear segments of the water bodies that are candidate cooling water sources, interrupted by areas excluded due to population density, distance to transmission lines, and/or distance to rail lines.

9.3.1.3 Potential Site Identification Process

A two-track process was used to identify potential sites within the above candidate areas.

The first track consisted of Duke Energy reviewing previous siting studies for both fossil and nuclear siting efforts to identify potential sites within the candidate areas. Seventeen sites were identified in the candidate areas. This list of 17 sites included Duke Energy's three existing nuclear sites; McGuire Nuclear Station, Catawba Nuclear Station, and Oconee Nuclear Station. However, after a review of these existing nuclear sites, two were eliminated prior to the potential site screening effort. McGuire Nuclear Station and Catawba Nuclear Station were eliminated based on insufficient land area to accommodate the new units, significant population growth concerns, transmission challenges, and water quality/thermal concerns. While the existing Oconee Nuclear Station does not have sufficient land area to accommodate the new units, Duke Energy property located adjacent to the site was identified as a potential site. Removing McGuire Nuclear Station and Catawba Nuclear Station from the list and substituting the new potential site adjacent to Oconee in place of Oconee reduced the number of potential sites to 15. After reviewing the remaining 15 sites, five additional sites were eliminated prior to the potential site screening effort due to significant on-going residential development in these areas which would make siting a nuclear plant difficult. These included two sites on Lake Keowee, one site on Lake Norman and two sites on Lake Hartwell that were eliminated from the list reducing the number of potential sites to 10.

The second track consisted of an entirely new exercise in potential site identification within the candidate areas. Starting with the areas remaining after ROI screening, general siting areas were identified that allowed evaluation of siting trade-offs within the Duke Energy service area.

Criteria applied in selecting these areas were:

- At least one siting area for each major water source.
- Proximity to load and transmission.
- Avoidance of high population areas.
- Avoidance of areas with significant ongoing development.
- Proximity to transportation, e.g., railroads.
- Diversity of siting areas between the two states in the Duke Energy service area.
- Areas particularly compatible with Duke Energy business objectives.

Areas identified using the considerations outlined above defined the geographic basis for delineating potential greenfield sites. Aerial photographs and other available geographic information were used in defining potential sites. Potential sites were defined to be approximately 6000 ac. in size, although favorable sites as small as 2000 ac. were considered. Thirteen sites were identified in the candidate areas as a result of this second independent effort. Since this second effort was independent of the previous review there was some overlap in the sites that were identified.

The two lists of potential sites were consolidated and duplicate sites were removed resulting in a total of 15 potential sites.

9.3.1.4 Screening Process to Identify Candidate Sites

A two-phased screening process was used to identify candidate sites. The first phase is a coarse screen using nine criteria to identify a smaller set of potential sites to be sent through the second phase, fine screening process. The fine screening process uses a much larger set of criteria (Table 9.3-2) to further evaluate the remaining potential sites that passed the coarse screening process to select the candidate sites.

The 15 potential sites were evaluated against the following set of nine coarse screening criteria to identify a smaller set of sites to be sent through the second phase, fine screening process:

- Water supply availability
- Flooding potential
- Distance to population centers
- Known hazardous land uses near the site
- Protected species or habitat near the site
- Acres of identified wetlands on the site
- Cost to construct access to nearest rail line
- Cost to construct transmission to nearest node
- Land acquisition costs

Screening criteria used in this evaluation were derived from those discussed in Section 4.2 of the EPRI Siting Guide. These screening criteria provided insights into the overall site suitability tradeoffs inherent in the available sites within the Duke Energy service area and were designed to take advantage of data available at this stage of the site selection process.

The overall process for applying the coarse screening criteria was composed of the following elements:

- **Criterion Ratings**: The sites were assigned a rating of 1 to 5 (1 = least suitable, 5 = most suitable) for each of the screening criteria.
- **Weight Factors**: Weight factors reflecting the relative importance of these criteria were developed consistent with the modified Delphi method suggested in the EPRI Siting Guide. Weight factors were developed before sites were evaluated so that participants

could provide an independent view of weights for nuclear power plant site screening before screening results were known. These weight factors were developed by a multidisciplinary committee of Duke Energy employees experienced with areas of nuclear power plant site suitability issues; it was composed of subject matter experts in water use and availability, real estate, ecology, transmission, land use, health and safety, socioeconomics, and public relations.

- **Composite Suitability Ratings**: Ratings reflecting the overall suitability of each site were developed by multiplying criterion ratings by the criterion weight factors, and summing overall criteria for each site.

Based on the coarse screening ratings results, a total of seven sites, roughly half the number reviewed in the first phase, coarse screening, were identified for further, more detailed evaluation in the fine screening process.

NUREG-1555 recommends at least four candidate sites for evaluation. The objective of this next phase of the site selection process was to further evaluate these seven remaining potential sites in order to select a smaller set of four candidate sites to be evaluated to determine the preferred site and the three alternate sites.

General siting criteria used in the fine screening process to evaluate the seven remaining potential sites were derived from those presented in Chapter 3.0 of the EPRI Siting Guide; criteria from the siting guide were tailored to reflect issues applicable to, and data available for, the Duke Energy service area candidate sites. General siting criteria used in evaluating the candidate sites are listed in Table 9.3-2.

The overall process for applying the general siting criteria was composed of the following elements:

- **Criterion Ratings**: Each site was assigned a rating of 1 to 5 (1 = least suitable, 5 = most suitable) for each of the siting criteria. Information sources for these evaluations included (1) publicly available data, (2) information available from Duke Energy files and personnel, (3) U.S. Geological Survey (USGS) topographic maps, and (4) information derived from site flyovers, windshield surveys, and site visits.

- **Weight Factors**: Weight factors reflecting the relative importance of these criteria were synthesized from those developed for previous nuclear power plant siting studies. The weight factors (1 = least important, 10 = most important) were derived using a methodology consistent with the modified Delphi process specified in the Siting Guide.

- **Composite Suitability Ratings**: Ratings reflecting the overall suitability of each site were developed by multiplying criterion ratings by the criterion weight factors and summing overall criteria for each site.

On completing this evaluation, the following four candidate sites were identified:

- **Lee Site**: The Lee Site is located in the south-central portion of the Duke Energy service area, near the northeast border of South Carolina. The site is in a rural area about 6 miles south of Blacksburg and Gaffney, on the west side of the Broad River. The site is located off McKowns Mountain Road, which connects to Road 105, leading to Gaffney, and Highway 329, that leads north to US 29 (Gaffney and Blacksburg) and I-85 (about 6 – 8 miles to the north). Distance to an area with a population density greater than 300 persons per sq. mi., Gaffney, South Carolina, is 6.3 mi. The distance to the nearest population center, which is Gastonia, North Carolina, is 19.8 mi.

- **Keowee Site**: The Keowee site is located in the southwest portion of the Duke Energy service area, near the northwest border of South Carolina. The Keowee site is located adjacent to the existing Oconee Nuclear Station. The Keowee site is bounded on the west side by Highway 130 and on the north side by Highway 183 and on the east side by the Keowee River. Distance to population density greater than 300 persons per sq. mi., which is Clemson, South Carolina, is 7 miles (mi.). The distance to the nearest population center, which is Anderson, South Carolina, is 21 mi.

- **Perkins Site**: The Perkins Site is located in the northeast portion of the Duke Energy service area, near the north-central border of North Carolina. The site is close to Mocksville, N.C. where US highways, 158, 64 and 601 meet. Access to the site is via Route 801 just to north of site, which connects with SR 601 and also connects with SR 64 about 4 miles north. Interstate 85 lies about 9 miles southeast of site. Distance to an area with a population density greater than 300 persons per sq. mi. (Salisbury, North Carolina) is 11 mi. The distance to the nearest population center, which is Winston-Salem, North Carolina, is 15.4 mi.

- **Middleton Shoals Site**: The Middleton Shoals Site is located in the southwest portion of the Duke Energy service area, near the northwest border of South Carolina. Routes 187 and 184 converge near the site and connect to SC 81 to the east (Iva) and 181 to the north (into Anderson). Distance to a population area with a density greater than 300 persons per sq. mi. is 9.7 mi. The distance to the nearest population center, which is Anderson, South Carolina, is 15 mi.

9.3.2 CANDIDATE SITES COMPARISON

In this subsection, the potential environmental impacts of constructing and operating the Lee Nuclear Station at each of four candidate sites (Lee Site, Keowee Site, Perkins Site, and Middleton Shoals Site) are discussed and compared against each other. The comparison of the candidate sites utilizes the impact significance defined in 10 CFR 51, Appendix B, Table B-1, Footnote 3. Unless the significance level is identified as beneficial, the effect is adverse, or in the case of SMALL it may be negligible. These definitions of significance are as follows:

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

MODERATE — Environmental effects are sufficient to alter noticeably, but not to destabilize, any important attribute of the resource,

LARGE — Environmental effects are clearly noticeable and are sufficient to destabilize any important attributes of the resource.

The comparison of potential environmental impacts for the four candidate sites are summarized in Table 9.3-3. This table illustrates that, although each of the candidate sites is a viable location for a nuclear power plant, none of the alternative sites were deemed environmentally superior to the Lee Site.

9.3.2.1 Land Use Impacts

The objective of this criterion was to evaluate the suitability of the four candidate sites with respect to potential conflicts in existing land uses at each site. Impacts include the amount of clearing and grading necessary to place the proposed AP1000 standard plant on the site, including any supporting infrastructure. Information sources include USGS topographic maps and first-hand observations from helicopter over-flights.

Lee Site

The Lee Site was previously owned by Duke Energy and was available for purchase at the time of the site selection study. Duke Energy has subsequently purchased the site. The site was developed as an industrial site (the former Cherokee Nuclear Site) and extensive rough grading, including the construction of two reservoirs, was completed in the 1970's. The surrounding land is rural and sparsely populated. An existing 8-mile rail spur to the site will need a small re-route (approximately 1800 feet) and the rail bed will need vegetation cleared, new ballast, rail ties and rails added to become operational for transporting materials and equipment to the site. Land use impacts would be SMALL.

Keowee Site

The Keowee site is owned by Duke Energy and is located adjacent to the Oconee Nuclear Station. The site is a wooded greenfield site, requiring extensive rough grading that would include the construction of a supplemental water reservoir. Residential development is absent on the site, but the surrounding area has a low level of development. There is a high level of residential development at the area where a water intake structure would be constructed. A 5.4-mile rail spur would be constructed to the site to transport materials and equipment to the site. Land use impacts would be MODERATE.

Perkins Site

Duke Energy currently owns the Perkins Site that was originally characterized for the Perkins Nuclear Station in the 1970's. The site remains a wooded greenfield site and is managed as a wildlife management area by the NC Fish and Wildlife Service under an agreement with Duke Energy. The site would require extensive rough grading. There is no residential development on the site but the surrounding area is undergoing a moderate amount of residential development particularly in the area proposed for a supplemental water reservoir. A 5.6-mile rail spur would be constructed to the site to transport materials and equipment to the site. Land use impacts would be MODERATE.

Middleton Shoals Site

This site is currently owned by Duke Energy. The site is a wooded greenfield site requiring extensive rough grading that would include the construction of a supplemental water reservoir. There is no residential development on the site and sparse residential development in the vicinity of the site. A 14-mile rail spur would be constructed to the site to transport materials and equipment to the site. Land use impacts would be MODERATE.

9.3.2.2 Hydrology and Water Quality Impacts

The four sites were compared based on impacts to water supply, water quality and potential for flooding.

Water Supply

The four sites were evaluated with respect to the cooling water assuming that each site would use cooling towers. The average cooling water consumptive water use for all plant needs would be 55 cfs. Total average water withdrawal for plant needs would be 78 cfs with 23 cfs being returned to the river or reservoir. Using groundwater to supply cooling needs is not an option at any of these sites as any wells drilled in these areas would have low yields.

Each site was also evaluated assuming augmentation as needed to yield an equivalent amount of cooling water during assumed low flow conditions. In each case, the amount of augmentation and reason for the assumed augmentation is provided below, in order to provide a basis for comparison. Impacts of such augmentation is comparable for all four sites. However, as a result of the inherent attributes of the AP1000 reactor design, offsite cooling water is not required for safe operation, and curtailment of operations is an equally viable option; relative impacts on water supply are considered under scenarios involving both normal flow and curtailed operation during low flow conditions.

Lee Site

The Lee Site is located on the Broad River. All the water needed to support plant needs at the Lee site during normal operations will be withdrawn from the Broad River. The closest USGS gauging station is at Gaffney just above the Lee Site, but this gauge ceased operation in 1991. Consequently, other gauges in North and South Carolina along the Broad River were used to augment the data after 1991. The average flow is estimated to be 2538 cfs and the 7Q10[1] flow at the Lee Site is estimated to be 479 cfs (1926-2006). The Broad River has adequate flow under average flow conditions to support the requirements of a closed cycle cooling water system. Low flow conditions (e.g., drought) could require supplemental water storage or curtailment of operations. Supplemental water storage for low-flow periods is estimated to be 7,301 ac-ft in addition to the capacity of existing ponds on the site. A withdrawal of 55 cfs for consumptive water use under normal flow conditions will be SMALL since this represents 2 percent of the average mean flow. Under low flow conditions, the impact should still be SMALL since consumptive withdrawal would be curtailed.

Keowee Site

All the water needed to support plant needs at the Keowee Site will be withdrawn from Lake Keowee. The Lake Keowee – Lake Jocassee storage would be sufficient to supply the additional

1. 7Q10 is a hydrological term indicating the seven consecutive low-flow days that occur once every ten years.

cooling requirements of a second nuclear station near Oconee Nuclear Station if agreements could be reached with the U.S. Army Corps of Engineers (USACE) to reduce the amount of water that is required to be released from Lake Keowee during low flow events. However, successful negotiation of such an agreement is not guaranteed. Therefore, a supplemental water storage reservoir for low-flow periods with an estimated volume of 4,800 ac-ft is assumed for comparison. A withdrawal of 55 cfs for consumptive water use under normal flow conditions will be SMALL. Under low flow conditions, the impact should still be SMALL even without the supplemental reservoir if withdrawal is agreed to, or as a result of curtailed consumptive use.

Perkins Site

The Perkins Site is located on the Yadkin River. All the water required to support plant needs at the Perkins Site will be withdrawn from the Yadkin River. The closest USGS gaging station is at Yadkin College, 3 miles upstream of the Perkins Site. Flow data for the Yadkin River at this station shows an average flow of 3031 cfs and a 7Q10 flow of 595 cfs for the period of 1963 – 2003. The Yadkin River has adequate flow under average flow conditions to support the requirements of a closed cycle cooling water system. Low flow conditions (e.g., drought) could require supplemental water storage or curtailment of operations. A supplemental reservoir, if used for low-flow periods, is estimated to be 8,635 ac-ft. A withdrawal of 55 cfs for consumptive water use under normal flow conditions will be SMALL since this represents < 2 percent of the average mean flow. Under low flow conditions, the impact should still be SMALL since consumptive withdrawal would be curtailed.

Middleton Shoals Site

The Middleton Shoals Site is located on the Savannah River/Russell Reservoir, just downstream of Hartwell Dam. All the water needed to support plant needs at the Middleton Shoals site will be withdrawn from Russell Reservoir. The USACE controls the water supply and flow in the Russell Reservoir at Middleton Shoals. Russell Reservoir should have an adequate supply, although an agreement would be needed with the USACE to allow continued use of the reservoir under low flow conditions. However, successful negotiation of such an agreement is not guaranteed. Therefore, a 4,800 ac-ft supplemental reservoir would be constructed for low flow events. A withdrawal of 55 cfs for consumptive water use under normal flow conditions will be SMALL. Under low flow conditions, the impact should still be SMALL even without the supplemental reservoir.

Water Quality

All four sites would operate under a National Pollutant Discharge Elimination System (NPDES) permit. As authorized by the Clean Water Act, the NPDES permit program controls water pollution by regulating discharges into the waters of the United States. The permit contains limits on what can be discharged, monitoring and reporting requirements, and other provisions to ensure that the discharge does not hurt water quality or human health. Any releases of contaminants to rivers or reservoirs as a result of construction or operation of a nuclear plant at the four sites would be regulated through the NPDES permit process to ensure water quality is protected. Therefore, impacts to water quality at all four sites would be SMALL.

Flooding

To estimate flood potential, a comparison was conducted between site grade elevation (based on suggested plant layout locations for the four sites, as shown on USGS Topographic maps at 1:24,000 scale) and the 100-year flood elevation for the major river on which the site is located. The 100-year flood elevations were based on Flood Insurance Rate Maps (FIRM) from FEMA for the respective counties in which the sites are located. Primary emphasis was on flood elevations for the main water bodies (rivers and reservoirs) and their major tributaries where flood elevations were identified. Onsite tributaries were noted but were typically identified as flood hazard free, based on the FEMA maps. FIRM maps also include 500-year floodplain, although none of the sites appear to be located within the 500-year floodplain.

