CHAPTER 3: RESOURCES AND ENVIRONMENTAL IMPACTS

Introduction

Scope of Environmental Issues

The SCR systems would physically be a minor addition to an expansive heavy industrial facility having a significant property buffer area. The plant areas that could be impacted by installation of the SCR reactors, ammonia storage and unloading area, interconnecting ammonia and service water piping, electrical conduits, retention basin and construction staging area, demolition scrap laydown area, expansion of the West Ash Pond and temporary or permanent office building have all been heavily disturbed by previous plant development activities (see Figure 3). The existing USACOE barge unloading facility nearby is adequate to meet SCR construction needs. As a result, the potential would be small for construction impacts to terrestrial ecology, aquatic ecology, noise, land use, air quality, visual aesthetics, and archaeological and historic resources.

Operational impacts are primarily dependent on the engineering features and safeguards of the proposed SCR systems. These features and safeguards would control the probability and extent of accidental or unintentional releases of anhydrous or aqueous ammonia to the environment. These potential releases and attendant impacts would be:

- Excessive ammonia slip passing through the Unit 1, 2 or 3 SCR reactors could result in ammonia contamination of the air heater wash causing potential effluent toxicity and/or odor. Additionally, fly ash could become contaminated with ammonia and sluiced to the ash pond causing potential effluent toxicity or problems meeting NPDES discharge requirements.
- Accidental releases of anhydrous ammonia to the air from the storage and unloading system or truck causing a potential hazard to plant operating personnel, the public, and the environment.
- Direct accidental releases of anhydrous ammonia or aqueous ammonia to surface water causing damage to aquatic life.

A number of assumptions concerning the proposed SCR systems and their operation are necessary to establish the basis for analyzing the potential environmental impacts of the proposed action. These assumptions are summarized here and addressed in more detail as appropriate in subsequent sections analyzing specific resource areas. Some of these assumptions and other measures are also environmental commitments listed under **Summary of Environmental Commitments** in Chapter 2.

SCR Reactor

Design, Construction and Operational Assumptions

1. A 90% NO_X removal rate would be achieved throughout the life of the system.
2. The SCRs would operate as needed to meet air quality requirements. Although the SCRs are designed for year round operation, their operation during the ozone

season of May through September is expected to be adequate to address the concerns for ambient air quality with respect to ozone.
3. An ammonia slip of 2 ppm would not be exceeded during normal operation.
4. Catalyst disposal would be managed by a catalyst contractor in compliance with applicable regulations.

Anhydrous Ammonia System

Design, Construction and Operational Assumptions

1. Two 68,130 L (18,000 gallon) (nominal) storage tanks would be installed.
2. A water fogging system with both automatic and manual activation would protect both the storage tanks and the truck off-loading area to limit the hazard from large ammonia leaks or catastrophic tank failure.
3. The drainage from the proposed ammonia unloading and storage area would be re-configured to drain to the existing chemical treatment pond which is immediately adjacent to the site. This basin is capable of receiving and holding, without discharge, the worst-case storage tank spill and the resulting volume of aqueous ammonia generated by operation of the fogging system.
4. The applicable chemical accident prevention measures required under 40 CFR 68 would be implemented prior to filling of the anhydrous ammonia storage system or receipt of ammonia in quantities exceeding 10,000 lbm.
5. Appropriate personal protective equipment (respirators, self-contained breathing apparatus, protective clothing) and training would be provided to operating personnel consistent with Occupational Safety and Health Administration's (OSHAs) regulations.

Air Quality

Resource Description

The air quality in the vicinity of ALF is generally good, with the area in compliance with all air quality standards. Regionally, air quality is also generally good. For some urban areas, however, attainment of the 1-hour ozone standard has been difficult. Until recently Memphis, Tennessee was designated as an ozone non-attainment area. This area, in addition to others, is expected to experience periods when ozone levels will be above EPAs recently promulgated 8-hour ozone standard of 80 ppb which was remanded back to the agency for further review. Some areas (including Memphis) are also expected to experience periods when fine particulate concentrations would be above EPAs recently promulgated annual PM-2.5 standard which was remanded back to the agency for further review.

Construction Impacts

Transient air pollutant emissions would occur during the construction phase of this project. Since the Allen site has already been developed as an industrial site, construction-related emissions would be relatively less than for a new site. Construction-related air quality impacts are primarily related to land clearing, site preparation, and the operation of internal combustion engines.

Vehicle Emissions and Excavation Dust

Land clearing, site preparation, and vehicular traffic over unpaved roads and construction sites result in the emission of fugitive dust particulate matter (PM) during site preparation and active construction periods. The largest size fraction (greater than 95% by weight) of fugitive dust emissions would be deposited within the construction site boundaries. The remaining fraction of PM would be subject to longer-range transport. If necessary, open construction areas and unpaved roads would be sprinkled with water to reduce fugitive dust emissions by as much as 50%. Combustion of gasoline and diesel fuel by internal combustion engines (vehicles, generators, construction equipment, etc.) would generate local emissions of PM, NO_X, carbon monoxide (CO), volatile organic compounds (VOCs), and SO_2 throughout the site preparation and construction period. The total amount of these emissions would be small and would result in minimal off-site impacts.

Air quality impacts from construction activities would be temporary and dependent on both manmade factors (e.g. intensity of activity, control measures, etc.) and natural factors (e.g. wind speed, wind direction, soil moisture, etc.). However, even under unusually adverse conditions, these emissions would have, at most, a minor, transient impact on off-site air quality and should not lead to an exceedance or violation of any applicable ambient air quality standard. Overall, the air quality impact of construction-related activities for the project would not be significant.

Plant Vicinity Operational Impacts

Operation of the SCR would not adversely impact local air quality. There would be the possibility, however, of slight increases in ammonia concentrations downwind of the plant site. This possibility is discussed below. Overall, SCR operation would improve air quality.

Ozone Scavenging Losses

Ozone concentrations below background levels occur immediately downwind of NO_X sources, such as power plants, due to ozone scavenging, i.e. NO emissions consuming ozone. Significant ozone production does not occur until 20 to 80 km downwind of the NO_X source. The reduction of NO_X emissions may reduce the size of the area in which ozone scavenging occurs. While ozone concentrations may increase in areas previously affected by ozone scavenging, they are not expected to increase above background ozone levels.

Plume Opacity and Plume Blight

Plume opacity is determined by the amount of NO_X and PM emitted. Due to the optical properties of NO_X and fine particulate, these pollutants tend to give a plume a slight reddish-brown color when viewed against a clear sky. Since the SCR will greatly reduce NO_X emissions, it is also expected to reduce plume opacity and plume blight. There is a possibility that SCR operation will be accompanied by an increase in SO_3 emissions which could result in some offset of the plume visibility improvements due to NO_X reduction. Since there is no experience with SCR on large utility boilers, quantification of this potential increase in SO_3 emissions is not possible. The potential exists, however, for minor increases in plume visibility and plume blight under some meteorological and operational conditions.

Regional Operational Impacts

Introduction

The primary purpose of the SCR installation is to reduce emissions of NO_X, a pollutant which can, in combination with VOCs and sunlight, lead to the production of ozone. The purpose of this section is to describe the nature of ozone and the impacts that reducing NO_X emissions from ALF will have on ambient ozone levels. In addition, the potential impact of the SCR operation on secondary particulate formation and regional haze is described.

Ozone

Ozone is a pollutant which is formed in the atmosphere as the result of exposure to sunlight of a mixture of NO_X and VOCs. Both NO_X and VOCs have natural and anthropogenic (man-made) emissions sources. For example, isoprene (a VOC important in ozone formation) is primarily emitted from trees and crops. Other VOCs, however, are emitted into the atmosphere as the consequence of human activity such as the use of solvents or the operation of motor vehicles. While there are also natural sources of NO_X, they are relatively small compared to the NO_X emitted from motor vehicles and other forms of fuel combustion. Since large utility boilers burn large quantities of fossil fuel, they are a major source of the NO_X emitted into the atmosphere.

Ozone levels in the TVA region have historically been less than the NAAQS (with the exception of a few urban centers). With the recent revision of the ozone standard from a 1-hour average concentration of 120 ppb to an 8-hour average of concentration of 80 ppb, more areas in the TVA region are expected to experience ozone concentrations exceeding the standard. Furthermore, it is anticipated that a number of urban areas—even some remote, rural areas in the Appalachian Mountains—which barely met the former 1-hour standard will experience ozone concentrations above the 8-hour standard.

Although it is not possible to quantify the change in ambient ozone concentration (or the frequency of that change) at a specific place due to NO_X emissions reductions at ALF, it is known from previous modeling and air quality research that the overall effect would be to reduce the amount of ozone produced in the atmosphere. It is also known that the area that would benefit the most would be the area within about 150 km downwind from ALF.

Secondary Particulate and PM-10/PM-2.5

Operation of an SCR requires the use of ammonia. Although almost all of the ammonia is chemically converted to nitrogen and water in the reactions that are responsible for the reduction in NO_X emissions, there is a possibility that some ammonia would be emitted from the stack. Since ammonia is associated with the formation of particulate in the atmosphere, any ammonia that is emitted has the potential to result in the formation of additional atmospheric particulate. Therefore, allowing ammonia to slip through the system without reacting can lead to the formation of particulate leading to a slight increase in the atmospheric particulate burden. The potential for a small increase in particulate due to ammonia emissions would be more than offset by the decrease in particulate due to NO_X reductions associated with SCR operation (NO_X is a source of secondary particulate).

Cumulative Impacts to Air Quality

Introduction—TVA's Proposed NO_X Control Strategy

TVA is considering the installation of additional NO_X controls, using SCR technology, at up to six other coal-fired power plants (Bull Run, Colbert, Cumberland, Paradise, Widows Creek and Kingston). Table 2 lists all units planned for SCRs including the proposed action at Allen. This strategy would reduce TVA coal-fired power plant NO_X emissions by 75,000 metric tons (83,000 tons) during the ozone season (May to September) beginning in 2005. When combined with other controls already planned to meet the acid rain requirements under the CAA Title IV, the total NO_X reduction during the 2005 ozone season will be 166,000 metric tons (183,000 tons). To meet Title IV requirements, low NO_X burners have already been installed or will be installed by 2000 on 34 TVA boilers, staged over-fire air has been installed on 6 units and combustion optimization has been installed on an additional 18 units. The controls would reduce TVA's seasonal NO_X emissions roughly 73% below 1990 levels.

Table 2. TVA Fossil Plant Units Planned for Installation of SCR Systems.

Unit	State	Generation Capacity (MW)	Installation Completed
Paradise 2	Kentucky	704	2000
Paradise 1	Kentucky	704	2001
Paradise 3	Kentucky	1,050	2003
Allen 3	Tennessee	330	2002
Allen 2	Tennessee	330	2002
Allen 1	Tennessee	330	2003
Widows Creek 7	Alabama	575	2003
Widows Creek 8	Alabama	550	2004
Cumberland 2	Tennessee	1,300	2004
Cumberland 1	Tennessee	1,300	2003
Bull Run	Tennessee	950	2003
Kingston 1-5	Tennessee	900	2004
Kingston 6-9	Tennessee	800	2003
Colbert 5	Alabama	575	2004
Colbert 1-4	Alabama	800	2005

Because the SCR installations listed in Table 2 would satisfy most if not all of TVA's requirements, there are currently no plans to install SCR systems at other units at Johnsonville, Widows Creek Units 1-6, Gallatin, John Sevier, and Shawnee Fossil plants. NO_X reduction from these units using SCR systems is more costly and produces less significant environmental benefit than the units identified in Table 2.

The new controls would help reduce local and regional ozone levels, and would help meet the more stringent 8-hour ozone standard promulgated by the EPA in 1997 that was remanded by the courts back to EPA for further review. The strategy is also consistent with the types of controls that would be needed to comply with EPA's proposed rule for ozone transport, known as the ozone transport SIP call.

NO_X emitted into the atmosphere leads to the formation of ozone and fine particulate, as well as contributing to increased acidity of precipitation. Thus, the cumulative impact on air quality (due to a reduction in NO_X emissions) would be beneficial.

Ozone Reduction

Precise quantification of ozone changes due to the proposed action is not practical or possible due to daily variations in meteorology and operating conditions. It is possible, however, to assess the overall impact of the proposed action in combination with anticipated NO_X reductions at other TVA fossil plants. This assessment is possible by comparing the results of photochemical modeling performed with and without consideration of TVA's overall NO_X reduction strategy. Specifically, modeling was performed as part of the effort of the OTAG work which considered the NO_X and VOC emissions in the eastern half of the United States projected to the year 2007. Photochemical modeling was performed with the OTAG emissions databases modified to reflect the effect of TVA's NO_X strategy. Although modeling was limited to a single 10-day episode in 1995, the results are illustrative of the effect of TVA's NO_X reduction strategy on atmospheric ozone. Within Alabama, Kentucky and Tennessee the modeling indicated that TVA's NO_X reduction strategy would decrease the overall peak 1-hour ozone in the ambient atmosphere by 2, 3 and 4 percent, respectively, and the peak 8-hour ozone burden would be decreased by 2, 3 and 4 percent, respectively. (It is important to note that the modeling did not account for additional NO_X emissions reductions that are likely to occur from other utilities as a consequence of recent EPA action establishing statewide NO_X budgets in the eastern states.)

