NUREG-1888

Draft Environmental Impact Statement for the Reclamation of the Sequoyah Fuels Corporation Site in Gore, Oklahoma

License No. SUB-1010

Draft Report for Comment

U.S. Nuclear Regulatory Commission
Office of Federal and State Materials and Environmental Management Programs
Washington, DC 20555-0001

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ABSTRACT

Sequoyah Fuels Corporation (SFC) is proposing to conduct reclamation activities at its 243-hectare (600-acre) former uranium conversion site in Gore, Oklahoma, in accordance with Title 10, "Energy," of the U.S. Code of Federal Regulations (CFR), Part 40 (10 CFR Part 40), Appendix A (which includes criteria for the disposition of uranium mill tailings or wastes). In its *Reclamation Plan* submitted to the U.S. Nuclear Regulatory Commission (NRC), SFC proposes to consolidate contaminated sludges and soils, demolish existing structures (with the exception of the administration building and the electrical substation), and construct an above-grade, on-site disposal cell for the permanent disposal of all contaminated materials. SFC also would implement its proposed groundwater *Corrective Action Plan* to restore the groundwater using the "hydraulic containment and pump back" method. Following the completion of surface reclamation and groundwater corrective actions, SFC would seek termination of its NRC license. As part of that future license termination process, SFC proposes the transfer of approximately 131 hectares (324 acres) of the site, including the land area encompassing the disposal cell and a surrounding buffer, to the custody of the United States or the State of Oklahoma for long-term control. SFC proposes that the remaining 112 hectares (276 acres) of the site be released for unrestricted use by members of the public.

This Draft Environmental Impact Statement (DEIS) was prepared in compliance with the National Environmental Policy Act (NEPA) of 1969 and NRC's regulations for implementing the Act, found at 10 CFR Part 51. This DEIS evaluates the potential environmental impacts of the proposed action and its reasonable alternatives. This DEIS also describes the environment potentially affected by SFC's proposed site reclamation activities, presents and compares the potential environmental impacts resulting from the proposed action and its alternatives, and describes SFC's environmental monitoring program and proposed mitigation measures.

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BACKGROUND

The U.S. Nuclear Regulatory Commission (NRC) is evaluating the potential environmental impacts of the reclamation activities proposed by Sequoyah Fuels Corporation (SFC) for its former uranium conversion site in Gore, Oklahoma. The NRC has determined that approval of SFC's proposal for on-site disposal of the radioactive waste from its previous operations, along with land use restrictions or other institutional controls to prevent inadvertent disturbance of waste, constitutes a major federal action. Therefore, preparation of an Environmental Impact Statement (EIS) is warranted, in accordance with the National Environmental Policy Act (NEPA) of 1969 and NRC's regulations implementing NEPA, found at Title 10, "Energy," of the U.S. Code of Federal Regulations (CFR), Part 51 (10 CFR Part 51).

THE PROPOSED ACTION

The proposed action considered in this draft EIS (DEIS) is the implementation of SFC's proposed reclamation activities for the 243-hectare (600-acre) Gore, Oklahoma, site. SFC's *Reclamation Plan* identifies the activities that would be undertaken by SFC to accomplish surface reclamation of the site in accordance with 10 CFR Part 40, Appendix A (which includes criteria for the disposition of uranium mill tailings or wastes). SFC proposes to consolidate contaminated sludges and soils, demolish existing structures (with the exception of the administration building and the electrical substation), and construct an above-grade, on-site disposal cell for the permanent disposal of all contaminated materials. SFC would also implement its proposed groundwater *Corrective Action Plan,* using the "hydraulic containment and pump back" method to restore groundwater impacted by past site operations.

Following the completion of surface reclamation and groundwater corrective actions, SFC would seek termination of its NRC license. As part of that future license termination process, SFC proposes the transfer of approximately 131 hectares (324 acres) of the site, including the land area encompassing the disposal cell and a surrounding buffer, to the custody of the United States or the State of Oklahoma for long-term control. SFC proposes that the remaining 112 hectares (276 acres) of the site be released for unrestricted use by members of the public.

PURPOSE OF AND NEED FOR THE PROPOSED ACTION

Background

In November 1992, SFC notified the NRC that it had permanently ceased production at its Gore, Oklahoma, uranium conversion facility and would terminate its depleted uranium hexafluoride operations by the end of July 1993. Information available to the NRC at the time of the SFC notification indicated that at least some of the identified waste and contamination at the site was known to exceed the NRC's radiological criteria for decommissioning. Consequently, the NRC required that the site be remediated to meet the radiological criteria contained in Subpart E of 10 CFR Part 20 (Standards for Protection Against Radiation). In July 2002, NRC granted a request by SFC to reclassify some of the waste at the site as "byproduct material," as defined in section 11e.(2) of the Atomic Energy Act (AEA) of 1954, as amended. Because of the reclassification,

Appendix A of 10 CFR Part 40 (which contains criteria for disposition of mill tailings or wastes) became the appropriate regulatory regime for site reclamation. As a result, SFC submitted a site *Reclamation Plan*, and also a groundwater *Corrective Action Plan* to NRC in 2003.

Purpose and Need

Under the AEA, the NRC has licensing and regulatory authority for nuclear energy uses within the commercial sector. This includes the responsibility to ensure the safe and timely decommissioning of nuclear facilities that are regulated by the NRC. Decommissioning means to "remove a site safely from service and reduce residual radioactivity [through remediation or reclamation of the site by the licensee] to a level that permits: (1) release of the property for unrestricted future use and ultimate termination of the license; or (2) release of the property under restricted conditions and ultimate termination of the license" (10 CFR 40.4). The proposed action is intended to satisfy the need to protect public health and safety and ensure that any potential long-term radiological and nonradiological hazards or other impacts on the environment are minimized.

The purpose of the proposed action is the reclamation of SFC's Gore, Oklahoma, uranium conversion site in accordance with the NRC performance standards contained in 10 CFR Part 40, Appendix A. These standards require, in part: (1) isolation of the waste materials in a manner that protects human health and the environment; (2) reduction in the rate of radon emanating from the disposal cell cover to an average of 20 picocuries (pCi) per square meter-second or less; (3) a level of stabilization and containment of contaminated materials for a long period of time (200 to 1,000 years); (4) minimal reliance on active maintenance of the disposal cell; (5) protection and restoration, as needed, of groundwater; and (6) clean up of the site and structures outside of the disposal cell to the applicable radiation standards.

Following the completion of surface reclamation activities and groundwater restoration, the NRC license for the site would be terminated. The disposal cell and a buffer area surrounding the cell, delineated by an institutional control boundary (ICB), would be transferred to a long-term custodian for perpetual care. The U.S. Department of Energy, another federal agency so designated by the President, or the State of Oklahoma would be this custodian and licensed under an NRC general license(10 CFR 40.28). The purpose of this general license is to ensure that the SFC site will be cared for in such a manner as to protect public health and safety and the environment after closure of the disposal cell.

ALTERNATIVES

This DEIS evaluates the potential environmental impacts of several alternatives to the proposed action, including the no-action alternative. Under the no-action alternative, consideration of which is required by the Council on Environmental Quality's (CEQ's) regulations implementing NEPA (at 40 CFR 1502.14), SFC would not implement its proposed *Reclamation Plan*, but it would continue its current programs to clean up the existing groundwater contamination. The SFC site buildings and waste materials would remain in their current condition and configuration.

The NRC staff considered a range of alternatives that would fulfill the underlying need and purpose for the proposed action. From this analysis, a set of reasonable alternatives was developed, and the impacts of the proposed action were compared with the impacts that would result if a given alternative were implemented. These alternatives include:

- Off-site disposal of all contaminated materials to off-site licensed disposal locations where the SFC waste materials met waste acceptance criteria, including the Energy*Solutions* site in Clive, Utah, and the Waste Control Specialists site near Andrews, Texas; and

- Shipment of specific contaminated materials (the dewatered raffinate sludge and the sediments from the North Ditch, Emergency Basin, and Sanitary Lagoon) to an appropriate off-site location. This alternative reflects provisions of the settlement agreement reached between SFC, the State of Oklahoma, and the Cherokee Nation in 2004. Potential off-site options considered were: (1) Use of the raffinate sludge as an alternate feed stock at a conventional uranium mill, (2) Disposal of the contaminated materials at an existing uranium mill tailings impoundment, and (3) Disposal of the contaminated materials at a licensed disposal facility. The remaining site contaminated materials would be placed in a disposal cell that SFC would construct on-site.

The NRC staff also considered other alternatives to the surface reclamation and groundwater corrective actions proposed by SFC, including: (1) On-site Retrievable Storage; and (2) Alternative Treatment Technologies. These alternatives were eliminated from further analysis due to economic, environmental, or maturity reasons.

POTENTIAL ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

This DEIS evaluates the potential environmental impacts of SFC's proposed action (Alternative 1) and two alternatives. The environmental impacts of the proposed action are generally SMALL, although they could be as high as MODERATE in the area of land use. Methods for mitigating the potential impacts are described in Chapter 5. Environmental monitoring methods are described in Chapter 6.

Determination of the Significance of Potential Environmental Impacts

A standard of significance has been established by the NRC for assessing environmental impacts. With standards based on the Council on Environmental Quality's regulations, each impact should be assigned one of the following three significance levels:

Small. The environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

Moderate. The environmental effects are sufficient to alter noticeably but not to destabilize important attributes of the resource.

Large. The environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

Source: NRC, 2003

Land Use

MODERATE IMPACT. The licensee proposes to construct a disposal cell in the former Process Area in the northern portion of the SFC site and demolish process buildings and equipment on the site. The only exceptions to this planned demolition would be the administration building, which would be available for potential reuse, and the electrical substation. Following completion of proposed site reclamation activities, SFC proposes the transfer of 131 hectares (324 acres) of the site to a long-term custodian for perpetual care and 112 hectares (276 acres) for unrestricted use by members of the public.

SMALL IMPACT. Because the 131-hectare portion of the SFC site would be held by a nontaxable government entity (i.e., the long-term custodian), local property taxes may be reduced slightly.

Surface Water Resources

SMALL IMPACT. Wastewater generated by SFC during site reclamation (e.g., water from existing ponds and impoundments, storm water runoff from work areas, water used for decontamination and reclamation processes, and recovered groundwater) would be collected and treated using an existing wastewater treatment system to remove uranium before discharge of the treated water to permitted Outfall 001. SFC would backfill soil excavation areas with on-site rock and soil (with concentrations of constituents of concern [COCs] below cleanup criteria), and the areas would be graded with a slight slope to provide adequate storm water drainage. The cap would be covered with topsoil and planted with native vegetation to minimize runoff and erosion. In addition, the majority of pavement and buildings on the site would be removed, thus decreasing site runoff and minimizing long-term effects on surface water quality.

Groundwater Resources

SMALL IMPACT. Implementation of SFC's proposed surface reclamation and groundwater corrective activities would result in concentrations of hazardous constituents in the groundwater being returned to levels that would be protective of public health and safety and the environment. Groundwater would be monitored by the long-term custodian responsible for perpetual care of the disposal cell and surrounding buffer zone to assess the performance of the proposed disposal cell.

Public and Occupational Health

SMALL IMPACT. The off-site public dose during SFC's reclamation activities is 0.005 millisievert (0.5 millirem) per year, and the long-term public dose in the unrestricted area surrounding the proposed ICB is 0.095 millisievert (9.5 millirem) per year. These values are below the regulatory limit of 1 millisievert (100 millirem) per year from all sources. Doses to the public and occupational workers if there were a loss of institutional controls within the proposed ICB following reclamation would be within regulatory limits. The estimate of latent cancer fatalities to the public and workers due to radiation exposure are significantly less than one. There would be no chemical exposures to workers or the public during reclamation due to the implementation of mitigation procedures (dust suppression). There would be a maximum of five occupational injuries per year during the construction period, and a fatality would be unlikely (the probability of a fatality is less than one fatality per year).

Transportation

SMALL IMPACT. The increased numbers of commuting workers and construction deliveries to the SFC site would be below the design capacity of State Highway 10. While the increased traffic volume would be noticeable to users of State Highway 10, and minor traffic slowdowns or delays might occur at the entrance to the SFC site and at the intersection of State Highway 10 and U.S. Highway 64 about 1.6 kilometer (km) (1 mile) north of the SFC facility, this would have a small impact on the quality of traffic flow in the area. Following SFC's completion of site reclamation, traffic conditions would return to normal.

SMALL NONRADIOLOGICAL IMPACTS. The predicted risk of fatalities from traffic accidents would be less than one; therefore, no truck-related fatalities are likely to occur as a result of SFC's reclamation activities. There would be no long-term direct or indirect traffic-accident-related effects following completion of site reclamation activities. The additional vehicle use during SFC's site reclamation would result in a predicted additional latent cancer fatality of 0.00055 (a probability of 1 in 2,000) for inhalation exposure to vehicle-related emissions, which is a very small fraction of the fatalities expected from all causes (1,500) within the population in proximity to the SFC site. Long-term indirect effects of inhalation of vehicular-generated particulates would not occur because there would be little to no activity conducted at the restricted portions of the SFC site following completion of reclamation activities.

SMALL RADIOLOGICAL IMPACTS. Under the proposed action, no waste materials would be transported off-site; therefore, no off-site transportation-related radiological impacts or accidents would occur under this alternative.

Cultural Resources

SMALL IMPACT. Consultation with the Oklahoma Historical Society, the Oklahoma Archaeological Survey, and the Cherokee Nation has determined that there are no prehistoric or historic cultural resources currently known on the SFC site. If cultural materials were identified during site reclamation, SFC has indicated that construction activities would be halted, the appropriate NRC official would be notified, and the Oklahoma Historical Society would be consulted. Similarly, if Native American human remains or funerary objects are discovered during reclamation, all construction activities in the area of the discovery would be halted for up to 30 days, the appropriate NRC official would be notified, and steps would be initiated to comply with the requirements of the Native American Graves Protection and Repatriation Act.

Visual and Scenic Resources

SMALL IMPACT. During demolition and construction at the SFC site, the movement of heavy equipment on the site would temporarily generate dust and noise, and open earth that might be visible to travelers on State Highway 10, U.S. Route 64, and I-40. Following completion of reclamation activities, the only structures that would remain on the SFC site would be the administration building and the electrical substation. The licensee's disposal cell would be a rise of about 12 meters (40 feet) above the existing grade. The top of the disposal cell would slope at 1% and the sides would slope at 20%. The cap of the cell would be covered in topsoil and planted with native grassy vegetation. Although the disposal cell may be visible from State Highway 10, U.S. Route 64, and the I-40 bridge, overall the SFC site would contain fewer structures and all exterior equipment and tanks would be removed. The revegetated and grassy disposal cell would blend into the existing natural landscape, although the surrounding fence would be visible to passersby.

Geology and Soils

SMALL IMPACT. SFC would excavate soils under the footprint of the disposal cell that exceed 560 picocuries per gram (pCi/g) uranium and soils outside the footprint that contain uranium, radium, or thorium in excess of the following:

- Uranium – 100 pCi/g;
- Radium – 5 pCi/g; and
- Thorium – 14 pCi/g.

Suitable clayey soils from the southern portion of the SFC site would be used as a liner in both the base and cover layers of the disposal cell. In addition, SFC would place soils collected and stored on-site from prior cleanup activities into the disposal cell. To reduce the potential for soil erosion, SFC would employ mitigation measures in the form of best management practices (e.g., the use of earthen berms, dikes, and silt fences) to minimize this impact. The excavation areas would be backfilled as necessary, graded, and planted with native grasses, which would mitigate any long-term impacts associated with soil erosion. In addition, NRC staff evaluated the effects of potential geologic hazards on the long-term integrity of the proposed disposal cell and determined that the design adequately protects public safety.

Climate, Meteorology, and Air Quality

SMALL IMPACT. Air concentrations of the criteria pollutants predicted for vehicle emissions and emissions of particulates of less than 10 microns (PM_{10}) from fugitive dust emissions would be below the National Ambient Air Quality Standards. Fugitive dust would be temporary and localized. Activities associated with the proposed action also have the potential to release radiological air emissions. Based on the results of data collected during and after remediation of a similar site (Department of Energy's Weldon Spring uranium conversion facility in east-central Missouri that was decommissioned in the late 1990s), it can be concluded that radiological emissions during site reclamation would be below the annual National Emission Standards for Hazardous Air Pollutants (NESHAPSs) of 0.1 millisievert (10 millirem).

Ecological Resources

SMALL IMPACT. Construction of the disposal cell by SFC would remove approximately 0.8 hectare (2 acres) of open field habitat. Based on the disturbed nature of the SFC site, the overall number of wildlife species and diversity are low. Any wildlife disturbed by construction activity and noise would likely return to the area following cessation of the disturbance, which would be temporary. No threatened or endangered species are likely to be adversely affected by the proposed action. The American burying beetle (a listed endangered species), if present on the

SFC site, would most likely occur in the larger tracts of forestland and pastureland outside the proposed construction areas. No jurisdictional wetlands are located on the SFC site.

Socioeconomic Conditions

SMALL IMPACT. The local workforce required by SFC for site reclamation would increase by an average of 72 workers during the peak level of activity, which would primarily be the first two years of reclamation activities. This workforce would include the management team, cell closure workers, health and safety technicians, equipment operators, truck drivers, welders and riggers, and general laborers. The overall number of short-term workers that would be needed is small compared with the total labor force available in the region.

Environmental Justice

SMALL IMPACT. Four census tracts within a 25-mile radius of the SFC site have a higher percentage of minority populations than their respective counties, and one census tract has a higher rate of low-income residents than its county. However, all of these census tracts are greater than 32 km (20 miles) from the SFC site. Since the environmental impacts associated with the SFC's site reclamation activities would be localized and temporary, these census tracts are too distant from the site to experience any adverse impacts. Therefore, based upon the NRC guidelines for evaluating environmental justice impacts, there would be no disproportionately high or adverse human health or environmental effects on these populations.

Noise

SMALL IMPACT. Reclamation activities would be limited to normal daytime working hours. The maximum noise level calculated for the nearest residence, 0.73 km (0.5 mile) to the northeast of the site boundary, was 54 decibels (A weighted), or dBA. This noise level would not exceed the United States Environmental Protection Agency's (EPA's) day-night level of 55 dB(A), which is recommended for protecting the public from interference with indoor and outdoor activities.

SUMMARY OF THE COSTS AND BENEFITS OF THE PROPOSED ACTION

The cost benefit analysis conducted on the proposed action and alternatives compares the full resource costs of each site reclamation alternative over the entire project lifetime to the anticipated benefits. The analysis conforms to the guidance contained in NUREG-1748, *Environmental Guidance for Licensing Actions Associated with NMSS Programs*, Section 5.7, and reference documents contained therein. In addition, the cost benefit analysis was conducted using procedures outlined in NUREG-1757 Vol. 2, Rev. 1, Appendix N.

The direct costs of the site reclamation activities associated with the proposed action would amount to approximately $31.1 million (in 2007 dollars). These direct costs represent site remediation and restoration costs, construction of an on-site disposal cell, and groundwater remediation and treatment. The total costs considered in the cost benefit analysis for the proposed action also included regulatory costs and the opportunity cost of land (see Table 7-6).

The main benefits measured in the cost benefit analysis consisted of the monetized direct health and safety benefits associated with removing residual radioactivity, referred to as the "collective radiation dose averted." The collective radiation dose averted would no longer be experienced by relevant population(s) at the site. The net monetized collective radiation dose averted for the proposed action totaled $191 million. Benefits also included regulatory costs avoided and the capitalized value of net agricultural income from unrestricted release of a portion of the land. The total net benefits of the proposed action (net benefits = total benefits less total costs) amounted to $177 million.