Site	Site Grade Elevation	Maximum Flood Elevation (from main water body)	Difference in Elevation
Lee	590 ft	520 ft	70 ft
Keowee	800 ft	680 ft or lower (Keowee River)	120 ft
Perkins	720-730 ft	650-660 ft	70 ft (minimum)
Middleton Shoals	550 ft	450 ft	100 ft

Based on the above results, the risk for flooding to the four sites is rated as SMALL.

9.3.2.3 Terrestrial Ecology Resources

The objective of this criterion is to evaluate the candidate sites with respect to potential construction and operation related impacts on important terrestrial species and ecology. Data were obtained from the South Carolina Rare, Threatened & Endangered Species Inventory (Reference 1) and North Carolina Natural Heritage Program (Reference 2), listing of rare plant and animal species. Wetland information was obtained from the National Wetlands Inventory (NWI) maps published by U.S. Fish and Wildlife Service or other existing environmental documentation for the candidate sites.

<u>Lee Site</u>

There are no documented rare, threatened or endangered (RTE) species on the Lee Site. There are no documented occurrences of RTE in the vicinity of the site. NWI maps did not reveal significant wetland acreage on the Lee Site. Because the Lee site is already cleared and graded it was determined that utilizing 400 ac for the plant facilities would have minimal impact on terrestrial ecosystems.

In NUREG 1437, NRC concludes potential adverse impacts due to drift from cooling towers to surrounding plants, primarily trees in this case, is minor. This potential impact can be minimized with the use of drift eliminators on the cooling towers.

Impacts to terrestrial ecology resources at the Lee Site are estimated to be SMALL.

Keowee Site

There are no documented RTE species on the Keowee Site. The federally listed endangered peregrine falcon (*Falco peregrinus*) has been occasionally sighted near the Oconee Nuclear Station (which is located next to the Keowee site). There are four state-listed plant species (Species of Concern) in the vicinity of Lake Keowee: *Nestronia umbellula* (Indian Olive), *Viola tripartite* (Three-parted violet), *Carex laxiflora* (Loose-flowered sedge), and *Carex prasina* (Drooping sedge). The NWI maps did not reveal significant wetland acreage on the Keowee Site. The site is wooded and utilizing 400 ac for the plant facilities would require removal of 400 ac of wooded habitat.

In NUREG 1437, NRC concludes potential adverse impacts due to drift from cooling towers to surrounding plants, primarily trees in this case, is minor. This potential impact can be minimized with the use of drift eliminators on the cooling towers.

Impacts to terrestrial ecology resources at the Keowee Site are estimated to be MODERATE.

Perkins Site

There are no documented RTE species at the Perkins Site. There are no documented occurrences of RTE species in the vicinity of the site. NWI maps did not reveal significant wetland acreage on the Perkins Site. The site is wooded and utilizing 400 ac for the plant facilities would require removal of 400 ac of wooded habitat.

In NUREG 1437, NRC concludes potential adverse impacts due to drift from cooling towers to surrounding plants, primarily trees in this case, is minor. This potential impact can be minimized with the use of drift eliminators on the cooling towers.

Impacts to terrestrial ecology at the Perkins Site are estimated to be SMALL to MODERATE.

Middleton Shoals Site

There are no documented RTE species on the Middleton Shoals site. There are no documented occurrences of RTE species in the vicinity of the site. NWI maps did not reveal significant wetland acreage on the Middleton Shoals Site. The site is wooded and locating 400 ac for the plant facilities would require removal of 400 ac of wooded habitat.

In NUREG 1437, NRC concludes potential adverse impacts due to drift from cooling towers to surrounding plants, primarily trees in this case, is minor. This potential impact can be minimized with the use of drift eliminators on the cooling towers.

Impacts to terrestrial ecology at the Middleton Shoals Site are estimated to be SMALL to MODERATE.

9.3.2.4 Aquatic Ecology Resources

The objective of this evaluation is to compare the candidate sites with respect to impacts to aquatic ecology resources from thermal discharges, entrainment and impingement. Data were obtained from the South Carolina Rare, Threatened & Endangered Species Inventory (Reference 1) and North Carolina Natural Heritage Program (Reference 2), listing of rare plant and animal species. Previous NRC evaluations of aquatic ecology impacts at operating power plants from NUREG-1437 were coupled with observations from helicopter flyovers of the sites and plant design considerations.

Lee Site

There are no documented occurrences of aquatic RTE species in the vicinity of the Lee Site. The Lee Site is located on a river which would likely provide sufficient heat rejection capacity for the proposed plant, using a closed cooling water system, without having significant thermal impacts to aquatic ecology. No information was discovered during the evaluation which revealed any concerns with significant thermal impacts at the site.

The proposed plant will include cooling towers that will reduce the amount of cooling water withdrawal required for plant operation. In NUREG 1437, NRC concluded that, with cooling towers and appropriate intake design, potential adverse impacts due to entrainment or impingement of aquatic organism are minor and do not significantly disrupt existing populations. Assuming a two unit closed-cycle plant at the site, and 100 percent of the local plankton passing through the plant, it appears that there would be no discernible effect on the plankton population in the existing water source. This is due to the very small volume of water used by the plant relative to the total volume available from the water source. Because of the low flow velocities of a closed cycle plant at the site, impingement of adult fish would be expected to be minimal.

Impacts to aquatic ecology resources were estimated to be SMALL.

Keowee Site

There are no documented occurrences of aquatic RTE species in the vicinity of the Keowee Site. The Keowee Site is located on a reservoir which would likely provide sufficient heat rejection capacity for the proposed plant, using a closed cooling water system, without having significant thermal impacts to aquatic ecology. No information was discovered during the evaluation which revealed any concerns with significant thermal impacts at the site.

The proposed plant will include cooling towers that will reduce the amount of cooling water withdrawal required for plant operation. In NUREG 1437, NRC concluded that, with cooling towers and appropriate intake design, potential adverse impacts due to entrainment or impingement of aquatic organism are minor and do not significantly disrupt existing populations. Assuming a two unit closed-cycle plant at the site, and 100 percent of the local plankton passing through the plant, it appears that there would be no discernible effect on the plankton population in the existing water source. This is due to the very small volume of water used by the plant relative to the total volume available from the water source. Because of the low flow velocities of a closed cycle plant at the site, impingement of adult fish would be expected to be minimal.

Impacts to aquatic ecology resources were estimated to be SMALL.

Perkins Site

There are no documented occurrences of aquatic RTE species in the vicinity of the Perkins Site. The Perkins Site is located on a river which would likely provide sufficient heat rejection capacity for the proposed plant, using a closed cooling water system, without having significant thermal impacts to aquatic ecology. No information was discovered during the evaluation which revealed any concerns with significant thermal impacts at the site.

The proposed plant will include cooling towers that will reduce the amount of cooling water withdrawal required for plant operation. In NUREG 1437, NRC concluded that, with cooling towers and appropriate intake design, potential adverse impacts due to entrainment or impingement of aquatic organism are minor and do not significantly disrupt existing populations. Assuming a two unit closed-cycle plant at the site, and 100 percent of the local plankton passing through the plant, it appears that there would be no discernible effect on the plankton population in the existing water source. This is due to the very small volume of water used by the plant relative to the total volume available from the water source. Because of the low flow velocities of a closed cycle plant at the site, impingement of adult fish would be expected to be minimal.

Impacts to aquatic ecology resources were estimated to be SMALL.

Middleton Shoals Site

There are no documented occurrences of aquatic RTE species in the vicinity of the Middleton Shoals Site. The Middleton Shoals Site is located on a reservoir which would likely provide sufficient heat rejection capacity for the proposed plant, using a closed cooling water system, without having significant thermal impacts to aquatic ecology. No information was discovered during the evaluation which revealed any concerns with significant thermal impacts at the site.

The proposed plant will include cooling towers that will reduce the amount of cooling water withdrawal required for plant operation. In NUREG 1437, NRC concluded that, with cooling towers and appropriate intake design, potential adverse impacts due to entrainment or impingement of aquatic organism are minor and do not significantly disrupt existing populations. Assuming a two unit closed-cycle plant at the site, and 100 percent of the local plankton passing through the plant, it appears that there would be no discernible effect on the plankton population in the existing water source. This is due to the very small volume of water used by the plant relative to the total volume available from the water source. Because of the low flow velocities of a closed cycle plant at the site, impingement of adult fish would be expected to be minimal.

Impacts to aquatic ecology resources were estimated to be SMALL.

9.3.2.5 Socioeconomics

Construction Related Effects

The capacity of the communities surrounding the plant site to absorb temporary construction population was estimated.

According to the AP1000 Siting Guide, the plant workforce (construction) includes a monthly maximum construction workforce requirement of 1000 persons per unit. It was assumed that construction would require a peak construction work force of 2000 workers (1000 per unit) and that no other major construction project would occur in the site vicinity concurrently with construction of the plant. Thus, sites were rated without consideration of potential cumulative impacts of other potential demands for labor.

Available population and economic data were obtained from the US Census Bureau (Reference 3) for each site. The data were collected by county to determine availability of an adequate labor force within commuting distance (based on an assumed location of the labor pool). Data relating to population and labor force (primarily construction industry) were compared with the construction labor requirement to determine availability of labor.

To address potential impacts on local community services, the following assumptions were used:

- 30 percent of these workers will in-migrate (600 workers);
- 50 percent of these in-migrating workers (300 workers) will bring their families (2.5 additional persons per family) (750 family members); and,
- An influx of direct workers also will bring in an influx of indirect workers (0.4 ratio of direct to indirect workers – in absence of site-specific information - pertaining to the Regional Industrial Multiplier System direct/indirect ratios calculated for each plant, as found in NUREG/CR-2749 (240 indirect workers); and 50 percent of these indirect workers will bring their families (2.5 additional persons per family) (300 family members).

The result is a total population influx of 1890 persons.

Sites were rated according to economic impacts based on the following criteria: economic effects were considered small if peak construction related employment accounted for less than 5 percent of total study area employment; moderate if it accounted for 5 to 10 percent of total study area employment; and large if it accounted for more than 10 percent of total study area employment.

The available population and work force data for the host county and surrounding counties are presented in the following tables. Projected growth rates from 2000 – 2010 are assumed to be the same as growth rates found between 1990 and 2000, based on U.S. Census data.

Site	Total Pop (2000)	Total Pop (2010)	Total Employed Workforce (2000)	Total Construction Workforce (2000)
Lee (SC)	1,419,710	1,769,357	781,819	58,767
Keowee (SC)	1,019,627	1,174,608	488,649	38,991
Perkins (NC)	1,287,650	1,546,061	649,073	45,381
Middleton Shoals (SC)	1,045,794	1,203,313	500,216	42,949

Source: Reference 3

Given the large population projections for the area in 2010 when construction is anticipated to start, and based on conservative workforce levels using 2000 Census Bureau data (construction workers only and without expected increases in 2010, although such increases might be used to support other large (non-nuclear) construction projects at that time), results indicate that the impact on study area employment from construction of two new units would be low at each site.

In conclusion, a comparison of socioeconomic conditions between the four candidate sites reveals minimal differences such that the impact will be SMALL for all sites.

Operation Related Effects

The anticipated operational plant staff is 800-1000 individuals. Based on the previous analysis that indicated construction related socioeconomic impacts for all four sites are SMALL, it may also be assumed that operation related socioeconomic impacts would also be SMALL.

9.3.2.6 Environmental Justice

The objective of this criterion is to ensure that the effects of proposed actions do not result in disproportionate adverse impacts to minority and low-income communities. In comparing sites, this principle is evaluated on the basis of whether any disproportionate impacts to these communities are significantly different when comparing one site to another.

The NRC guidance for determining if potential environmental justice conditions exist is:

- The minority populations of a census block or the environmental impact area exceed 50 percent.
- The minority population percentage of the environmental impact area is significantly greater (typically at least 20 percentage points) than the minority population percentage in the geographic area chosen for the comparative analysis.

Environmental justice data for the host county and surrounding counties for the four sites are summarized below.

Site	Population (2000)	White	Minority*	Low Income*
Lee (SC)	1,419,710	69.8 %	30.2 %	10.8 %
Keowee (SC)	1,019,627	79.5 %	20.5 %	11.7 %
Perkins (NC)	1,287,650	65.7 %	34.3 %	10.2 %
Middleton Shoals (SC)	1,045,794	79.2 %	20.8 %	11.8 %

*State Average for NC is 27.9 percent minority and 12.3 percent below poverty line. State Average for SC is 32.3 percent minority and 14.1 percent below poverty line.

- The Lee, Keowee and Middleton Shoals sites are all below 50 percent minority and below the South Carolina average percent minority.

- The Perkins Site is below 50 percent minority but above the North Carolina average of 27.9 percent minority. However, it is not more than 20 percent above the North Carolina average.

- Low-income populations at all sites are below the respective state average.

Based on the NRC guidance, it is not likely that there are environmental justice issues at any of the four sites.

Environmental justice consequences of the construction and operation of a nuclear plant at any of the four sites would be SMALL.

9.3.2.7 Historic and Cultural Resources

Lee Site

There are no documented sites eligible for listing on the National Register of Historic Places (NRHP) on the Lee Site. The Ninety-Nine Islands Hydroelectric Station and Dam near the Lee Site are eligible for listing on the NRHP but are not likely to be impacted by the construction or operation of a nuclear power plant.

Keowee Site

There are no documented sites eligible for listing on the NRHP on the Keowee Site. There are no documented sites eligible for listing on the NRHP in the vicinity of the Keowee Site.

Perkins Site

There are no documented sites eligible for listing on the NRHP on the Perkins Site. The NC Department of Cultural Resources lists a possible historic Indian circle (eligible for the NRHP listing) in the vicinity of the site.

Middleton Shoals Site

There are no documented sites eligible for listing on the NRHP on the Middleton Shoals Site. There are no documented sites eligible for listing on the NRHP in the vicinity of the Middleton Shoals Site.

Siting a nuclear plant at any of the four sites would require a formal cultural resources survey be conducted so that no archeological or historic resources would be damaged during plant construction. Mitigative measures would be performed to prevent permanent damage and ensure that any impacts to cultural resources from construction or operation at any of the four sites would be SMALL.

9.3.2.8 Air Quality

Air pollutant emissions from construction will be temporary and will be similar to any large-scale construction project. Particulate emissions in the form of dust from disturbed land, roads, and construction activities would be generated in proportion to the amount of grading needed for a specific site. Air pollutants emitted from the exhaust systems of construction vehicles and equipment and from vehicles used by construction workers to commute to the site are governed by mobile emission standards and should be similar for all sites. The amount of pollutants emitted in this way would be small compared to total vehicular emissions in the region.

During station operation, standby diesel generators would be used for auxiliary power. It is expected that these generators would see limited use and, when used, they would operate for short time periods. A nuclear plant at any of the four sites would be subject to a Synthetic Minor Operating Permit to ensure that the facility operations would not interfere with attaining or maintaining Primary and Secondary National Air Quality Standards (NAAQS). Therefore, air pollutant emissions from the standby diesel generators are expected to be minimal and would not result in any violation of NAAQS. Therefore the air quality impacts from operation of a nuclear plant at any of the four sites would be SMALL.

<u>Lee Site</u>

The counties surrounding the Lee Site were designated, at the time of the site selection study, as being unclassified or in attainment of the NAAQS. It is not expected that construction-related emissions would result in any violation of NAAQS. Because the Lee site does not require extensive rough grading, impacts from fugitive dust are estimated to be SMALL.

<u>Keowee Site</u>

The counties surrounding the Keowee Site are designated, at the time of the site selection study, as being unclassified or in attainment of the NAAQS. It is not expected that construction-related emissions would result in any violation of NAAQS. Because the Keowee Site would require extensive rough grading, impacts from fugitive dust are estimated to be SMALL to MODERATE.

<u>Perkins Site</u>

The counties surrounding the Perkins Site are designated, at the time of the site selection study, as being unclassified or in attainment of the NAAQS. It is not expected that construction-related emissions would result in any violation of NAAQS. Because the Perkins Site would require extensive rough grading, impacts from fugitive dust are estimated to be SMALL to MODERATE.

<u>Middleton Shoals Site</u>

The counties surrounding the Middleton Shoals Site are designated, at the time of the site selection study, as being unclassified or in attainment of the NAAQS. It is not expected that construction-related emissions would result in any violation of NAAQS. Because the Middleton Shoals Site would require extensive rough grading, impacts from fugitive dust are estimated to be SMALL to MODERATE.

9.3.2.9 Human Health

For this analysis, it was assumed that each site was capable of supporting the NRC requirements for an exclusion area and low-population zone, since these were exclusionary criteria used in ruling out sites early in the site selection process. Consequently, it is assumed that this fact coupled with the AP1000 design would ensure that all the candidate sites could meet NRC requirements for dose to individual members of the public.

This evaluation looked at the probable impacts to population dose considering the distribution of population in the vicinity of each candidate site and any susceptibility due to the pathways for radiological contamination at each site.

Data used were census estimates at the time of the site selection study, population projections for 2010, and distance to a public water supply. Hydro-geologic data from publicly available documents were used as input to the EPA DRASTIC groundwater model. The EPA DRASTIC groundwater model (Reference 4) was used to estimate a site's susceptibility to groundwater contamination. The higher the DRASTIC ranking the more vulnerable the site is to groundwater contamination.