Ammonia Storage and Handling Safety

Introduction

Anhydrous ammonia is 99.5% commercial grade ammonia (with 0.5% water) as compared to aqueous ammonia which is a solution of ammonia and water. A saturated aqueous ammonia solution is 47% ammonia by weight at 32°F and at atmospheric pressure (by comparison household ammonia is a 5% solution). Anhydrous ammonia is very volatile and boils at –33.3°C under atmospheric pressure. Anhydrous ammonia must be pressurized or refrigerated to be maintained as a liquid. Air mixtures of ammonia are difficult to ignite. The autoignition temperature is 650°C. The lower explosive level is 16% by volume and the upper explosive level is 27% by volume. The reportable quantity (RQ) under the Comprehensive Environmental Responsibility, Compensation and Liability Act (CERCLA) for release of ammonia is 100 lbm.

A typical material safety data sheet (MSDS) for anhydrous ammonia is given in Appendix A. Excerpts from the MSDS concerning the acute and chronic health hazards are as follows:

> *Inhalation: Vapor may cause irritation to the respiratory tract. High atmospheric concentrations in excess of the occupational exposure limit may cause injury to the mucous membranes. Fluid build up on the lung (pulmonary edema) may occur up to 48 hours after exposure to*

extremely high levels and could prove fatal. The onset of the respiratory symptoms may be delayed for several hours after exposure.

Skin Contact: High concentrations of vapor may cause irritation. By rapid evaporation, the liquid may cause frostbite.

Eye Contact: The vapor is an irritant but the liquid is a severe irritant. Liquid splashes or spray may cause freeze burns. May cause severe damage if eye is not immediately irrigated. The full effect may occur after several days

Ingestion: Will cause corrosion of and damage to the gastrointestinal tract.

Long-term Exposure: This material has been in use for many years with no evidence of adverse effects.

Air concentration thresholds have been established for ammonia as guides for purposes of monitoring short-term and long-term occupational exposure, and for the purpose of emergency planning. These threshold concentration values for ammonia vapor, their application, and the reference guideline, standard or regulation are listed in Table 3.

Table 3. Ammonia Concentration Limits.

Concentration	Application	Reference
25 ppm (17.75 mg/m^3)	Recommended exposure limit for 10 hour work day during a 40 hour work week	NIOSH Guide and ACGIH
35 ppm (24.85 mg/m^3)	Short-term exposure limit not to be exceeded in a 15-minute period	NIOSH Guide and ACGIH
50 ppm (35.5 mg/m^3)	Permissible exposure limit	OSHA
197 ppm (140 mg/m^3)	The concentration that defines the endpoint for a hazard assessment of off-site consequences	40 CFR 68
500 ppm (355 mg/m^3)	Concentration that is immediately dangerous to life or health for a worker without a respirator with an exposure time greater than 30 minutes	NIOSH Guide and ACGIH

Anhydrous Ammonia Safety

The storage and handling of anhydrous ammonia in large quantities is a potentially significant hazard. This requires attention to the engineered features, control and mitigation safeguards, and operating procedures and training for plant personnel. Applicable guidelines, standards and regulations related to the use of anhydrous ammonia are listed below.

- American National Standard Institute (ANSI) Standard K61.1 (Compressed Gas Association (CGA) Standard G-2.1)— Storage and Handling of Anhydrous Ammonia
- 29 CFR 1910.38 - Employee Emergency Plans and Fire Protection Plans
- 29 CFR 1910.111—Storage and Handling of Anhydrous Ammonia
- 29 CFR 1910.119—Process Safety Management of Highly Hazardous Chemicals
- 29 CFR 1910.1000 - Air Contaminants
- 40 CFR 68—Chemical Accident Prevention Provisions
- Pocket Guide to Chemical Hazards—National Institute for Occupational Safety and Health (NIOSH)
- Threshold Limit Values for Chemical Substances—American Conference of Governmental Industrial Hygienists (ACGIH)
- Emergency Response Guidebook—U.S. Department of Transportation

The applicability of standards and regulations are generally triggered by the quantity of ammonia stored. These quantities are called threshold quantities and are listed in Table 4.

Table 4. Regulatory Threshold Quantities for Ammonia.

Chemical	Threshold Quantity	Federal Regulation
Anhydrous Ammonia	10,000 lbm	40 CFR 68
Aqueous Ammonia >20%	10,000 lbm	40 CFR 68
Anhydrous Ammonia	10,000 lbm	29 CFR 1910.119
Aqueous Ammonia >44%	15,000 lbm	29 CFR 1910.119

The proposed storage quantity for the Allen SCR systems (36,000 gallons or 173,930 lbm) would exceed threshold quantities. In addition to on-site storage, anhydrous ammonia must be transported to the plant site to replenish system storage. The use of trucks with a capacity of 27,249 L (7,200 gallons) each would be the mode of transportation.

Approximately 80 plant employees and contractors would be working within 500 m (547 yd) of the ammonia storage and unloading facilities. The nearest residence is approximately three miles from the plant.

Risk Factors

The risk and potential severity of an ammonia storage or handling accident would be influenced by a number of factors including:

- Design of the ammonia storage and handling facility including engineered features and safeguards, and the quantity of ammonia stored
- Transportation mode for ammonia deliveries—truck, and the frequency of deliveries (see **Transportation**)
- Procedures for normal operations
- Training of operations personnel for normal operations and emergency response
- Population distribution in the plant vicinity
- Emergency planning and response procedures
- Probability of events such as earthquakes and tornadoes that could initiate a worst case release.

Engineered Features and Safeguards

Properly engineered features and safeguards as well as adequate operating and maintenance procedures and training should make accidents unlikely and limit their consequences. Adherence to standards such as CGA G-2.1 or OSHA 29 CFR 1910.111 can result in safe equipment design. Compliance with 40 CFR 68 and 29 CFR 1910.119 ensures proper hazard assessment, operating procedures, employee training, and emergency planning have been provided.

A primary feature for limiting the potential hazard from an ammonia release would be a water fogging system with both automatic and manual actuation to protect both the storage tank area and unloading area. A fogging system applies a fog blanket of small water droplets to wash ammonia vapor from the air, combining with the ammonia to form liquid aqueous ammonia which would drain to, and be retained in, the chemical treatment pond. This retention basin is necessary to prevent uncontrolled discharge of aqueous ammonia to surface waters which would kill aquatic life. Similarly, this same retention basin would receive fogging runoff from the unloading area.

To be completely effective, a fogging system must, at a minimum, deliver a uniform spray of fine droplets over the surface of an ammonia spill at a rate that exceeds the mass transfer (boil-off) of anhydrous ammonia by a factor of at least 3.5. This accounts for the fact that a saturated aqueous ammonia solution at 100° F (summer design condition) is about 29% ammonia by weight. Thus, 3.5 pounds of water must be combined with each pound of ammonia vapor boiling off of a spill to simply achieve a saturated solution. The fogging system is expected to have nine nozzles, each releasing 10 gallons per minute with a cutoff after 30 minutes; therefore, this system could effectively control releases of approximately 1200 gallons or less. However, this fogging system is not designed to mitigate the worst-case failure of a storage tank and it would be effective in controlling approximately 8% of a catastrophic release.

Accidental Release of Anhydrous Ammonia

Hazard Assessment Criteria and Methods

The criteria and methods of 40 CFR 68, Subpart B—Hazard Assessment were used as guidance in analyzing accidental ammonia releases. The analysis of accidental releases of certain chemicals, including ammonia, is required by 40 CFR 68. The accident must be analyzed to determine the distance from the point of release to the toxic endpoint. The toxic endpoint for ammonia is 197 ppm or 0.14 mg/L[1] (see Table 3). This concentration was developed by the American Industrial Hygiene Association (AIHA) and is defined as the maximum airborne concentration below which nearly all individuals can be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action.

The Risk Management Plan (RMP)-comp model, developed by EPA and NOAA to perform off-site consequence analyses required under EPA's Risk Management Planning rule was used. RMP-comp uses the EPA defined worst-case conditions: stability Class F[2] and wind speed of 1.5 meters per second (3.4 miles per hour) for worst-case release scenarios, and stability class D and wind speed of 3.0 meters per second (6.7 miles per hour) for alternative release scenarios. Ambient air temperature of 77° F (25° C) and relative humidity of 50% are used for both worst-case and alternate release scenarios. Rural topography was assumed in using the model. Compliance with 40 CFR 68 is listed in the **Summary of Commitments** in Chapter 2 to be completed prior to initial fill of the ammonia storage tanks or transport of ammonia onsite.

Worst Case Release Scenario—Storage Tank Failure

The worst-case release scenario is defined as one where the entire contents of one tank (18,000 gallon) with an effective storage capacity of 16,000 gallons is released to the environment in 10 minutes with no active mitigation. The RMP-comp model was used to estimate the distance to the endpoint, assuming that the release occurred during worst-case dispersion conditions. The endpoint is an ammonia concentration of 140 mg/m^3 or 197 ppm as prescribed in 40 CFR 68. The modeling results indicate that the distance to the endpoint would be about 8.2 km (5.1 miles).

Worst Case Release Scenario—On-site Tanker Truck Failure

A similar analysis was performed for the case of sudden failure of a tanker truck loaded with 7,200 gallons of ammonia with no active mitigation. For this case the distance to the endpoint (under worst case conditions) was estimated to be about 5.8 km (3.6 miles).

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[1]Based on Emergency Response Planning Guideline 2 (ERPG-2), the "toxic" endpoint of ammonia is 0.14 mg/L or 140 mg/m^3. This endpoint was developed by the American Industrial Hygiene Association (AIHA) and is defined as the maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual's ability to take protective action.

Alternate Release Scenarios—Tank Leaks and Process Line Leaks

The first alternative scenario assumes a leak from a ¼-inch diameter hole in the storage tank or tanker truck, such as a rupture of a gasket or a pump seal leak. This would cause a release of 3600 pounds of ammonia with a release rate of 120 pounds per minute and a duration of 30 minutes (this duration assumes that employees respond to isolate the leak). The estimated distance to the endpoint is 0.3 km (0.2 miles) for this scenario. The second alternative scenario assumes a leak from a 2-inch diameter hole in the storage tank or tanker truck, such as a transfer hose failure or sudden uncoupling. This would cause a release of 2,380 pounds of ammonia with a release rate of 238 pounds per minute for a duration of 10 minutes. The estimated distance to endpoint is 0.5 km (0.3 miles) for this scenario. A third alternative scenario involves a process line leak in the supply line that connects the storage tanks to the vaporizers located near the SCR reactors. This would cause a 2.5-inch diameter hole with a release of 1,270 pounds of ammonia with a release rate of 254 pounds per minute for a duration of 10 minutes. The estimated distance to endpoint is 0.3 km (0.2 miles) for this scenario. These three scenarios do not take into account any active mitigation, such as the water fogging system.

Alternate Release Scenarios—Tank Failures with Active Mitigation

As an alternate release scenario, the fogging system was assumed to release 90 gallons per minute during a release based on catastrophic failure of the storage tank, releasing 16,000 gallons of ammonia in 10 minutes. In this scenario, the water fogging system would be effective in removing 8% of the ammonia released into the atmosphere, thus 75,500 pounds of ammonia would be released to the atmosphere, which would result in an estimated distance to endpoint of 2.6 km (1.6 miles). The water fogging system would be much more effective in controlling smaller leaks, such as a leak from a 2-inch diameter hole in the storage tank or tanker truck, for example a transfer hose failure or sudden uncoupling. In this situation, the control efficiency of the fogging system would likely be 86% so while the leak would release 2,380 pounds of ammonia in 10 minutes, the fogging system would allow only 323 pounds to be released to the atmosphere. The estimated distance to endpoint is 0.2 km (0.1 miles) for this scenario. This endpoint is approximately one-third the distance of the similar scenario without the fogging system.

Potential for Worst Case Ammonia Releases

The worst case releases assume that a tank fails catastrophically, that the water fogging system is inoperable, and that there is no onsite emergency response to mitigate the release. Possible events that could result in this situation are occurrence of a major earthquake or a tornado. These events could cause tank failure and a loss of power onsite that would disable the pumps supplying the water fogging system. Presumably, emergency response would be significantly hindered in such situations. To judge the risk of these accidents, the probability of major earthquakes and tornadoes were evaluated in the following sections.