The expenditures associated with these remediation activities and costs noted above would mainly be spent locally for goods, services, and wages. These expenditures would have a one-time additional economic indirect impact by creating temporary additional employment and economic activity. Because the 131-hectare (243-acre) portion of the SFC site would be held in permanent custody of a nontaxable government entity, the county tax base would be reduced since SFC currently makes an annual property tax payment to Sequoyah County at the same rate it paid when its facility was in operation.

COMPARISON OF ALTERNATIVES

No-Action Alternative

Under the no-action alternative, SFC would not implement its proposed *Reclamation Plan* and the site would remain in its current condition and configuration. SFC would not remove potential sources of additional groundwater contamination but would continue its current programs to clean up the existing groundwater contamination and perform associated monitoring. This alternative would have SMALL impacts with respect to transportation, cultural resources, air quality, ecological resources, socioeconomic conditions, environmental justice, and noise. For land use, the LARGE adverse impact would be the restricted use of the site in perpetuity. There would be no possibility of the site being productively reused for another purpose.

If reclamation of the site is not conducted, the potential exists for the manifestation of broader contamination across the site in the long term, with MODERATE to LARGE adverse environmental effects on surface water and groundwater resources, public and occupational health, and geology and soils. The existing structures on the SFC site would continue to deteriorate and result in MODERATE adverse impacts on the visual quality of the site.

Alternative 2 (Off-site Disposal of All Contaminated Materials)

Under this alternative, SFC would remove all contaminated soils, sludges, and structures from the site and restore the groundwater under an NRC-approved groundwater *Corrective Action Plan*. In the short-term, there would be SMALL impacts on land use, surface water and groundwater resources, public and occupational health, cultural resources, geology and soils, air quality, ecological resources, socioeconomic conditions, environmental justice, and noise. There would be a short-term MODERATE impact on transportation due to the combined effects of the increased number of community workers, the construction and use of a rail spur to connect to the main railroad line, and construction deliveries to the site. In the long-term, this alternative would have a MODERATE positive impact on land use in that the entire site would be released for unrestricted use. For all other resource areas, the long-term impacts would be SMALL.

Alternative 3 (Partial Off-site Disposal of Contaminated Materials)

Partial off-site disposal of contaminated materials would result in the most contaminated materials being removed from the SFC site (the dewatered raffinate sludge and the sediments from the Emergency Basin, North Ditch, and Sanitary Lagoon). In the short-term, there would be SMALL impacts on land use, surface water and groundwater resources, public and occupational health, cultural resources, geology and soils, air quality, ecological resources, socioeconomic conditions, environmental justice, and noise. There would be a short-term MODERATE impact on transportation due to the movement of contaminated materials off-site on local and regional highways. In the long-term, this alternative would have MODERATE impacts on land use in that a portion of the site would be released for unrestricted use. For all other resource areas, the long-term impacts would be SMALL.

Comparison of No-Action and Alternatives 2 and 3 with the Proposed Action

In comparison to the no-action alternative, the proposed action (Alternative 1, On-site Disposal of Contaminated Materials) and Alternatives 2 and 3 would almost all have SMALL impacts, with the exceptions of land use and transportation. Alternatives 1, 2, and 3 would all have MODERATE land use impacts, differing only in the amount of the site acreage that is proposed for release as unrestricted use. Alternatives 2 and 3 would have MODERATE transportation impacts because, in combination with commuting workers and construction activities, either railcars or trucks would be used for transporting contaminated materials off-site. For all other resource areas, the magnitude of potential impacts among Alternatives 1, 2, and 3 would be SMALL.

LIST OF ACRONYMS AND ABBREVIATIONS

ACHP	Advisory Council on Historic Preservation
ACL	alternate concentration limit
AEA	Atomic Energy Act
AES	AES Corporation
ALARA	as low as reasonably achievable
ALI	annual limit of intake
amsl	above mean sea level
bgs	below ground surface
Bq/g	Becquerels per gram
CDC	Centers for Disease Control and Prevention
CDPHE	Colorado Department of Public Health and Environment
CEDE	committed effective dose equivalent
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	U.S. Code of Federal Regulations
CL	cleanup level
COC	constituent of concern
DAC	derived air concentration
DCGL	derived concentration guideline level
DEIS	Draft Environmental Impact Statement
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
DOL	U.S. Department of Labor
DUF_4	depleted uranium tetrafluoride
DUF_6	depleted uranium hexafluoride

E & E	Ecology and Environment, Inc.
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESRI	Environmental Systems Research Institute, Inc.
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FRTR	Federal Remediation Technologies Roundtable
g	gram
GEIS	Generic Environmental Impact Statement
gpm	gallons per minute
HCM	Highway Capacity Manual
HDPE	high-density polyethylene
HEPA	high-efficiency particulate air
ICB	institutional control boundary
ICRP	International Commission on Radiological Protection
IUC	International Uranium Corporation
kg	kilogram
km	kilometer
LCF	latent cancer fatality
LLRW	low-level radioactive waste
lpm	liters per minute
MCL	maximum contaminant level
MEI	maximally exposed individual
mg	milligram
mg/L	milligrams per liter
mrem	millirem

mSv	millisievert
MW	megawatts
NAAQS	National Ambient Air Quality Standards
NAIP	National Agricultural Imagery Program
NCHS	National Center for Health Statistics
NCI	National Cancer Institute
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NWI	National Wetlands Inventory
NWR	National Wildlife Refuge
OAS	Oklahoma Archaeological Survey
OCES	Oklahoma Cooperative Extension Service
ODEQ	Oklahoma Department of Environmental Quality
OESFO	Oklahoma Ecological Services Field Office
OG&E	Oklahoma Gas & Electric
OHS	Oklahoma Historical Society
OMB	Office of Management and Budget
OPDES	Oklahoma Pollutant Discharge Elimination System
OSDH	Oklahoma State Department of Health
OSHA	Occupational Safety and Health Administration
OWRB	Oklahoma Water Resources Board
pCi	picocuries

pCi/g	picocuries per gram
pCi/L	picocuries per liter
PMC	Pathfinder Mines Corporation
ppm	parts per million
RCRA	Resource Conservation and Recovery Act
RIS	Regulatory Information Summary
ROW	right-of-way
SARA	Superfund Amendments and Reauthorization Act
SER	Safety Evaluation Report
SFC	Sequoyah Fuels Corporation
SHPO	State Historic Preservation Officer
Sv	sievert
TEDE	total effective dose equivalent
TI	transport index
TRB	Transportation Research Board
UDEQ	Utah Department of Environmental Quality
UF_6	uranium hexafluoride
µg/L	micrograms per liter
UMTRCA	Uranium Mill Tailings Radiation Control Act of 1978
U.S.C.	United States Code
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WCS	Waste Control Specialists
yr	year

1. INTRODUCTION

1.1 Background

The U.S. Nuclear Regulatory Commission (NRC) staff and its contractor, Ecology and Environment, Inc., prepared this Draft Environmental Impact Statement (DEIS) to evaluate the potential environmental impacts of the reclamation activities proposed by Sequoyah Fuels Corporation (SFC) for its former uranium conversion site in Gore, Oklahoma. These reclamation activities include both surface reclamation and groundwater corrective actions. The SFC Gore site is located in Sequoyah County in eastern Oklahoma (see Figure 1.1-1).

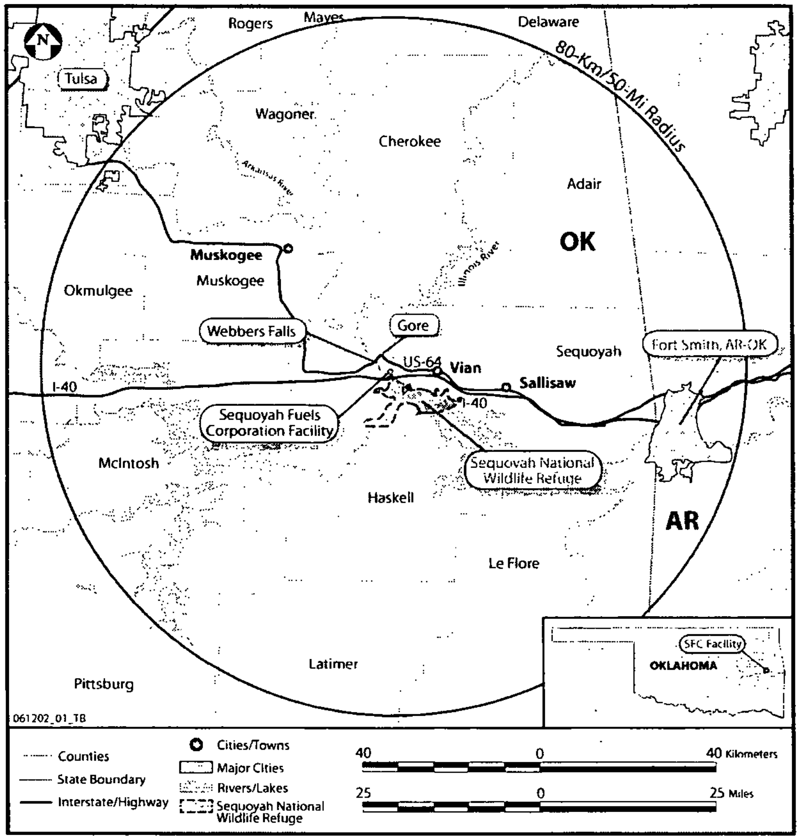

Figure 1.1-1 Location of Sequoyah Fuels Corporation Facility, Gore, Oklahoma

The NRC has determined that approval of SFC's proposal for on-site disposal of the radioactive waste from its previous operations, along with land use restrictions or other institutional controls to prevent inadvertent disturbance of the waste, constitutes a major federal action and, therefore, warrants the preparation of an EIS in accordance with the National Environmental Policy Act (NEPA) of 1969, as amended. This DEIS meets the requirements of the NRC regulations implementing the NEPA, found at Title 10, "Energy," of the U.S. Code of Federal Regulations (CFR), Part 51 (10 CFR Part 51).

The SFC site is licensed under NRC license SUB-0110. In accordance with conditions in that license, SFC submitted its proposed site *Reclamation Plan* and its proposed groundwater *Corrective Action Plan* in 2003 for NRC approval. Both plans have since been revised in response to NRC staff reviews and requests for additional information.

Before SFC can proceed with its proposed surface reclamation activities and groundwater corrective actions, these activities must be approved by the NRC. This approval would come in the form of NRC-issued amendments to SFC's license, which would require SFC to conduct surface reclamation and groundwater corrective actions in accordance with the approved plans. To approve SFC's proposed plans, the NRC must determine that they meet the requirements of Appendix A to 10 CFR Part 40 and that the environmental impacts of such plans have been evaluated and appropriately considered.

This DEIS documents the evaluation and assessment of the potential environmental impacts of SFC's proposed *Reclamation Plan* and groundwater *Corrective Action Plan*. The NRC staff's review of SFC's plans against the requirements in Appendix A to Part 40 are contained in separate Safety Evaluation Reports (SERs).

1.2 The Licensee's Proposed Action (Alternative 1)

The proposed action considered in this DEIS is the implementation of SFC's proposed reclamation activities for the 243-hectare (600-acre) Gore site. SFC's *Reclamation Plan* (SFC, 2006a) identifies the activities that would be undertaken by SFC to accomplish surface reclamation of the site in accordance with 10 CFR Part 40, Appendix A (which includes Criteria for the Disposition of Uranium Mill Tailings or Wastes). SFC proposes to consolidate contaminated sludges and soils, demolish existing structures (with the exception of the administration building and the electrical substation), and construct an above-grade, on-site engineered disposal cell for the permanent disposal of all contaminated materials.

SFC has also submitted a groundwater *Corrective Action Plan* (SFC, 2003) that identified activities to address groundwater contamination at the site. SFC subsequently modified its groundwater *Corrective Action Plan* in response to NRC staff requests for additional information (SFC, 2005).

Following the completion of surface reclamation and groundwater corrective actions, SFC would seek termination of its NRC license. As part of that future license termination process, SFC proposes to transfer approximately 131 hectares (324 acres) of the site, including the land area encompassing the disposal cell and a surrounding buffer, to the United States or the State of Oklahoma for long-term control (the final size of the area to be transferred is subject to negotiation between SFC and the long-term custodian). The State of Oklahoma would have the first option to take responsibility for long-term custodial care of the site. If the State declines this role, the U.S. Department of Energy (DOE) (or other federal agency) would take custody of the site under the provisions of Section 83 of the Atomic Energy Act (AEA) of 1954, as amended by the Uranium Mill Tailings Radiation Control Act of 1978. The remaining 112 hectares (276 acres) of the site would be released for unrestricted use.

1.3 Purpose and Need for the Proposed Action

This section of the DEIS describes the regulatory history of the site and the relevant NRC hearing history in the context of the purpose and need for the proposed action.

1.3.1 Regulatory History

In November 1992, following a release of nitrous oxide, SFC notified the NRC that it had permanently ceased production of uranium hexafluoride (UF_6) and would terminate the depleted uranium hexafluoride (DUF_6) operation by the end of July 1993. Accordingly, SFC notified NRC by letter that all production activities at its Gore, Oklahoma, uranium conversion facility had ceased on July 6, 1993 and that SFC was seeking termination of its license in compliance with the requirements of 10 CFR 40.42(e) (License Termination and Decommissioning of Sites).

The information available to the NRC at the time of the SFC notification indicated that at least some of the identified waste and contamination at the facility was known to exceed the NRC's radiological criteria for decommissioning. In the vicinity of the process buildings, process impoundments, and uranium handling areas, concentrations of uranium in the soils were found to exceed background levels. Consequently, the NRC required that the site be remediated to meet the radiological criteria contained in Subpart E of 10 CFR Part 20 (Standards for Protection Against Radiation). SFC subsequently submitted a *Site Characterization Report* and a study of remediation alternatives (SFC 1998) to the NRC. In a *Decommissioning Plan* submitted to the NRC staff in March 1999 (SFC, 1999), SFC proposed the construction of an on-site disposal cell for the disposal of contaminated materials, including consolidated waste and soils.

> **Byproduct Material** means . . . (2) the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content." 42 U.S.C. § 2014(e)(2).

In July 2002, the NRC granted a request by SFC to reclassify some of the waste at the site as AEA Section 11e.(2) "byproduct material" (42 U.S. Code [U.S.C.] 2014(e)(2)) and in December 2002 issued a license amendment to authorize SFC's possession of this reclassified material. With the reclassification of some of the contaminated waste and soils, the applicable regulatory regime was transferred from Subpart E of 10 CFR Part 20 (Standards for Protection Against Radiation) to Appendix A of 10 CFR Part 40 (which includes Criteria for the Disposition of Mill Tailings or Wastes). This shift required SFC to withdraw its 1999 *Decommissioning Plan* and to prepare a *Reclamation Plan*, which was submitted to the NRC staff in January 2003, with further revisions being submitted in May 2005 and December 2006 (SFC, 2006a). In addition, SFC submitted a groundwater *Corrective Action Plan* to NRC in June 2003 (SFC, 2003), which was subsequently revised (SFC, 2005).

In its *Reclamation Plan*, SFC proposes to conduct many of the same types of activities to achieve surface reclamation of its Gore, Oklahoma site as it proposed under its previous *Decommissioning Plan*. Implementation of these activities would result in many of the same environmental issues—disturbance of surface soils, control of surface runoff, corrective groundwater actions, and ultimately the release of at least a portion of the site for future use.

1.3.2 Relevant Hearing History

In 2003, the State of Oklahoma and the Cherokee Nation submitted hearing requests to the NRC's Atomic Licensing Board regarding SFC's plan for reclamation of their Gore, Oklahoma, site. The licensing board withheld action on the hearing requests because negotiations were in progress and, in December 2004, a Settlement Agreement was entered into by SFC, the State of Oklahoma, and the Cherokee Nation (NRC, 2004). The topics addressed by the Settlement Agreement included, among others, the disposition of contaminated sludges and sediments, as well as PCBs and asbestos.

The parties agreed that SFC would revise the *Reclamation Plan* to state that the raffinate sludge, North Ditch sediment, Emergency Basin sediment, and Sanitary Lagoon sediment would be disposed at an appropriate off-site location and that SFC would spend up to $3.5 million for off-site disposal of this material. The parties acknowledged that off-site disposal of this material would be given high priority but that complete off-site disposal may not be economically possible due to circumstances outside the control of SFC.

To date, the *Reclamation Plan* has not been revised to provide for any off-site disposal of raffinate sludge, North Ditch sediment, Emergency Basin sediment, and Sanitary Lagoon sediment as described in the terms of the Settlement Agreement. If SFC changes the *Reclamation Plan* to provide for off-site disposal as described in the Settlement Agreement, SFC would be obligated to submit a license amendment to the *Reclamation Plan* to the NRC for approval. At that time, the NRC staff would make a determination as to whether a supplement to the DEIS would be necessary.

1.3.3 Purpose and Need

Under the AEA of 1954, as amended, the NRC has licensing and regulatory authority for nuclear energy uses within the commercial sector. One part of this licensing responsibility is to ensure the safe and timely decommissioning of nuclear facilities that are regulated by the NRC. Decommissioning means to "remove a site safely from service and reduce residual radioactivity [through remediation or reclamation of the site by the licensee] to a level that permits: (1) release of the property for unrestricted future use and ultimate termination of the license; or (2) release of the property under restricted conditions and ultimate termination of the license" (10 CFR 40.4). The proposed action is intended to satisfy the need to protect public health and safety and ensure that any potential long-term radiological and nonradiological hazards or other impacts on the environment are minimized. Satisfying this need would be consistent with NRC's statutory mission under the AEA.

The purpose of the proposed action is the reclamation of SFC's Gore, Oklahoma, uranium conversion site in accordance with the NRC performance standards contained in 10 CFR Part 40, Appendix A. These standards require, in part: (1) isolation of the waste materials in a manner that protects human health and the environment; (2) reduction in the rate of radon emanating from the disposal cell cover to an average of 20 picocuries (pCi) per square meter-second or less; (3) a level of stabilization and containment of contaminated materials for a long period of time (200 to 1,000 years); (4) minimal reliance on active maintenance of the disposal cell; and (5) protection and restoration, as needed, of groundwater, and (6) clean up of the site and structures outside of the disposal cell to the applicable radiation standards.

Following the completion of surface reclamation activities and groundwater restoration, the NRC license for the site would be terminated. The disposal cell and a buffer area surrounding the cell, delineated by an institutional control boundary (ICB), would be transferred to a long-term custodian for perpetual care. The DOE, another federal agency so designated by the President, or the State of Oklahoma would be this custodian and licensed under an NRC general license at 10 CFR 40.28. The purpose of this general license is to ensure that the SFC site will be cared for in such a manner as to protect public health and safety and the environment after closure of the disposal cell.

1.4 Scope of the Environmental Analysis

To fulfill its responsibilities under NEPA, the NRC has prepared this DEIS to analyze the potential environmental impacts (i.e., direct, indirect, and cumulative impacts) of the reclamation activities proposed by SFC for its Gore, Oklahoma site, as well as reasonable alternatives to the proposed action. The scope of this DEIS includes consideration of both radiological and nonradiological (including chemical) impacts associated with the proposed action and the reasonable alternatives. The DEIS also addresses potential environmental impacts relevant to transportation.

In addition, this DEIS addresses cumulative impacts to physical, biological, economic, and social parameters. This DEIS also identifies resource uses, monitoring, potential mitigation measures, unavoidable adverse environmental impacts, the relationship between short-term uses of the environment and long-term productivity, and irreversible and irretrievable commitments of resources.