Data from the National Agriculture Statistics Service (Reference 5) were used to estimate the contribution of potential radiological contamination through the food pathway for each site.

Lee Site

Population density in Cherokee County was estimated as 134 individuals per square mile and population in adjoining York County was estimated as 241 individuals per square mile. Projected 2010 population for Cherokee County is 62,000. The nearest population center (>25,000 people) is 19.8 miles away.

The closest downstream public water supply intake is the city of Union, 21 miles downstream. Using data from the Catawba Nuclear Station Environmental Report, V.C. Summer Nuclear Station Final Safety Analysis Report, and USGS geological maps, a DRASTIC index of 83-128 was estimated for the Lee Site indicating a low to moderate vulnerability to groundwater contamination.

Agriculture (farmland) represents 64,020 acres of total Cherokee county area of 251,520 acres (25 percent). Out of total farmland, 25,279 acres are planted in crop (39 percent); other farmland is used for cattle (beef and milk) (9,468 head), hogs and pigs (57), sheep/lambs (187) and no poultry. The Lee site was estimated to have a low potential of contamination through the food pathway.

Because of low population, distance to downstream water and relatively small agricultural production, the overall risk of impacts to Human Health for the Lee Site was estimated to be SMALL.

Keowee Site

Population in Oconee County was estimated as 106 individuals per square mile and population in adjoining Pickins County was estimated as 223 individuals per square mile. Projected 2010 population for Oconee County is 100,000. The nearest population center (>25,000 people) is 21 miles away. However, population within 10 miles of the site will exceed 25,000 people seasonally during summer due to summer homes on Lake Keowee and Lake Hartwell.

The closest downstream public water supply intake is the city of Clemson, two miles downstream. Using data from the V.C. Summer Nuclear Station Environmental Report and Final Safety Analysis Report, and USGS geological maps, a DRASTIC index of 75-120 was estimated for the Keowee Site indicating a low to moderate vulnerability to groundwater contamination.

Agriculture (farmland) represents 78,349 acres out of 400,000 acres in Oconee County (19 percent). Out of total farmland, 31,949 acres are planted in crop (40.8 percent). Other farmland is used for cattle (19,828 head), hogs and pigs (1266), sheep/lambs (110), and 27 million poultry (sold in 2002). The Keowee site was estimated to have a moderate to high potential of contamination through the food pathway.

Because of moderate population levels, relatively close proximity to a downstream drinking water intake and moderate agricultural production, overall risk of impacts to Human Health was estimated to be SMALL to MODERATE for the Keowee Site.

Perkins Site

Population in Davie County was estimated as 131 individuals per square mile. Projected 2010 population for Davie County is 44,000. The nearest population center (>25,000 people) is 15.4 miles away.

The closest public water supply intake is Salisbury, nine miles downstream. Using data from the McGuire Nuclear Station Environmental Report and Final Safety Analysis Report, Shearon Harris Nuclear Station Final Safety Analysis Report, and USGS geological maps, a DRASTIC index of 77-124 was estimated for the Perkins Site indicating a low to moderate vulnerability to groundwater contamination.

Agriculture (farmland) represents 76,295 acres of total county area of 169,600 acres (45 percent). Out of total farmland, 43,056 acres are planted in crop (56 percent); other farmland is used for cattle (beef and milk) (15,120 head), sheep/lambs (99) and no poultry. The Perkins Site was estimated to have a moderate potential of contamination contribution via the food pathway.

Because of low population, distance to a downstream water intake and moderate level of agricultural production, overall risk of impacts to Human Health was estimated for the Perkins Site as SMALL.

Middleton Shoals Site

Population in Anderson County was estimated as 231 individuals per square mile. Projected 2010 population for Anderson County is 189,000. The nearest population center (>25,000 people) is 15 miles away.

The closest public water supply intake is Abbeville, eight miles downstream. Using data from the V.C. Summer Nuclear Station Final Safety Analysis Report, and USGS geological maps, a DRASTIC index of 75-124 was estimated for the Lee Site indicating a low to moderate vulnerability to groundwater contamination.

Agriculture (farmland) represents 176,947 acres of total Anderson county area of 459,520 acres (38 percent). Out of total farmland, 87,393 acres are planted in crop (49 percent); other farmland is used for cattle (beef and milk) (40,505 head), hogs and pigs (1787), sheep/lambs (422) and over 5 million poultry (sold in 2002). The potential for contamination through the food pathway was estimated as moderate to high for the Middleton Shoals Site.

Because of higher population and the highest levels of agricultural production, the overall risk of impacts to Human Health for the Middleton Shoals Site was estimated as SMALL to MODERATE.

9.3.2.10 Accidents

Impacts from accidents were evaluated based on population distribution and ability to evacuate the area in the event of an accident.

Lee Site

Population density in Cherokee County was estimated as 134 individuals per square mile and population in adjoining York County was estimated as 241 individuals per square mile. Projected 2010 population for Cherokee County is 62,000. The nearest population center (>25,000 people) is 19.8 miles away.

Cherokee County sits just off I-85 between Charlotte/Gastonia and Greenville-Spartanburg. The site is in a rural area about 6 miles south of Blacksburg and Gaffney, on west side of river. The site is located off McKowns Mountain Road, which leads west to Road 105/329 that in turn leads north to US 29 (Gaffney and Blacksburg) and I-85 (about 6-8 miles to the north). No close access (bridge) to the east side of the river exists, but SR 5 in Blacksburg lies to the north and runs south into York County east of site.

Impacts related to potential accidents were estimated as SMALL to MODERATE.

Keowee Site

Population in Oconee County was estimated as 106 individuals per square mile and population in adjoining Pickens County was estimated as 223 individuals per square mile. Projected 2010 population for Oconee County is 100,000. The nearest population center (>25,000 people) is 21 miles away. However, population within 10 miles of the site will exceed 25,000 people seasonally during summer with summer homes on Lake Keowee and Lake Hartwell.

Oconee County is served by I-85 at its southeast corner, plus U.S. highways 76 and 123 and State highways 28 and Scenic 11. The Keowee Site is on a two-lane highway with service to the site being convenient from four main directions. There are no limiting climate or terrain conditions.

Oconee Nuclear Station is adjacent to the Keowee Site, and brings the advantage of already having an existing Emergency Plan that could be easily adapted to include the Keowee Site. However, both sites would require evacuation under emergency conditions.

Adjacent Pickens County is not served by the Interstate Highway system, but has ready access to the I-85 corridor via U.S. 76, 123, and 178. State Highways 8, 96, 135, 137, 124, and Scenic 11 complete the major road net. Highway 123 runs the length of Pickens County from east to west with four-lane service to Greenville. State Highway 133 (which runs north-south on the east side of Lake Keowee) and State Highway 183 from Pickens serve as commuting highways from Pickens County to Oconee Nuclear Station. Although several of the residential communities on both sides of Lake Keowee have long, narrow access roads, none of these roads has been identified as seriously congested.

Impacts related to potential accidents were estimated as SMALL.

Perkins Site

Population in Davie County was estimated as 131 individuals per square mile. Projected 2010 population for Davie County is 44,000. The nearest population center (>25,000 people) is 15.4 miles away.

The Perkins Site is close to Mocksville, which is an important center for highway transportation – where US highways, 158, 64 and 601 meet. These highways join Interstate 40 which is approximately 9 miles to the northwest of the site. Access from the site (Davie County) is via Route 801 just to north of site; connects with SR 601 (runs north-south west of site); also connects with SR 64 about 4 miles north (east-west route); I-85 lies about 9 miles southeast of site; no bridges across river; only way out is 801 to 64 to I-85.

Impacts related to potential accidents were estimated as SMALL.

Middleton Shoals Site

Population in Anderson County was estimated as 231 individuals per square mile. Projected 2010 population for Anderson County is 189,000. The nearest population center (>25,000 people) is 15 miles away.

Good access to the site from local roads on east side of Savannah River. Routes 187 and 184 converge near the site and connect to SC 81 to the east (Iva) and 181 to the north (into Anderson). Larger Routes include (SR) 72 to the south (15 miles) and US 29 to the north (7-8 miles). Closest interstate is I-85 to the north [5 miles north of Anderson] that connects to the Greenville–Spartanburg area. Anderson County includes 37 miles of I-85 frontage. City of Anderson is 30 miles south of I-385 and 50 miles south of I-26.

No limiting climate or terrain conditions.

Impacts related to potential accidents were estimated as SMALL.

9.3.2.11 Transmission Corridors

Lee Site

Seven miles of 230 kV transmission line and fifteen miles of 525 kV transmission line would be needed to connect the site to the transmission system. Route selection would avoid populated areas and residences to the extent possible. The use of lands currently used for forests or timber production would be altered. Trees would be replaced by grasses and other low-growing types of ground cover. The new transmission corridor would not be expected to permanently affect agricultural areas, but has the potential to affect residents along the right-of-way. For this reason, impacts to land use along the right-of-way would be MODERATE.

Keowee Site

Due to close proximity of the Oconee switchyard, only very short runs would be needed to connect the site to the transmission system. For this reason, impacts to land use along the right-of-way would be SMALL.

Perkins Site

Seven and half miles of 230 kV transmission line and fifteen miles of 525 kV transmission line would be needed to connect the site to the transmission system. Route selection would avoid populated areas and residences to the extent possible. The use of lands currently used for forests or timber production would be altered. Trees would be replaced by grasses and other low-growing types of ground cover. The new transmission corridor would not be expected to permanently affect agricultural areas, but has the potential to affect residents along the right-of-way. For this reason, impacts to land use along the right-of-way would be MODERATE.

Middleton Shoals Site

Fifteen miles of 230 kV transmission line would be needed to connect the site to the transmission system. Route selection would avoid populated areas and residences to the extent possible. The use of lands currently used for forests or timber production would be altered. Trees would be replaced by grasses and other low-growing types of ground cover. The new transmission corridor would not be expected to permanently affect agricultural areas, but has the potential to affect residents along the right-of-way. For this reason, impacts to land use along the right-of-way would be MODERATE.

9.3.2.12 Conclusion

Table 9.3-3 summarizes the comparison of the candidate sites. Although all four candidate sites are suitable for construction and operation of twin AP1000 nuclear units, no site was deemed superior to the Lee Site.

9.3.2.13 References

1. South Carolina Department of Natural Resources (SCDNR). 2003. South Carolina Rare, Threatened & Endangered Species Inventory. Accessed at http://www.dnr.state.sc.us / heritage/owa/species.login. Note: This is a protected website that is accessible only through SCDNR authorization.

2. North Carolina Natural Heritage Program, 2005. Listing of rare plant and animal species. NC NHP database updated: July 2005. Accessed at http://207.4.179.38/nhp/quad.html.

3. U.S.Census Bureau, http://quickfacts.census.gov/qfd/ for SC and GA

4. U.S. Environmental Protection Agency, “DRASTIC: A Standardized System for Evaluating Ground Water Pollution Potential Using Hydrogeologic Settings”, EPA Manual, 1987.

5. National Agricultures Statistics Service, 2002 Census of Agriculture for North and South Carolina, Web Site: http://151.121.3.33:8080/Census/Create_Census_US_CNTY.jsp.

TABLE 9.3-1 (Sheet 1 of 2)
CRITERIA APPLIED TO INITIAL SCREENING OF THE REGION OF INTEREST

Criteria Data Category	Screening Criteria	Explanation/Rationale
Seismic	Exclude areas < 25 mi. from capable faults Exclude areas < 5 mi. from surface faults	An examination of geology/seismology information for the Duke Energy service area indicated that there are no capable or surface faults that would affect the suitability of sites for a nuclear power plant. Accordingly, this criterion was eliminated from the ROI screening process.
Population	Exclude counties where population density > 300 persons per sq. mi	Counties with > 300 persons per sq. mi. likely have multiple imbedded areas > 500 persons per sq. mi. Siting within these areas would place the plant within an unacceptable distance of high population density areas.
Water Availability	Exclude areas not within 5 mi. of water bodies that support AP1000 water requirements	Rivers for which more than 10% of the average flow would be required for makeup water may present permitting or operational water supply problems. Pumping makeup water more than 5 mi. imposes significant construction and operational costs and can result in operational risks.
Dedicated Land Use	Exclude federal & state parks, monuments, wildlife areas, wilderness areas	Lands in the identified categories have been formally designated for uses that are not compatible with use as a power plant site.

TABLE 9.3-1 (Sheet 2 of 2)
CRITERIA APPLIED TO INITIAL SCREENING OF THE REGION OF INTEREST

Criteria Data Category	Screening Criteria	Explanation/Rationale
Regional Ecological Features	Exclude significant known, mapped wetlands, threatened & endangered species habitat	Development of a plant at the location of significant known areas of ecological importance could result in unacceptable environmental impacts and/or challenges as to whether obviously superior alternatives are available. Other than ecological areas associated with dedicated land uses, no known ecologically sensitive areas were identified at a regional scale. Site suitability from an ecological perspective was evaluated on a site-specific basis.
Transmission	Exclude areas > 15 mi. from 525 kV lines and/or 230 kV nodes	Sites at large distances from the existing grid require large transmission construction costs and result in additional operational line losses. Long interconnects also decrease redundancy and increase the potential for operational interruptions.
Rail	Exclude areas > 10 mi. from existing lines	Sites at large distances from existing lines require large rail spur construction costs to provide for delivery of large plant components and construction modules.

TABLE 9.3-2 (Sheet 1 of 2)
GENERAL SITING CRITERIA USED FOR SECOND PHASE FINE SCREENING OF SITES

Siting Criteria
Health and Safety Criteria: Accident Cause-Related Criteria
Geology and Seismology
Cooling System Requirements: Cooling Water Supply
Cooling Water System: Ambient Temperature Requirements
Flooding
Nearby Hazardous Land Uses
Health and Safety Criteria: Accident Effects-Related
Extreme Weather Conditions
Population
Emergency Planning
Atmospheric Dispersion
Health and Safety Criteria: Operational Effects-Related
Surface Water- Radionuclide Pathway
Groundwater - Radionuclide Pathway
Air - Radionuclide Pathway
Air-Food Ingestion Pathway
Surface Water – Food Radionuclide Pathway
Transportation Safety
Environmental Criteria: Construction-Related Effects on Aquatic Ecology
Disruption of Important Species/Habitats
Bottom Sediment Disruption Effects
Environmental Criteria: Construction-Related Effects on Terrestrial
Disruption of Important Species/Habitats and Wetlands
Dewatering Effects on Adjacent Wetlands
Environmental Criteria: Operational-Related Effects on Aquatic Ecology
Thermal Discharge Effects
Entrainment/Impingement Effects
Dredging/Disposal Effects

TABLE 9.3-2 (Sheet 2 of 2)
GENERAL SITING CRITERIA USED FOR SECOND PHASE FINE SCREENING OF SITES

Siting Criteria
Environmental Criteria: Operational-Related Effects on Terrestrial Ecology
Drift Effects on Surrounding Areas
Socioeconomic Criteria
Socioeconomics – Construction Related Effects
Environmental Justice
Land Use
Engineering and Cost Related Criteria: Health and Safety Related Criteria
Water Supply
Pumping Distance
Flooding
Civil Works
Engineering and Cost: Transportation or Transmission Related Criteria
Railroad Access
Highway Access
Barge Access
Transmission Cost and Market Price Differentials
Engineering and Cost- Related Criteria: Related to Socioeconomic & Land Use
Topography
Land Rights
Labor Rates

TABLE 9.3-3
SUMMARY OF POTENTIAL ENVIRONMENTAL IMPACTS AT CANDIDATE SITES

Potential Environmental Impact Area	Lee Site	Keowee Site	Perkins Site	Middleton Shoals Site
Land Use	SMALL	MODERATE	MODERATE	MODERATE
Hydrology and Water Quality	SMALL	SMALL	SMALL	SMALL
Terrestrial Ecology Resources	SMALL	MODERATE	SMALL - MODERATE	SMALL - MODERATE
Aquatic Ecology Resources	SMALL	SMALL	SMALL	SMALL
Socioeconomics	SMALL	SMALL	SMALL	SMALL
Environmental Justice	SMALL	SMALL	SMALL	SMALL
Historic and Cultural Resources	SMALL	SMALL	SMALL	SMALL
Air Quality	SMALL	SMALL - MODERATE	SMALL - MODERATE	SMALL - MODERATE
Human Health	SMALL	SMALL - MODERATE	SMALL	SMALL - MODERATE
Accidents	SMALL - MODERATE	SMALL	SMALL	SMALL
Transmission Corridors	MODERATE	SMALL	MODERATE	MODERATE

9.4 ALTERNATIVE PLANT AND TRANSMISSION SYSTEMS

This section discusses alternatives in each of three system areas for the Lee Nuclear Station. This information is provided to enable a comparison of the environmental impacts of each alternative to those of the selected system.

Subsection 9.4.1 presents alternatives to the plant heat dissipation system. Subsection 9.4.2 evaluates alternatives to the circulating water system. These are presented as alternatives in the areas of intake designs and locations, discharge designs and locations, water supplies, and water treatment. Subsection 9.4.3 presents alternatives to the transmission system. These include alternative corridor routes and alternatives to the selected transmission system design, construction, and maintenance practices.