[2] Class F atmospheric stability is an uncommon inversion condition that occurs primarily at night during about 10 to 15% of the hours in a year.

Evaluation of Seismic Hazard

The primary source of earthquake hazard to the ALF site is the New Madrid Seismic Zone (NMSZ). The NMSZ is located in the central Mississippi Valley and extends from northeastern Arkansas to northwestern Tennessee and southeastern Missouri (Figure Appendix C-1). The NMSZ has produced several damaging earthquakes highlighted by the sequence of great earthquakes and aftershocks that occurred during 1811-12.

The ALF is underlain by 20 to 40 feet of fill that rest on Quaternary alluvium (Hart 1979). Geotechnical investigations reveal that the soils at the site belong to soil category D (LAWGIBB 1999, ICBO 1997). This site is susceptible to earthquake induced liquefaction.

The earthquake hazard at the ALF relative to other locations in the United States is considered to be high based on the U.S. Geological Survey's (USGS) (1996) probabilistic seismic hazard mapping. Appendix C provides the details of the USGS (1996) results and includes a more complete description of the geologic and seismologic conditions at the ALF.

The earthquake hazard to ordinary buildings at the proposed project site will be addressed through adherence to the seismic provisions of the UBC (ICBO 1997). Special structures that house hazardous processes or sensitive equipment may require additional considerations. Transport of hazardous substances through underground or aboveground piping (e.g., ammonia) may also require special designs and careful siting to address seismic hazards, especially since earthquake induced liquefaction is a possibility at this site.

Evaluation of Tornado Risk

There are excellent records of the occurrence of tornadoes in populated areas of the United States. One source used for nuclear plant siting applications is "Tornado Climatology of the Contiguous United States" (NRC 1986). To determine the probability of a tornado affecting ALF, a study area was defined as a box of one degree of latitude by one degree of longitude containing the county (90°W to 91°W by 35°N to 36°N). This resulted in a study area of approximately 3,887 square miles which is equivalent to a square with sides about 62 miles in length.

The average tornado path affects an area of 2.82 square miles (Thom 1963). As an example, this would be equivalent to a tornado with a path width of 0.25 miles and a travel distance of 11.28 miles (0.25 miles x 11.28 miles = 2.82 square miles). For the study area, 69 tornadoes occurred during the 30 year period 1954 to 1983. This results in a tornado frequency of 2.30 tornadoes per year (69 tornadoes/30 years = 2.30). The annual probability of affecting a particular site in the study area, such as ALF may be calculated as follows:

$$\text{ANNUAL PROBABILITY} = \frac{(2.30\ \textit{tornadoes / year}) \times (2.82\ \textit{square miles affected / tornado})}{(3{,}887\ \textit{square miles study area})}$$

$$= \mathbf{0.0017}\ \textit{per year.}$$

In other words, there is a 0.17% chance each year of a tornado affecting a particular site in the study area. This is less than two-tenths of one percent chance per year. Another way to express risk is to calculate how often, on average, a tornado may affect a particular site. This may be calculated by:

RECURRENCE INTERVAL = 1/(0.0017 *per year*) ~ **588** *years*.

So, on average, a tornado would be expected to affect a site in the study area, such as ALF, once every 588 years. Additionally, the probability of Class F[3] stability occurring is about 0.1 to 0.15, although occurrence immediately after a tornado is unlikely and therefore even lower. The resulting probability of both a tornado and Class F[3] stability in the study area is about 2×10^{-4}.

Potential Impacts of Ammonia Releases

Worst Case Releases

The worst case releases have endpoints that extend off-site and into the city of Memphis. The estimated populations within the radius of each accident were developed from 1990 U.S. census data using block and tract data and are given in Table 5 (GeoLytics 1998). The amount of time that it would take for the ammonia plume to reach the endpoint distance and the nearest residence (approximately 3 miles away) is also listed. These times are based on a wind speed of 1.5 meters per second (3.4 mph). This is the wind speed which results in the highest concentrations due to very little dispersion. If the wind were blowing harder, the amount of time to reach the endpoints would be reduced, because the plume would travel faster. But due to increased turbulence at the higher wind speed, the plume would be more dispersed resulting in a closer endpoint distance, i.e. a smaller impact area. Since, by definition, the endpoint concentration is the maximum concentration below which nearly all individuals can be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action, residents in the affected areas would have adequate time to evacuate the impacted area without any harm. Further, probability of such a worst case release is 2×10^{-4}.

Alternate Releases

The alternate releases for leaks result in endpoints that would be confined to the plant site. The normal day shift at Allen includes approximately 80 employees, though during an outage as many as 1000 employees can be onsite. The alternate release which considers active mitigation for storage tank failure results in an endpoint that would be, to a large extent, confined to the plant site or unpopulated areas surrounding the plant.

[3]Class F atmospheric stability is an uncommon inversion condition that occurs primarily at night during about 10 to 15% of the hours in a year.

Table 5. Potentially Affected Populations for Worst Case Ammonia Releases.

Worst Case Releases	Distance to Endpoint	Time to Reach Endpoints		Estimated Population Within Final Endpoint
		3 Miles	Final Endpoint	
Storage Tank	8.2 km (5.1 miles)	53 min	1.5 hr	42,230
Tanker Truck	5.8 km (3.6 miles)	53 min	1.1 hr	5,280

The alternate release which considers active mitigation for a large leak results in an endpoint that would be confined to the plant site. Table 6 summarizes these releases and the potentially affected populations within their endpoint radii. The amount of time that it would take for the ammonia plume to reach the endpoint distance is listed. These times are based on a wind speed of 3.0 meters per second (6.7 mph). If the wind were blowing harder, the amount of time to reach the endpoints would be reduced, because the plume would travel faster. But due to increased turbulence at the higher wind speed, the plume would be more dispersed resulting in a closer endpoint distance, i.e. a smaller impact area. Since, by definition, the endpoint concentration is the maximum concentration below which nearly all individuals can be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action, residents in the affected areas would have adequate time to evacuate the impacted area without any harm.

Table 6. Potentially Affected Populations for Alternate Ammonia Releases.

Alternate Releases	Distance to Endpoint	Time to Reach Endpoints	Estimated Population Within Endpoint
Tank Leak—Small	0.3 km (0.2 miles)	2 min	Most plant staff
Tank Leak—Large	0.5 km (0.3 miles)	3 min	Most plant staff
Process Line Leak—Large	0.3 km (0.2 miles)	2 min	Most plant staff
Water Fogging System:			
Storage Tank Failure	2.6 km (1.6 miles)	14 min	Plant staff
Large Tank Leak	0.2 km (0.1 miles)	1 min	Most plant staff

Based on the limited public population potentially affected and the availability of emergency response measures, the potential impact of alternate releases are considered minimal.

Both worst case and alternate release scenarios can potentially affect plant staff and operations. Meeting the requirements of OSHA's process safety management standard (29 CFR 1910.119) and emergency planning standard (29 CFR 1910.38) would significantly reduce the potential effects. Operations, evacuation, and rescue procedures covering emergency situations would be in place and practiced prior to startup. Pre-startup safety review and mechanical integrity testing would be completed. The plant staff would be trained to properly respond to emergencies and use the protective systems to prevent their injury and maintain control of the plant operations.

The industrial gas industry has a very good safety and employee injury and illness performance. According to OSHA, this industry's injury and illness incident rate was 2.4 per 100 workers and the lost time incident rate was 1.1 per 100 workers in 1996. For comparison, the rates for the general chemical industry were 4.8 and 2.4 respectively in 1996. TVA's rates were 1.23 and 0.24 in 1996 and 1.01 and 0.20 in 1997. TVA's rates reflect the Agency's emphasis on safe plant operations.

The health impacts to plant staff from ammonia could be serious if exposure occurs. Potential exposure to ammonia is substantially reduced by the design and engineering of the SCR systems, by the emergency planning and operation procedures, by the staff training and awareness, and by the superior safety culture and record at ALF. The potential effects on plant staff from SCR systems operations should be minimal as they are from current operations. Compliance with 40 CFR 68, 29 CFR 1910.119 and 29 CFR 1910.38 are commitments prior to filling the ammonia tanks or transporting quantities exceeding 10,000 lb and beginning operations of the SCR systems.

In summary, the risk of a worst case release and related impacts are considered minimal based on the following factors:

- Development of a RMP in compliance with 40 CFR 68.
- Substantive compliance with 29 CFR 1910.119 and 29 CFR 1910.38.
- Low probability of a tornado or major earthquake.
- Commitment to earthquake resistant design of the ammonia storage facility.
- Low probability of Class F[4] atmospheric stability coincident with a catastrophic tank failure.

Terrestrial Ecology

Resource Description

The area in and around the ALF has been heavily impacted and altered as a result of the construction and operations of the facility. No natural landscape remains and vegetated areas, where present, are maintained by mowing and other routine landscape procedures. A small area, currently used for informal parking, has exposed soil, young black willow, yellow poplar, red maple, hachberry, Johnson grass and kudzu.

[4]Class F atmospheric stability is an uncommon inversion condition that occurs primarily at night during about 10 to 15% of the hours in a year.

A review of the TVA Natural Heritage database indicates that the proposed project at ALF is not located in a managed area. The project site is immediately adjacent to a managed area. In addition, there is one managed area and one ecologically significant site within five miles of the project site. These sites are:

T.O. Fuller State Park borders the south side of ALF. The park is located approximately 1.0 mile southeast of the actual project site. This 1128-acre area is owned and managed by TDEC, Division of State Parks, and provides daytime recreational opportunities. Within the boundaries of the park is the Chucalissa Village State Archaeological Area. This area features a reconstructed Choctaw village and museum and is operated by the University of Memphis.

Riverside City Park is located 3.5 miles northeast of the project site. The park is managed by the Memphis Park Commission.

Martyrs Park Potential National Natural Landmark is located 5.0 miles northeast of the project site. This 2-acre site is a municipal property, managed by the Memphis Park Commission. The National Natural Landmark (NNL) program was established in the 1970s by the National Park Service to identify nationally significant examples of ecologically pristine or near pristine landscapes. This tract, while meeting the criteria for listing, was never registered as a NNL.

Protected Terrestrial Species

No state or federal-listed plant species are known to occur within five miles of the ALF. In addition, habitat for such species is not likely to be present on or adjacent to the project area. Four rare terrestrial animal species and one heronry have been documented from the vicinity of the project area. Rare species reported from the area include least tern (*Sterna antillarum*), Mississippi kite (*Ictinia mississippiensis*), Bewick's wren (*Thryomanes bewickii bewickii*) and mole salamander (*Ambystoma talpoideum*). Least terns have been reported 1.25 and 1.7 miles from the proposed construction site. The Mississippi kite and mole salamanders have been reported one mile from the construction site. Lastly, a heron colony is located 4 miles from the project location.

Potential Impacts

Under the No Action Alternative direct impacts to the existing terrestrial ecology would be insignificant. Indirect impacts to the existing terrestrial ecology, as a result of the continuous production of NO_X would continue to occur. Although there is a managed area adjacent to ALF, no impact is anticipated because the managed area would remain unchanged.

Because the proposed project lies entirely in highly disturbed areas within the existing fossil plant or immediately adjacent areas, and because no rare plants or animals are known from the vicinity, no impacts to federal- or state-listed rare plant species or sensitive habitats are anticipated as a result of the No Action Alternative.

Because the proposed project lies entirely within the existing fossil plant, direct and indirect impacts from the proposed action to the terrestrial ecology would be insignificant, and possibly beneficial, at the state and regional level. Although there is a managed area adjacent to the proposed project at ALF, no impact is anticipated because of the distance from the actual project site and because all work will take place within the plant physical structure. No impact is anticipated to areas within five miles of the project site because of the distance.

No suitable habitat for any rare terrestrial plant or animal species would be present on the areas proposed for construction or demolition activities. Due to distance from the plant site and because construction activities would be restricted to the ALF properties, installation of the SCR system would not result in adverse impacts to rare terrestrial plants, animals or their habitat.

Wetlands and Floodplains

Resource Description

National Wetland Inventory (NWI) maps indicate forested, scrub-shrub, and emergent wetlands occur in the general vicinity of ALF. These areas are associated with the Mississippi River and Nonconnah Creek. Various species of resident and migratory waterfowl, wading birds, shorebirds and marsh birds use these habitats regularly during various seasons.

There are numerous ponds at Allen for water treatment that may in part be wetlands which support waterfowl use. These ponds include coal yard drainage basins, fly ash ponds, metal cleaning waste ponds, and others. However, because these wetland areas are a part of the plant wastewater treatment system, none of these treatment units are classified as jurisdictional wetlands falling under the Clean Water Act (CWA).