The development of this DEIS is the result of the NRC staff's review of the SFC *Reclamation Plan* (SFC, 2006a), its supporting *Environmental Report* (SFC, 2006b), and the SFC groundwater *Corrective Action Plan* (SFC, 2003, as amended). This DEIS review has been closely coordinated with the development of the SERs prepared by the NRC staff (NRC, 2005) to evaluate, among other aspects, the health and safety impacts of the proposed action. These SERs are the outcome of the NRC safety review of SFC's surface reclamation and groundwater corrective action plans.

1.4.1 Scoping Process and Public Participation Activities

The NRC's NEPA implementing regulations in 10 CFR Part 51 contain requirements for conducting a scoping process prior to the preparation of an EIS. Scoping was used to help identify those issues to be addressed in detail and those issues that are either beyond the scope of the EIS or are not directly relevant to the assessment of potential impacts from the proposed action and reasonable alternatives.

On October 20, 1995, the NRC published a Notice of Intent (NOI) to prepare an EIS to evaluate the environmental impacts of proposed decommissioning of the SFC Gore, Oklahoma, site in the Federal Register (60 FR 54260). At that time, the radiological criteria for license termination contained in 10 CFR 20, Subpart E (Standards for Protection Against Radiation), were the applicable standards for the NRC oversight of proposed SFC site decommissioning activities. In 2002, regulatory oversight was subsequently transferred to the NRC's uranium recovery program, which regulates uranium mill tailings per Appendix A of 10 CFR Part 40 (which includes criteria for the disposition of mill tailings or wastes), following a decision by the NRC to grant a request by SFC to reclassify some of the waste. (The regulatory history of the SFC site, including the reclassification of some of the waste, was previously discussed in Section 1.3.1.) In 2003, the NRC published another NOI in the Federal Register (68 FR 20033) for a rescoping meeting. This rescoping meeting was held on May 13, 2003, at Gore High School in Gore, Oklahoma. The purposes of the rescoping meeting were threefold: (1) to inform the public about the *Reclamation Plan* and the groundwater *Corrective Action Plan*; (2) to explain how these plans would be used to reassess the potential impacts of the proposed action; and (3) to solicit additional public input on the DEIS. The NRC considered the comments and suggestions received during the rescoping in preparing this DEIS. The Rescoping Summary Report is included in Appendix A to this DEIS.

1.4.2 Issues Studied in Detail

In the 2003 NOI, the NRC identified the issues to be studied in detail as they relate to implementation of the proposed action. During the subsequent scoping process, the public identified additional issues. The following issues identified by the NRC and the public could result in short- or long-term impacts on resources during SFC's proposed reclamation of their Gore, Oklahoma, site:

- **Land Use and Tax Revenues.** SFC is proposing that the radioactive waste at the site be consolidated and placed in an on-site disposal cell. In addition, long-term control by the state or federal government would be required in perpetuity to protect the disposal cell and surrounding contaminated areas from inadvertent intrusion by the public. As a result, the proposed site reclamation would make portions of the site unavailable for future unrestricted use. The public has commented that restricted use of the SFC site would have significant societal and economic impacts. Section 4.2, Land Use, discusses land use and tax revenue impacts related to the alternatives assessed in this DEIS.

- **Water Resources.** There are both groundwater and surface water issues associated with SFC's proposed plan for site reclamation.

  - **Surface Water Resources.** Although past operations at the SFC facility have had no significant effect on the surface water environment in the vicinity of the SFC site, the public has expressed concern that, even after the completion of site reclamation, drainage from and erosion of the site could result in suspended radionuclide-contaminated soils being washed into nearby rivers. The public also is concerned about ingesting fish products from a river or reservoir that has been contaminated with radionuclides by surface runoff or groundwater from the site. The potential for surface water contamination during and after surface reclamation of the site is discussed in detail in Section 4.3, Impacts on Water Resources, of this DEIS.

  - **Groundwater Resources.** During operations, SFC inadvertently released radioactive materials into the ground, contaminating the surrounding soil and groundwater. Elevated concentrations of uranium have been identified in the upper levels of groundwater in the vicinity of the main process building. There also are groundwater plumes from the storage ponds with uranium concentrations exceeding the drinking water standard contained in 40 CFR 141.66 (30 milligrams per liter [mg/L]).

The public is concerned that contaminated groundwater plumes could reach underlying aquifers and believes the groundwater should be cleaned up before such plumes reach local rivers or the Robert S. Kerr Reservoir. The public also is concerned that, even after the completion of surface reclamation, seepage from the on-site disposal cell could still be directed downward to the groundwater and ultimately reach surface water resources.

Under SFC's proposed action, approximately 112 hectares (276 acres) would be made available to the public for unrestricted use. An alternative to SFC's proposed action would make the entire site (243 hectares [600 acres]) available for unrestricted use. Of concern, then, is the potential for future residents to use the groundwater for drinking or other domestic uses. The potential impacts on groundwater resources are discussed in detail in Section 4.4, Water Resources, of this DEIS.

- **Public and Occupational Health.** Public and occupational health and safety issues are of concern to the public, including the potential for adverse effects on human health related to chronic and acute exposures to ionizing radiation and hazardous chemicals present on the site, as well as from physical safety hazards. The public has indicated that effects on human health might occur during and after site reclamation and during transportation of any contaminated wastes under off-site disposal alternatives. The potential impacts on public and worker safety and health are discussed in detail in Section 4.4, Public and Occupational Health, of this DEIS.

- **Transportation.** As a result of surface reclamation activities proposed by SFC, there would be an increase in traffic operating on the SFC site and accessing the site from public highways. This increase in traffic would include construction workers commuting in private vehicles, earthmoving equipment operating on-site, and large trucks delivering equipment and materials to and removing waste from the site. The public is concerned with the consequences of increased traffic, such as accidents and exposure of local residents to transportation-related radiological doses. The potential for impacts due to transportation issues is discussed in detail in Section 4.5, Transportation Impacts, of this DEIS.

1.4.3 Issues Eliminated from Detailed Study

The NRC has determined that detailed analysis of several issues is unnecessary because, after examination, they were found to have small to no impacts and thus are not considered potential discriminators among the proposed action and the reasonable alternatives. These issues and any associated impacts are briefly described below and are further discussed in Appendix B, Issues Eliminated from Detailed Study, of this DEIS.

- **Geology and Soils.** Reclamation of the SFC site would disturb surface soils during excavation and grading activities to remove and consolidate contaminated materials prior to disposal and during construction of the disposal cell, including its closure and capping. At completion of the *Reclamation Plan*, contaminated soils would be isolated within the on-site disposal cell. Excavated areas would be regraded and reseeded. Therefore, impacts on geology and soils would be small.

- **Cultural Resources.** Consultation conducted with the Oklahoma State Historic Preservation Officer (SHPO) revealed that no historic properties would be affected by implementation of SFC's proposed reclamation activities (OHS, 2006). The Oklahoma Archaeological Survey (OAS) identified only one archaeological site in the area, to the west of the SFC site boundary (OAS, 2000). This site would not be disturbed during the proposed SFC reclamation activities. Therefore, there would be no impacts on cultural resources from on-site reclamation activities. Consultations regarding construction of a rail spur east of the site for another reasonable alternative would be pursued if needed.

- **Visual and Scenic Resources.** Visual and scenic resources comprise those features that relate to the overall impression a viewer receives of an area. The value of the affected setting is highly dependent on existing land use. The SFC site is an industrial facility located in a rural area and is surrounded by a mix of forest and pastureland with rolling hills. The waterways adjacent to or near the site (the Illinois and Arkansas rivers, including the Robert S. Kerr Reservoir) are used by the public for recreation. The SFC facility currently contrasts with the rural and natural character of the surrounding area.

  This contrast would continue to be evident during the licensee's construction of the disposal cell and related reclamation activities. Travelers on Interstate 40, U.S. Route 64, and State Highway 10 would be able to observe dust and construction equipment on the site and increased traffic on the roads leading to the SFC site. Following reclamation, the only structures that would remain on the SFC site would be the administration building and the electrical substation. After revegetation, the disposal cell would blend into the existing natural landscape, although the surrounding fence would be visible to passersby. In summary, following SFC's completion of the reclamation activities, the overall visual and scenic impacts would be small.

- **Air Quality.** Air quality and visibility could be temporarily affected by site reclamation activities. Demolition or earthmoving activities during removal of structures and consolidation of contaminated soils and sludges would result in fugitive dust and vehicular emissions, causing local, short-term degradation of air quality. SFC would implement standard dust-suppression practices and maintain appropriate emission controls on diesel and gasoline engines during the reclamation activities. Therefore, the action will not exceed any National Ambient Air Quality Standards (NAAQS). Applicable radiological air quality standards are not expected to be exceeded as evidenced by experience from decommissioning of the former uranium conversion facility at Weldon Spring, Missouri. The concentration ranges of contaminants at that site and at the SFC site are comparable, and decommissioning at the former site included removal and temporary storage of contaminated soil and other material as well as permanent disposal in an on-site earthen cell. In addition, the results of the dose assessment study conducted for this DEIS indicate that the radiological dose from all potential pathways, including air emissions, would be within regulatory limits. Therefore, the impact would be small. In summary, any air quality impacts would be small since they would be temporary and occur only as reclamation activities were being conducted.

- **Ecological Resources.** As proposed in its *Reclamation Plan*, the licensee would raze all of the former process buildings (with the exception of the administration building and the electrical substation) and construct an on-site disposal cell for the disposal of the contaminated material consolidated from different areas of the site. Following capping of the disposal cell, it and the former Process and Industrial Areas would be graded and seeded with grasses to prevent erosion. As a result, the amount of wildlife habitat on the site would increase. In addition, the potential risks to wildlife from exposure to radiological and nonradiological contaminants would be reduced. While the construction phase of the proposed action would result in short-term, moderate disturbance to wildlife, in the long-term, implementation of SFC's proposed reclamation activities would improve the quality of local wildlife habitat. Therefore, overall potential impacts on ecological resources would be small.

- **Noise.** Reclamation activities at the SFC site would result in temporarily increased noise levels from the operation of heavy trucks, jackhammers, bulldozers, loaders, and other equipment that would be used to dismantle and demolish structures and to conduct other activities necessary to remediate the site. Noise levels in the immediate vicinity of the equipment could reach 110 decibels or more if there are multiple nearby sources, but noise levels at the nearest receptor would be about 55 decibels, which would be comparable to residential construction. Appropriate controls to limit worker exposure to noise would be implemented by SFC in accordance with regulations of the Occupational Safety and Health Administration (OSHA) (29 CFR 1910.95). Noise impacts would be small since they would occur only during the construction phase of SFC's reclamation efforts at the site and would not adversely affect nearby residents.

- **Socioeconomic Impacts.** SFC has indicated that implementation of the proposed *Reclamation Plan* would likely involve the hiring of 72 to 78 on-site workers, most of whom would be local. As a result, short-term construction-related impacts on regional housing, public infrastructure, and economic resources would be small. Under the Proposed Action, SFC is proposing to "restrict use" of more than 50% of the site in the long-term, with additional long-term restrictions on the use of groundwater at the site. Thus, significant changes in the socioeconomic conditions surrounding the site would be unlikely and potential long-term socioeconomic impacts would be small. Even with full release of the entire SFC site for unrestricted use, it is anticipated that redevelopment would have a small impact on socioeconomic conditions of the region.

- **Environmental Justice.** Executive Order 12898 directs federal agencies to address disproportionately high and adverse human health or environmental effects of proposed actions on minority and low-income populations. Appendix B of this DEIS describes the distributions of minority and low-income populations in the vicinity of the SFC site. This analysis shows that there are four census tracts where the percentage of minority populations within 40 kilometers (km) (25 miles) of the SFC facility exceed the percentage of these populations in the region as a whole. In addition, there was one census tract within 32 kilometers (20 miles) of the SFC site where the low-income population exceeded that of the region. Since the environmental impacts associated with SFC's proposed site reclamation activities would be localized and temporary, these census tracts are too distant from the SFC site to experience adverse impacts. Based upon NRC environmental justice guidelines and further analysis, it was determined that the implementation of SFC's proposed action would not have disproportionately high and adverse human health or environmental effects on minority or low-income populations.

- **Mineral Resources.** Minerals mined in the area include coal, limestone, sandstone, sand/gravel from the Arkansas River floodplain, clay, and shale. No coal mining operations, oil or gas fields, or other mineral resources in the immediate area of the SFC site would be affected by implementation of SFC's proposed *Reclamation Plan*.

- **Cost.** SFC provided cost estimates to support the alternatives, and the NRC obtained quotes from transporters and off-site facilities licensed to accept the contaminated materials. These were used to develop a cost benefit analysis based on the guidance contained in NUREG-1748, *Environmental Guidance for Licensing Actions Associated with NMSS Programs*, Section 5.7 (NRC, 2003), and reference documents contained therein. In addition, the cost benefit analysis was conducted using procedures outlined in NUREG-1757 Vol. 2, Rev. 1, Appendix N. The results of the cost benefit analysis indicated Alternative 1 (Licensee's Proposed Action) would yield the greatest net benefits.

1.4.4 Issues Outside the Scope of the DEIS

The following issues were identified in the public scoping process to be outside the scope of the DEIS:

- Impacts of past exposures to radioactive materials.

- Legal actions.

- Siting of low-level radioactive waste (LLRW) disposal facilities.

A summary of the scoping process is presented in Appendix A.

1.4.5 Related NEPA and Other Relevant Documents

The following NEPA documents were reviewed as part of the development of this DEIS to obtain information relevant to the issues raised:

- **Final EIS (FEIS) for Operation of the SFC Facility (NRC, 1975).** In 1975, the NRC published an FEIS regarding the operation of the SFC facility. This document did not discuss the environmental impacts associated with decommissioning because a detailed description of decommissioning was not expected until just before SFC's license would be terminated.

- **Environmental Assessment for SFC License Renewal (NRC, 1985).** In 1985, the NRC published an Environmental Assessment for renewal of SFC's license. This document noted that SFC had submitted a decommissioning plan and cost estimate, but that the plan did not review the environmental impacts of decommissioning.

- **NUREG-0586, Final Generic Environmental Impact Statement (GEIS) on Decommissioning of Nuclear Facilities (NRC, 1988).** This GEIS describes and evaluates the generic impacts associated with the decommissioning process for various nuclear fuel cycle facilities, including a uranium conversion plant, and concludes that the environmental consequences of decommissioning a uranium conversion plant are small. The impacts of decontaminating building structures and areas of contaminated soils also are discussed in the document.

- **NUREG-1496, Generic Environmental Impact Statement in Support of Rulemaking on Radiological Criteria for License Termination of NRC-Licensed Nuclear Facilities (NRC, 1997).** This GEIS focuses on the costs and environmental effects of the activities required to achieve the residual dose criteria contained in 10 CFR Part 20 and evaluates the environmental impacts associated with the remediation of several types of NRC-licensed facilities. The analysis encompasses many of the likely impacts that would in situations where the licensee proposes to release a decommissioned site for unrestricted use.

- **NRC Safety Evaluation Reports.** The NRC staff has prepared SERs for the reclamation of the SFC site. In the SERs, the NRC staff evaluates whether the licensee's proposed action can be accomplished in accordance with the criteria in 10 CFR Part 40, Appendix A. These SERs evaluate the licensee's *Reclamation Plan* and the groundwater *Corrective Action Plan* and include reviews of the extent of contamination at the facility, the radiation protection program, the design of the disposal cell and proposed groundwater corrective actions, potential for accidents, and the funding needed to complete site reclamation.

1.5 Applicable Regulatory Requirements and Permits

This section provides a summary assessment of major environmental requirements, agreements, Executive Orders, and permits relevant to the performance of proposed reclamation activities at the SFC site.

1.5.1 Federal Laws and Regulations

1.5.1.1 National Environmental Policy Act of 1969, as amended (42 U.S.C. §4321 et seq.)

NEPA establishes national environmental policy and goals for the protection, maintenance, and enhancement of the environment to ensure for all Americans a safe, healthful, productive, and aesthetically and culturally pleasing environment. The Act provides a process for implementing these specific goals within the federal agencies responsible for the action. This DEIS has been prepared in accordance with NEPA requirements and the NRC's regulations for implementing NEPA (10 CFR Part 51).

1.5.1.2 Atomic Energy Act of 1954, as amended (42 U.S.C. §2011 et seq.)

The AEA and the Energy Reorganization Act of 1974 (42 U.S.C. §5801 et seq.) give the NRC the licensing and regulatory authority for nuclear energy uses within the commercial sector. The NRC staff's environmental and safety reviews of the licensee's proposed *Reclamation Plan* and groundwater *Corrective Action Plan* ensure that the surface reclamation of the SFC site and groundwater corrective actions are conducted such that public health and safety are protected and that any long-term radiological and nonradiological hazards or other impacts on the environment are minimized.

1.5.1.3 Uranium Mill Tailings Radiation Control Act of 1978

The Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA) was enacted to provide for the disposal, long-term stabilization, and control of uranium mill tailings in a safe and environmentally sound manner and to minimize or eliminate radiation health hazards to the public. Regulatory oversight for the SFC site falls under the UMTRCA Title II program, which provides NRC the authority to control radiological and nonradiological hazards, gives the U.S. Environmental Protection Agency (EPA) the authority to set generally applicable standards for both radiological and nonradiological hazards, and provides for eventual State of Oklahoma or federal ownership of the disposal site (disposal cell and area within the ICB).

1.5.1.4 Clean Air Act, as amended (42 U.S.C. §7401 et seq.)

The Clean Air Act establishes regulations to ensure air quality and authorizes individual states to manage permits. The Clean Air Act requires: (1) the EPA to establish NAAQS as necessary to protect the public health, with an adequate margin of safety, from any known or anticipated adverse effects of a regulated pollutant (42 U.S.C. §7409 et seq.); (2) establishment of national standards of performance for new or modified stationary sources of atmospheric pollutants (42 U.S.C. §7411); (3) specific emission increases to be evaluated so as to prevent a significant deterioration in air quality (42 U.S.C. §7470 et seq.); and (4) specific standards for releases of hazardous air pollutants (including radionuclides) (42 U.S.C. §7412). These standards are implemented through plans developed by each state with EPA approval. The Clean Air Act requires sources to meet air quality standards and obtain permits to satisfy those standards.

1.5.1.5 Clean Water Act, as amended (33 U.S.C. §1251 et seq.)

The Clean Water Act requires the EPA to set national effluent limitations and water quality standards and establishes a regulatory program for enforcement. Specifically, Section 402(a) of the Act establishes water-quality standards for contaminants in surface waters. The Clean Water Act requires that a National Pollutant Discharge Elimination System (NPDES) permit be obtained before discharging any point source pollutant into U.S. waters. In 1996, the Oklahoma Department of Environmental Quality (ODEQ) assumed NPDES permitting authority from the EPA, with the exceptions of Agricultural (e.g., feedlots), General Permits, Indian Lands, and Oil, Gas, and Pipeline Facilities (Standard Industrial Classification code 1300s, with the exception of both 1321 and 1389 where the discharges are not associated with an exploration or production-site). Similarly, ODEQ has the authority to issue storm water permits for industries operating in Oklahoma and has primacy in enforcement actions. SFC currently holds Oklahoma Pollutant Discharge Elimination System (OPDES) stormwater permits.

Section 404 of the Clean Water Act specifically establishes the program that regulates the discharge of dredged and fill material into waters of the United States, including wetlands. Activities in waters of the United States that are regulated under this program include fills for development, water resource projects (such as dams and levees), infrastructure development (such as highways and airports), and conversion of wetlands to uplands for farming and forestry.