Each subsection provides an evaluation of alternatives to the selected system based on the guidance provided in NUREG-1555, “Standard Review Plans for Environmental Reviews for Nuclear Power Plants,” for that subsection. Each evaluation identifies those system alternatives that are either environmentally preferable or equivalent to the selected system. Environmentally preferable alternatives are then compared with the selected system on a benefit-cost basis to determine their need to be considered as a preferred alternative. Only systems considered feasible for construction and operation at the Lee Nuclear Site are considered, provided that they:

- Are not prohibited by federal, state, regional, or local regulations, or Native American tribal agreements.
- Are consistent, where applicable, with any findings of the National Pollutant Discharge Elimination System (NPDES) (Reference 4) or the Federal Water Pollution Control Act (FWPCA), commonly referred to as the Clean Water Act (CWA) (Reference 5).
- Are judged as practical from a technical standpoint with respect to the proposed dates of plant construction and operation.
- Are applicable to and compatible with the plant, the service area, and the regional transmission network, where appropriate.

This analysis has two objectives. The first is to identify and verify means to mitigate adverse impacts associated with the selected system. The second is to identify and analyze reasonable alternatives to the selected system and rank them as environmentally preferable, equivalent, or inferior to the selected system. The selected system, with any verified mitigation applied (i.e., measures and controls to limit adverse impacts, if any), is the baseline system against which alternative systems are compared. If no adverse impacts are predicted for the selected system, the review is limited to analyzing the alternative systems to determine their environmental equivalence to the selected system.

9.4.1 HEAT DISSIPATION SYSTEMS

The purpose of the plant cooling system is to dissipate energy to the environment. The condenser creates the low pressure required to drag steam through and increase the efficiency of the turbines. The lower the pressure of the exhaust steam leaving the low-pressure turbine, the more efficiency is gained. The limiting factor is the temperature of the cooling water.

The various heat dissipation system options differ in how the energy transfer takes place and, therefore, have different environmental impacts. Potential alternatives considered are those generally included in the broad categories of “once-through” and “closed-cycle” systems. The once-through method involves the use of large quantities of cooling water, withdrawn from and returned to a large water source after circulating through the main condenser. Closed-cycle cooling systems involve substantially less water usage, because the water performing the cooling is continually recirculated through the main condenser and only makeup water for normal system losses is required. Normal system losses can include evaporation, blowdown, and drift. Evaporation occurs as part of the cooling process in wet systems. The purpose of blowdown is to control solids in the water that accumulate due to evaporation, which helps protect surfaces from scaling or corrosion problems. Drift is liquid water that escapes from the heat dissipation system in the form of unevaporated droplets during operation.

Open-mode systems, discussed here as once-through cooling, are excluded per the discussion in Subsection 9.4.1.2.1.

The analysis of each alternative heat dissipation system considers various factors during construction and operation. These factors are discussed below for the selected Lee Nuclear Station heat dissipation system and for alternative designs, and a summary comparison is presented in Table 9.4-1.

9.4.1.1 Selected Heat Dissipation System

This subsection describes the selected heat dissipation system, identifies any associated adverse impacts, and addresses the expected mitigation.

Lee Nuclear Station has two cooling systems that transfer heat to the environment during normal modes of plant operation. These systems are the service water system (SWS) and the circulating water system (CWS), as described in Sections 3.4 and 5.3. Heat generated during each operational mode can be released by these systems to the atmosphere and to the Broad River. Operation outside of normal modes of plant operation is not covered in this subsection.

The CWS uses three mechanical-draft cooling towers per unit to dissipate heat. The mechanical-draft cooling towers use fans to force convection within the cooling tower. These cooling towers discharge to the outfall structure on the Broad River via the blowdown pipe.

The CWS makeup is provided by the raw water system that pumps makeup water from the Make-Up Pond A to the CWS, and makeup water to the clarification system used in the service and demineralized water systems. Water chemistry is maintained in the circulating water by the turbine island chemical feed system. The normal concentration of dissolved solids in the circulating water is four cycles of concentration (Section 5.2.3.1).

The environmental impacts of the selected heat dissipation system on the atmosphere and terrestrial ecosystems during unit operation, as described in Subsection 5.3.3, include:

- Heat dissipation to the atmosphere.
- Length and frequency of elevated plumes.
- Frequency and extent of ground level fogging and icing in the site vicinity.

- Solids deposition (i.e., drift deposition) in the site vicinity.
- Cloud formation, cloud shadowing, and additional precipitation.
- Interaction of vapor plume with existing pollutant sources located within 1.25 miles (mi) of the Lee Nuclear Site.
- Ground level humidity increase in the site vicinity.

9.4.1.2 Screening of Alternatives to the Selected Heat Dissipation System

Due to the nature of the site selected, only a limited number of cooling system alternatives is feasible. An initial environmental screening of the alternative designs eliminated those systems that are obviously unsuitable for use in a new facility. The screening criteria include on-site land use requirements and terrain conditions, water use requirements, and legislative restrictions that might preclude the use of any of the alternatives.

The AP1000 standardized design utilizes a turbine exhausting to a shell-and-tube surface condenser. Circulating water is used for the condenser cooling medium. For maximum thermal performance, the AP1000 turbine low pressure stage design requires operation at an average condenser backpressure of 3 inches (in.) Hg absolute.

Because the AP1000 standardized design uses a specific condenser and turbine design, the compatibility of tower technology with the AP1000 design is an essential element of the alternative evaluation screening. In addition, it is important to consider that the fundamental goal of the 10CFR Part 52 process is to maintain standardization in plant design.

The following alternative heat dissipation systems have been identified for screening:

- Once-through systems.
- Closed-cycle systems.
- Cooling ponds.
  - Dry cooling towers.
  - Wet dry cooling towers.
  - Spray systems.
  - Natural draft wet cooling towers.
  - Mechanical draft wet cooling towers.

9.4.1.2.1 Once-through Systems

Based on the relatively low flow in the Broad River, a once-through cooling system is not considered feasible for the Lee Nuclear Station. EPA 316 regulatory limits for cooling water withdrawal and thermal releases would severely impact plant operation during most months of the year. Therefore, this system is inferior to the selected heat dissipation system.

9.4.1.2.2 Cooling Ponds

A cooling pond is not considered feasible at the Lee Nuclear Site because the surrounding topography does not lend itself to construction of a pond of adequate size (approximately 7000 acres [ac.]) to dissipate the waste heat from the units. Therefore, this system is inferior to the selected heat dissipation system.

9.4.1.2.3 Dry Cooling Towers

Dry cooling is an alternative cooling method in which heat is dissipated directly to the atmosphere using a tower. This tower transfers the heat to the air by conduction and convection rather than by evaporation. Heat transfer is then based on the dry-bulb temperature of the air and the thermal transport properties of the piping material. A natural- or mechanical-draft configuration can be used to move the air.

Because there are no evaporative or drift losses in this type of system, many of the problems of conventional cooling systems are eliminated. For example, there are no problems with blowdown disposal, chemical treatment, fogging, or icing when dry cooling towers are utilized. Although elimination of such problems is beneficial, most currently available dry tower technologies require condenser and turbine designs outside the scope of the AP1000 standardized design.

While a wet tower uses the processes of evaporation, convection and conduction to reject heat, a dry tower is dependent on conduction and convection only. As a result, heat rejection is limited by the dry bulb temperature at the site. The higher the ambient temperature at the site, the higher the steam saturation pressure, and consequently, the higher the turbine backpressure will be.

Since dry towers do not rely on the process of evaporative cooling as does the wet tower, larger volumes of air must be passed through the tower compared to the volume of air used in wet cooling towers. As a result, dry cooling towers need larger heat transfer surfaces and must be larger in size than comparable wet towers.

The U.S. Environmental Protection Agency (EPA) rejects dry cooling as the best available technology for a national requirement because the technology carries costs that are sufficient to pose a barrier to its entry to the marketplace for some projected new facilities. Dry cooling technology also poses some detrimental effects on electricity production by reducing the energy efficiency of steam turbines.

The increased exhaust gas emissions of dry cooling tower systems as compared with wet cooling tower systems provide additional support for EPA's rejection of dry cooling as the best available technology. Dry cooling technology results in a performance penalty for electricity generation that is likely to be significant under certain climatic conditions. A performance penalty is applied by the EPA to any technology (i.e., dry cooling) that requires the power producer to use more energy than would be required by another available technology (i.e., recirculating wet cooling) to produce the same amount of energy. Therefore, EPA does not consider dry cooling technology as the best available technology for minimizing adverse environmental impacts.

Two technologies are used in dry coolers: the air-cooled condenser and the indirect dry cooling tower.

The most common form of dry cooling tower technology is the air-cooled condenser (ACC). In this design, steam from the turbine exhaust is piped through large ducts to a separate air-cooled condenser located next to the turbine building. Fans draw air through cooling coils to reject heat from the exhaust steam. As the steam loses its heat, it condenses to water and is returned as steam generator feedwater.

Incorporation of the ACC technology would require large-scale changes to the standardized design. The ACC is not compatible with the condenser and turbine design described in the certified design and would require extensive revision to fundamental design elements of the main steam, feedwater and heater drains systems. Essential elements of the turbine building foundation, structure and turbine missile evaluation would require revision.

The cooling units for an ACC must be located in immediate proximity to the turbine building and the size of the units requires extensive land use. As stated previously, dry towers require much larger heat transfer surfaces and are much larger in size than comparable wet towers. Extensive changes to the AP1000 turbine building footprint would be required to accommodate this design.

Because of the larger volume of air required for heat rejection, fan horsepower requirements for the ACC are typically 3 to 4 times higher than wet towers. This will significantly decrease the net electrical output of the unit. In addition, the AP1000 standardized electrical distribution design is not sized to accommodate these additional loads.

In addition to the impact on the AP1000 design, an ACC is not as thermally efficient as a wet cooling tower system, which would have a negative impact on plant performance. Dry cooling designs are unable to maintain design plant thermal performance during the hottest months of the year. Depending on weather conditions and the design heat rate, a plant can experience capacity reductions of up to 10 to 25 percent on the steam side alone, because of increased turbine backpressure.

As previously stated, the AP1000 turbine low pressure stage design requires operation at an average condenser backpressure of 3 inches (in.) Hg absolute to maintain design electrical output and has operational limits at 5 inches Hg absolute. State-of-the-art ACC designs can not operate within these parameters during the summer temperature conditions expected at the Lee Nuclear Station. This would increase the probability of forced down powers and turbine trips. It is important to note that ACC designs in current use in the United States are combined with turbines specially designed to operate at these higher backpressures.

Incorporation of the ACC technology at the Lee Nuclear Station would extensively revise the AP1000 design reviewed during the 10CFR 52 Design Certification process. The revisions would impact safety-related design attributes, such as the offsite dose analysis. An ACC can not be integrated with the standardized turbine generator design without greatly increasing the probability of plant transients during summer operation. Therefore, this system is inferior to the selected heat dissipation system.

The second type of dry cooling tower technology is the indirect dry tower. In this design, the wet tower in the AP1000 standardized design is replaced with a large air-water heat exchanger.

Circulating water from the condenser is piped through metal-finned tubes and fans force air over the tubes to reject heat to the air and atmosphere.

The advantages of indirect dry cooling towers are the same as the ACC design. The requirement for cooling water is eliminated and there are no problems with blowdown disposal, chemical treatment, icing or fogging.

The most significant disadvantage of indirect dry cooling towers is the size of the units. Indirect dry cooling is much less efficient than air cooled condensers because heat rejection is dependent on two thermal interfaces (steam/CWS/air), rather than the single interface used in the ACC (steam/air). Since indirect cooling has never been utilized at a 1000 MWe fossil or nuclear unit in the United States, establishing the actual size of the unit is difficult. However, based on relative efficiencies, an indirect dry cooling tower would require much more space than an ACC and would dwarf the footprint of a wet cooling tower.

Because of the loss of efficiency, the indirect dry cooling tower requires an even larger volume of air for heat rejection than the ACC. Therefore, fan horsepower requirements would increase beyond the ACC design, which is already 3 to 4 times greater than wet towers. An indirect cooling tower would decrease the plant net electrical output even more than an ACC. And as stated previously, the standardized electrical distribution design for the AP1000 is not sized to accommodate either the ACC or indirect dry cooling tower fan horsepower requirements.

The ACC and indirect dry cooling towers both rely upon sensible heat rejection for cooling, so the turbine backpressure limitations in the ACC technology discussion are applicable to the indirect dry cooling design. Like the ACC, indirect dry cooling towers in current use are combined with turbines specially designed to operate at higher backpressures than the AP1000 standard design.

Incorporation of the indirect dry cooling tower technology at the Lee Nuclear Station is not possible because the site cannot provide the land usage required for the towers. The tower fan horsepower requirements greatly exceed the AP1000 standardized electrical distribution design and would substantially decrease the net electrical output of the plant. The indirect dry cooling towers would also require changes to the AP1000 design that would impact the 10CFR 52 certification of the plant design and negatively impact utility efforts towards plant standardization. Therefore, this system is inferior to the selected heat dissipation system.

9.4.1.2.4 Wet Dry Cooling Towers

A wet dry (Hybrid) cooling tower functions, in principle, like a wet cooling tower. An additional dry section, installed in the upper or lower part of the cooling tower, reduces the visible plume by heating wet air coming from the lower wet zone. Fans are located in both the wet section and the dry section of the tower. In the dry section, the fans are located above the wet level in front of the heat exchangers. The hyperbolic shell achieves a natural-draft effect that helps reduce power consumption. Lower operating costs are achieved by using two-speed motors (Reference 3).

Wet dry cooling towers provide the high efficiency advantages of wet cooling towers as well as the reduced visible plume which is characteristic of dry cooling towers. When the ambient temperature is low, the wet dry cooling tower may be operated as a dry cooling tower, eliminating water consumption and plume production. The wet dry cooling tower traditionally uses air-cooled steel coils in tandem within the evaporative section of the cooling tower. New non-metallic heat exchanger technologies improve corrosion resistance and may be used to minimize cost and fouling.

The dry cooling tower section of the system is not as efficient as the wet cooling tower section because dry cooling requires movement of a large amount of air through the heat exchangers. This reduces the net electrical power available for distribution. Consequently, replacement generating capacity would be needed to offset the loss in efficiency from dry cooling, resulting in increased environmental impacts. This alternative is not considered environmentally equivalent or preferable to the wet mechanical-draft cooling tower selected system.

The noise impacts from the wet dry towers exceed those from the wet mechanical-draft cooling towers. The anticipated noise level for the wet dry cooling towers is 65 A-weighted decibels (dBA) at a distance of 1000 ft. In the North Anna Unit 3 draft environmental impact statement, the staff states that the noise level for that unit's wet dry cooling towers, as provided in the plant perimeter envelope (PPE), is 65 dBA at a distance of 1000 feet (ft.). Subsection 5.3.4 states that the mechanical-draft cooling towers selected for Lee Nuclear Station generate approximately 85 dBA in proximity during operation, which attenuates 55 dBA at a distance of 1000 ft.

The EPA does not consider wet dry cooling systems as a candidate best available technology for heat dissipation at new generating plants of the size proposed for the Lee Nuclear Site. Reasons include the lack of adequate demonstration of this technology's use at similarly sized power plants.

Since the dry cooling section of the wet dry cooling tower recovers the moisture in the tower plume and provides some rejection of sensible heat, the water requirements for wet dry towers can be less than wet towers. However, the water conservation effect is much less pronounced during hot weather conditions, when plume formation is minimal and the ambient temperatures limit heat rejection from the dry cooling section. Unfortunately, these are the conditions where water consumption is most desirable at the Lee Nuclear Station.

In addition, most of the advantages to be gained by wet dry towers are in the areas of reduced fogging and icing. Neither of these problems is of sufficient magnitude at the Lee Nuclear Site to justify a much higher cost for wet dry towers. The higher cost of wet dry cooling towers is incurred in the form of less net electrical power for distribution (i.e., the power required to run the fans of both the wet and the dry sections of the tower is greater compared with the power required by the selected system). Therefore, this system is inferior to the selected heat dissipation system.

9.4.1.2.5 Closed Cycle Spray Systems

A closed-cycle spray system is composed of a spray canal system approximately 2.5-mi. long and 200-ft. wide. During operation, water is sprayed upward at between 15 and 20 ft. The system's efficiency is a very strong function of the wet-bulb temperature alone. Because heat transfer coefficients vary as much as 50 percent for wet-bulb temperature variations between 40ºF and 80ºF, winter use requires a minimum canal size large enough for the system to operate in the low winter wet-bulb temperatures. Hourly wet-bulb temperature variations change the condenser intake temperature, and thus affect the power production efficiency.

The atmospheric effects of closed-cycle spray systems are fogging and icing. These effects are largely dependent on the quantity of evaporation of the spray effluent and the absolute humidity deficit of the atmosphere. Therefore, the expected plume lengths are greater than those estimated for cooling towers because of the usually lower ambient temperature and greater amount of moisture within the near-surface layer, where most of the effluent is dispersed.

The aesthetics of closed-cycle spray systems are reasonable. The operation of a spray canal increases noise levels at the plant site by a small amount. This increase is due to motors and the falling water. Normally acceptable noise levels occur at the site boundary.