Potential Impacts

There are no jurisdictional or non-jurisdictional wetlands at the proposed locations of the SCR reactors and the ammonia storage tanks. No wetlands would be disturbed by construction activities and trenching associated with piping for the project, and no operational impacts to wetlands from accidental ammonia releases would occur.

Floodplains

All SCR equipment including the ammonia unloading and storage facility would be constructed above both the 100-year floodplain and project design flood elevation (approximating the 500-year floodplain). Thus, no impacts to floodplains would occur and the project would comply with Executive Order 11988. The proposed expansion of the existing West Ash Pond in order to better manage the ammonia contaminated fly ash could involve some construction within the 100-year floodplain and would therefore be subject to compliance with Executive Order 11988. Alternatives to expanding in the floodplain were evaluated and the determination made that there is no practicable alternative to the proposed project because there is no other land available on-site and off-site would be prohibitively expensive. The expansion of the West Ash Pond would not increase the incidence of flooding or flood damage potential, which fulfills the requirements of Executive Order 11988.

Land Use and Visual Aesthetics

Resource Description

The plant site is on the south bank of Lake McKellar, an embayment of the Mississippi River. A variety of industrial facilities are also located across the lake on the north bank. The site is located at the end of the access road adjacent to the sewer treatment plant, and about a mile west of Fuller State Park. It is surrounded by relatively flat open land, with the river about 1½ miles west beyond a woodland buffer. The existing plant facilities provide a significant visual contrast to the surrounding rural landscape. They include large scale industrial structures and operations that are seen above trees and across open areas. The facilities are visible to boats on the lake, industrial development across the lake, and a few passing motorists. They may also be seen seasonally from elevated locations in the state park and homes toward the southeast.

Potential Impacts

The proposed SCR, ammonia, and construction features, such as the West Ash Pond expansion, would be located primarily in the plant area, adjacent to existing facilities. Since these locations are used intermittently for related industrial purposes, the land use would not change.

The proposed additions would cause little if any visual change, and the overall character of the industrial plant would appear the same. The SCR facilities would be somewhat smaller than adjacent structures but would have a similar appearance. The new features would be seen from the lake, but visual continuity with existing facilities would make these additions hardly noticeable. The ammonia storage facilities would be relatively small scale industrial features. They would be seen from boats and a few public motorists that pass the plant, but would be a visually insignificant addition to the industrial facilities near-by.

Construction activities, equipment, and materials would be seen primarily from boats on the lake. It would temporarily add minor visual discord on site. Existing facilities would screen most views of construction from the state park and residences to the southeast.

Archaeological and Historic Resources

Resource Description

Southwestern Tennessee has been an area of human occupation for the last 12,000 years. Human occupation of the area is generally described in five broad cultural periods: Paleo-Indian (11,000-8,000 BC), Archaic (8000-1600 BC), Woodland (1600 BC-AD 1000), Mississippian (AD 1000-1700), and Historic (AD 1700- to present). Prehistoric land use and settlement patterns vary during each period, but short- and long-term habitation sites are generally located on flood plains and alluvial terraces along rivers and tributaries. Specialized campsites tend to be located on older alluvial terraces and in the uplands. European interactions with Native Americans in this area began in the 17th and 18th centuries associated with the fur trading industry. At the end of the 18th century, the Spanish constructed Fort San Fernando near present day

Memphis (Harkins 1998). Following various smaller settlements, the city of Memphis and Shelby County were founded in 1819 following the forced removal of the Chickasaw (Harkins 1998; Williams 1998).

At least seven archaeological sites have been recorded within one mile of the proposed facility. These sites include a Mississippian Period ceremonial center (Chucalissa), Woodland Period habitation sites, and historic farmsteads. A total of 158 historic properties have been listed on the National Register of Historic Places (NRHP) in Shelby County, Tennessee. The majority of these lie within the city limits of Memphis. Important properties near the project area that are listed on the NRHP are the Chucalissa Indian Village.

No systematic survey has been conducted of the ALF facility. A survey of a proposed biogas pipeline and biomass facility at and near the plant did not encounter any cultural resources (Walker and Weaver 1999). The ALF site is highly disturbed in most areas, including the footprint areas for the proposed SCR system. No archaeological resources occur in the area of effect of the SCR system, including the West Ash Pond expansion, because of previous disturbance of the proposed construction sites.

Potential Impacts

There are no historic structures within the plant site. Due to the highly disturbed nature of the project area and the distance to any historic properties from the project area, no historic properties would be affected by either the proposed action or the no action alternative. The Tennessee SHPO has concurred with this finding (Appendix B).

Solid and Hazardous Waste—Coal Combustion By-Product (CCB) Generation, Marketing and Handling

Existing Conditions

ALF is expected to burn between 2.3 and 2.7 million tons of coal annually through at least 2014. The coal averages 6.9% ash; therefore, total ash production will range from approximately 160,000 to 186,000 tons of ash per year. The ash is collected as either fly ash (which is fine enough and light enough to be carried with the flue gas stream exiting the boiler) or as boiler slag which is formed as a molten liquid in the bottom of the boiler, then quenched in water. The fly ash/boiler slag split is about 30% fly ash and 70% boiler slag. All fly ash and boiler slag is sluiced to the ash pond complex.

Fly ash, which is separated from the flue gases in electrostatic precipitators and collected in hoppers, is lighter and is carried further out into the pond. Due to the small quantities of fly ash produced at ALF and that it is sluiced rather than collected dry, TVA has been unable to market ALF fly ash. Fly ash production is expected to range from about 48,000 to 56,000 tons per year, depending on coal burn, through 2014.

Potential impacts of "ammonia slip" or excess ammonia as a result of the SCR installation could include ammonia being deposited on the fly ash. If ammoniated fly ash is sluiced directly to the ash pond complex, the ammonia would dissolve rapidly in the sluice water. The concentration of ammonia in the sluice water would be dependent upon the concentration of ammonia on the fly ash, the amount of fly ash sluiced to the pond, the volume of water sluiced and the volume of water in the ash pond.

Boiler slag which collects in the bottom of the boiler and quenched is periodically sluiced to a boiler slag dewatering area within the East Ash Pond complex. The boiler slag is removed from this area with dozers or front end loaders by an ash marketing company and then carried to storage areas within the ash pond complex. The boiler slag is then washed to remove the fines and screened to sort the material into various size fractions. About 85% of the boiler slag is recovered for marketing in this process. Boiler slag production is expected to range from about 112,000 to 130,000 tons per year, depending on coal burn, through 2014.

Although ALF has used some of the boiler slag produced through the end of 1999 to construct plant roadways, dikes, and donates the material to local city and county highway departments for road base construction and snow and ice control, most ALF boiler slag is used in roofing granule manufacturing and as industrial abrasives.

Potential Impacts

Fly Ash

During operation of the SCR system, "ammonia slip" will increase as the catalyst ages. Most of this ammonia will be adsorbed on the fly ash in the form of ammonium bi-sulfate which tends to be a "sticky" molecule. Some of this sticky ash will adhere to the air pre-heaters (APHs) where it will be removed periodically by washing with water. Most of the rest of the ammoniated ash will be removed in the electrostatic precipitators and collected in hoppers, then sluiced to the ash pond complex. See the following wastewater section for discussion of water quality issues associated with fly ash disposal and proposed fly ash management, including reactivation and expansion of the West Ash Pond.

Bottom Ash/Boiler Slag

Boiler slag is collected in the boiler prior to ammonia injection. No impacts associated with boiler slag marketing, utilization or disposal have been identified as a result of SCR installation and operation at ALF.

Catalyst Recycling and Disposal

The catalyst for the SCR would be vanadium pentoxide. This chemical falls in a unique class of hazardous waste under the Resource Conservation and Recovery Act (RCRA). The classification is as a listed P120 RCRA waste, which refers only to unused product. If it is used product (spent catalyst), normal special waste rules apply. Any unused product, other than a *de minimis* amount, must be treated as a hazardous waste. There is also some potential that spent catalyst could have an accumulation of heavy metals found in coal combustion flue gas.

TVA anticipates that it would have a catalyst management contract with the catalyst vendor. These services would include acceptance and ownership of spent catalyst by the vendor. If the spent catalyst is classified as a hazardous waste, TVA would have responsibility for proper disposal. It is common practice to recycle the catalyst thus minimizing the need for waste disposal. Should TVA become the custodian of any hazardous waste associated with the catalyst, a qualified hazardous waste disposal facility would be used for ultimate disposal. Spent catalyst handling would likely require respiratory protection of workers to prevent inhalation of dust or fines. The MSDS (see Appendix A) for vanadium pentoxide lists a 3 ppm limit for respiratory protection.

Construction Waste Disposal

Asbestos Disposal

Any asbestos waste resulting from flue gas duct work modifications would be properly managed according to TVA procedures and state regulations. TVA has existing contract with Waste Management Inc. who will transport and dispose of any asbestos generated in their Tunica County Mississippi landfills approved for asbestos disposal. A 10-day renovation notification would be filed with the Memphis, Shelby County Health Department.

Construction Rubble and Demolition Waste

There may be used lumber, scrap metal and masonry rubble resulting from the plant modifications and new construction. To the extent practicable, these materials would be reused or recycled as scrap. As necessary, onsite disposal in solid waste management units would be used.

Hazardous Wastes

Hazardous wastes such as paint, coating and adhesive wastes, and spent solvents could be produced from the construction activities. These wastes would be temporarily stored in properly managed hazardous waste storage areas onsite. A qualified hazardous waste disposal facility would be used for ultimate disposal of the wastes.

Aquatic Ecology

Resource Description

Installation and operation of the SCR systems could potentially impact aquatic communities in McKellar Lake (the Condenser Cooling Water [CCW] intake location) and the Mississippi River. McKellar Lake, an oxbow adjoining the Mississippi River near Memphis, is 12.6 km long and empties into the Mississippi River at mile 725.7. Water flow is typically from McKellar Lake into the Mississippi River, however, rising waters in the Mississippi occasionally produce a back flow into McKellar Lake. McKellar Lake is the principal harbor for Memphis, with heavily industrialized shoreline and heavy barge traffic. The CCW discharge is into the Mississippi River at mile 725, downstream of the mouth of McKellar Lake (TVA 1981).

TVA conducted two rotenone samples each year in 1979 and 1980 in McKellar Lake. A total of 45 species was collected in the four samples; however, only 28 species were common to both 1979 and 1980 collections (Appendix D, Table D-1). Dominant species in both years were gizzard shad, various sunfish, and freshwater drum (TVA 1981). Although abundance and presence of various species can fluctuate over time, most of these species could be expected to regularly inhabit McKellar Lake. The existing fish community is typical of similar habitats along this portion of the Mississippi River.

Tennessee Wildlife Resources Agency (TWRA) fish collections with electrofishing and trawling gears in the Mississippi River between the Interstate 40 bridge and the Tipton County, Tennessee, line in October 1999, collected 37 species of fish (Appendix D, Table D-2) (Wilson 2000).

Protected Aquatic Species

No protected aquatic species are known or are particularly likely to occur in the substantially disturbed habitat of McKeller Lake. One federal and Tennessee endangered species (the pallid sturgeon, *Scaphirhynchus albus*), however, is known from the main channel of the Mississippi River near Memphis. It would be possible for individual pallid sturgeons to wander into McKeller Lake as they were searching for food.

Construction Impacts

Potential construction impacts to McKeller Lake and the Mississippi River would include temporary erosion and siltation resulting from soil disturbing activities during installation of the SCR reactors, ammonia storage and unloading area, interconnecting ammonia and service water piping, electrical conduits, reactivation and expansion of the West Ash Pond and retention basins. These areas have previously been disturbed by plant construction and modification activities. These impacts would be minimized by implementation of Best Management Practices (BMPs) to control erosion during construction and stabilize disturbed areas after construction is complete, and by routing surface runoff to existing treatment facilities that meet regulatory requirements. These measures would substantially reduce the potential impacts in McKeller Lake, to the point of causing only minor and temporary effects on fish and other aquatic life. The proposed construction activity would not have any adverse effect on endangered, threatened, or other protected species which might be present in this part of the river system.

Operational Impacts

Ammonia is very toxic to fish and other forms of aquatic life. Because provisions have been made for containment of accidental spills from storage tanks, aquatic life should not be impacted by spills. During routine operations at ALF, management of ammonia slip, reactivation and expansion of the West Ash Pond, establishment of appropriate effluent toxicity limits and pH control of fly ash pond discharges, combined with monitoring of ash pond and condenser cooling water discharges, will result in insignificant impacts to aquatic life that use adjacent areas of the Mississippi River or McKellar Lake for spawning or feeding.

Protected Aquatic Species

The proposed project would not result in any harmful levels of ammonia discharged to surface waters, and therefore, there would be no adverse impacts to protected aquatic animals.