The licensee's proposed on-site reclamation activities would not involve the discharge of dredged or fill materials into waters of the United States. Applicants requesting a Section 404 permit for any activity that may result in a discharge into waters of the U.S. must first obtain a State 401 water quality certification. Construction of the rail spur under the off-site disposal alternative would require a Section 404 CWA permit from the U.S. Army Corps of Engineers (USACE), Tulsa District, for disturbance to two intermittent tributaries of Salt Branch, an intermittent tributary of the lower Illinois River. It is expected that both stream crossings would qualify for coverage under a Section 404 Nationwide Permit. An accompanying Section 401 water quality certification from the ODEQ also would be required for the stream crossings.

1.5.1.6 Resource Conservation and Recovery Act, as amended (42 U.S.C. §6901 et seq.)

The Resource Conservation and Recovery Act (RCRA) requires the EPA to define and identify hazardous waste; establish standards for its transportation, treatment, storage, and disposal; and require permits for persons engaged in hazardous waste activities. Section 3006 of RCRA (42 U.S.C. §6926) allows states to establish and administer these permit programs with EPA approval. The EPA has delegated regulatory jurisdiction to the ODEQ, acting under the Oklahoma Hazardous Waste Management Act, for nearly all aspects of RCRA permitting. The EPA, however, retains its authority under RCRA sections 3007, 3008, 3013, and 7003, which include, among others, authority to: (1) conduct inspections, and require monitoring, tests, analyses or reports; (2) enforce RCRA requirements and suspend or revoke permits; and, (3) take enforcement actions regardless of whether the state has taken its own actions. In a letter dated May 24, 2006, the ODEQ stated its determination that the non-11e.(2) byproduct materials proposed for disposal in the on-site disposal cell was the calcium fluoride sludge. Following review of sludge analytical results, DEQ stated that they would not assert their jurisdiction to regulate any of the SFC non-11e.(2) byproduct material as hazardous waste.

1.5.1.7 Emergency Planning and Community Right-to-Know Act of 1986 (42 U.S.C. §11001 et seq.) (also known as Superfund Amendments and Reauthorization Act (SARA) Title III)

The Emergency Planning and Community Right-to-Know Act of 1986, which is the major amendment to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 U.S.C. §9601), establishes the requirements for federal, state, and local governments; Indian tribes; and industry regarding emergency planning and "Community Right-to-Know" reporting on hazardous and toxic chemicals. The "Community Right-to-Know" provisions increase the public's knowledge and access to information on chemicals at individual facilities, their uses, and releases into the environment. States and communities working with facilities can use the information to improve chemical safety and protect public health and the environment. This Act requires emergency planning and notice to communities and government agencies concerning the presence and release of specific chemicals. EPA Region VI has deferred to RCRA and NRC reviews with respect to this Act.

1.5.1.8 Safe Drinking Water Act, as amended (42 U.S.C. § 300f et seq.)

The Safe Drinking Water Act was enacted to protect the quality of public water supplies and sources of drinking water. Under the Act, Oklahoma has primary enforcement responsibility (or "primacy") over its water supply systems. Other programs established by the Safe Drinking Water Act include the Sole Source Aquifer Program (there are no designated sole source aquifers in eastern Oklahoma), the Wellhead Protection Program, and the Underground Injection Control Program. In addition, the Act provides underground sources of drinking water with protection from contaminated releases and spills (e.g., requiring the implementation of a Spill Prevention Control and Countermeasure Plan). SFC would not use on-site groundwater or surface water supplies in conducting on-site reclamation activities. Remediation of existing groundwater contamination at the SFC site is the focus of the groundwater *Corrective Action Plan* and is addressed in this DEIS.

1.5.1.9 Noise Control Act of 1972, as amended (42 U.S.C. § 4901 et seq.)

The Noise Control Act delegates the responsibility of noise control to State and local governments. Commercial facilities are required to comply with federal, state, interstate, and local requirements regarding noise control. The SFC site is located in Sequoyah County, which does not have a noise control ordinance.

1.5.1.10 National Historic Preservation Act of 1966, as amended (16 U.S.C. § 470 et seq.)

The National Historic Preservation Act (NHPA) was enacted to create a national historic preservation program, including the National Register of Historic Places and the Advisory Council on Historic Preservation (ACHP). Section 106 of the NHPA requires federal agencies to take into account the effects of their undertakings on historic properties. The ACHP regulations implementing Section 106, found in 36 CFR Part 800, were revised and became effective on August 5, 2004. These regulations call for public involvement in the Section 106 consultation process, including Indian tribes and other interested members of the public, as applicable. The NRC staff has completed the Section 106 consultation process addressing the potential historic and archaeological sites that have been identified on and in the vicinity of the SFC site.

1.5.1.11 Endangered Species Act of 1973, as amended (16 U.S.C. § 1531 et seq.)

The Endangered Species Act was enacted to prevent the further decline of endangered and threatened species and to restore those species and their critical habitats. Section 7 of the Act requires consultation with either or both the U.S. Fish and Wildlife Service (USFWS) of the U.S. Department of the Interior (DOI) and the National Marine Fisheries Service of the U.S. Department of Commerce to determine whether endangered and threatened species or their critical habitats are known to be in the vicinity of the proposed action. The NRC has completed the consultation process with the USFWS for the proposed SFC site reclamation activities.

1.5.1.12 Occupational Safety and Health Act of 1970, as amended (29 U.S.C. § 651 et seq.)

The Occupational Safety and Health Act establishes standards to enhance safe and healthy working conditions in places of employment throughout the United States. The Act is administered and enforced by OSHA, a DOL agency. The identification, classification, and regulation of potential occupational carcinogens are found in 29 CFR §1910.101, while the standards pertaining to hazardous materials are listed in 29 CFR §1910.120. The OSHA regulates mitigation requirements and mandates proper training and equipment for workers. SFC would be required to comply with the requirements of these regulations during site reclamation activities.

1.5.1.13 Hazardous Materials Transportation Act (49 U.S.C. § 1801 et seq.)

The Hazardous Materials Transportation Act regulates the transportation of hazardous material (including radioactive material) in and between states. According to the Act, states may regulate the transport of hazardous material as long as they are consistent with the Act or the U.S. Department of Transportation regulations provided in 49 CFR Parts 171-177. Title 49 CFR Part 173, Subpart I, contains other regulations regarding packaging for transportation of radionuclides. Transportation of contaminated materials from the SFC site would require compliance with the U.S. Department of Transportation regulations.

1.5.2 Applicable Executive Orders

Executive Order 11988 (Floodplain Management) directs federal agencies to establish procedures to ensure that the potential effects of flood hazards and floodplain management are considered for any action undertaken in a floodplain and that floodplain impacts be avoided to the extent practicable.

Executive Order 12898 (Environmental Justice) requires federal agencies to address environmental justice in minority and low-income populations (59 FR 7629) and directs federal agencies to identify and address, as appropriate, disproportionately high and adverse health or environmental effects of their programs, policies, and activities on minority and low-income populations.

1.5.3 Applicable State of Oklahoma Laws and Regulations

Certain environmental requirements, including those discussed earlier, have been delegated to state authorities for implementation, enforcement, or oversight. Table 1.5-1 provides a list of applicable State of Oklahoma laws, regulations, and agreements. Any changes to SFC's permits issued under Oklahoma statutes and administrative codes would require a permit modification and in some cases a closure plan, which would be independent of any NRC authority or jurisdiction.

Table 1.5-1 Applicable State of Oklahoma Laws, Regulations, and Agreements

Law/Regulation/ Agreement	Citation	Requirements
Oklahoma Clean Air Act	**Oklahoma Statutes**, Title 27A, Chapter 2, Article 5 **Oklahoma Administrative Code**, Title 252, Ch. 100, Air Pollution Control	Establish air quality standards and require permits for construction/ modification of an air contaminant source; require operating permits for pollutant producers; impose hazardous air pollutant emission standards.

Table 1.5-1 Applicable State of Oklahoma Laws, Regulations, and Agreements

Law/Regulation/ Agreement	Citation	Requirements
Oklahoma Radiation Management Act	**Oklahoma Statutes**, Title 27A, Chapter 2, Article 9, Section 2-9-103 **Oklahoma Administrative Code**, Title 252, Ch. 410 Radiation Management	Establish radiation protection standards; records maintenance; prevention and control of hazards; reporting; inspections; permitting and licensing.
Oklahoma Water Quality Act (Oklahoma Pollutant Discharge Elimination System Act)	**Oklahoma Statutes**, Title 27A, Chapter 2, Article 6, Section 2-6-101 *et seq.* **Oklahoma Administrative Code**, Title 252, Chapters 606, 616, and 690	Establish and implement water quality standards, discharge permitting and requirements, industrial wastewater permitting procedures and standards, and review of impacts on water quality from various activities.
Oklahoma Groundwater Law	**Oklahoma Administrative Code**, Title 785, Ch. 45, Subchapter 7, Groundwater Quality Standards	Rules to protect beneficial uses and classifications of groundwater, to ensure that degradation of the existing quality of groundwater does not occur, and to provide minimum standards for remediation.
Oklahoma Solid Waste Management Act	**Oklahoma Statutes**, Title 27A, Chapter 2, Article 10 **Oklahoma Administrative Code**, Title 252, Chapter 515, Management of Solid Waste	Establish State standards for the management of solid wastes.
Oklahoma Hazardous Waste Management Act	**Oklahoma Statutes**, Title 27A, Chapter 2, Article 7 **Oklahoma Administrative Code**, Title 252, Chapter 205	Establish State standards for the management of hazardous wastes.
Oklahoma Hazardous Materials Planning and Notification Act	**Oklahoma Statutes**, Title 27A, Chapter 5, Article 3 **Oklahoma Administrative Code**, Title 252, Chapter 20, Emergency Planning and Community Right-to-Know	Administer and enforce the reporting requirements of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA Title III).
Oklahoma Wildlife Conservation Code	**Oklahoma Statutes**, Title 29, Game and Fish, Chapter 1 **Oklahoma Administrative Code**, Title 800, Ch. 25, Wildlife Rules	Encourage habitat conservation on private lands.

Table 1.5-1 Applicable State of Oklahoma Laws, Regulations, and Agreements

Law/Regulation/ Agreement	Citation	Requirements
Wildlife Rules (Raptors)	**Oklahoma Statutes**, Title 29, Game and Fish, Chapter 1, Article 5, Section 5-410, **Hawks, Falcons, Owls,** Eagles **Oklahoma Administrative Code,** Title 800, Ch. 25, Subchapter 7, General Hunting Seasons, Part 7, Falconry	Unlawful to molest, injure or kill any species of hawk, falcon, owl or eagle, their nests, eggs or young.
Threatened/Endangered Animal Species - List	**Oklahoma Administrative Code,** Title 800, Ch. 25, Subchapter 19, Oklahoma Endangered Species	Establishes the list of threatened and endangered animal species.
Oklahoma 401 Water Quality Certification	**Oklahoma Administrative Code,** 252:610-1-1, and 252:610-3-1 through 252:610-3-10 pursuant to 28A Oklahoma Statute, Section 2-6-103(i)(2)	Section 401 Water Quality Certification is required for projects receiving authorization under Section 404 of the CWA.
Transportation and Highway	**Oklahoma Statutes**, Title 69, Chapter 1, Oklahoma Highway Code of 1968 **Oklahoma Administrative Code,** Title 730, Ch. 35, Maintenance and Control of State Highway System	Establishes state highway management requirements.
State Trust Lands/Land Exchanges	**Oklahoma Statutes**, Title 64, Ch. 1, Section 1.3, **Manner of Acquiring Property for Utilizing Trust Lands for Development of Commercial Lease** **Oklahoma Administrative Code,** Title 385, Ch. 25, Section 385:25-1-41, Procedure for Exchanging Land	Establishes State standards and procedures for exchanges of lands held in trust.
Cultural Properties	**Oklahoma Statutes**, Title 53, Chapter 20, Section 361, **Oklahoma Historical Societies and Associations**	Establishes State Register of Historical Places and permitting requirements.

1.5.4 Permits and Approval Status

Several construction and operating permit applications would be prepared and submitted, and regulator approval and/or permits would be received prior to implementation of reclamation activities. Table 1.5-2 lists the required federal and state authorizations and their status.

Table 1.5-2 Federal and State Authorizations

Agency	Authority	Activity Covered	Status
Authorizations			
U.S. Nuclear Regulatory Commission	AEA/UMTRCA 10 CFR Part 40	Licensing authority	Amendment applications currently under review
U.S. Army Corp of Engineers	Section 404 of the Clean Water Act	Wetland Delineation	Reported that no jurisdictional wetlands are on the site.
Oklahoma Department of Environmental Quality	Oklahoma Statutes Title 27 A, Chapter 2, Article 6, Section 2-6-101 *et seq.* Oklahoma Administrative Code, Title 252, Chapters 606, 616, and 690	Oklahoma Pollutant Discharge Elimination System (OPDES) Permits	Currently active: OPDES Permit No. OK0000191 and OPDES Storm Water Industrial General Permit Authorization No. OKGP00046

1.6 Cooperating Agencies and Required Consultations

This section of the DEIS provides details on the Cooperating Agencies for this document and the status of consultations required under Section 7 of the Endangered Species Act and under Section 106 of the NHPA.

1.6.1 Cooperating Agencies

The Council on Environmental Quality (CEQ) in 10 CFR 1508.5 defines a cooperating agency as a federal, state, or local agency or tribal government that has jurisdiction by law or special expertise with respect to any environmental impact involved in a proposal. The NRC, the EPA, USACE, the U.S. Geological Survey (USGS), the ODEQ, and the Cherokee Nation have an interest in the proposed reclamation of the SFC site. Because the interests of these agencies are interrelated on this project, and these agencies have jurisdiction by law or special expertise pertinent to potential environmental impacts associated with the proposed reclamation of the SFC site, the EPA, USACE, USGS, ODEQ, and the Cherokee Nation have agreed to cooperate with the NRC in the preparation of this DEIS. The NRC is the lead agency for the DEIS, and all the cooperating agencies are involved in or supporting its development and review. Each cooperating agency's special expertise/interest in the DEIS is described as follows:

- **Cherokee Nation.** The Cherokee Nation formally requested to become a cooperating agency for a variety of reasons. Issues related to environmental contamination are important to the Cherokee Nation because historical, cultural, and religious issues mandate the tribe's symbiotic relationship with a clean, healthy environment. As a result, appropriate reclamation of the SFC site is of interest and concern to the tribe. In addition, the Cherokee Nation owns land next to and near the site. Potential development of these lands and of the SFC site is of interest to the tribe.

- **EPA.** The EPA is exercising its right to review state actions because Oklahoma has been authorized under both RCRA and CERCLA. The EPA lead in this project is Region VI.
- **USACE.** It is the policy of the Secretary of the Army, acting through the Chief of Engineers, to provide the public with safe and healthful recreation as well as commercial and industrial opportunities within and along the McClellan-Kerr Navigation System and, more specifically, within Robert S. Kerr Reservoir and its tributaries. The USACE manages public lands on Robert S. Kerr Reservoir immediately next to the SFC facility on the north, west, and south.
- **USGS.** The USGS collects water quality and related natural resource data for the State of Oklahoma, and its staff has written several hundred reports related to environmental issues in the state. In addition, the USGS staff has attended meetings and reviewed documents related to environmental investigations and determinations at the SFC site. The USGS staff will assist the NRC in the review of the DEIS and will participate in investigations at the site, as needed.
- **ODEQ.** The ODEQ has committed to working with the NRC as a cooperating agency in identifying information needs, reviewing relevant data, and participating in the determination of required remediation activities at the SFC site. The ODEQ represents the interests of the citizens of Oklahoma. The SFC may hold or be required to obtain ODEQ permits relating to air and water quality issues.

In addition to the cooperating agencies listed above, other governmental agencies and organizations (see Table 1.5-3) have been consulted to gather the information needed to produce an informed DEIS.

Table 1.5-3 Cooperating and Other Agencies and Organizations Contacted

Federal Agencies
U.S. Department of Transportation
U.S. Fish and Wildlife Service
Oklahoma Agencies
Archaeological Survey
Department of Agriculture
Department of Commerce
Department of Transportation
Department of Wildlife Conservation
Office of the Attorney General
State Historic Preservation Officer
State Parks and Resorts
University of Oklahoma National Heritage Inventory
Water Resources Board
Local and County Governments Contacted
Cherokee County, Oklahoma
Eastern Oklahoma Development Commission
Gore, Oklahoma
Haskell County, Oklahoma

Table 1.5-3 Cooperating and Other Agencies and Organizations Contacted

Indian Nations Council of Governments
McIntosh County, Oklahoma
Muskogee County, Oklahoma
Salisaw, Oklahoma
Sequoyah County, Oklahoma
Sequoyah County I-40 Industrial Park and Port Trust
Tahlequah, Oklahoma
Vian, Oklahoma
Webbers Falls, Oklahoma

1.6.2 Consultations

1.6.2.1 Endangered Species Act of 1973 Consultation

The NRC staff consulted with the USFWS to comply with the requirements of Section 7 of the Endangered Species Act of 1973 (see Appendix C). On November 28, 2006, the NRC staff sent a letter to the USFWS Oklahoma Ecological Services Field Office (OESFO) in Tulsa, Oklahoma, briefly describing the proposed action and providing its determination that consultation under Section 7 was not required, because the proposed action would not adversely affect threatened or endangered species or critical habitat within the area of potential effect (see Appendix C). However, further consultation regarding construction of a rail spur east of the site for another reasonable alternative would be required if needed.

1.6.2.2 National Historic Preservation Act of 1966 Consultation

The NRC staff has offered state agencies, federally recognized Indian tribes, and other organizations that may be concerned with the possible effects of the proposed action on historic properties an opportunity to participate in the consultation process required by Section 106 of the NHPA (see Appendix C). The following sections provide a summary of the consultation performed.

The Cherokee Nation

In 2001, the NRC staff initiated the Section 106 consultation process with the Cherokee Nation, a federally recognized Indian tribe with interest in the area of the SFC site. By a letter dated August 29, 2001, the Cherokee Nation indicated that the tribe did not have objections to SFC's proposed site reclamation and that the tribe was unaware of any significant prehistoric or historic sites at or in the vicinity of the SFC site (Rabon, 2001). The Cherokee Nation did request that they be contacted if buried archaeological materials such as chipped stone tools, pottery, and building materials are discovered during site reclamation. By a letter dated March 19, 2007, the NRC staff requested of the Cherokee Nation a re-confirmation of the tribe's 2001 determination (see Appendix C).

If Native American human remains or funerary objects are discovered during site reclamation, SFC would halt all ground disturbance in the area of the discovery for up to 30 days, notify the appropriate NRC official and the Cherokee Nation, and take steps to comply with the Native American Graves Protection and Repatriation Act. If any ground-disturbing site reclamation activities were conducted off the SFC site, the SHPO and OAS would be consulted prior to any ground disturbance in compliance with the NHPA (SFC, 2006a).

Oklahoma State Historic Preservation Officer

By letters dated November 28, 2006, and November 27, 2006, respectively, the NRC initiated consultations with the Oklahoma SHPO and the OAS under Section 106 of the NHPA of 1966. These letters described the potentially affected area and requested the views of the SHPO on further actions required to identify historic properties that may be affected. The Oklahoma SHPO and OAS have confirmed that there would be no effect on historic or prehistoric properties on or near the SFC site as a result of SFC's proposed reclamation activities (see Appendix C).

If historic or prehistoric cultural materials were identified during site reclamation activities, SFC would halt ground disturbance in the area of the discovery and notify the appropriate NRC official, and treatment of the discovery would be determined in consultation with the SHPO (SFC, 2006a).