Closed-cycle spray systems were not considered as an alternative cooling means for the Lee Nuclear Site because of the large land requirements for canals or spray ponds, which can only be used as a cooling medium. Therefore, this system is inferior to the selected heat dissipation system.

9.4.1.3 Potential Alternatives to the Selected Heat Dissipation System

Based on the results of the screening, the following alternatives are evaluated in more detail for use at the Lee Nuclear Site:

- Circular mechanical-draft cooling towers (selected).
- Rectangular mechanical-draft cooling towers.
- Natural-draft cooling towers.

A summary of the screening is presented in Table 9.4-1. Table 9.4-5 provides a cost comparison of the alternative heat dissipation systems. The Lee Nuclear Station heat dissipation system design, circular mechanical-draft cooling towers, is described in Subsection 9.4.1.1.

Rectangular mechanical-draft cooling towers have features similar to those of circular mechanical-draft cooling towers. The two mechanical-draft towers have the same makeup and intake velocity requirements, blowdown requirements, chemical concentration of blowdown water, consumptive use of river water, fogging/icing issues, noise considerations, and salt discharges. Also, the efficiency of the circular and rectangular mechanical-draft cooling towers is very similar. Land use for rectangular mechanical-draft cooling towers is 93 ac. larger than for circular mechanical-draft cooling towers. In addition, economic costs for the rectangular cooling towers are greater than for the selected heat dissipation system (rectangular mechanical-draft cooling towers cost approximately $22,881,425 more than circular mechanical-draft cooling towers, in 2007 dollars). The increase in necessary land use ultimately increases the effect on nearby wildlife and could cause increased land erosion, which increases the amount of silt in the river. The increases in erosion, silt, and harmful effects on wildlife make this alternative environmentally inferior to the selected system.

The natural-draft cooling towers have features similar to those of the circular mechanical-draft cooling towers. Makeup requirements, intake velocities, river consumptive use, construction land needs, and length/frequency of plumes are all similar for both options. Natural-draft cooling towers are more efficient as compared to circular mechanical-draft cooling towers, due to the power penalty associated with supplying electricity to the fan motors of the mechanical-draft cooling towers (natural-draft towers do not have such mechanical needs). However, this difference does not warrant the selection of natural-draft towers over the selected system. The natural-draft cooling towers cost more than the selected system (natural-draft cooling towers cost approximately $5,459,265 more than circular mechanical-draft cooling towers, in 2007 dollars).

In addition, the visual impact of the cooling towers is much greater for the natural-draft design (approximately 500-ft. tall) than for the mechanical-draft design. The increased discharge temperatures and visual disturbance caused by the natural-draft cooling towers being taller than the circular mechanical-draft cooling towers makes this alternative environmentally inferior compared to the selected circular mechanical-draft cooling towers.

9.4.2 CIRCULATING WATER SYSTEMS

The CWS is an integral part of the heat dissipation system discussed in Subsection 9.4.1. The CWS provides the interface between the main condenser and the heat dissipation system. This subsection describes the selected CWS design configuration and alternatives to the following components of the Lee Nuclear Station CWS:

- Intake systems
- Discharge systems
- Water supply
- Water treatment

9.4.2.1 Selected Circulating Water System

The selected intake system for the CWS is described in Subsections 3.4.2.1 and 5.3.1. The selected water intake system is composed of four parts: (1) a river intake structure, (2) piping from the river intake structure to the Make-Up Pond A, (3) the Make-Up Pond A, and (4) a makeup intake structure for pumping water to the plant from the Make-Up Pond A. The following discussion focuses only on the river intake structure and the piping to the Make-Up Pond A because the other design features of the selected CWS and the alternative systems are identical.

The environmental effects of the selected intake system on the aquatic ecology and the physical impacts, such as scouring, silt build-up, and shoreline erosion caused by the flow field during unit operation are discussed in Subsection 5.3.1. Environmental impacts for the intake system portion of the selected CWS are SMALL, and no mitigation is warranted.

The selected discharge system for the Lee Nuclear Station CWS is described in Subsections 3.4.2.2 and 5.3.2. Evaporation from the cooling towers is discharged to the atmosphere, while blowdown from the cooling towers is discharged to the Broad River. This discharge meets the thermal and chemical requirements of state and federal regulations, as discussed in Subsections 3.4.2.2 and 5.3.2.

The environmental effects of the selected discharge system on the physical impacts and the aquatic ecology are discussed in Subsection 5.3.2. Environmental impacts for the discharge system portion of the selected CWS are SMALL, and no mitigation is warranted.

The raw water supply for the Lee Nuclear Station is from the Broad River. Sufficient volume is provided for maximum system requirements, and intake structure geometry is designed to function under the worst expected river and reservoir conditions, as described in Subsection 9.4.2.2.4.

As discussed above, environmental impacts for the water supply for the selected intake system of the CWS are SMALL, and no mitigation is warranted.

The selected water treatment, or circulating water chemistry, for the Lee Nuclear Station CWS is maintained by the turbine island chemical feed system, as described in Subsection 3.3.2. Turbine island chemical equipment injects the required chemicals into the circulating water downstream of the CWS pumps. The chemicals used can be divided into three categories based on function: (1) biocide/algaecide, (2) pH adjuster, and (3) silt dispersant. The biocide/algaecide, pH adjuster, and dispersant are metered into the system continuously or as required to maintain proper concentrations. The biocide and algaecide application frequency may vary with seasons.

9.4.2.2 Alternatives to the Selected Circulating Water System

The purpose of this subsection is to identify and analyze reasonable alternatives to the selected intake, discharge, water supply, and water treatment systems of the CWS. These alternatives are ranked as environmentally preferable, equivalent, or inferior to the selected system. Account is taken of the kind and magnitude of environmental impacts and the efficiencies and economics of the alternatives.

The analysis of each alternative system considers various factors during construction and operation, for comparison with those of the selected system. This subsection provides separate descriptions of the alternative intake system, discharge system, water supply, and water treatment system features, including comparative evaluation summary data for each alternative.

9.4.2.2.1 Alternatives to the Selected Intake System

The following river intake facilities are considered:

- Bankside river intake structure (selected).
- Off-river intake structure on an open-ended approach canal.
- Perforated pipe intake with off-river pump structure.
- Infiltration bed intake with off-river pump structure.

In the process of considering alternative intake systems, the following six methods for screening fish and debris are considered:

- Vertical traveling screens (selected)
- Fixed screens
- Revolving drum screens
- Psychological screens
- Perforated pipe
- Infiltration bed

The first four screening systems are applicable to intake structures with integral screening devices.

Any alternative intake system design withdraws makeup water from the same source body as does the selected intake system design, i.e., the Broad River. To avoid recirculation, the intake structure for the Lee Nuclear Station units is located upstream of the discharge point. Alternative intake system locations that were evaluated include placement at the shoreline or in an offshore intake structure. A detailed comparative evaluation of the intake systems has been performed and reported in, "Duke Power Company Project 81, Cherokee Nuclear Station, Environmental Report," Amendment 4 (Reference 1). A summary comparison of the alternative intake systems is provided in Table 9.4-2. No environmentally preferable alternative to the selected intake structure was identified.

No improvements are apparent where substitution of components or modifications to the size or function of components would improve the operability of the system for its intended purpose.

The hydrodynamics of the selected intake system are planned to generate a smooth, continuous source of water to the intake structure. Additional precautions were incorporated into the intake canal so that water would flow under the worst combination of river supply and weather conditions expected. The intake structure is located on the west bank of the Broad River, approximately 1.5 mi. upstream from the Ninety-Nine Islands Dam. This location ensures river flows that are sufficient for cooling purposes in the event that the dam fails and river flow decreases. The only other location considered for the intake structure was a position 800 ft. upstream from the Ninety-Nine Islands Dam. However, after considering the channel stability experienced in the vicinity of this location and the cost of constructing and maintaining a control dike, this alternative location was not selected.

The physical effects of the selected water intake system are addressed in Subsection 5.3.1. Construction and operation of this system have SMALL environmental impacts on groundwater, physical alterations of local streams and wetlands, and downstream water quality as a result of erosion and sedimentation.

The selected system's pumping facilities present SMALL environmental impacts, as described in Subsection 5.3.1. No environmentally superior or equivalent alternative method of intake defouling, including chemicals, has been identified. No adverse impacts are identified, and no mitigation is warranted.

The selected bankside river intake structure requires only 1 ac. of land and disturbs only 0.5 ac. during construction. Due to the orientation of the structure, silt and debris do not present issues requiring mitigation. Also, river channel integrity is protected by constructing an artificial vertical bank. Industry long-term operating experience with structures essentially of this type allows prediction of maintenance and operating characteristics. Because no alternative design is environmentally desirable, costs were not quantified. For these reasons, the bankside river intake structure is the selected system for Lee Nuclear Station.

9.4.2.2.1.1 Bankside River Intake Structure (Selected)

This selected system design and environmental impacts are described in Subsections 3.4.2.1 and 5.3.1.

The makeup water system replaces water lost from the cooling towers due to evaporation and blowdown. The intake structure is located on the west bank of the Broad River, approximately 1.5 mi. upstream from the Ninety-Nine Islands Dam. This location ensures river flows sufficient for cooling purposes in the event that the dam fails and the river flow decreases. The river intake structure serves as a platform to support trash racks, traveling screens, pumps, motors, and other equipment. As described in Section 3.4, the pumps located at the river intake structure transfer maximum flow of 60,000 gallons-per-minute (gpm) to the intake Make-Up Pond A, where a second set of pumps is located. These pumps are sized to supply the required makeup water to the cooling tower basin. The maximum flow rate through the traveling screens located in front of each pump is 20,000 gpm, with a maximum velocity of less than 0.5 foot-per-second (ft/sec) for all river flows above the 508 ft. mean sea level (msl) elevation, which is the approximate low-water pumping elevation. All intake water pumped from the Broad River passes through a curtain wall, stop log assemblies, bar screens, and traveling screens designed to minimize uptake of aquatic biota and debris. Each traveling screen has fish collection and return capability. The screens are sized so that the average through-screen velocity is in accordance with Section 316(b) of the Clean Water Act (Reference 5). The traveling screens are modified "Ristroph" design (or equivalent) fish-handling screens with Fetcher-type fish-friendly buckets on each screen basket. The screens are equipped with dual-pressure spray header systems and separate fish and debris troughs. The fish and debris troughs are supplied with a supplemental flow sufficient to move the fish through a fish return trough. The fish return trough exits the intake structure on the downriver side, and returns the fish to the riverine section of the Broad River downstream of the intake structure. Debris collected by the trash racks and traveling screens is collected and disposed of as solid waste by other commercial means. Water from screen backwashing is returned to the structure at the screen forebay.

The traveling screens are protected by a rack structure. The upstream rack is situated at a shallow angle to the river flow and consists of closely spaced, heavy horizontal bars, allowing easy deflection of large debris. Racks parallel to the river flow consist of closely spaced, heavy horizontal bars, again allowing for large debris to be deflected. The downstream rack consists of widely spaced bars that provide nominal protection from debris and allow easy passage of fish and other swimming organisms. The effect of the sweeping river current through the rack structure and the low approach velocity to the traveling screens provides for minimum fish impingement. Three other features that reduce fish impingement are appropriate location, location of traveling screens flush with the river bank, and an approach velocity to the screen of 0.5 ft/sec or less. For these reasons, the bankside structure has a negligible effect on fish entrapment or impingement. For additional details, see Figures 3.4-1 and 5.3-1.

Costs of this system include the rack structure, river intake structure including pumps and screens, piping to the Make-Up Pond A, access road, construction cofferdam, and excavation.

A cellular sheet-pile cofferdam or similar structure is built out from the river bank so that the intake structure is constructed in the dry with no adverse impact on the river water during construction. A major portion of the slope protection around the structure is completed before the cofferdam is removed. No permanent or temporary adverse environmental impacts on the river are expected. The effect of increased noise and movement of men, materials, and machines during construction is essentially the same as that of construction of the remainder of the plant. In addition, any slight increase in the noise level by any alternative is caused mainly by operation of the water pumps and is not expected to adversely affect the surrounding area.

As discussed above, the selected intake structure is located on the west bank of the Broad River, approximately 1.5 mi. upstream from Ninety-Nine Islands Dam. This location provides river flows that are sufficient for cooling purposes in the event that the dam fails and river flow decreases.

The bankside river intake structure requires approximately 1 ac. of land and disturbs less than 0.5 ac. of river bottom during construction. Negligible problems with silt and debris are anticipated due to orientation and location. River channel stability is also assured by use of an artificially created vertical bank. Long-term operating experience with structures essentially of this type allow prediction of maintenance and operating characteristics. For these reasons, the bankside river intake structure is the selected intake facility.

9.4.2.2.1.2 Off-River Intake Structure on an Open-Ended Approach Canal

The river intake structure is located at the end of an intake canal. A submerged weir and training wall are located at the canal entrance, and the intake structure is equipped with trash racks and traveling screens to handle debris. The submerged weir is necessary to route the stream bed load by the canal entrance. Use of the approach canal without the weir would result in extreme silt accumulation in the canal. The velocity in the 700-ft.-long canal is less than 0.5 ft/sec and allows most fish that swim in to also swim out. The canal allows some silt to settle before it reaches the intake structure and, therefore, requires periodic silt removal during operation. Use of the canal situates the intake structure closer to the plant yard, resulting in better protection from floodwaters, a shorter piping system, lower pumping costs, improved construction conditions, and easier access. For location and details, see Figure 9.4-1.

Costs of this system include the submerged weir, training wall, canal, intake structure including pumps and screens, piping to the Make-Up Pond A, access road, periodic silt removal operation, and cofferdams for canal entrance facilities.

The alternative off-river intake structure incorporates a submerged weir and training wall, which directs the river stream away from the intake waterway. This device should aid in carrying fish past the entrance. Most fish that enter the canal can swim against its current of less than 0.5 ft/sec and reenter the flow of the river just as they would at any other inlet on the river. The intake structure has an inlet velocity of less than 0.5 ft/sec and also has bar racks to help keep larger fish and debris out. The traveling screens keep all but the smallest fish from entering the pump well.

Because the structure is connected to the river by the canal, it can be built in the dry with no effect on the river. Construction of the canal entrance facilities requires less temporary river protection than the selected facility, because the canal can also be built in the dry before it is connected to the river channel. When the mouth of the canal is opened, the turbidity of the river is slightly increased for only a short time with no permanent adverse impact on the river. The effect of increased noise and movement of men, materials, and machines during construction is essentially the same as that of construction of the remainder of the plant. In addition, any slight increase in the noise level by any alternative is caused mainly by operation of the water pumps and is not expected to adversely affect the surrounding area.

The off-river intake structure on an open-ended approach canal requires 4 ac. of land and does not disturb more than 0.5 ac. of river bottom during construction. Problems with silt are anticipated in the canal and periodic dredging operations are required. Possible problems with river channel stability and silt removal operations are the primary reasons for not selecting this system.

The greater land requirements associated with an open-ended canal, as compared with the selected system, adversely impact the surrounding environment. Silt removal and dredging operations for an open-ended canal increase the monetary and time costs as compared to the selected system. For these reasons this system is not selected.

9.4.2.2.1.3 Perforated Pipe Intake with Off-River Pump Structure

The perforated pipe intake with off-river pump structure consists of a perforated pipe intake located in the river channel, piping to a pump structure, the pump structure, and the intake water pumps including piping for backwashing the perforated pipe. The currents of the river carry both fish and debris past the openings in the perforated pipe. Inlet velocities of less than 0.5 ft/sec assure sufficient protection for all fish against impingement on the pipes. Stability for the channel in this area is provided by a thick concrete mat, which anchors the pipes in the river. This concrete mat is anchored into the rock underlying the river bed. Stiffened and streamlined pipe heads provide protection from floodwater debris loading. Four steel pipes, each with a diameter of 3 ft., carry water to the pumping structure. These pipes are fully encased in concrete in the river channel. The concrete pumping structure supports the intake pumps and is located approximately 150 ft. from the water’s edge. The frequency of backwashing the perforated pipes is determined by head loss due to debris loading. The location is at the same point of the river as the selected intake system. For details, see Figure 9.4-2.

Costs of this system include perforated pipe, concrete foundation, piping to the pump structure, the pumping structure including pumps and backwash piping, piping to the Make-Up Pond A, access road, and construction cofferdam.

The perforated pipe intake with off-river pump structure utilizes river currents to sweep fish past the plotted openings in the pipe. With an inlet velocity of less than 0.5 ft/sec, fish entrapment should not occur.

A cellular sheet-pile cofferdam or similar structure is constructed out from the river bank so that the anchorage system, concrete mat, perforated pipe, and piping to the pump structure can be built in the dry with no adverse impact on the river water during construction. Temporary adverse impacts on the river are SMALL. The effect of increased noise and movement of men, materials, and machines during construction is essentially the same as that of construction of the remainder of the plant. In addition, any slight increase in the noise level by any alternative is caused mainly by operation of the water pumps and is not expected to adversely affect the surroundings.