Wastewater

Fuel Burning Equipment Description

ALF has three cyclone-furnace, coal-fired boiler units. Each of the three identical units has a nameplate generating capacity of 330 gross MW. The normal fuel is low sulfur coal, with distillate (#2) fuel oil or alternative fuel oils, which meet all applicable standards for startup. Fuel oil may be burned under non-steady-state and low-load conditions to ensure flame stability. Wood waste may be burned at a maximum expected rate of 24 percent by weight. Shredded tires or Tire Derived Fuel (TDF) may be burned at an expected rate of 8 percent by weight. Up to 50,000 gallons of used oil and non-hazardous solvents may be burned at this installation, along with non-hazardous oil contaminated soil, absorbent material, and filters, rags containing oil or other non-hazardous materials.

Existing Coal Combustion By-Products (CCB) Wastewater Treatment Facilities

The CCB handling systems include the following areas that receive and treat wastewater effluents: East Ash Pond, Chemical Treatment Pond, and an inactive West Ash Pond. The east ash pond receives all of the fly ash and bottom ash wastewater and the chemical treatment pond receives intermittent wastewater from the air pre-heater washes. The West Ash Pond received fly and bottom ash until 1992, but is now inactive. Currently there are plans to reopen the west ash pond to accept fly ash before ammonia slip from the SCRs results in ammonia levels of concern in the east ash pond discharge into McKellar Lake (DSN 001) or the Horn Lake Cutoff (DSN 001A). The discharge from the reopened west pond would be mixed in the condenser cooling water (CCW) conduit, or discharged directly at the point where DSN 003 discharges into the open CCW canal, before discharging into the Mississippi River

East Ash Pond

The useful life expectancy of the east ash pond with its current configuration is approximately 10-15 years. The stop gate between the east ash pond and stilling pond was recently raised 4 feet to increase the Free Water Volume (FWV), effectively accommodating more ash. With plans to re-open the west ash pond for fly ash, the main inflow to the east pond would be bottom ash water (Table 7).

The boiler slag, or bottom ash, is collected in slag tanks and then sluiced to the east pond. Reed Minerals collects the slag from the east pond for processing. Material not collected by Reed is deposited in the pond and the water is returned to McKellar Lake. No ammonia would be added to the east ash pond after a west ash pond is placed into service. Until the West Ash Pond is brought into service, ammonia added to the east ash pond will be limited not to exceed 0.85 mg NH_3-N/L (determined to be protective of aquatic life in McKellar Lake) in the pond's discharge(s) by limiting ammonia slip through catalyst management.

Table 7. Inflow Sources to the ALF Ash Ponds* (Source of Flow Rates: Allen Fossil Plant Storm Water and Wastewater Flow Schematic rev. 10/04/99)

	Inflow to Pond (MGD)
West Ash Pond	
Fly Ash Sluice Water including:	4.5513
Reverse Osmosis Re-generative Waste/Backwash	
Acid Blending Station	
Powerhouse Roof and Yard Drains	0.0344
West 161 kV Switchyard	0.0076
Precipitator Pad Washing	0.0011
Car Wash	0.0009
Precipitation	0.1226
Evaporation	-0.1517
Total	4.5662
East Ash Pond	
Bottom Ash Removal	4.3508
Floor Drain Sump	0.7289
Reed Mineral Ash Processing	0.3118
Sluice Line Trench Runoff Sump	0.0803
Coal Pile Runoff Pond	0.0462
North Coal Yard Drainage	0.0191
Boiler Sump Blowdown	0.0127
Sump for: U-Bldg Yard and TDF Facility Drainage (0.0071)	0.0083
Equipment Garage and Wash Rack Grease Trap (0.0012)	
Boiler Fireside Wash Water (intermittent flow)	0.0014
Precipitation	0.3151
Evaporation	-0.1034
Total	5.7712

* Assuming the West Pond is Reactivated

West Ash Pond

ALF is expected to burn between 2.3 and 2.7 million tons of coal annually through at least 2014. The feed coal averages 6.9% ash, therefore total ash production will range from approximately 160,000 to 186,000 tons of ash per year. Approximately 75% of the ash is removed from the bottom of the boiler. The remaining ash is conducted through a cold-side electrostatic precipitator (ESP) designed to remove 99.0% of the particulate matter (PM) from flue gases generated by burning coal containing 12% ash and 2.5% sulfur. An SO_3 flue gas conditioning system may be used to improve the ESP performance with low sulfur coal by increasing the particulate resistivity. The fly ash removed from the ESP hoppers by a hydroveyor, one per unit, will be pumped by Jetpulsion pumps to the west pond. After the pond reactivation, the ash would settle out in the pond and the water will discharge to the CCW conduit that empties into the CCW canal (DSN 003) or directly to the canal (DSN 002) before flowing in an open channel directly into the Mississippi River.

With the reactivated west pond configuration, about 4.5662 mgd of ash sluice water and other constituent flows would be discharged from the west pond via DSN 003, with the remaining 5.7712 mgd still discharging into McKellar Lake through DSN 001 or DSN 002. Flow is diverted from the east stilling pond to the Horn Lake cutoff, DSN 001-A, during periods when the Mississippi River is in flood stage. Flow distribution to the ash ponds is shown in Table 7. TVA is required to meet effluent characteristics as shown in Table 8 on these discharge points.

Table 8. DSN 001, DSN 001-A, and DSN 003 discharge requirements (Source: NPDES Permit No. TN0005355).

DSN 001 and DSN 001-A

Effluent Characteristics	Effluent Limitations		Monitoring Requirements	
	Monthly Average mg/l	Daily Maximum mg/l	Measurement Frequency	Sample Type
Flow (MGD)	Report	Report	1/week	Instantaneous
pH	within range 6.0-9.0	within range 6.0-9.0	1/week	Grab
Oil and Grease	15.0	20.0	1/month	Grab
Total Suspended Solids	30.0	100.0	1/month	Grab
Total Copper	-	Report	1/quarter	Grab
Total Lead	-	Report	1/quarter	Grab
Total Mercury	-	Report	1/quarter	Grab
Total Selenium	-	Report	1/quarter	Grab
Total Cadmium	-	Report	1/year	Grab
Total Chromium	-	Report	1/year	Grab
Total Iron	-	Report	1/year	Grab
Total Manganese	-	Report	1/year	Grab
Total Silver	-	Report	1/year	Grab
48 HR LC_{50}	(Survival in 100 % effluent)		1/year	

DSN 003

Effluent Characteristics	Effluent Limitations		Monitoring Requirements	
	Monthly Average mg/l	Daily Maximum mg/l	Measurement Frequency	Sample Type
Flow (MGD)	Report	Report	1/day	Estimate
Intake Temperature			1/day	Grab
Discharge Temperature		44.4 °C	1/day	Calculated
Total Residual Oxidant (reported as Cl)		0.2 mg/l	1/week	
Time of Oxidant Addition		120	1/day	Log Records
48 HR LC_{50}	Monitor		1/5 years	

Chemical Treatment Pond

The chemical treatment pond receives the intermittent wash-water from the unit APH wash, boiler wash, and the cooling tower wash. The floor drains from the de-ionized water system are also collected here. It is estimated that approximately 60-80% of the original pond capacity of 9.6 million gallons remains currently.

The chemical treatment pond currently discharges into McKellar Lake through DSN 006. TVA is required to meet oil and grease, total suspended solids, total iron, total copper, and pH. Samples are to be taken at the beginning and end of a discharge event for each batch treated (Source: NPDES Permit TN0005355).

Plans to reconfigure the chemical treatment pond away from McKellar Lake will be initiated before the SCRs are operational. The new configuration will redirect the chemical treatment pond discharge to the CCW conduit that empties into the CCW canal that flows directly into the Mississippi River. After the modification, the permitted outfall DSN 006 will be terminated.

Construction Impacts

Surface Runoff

All construction activities related to the SCR installation would be performed within the existing plant site. Surface runoff would flow to existing facilities that meet regulatory requirements. Appropriate best management practices would be adopted and all construction activities would be conducted in a manner to ensure that waste materials are contained and that the introduction of polluting materials into the receiving waters would be minimized.

Construction Workforce Domestic Sewage Disposal

Portable toilets would be provided for the construction workers. These toilets would be regularly pumped out and the sewage transported by tanker truck to a publicly owned treatment works accepting pump out.

Operational Impacts

Wastewater Management of Ammonia Slip

Ammonia slip, the emission of unreacted ammonia (NH_3), is caused by the incomplete reaction of injected ammonia with NO_x present in the flue gas. The estimated maximum slip at ALF is 2.85 lb NH_3/hr (at 2 ppmv) for each of the three units for a worst case slip of 8.55 lb NH_3/hr. This worst case scenario would be for the catalyst in all three units to reach saturation simultaneously. The concentration of NH_3 in the slip will ultimately be determined by the degradation of the catalyst. The catalyst would be replaced when the ammonia concentration reaches 2.0 ppmv flue gas concentration.

The unreacted residual NH_3 will react with available gaseous sulfuric acid to form ammonium bisulfate (NH_4HSO_4). The resulting ammonium bisulfate would either mix in with the sluiced fly ash or build up on the air pre-heater elements.

$$NH_3 + H_2O + SO_3 \Longleftrightarrow NH_4HSO_4$$

European experience using low sulfur coals led to a recent study conducted by ABB Environmental Systems in which, about 20% of the NH_3 slip adhered to the heating surfaces in the air pre-heater, and about 80% adhered to fly ash (ABB Environmental Services 1999). Until there is some experience with U.S. coal types, there is no certainty of the exact mechanism or extent of APH problems TVA will face.

The best way to prevent ammonia salts from forming is to control the amount of ammonia slip by replacing the catalyst as the slip approaches 2 ppmv. Also, the use of low sulfur coal reduces the excess sulfuric acid which reacts with the ammonia to form the corrosive ammonia salts (i.e. NH_4HSO_4). ALF burns a low sulfur blend of coal, so it is thought that ammonium bisulfate production may not be as severe as when using a higher sulfur coal. However, there is still a significant opportunity for ammonia to be deposited in the APH. The postulation is that some of the ammonia is physically absorbed in the voids in the ash particles or moisture in the particles or both, in addition to ammonium bisulfate (Giles 2000). Whatever the mechanism, ammonia build-up on the APHs occurs continuously in proportion with the rate of ammonia slip and time of accumulation. Consequently, there is the potential for a concentrated slug of ammonia to enter the wastewater stream when the APHs are being washed following the accumulation over an extended period.

Air/Water Distribution for Ammonia Slip

As discussed above, the ammonia slip will be captured with ash by the either ESPs or build-up in some form on the APHs. In either case, the eventual fate is one of the treatment ponds.

Air Separator Tanks

Ammonia that is captured with the fly ash in the ESPs will travel with the hot fly ash meeting cooler raw water in the unit hydroveyor exhauster. The ammonia will immediately dissolve in the created slurry that then flows to the air separator tank. In order to prevent air-lock during ash sluicing, the air separator tank removes all of the air from the fly ash slurry venting it directly to the atmosphere. This is also the only opportunity for any dissolved ammonia to volatilize until the slurry reaches the fly ash pond. After passing through the air separator tanks, the fly ash slurry is sluiced to the fly ash pond with little or no gas phase so there is no opportunity for ammonia evolution to occur until it reaches the end of the sluice pipe.

Factors controlling the air/water distribution of the ammonia slip at any location include pH, temperature of the ash fluid and the air above, mixing, and chemical nature of the gas, as indicated by the Henry's Law coefficient.

The aqueous equilibrium between the unionized molecular ammonia and the ionized ammonium is given by the equation:

$$NH_4^+(aq) \Longleftrightarrow NH_3(aq) + H^+(aq)$$

Thus, the higher H^+ concentrations, i.e., lower pH values, favor the ionized or ammonium form. Conversely, the lower H^+ ion concentrations or higher pH values favor the unionized molecular or ammonia form. The tendency of the above equation to go to the right as written is positively related to temperature, so that higher temperatures favor the molecular ammonia form.

The pH and temperature characteristics of several of the critical plant site locations in the current configuration, including the air separator tank, are provided in Table 9 below.

Table 9. Measurements for pH and temperature taken at various locations for the current ash treatment configuration at ALF **

Sample location	pH	Temperature (range average in °C)
Plant intake	7.6	15-30
Air Separator Tank	7.3	15-30
End of FA sluice line	7.2	15-30
Delta flow into east ash pond	8.3	15-30
East ash pond	9.2	15-30
Chemical pond	6.0-10.5	15-30

** It is assumed that pH and temperature conditions will remain similar after the fly ash is routed to the west pond.

At pH 7.3, the level observed for the ash slurry in the air separator tank, less than 0.1% of the ammonia in solution is in the unionized molecular form. This, together with likely residence time of 10 to 20 seconds for ash within each of the air separator tanks, indicates that losses and ammonia from these tanks would be negligible. Thus, at this point all of the ammonia flowing to the air separator tanks remains in the ash slurry and is transported via the sluice pipes to the fly ash pond.