1.7 Organizations Involved in the Proposed Action

Two organizations have specific roles in the implementation of the proposed action:

- SFC is the NRC licensee. SFC owns and maintains the site under NRC License Number SUB-1010, Docket Number 40-8027. General Atomics, a privately held high-technology company, is the parent company of SFC, having purchased the SFC subsidiary from Kerr-McGee in 1988.

- The NRC is the licensing agency. The NRC has the responsibility to conduct an evaluation of the safety and environmental aspects of the licensee's proposed *Reclamation Plan* and groundwater *Corrective Action Plan* for compliance with NRC regulations associated with the reclamation of uranium mill facilities. These regulations include 10 CFR Part 40, including Appendix A. To fulfill the NRC's responsibilities under NEPA, the environmental impacts of the proposed action and its alternatives are evaluated in accordance with the requirements of 10 CFR Part 51 and documented in this DEIS.

References

(NRC, 1975) U.S. Nuclear Regulatory Commission. *Final Environmental Statement Related to the Sequoyah Uranium Hexafluoride Plant.* NUREG-75/007. February 1975.

(NRC, 1985) U.S. Nuclear Regulatory Commission. *Environmental Assessment for Renewal of Source Nuclear Material License No. SUB-1010, Docket No. 40-8027, Sequoyah Fuels.* NUREG-1157.

(NRC, 1988) U.S. Nuclear Regulatory Commission. *Final Generic Environmental Impact State (GEIS) on Decommissioning of Nuclear Facilities.* NUREG-0586.

(NRC, 1997) U.S. Nuclear Regulatory Commission. *Generic Environmental Impact Statement in Support of Rulemaking on Radiological Criteria for License Termination of NRC-Licensed Nuclear Facilities*. NUREG-1496.

(NRC, 2003) U.S. Nuclear Regulatory Commission. *Environmental Review Guidance for Licensing Actions Associated with NMSS Programs*. NUREG-1748. August 2003.

(NRC, 2004) U.S. Nuclear Regulatory Commission. Atomic Safety and Licensing Board Panel. Memorandum and Order, Docket No. 40-8027-MLA-6 and Docket No. 40-8027-MLA-9. Appendix, Settlement Agreement. December 2004.

(ODEQ, 2006) Oklahoma Department of Environmental Quality. Letter from Scott A. Thompson, Director, Land Protection Division, to Myron Fliegel, Senior Project Manager, U.S. Nuclear Regulatory Commission, Fuel Cycle Facilities Branch, regarding disposal of non-11e.(2) byproduct materials (non-hazardous calcium fluoride sludge) on-site at the Sequoyah Fuels Corporation site in Gore, Oklahoma. May 24, 2004.

(OHS, 2000) Oklahoma Historical Society. Letter from Melvena Heisch, Preservation Officer, to Thomas Essig, U.S. Nuclear Regulatory Commission, regarding File #1933-00; Sequoyah Fuels Corp. Proposed Decommission Project near Gore, Oklahoma. June 27, 2000.

(OHS, 2006) Oklahoma Historical Society. Letter from Melvena Heisch, Preservation Officer, to Jennifer Davis, U.S. Nuclear Regulatory Commission, regarding File #0426-07; Sequoyah Fuels Reclamation Project in Gore, Oklahoma. December 20, 2006.

(Rabon, 2001) Rabon, David (Cherokee Nation). Letter to Phyllis Sobel, Project Manager, U.S. Regulatory Commission, regarding the Proposed Decommissioning of Sequoyah Fuels Site in Sequoyah County, OK. August 29, 2001.

(SFC 1998) Sequoyah Fuels Corporation. *Site Characterization Report*. Gore, Oklahoma. December 15, 1998.

(SFC, 1999) Sequoyah Fuels Corporation. *Decommissioning Plan*. March 26, 1999.

(SFC, 2003) Sequoyah Fuels Corporation. (Groundwater) *Corrective Action Plan*. June 2003.

(SFC, 2005) Sequoyah Fuels Corporation. Response to Request for Additional Information: Groundwater Information: (Groundwater) Corrective Action Plan Review. December 2005.

(SFC, 2006a) Sequoyah Fuels Corporation. *Reclamation Plan: Sequoyah Facility*. Rev. 2. December 2006.

(SFC, 2006b) Sequoyah Fuels Corporation. *Environmental Report* [for the] *Reclamation Plan*. October 13, 2006.

2. ALTERNATIVES

This chapter describes SFC's proposed reclamation activities at its Gore, Oklahoma, site and other reasonable alternatives to these activities. As required by NEPA, this chapter also presents a no-action alternative. Under the no-action alternative, SFC would conduct neither the surface reclamation activities nor implement the groundwater corrective actions it has proposed for its Gore, Oklahoma, site. The no-action alternative provides a basis from which to compare and evaluate the potential environmental impacts of the licensee's proposed action and alternatives to it.

2.1 Past Operations at the SFC Site

From 1970 until 1993, SFC operated a uranium conversion facility at Gore, Oklahoma, under the authority of NRC Materials License SUB-1010, issued pursuant to 10 CFR Part 40 (Domestic Licensing of Source Material). During this 23-year period, two major operations were conducted at the facility:

- Conversion of uranium oxide (yellowcake) to UF_6, which is an important step in the nuclear fuel cycle leading to the production of fuel elements for nuclear reactors. During this conversion, impurities in the yellowcake are removed through the use of strong acids and alkalis and the uranium is combined with fluorine to create the UF_6 gas, which is cooled and solidified in cylinders and shipped to a uranium enrichment plant. SFC began these operations in 1970.

- Conversion of DUF_6 to depleted uranium tetrafluoride (DUF_4). SFC began these operations in 1987. SFC conducted this conversion process under a subcontract to a defense contractor for use in the defense armament industry.

> **Source Material** means (1) uranium, thorium, or any other material which is determined by the NRC pursuant to the provisions of section 61 of the Atomic Energy Act of 1954, as amended, to be source material; or (2) ores containing one or more of the foregoing materials, in such concentration as the NRC may by regulation determine from time to time.
>
> **Yellowcake:** A uranium mill is a chemical plant that extracts uranium from mined ore. The product is a powder-like substance that is a mixture of uranium oxides. It is called yellowcake due to its color.
>
> **Uranium and Depleted Uranium:** Naturally occurring uranium consists of uranium-238 (99.27%), uranium-235 (0.72%), and uranium-234 (0.01%), which are called isotopes of uranium. Depleted uranium results from processes that separate the isotopes of uranium such that the remaining residue contains a lower percentage of U-235 than shown above.

When active, production processes at the SFC facility were largely confined to an 81-hectare (200-acre) Industrial Area. The Industrial Area, shown in Figure 2.1-1, generally bounds the overall area on the SFC site that has been directly and indirectly affected by past uranium conversion industrial activities. Within this Industrial Area is a smaller Process Area (34 hectares [85 acres]) where the buildings and related facilities are located and where uranium processing operations were conducted. The remaining 47 hectares (115 acres) of the Industrial Area were used by the licensee for storm water management and process material storage. SFC's proposed *Reclamation Plan* focuses on the Process and Industrial Areas.

Contaminated materials are present throughout the Process Area of the SFC site. These contaminated materials include scrap materials and debris, soils, and groundwater; buried

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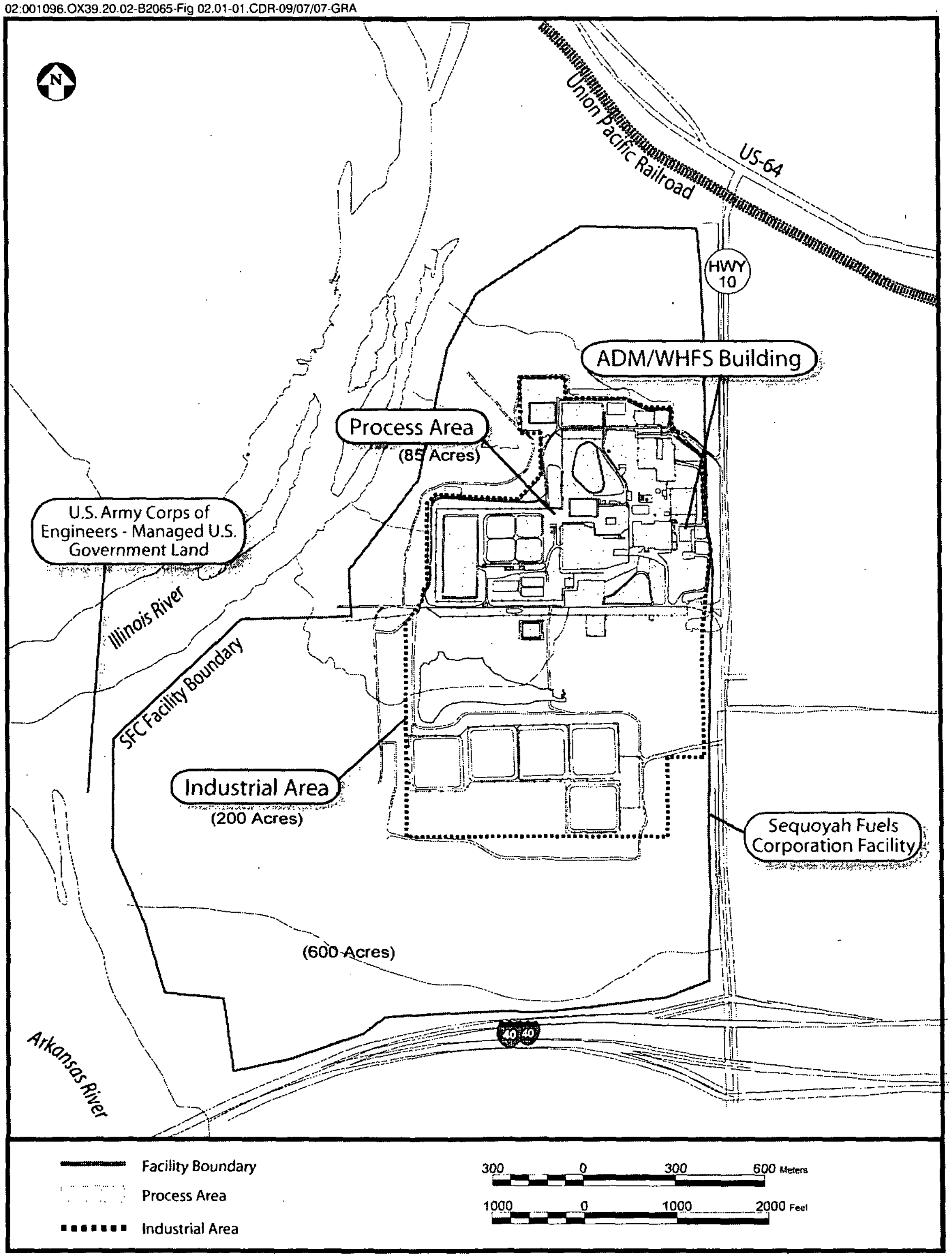

Figure 2.1-1 Sequoyah Fuels Corporation Site Layout During Active Operations

wastes; ponds containing sludges; surfaces of equipment; and some surfaces and the interiors of the process buildings (SFC, 2006a). Contamination of the exterior and interior of each of the buildings, including equipment and surrounding concrete pads, is dependent upon each building's original use. Within the Process Area, the main process building, the miscellaneous-digestion building, and the solvent extraction building were all used in the uranium conversion process (see Figure 2.1-2). Feed material consisted of ore concentrates (i.e., yellowcake) that were stored on a storage pad southwest of the main process building. Cylinders containing high purity UF_6 were stored on a cylinder storage pad north of the main process building. Uranium has been detected at concentrations above 35 picocuries per gram (pCi/g) in soil below the Process Area to a maximum depth of about 9 meters (31 feet).

Processing of the raffinate was primarily conducted in clarifiers (settling basins) west of the yellowcake storage pad (SFC, 2006a). The raffinate liquid was treated with anhydrous ammonia to neutralize the nitric acid and precipitate radioactive and heavy metals. The resulting ammonium nitrate solution and the precipitated material were separated. The precipitate was referred to as raffinate sludge. SFC impounded the treated ammonium nitrate solution in storage ponds on the southern end of the site. This solution was used for beneficial reuse as a part of SFC's land application program (SFC, 2006b).

Raffinate: A liquid acid solution resulting from the solvent extraction process and containing impurities such as nitric acid, metallic salts, and small quantities of uranium, thorium-230, and radium-226.

Dewatered raffinate sludge: Sludge from the bottom of the ponds that has gone through a dewatering process such that the sludge volume has been reduced to approximately one-third of the original volume. The sludge is currently stored on-site in covered, 1-cubic-yard-capacity packages known as "super sacks."

In 2005, SFC removed and dewatered the raffinate sludge remaining from treatment of the raffinate liquid from three lined impoundments on-site. The liquid (filtrate) removed from the sludge was returned to the lined impoundments. The dewatered raffinate sludge, totaling approximately 6,995 cubic meters (9,150 cubic yards) in volume, is now stored on a concrete pad in the central portion of the site (the former yellowcake storage pad) in covered, approximately 0.76-cubic-meter (1-cubic-yard) capacity polypropylene bags (approximately 0.91 meter by 0.91 meter by 1.2 meter [3 feet by 3 feet by 4 feet]) known as "super sacks." The raffinate sludge contains a significant fraction of the radionuclides presently on the SFC site (34% of the uranium [41.5 curies], 76% of the thorium-230 [156 curies], and 38% of the radium-226 [1.1 curies]). The sludge also contains various other metals.

In the northern portion of the Process Area in a building known as the DUF4 building, SFC produced DUF_4 using DUF_6 as feed material. The approximately one thousand 208-liter (55-gallon) drums of depleted uranium that had been stored on-site were removed by the U.S. Army as required by the provisions of John Warner National Defense Authorization Act for Fiscal Year 2007 §316. (The management and disposal of these wastes is not considered further in this DEIS.)

At two areas to the north and west of the DUF4 building but within the Process Area, solid waste was buried by the licensee in the 1970s and 1980s (SFC 2006a). These areas are known as Solid Waste Burial Areas No. 1 and No. 2. LLRW materials buried at these locations consist of

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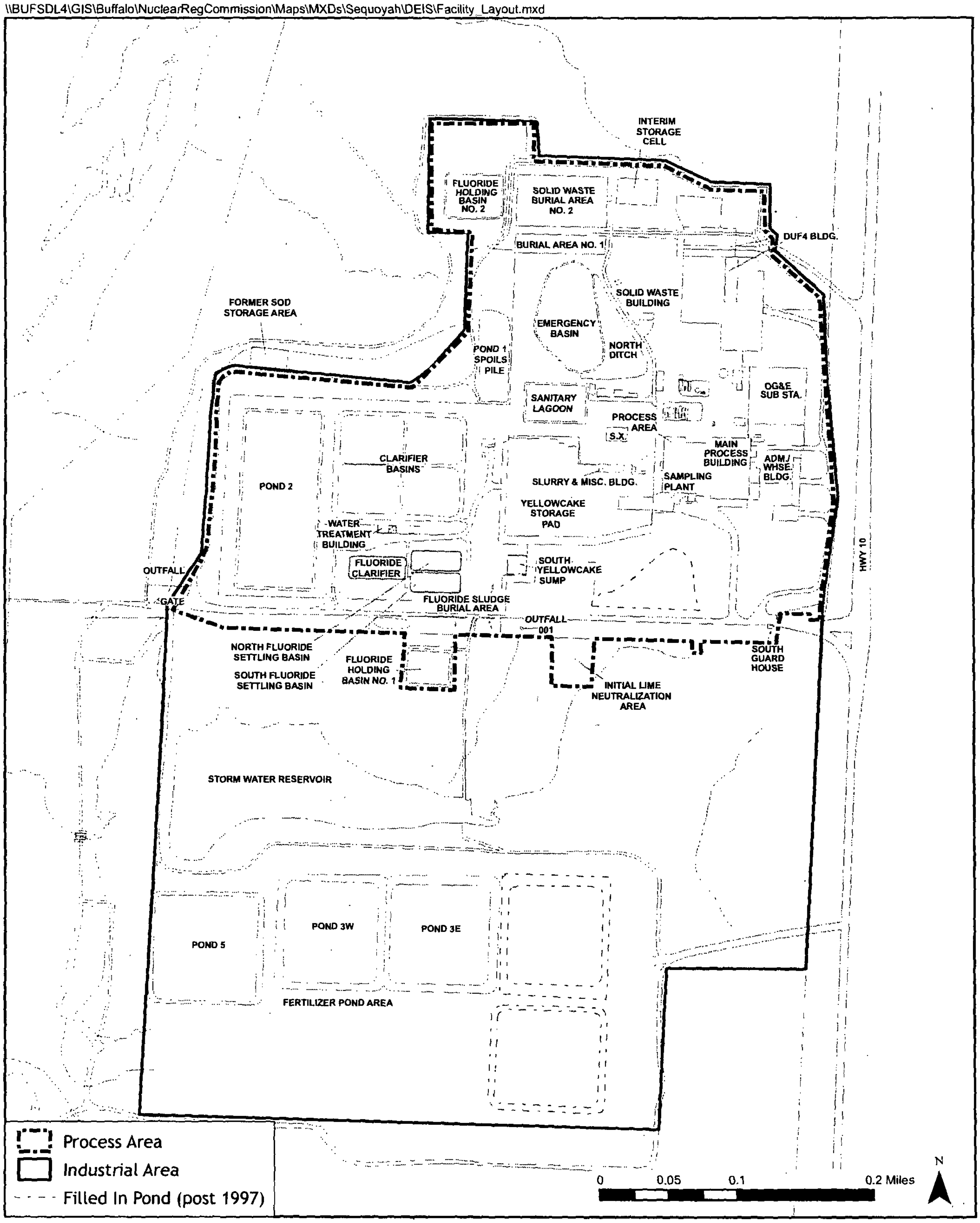

Figure 2.1-2 Sequoyah Fuels Corporation General Site Layout

contaminated drums, equipment, and other solid waste. Surface and groundwater at the site were affected by the operations at the SFC uranium conversion facility. Liquid wastes containing traces of radioactivity were treated by the licensee and released to the lower Illinois River. As a result a natural drainage course between the Process Area buildings and the river was contaminated (SFC 2006a). Groundwater beneath portions of the SFC site is contaminated by uranium from past leaks and spills at the uranium conversion facility. The vertical extent of the affected groundwater is controlled, in part, by a low-permeability sandstone layer underlying most of the site, which inhibits downward migration of contamination (SFC, 2003a).

Uranium has been found at elevated concentrations throughout the Process Area. SFC has identified the areas of uranium soil contamination that exceed the proposed cleanup levels (CLs) (see Figures 2.1-3 and 2.1-4). Uranium contamination can be found at depths up to 20 feet, although the majority of the contamination is present within the first 15 centimeters (6 inches). Thorium-230 and radium-226 are generally associated with the uranium contamination and have been found in similar areas (SFC, 1998). The concentration ranges of these radioactive elements in the soils and sediments at the SFC site are summarized in Table 2.1-1. Chemical contaminants present on-site that exceed background concentrations and health-based screening criteria in soil and sediment include fluoride, arsenic, lead, antimony, and several other metals (see Section 4.4).

Table 2.1-1 Maximum Radionuclide Concentrations Measured in Soils and Sediments

Contaminant	Concentrations (Bq/g)			
	Minimum	Maximum	Mean	Median
Total Uranium	0.03	1,726	18	0.52
Radium-226	0.002	8.5	0.30	0.05
Thorium-230	0.004	216	6.9	0.10

Source: (SFC, 1999).
To convert becquerels to picocuries, multiply by 27.