The perforated pipe intake with off-river pump structure has SMALL impacts on fish and plankton. Turbidity of the river may increase slightly during backwash operations. The facility requires approximately 1 ac. of land and disturbs less than 0.5 ac. of river bottom during construction. River currents are expected to keep problems with silt to a minimum. Debris may cause some damage to the intake during flood conditions. The presence of the perforated pipe in the channel causes localized stream flow alterations, which may affect sediment distribution in the channel bottom. No effective means is available to inspect and repair the perforated pipe intake and no operating experience is available for prediction of such maintenance. Lack of operating experience within the industry, possible damage by debris, and lack of inspection and maintenance capability are the primary reasons for not selecting this system.

9.4.2.2.1.4 Infiltration Bed Intake with Off-River Pump Structure

The infiltration bed intake with off-river pump structure consists of an infiltration bed, piping to the pump structure, the pump structure, and the intake water pumps including piping for backwashing the infiltration bed. Negligible intake velocities assure no impingement of free-swimming organisms. Backwashing of the bed forces entrapped sediment and debris up into the river current, allowing it to continue downstream. Water from numerous smaller, perforated pipes in the bed is collected into four 3-ft.-diameter steel pipes, which carry water to the pumping structure. These pipes are fully encased in concrete in the river channel. The concrete pumping structure supports the intake pumps and is located approximately 150 ft. from the water's edge. The frequency of backwashing the perforated pipes is determined by head loss due to debris loading. The location is at the same point of the river as the selected intake system. For details, see Figure 9.4-3.

Costs of this system include washed crushed stone, perforated pipe and headers, piping to the pump structure, the pumping structure including pumps and backwash piping, piping to the Make-Up Pond A, access road, and construction cofferdam.

The infiltration bed intake with off-river pump structure utilizes low inlet velocities during intake of river water. Due to these low velocities, no problem is foreseen with fish entrapment.

A cellular sheet-pile cofferdam or similar structure is constructed out from the river bank so that the perforated pipe, gravel filter, and piping to the pump structure can be built in the dry. Slightly less than one acre of the river bottom is excavated, approximately 6 ft. deep, for use as the filter bed. Due to the large cofferdam size for this alternative, some additional scour of the river bottom is anticipated adjacent to the cofferdam. No permanent impacts on the river are expected. The effect of increased noise and movement of men, materials, and machines during construction is essentially the same as that of construction of the remainder of the plant. In addition, any slight increase in the noise level by any alternative is caused mainly by operation of the water pumps and is not expected to adversely affect the surroundings.

The infiltration bed intake with off-river pump structure has SMALL effects on fish and plankton. Heavy sediment load in the river is expected to require frequent backwashing, which causes a significant increase in turbidity downstream of the intake. The facility requires approximately 1.5 ac. of land and disturbs less than 1.5 ac. of river bottom during construction. Additional scour may also result from use of the large cofferdam. Additional problems include possible scour of the bed by river currents. No operating experience is available with this system and no backwash system has been demonstrated to effectively cleanse such an infiltration bed in a turbid river. For the above reasons, this system is not selected.

9.4.2.2.2 Screening Alternatives

9.4.2.2.2.1 Vertical Traveling Screens (Selected)

The design and operation of the selected traveling screens are described in Section 3.4. The screen is an endless belt of 3/8-in. mesh panels that travel vertically, enabling the panels to pass through a backwash jet spray for cleaning. The debris is washed into a trough and collected at one end of the structure. The collected debris is transported away from the structure for appropriate disposal. The mesh is sized by the maximum particle size that can be tolerated by the system, and by the size of the smallest fish to be protected.

9.4.2.2.2.2 Fixed Screens

This system is practicable only where suspended debris is negligible, so that cleaning requirements are minimal. When the screen is lifted out for spray cleaning, a backup screen must be dropped into place just behind the screen raised for cleaning. The process of cleaning the fixed screens is very time-consuming and not cost-effective as compared to the selected system.

9.4.2.2.2.3 Revolving Drum Screens

The normal operation of this system prevents fish from entering the system but discharges debris into the downstream flow. Discharged debris into the downstream flow negatively impacts the intake structure and allows debris to enter various pumps and components. This alternative system is not selected due to its inability to adequately obstruct debris, as compared to the selected system.

9.4.2.2.2.4 Psychological Screens

These systems, such as electrically charged screens, air bubble screens, sound screens, and light screens, aid somewhat in diverting fish away from the intake but do not prevent debris from entering the structure. This alternative system is not selected due to its inability to adequately obstruct debris, as compared to the selected system.

9.4.2.2.2.5 Perforated Pipe

This system consists of perforated pipe placed in the river channel and oriented in such a manner that the passing current sweeps debris and most suspended solids downstream. Approximately 25 percent of the pipe area is utilized for water intake. Debris larger than the 3/8-in.-wide inlet slots is excluded from the pipe. Construction and implementation of this system disrupt the riverbed, presenting negative impacts on the environment. Therefore, a perforated pipe system is not a preferable screening system alternative to the selected system.

9.4.2.2.2.6 Infiltration Bed

This system consists of perforated pipe embedded in a gravel bed beneath the river bottom. The size of particle screened depends upon gradation of the filter medium and pipe perforation size. Trapped particles are removed by backwashing the system and allowing the river flow to carry the particles downstream. Construction and implementation of this system disrupt the riverbed, presenting negative impacts on the environment. Therefore, an infiltration bed is not a preferable screening system alternative to the selected system.

9.4.2.2.2.7 Selected Screening System

The vertical traveling screen system is the proposed screening system for the site. The rotation allows for aquatic life to be safely washed away by backwash into a trough that leads back to the river. The mesh spacing of the screens is small enough to block all but the smallest fish from entering the system. The other screening alternatives have been rejected for the following reasons:

- Fixed screens would require more maintenance than the proposed system.

- Revolving drum screens would displace debris into the downstream flow.
- Psychological screens do not guarantee that fish would be diverted from the intake and they have no means of stopping debris.
- Perforated pipe and infiltration bed construction would cause more of an environmental impact than the selected system.

For all of these reasons, the vertical traveling screen system has been selected for the site.

9.4.2.2.3 Alternatives to the Selected Discharge System

The primary purpose of the discharge system is to disperse cooling tower blowdown into the Broad River to limit the concentration of dissolved solids in the heat dissipation system. The heated water discharge tends to remain at (or move toward) the surface of the Broad River. The discharge forms plumes of warm water that dissipate with distance from the source by rejecting heat to the atmosphere or mixing with cooler ambient waters. Mixing tends to occur more rapidly in rivers than in lakes or reservoirs because of increased turbulence. Also because of turbulence, rivers do not naturally thermally stratify and, as a result, alteration of temperature stratification caused by nuclear power plant water discharges is not an issue. The selected discharge system design is described in Subsections 3.4.2.2 and 5.3.2. The evaluation results for the alternative discharge systems screening are presented in Table 9.4-3. The environmental effects of the selected discharge system are discussed in detail in Subsection 5.3.2.

In general, for plant designs that include cooling towers, the effects were found to be minor. The thermal plume discharged by the Lee Nuclear Station in particular is so small that adverse impacts to biota are not expected.

In winter, fish attracted to the elevated temperature of the Lee Nuclear Station plume could stay an extended time. This could result in accelerated spawning and increased larval mortality from asynchrony with food source development or cold shock of migrant larvae. Drifting benthos, plankton, and larval fish may be impacted passing through the thermal plume at the site during the winter. Any resulting impact is considered SMALL due to the plume size and considering the total populations.

The selected closed-cycle system employing cooling towers is discussed in Subsection 9.4.1. Evaporation from the cooling towers discharges to the atmosphere. Blowdown from the cooling towers is discharged to the Broad River. This discharge meets the thermal and chemical requirements of the state and federal regulations.

The following discharge options are considered:

- Single port spillway apron discharge structure.
- Bankside single port discharge structure.
- River bottom single port diffuser structure.
- Mid river single port diffuser structure (selected).

The Ninety-Nine Islands Dam has eliminated fish migration on this reach of the Broad River. The systems, therefore, have no impact on fish migration. There is also no increase in noise level expected from the discharge structure for this application. Detailed descriptions of the alternative discharge systems evaluated for use at Lee Nuclear Station are provided in the following subsections.

9.4.2.2.3.1 Single Port Spillway Apron Discharge Structure

The single port spillway apron discharge structure consists of a single pipe anchored through a concrete headwall and emptying onto a rocky ledge leading to the river adjacent to the west abutment of the Ninety-Nine Islands Dam spillway apron. Recirculation of water to the intake is prevented by the dam. Average blowdown from the cooling towers is discharged into the Broad River at a rate of approximately 4040 gpm per unit, and the maximum approximate blowdown rate per unit is 14,000 gpm. The alternative discharge structure is shown in Figure 9.4-4.

Construction of the single port spillway apron discharge structure has SMALL effects on the natural surface water body. All construction related to this structure is in the dry and is located outside of the normal water course. The effect of increased noise and movement of men, materials, and machines during construction is essentially the same as that of construction of the rest of the plant.

The blowdown discharge structure is located below the Ninety-Nine Islands Dam at a point where the river bed consists of mainly bedrock. For this reason, river bed scour is not considered to be a problem. The single port spillway apron discharge structure has negligible impacts on the river and the surrounding environment. The economics and simplicity of the selected structure, with its adequate dispersion pattern, lend themselves favorably to a blowdown discharge application. Because construction is accomplished in the dry, this design does not disturb the river bottom. However, the Ninety-Nine Islands Dam is considered a historical site and the addition of a single port spillway apron discharge structure would negatively affect the aesthetics of the historical site. In addition, CORMIX modeling indicates that the single port spillway apron discharge structure alternative does not meet temperature requirements.

9.4.2.2.3.2 Bankside Single Port Discharge Structure

The bankside single port discharge structure consists of a single pipe anchored through a concrete headwall and emptying into the river at or about the water surface of the river. The discharge pipe is sized for an effluent velocity of approximately 5 ft/sec. The structure is located approximately 1200 ft. downstream of the Ninety-Nine Islands Dam.

Sheet-pile cofferdams or similar type structures are built out from the river bank so the discharge structure can be built in the dry with no adverse impact on the river water during construction. A major portion of the slope protection around the structure is expected to be completed before the cofferdam is removed. Permanent or temporary adverse impacts on the river are expected to be SMALL. The effect of increased noise and movement of men, materials, and machines during construction is essentially the same as that of construction of the rest of the plant.

The bankside single port structure is similar to the selected structure in most aspects. Location of the structure approximately 1200 ft. downstream increases the costs compared with those of the selected system. In addition, cofferdam requirements disturb a portion of the river bottom not required for the selected system. Also, CORMIX modeling indicates that the bankside single port discharge structure alternative does not meet temperature requirements. The practicability of the bankside single port discharge structure is so low that a sketch of the preliminary design is not warranted.

9.4.2.2.3.3 River Bottom Single Port Diffuser Structure

The river bottom single port diffuser structure consists of a single exit pipe anchored to the river bottom. Discharge is perpendicular to river flow. The structure is located approximately 1200 ft. downstream of the Ninety-Nine Islands Dam.

Sheet-pile cofferdams or similar type structures are built out from the river bank so the discharge structure can be built in the dry with no adverse impact on the river water during construction. A major portion of the slope protection around the structure is expected to be completed before the cofferdam is removed. No permanent or temporary adverse impacts on the river are expected. The effect of increased noise and movement of men, materials, and machines during construction is essentially the same as that of construction of the rest of the plant.

The river bottom single port diffuser structure has SMALL impacts on the river and the surrounding environment. Its capabilities for mixing are approximately the same as for the previously discussed structures. Additional protected piping is required for this application. Larger cofferdam requirements also disturb a larger portion of the river bottom. Construction and implementation of this discharge system require use of larger cofferdams and disturb a larger portion of the river bottom than required for the selected system, increasing the negative impacts on the environment. For these reasons, this alternative discharge system is not selected. The practicability of the river bottom single port diffuser structure is so low that a sketch of the preliminary design is not warranted.

9.4.2.2.3.4 Mid River Single Port Diffuser Structure (Selected)

The mid river single port diffuser structure consists of a single, 3-ft.-diameter exit pipe that extends into the Broad River at an approximate elevation of 505.1 ft. above msl. This places the diffuser approximately 6 ft. under the normal water level of the river. The diffuser is composed of a steel pipe with sixteen 1-in.-diameter holes per foot over a length of 65 ft., which provides more than 1000 holes. The port is located immediately upstream of the Ninety-Nine Islands Dam, at a position which allows the discharged water to flow directly into the turbine of the hydroelectric station. The selected discharge structure is shown in Figure 5.3-4 Sheets 1 and 2.

The discharge line is installed by divers. Any permanent or temporary adverse impacts on the river are expected to be SMALL. The effects of increased noise and movement of people, materials, and machines during construction are essentially the same as for construction of the other portions of the plant.

The flow from the diffuser exits the pipe at such a position where it immediately mixes into the intake water of the Ninety-Nine Islands turbine structure, and therefore has SMALL impacts on the aquatic life and river temperature. This discharge structure also has a SMALL differentiating impact on river water use because it mixes into the turbine intake. The aesthetic impact on the historical Ninety-Nine Islands Dam is also SMALL, because the discharge structure is located approximately 6 ft. below the normal water level of the Broad River. For these reasons, the mid river single port diffuser structure is the selected system for the site.

9.4.2.2.4 Alternatives to the Selected Water Supply

The selected water supply for the heat dissipation system at the Lee Nuclear Station is the Broad River. No alternative sources of water supply are available. This selected water supply system is designed so that the bottom of the intake channel is at sufficient depth to ensure direct flow from the main river channel to the water intake. As described in Section 5.3, the maximum amount of water introduced into the system from the Broad River is approximately 60,000 gpm for the two operating units. The annual mean flow at the Broad River is 2538 cubic feet per second (cfs). Based on the anticipated maximum intake flow of 60,000 gpm for both operating units, the intake withdraws approximately 5 percent of the annual mean river flow. During low-flow conditions in the river, raw water is pumped from the Make-Up Pond B intake structure to the Make-Up Pond A. For further discussion of the Make-Up Pond B and the Make-Up Pond A, see Section 5.3.

Groundwater was evaluated and not considered a viable alternative water source because the groundwater would not be able to support the large component cooling makeup water requirement of 60,000 gpm for both units.

The environmental impact of using the Broad River water supply during times of normal flow is SMALL. However, low river flow may not supply enough water to the CWS, and therefore, during low-flow conditions in the river, raw water is pumped from the Make-Up Pond B intake structure to the Make-Up Pond A. No environmentally equivalent or superior alternative raw water source is identified. Environmental impacts are SMALL, and no mitigation is needed.

9.4.2.2.5 Alternatives to the Selected Water Treatment System

Evaporation of water from cooling towers leads to an increase in chemical and solids concentrations in the circulating water, which in turn increases the scaling tendencies of the water. The Lee Nuclear Station CWS is operated so that the concentration of total dissolved solids in the cooling tower blowdown is monitored to meet the values on the NPDES permit. The selected water treatment system is described in Subsection 3.3.2. The Broad River is the source of the makeup water for the CWS. Circulating water chemistry, including blowdown and makeup water from the Broad River, is maintained by the turbine island chemical feed system. Turbine island chemical feed equipment injects the required chemicals into the circulating water downstream of the CWS pumps. This maintains a noncorrosive, nonscale-forming condition and limits the biological film formation. This formation reduces the heat transfer rate in the condenser and heat exchangers supplied by the CWS. The SWS cooling towers use the same water treatment chemicals as the CWS.

The chemicals used can be divided into six categories based upon function: (1) biocide, (2) algaecide, (3) pH adjuster, (4) corrosion inhibitor, (5) scale inhibitor, and (6) silt dispersant. The pH adjuster, corrosion inhibitor, scale inhibitor, and dispersant are metered into the system continuously or as required to maintain proper concentrations. The biocide application frequency may vary with seasons. The algaecide is applied, as necessary, to control algae formation on the cooling water.

Additional treatment for biofouling, scaling, or suspended matter reduction through the addition of biocides, antiscalants, and dispersants occurs in the cooling tower basin. Sodium hypochlorite and bromine can be used to control biological growth in the CWS. Sodium hypochlorite is as effective a biocide and alleviates some of the safety concerns associated with storing and using gaseous chlorine. Alternative biocides include hydrogen peroxide or ozone. The final choice of chemicals or combination of chemicals is dictated by makeup water conditions, technical feasibility, economics, and discharge permit requirements. Because the discharges from CWS and the SWS are subject to NPDES permit limitations that consider aquatic impacts, different water treatment chemicals used in the system would be environmentally equivalent.

Because of strict regulation of chemical discharges from steam electric power plants (e.g., EPA regulations at Title 40 Code of Federal Regulations [CFR] 423), water treatment systems for cooling tower blowdown have been developed. All nuclear power plants are required to obtain an NPDES permit to discharge effluents. These permits are renewed every five years by the regulatory agency, either EPA or, more commonly, the state's water quality permitting agency. The periodic NPDES permit renewals provide the opportunity for the issuing agency to require modification of power plant discharges or to alter discharge monitoring in response to water quality concerns. A more detailed discussion of this subject is provided in Section 3.6.