West Ash Pond

Sampling the air separator tanks at ALF showed the pH level and temperature not suitable for volatilization of ammonia. The pH range is between 6.5 and 7.5 and temperature is controlled by that of the raw water intake. Sampling performed at the end of fly ash sluice lines to the east pond (current configuration), in conjunction with the air separator tanks, show little change in pH or temperature. Fresh samples from the air separator tank were taken and stored in an open container. An increase of two pH units was observed between the initial pH and the pH measured over a 24-hour period. This rise in pH could be attributed to CO_2 evolution, together with the slow hydrolysis of the calcium oxide (CaO) component of the PRB coal fly ash.

Since there should be no losses of ammonia through volatilization in the sluicing process, the maximum concentration of ammonia in the west ash pond effluent would be controlled by the rate of slip, effluent flow after the pond reaches a steady-state concentration, and mixing within the CCW conduit. A worst case scenario would be for all three units to reach saturation simultaneously and for the loading to have occurred at a constant rate. The addition of ammonia from the APH's soot blowing is another factor. It is assumed that 10% of the material will be removed from the APHs by the soot-blowers. Comparison of the preceding conditions with a probable gradual loading is shown in Table 10.

Detailed evaluation of volatilization in the west ash pond was not performed due to the low concentrations in Table 10. The pH and temperature in the west pond should be similar to the current east pond. The possibility for some ammonia removal by volatilization is there, but the more likely removal mechanism, if any, in the ash/stilling pond will be algal uptake.

Table 10. Potential NH3-N concentration at outfall DSN 003 (Route: West Ash Pond into CCW Conduit then into CCW Canal (DSN 003).

	Total NH_3 load* (lb. NH_3/hr)	Concentration** of ammonia at outfall (mg NH_3-N/L)
Constant slip (worst case) †	6.84	0.052
Gradual slip (more likely) ††	3.0	0.024

* Loading and concentration is for all three units combined.

** Net values are shown, which are in addition to NH_3 present in intake water from McKellar Lake used for sluicing ash and from chemical treatment pond discharges that could contain ammonia following air pre-heater washes.

† Assumes slip rate is constant at the highest anticipated level (2ppmv)

†† Assumes the slip rate occurs gradually using the catalyst manufacturer estimates

Concentration and loading values shown in Table 10 would also occur in the CCW open canal after mixing with CCW flow if the option is selected to discharge the re-activated West Ash Pond to the open canal (DSN 002).

DSN 003

There is currently no ammonia discharge limit for outfall DSN 003 nor a requirement to monitor ammonia. There is, however, a requirement to monitor acute toxicity once per five years in the renewed NPDES permit, effective June 1, 2000. The ammonia discharge limit necessary to meet acute toxicity requirements would be a function of pH. For example, the ammonia concentration to protect from acute (lethal) effects to aquatic life in undiluted effluent is 32.9 mg N/L at pH 7.1 (low end of DSN 003 pH range measured in toxicity tests conducted 1994-2000) and 7.0 mg N/L at pH 8.1 (high end of DSN 003 pH range measured in toxicity tests conducted 1994-2000). Under worst case conditions (constant 2 ppm slip simultaneously from three units, a pH of 8.1 and a temperature of 30°C) the amount of unionized ammonia in the mixed discharge would only be 0.0057 mg/L.

Table 10 shows that the ammonia concentrations projected for Outfall DSN 003, or from DSN 003 and DSN 002 after mixing, under the calculated likely and worst case scenarios are below the maximum allowable concentrations for protection of aquatic life. In addition, results from ammonia spiking studies conducted in 1999 using pH adjusted, ammonia spiked east ash pond water from ALF indicate that the anticipated discharge concentrations are below toxic levels. Acute test results are summarized in Table 11.

Table 11. Toxicity Endpoint Summary: Baseline and Ammonia Spiked East Ash Pond Water Results (expressed as mg/L N), August 23, 1999

Parameter	Baseline	pH 7.5	pH 8.0	pH 8.5
Fathead 48-h LC_{50}*	>100%	53.4	19.3	5.3
Fathead 96-h LC_{50}*	>100%	26.2	11.5	5.3
Daphnid 48-h LC_{50}*	>100%	50.5	21.0	14.5
Daphnid 96-h LC_{50}*	>100%	50.5	21.0	11.9

* Based on measured concentrations.

A test was conducted in the east ash pond during summer 2000, in which 15% ammonia hydroxide (NH_4OH) was added to the fly ash sluice lines. During the steady-state period of the study, the average ash pond effluent concentration was 0.5 mg NH_3-N/L with a high reading during steady-state of 0.85 mg NH_3-N/L. Comparison of these concentrations with Table 10 shows they are well above anticipated discharge concentrations, while Table 11 shows these values are below toxic levels at an expected effluent pH range of 7.1 to 8.1. In addition, toxicity studies conducted during the steady state phase of the ammonia addition study confirmed no acute toxicity was present. Results also showed some ammonia removal (about 12%) in the ash/stilling pond complex as a result of algal uptake.

Ammonia limits for ash ponds have not been promulgated by EPA. Numeric ammonia limits and toxicity limits would be met by operational and/or treatment measures. As indicated above, the fraction of ammonia nitrogen entering the wastewater stream may be below the discharge requirements. Operational changes including limiting the maximum ammonia slip to less than 2 ppmv and phasing catalyst replacement so that 2 ppmv slip does not occur for all three units simultaneously will help to meet both effluent toxicity and numeric requirements. TVA's commitment to diverting SCR-related ammonia and fly ash sluice water discharges away from McKellar Lake would result in greater protection of water quality in that water body and lower the overall impact of discharging ammonia-containing wastewater to any water body.

Chemical Treatment Pond

Ammonia that builds-up on the APHs will be washed at regular intervals into the chemical treatment pond where small amounts of ammonia will dissipate through volatilization. As in the air separator tank and the ash pond water, the factors which will determine how much of the ammonia will volatilize are the pH, temperature, mixing, and the partitioning between the water and air phases, as reflected in the Henry's Law coefficient.

Values for ranges in pH and temperature are presented in Table 9 for the ALF ash handling system from initial fly ash slurry generation to ash pond and APH wash to the chemical treatment pond.

As discussed before, the aqueous molecular ammonia is subject to losses from the aqueous phase to the air phase. This partitioning of the unionized ammonia between the water and air phases at equilibrium is quantified in the Henry's Law coefficient. This partitioning varies with temperature with higher temperatures favoring higher concentrations of this ammonia in the air phase and lower temperatures favoring ammonia in the water phase.

ALF has not needed to wash the air pre-heaters in the past 4 years due to the switch to low sulfur fuel. Currently, the APH's are air blown once every twenty four hours. There are three lances, ½ hour for each lance totaling 1½ hours each day (Waters 2000). Soot-blowing waste goes directly to the ESP's. The worst case loading of ammonia to the wastewater will be when all three units are washed simultaneously during an outage. Currently there are plans to install new APH's during the SCRs installation (Elder 2000). The new heaters will most likely use a combination cleaning nozzle that is capable of using steam, air, or water. The APH's will be equipped for both high and low pressure water washing. The current plans are to water wash off-line since online washing is not as favorable because it promotes acidic corrosion and thermal distortion problems. It is unknown how effective the soot-blowers will be, but for this analysis it is assumed that 10% of the ammonia build-up on the APH's will be removed by soot-blowing and collected by the ESP's which eventually is wet sluiced with the fly ash.

The worst case scenario analyzed assumes all three APH's are washed every 18 months simultaneously. The potential chemical treatment pond loading scenario's are summarized in Table 12. To help manage ammonia nitrogen to the CCW, the chemical treatment pond will be discharged over at least a five-day period, as shown in Table 13. In addition to staging the discharge as shown in table Y, the pond will be held until a time when any other NH_3-N sources (i.e. SCR resultant fly ash pond concentrations) are minimal.

Table 12 shows the range of concentrations the chemical treatment pond could receive. The pH of a typical APH wash is low due to the metal content. Prior to discharging through outfall DSN 006 the pH is elevated to ~ pH 10.5 to drop out the metal content, then adjusted back down to meet the pH limits of 6.0-9.0 S.U.. For the worst case, ammonia concentrations in the pond could reach 340 mg NH_3-N/L which would cause probable air quality issues if the pond pH is allowed to rise to normal operating conditions which would allow some ammonia to dissipated through volatilization. Even if the more likely scenario of gradual build-up of ammonia over time is considered, the probable concentrations (120-186 mg NH_3-N/L) are still a high air concern. To further investigate these concerns, the diffusion model discussed below was run.

Table 12. Potential NH_3-N concentrations in the chemical treatment pond from APH wash.

Constant slip rate	Total loading (lb. NH_3/ wash)	Concentration assuming 60% original chemical pond capacity remains (mg NH_3-N/L)	Concentration assuming 80% original chemical pond capacity remains (mg NH_3-N/L)
18 month build-up w/10% removal from soot blowers	19,946	340	255
12 month build-up w/10% removal from soot blowers	13,296	226	169
Gradual slip * rate build-up using slip vs. time chart	(lb NH_3/ wash	(mg NH_3-N/L)	(mg NH_3-N/L)
18 month build-up w/10% removal from soot blowers	10,971	186	141
12 month build-up w/10% removal from soot blowers	9,308	160	120

* The gradual slip rate is a more likely case and was derived from input by the catalyst manufacturer.

Table 13. Required Number of Days Required to Discharge Air Preheater Wash Water into CCW and the Resultant Effluent (DSN 003).

* Assumes build-up on APH is gradual using catalyst manufacturer slip vs. time chart

	# Days of Discharge	Concentration with 60 % Remaining Capacity mg NH_3-N/l *	Concentration with 80 % Remaining Capacity mg NH_3-N/l *
18 Month Wash Cycle*	1	2.22	2.21
	3	0.74	0.74
	5	0.44	0.44
12 Month Wash Cycle	1	1.88	1.87
	3	0.63	0.62
	5	0.38	0.37

Equilibrium concentrations can range up to 800 ppmv for ammonia in air in equilibrium with the worst case concentrations in the chemical treatment pond water resulting from the APH washes. An infinite box diffusion model was used to calculate the ammonia concentration in the air at various heights and times above the pond surface (Copeland 2001). Assumptions included maintaining the surface concentration of 800 ppmv as a boundary condition, that the transfer is in equilibrium with the liquid phase, there is no air flow, and the pond is well mixed but the surface is quiescent. The overall conclusion is that because the time to reach dangerous levels is significant under no air flow conditions, and even low wind speeds (0.5 mph) will sweep the pond surface in times on the order of 10 minutes, dangerous ammonia concentrations should not accumulate at working heights above the pond surface.

A height of 1 meter above the pond surface was selected as a threshold height of concern. The "no air flow" model estimated that at 1 meter above the pond surface, it would take about 40 minutes for the ammonia concentrations to reach the conservative ammonia odor threshold of 5 ppmv and about 90 minutes to reach the Short Term Exposure Limit (STEL) of 50 ppmv. Any significant air flow will favor dissipation of the ammonia and reduce the accumulation of ammonia immediately above the pond surface. The time for a 0.5 mph wind to sweep across the longer dimension (500 feet) of the pond surface, i.e., the sweep cycle, is 682 seconds (~10 minutes). Thus, the 40- and 90-minute accumulation times mentioned above are equivalent to 4 and 9 sweep cycles, respectively, for the relatively mild 0.5 mph wind. Because data for the joint wind speed frequency (Wastrack 2000) indicated that much higher wind speeds predominate at ALF, it is very unlikely that ammonia concentrations will reach either the odor threshold for more than very short periods if at all or the STEL, at 1 meter above the pond surface.

Also, by this model, initial ammonia losses occurred at a rate of 0.25 per cent per day and would diminish as the ammonia concentration in the pond decreases. Even assuming that the loss rate remained constant at the faster initial value, it would take just over one year for the worst case ammonia concentration to dissipate from the pond completely, with diffusion as the main transfer and loss mechanism for ammonia from the pond. This would in effect make the pond unusable for emergency storage of large volumes of water during the period when the ammonia is being dissipated. Because the rate of diffusive ammonia losses is limited by the diffusion of ammonia in water, any mechanisms to increase the loss rate of ammonia from the pond must incorporate agitation of the pond water.