2.2 Alternative 1: On-site Disposal of Contaminated Materials (the Licensee's Proposed Action)

The proposed action is the implementation of SFC's proposed surface reclamation and groundwater restoration activities for its 243-hectare (600-acre) Gore, Oklahoma, site. SFC's *Reclamation Plan* (SFC 2006c) forms the basis for how SFC would undertake the proposed surface reclamation activities at the site to meet the requirements of 10 CFR Part 40, Appendix A (which includes criteria for the disposition of uranium mill tailings or wastes).

Implementation of SFC's *Reclamation Plan* would involve the following activity elements:

- Demolition of existing structures, equipment, and concrete floors and pads; excavation of underground utilities; and compaction of debris. The administration building and Oklahoma Gas & Electric (OG&E) electrical substation would remain intact for future reuse.

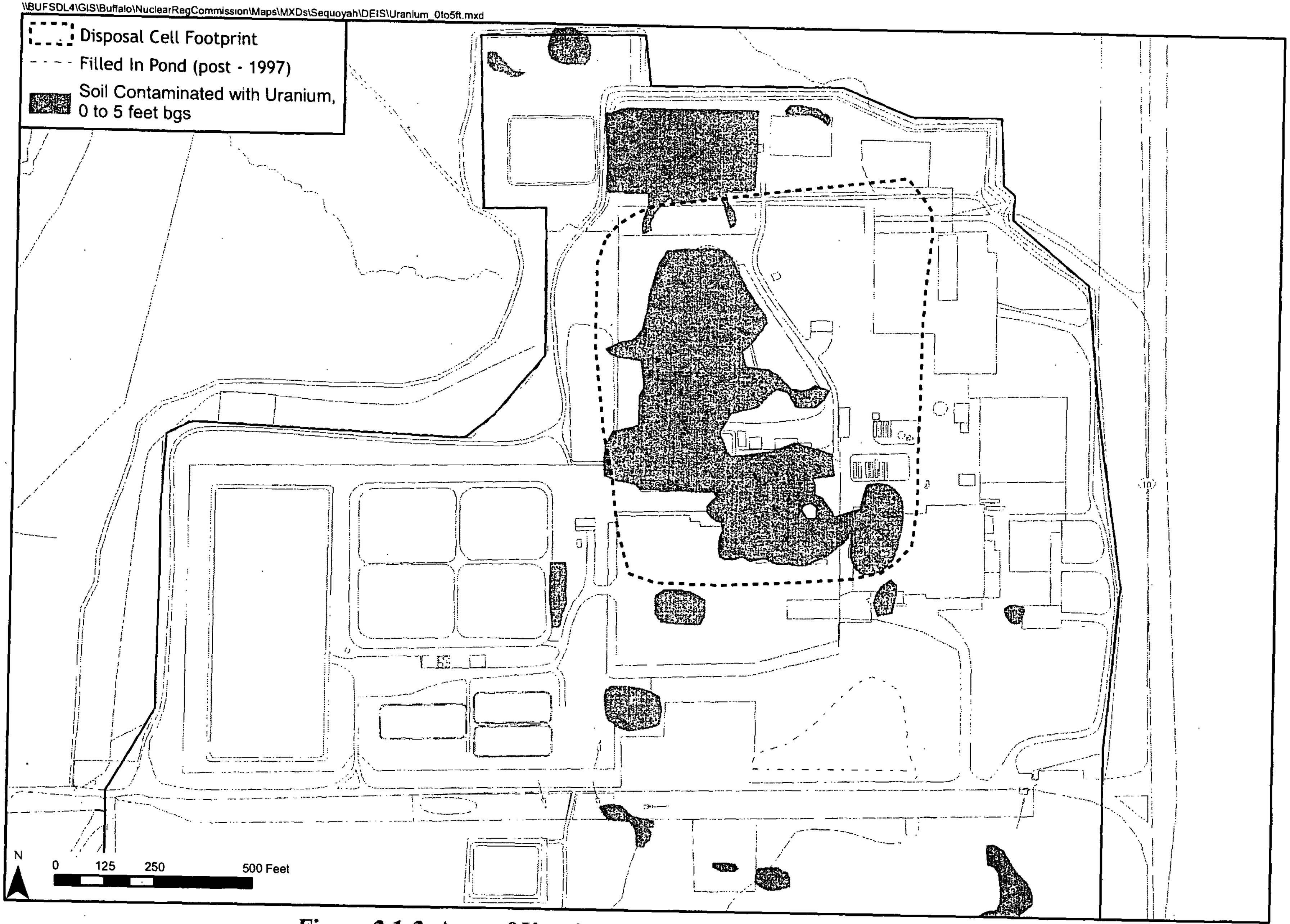

Figure 2.1-3 Area of Uranium Contamination, Depths 0 to 5 feet

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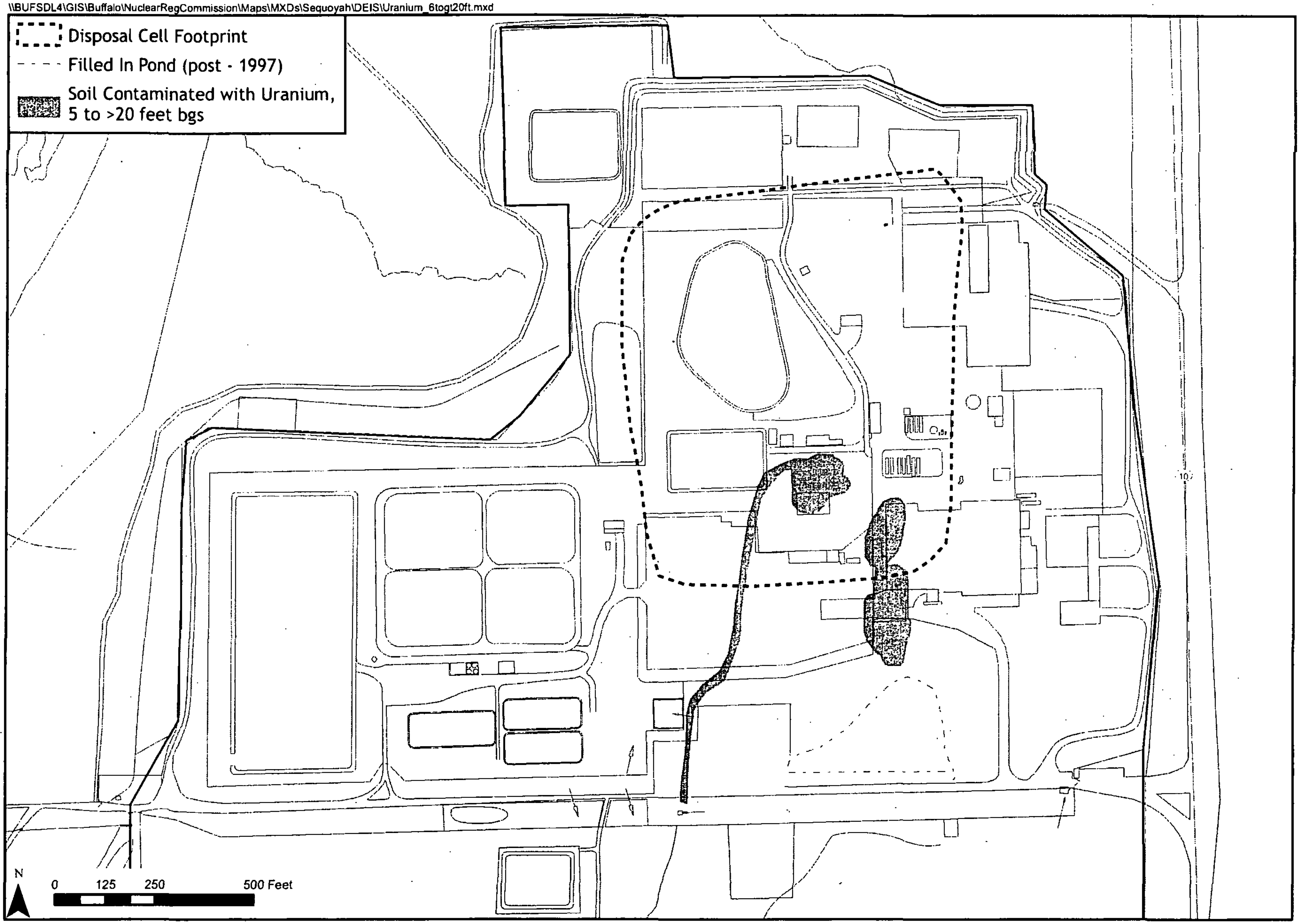

Figure 2.1-4 Area of Uranium Contamination, Depths 5 to >20 feet

- Removal and consolidation of contaminated sludges and sediments from the ponds and lagoons and excavation of buried wastes and contaminated soils on the site. The storm water impoundment would remain intact for future use

- Construction of an on-site, above-grade, engineered disposal cell for the permanent disposal of all contaminated material.

- Placement of demolition debris and contaminated sludges and soils within the disposal cell followed by closure, capping, regrading, and revegetation of the completed disposal cell.

- Management and treatment of produced groundwater and storm water during construction activities.

SFC would also implement a groundwater *Corrective Action Plan* to clean up existing groundwater contamination that resulted from previous site operations (SFC, 2003a). The goal of the cleanup is to reduce the concentrations of the identified hazardous constituents in the groundwater to levels that are either less than the maximum concentration limits for each constituent or to less than the background levels for each constituent, whichever is greater. The NRC staff is currently reviewing SFC's groundwater *Corrective Action Plan*, submitted by SFC on June 30, 2003 (SFC, 2003a). The results of this review will be documented in an SER.

After completion of these surface reclamation and groundwater corrective actions, and following the final site survey and monitoring of site conditions, SFC would seek termination of its NRC license. As part of that future termination process, SFC proposes to turn over approximately 131 hectares (324 acres) of the site, including the land area encompassing the disposal cell and a surrounding buffer, to the United States or the State of Oklahoma for long-term control. The State of Oklahoma would have the first option to take responsibility for long-term custodial care of the site. If the state declines this role, the Department of Energy (or other federal agency) would take custody of the site under the provisions of Section 83 of the AEA of 1954, as amended by the UMTRCA. The remaining 112 hectares (276 acres) of the SFC site would be released for unrestricted use.

2.2.1 Site Reclamation in Accordance with the Proposed Reclamation Plan and Groundwater Corrective Action Plan

This section describes how SFC proposes to conduct surface reclamation and groundwater restoration in accordance with its proposed *Reclamation Plan* and groundwater *Corrective Action Plan*. By doing so, SFC would remove potential sources of additional groundwater contamination. Among the areas to be reclaimed are the underground utility trenches in the Process Area and the granular backfill material near the Main Processing Building. These trenches and associated backfill provided preferential drainage routes for shallow subsurface water, and spills of uranium-contaminated liquids tended to seep into these trenches and the backfill (SFC, 2003a).

SFC would sequence activities to avoid stockpiling and double-handling of contaminated materials. Thus, the following discussion is not in the order that SFC might undertake the proposed surface reclamation activities. The licensee's proposed sequence for disposal cell construction and placement of contaminated materials within the cell is described in Section 2.2.1.3. SFC's proposed groundwater restoration activities are discussed in Section 2.2.1.6.

The licensee estimates that the workforce needed to accomplish all the activities required under the proposed *Reclamation Plan* would range from a minimum of 26 to a maximum of 72 employees. Only one employee would be required after these activities were completed.

2.2.1.1 Excavation and Consolidation of Contaminated Sludges, Sediments, and Soils

SFC would undertake excavation and removal of contaminated sludges, sediments, and soils from various locations within the Industrial and Process Areas for placement in the disposal cell. These contaminated materials would include:

- Dewatered sludges and sediments from the ponds and lagoons, with the exception of the storm water impoundment, which would remain intact for future use.
- Buried solid waste materials in Solid Waste Burial Areas No. 1 and No. 2.
- Soils outside of the footprint of the proposed disposal cell and soils and clay liners beneath the ponds and lagoons that contain uranium, radium, or thorium in excess of the proposed site-specific cleanup criteria. Materials with concentrations above the release criteria would be disposed of in the disposal cell. The derived concentration guideline level (DCGL) would be applied to materials under the intended cell footprint, and CLs would be applied elsewhere (see Table 2.2-1). (SFC has already excavated and consolidated some of the contaminated soils on the site. These soils are covered and stored on a concrete pad on the northern portion of the site.)

Table 2.2-1 DCGLs and CLs

Condition	Natural Uranium Bq/g (pCi/g)	Thorium-230 Bq/g (pCi/g)	Radium-226 Bq/g (pCi/g)[a]
DCGL	21 (570)	2.4 (66)	0.18/0.56 (5.0/15)
CL	3.7 (100)	≤0.52/1.6 (14/≤43)	≤0.18/0.56 (5.0/15)

Source: SFC, 2006c.

[a] As stated in 10 CFR 40, Appendix A, Criterion 6(6), the concentration of radium in the first 15-centimeter (5.9-inch) layer below the surface/followed by the concentration in subsequent 15-centimeter layers more than 15 centimeters below the surface.

In addition, as previously discussed, SFC has already dewatered and consolidated the raffinate sludge. This material is packaged, covered, and staged for disposal on the former yellowcake storage pad in the central portion of the Process Area.

The dewatered calcium fluoride sludge, sediments (Emergency Basin, North Ditch, and Sanitary Lagoon), and Pond 2 sediments would be solidified and stabilized to improve their structural properties prior to placement in the disposal cell. The materials would be solidified using fly ash and other additives to increase the compressive strength of these various materials (SFC, 1999). The fly ash would be obtained from a coal-fired power plant in Poteau, Oklahoma, about 82 km (51 miles) southeast of the SFC site (SFC, 2006a).

2.2.1.2 Demolition of Structures, Equipment, and Management of Other On-Site Materials

As described in the site history, existing buildings, including equipment, concrete floors, pads, and underground utilities, have been contaminated by the licensee's uranium conversion operations at the site. SFC has already removed, decontaminated (where necessary), and recycled the majority of salvageable equipment and materials from the site. All remaining structures, equipment, and piping will be dismantled, and the debris will be crushed into manageable pieces and compacted in preparation for placement in the disposal cell. Other materials on-site, including scrap metal, empty drums, packaged wastes, wooden pallets, etc., would also be crushed and compacted. Underground utilities, including contaminated sand backfill from utility trenches and building foundation areas, would be excavated. The only structures that would remain on-site following demolition activities would be the administration building and the OG&E electrical substation. These structures would remain intact for future reuse.

SFC would complete certain pre-demolition activities prior to undertaking the actual demolition of structures and buildings. These activities would include removing any product, reagents, residues, and other fluids from equipment, buildings, or other structures and disconnecting utilities on a building-by-building basis. In addition, as required by the terms of an agreement with the Cherokee Nation and the State of Oklahoma (NRC, 2004), SFC would have the asbestos from the SFC buildings removed and packaged by a contractor that is licensed to conduct such activities in Oklahoma and in accordance with the applicable requirements in 40 CFR Parts 61.145 and 61.150 and Oklahoma law. The State of Oklahoma has agreed to the use of the on-site disposal cell for disposal of the asbestos currently on the SFC site.

SFC would then conduct the actual demolition activities in four stages: (1) demolition of above-ground structures such as piping and tanks, then buildings and enclosed structures; (2) removal of concrete, including structure floor slabs, belowground walls, and footings; (3) removal of underground utilities (may be concurrent with concrete removal); and (4) excavation and removal of contaminated soils beneath structures. SFC proposes using mechanized demolition equipment to minimize manual labor. Specific demolition equipment proposed for use by the licensee is identified in Table 2.2-2.

Table 2.2-2 Proposed Demolition Equipment

Hydraulic Shear	Trucks
Grapple	Scraper
Backhoe Excavator	Soil Ripper
Front-end Loader	Water Truck
Concrete Shear	Grader
Concrete Impactor	

Because of the wide variety of shapes and sizes of equipment and structural materials, SFC would cut or dismantle large pieces so that they could be safely lifted or carried with the equipment available and to minimize void spaces. SFC would use a backhoe or front-end loader to crush or compact compressible materials. Debris with voids that cannot be eliminated through crushing or compacting would be filled with sand or other materials prior to disposal in the disposal cell.

2.2.1.3 Construction of an Engineered Disposal Cell

SFC proposes to construct an engineered disposal cell on-site for disposition of the contaminated waste that would result from the consolidation of sludges, sediments, and soils and the debris and rubble that would result from demolition activities.

Location of the Disposal Cell. Based on the results of a siting evaluation conducted by SFC and appended to the SFC *Reclamation Plan* (SFC, 2006c) as Appendix H, the proposed location for the disposal cell would be in the central portion of the SFC Process Area (see Figure 2.2-1). This is the current location of the Emergency Basin, solid waste building, solvent extraction building, and the western half of the main processing building. SFC evaluated four potential sites for the disposal cell using a qualitative ranking system. The Process Area was selected by the licensee as the preferred site for the disposal cell since it met all of the ranked environmental factors and had the following advantages:

- The Process Area is already contaminated with uranium, radium-226, thorium-230, arsenic, nitrates, and fluoride. Therefore, use of this location for the disposal cell would minimize the amount of property that would be restricted for future reuse.
- The geometry of the area surrounding the Process Area would allow for the disposal cell footprint to be expanded, if required;
- Leachate management with respect to leachate transfer, treatment, and discharge would be less complex at this location;
- The upstream rainfall catchment area would be very small; and
- The proximity and lateral extent of competent sandstone bedrock would limit the potential for long-term erosion to undercut the disposal cell.

Based on the above summary, the NRC staff has determined that the site selection process for the SFC on-site disposal cell was rational and objective and appears reasonable. None of the candidate sites were obviously superior to the SFC preferred site in the Process Area; therefore, no other site was selected for further analysis.

Disposal Cell Design. SFC has designed the proposed disposal cell to meet the NRC performance standards specified in 10 CFR Part 40, Appendix A. The disposal cell would be capable of accommodating approximately 254,850 cubic meters (9 million cubic feet) of waste, but SFC would be able to adjust its capacity, as needed, for the disposal of between approximately 141,600 to 339,800 cubic meters (5 million to 12 million cubic feet) of waste.