A detailed description of treatment system operating procedures, including plant operational and seasonal variations, is provided in Section 3.6. The frequency of treatment for each of the normal modes of operation is described in Table 3.6-1, as well as the quantities and points of addition of the chemical additives. All methods of chemical use are monitored.

Duke Power Company evaluated alternative water treatment systems to prepare for the construction of the previous Cherokee Nuclear Station Units 1, 2, and 3. Most of the evaluation still applies to the Lee Nuclear Station units. The water treatment system has been evaluated, and the results are provided in Reference 2. The summary results of the alternative water treatment systems screening are presented in Table 9.4-4.

The Westinghouse water treatment chemical addition strategy for the CWS and SWS cooling towers consists of:

- Biocide: sodium hypochlorite
- Algaecide: quarternary amine
- pH adjuster: sulfuric acid
- Corrosion inhibitor: polyphosphate
- Scale inhibitor: phosphonate
- Silt dispersant: polyacrylate

The Duke Energy water treatment chemical addition strategy for the Lee Nuclear Station CWS and SWS cooling towers (i.e., the Lee water treatment chemical addition strategy) consists of:

- Biocide/algaecide: sodium hypochlorite and sodium bromide
- pH adjuster: sulfuric acid
- Silt dispersant: polyacrylate

The following additional factors were considered in selecting water treatment alternatives:

- Biocide/algaecide - This chemical treatment creates an oxidizing biocide based on chlorine and hypobromous acid that is expected to control biofouling and underdeposit corrosion. No amine-based algaecide is utilized, due to current NPDES permitting guidelines.

- Corrosion inhibitor - The selection of non-corrosive tower materials, pH control, and the maintenance of a bromine residual provide the required corrosion control. No phosphate-based corrosion inhibitor is utilized, due to current NPDES permitting guidelines.

- Scale inhibitor - pH control is used to maintain a non-scaling water chemistry in the cooling towers. No phosphate-based scale inhibitor is utilized, due to current NPDES permitting guidelines.

Based on the above comparison and the comparison made in Table 9.4-4, the Lee water treatment chemical addition strategy is the selected strategy for the CWS and SWS cooling towers.

9.4.3 TRANSMISSION SYSTEMS

Duke Energy's electrical system planners are conducting a comprehensive siting study to determine the routes for new electrical transmission lines to connect the Lee Nuclear Station to the existing electric transmission grid within the Duke Energy service area in North and South Carolina.

After conducting a review of the existing transmission grid in the vicinity of the Lee Nuclear Station, including current loads and available capacity, Duke Energy determined that two existing overhead transmission lines should be "folded-in" to the station's proposed switchyard. The use of two existing transmission lines allows for more than one pathway to move power from the Lee Nuclear Station to existing load centers in the Duke Energy service area. A fold-in configuration requires that each of the existing lines be diverted from its current route at two points to (1) depart the existing line and enter the switchyard, and then (2) exit the switchyard and return to the existing line. The segment of the existing line between the diversions is de-energized.

The two existing transmission lines selected for the fold-in are the Asbury 525-kilovolt (kV) line that generally runs east to west about 16 mi. south of the Lee Nuclear Station and the Roddey 230 kV line that generally runs east to west about 8 mi. south of the station. The fold-in configuration as planned adheres to the following requirements:

- The two new 525 kV lines to and from the Asbury route are separated by a minimum of 1 mi. to reduce the possibility that a single unanticipated event such as a storm, plane crash, or sabotage could simultaneously interrupt service on both lines.

- The two 230 kV lines from the Roddey route are similarly separated for the same reason.

- One 230 kV line can parallel one 525 kV line within a common right-of-way (ROW) 325-ft. wide. The ROW for a single 230 kV line is 150-ft. wide and the ROW for a single 525 kV line is 200-ft. wide.

Thus, the overall objective of the study is to select two transmission line routes that are separated by a minimum of 1 mi. Along the first route, a single-circuit 525 kV line would run northward within a 200-ft.-wide ROW from the existing Asbury 525 kV line to intersect the existing Roddey 230 kV line. Thereafter, the 525 kV line and a double-circuit 230 kV line would continue parallel to each other within a 325-ft. ROW to the Lee Nuclear Station switchyard. Along the second route, the new 230 kV and 525 kV lines would exit the switchyard in parallel, continue southerly to tie-in to the Roddey 230 kV line, after which the 525 kV line would continue southward to its termination at the existing Asbury 525 kV line.

The siting study is being conducted in three phases (Figure 9.4-5). They are:

- Alternate route development.
- Alternate route evaluation and comparison.
- Study documentation and agency approvals.

The first phase of the study is now complete. Selection of preferred alternative routes is in progress. Each of these phases is discussed in greater detail in the following subsections.

9.4.3.1 Siting Study Area

Duke Energy defined a 284-square mile (sq. mi.) siting study area (Figure 9.4-6) located within Cherokee, York, and Union counties. The study area was selected based on consideration of the proposed location of the Lee Nuclear Station, the presence of existing 230 kV and 525 kV lines, topography, the Broad River, land use and development patterns, and transportation corridors. Field reconnaissance of the general area between the proposed site and the existing transmission lines indicated that expanding the area shown on Figure 9.4-6 from west to east would be counterproductive. Expansion would dictate increasingly longer ROW with a correspondingly greater potential for environmental and land use impacts and higher overall cost.

Once defined, Duke Energy collected aerial photographs and topographic maps and conducted extensive field reconnaissance visits to gather data including, but not limited to, land use, aesthetics, cultural resources, natural resources, and development and infrastructure in the study area. This information was supplemented by contacting federal, state, and local natural resource and planning agencies for pertinent environmental information and records.

Data were then grouped into 12 data layers for manipulation by a Geographical Information System (GIS). The data layers are:

- Cultural resources
- Rare, threatened, and endangered species
- Land cover
- Prime farmland soils and soils of statewide importance
- Land use

- Future land use
- Zoning
- Occupied buildings
- Public visibility
- Federal Emergency Management Agency (FEMA) floodzones
- Hydrography
- Wetlands

Figure 9.4-7 is a sample data layer illustrating the application of public visibility factors to the study area. Once all twelve data layers were mapped in a manner similar to Figure 9.4-7, Duke Energy held two community workshops, in April 2007. Two weeks before the workshops, Duke Energy mailed invitations to 4182 property owners of record in the siting study area along with Community Questionnaires designed to solicit substantive information to support the siting process. The Community Questionnaires were also available at the workshop. The workshops were designed to inform local residents about the project, explain the siting process, and solicit public feedback that might influence the selection of alternative routes within the study area and Duke Energy's final evaluation of those alternatives. Held in Union, South Carolina, and York, South Carolina, the workshops were attended by a total of 116 people and 348 Community Questionnaires were completed and returned. In addition to local residents, Duke Energy invited elected public officials, governmental agency personnel, and local community leaders to attend.

Feedback at the workshops, upon review and discussion of the data layers, revealed several issues of special concern to the attendees. Included were protection of water resources (including the Broad River, a state-designated scenic river downstream of the Ninety-Nine Islands Dam) and historic structures, potential effects on and visibility of the new lines from residences, and the presence of a local wildlife management area. The wildlife management area encompasses a geographic feature known as Worth Mountain that was identified by numerous attendees as an area of special concern to local residents and landowners. The data layers were then augmented to reflect any pertinent new information generated during the workshops.

9.4.3.2 Alternative Corridors

After adjusting the data layers to reflect public feedback, Duke Energy assigned numeric weights to each of the factors included within a data layer to represent the relative influence of each on and the sensitivity of each to transmission line routing. The weighted data were then combined in the GIS to produce a single map representing the cumulative effect of all data layers to transmission line routing. This map, called a Suitability Composite, displays a range of low constraints (i.e., high suitability) to high constraints (i.e., low suitability) on transmission line routing alternatives within the study area.

Duke Energy then used the composite to identify a series of 21 alternative routes (identified as Alternate Routes A-U), largely confined to low-constraint areas, for additional analysis and evaluation (Figure 9.4-8). Although the GIS algorithm produces direct routes, Duke Energy converted these routes to 1500-ft.-wide corridors for purposes of future real estate and engineering analysis and to allow flexibility when selecting actual ROW. Table 9.4-6 illustrates the twelve data layers, and results for selective individual criteria within the data layers.

Once mapped, the alternative routes were again presented to the public and local decision-makers, at community workshops held in June 2007. Duke Energy again solicited feedback. The purposes of these workshops were to provide complete information about the project and the transmission line siting process, and to offer the public an opportunity to inspect the alternative routes and provide additional information that could affect evaluation of the 21 alternatives directly to Duke Energy's siting team.

9.4.3.3 Preferred Alternatives

The data gathered during the siting study and public feedback were used to regroup factors contained in the 12 data layers discussed above into nine route evaluation categories for additional analysis by GIS of the viable alternatives. The categories are:

- Cultural and natural resources
- Land cover
- Soil
- Property ownership
- Land use
- Occupied buildings
- Public visibility
- Residential visibility
- Water quality

Within each of the above categories, criteria are developed to allow qualitative and quantitative comparisons of the alternative route combinations based on the sensitivity of each data factor to transmission line construction and long-term operation. As part of this comparative analysis a weight ranging from 1-10 is assigned to each data factor, with a value of 10 assigned to the most sensitive factors. For example, the number of homes within 200 ft. of the proposed route where the new line(s) would not be parallel and adjacent to an existing line would be assigned a weight of 10.

The factor weights are then multiplied by the factor score (e.g., units, miles, acres) in each category for each alternative route to calculate individual factor scores. Individual factor scores for each route are then added to compile a total evaluation category score for each of the alternative combinations.

Once so calculated, the total evaluation category scores are normalized on a scale of 1-10. Normalizing the category scores prevents any single evaluation category from unjustifiably influencing the overall alternative route score. For example, the unit of measure in the Occupied Buildings category is the actual number of buildings within a certain distance of the route, and the unit of measure in the Land Cover category is acres. The total evaluation score in the Occupied Buildings category is often low (e.g., no more than tens of units) compared to scores an order of magnitude greater (e.g., hundreds of acres) in the Land Cover category. Without score normalization, the larger Land Cover scores would render the lower Occupied Buildings scores (and other categories with low numeric values) unimportant in the comparative analysis.

The normalized evaluation scores for each of the nine categories are added to compile a total route evaluation score for each of the alternative route combinations. Alternative route combinations with the lowest total evaluation score (i.e., highest suitability) are those that minimize impacts over the broadest range of environmental, land use, cultural, and aesthetic factors used in the analysis. Duke Energy then performs a comprehensive cost estimate for each alternative route combination. The preferred routes are those with high suitability ratings in the evaluation categories and reasonable, but not necessarily lowest overall cost.

Once selected, the preferred alternative routes are subjected to a further field evaluation designed to detect any fatal flaws not evident in the data collected to date. The selected routes, along with a summary of the siting study, are then submitted to the Public Service Commission of South Carolina (PSCSC) in compliance with the Utility Facility Siting Act. The PSCSC will hold public hearings and issue a decision on Duke Energy's request to construct a transmission line along the selected route. Upon completion, the results of the corridor selection process will be submitted as a supplement to this Environmental Report.

9.4.3.4 Rights-of-Way

As the final step in the process, Duke Energy would select an actual ROW within each corridor and apply for the necessary permits to construct and operate the new transmission lines in accordance with all applicable laws and regulations.

Once Duke Energy secures the right to enter a property, the ROW is subjected to site-specific pre-construction investigations, possibly including but not limited to a cultural resource field survey and reconnaissance to ascertain the presence or absence of plant species of special concern, as required by permitting or review agencies at the federal or state level.

9.4.4 REFERENCES

1. U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, *Final Environmental Statement Related to Construction of Cherokee Nuclear Station, Units 1, 2, and 3, Duke Power Company, Docket Nos. STN 50-491, STN 50-492, and STN 50-493*, NUREG-75/089, Washington, DC, October 1975.

2. Duke Power Company, *Project 81, Cherokee Nuclear Station, Environmental Report, Amendment 4*, Charlotte, NC, October 13, 1975.

3. SPX Cooling Technologies, Hybrid Cooling Tower, Website, http://spxcooling.com/en/products/detail/hybrid-circular-tower/, accessed May 2007.

4. 40 CFR 122, "EPA Administered Permit Programs: The National Pollutant Discharge Elimination System."

5. Federal Water Pollution Control Act (Clean Water Act), 33 USC 1251 et seq.

TABLE 9.4-1 (Sheet 1 of 3)
SCREENING OF ALTERNATIVE HEAT DISSIPATION SYSTEMS

Factors Affecting System Selection	Circular Mechanical-draft Cooling Towers (Selected)	Rectangular Mechanical-draft Cooling Towers	Natural-draft Cooling Towers
On-site Land Requirements	Construction activities would expose 100 ac. of forest and other lands to erosion (Reference 2).	Construction activities would expose 193 ac. of forest and other lands to erosion (Reference 2).	Construction activities would expose 99 ac. of forest and other lands to erosion (Reference 2).
Terrain Considerations	Terrain features of the Lee Nuclear Site are suitable for this system.	Terrain features of the Lee Nuclear Site are suitable for this system.	Terrain features of the Lee Nuclear Site are suitable for this system.
Water Use	20,820 gpm per unit	20,820 gpm per unit	20,820 gpm per unit
Atmospheric Effects	No adverse effects due to fogging or icing from the tower to off-site activities. No chemical discharge other than salt and no odors attributed to the system.	No adverse effects due to fogging or icing from the tower to off-site activities. No chemical discharge other than salt and no odors attributed to the system.	No adverse effects due to fogging or icing from the tower to off-site activities. No chemical discharge other than salt and no odors attributed to the system.
Thermal and Physical Effects	Discharge and site construction add some turbidity to the water, but have no overall adverse effects.	Discharge and site construction add some turbidity to the water, but have no overall adverse effects.	Discharge and site construction add some turbidity to the water, but have no overall adverse effects. Natural-draft cooling towers also have a slightly higher discharge temperature, which causes a slight increase to the river temperature as compared to the other alternatives.

TABLE 9.4-1 (Sheet 2 of 3)
SCREENING OF ALTERNATIVE HEAT DISSIPATION SYSTEMS

Factors Affecting System Selection	Circular Mechanical-draft Cooling Towers (Selected)	Rectangular Mechanical-draft Cooling Towers	Natural-draft Cooling Towers
Noise Levels	Some noise is attributed to the mechanical portions of the tower, however, these disturbances are unobtrusive to the surroundings (Reference 2).	Some noise is attributed to the mechanical portions of the tower, however, these disturbances are unobtrusive to the surroundings (Reference 2).	Because there are no mechanized parts, there is no significant noise related to this system, other than falling water (Reference 2).
Aesthetic and Recreational Benefits	Consumptive water use for this system is consistent with minimum stream flow requirements for the Broad River, environmental maintenance of fish and wildlife water demand, and recreation. Any plumes are visible, but resemble clouds and do not disrupt the surroundings. Each tower is approximately 60-ft. tall.	Consumptive water use for this system would be consistent with minimum stream flow requirements for the Broad River, environmental maintenance of fish and wildlife water demand, and recreation. Any plumes are visible, but they resemble clouds and do not disrupt the surroundings. Each tower is approximately 60-ft. tall.	Consumptive water use for this system is consistent with minimum stream flow requirements for the Broad River, environmental maintenance of fish and wildlife water demand, and recreation. The tall towers (500 ft.) are visible for longer distances. Plumes are also more visible.
Legislative Restrictions	An intake structure for this system would meet Section 316(b) of the CWA and the implementing regulations, as applicable. The NPDES discharge permit thermal discharge limitation addresses the additional thermal loads from the blowdown. These regulatory restrictions have a small impact on this heat dissipation system.	An intake structure for this system would meet Section 316(b) of the CWA and the implementing regulations, as applicable. The NPDES discharge permit thermal discharge limitation addresses the additional thermal loads from the blowdown. These regulatory restrictions have a small impact on this heat dissipation system.	An intake structure for this system would meet Section 316(b) of the CWA and the implementing regulations, as applicable. The NPDES discharge permit thermal discharge limitation addresses the additional thermal loads from the blowdown. These regulatory restrictions have a small impact on this heat dissipation system.

TABLE 9.4-1 (Sheet 3 of 3)
SCREENING OF ALTERNATIVE HEAT DISSIPATION SYSTEMS

Factors Affecting System Selection	Circular Mechanical-draft Cooling Towers (Selected)	Rectangular Mechanical-draft Cooling Towers	Natural-draft Cooling Towers
Operating and Maintenance Experience	Mechanical-draft cooling tower systems are common to power plants (both fossil and nuclear) and are considered highly reliable.	Mechanical-draft cooling tower systems are common to power plants (both fossil and nuclear) and are considered highly reliable.	Natural-draft cooling tower systems are common to power plants (both fossil and nuclear) and are considered highly reliable.
Generating Efficiencies	The energy requirements for mechanical-draft cooling towers would be more than natural-draft cooling tower systems.	The energy requirements for mechanical-draft cooling towers would be more than natural-draft cooling tower systems.	Natural-draft cooling tower energy requirements would be less than the mechanical-draft systems.
Other Considerations	NA	NA	NA
Cost[(a)(b)(c)]	$204,912,575	$227,794,000	$210,371,840
Is this a suitable alternative for the Lee Nuclear Site?	Yes	Yes	Yes

a) Estimated cost in 2007 dollars per Table 10.1.0-1 of Reference 2.

b) The 1986 dollars from Reference 2, Table 10.1.0-1, were converted to 2007 dollars. The dollar values were converted by applying the Consumer Price Index (CPI) ratio of the June 2007 southern region value (201.675) to the June 1986 value (108.7). CPI data are from the U.S. Department of Labor, Bureau of Labor Statistics.

c) See Table 9.4-5 for more details on Cost.