Whole Effluent Toxicity

Discharge from outfalls DSN 001, 001A, and DSN 003 is regulated under NPDES Permit No. TN0005355. There is insufficient dilution in the receiving stream to demonstrate that there is no reasonable potential for outfall DSN 001 to cause toxicity to aquatic life; however, since no effluent related toxicity occurred during the last five year permit cycle, the frequency of toxicity monitoring has been reduced from quarterly to annual under the renewed permit (effective June 1, 2000). The permit currently contains a whole effluent toxicity (WET) limit of fifty percent mortality in undiluted effluent (48-hour LC50 $\geq$ 100% effluent). The proposed options for changing configuration of the ash pond(s) would not be expected to have a negative impact on the ability to comply with the current WET limit for DSN 001 since bottom ash sluice is typically not toxic at other fossil fueled power facilities. In addition, the volume of wastewater discharged into McKellar Lake will be reduced by approximately 56 percent.

There is currently no WET limit for outfall DSN 003. The previous permit contained semi-annual monitoring requirements for acute toxicity, with a WET limit of 50 percent mortality in 1.6 percent effluent (48-hour LC50 $\geq$ 1.6% effluent). Since biomonitoring data demonstrated no reasonable potential for exceeding ambient water quality criteria for acute toxicity, the limit was removed, with monitoring required only once per five years to demonstrate continued compliance.

Acute toxicity of ammonia to aquatic life is pH-dependent, such that at higher pH levels toxicity increases. In addition, the presence or absence of salmonids is a factor in determining the acute criterion. The formula for calculating the acute criterion, or Criteria Maximum Concentration (CMC) for ammonia is provided in the recently revised criteria document (EPA-822-R-99-014, December 1999). The acute CMC is the one-hour average concentration of total ammonia nitrogen (in mg N/L) that should not be exceeded more than once every three years on the average.

To protect aquatic life from ammonia toxicity at the discharge point for outfalls DSN 001 and DSN 003, effluent ammonia concentrations that should not be exceeded at various pHs are provided in Table 14. As described in the previous section, operational treatment measures would be utilized to meet permitted toxicity limits for the east ash pond discharge. It appears ammonia related toxicity would not be expected for outfall DSN 003, or DSN 003 and DSN 002, based on concentrations projected in Table 10.

Table 14. Maximum Allowable Ammonia Concentrations to Protect Aquatic Life from Acute Effects at Typical pH Levels (Assumes Salmonids absent).

Acute Criterion (mg N/L)						
pH 6.0	pH 6.5	pH 7.0	pH 7.5	pH 8.0	pH 8.5	pH 9.0
54.99	48.83	36.09	19.89	8.41	3.20	1.32

Surface Water Quality

Resource Description

ALF is located approximately eight miles from downtown Memphis, Tennessee on a flood-plain along the southern shore of McKellar Lake. The plant is less than two miles east of the Mississippi River at Mississippi River Mile (MRM) 725. Currently fly ash from this plant is sluiced into a settling pond (East Ash Disposal Pond) and discharged into McKellar Lake at outfall DSN 001. The discharge from outfall DSN 001 enters McKellar Lake from there to Mississippi River at latitude 35 degrees, 04 minutes, 28 seconds and longitude 90 degrees, 07 minutes, and 57 seconds. This pond also receives bottom ash and coal yard drainage. However, roughly 90% of the bottom ash is recovered for use by Reed Minerals. Ash pond discharge is diverted to Horn Lake Cutoff pumping station (outfall DSN 001-A) when McKellar Lake levels are extremely high. These occurrences are very rare. The discharge from outfall DSN 001-A enters the Horn Lake Cutoff which drains to the Horn Lake pumping station located a couple of miles south of the plant. The pumping station discharges to the Mississippi River backwaters. As mentioned in the wastewater section of this report, redirection of fly ash to the west pond will occur. The west pond will discharge into the CCW conduit that discharges into a canal (DSN 003) that leads directly to the Mississippi River at latitude 35 degrees, 04 minutes, 26 seconds and longitude 90 degrees, 09 minutes, and 44 seconds.

McKellar Lake

McKellar Lake is an oxbow lake with a watershed of 881 ha (2176 acres) whose elevation fluctuates with the Mississippi River between 52.5 m and 70.5 m MSL. Also known as the Memphis Harbor, McKellar Lake is the heart of the International Port of Memphis. Among the features of the harbor are a closure dam and revetment, bank paving and sodding, and a dredged channel that measures 12 by 300 feet.

McKellar Lake is classified by Tennessee Department of Environment and Conservation (TDEC) as a suitable warm water habitat and was placed on the 1998 Tennessee 303(d) list for pesticides, siltation, PCB's, and dioxins. The 1998 303(d) List of waters shows McKellar Lake as *not supporting*. McKellar Lake was also placed on 305(b) advisory for chlordane and other organics ending at the Horn Lake Road Bridge. By definition, the body of water is highly impacted by pollution and water quality criteria are exceeded on a regular or frequent basis. Water quality is considered severely impacted (TDEC 1998).

Mississippi River

The lower Mississippi is a meandering alluvial river. The water quality in the vicinity of MRM 725 is subject to advisories and was placed on the 1998 Tennessee 305(b) list for chlordane and other organics down to the Mississippi state line. During this advisory, the TWRA prohibited commercial fishing. The 1998 303(d) List of waters shows this area of the Mississippi River as *not supporting*. The Mississippi was also placed on 1998 Tennessee 303(d) list for pesticides, siltation, PCB's, and dioxins. By definition, the body of water is highly impacted by pollution and water quality criteria are exceeded on a regular or frequent basis. Water quality is considered severely impacted.

At MRM 725 there is a large volume of barge traffic from McKellar Lake. The Mississippi River and associated streams near Memphis have experienced historical degradation of water quality. The degradation has typically been localized due to the enormous dilution capacity of the Mississippi River. The 7 day, 10 year low flow recurrence interval is 108,000 cfs for the period 1933-1994. The 1937 flood of record reached elevation 70.90 mmsl at this site. The maximum bankfull stage is 66.42 mmsl (Thornton 2000).

Construction Impacts

No impacts to surface water would be expected from construction and installation of the SCRs, associated ammonia storage, and related systems. ALF is already an industrial facility with existing Best Management Practices (BMPs) in place. Any additional BMPs to prevent erosion and runoff to surface waters will be implemented as needed.

Operational Impacts

No direct negative (toxic) impacts on water quality of McKellar Lake or the Mississippi River would be anticipated since the reconfigured ash pond and chemical treatment pond discharges would be required to meet NPDES limits.

Groundwater Quality

Resource Description

The principal groundwater aquifers in the area are the alluvium and the Memphis Sand. They are separated by the Jackson-upper Clairborne confining unit which is approximately 30-45 meters thick in the ALF area (Danzig 1999). The alluvial aquifer consists primarily of fine sand, silt, and clay. The Memphis Sand Aquifer, the primary drinking water source for the city of Memphis, is believed to be separated from the alluvial aquifer by the Jackson Formation. A geophysical log of one well in the ALF area showed the thickness of the upper confining unit to be approximately 33 meters (Parks 1990). However, borehole data indicate that at least one sand and gravel bed in the confining layer was found at the ALF site. Parks et al. (1995) discovered that the confining layer underlying the alluvium in the Mississippi Alluvial Plain near the Davis well field (approximately 6 km. south of ALF) is thin or absent. The thickness of the alluvium is 30 to 45 meters. If alluvial water is able to penetrate the upper confining layer to the Memphis aquifer, zones of depression from pumping at the nearby Davis and Allen well fields could influence water movements in those directions. Hydraulic conductivity is estimated to range from 0.1 to 0.35 cm/s (USDOE 1981).

All of the 10 wells in the monitoring network are located in the alluvial aquifer. The shallower wells may be screened in material dredged from Lake McKellar used as fill for the Plant. The groundwater gradient toward Lake McKellar is not clearly evident. During high river stage it is not uncommon for the lake water level to be higher than the groundwater levels at ALF.

Groundwater appears to flow both to and from Lake McKellar, depending on river stage. Only iron, manganese, and sulfate have been detected in groundwater at elevated concentrations, but not at levels that will impact the Mississippi River system.

Groundwater level appears, to be closely tied to river stage, which varies by several meters during the year (Danzig 1999).

Historical data show the alluvial aquifer is high in concentrations of iron, manganese, sulfates, and total dissolved solids. Groundwater measured in the well adjacent to the metals cleaning pond showed the highest levels of these parameters (Danzig 1999).

Based on the raw data and ionic distribution of the conventional wells, the water quality of the wells south of plant site and adjacent to the metals cleaning pond appears to be the most severely impacted of the wells sampled. However, no health-related parameters were exceeded, and the extent of any contamination appears to be limited to excessive iron, manganese, and total dissolved solids (Danzig and Bohac 1992).

Primary maximum contaminant levels (MCLs) were rarely exceeded at ALF and no primary exceedances were found from TVA wells since November 1992 (Danzig 1999).

Parameters with established secondary MCLs are regulated primarily for their aesthetic effects in drinking water. Of these pH, sulfate (SO_4), and total dissolved solids (TDS) are considered to be possible indicators of coal ash leachate, while aluminum, iron, manganese may be associated with natural conditions, ash leachate or particulates in the sample. MCLs for all iron and manganese were exceeded in virtually all samples at ALF. Secondary MCLs were exceeded to varying degrees for pH, SO_4, iron, manganese and TDS (Danzig 1999).

Construction Impacts

No additional impacts to groundwater would be expected as a result of construction activities associated with SCR reactors or supporting ammonia facilities. The ALF plant is a heavily industrialized site with severely disturbed soils and geology and generally poor groundwater quality.

Operational Impacts

Potential sources for groundwater contamination are:

1. Leakage from an ammonia supply pipe, and
2. Seepage from the chemical treatment pond serving as the retention basin for the ammonia storage tanks and unloading area in case of spillage, overflow, or tank failure

The majority of the process piping would be above ground thus allowing rapid leak detection and worker response to isolate the leak and minimize the amount of ammonia leakage to minor quantities.

The area surrounding the ammonia unloading and storage facilities would be reconfigured to drain into the existing chemical treatment pond that is immediately adjacent to the proposed site. This pond has a storage capacity of about 5.8×10^6 gallons, and is bottomed with a liner comprised of compacted local native soil. This pond has more than enough capacity to contain and control an accidental release of ammonia from a storage tank.

The worst case scenario for potential impacts to groundwater would be the catastrophic failure of one of the liquid ammonia tanks (effective storage 15,750 gallons), the discharge of 2,700 gallons of emergency fogging water, together with the accumulation of 29,924 gallons of water from the 10-year 24-hour rainfall event (Smith 2000). For the worst case scenario, it is estimated that a total of 48,374 gallons of concentrated ammonia solution would be generated for capture in the retention basin for the tank storage area. With use of the chemical treatment pond, it is anticipated that an accidentally released solution would be totally contained within the basin, except for the likely off gassing of a portion of the ammonia.

Limited technical information is available for the liner of the chempond as constructed in 1975 (Buchanan 1975). The liner which is three feet thick, was constructed of soils having a minimum of 35 percent fines (<200 mesh), compacted to at least 95 percent of the maximum standard dry density, and maintained within about 3 percent of the optimum moisture content. This information is sufficient to indicate that close to the lowest permeability was achieved for the available materials, without specifying actual permeabilities. Also, general observations of the chempond indicate that, despite only intermittent use for collection of various chemical washes, water is maintained in pond throughout the year, indicating at worst only limited loss of containment by seepage through the liner. Slightly elevated contaminates were observed at the well near the existing chemical treatment pond. There are, however, no indications these occurrences are the result of the chemical treatment pond seepage since the extent of such occurrences is not much greater than found in background conditions.

In the absence of more definitive information regarding the permeability of the chempond liner, the storage of emergency ammonia solution releases would be limited to short periods. Options for the management of the liquid accumulated in the chempond include pump and haul for commercial disposal, or discharge to an NPDES-permitted outfall.

Based on the volume of anhydrous ammonia released and the volumes of water as specified above, the ammonia solution in the chempond (retention basin) would be about 0.001 molar in ammonia/ammonium and would have a pH of about 11. This pH falls well below the threshold (pH 12.5) that would qualify the solution as a hazardous waste (US EPA 1999a). Nevertheless, the concentrated ammonia solution would still be very caustic. Also, ammonia vapor would volatilize quite readily from such a high pH solution. Thus, as an interim management measure, careful neutralization of the ammonia solution accumulating in the chempond from an accidental release would reduce the pH to less than 8 and ensure NPDES permit requirements are met. At pH 8, the volatilization of ammonia would be negligible.

Socioeconomics

Resource Description

The ALF is located in Shelby County, Tennessee, at the west end of the county. Shelby County is only 17 percent rural, with 83 percent of its population in the cities of Memphis, Germantown, Bartlett, Millington, Collierville, Arlington, and Lakeland. The distribution of employment in the county shows less dependence on manufacturing than the state as a whole, with 8.1 percent of Shelby County employment, compared to

15.8 percent statewide. The employment share in farming is also less than the state. Conversely, Shelby County has a larger share in transportation and public utilities, wholesale trade, services, and in the finance, insurance, and real estate sector. Total employment in Shelby County in 1998 was 613,612, including both full time and part time jobs. The labor market area had 724,013 jobs. Based on current commuting patterns and on proximity, the labor market area is defined to include all adjacent counties.