The NRC staff is reviewing the proposed design against the performance standards contained in 10 CFR Part 40, Appendix A, with respect to the geologic, seismic, geotechnical, and surface erosional aspects of long-term stability, groundwater standards, and radiation protection. Once

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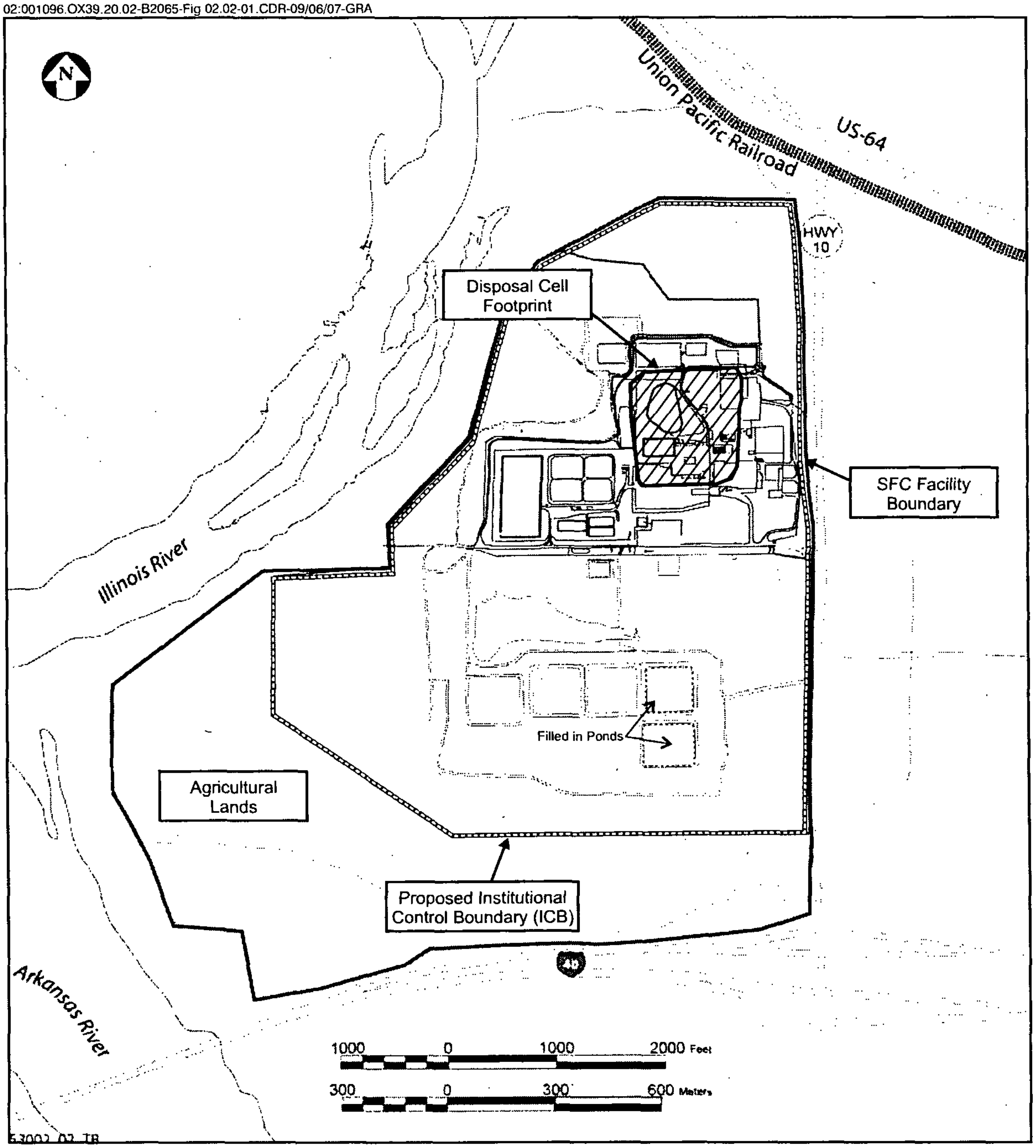

Figure 2.2-1 SFC Proposed Disposal Area Footprint

the review is complete, NRC staff will present a conclusion in the final SER on the suitability and adequacy of the proposed *Reclamation Plan* (NRC, 2005a).

Cell Base Liner System. SFC has proposed a multi-layered cell base and liner system to underlie the contaminated materials that would be placed in the cell. The components of this system are shown on Figures 2.2-2 and 2.2-3 and are listed below (from bottom to top):

- **Subsurface Fill.** SFC proposes to construct the cell base from a combination of weathered sedimentary rock surfaces, undisturbed surfaces of native soil, and the concrete pads that already exist within the area of the proposed cell footprint. SFC would establish the required base grade by backfilling any areas within the disposal footprint that would be excavated prior to disposal cell construction for the purposes of remediating soil and terrace-shale 1 groundwater system. To facilitate leachate collection and liner leak detection, SFC proposes to slope the base of the disposal cell to drain to the west.

- **Compacted Clay Layer.** SFC would place a 0.9-meter (3-foot) -thick compacted clay layer on the subsurface fill or foundation surface to form the lower liner system. The licensee would obtain this clay from a borrow area at the extreme southern end of the SFC site (see Figure 2.2-4). In the draft SER, the NRC staff concluded that this source of clayey soils is suitable for use in disposal cell construction and sufficient quantities are present to complete the proposed disposal cell design (NRC, 2005a).

- **Sand Bedding Layer Containing a Leak Detection System.** On top of the clay liner, SFC would place a 15-centimeter (6-inch) -thick gravelly sand bedding layer. This would form a free-draining bedding layer for the synthetic (upper) liner and provide a leak detection zone above the clay layer (should leakage through the upper liner occur). SFC's proposed leak detection system would consist of a series of 10-centimeter (4-inch) -diameter slotted pipes installed in the bedding layer. SFC would test, remove, and dispose of any leachate collected in the sumps connected to this system. This bedding material would be obtained by SFC from an off-site commercial source (SFC, 2003b).

- **Synthetic Liner.** A synthetic liner consisting of 60-mil high-density polyethylene (HDPE) or similar material of appropriate low permeability, puncture resistance, and resistance to oxidation would be placed by SFC on top of the bedding layer surface. The licensee's purpose in using a synthetic liner is to provide a hydraulic barrier between the waste and the clay liner to prevent dissolved hazardous constituents from accumulating in the clay liner.

- **Sand Cover Layer with Leachate Collection System.** On top of the synthetic liner, SFC would place a 46-centimeter (18-inch) -thick sand cover layer that would protect the synthetic liner from puncture during waste placement and act as a drainage layer for the leachate collection system. The leachate collection system would consist of a series of 15-centimeter (6-inch) -diameter slotted pipes installed in the cover layer. This material would be obtained from the TM Gravel and Souter Quarry in Gore, which is approximately 11 km (7 miles) away.

- **Waste Materials.** The waste materials would be placed on top of the sand cover layer. Section 2.2.1.4 describes the placement of waste materials within the cell.

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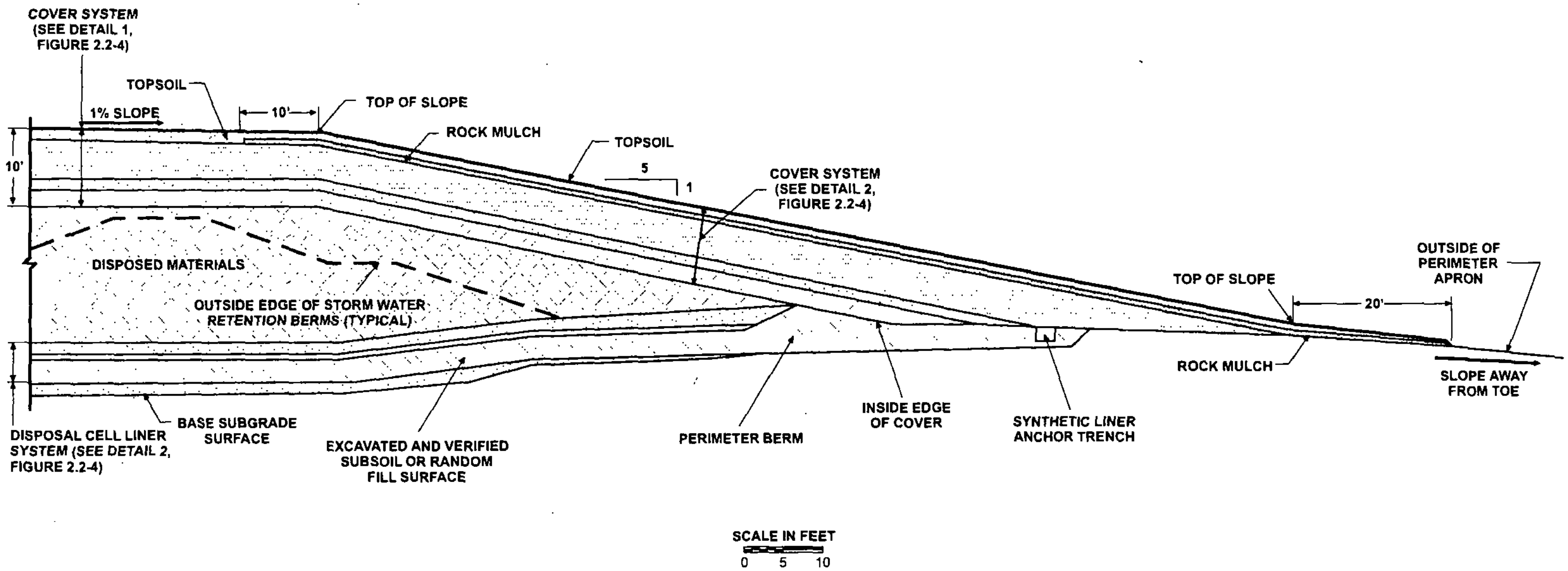

TYPICAL CROSS SECTION ON EAST SIDE OF DISPOSAL CELL

Figure 2.2-2 Disposal Cell Cross Section

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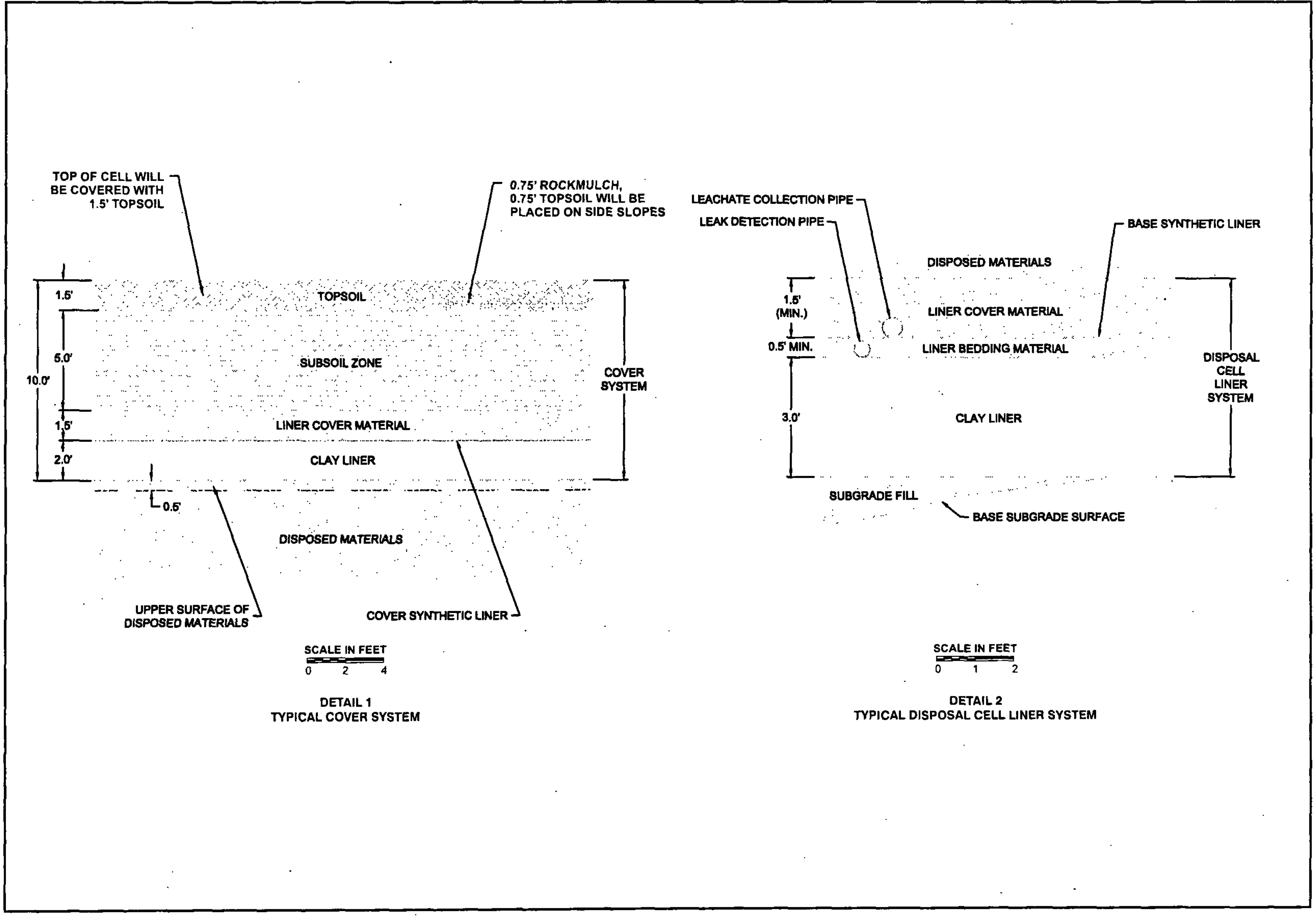

Figure 2.2-3 Disposed Cell Cover and Liner Details

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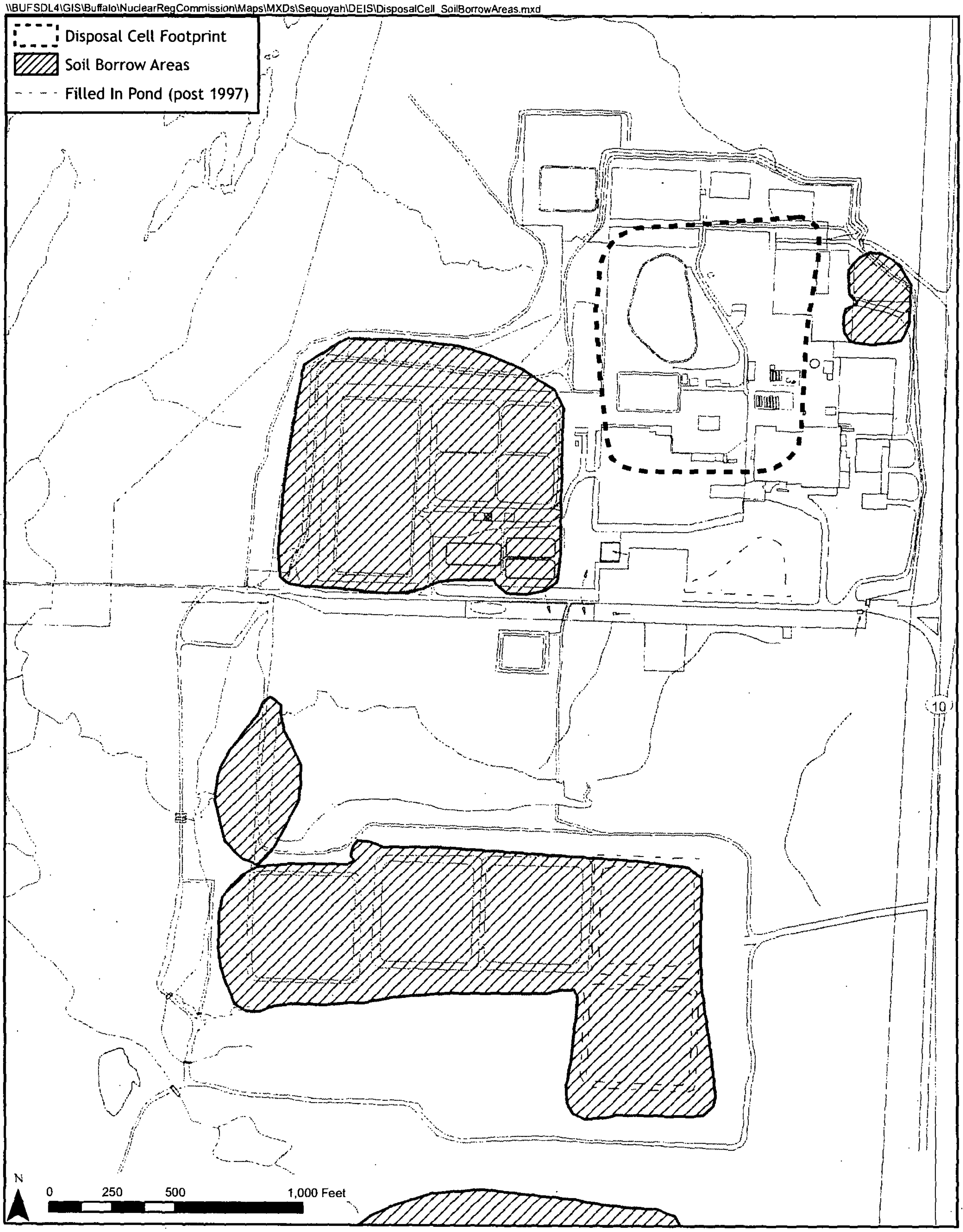

Figure 2.2-4 Sequoyah Fuels Corporation Disposal Area Footprint and Soil Borrow Areas

- **Cover System.** SFC proposes a disposal cell cover system over the waste designed to promote long-term vegetative growth. The licensee's proposed design is for a multi-layered cover system with a thickness of 3 meters (10 feet) (see Figure 2.2-3). The cover system would consist of the following layers, beginning at the top of the waste (bottom layer of the disposal cell cover) to the surface (top and sides) of the disposal cell.

- **Compacted Clay Layer.** The licensee's proposal is to place 61 centimeters (2 feet) of compacted clay directly on top of the waste. SFC's source for this clay layer would be the same as described for the clay liner in the cell base liner system.

- **Liner Cover Material.** The licensee proposes to place 46 centimeters (18 inches) of liner cover materials between the compacted clay layer and the synthetic liner (see below). This material would be obtained by SFC from the borrow area at the southern end of the SFC site.

- **Synthetic Liner.** SFC would place a synthetic liner on the surface of the compacted clay layer. The liner would be made of 60-mil HDPE or similar material of appropriate low permeability, puncture resistance, and resistance to oxidation.

- **Subsoil Layer.** SFC proposes placing a 1.5-meter (5-foot) -thick layer of soil on top of the synthetic liner. The licensee contends that any infiltrating water would be contained within this subsoil layer and above the synthetic liner and drain to the sides of the cell. The material for this layer would be obtained by the licensee from the tornado berm and settling pond berm materials on the SFC site (SFC, 2003b).

- **Rock Mulch.** A 23-centimeter (9-inch) -thick rock mulch layer would be placed on the sides of the disposal cell but not on the top of the disposal cell. This material would be obtained from the TM Gravel and Souter Quarry. The purpose of the rock mulch would be to form an erosion protection zone on the side slopes and perimeter apron of the disposal cell.

- **Topsoil.** SFC proposes to use a layer of topsoil as the final layer of the disposal cell cover system. This layer of topsoil would enhance erosion protection and allow for vegetative growth, which would minimize rainfall infiltration into the disposal cell. The licensee would place 61 centimeters (18 inches) of topsoil on the top of the disposal cell and 23 centimeters (9 inches) on the sides. This material would be obtained by the licensee from the agricultural land on the western side of the SFC site.

- **Vegetation.** The licensee would plant the cover surface with native grasses, wildflowers, and brush (proposed species are identified in Table 2.2-3). SFC proposes that the grass be mowed approximately 6 times per year to prevent the growth of trees on the cover of the disposal cell.

SFC proposes that the top of the disposal cell will have a final elevation of 9 to 15 meters (30 to 50 feet) above the surrounding ground elevation, depending on the volume of waste placed within the disposal cell (SFC, 2006c). The maximum elevation would be approximately 180 meters (590 feet) above mean sea level. The licensee proposes that the finished side slopes of the disposal cell would have a slope of 5:1 (horizontal face to vertical face) or less, and the corners of the disposal cell would be rounded to create a four-sided dome or rolling hillside to blend in with the surrounding topography. Outside the bottom of the side slopes, SFC proposes to construct a 6-meter (20-foot) -wide perimeter apron to provide protection against the potential migration of gullies toward the disposal cell. The apron would consist of the same topsoil and rock mulch layers that would be placed on the side slopes of the disposal cell (SFC, 2006c). The structure's top surface would drain to the southeast at a 1% slope.