TABLE 9.4-2 (Sheet 1 of 4)
SCREENING OF ALTERNATIVE INTAKE SYSTEMS

Factors Affecting System Selection	Bankside River Intake Structure (Selected)	Off-River Intake Structure on an Open-Ended Approach Canal	Perforated Pipe Intake with Off-River Pump Structure	Infiltration Bed Intake with Off-River Pump Structure
Construction Impacts	A cellular sheet pile cofferdam or similar structure is built out from the river bank so that the intake structure is built in the dry with no adverse effect on the river water during construction. Noise disruption is slight.	Because the structure is connected to the river by a canal, it can be built on dry land with no effect on the river. Canal entrance facilities require less temporary river protection than the selected facility. Noise disruption is slight.	A cellular sheet pile cofferdam or similar structure is built out from the river bank so that the anchorage system, concrete mat, perforated pipe, and piping to the pump structure can be built in the dry with no adverse effect on the river water during construction. Noise disruption is slight.	A cellular sheet pile cofferdam or similar structure is built out from the river bank so that the perforated pipe, gravel filter, and piping to the pump structure can be built in the dry. About 1 ac. of river bottom is excavated approximately 6-ft.-deep for use as the filter bed. Due to the large cofferdam size for this alternative, some additional scour of the river bottom is anticipated adjacent to the cofferdam. No permanent effects on the river are expected. Noise disruption is slight.

TABLE 9.4-2 (Sheet 2 of 4)
SCREENING OF ALTERNATIVE INTAKE SYSTEMS

Factors Affecting System Selection	Bankside River Intake Structure (Selected)	Off-River Intake Structure on an Open-Ended Approach Canal	Perforated Pipe Intake with Off-River Pump Structure	Infiltration Bed Intake with Off-River Pump Structure
Aquatic Impacts	All intake water taken from the Broad River passes through a curtain wall, stop log assemblies, bar screens, and traveling screen designed to minimize uptake of aquatic biota and debris. Maximum velocities for all river flows are less than 0.5 ft/sec. (Reference 2).	Structure incorporates a submerged weir and training wall, which directs the river stream away from the intake waterway, to aid in carrying fish past the entrance. The canal current is less 0.5 ft/sec, which should allow fish to swim out of the canal. In addition, structure has bar racks and traveling screens to keep fish and debris out of the pump well (Reference 2).	Provides negligible effects on fish and plankton. Intake velocity of less than 0.5 ft/sec assures sufficient protection for all fish against impingement on the pipes. Turbidity of the river may increase slightly during backwash operations (Reference 2).	Negligible intake velocities assure no impingement of free-swimming organisms. Heavy sediment load in the river requires frequent backwashing, which causes a significant increase in turbidity downstream of the intake (Reference 2).
Land Use Impacts	Requires approximately 1 ac. of land and disturbs less than 0.5 ac. of river bottom during construction. Negligible problems with silt and debris are anticipated.	Requires 4 ac. of land and does not disturb more than 0.5 ac. of the river bottom during construction. Problems with silt are anticipated in the canal and periodic dredging operations are required.	Requires approximately 1 ac. of land and disturbs less than 0.5 ac. of river bottom during construction.	The facility requires 1.5 ac. of land for operation, of which approximately 1 ac. is river bed. During construction, approximately 1.5 ac. of river bottom are disturbed.

TABLE 9.4-2 (Sheet 3 of 4)
SCREENING OF ALTERNATIVE INTAKE SYSTEMS

Factors Affecting System Selection	Bankside River Intake Structure (Selected)	Off-River Intake Structure on an Open-Ended Approach Canal	Perforated Pipe Intake with Off-River Pump Structure	Infiltration Bed Intake with Off-River Pump Structure
Water Use Impacts	The relative position of the intake (shoreline or offshore) would have no differentiating impact on the water use requirements, and, therefore, it would not be an important factor.	The relative position of the intake (shoreline or offshore) would have no differentiating impact on the water use requirements, and, therefore, it would not be an important factor.	The relative position of the intake (shoreline or offshore) would have no differentiating impact on the water use requirements, and, therefore, it would not be an important factor.	The relative position of the intake (shoreline or offshore) would have no differentiating impact on the water use requirements, and, therefore, it would not be an important factor.
Compliance with Regulations	The intake structure meets CWA Section 316(b) requirements and the implementing regulations, as applicable.	The intake structure meets CWA Section 316(b) requirements and the implementing regulations, as applicable.	The intake structure meets CWA Section 316(b) requirements and the implementing regulations, as applicable.	The intake structure meets CWA Section 316(b) requirements and the implementing regulations, as applicable.

TABLE 9.4-2 (Sheet 4 of 4)
SCREENING OF ALTERNATIVE INTAKE SYSTEMS

Factors Affecting System Selection	Bankside River Intake Structure (Selected)	Off-River Intake Structure on an Open-Ended Approach Canal	Perforated Pipe Intake with Off-River Pump Structure	Infiltration Bed Intake with Off-River Pump Structure
Total Annual Costs	Costs include the rack structure, river intake structure including pumps and screens, piping to the Make-Up Pond A, access road, construction cofferdam, and excavation. Cost comparison of alternative intake systems is shown in Table 10.2.4-1 of Reference 2.	Costs include the submerged weir, training wall, canal, intake structure including pumps and screens, piping to the Make-Up Pond A, access road, periodic silt removal operations, and cofferdams for canal entrance facilities. Cost comparison of alternative intake systems is shown in Table 10.2.4-1 of Reference 2.	Costs include perforated pipe, concrete foundation, piping to the pump structure, pumping structure including pumps and backwash piping, piping to the Make-Up Pond A, access road, and construction cofferdam. Cost comparison of alternative intake systems is shown in Table 10.2.4-1 of Reference 2.	Costs include washed crushed stone, perforated pipe and headers, piping to the pump structure, pumping structure including pumps and backwash piping, piping to the Make-Up Pond A, access road, and cofferdam. Cost comparison of alternative intake systems is shown in Table 10.2.4-1 of Reference 2.

TABLE 9.4-3 (Sheet 1 of 3)
SCREENING OF ALTERNATIVE DISCHARGE SYSTEMS

Factors Affecting System Selection	Single Port Spillway Apron Discharge Structure	Bankside Single Port Discharge Structure	River Bottom Single Port Diffuser Structure	Mid River Single Port Diffuser Structure (Selected)
Construction Impacts	Construction of structure has negligible effect on the natural surface water body. All construction related to this structure is in the dry and located outside the normal water course. Noise disruption impacts are SMALL. The aesthetic appearance of the Ninety-Nine Islands Dam is negatively impacted by this system.	Sheet-pile cofferdams or similar structures are built out from the river bank so the discharge structure can be built in the dry with SMALL adverse effects on the river water during construction. Noise disruption impacts are SMALL.	Sheet-pile cofferdams or similar type structures are built out from the river bank so the discharge structure can be built in the dry with SMALL adverse effects on the river water during construction. Noise disruption impacts are SMALL.	The discharge line is installed by divers. Any permanent or temporary adverse impacts on the river are expected to be SMALL. Noise disruption impacts are SMALL. The aesthetics impacts of this system on the historical Ninety-Nine Islands Dam are SMALL.

TABLE 9.4-3 (Sheet 2 of 3)
SCREENING OF ALTERNATIVE DISCHARGE SYSTEMS

Factors Affecting System Selection	Single Port Spillway Apron Discharge Structure	Bankside Single Port Discharge Structure	River Bottom Single Port Diffuser Structure	Mid River Single Port Diffuser Structure (Selected)
Impacts on Aquatic Ecology	The blowdown discharges below the Ninety-Nine Islands Dam. This dam has eliminated fish migration on this reach of the Broad River. The system, therefore, has SMALL effects on fish migration. System has MODERATE effects on the river and the surrounding environment based on not meeting temperature requirements per CORMIX modeling.	The blowdown discharges below the Ninety-Nine Islands Dam. This dam has eliminated fish migration on this reach of the Broad River. The system, therefore, has SMALL effects on fish migration. System has MODERATE effects on the river and the surrounding environment based on not meeting temperature requirements per CORMIX modeling.	The blowdown discharges below the Ninety-Nine Islands Dam. This dam has eliminated fish migration on this reach of the Broad River. The system, therefore, has SMALL effects on fish migration. System has SMALL effects on the river and the surrounding environment.	The blowdown discharges directly upstream from the Ninety-Nine Islands Dam. This location allows for flow to adequately mix with the intake to the turbine of the hydroelectric station. The system, therefore, has SMALL impacts on fish migration, the river, and the surrounding environment.
Water Use Impacts	The position of the discharge would have SMALL differentiating impacts on the water use requirements, and, therefore, it would not be an important factor.	The position of the discharge would have SMALL differentiating impacts on the water use requirements, and, therefore, it would not be an important factor.	The position of the discharge would have SMALL differentiating impacts on the water use requirements, and, therefore, it would not be an important factor.	The position of the discharge has SMALL differentiating impacts on the water use requirements, and, therefore, it would not be an important factor.

TABLE 9.4-3 (Sheet 3 of 3)
SCREENING OF ALTERNATIVE DISCHARGE SYSTEMS

Factors Affecting System Selection	Single Port Spillway Apron Discharge Structure	Bankside Single Port Discharge Structure	River Bottom Single Port Diffuser Structure	Mid River Single Port Diffuser Structure (Selected)
Compliance with Regulations	Per CORMIX modeling, the structure **would not** meet the National Pollutant Discharge Elimination System (NPDES) temperature requirements as mandated by the South Carolina Department of Health and Environmental Control (SCDHEC).	Per CORMIX modeling, the structure **would not** meet the NPDES temperature requirements as mandated by the SCDHEC.	Per CORMIX modeling, the structure **would** meet the NPDES temperature requirements as mandated by the SCDHEC.	The structure **would** meet the NPDES temperature requirements as mandated by the SCDHEC.

TABLE 9.4-4 (Sheet 1 of 2)
SCREENING OF ALTERNATIVE WATER TREATMENT SYSTEMS

Factors Affecting System Selection	Westinghouse Water Treatment Chemical Addition Strategy for the CWS and SWS	Lee Water Treatment Chemical Addition Strategy for the CWS and SWS (Selected)
Chemicals Used	Biocide: sodium hypochlorite Algaecide: quarternary amine pH adjuster: sulfuric acid Corrosion inhibitor: polyphosphate Scale inhibitor: phosphonate Silt dispersant: polyacrylate	Biocide/algaecide: sodium hypochlorite and sodium bromide pH adjuster: sulfuric acid Silt dispersant: polyacrylate
Construction Impacts	Installation of the chemical treatment systems would result in additional commitments of land. Associated soil erosion and sediment impacts, however, would be SMALL.	Installation of the chemical treatment systems would result in additional commitments of land. Associated soil erosion and sediment impacts, however, would be SMALL.
Aquatic Impacts	Residual chemicals from this treatment process could affect aquatic resources in the downstream Broad River. Biocides, corrosion inhibitors, and pH adjustment chemicals are potentially toxic to aquatic life.	Residual chemicals from this treatment process could affect aquatic resources in the downstream Broad River. Biocides, and pH adjustment chemicals are potentially toxic to aquatic life.
Land Use Impacts	There would be no appreciable land use impacts.	There would be no appreciable land use impacts.

TABLE 9.4-4 (Sheet 2 of 2)
SCREENING OF ALTERNATIVE WATER TREATMENT SYSTEMS

Factors Affecting System Selection	Westinghouse Water Treatment Chemical Addition Strategy for the CWS and SWS	Lee Water Treatment Chemical Addition Strategy for the CWS and SWS (Selected)
Water Use Impacts	Chemical treatment systems would not impact water withdrawal requirements.	Chemical treatment systems would not impact water withdrawal requirements.
Compliance with Regulations	An amine-based algaecide cannot be utilized due to current NPDES permitting guidelines. Phosphate-based corrosion or scale inhibitor cannot be utilized, due to current NPDES permit guidelines.	Permits may have to be revised to account for the chemically treated cooling system effluent.

TABLE 9.4-5

COST[a] COMPARISON – COOLING SYSTEM ALTERNATIVES

Component	Circular Mechanical-draft Cooling Towers (Selected)	Rectangular Mechanical-draft Cooling Towers	Natural-draft Cooling Towers
Cooling Towers[b]	$54,919,130	$63,802,725	$74,910,465
Fan Motors and Switchgear	$7,694,540	$8,508,885	---
CWS Pumps	$8,382,745	$8,382,745	$8,382,745
CWS Pump Motors	$6,540,730	$6,540,730	$6,540,730
Piping	$31,074,960	$44,748,165	$28,589,260
Penalties	$96,300,470	$95,827,445	$91,948,640
Total	$204,912,575	$227,794,000	$210,371,840

a) Estimated cost in 2007 dollars per Table 10.1.0-1 of Reference 2. The 1986 dollars from Reference 2, Table 10.1.0-1, were converted to 2007 dollars. The dollar values were converted by applying the Consumer Price Index (CPI) ratio of the June 2007 southern region value (201.675) to the June 1986 value (108.7). CPI data are from the U.S. Department of Labor, Bureau of Labor Statistics.

b) Includes cooling tower, precast concrete, erection, and basin.

TABLE 9.4-6 (Sheet 1 of 2)
SUMMARY OF TRANSMISSION LINE SITING CRITERIA RESULTS

		Alternate Routes										
Criterion	Units	A	B	C	D	E	F	G	H	I	J	K
Total Length	Miles	18.54	18.72	18.98	17.46	17.72	16.67	18.22	18.40	18.66	17.14	17.40
Recorded Cultural Resources within 1000 ft.	Count	0	0	0	0	0	0	0	0	0	0	0
Recorded Cultural Resources within 1.2 mi.	Count	0	0	0	0	0	0	0	0	0	0	0
Recorded Rare, Threatened or Endangered Species within 50 ft.	Count	0	0	0	0	0	0	0	0	0	0	0
Lake or Pond	Acres	4.68	4.43	4.49	2.70	2.70	2.47	4.68	4.48	4.49	2.70	2.70
Wetlands, Emergent	Acres	0.48	0.00	0.00	0.00	0.00	0.00	0.48	0.00	0.00	0.00	0.00
Wetlands, Forested	Acres	8.81	7.96	8.04	7.06	7.06	6.52	8.81	8.01	8.04	7.06	7.06
Bottomland Forest	Acres	41.76	18.93	20.18	20.01	21.19	14.66	39.29	16.50	17.68	17.55	18.72
Grassland/Pasture	Acres	127.48	159.50	131.26	119.42	90.59	68.39	125.36	157.49	129.10	117.31	88.48
Prime Farmland	Acres	29.66	22.85	21.34	20.42	18.86	14.00	29.66	22.86	21.34	20.42	18.86
Occupied Buildings within 200 ft.	Count	0	0	0	0	0	0	0	0	0	0	0
Future Land Use Agriculture	Acres	458.37	456.12	458.81	391.69	391.69	461.28	445.22	443.79	444.85	378.69	378.69
Future Land Use Industrial	Acres	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TABLE 9.4-6 (Sheet 2 of 2)
SUMMARY OF TRANSMISSION LINE SITING CRITERIA RESULTS

		Alternate Routes									
Criterion	Units	L	M	N	O	P	Q	R	S	T	U
Total Length	Miles	16.35	13.78	14.37	13.90	13.55	14.78	13.73	16.93	17.22	16.71
Recorded Cultural Resources within 1000 ft.	Count	0	0	0	0	1	1	1	0	2	2
Recorded Cultural Resources within 1.2 mi.	Count	0	0	3	3	5	5	7	12	18	11
Recorded Rare, Threatened or Endangered Species within 50 ft.	Count	0	0	0	0	0	0	0	0	0	0
Lake or Pond	Acres	2.47	0.91	2.97	1.72	5.76	5.73	2.89	3.59	2.45	2.45
Wetlands, Emergent	Acres	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.06	0.00	2.26
Wetlands, Forested	Acres	6.52	15.72	15.72	0.00	7.69	6.01	7.27	28.86	12.32	5.83
Bottomland Forest	Acres	12.20	38.94	30.95	6.33	25.15	23.11	32.57	36.10	24.98	23.00
Grassland/Pasture	Acres	66.28	72.85	66.20	91.52	139.19	154.96	109.39	139.67	99.32	98.60
Prime Farmland	Acres	14.00	12.42	12.42	24.96	19.14	31.35	35.28	33.40	25.33	12.48
Occupied Buildings within 200 ft.	Count	0	0	0	0	0	0	0	0	0	0
Future Land Use Agriculture	Acres	448.26	366.18	390.74	379.73	422.55	541.59	404.94	538.58	549.38	552.01
Future Land Use Industrial	Acres	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00