Compared to its labor market area and the state, Shelby County has a larger share of its workers employed in professional, technical, and service jobs. The county has a lower share in most other occupational categories. The labor market area also has a larger share of its workers in professional, technical, and service jobs than does the state as a whole.

Population

According to population estimates by the U. S. Census Bureau, Shelby County had a population in 1999 of 873,000, an increase of 5.6 percent since the 1990 Census of Population count of 826,330. The labor market area had a 1999 population of 1,161,798, an increase of 9.7 percent from the 1990 total of 1,059,099.

The population of Shelby County is 52.2 percent white as of 1999 according to estimates by the U. S. Census Bureau. The remaining population is largely black, 46.2 percent of the total. The Hispanic population is estimated to be 1.4 percent of the total. The labor market area is slightly more white, with 56.1 percent white and 42.5 percent black. The state is far more white at 82.1 percent white and 16.6 percent black.

Income and Employment

Per capita personal income in Shelby County in 1998 was $28,984 or 118.6 percent of the state average of $24,437, and 106.5 percent of the national average of $27,203. The level was somewhat lower in the labor market area as a whole, $27,098 or 110.9 percent of the state, and 99.6 percent of the nation. There was considerable variability, however, among the counties in the labor market area, ranging from $17,878 in Marshall County, Mississippi to $28,984 in Shelby County.

Service sector employment was the largest source of earnings in Shelby County, contributing 29 percent of total earnings. Employment in transportation and public utilities accounted for 14 percent of earnings. Government and manufacturing contributed 13 percent and 11 percent respectively, while retail trade, wholesale trade, and finance, insurance, and real estate totaled 9 percent each.

The distribution of jobs by industry in Shelby County is similar to that of earnings, but differences in wages and in use of part-time employees among industries yield some variation in the above percentages. As a percent of county totals, employment in manufacturing is 8 percent (versus 11 for earnings), and transportation and public utilities is 11 percent (versus 14 for earnings), reflecting higher than county average wages in those industries. While just the reverse is true in the case of retail trade (17 percent of employment versus 9 percent of earnings) and services (32 percent of employment versus 29 percent of earnings).

With a civilian labor force of 448,730 in 1999, Shelby County had an unemployment rate of 3.7 percent. The labor market area unemployment rate was also 3.7 percent. This rate is below the state (4.0), and the national (4.2) unemployment rates, and this trend has persisted through the 1990s.

Potential Impacts

Employment

During the construction period, the most intense work activity will occur during construction outages. The outage workforce is likely to reach about 600 for a few weeks at most, and somewhat less for a few weeks before and after the peak. As a result, total personnel on-site during outages may reach levels as high as around 2.5 times the typical day shift at the plant. These employment spikes would be of short duration, rising and falling quickly over a period of probably one to two months. For a few months before and after the outages, a smaller number of additional workers may be on-site performing construction-related work.

Based on experience at previous TVA construction projects and on the site's proximity to a fairly large labor force, it is estimated that at least 50 percent of these workers would already live in the general area, close enough that they would commute rather than move, depending on worker needs elsewhere in and out of the Valley. The remaining workers would move to the general vicinity of the plant.

Income

The cost of labor for these units, expected to be several million dollars each, would be less than one-tenth of one percent of total earnings in Shelby County. In addition, while many of the workers might already reside in Shelby County, a significant number would likely commute from nearby counties, resulting in an even smaller impact on Shelby County. Spending by movers would have a small but positive impact on income in the county and surrounding area. And some businesses might experience noticeable increases in sales.

Population

Assuming that 50 percent of the workers would move into the area, the maximum impact on population at any one time would be about 300 workers plus whatever family they brought with them. As noted above, employment peaks would be of very short duration, so the number of family members who would move with the workers probably would be lower than for longer-term construction jobs. It is likely that the maximum population impact at any one time would be somewhere around 600 persons, less than one-tenth of one percent of the current population of Shelby County. However, not all of these workers would locate in Shelby County. The distribution of this population among counties and within counties would depend largely on the availability of housing or of sites for trailers. Locations near the site or near shopping and other amenities would generally be favored.

Community Services and Infrastructure

Impact on community services, such as schools, police, fire, and medical, would be small because of the small size of the impact on population and because of the short duration of the maximum impact.

Environmental Justice

The proposed actions would be a minor physical addition to an expansive heavy industrial facility having a substantial property buffer area. The nearest residences are approximately 3 miles from the site. Therefore, there is low potential during construction for important impacts on any of the residents of the surrounding area. On the other hand, all the residents of the surrounding area would benefit from the resulting reduction in NO_X.

In general, operational impacts would be minor and not noticeable to residents of the surrounding area. However, there is a small probability of ammonia releases, as discussed above. In the unlikely event of such releases, demographic data for the area around the site indicate that there would be disproportionate impacts on minority and low-income populations. That is to say, the area around the plant that would be most affected by an ammonia release has a much larger share of minorities and persons below the poverty level than does the state as a whole. The minority and low-income share of the population in the potentially affected area is also far greater than in Shelby County as a whole (see Table 15). However, the benefits of reduced NO_x would also disproportionately impact disadvantaged populations.

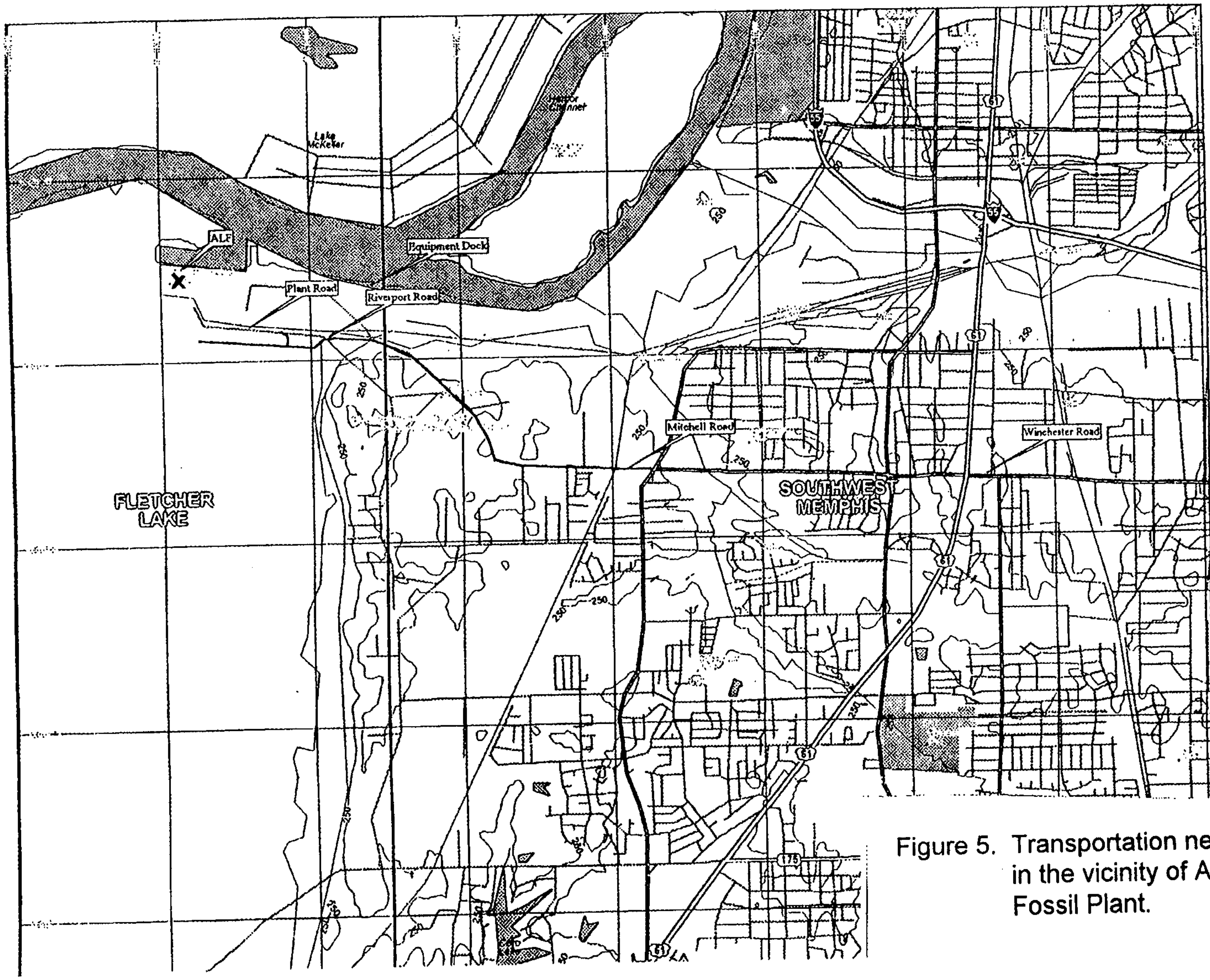
Table 15. Plant Vicinity Demographics for Minority and Low-income Populations.

Distance from site to endpoint	Total Population, 1990	Minority Population (Nonwhite and White Hispanic) (%)	Low-income Population (% below poverty level)
5.8 km (3.6 miles)	5,280	99.3	31.7
11.1 km (6.9 miles)	119,620	81.4	29.9
Tennessee	4,877,203	17.4	15.7

Transportation

Resource Description

Allen Fossil Plant is served by highway, rail, and barge modes of transportation. Portions of the existing transportation network in the vicinity of the plant are shown in Figure 5. The plant is located in Memphis, Tennessee in Shelby County. Vehicle access to the plant is via U.S. Highway 61 from the north and south or from Winchester Road from the east. At the intersection of U.S. Highway 61 and Winchester Road, the road becomes Mitchell Road and travels west for about 3½ miles toward the plant. Mitchell Road passes through an area of residential housing and a school zone. Riverport Road provides access northwest from Mitchell Road to Plant Road and has been recently extended, bypassing Chucalissa Park, and upgraded to a high quality road to provide for an adequate industrial access route for heavy trucks and equipment to the industrial park located west of ALF. Riverport Road is a four-lane roadway with a center turning lane and 12 foot lane widths. The nearest interstate highways are Interstate 40, which runs between Nashville and Memphis, Tennessee and Interstate



3-D TopoQuads Copyright © 1999 DeLorme Yarmouth, ME 04096 2000 ft Scale: 1 : 50,000 Detail: 12-0 Datum: WGS84

Figure 5. Transportation network in the vicinity of Allen Fossil Plant.

55 which runs between Memphis and Jackson, Mississippi. The following table shows the Average Daily Traffic (ADT) counts (Reference *1998 Average Daily Traffic* report prepared by the Tennessee Department of Transportation; 1996 Traffic Counts per City of Memphis Traffic Engineering department).

	ADT (veh/day)
Winchester Road	11,510 ('96)
U. S. Highway 61	27,320 ('98)
Mitchell Road	3,260 ('96)
Riverport Road	not available
Plant Road	not available

The USACOE equipment dock located just east of the plant will be used for some SCR equipment delivery. Truck delivery from this point will be by roadway along Lake McKellar and directly onto the ALF reservation.

Potential Impacts

By building a SCR facility at ALF, there would be minor impacts to the state and county roads due to the additional generation of traffic during both the construction and operational periods. The construction period for the three units would span a period of almost two years. During the construction period, the most intense work would occur during construction outages. The peak outage workforce would be about 600 employees. Assuming an average ridership of 1.6 persons per vehicle, and a trip in and out each day, about 750 vehicles would be added to the road network due to daily commuters during this period. There would also be additional traffic added to the road network throughout the day in the form of construction material deliveries to the site. Some additional delay may be experienced at the intersection of Plant Road and Riverport Road at shift changes. The primary people experiencing the delay would be the construction commuters. Such a problem can be easily tolerated for the duration of the construction period. The employment levels would spike to peak levels in short durations, rising and falling quickly over a period of one to two months. A much smaller number of additional workers may be on-site performing construction-related work during the few months before and after outages. In the long term, operation of the SCR would not generate any noticeable additional traffic for the roads in the local area. The roads in this area are fully capable of absorbing this additional traffic with no drop in the existing level of service currently provided to the road users. The potential traffic impact for both the construction and operational phase of the SCR is insignificant.

Ammonia Unloading Facilities/Operation

The ammonia unloading facility would be sited on the western side of ALF adjacent to the chemical pond and the West Ash Pond. After construction is completed, operation of the SCR will require ammonia deliveries of approximately one tanker truck per day. These deliveries would not affect the capacity or level of service currently provided by the existing road network.