Table 2.2-3 Proposed Seed Mix

Species		Pounds of Pure Live Seed per Acre
Common Name	**Latin Name**	
Big bluestem	*Andropogon gerardii*	6
Little bluestem	*Schizachyrium scoparium*	3
Switchgrass	*Panicum virgatum*	2
Indiangrass	*Sorghastrum nutans*	2
Hairy wildrye	*Elymus villosus*	2
High plains goldenrod	*Solidago altiplanities*	1.5
Prairie sunflower	*Helianthus petiolaris*	1.5
Compassplant	*Silphium laciniatum*	0.5
Blazing star	*Liatris Gaertn. Ex Schreb.*	0.5
Littleleaf sumac	*Rhus microphylla*	2

In addition to placing a rock apron at the side slopes of the disposal cell, SFC would install rock armor in the 005 drainage outlet to the west of the proposed disposal cell (see Figure 3.3-1). The rock would be obtained from the TM Gravel and Souter Quarry.

Disposal Cell Construction Sequence. The licensee would construct the disposal cell in three phases (see Figure 2.2-5), which would allow SFC to prepare one area of the disposal cell base for receipt of materials excavated from another area of the cell. After all three base areas of the cell have been constructed, SFC would be able to place materials from outside the disposal cell footprint throughout the cell. By sequencing site reclamation activities, the licensee would avoid stockpiling and double-handling of contaminated materials.

During Phase I, SFC would empty and clean the clarifier ponds (for storm water storage) and initiate building demolition in the Phase I cell area. The licensee would then initiate cell construction on top of the concrete pad or asphalt pads, with the liner system and 0.9-meter (3-foot)-high perimeter berm on the outside edges of the cell (SFC, 2006c). In addition, SFC would construct a 0.9-meter (3-foot)-high internal berm on the inside edges of the cell to tie into the adjoining cell base. The purpose of the perimeter and internal berms is to aid in leachate collection during each cell phase.

Water management during disposal cell construction will be based on containing within the cell water that is affected by disposed materials, and discharging storm water that is unaffected by disposed materials. SFC will construct interior berms or embankments primarily with compacted contaminated site soils, other soils to be disposed in the cell, and minor amounts of concrete. The berms will be constructed within the cell (on top of the cell base and liner) and will be covered by the cell cover. The inside slopes of the berms will be covered with synthetic material during the filling activities, which will minimize contact with the storm water that is collected and aid in retention until the water is processed. Clean soil will be used on the outside

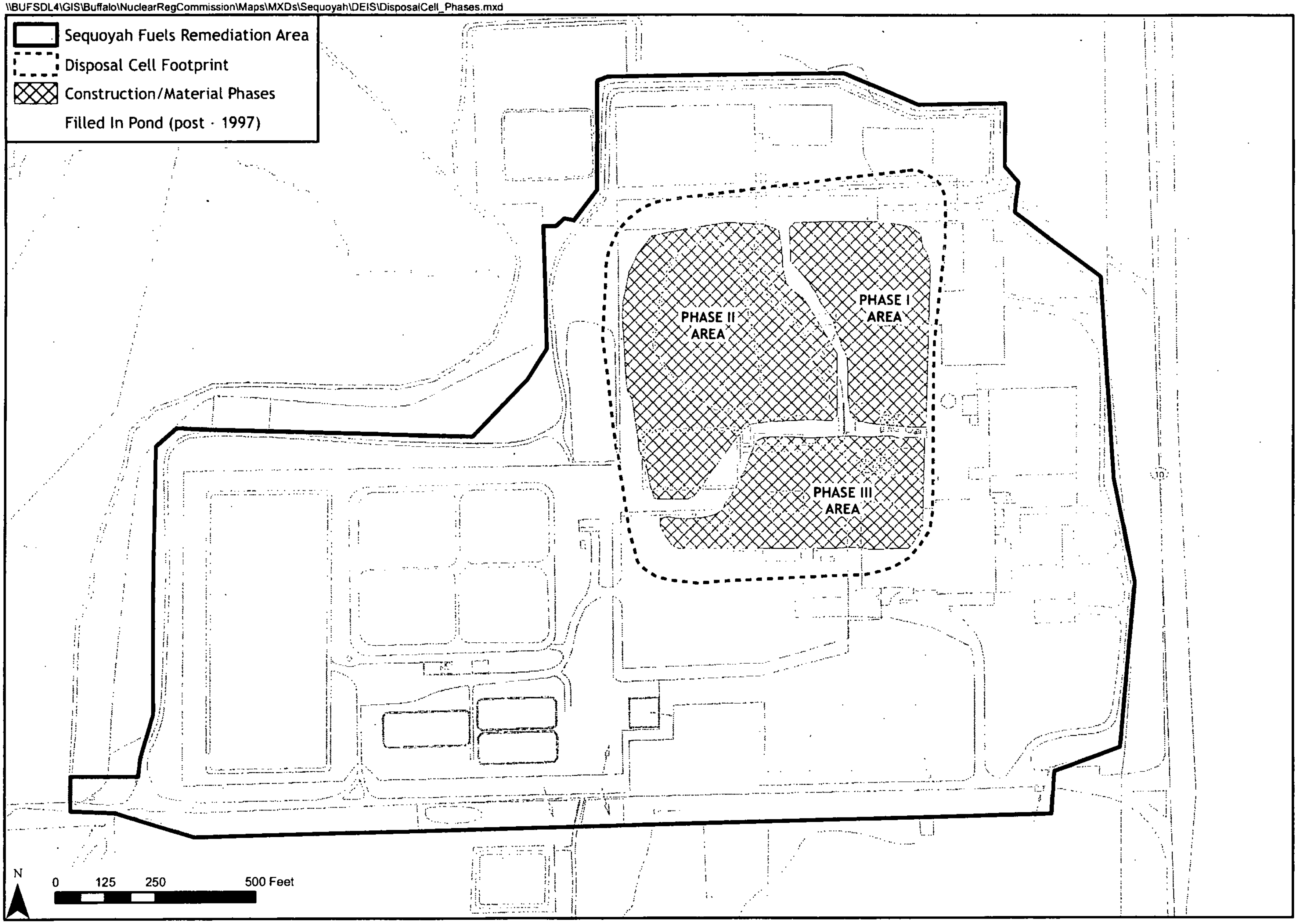

Figure 2.2-5 Disposal Cell Construction/Material Placement Phases

slopes of the berm in areas that require clean storm water discharge. The licensee would maintain the elevation of the retention berms at a minimum of 1.5 meters (5 feet) above the top surface elevation of the interior materials (SFC, 2006c).

Once the cell base for Phase I is constructed, SFC would place contaminated soils from the Phase II area (Emergency Basin, North Ditch, and Sanitary Lagoon) in the completed disposal cell. The dewatered sludges (with the exception of the already packaged raffinate sludge) and pond residues could be pumped to the disposal cell for placement by the licensee as backfill around large construction debris and equipment. SFC would then raise the storm water retention berm as soils are available and as needed. Contaminated materials from the Phase III disposal cell area would be placed by the licensee in the completed Phase II cell area, and contaminated materials from outside the footprint of the disposal cell would then be placed in various locations of the cell.

During disposal cell construction, SFC would apply the same controls to the construction site as identified in Section 2.2.1.2 (Demolition of Structures, Equipment, and Management of Other On-site Materials) to protect human health and safety, control dust, managed residues, control contamination, and protect surface and groundwater resources. In addition, to reduce the generation of fugitive dust, SFC would transport clay, soils, rock mulch, and rock armor from source areas to stockpiles (as needed) or to the disposal cell along existing roads as much as possible. The licensee would use haul trucks for long distances and loaders for short distances.

Following completion of the disposal cell, SFC would ensure that materials to be disposed in the disposal cell have been so disposed and that all contaminated soils outside the disposal cell footprint have been excavated and placed in the disposal cell. SFC would restore the site by backfilling where necessary, grading, and reestablishment of vegetation by seeding.

2.2.1.4 Placement of Materials Inside the Disposal Cell

SFC would place waste materials into the disposal cell in layers to minimize leaching and optimize shielding. The layers would be identified alphabetically from A to D, proceeding from the cell bottom layer upward:

- **Layer A materials.** In the lowest layer in the disposal cell, SFC proposes placing those waste materials that contain higher activity radionuclides. Therefore, the Layer A materials would consist of the Pond 2 residual materials, dewatered raffinate sludge, and sediments from the Emergency Basin, North Ditch, and Sanitary Lagoon. The already packaged raffinate sludge would remain in the super sacks.

- **Layer B materials.** SFC proposes placing subsoil materials, including soil, clay, and synthetic liner materials excavated from beneath the clarifier, the calcium fluoride basins, Pond 3E, the Emergency Basin, the North Ditch, and the Sanitary Lagoon, as well as the Pond 1 spoils pile, in Layer B.

- **Layer C materials.** In Layer C, the licensee would place structural debris such as concrete and asphalt, calcium fluoride basin materials and sediments, and on-site buried materials from Solid Waste Burial Areas Nos. 1 and 2. SFC could also place these Layer C materials with Level B materials.

- **Layer D materials.** In Layer D, SFC proposes to place on-site contaminated soils and sedimentary rock excavated from areas of the site other than the retention ponds, basins, and lagoon described for Level B materials.

The estimated volumes of materials assigned by SFC to each disposal cell layer are provided in Table 2.2-4.

Table 2.2-4 Disposal Material Summary

Layer	Estimated Volume		Fraction of Total Volume (%)	Natural Uranium (Bq/g)	Radium-226 (Bq/g)	Thorium-230 (Bq/g)
	cubic meters	cubic feet				
A	31,362	1,107,543	22	13.2-448	0.22-12.3	7.81-604
B	33,256	1,174,441	23	0.19-3.52	0.02-0.08	1.74-2.59
C	58,045	2,049,840	40	6.22-19.3	0.01-0.03	0.08-0.18
D	22,984	811,685	16	-	9.26	–
Total	145,647	5,143,509	100	–	–	–

To convert becquerels to picocuries, multiply by 27.

The licensee would spread out incompressible structural materials or lay them out in lifts, the longest dimension laid out horizontally. For large incompressible materials exceeding 0.61 m (2 feet) in vertical dimension (e.g., thick-walled tanks or vessels), SFC would fill interior void spaces with sand or grout. SFC would place soil and soil-like materials around and within the demolition materials to reduce pore spaces.

2.2.1.5 Management and Treatment of Produced Groundwater and Storm Water During Construction Activities

As reclamation activities are conducted at the site, SFC would collect stormwater and recovered groundwater and leachate and treat it using its existing wastewater treatment system, located south of the clarifier basins. The SFC wastewater treatment system is designed for batch treatment of wastewater and uses precipitation, filtration, and ion exchange processes to remove uranium prior to release of the water. SFC would sample and analyze treated water for uranium prior to discharge through SFC's permitted Outfall 001. If the treated water is found to meet SFC discharge permit limits (i.e., uranium concentration of less than the Safe Drinking Water Act maximum concentration limit of 30 micrograms per liter (μg/L)), it would be released to the Lower Illinois River through permitted Outfall 001. If the water still contains relatively high concentrations of nitrates after treatment, the water would be applied to the land application areas at the south end of the SFC site for beneficial reuse. As necessary, the sand filter and polishing filter used in the water treatment would be backwashed by the licensee to the precipitate settling tank. SFC would periodically flush uranium-bearing sludge from the precipitate settling tank for dewatering using a small vacuum drum filter. The filtrate would be shipped off-site via truck for uranium recovery or disposal. Options for use as alternative feed or disposal would be the same as identified in Sections 2.3.2 and 2.3.3.

2.2.1.6 Implementation of Groundwater Corrective Action Plan Activities

SFC's proposal to restore the groundwater would use the "hydraulic containment and pump back" method (SFC, 2003a). This method involves the interception of site-impacted groundwater before it reaches the surface or enters surface waters and the containment and treatment of recovered groundwater. Under this approach, SFC is currently recovering groundwater contaminated by past operations using three drainage collection trenches: one is located at the head of the 005 drainage, another is located between Pond 2 and monitoring well MW095A, and the third is in the swale area just north of the former Decorative Pond (see Figure 3.3-1). Groundwater recovered at these trenches is pumped to the clarifier basins, where it is stored prior to treatment in the Water Treatment Plant to reduce arsenic, nitrate, and uranium concentrations to levels suitable for land application. After treatment, the treated water would be pumped to Pond 5, further diluted, and stored for eventual beneficial reuse as part of SFC's land application program at the southern end of the site (SFC, 2003a).

In addition to these three trenches, SFC is proposing to install two groundwater extraction wells in the northwest section of the facility in response to a plume of uranium-contaminated groundwater in that area. One of the wells would be installed in the northwest corner of Fluoride Holding Basin No. 2, and the other well would be installed just to the east, in the southwest corner of Solid Waste Burial Area No. 2. Groundwater recovered using these wells would be handled in the same fashion as that recovered from the three drainage collection trenches.

All water recovered in the corrective action areas would be treated by SFC to meet the land application standards included in SFC's existing materials license. The NRC staff approved a *Groundwater Monitoring Plan* for the SFC site on August 22, 2005 (NRC, 2005b). A summary of this monitoring plan is provided in Chapter 6, Environmental Measurement and Monitoring Programs.

SFC's approved *Groundwater Monitoring Plan* addresses identification of (1) hazardous constituents in the groundwater that result from licensed site operations; (2) groundwater protection standards for the hazardous constituents; and (3) monitoring locations, frequency, and parameters. For the purposes of groundwater monitoring, SFC identified antimony, arsenic, barium, beryllium, cadmium, chromium, fluorides, lead, mercury, molybdenum, nickel, nitrates, radium-226, selenium, silver, thallium, thorium-230, and uranium as constituents of concern (COCs) or hazardous constituents (SFC, 2005). However, the main constituents with sizable groundwater contaminant plumes are arsenic, nitrates, fluoride, and uranium. For each of these COCs, a groundwater protection standard was set in accordance with concentration limits found in 10 CFR Part 40, Appendix A, or in the U.S. EPA's National Primary Drinking Water Regulations. The standards in 10 CFR Part 40 and in the U.S. EPA's regulations have been determined to be protective of public health and safety.

Under the approved *Groundwater Monitoring Plan*, SFC will collect and analyze samples from the groundwater, drainages and seeps, and surface water. On an annual basis, SFC will collect and analyze samples from 64 groundwater monitoring wells (see Figure 2.2-6) located around the site. The samples will be collected from different levels (i.e., different shale units) beneath the site. SFC may abandon and plug up to 24 of these wells as surface reclamation proceeds. On a quarterly basis, SFC will collect samples from the three drainage collection trenches and

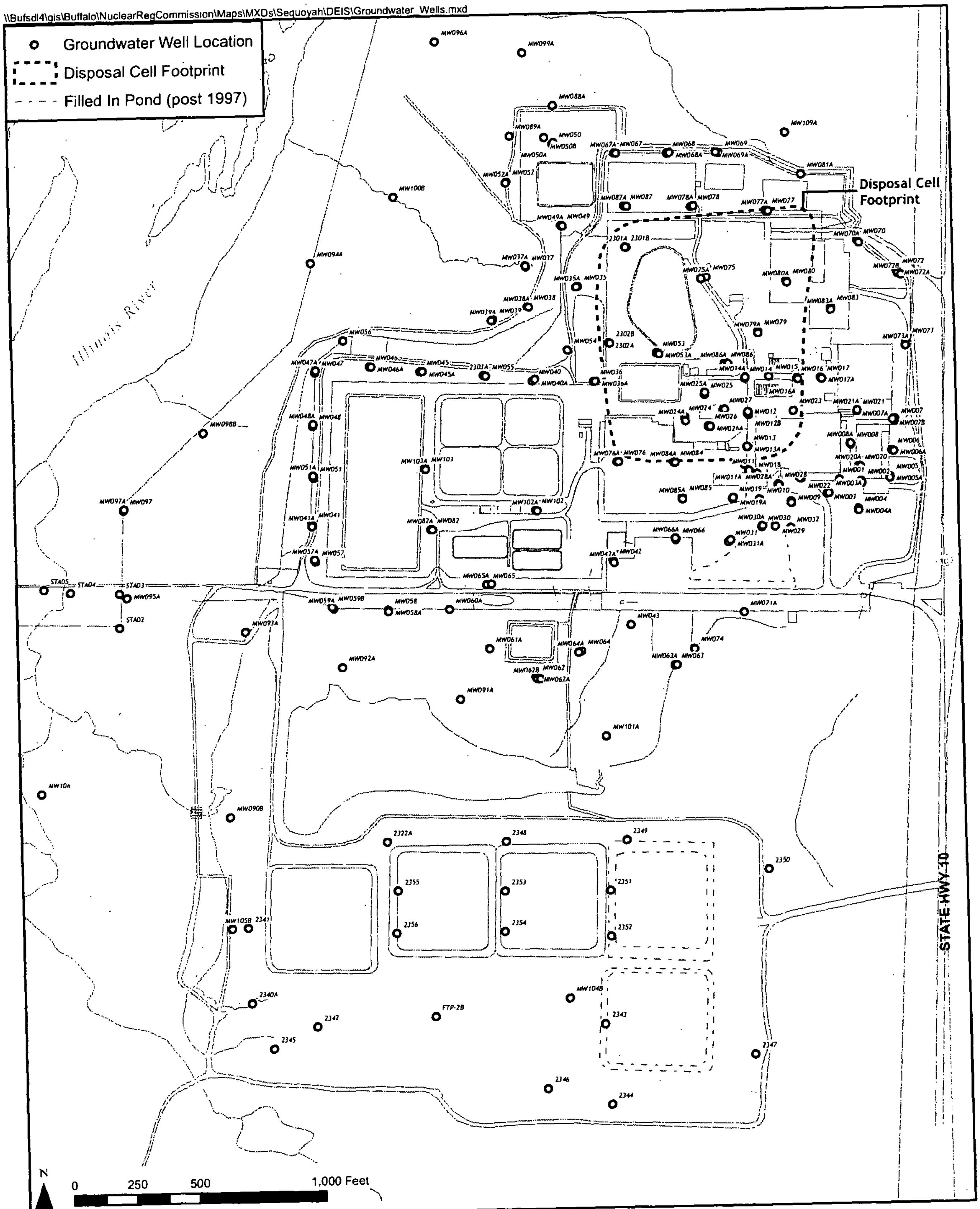

Figure 2.2-6 Sequoyah Fuels Corporation Groundwater Monitoring Well Locations

associated monitoring wells and from six drainage and seep locations on the site. SFC will also collect surface waters samples on an annual basis from two locations on the Illinois River and two locations on the Arkansas River. SFC is required under its NRC license to submit, by April 1 of each year, the results of its monitoring analyses in a groundwater compliance monitoring summary report (NRC, 2005b).

2.2.1.7 Release of the SFC Site

After completion of surface reclamation activities and construction of the on-site disposal cell, SFC would perform final status surveys in accordance with the guidance provided in NUREG 1575, *Multi-Agency Radiation Survey and Site Investigation Manual* (NRC, 2002) and the requirements of 10 CFR 40, Appendix A, Criterion 6. The survey methodology would be designed to demonstrate that residual radioactivity levels meet the established cleanup criteria identified in Table 2.2-1. The NRC staff would perform a follow-on verification radiation survey to confirm SFC's findings. If the radiation surveys confirm that residual radioactivity levels meet the cleanup criteria and groundwater corrective actions are completed, SFC would seek termination of its NRC license. As part of that future termination process, SFC proposes to turn over approximately 131 hectares (324 acres) of the site, including the land area encompassing the disposal cell and a surrounding buffer (the ICB; see Figure 2.2-1), to the United States or the State of Oklahoma for long-term control. The State of Oklahoma would have the first option to take responsibility for long-term custodial care of the site. If the state declines this role, the Department of Energy (or other federal agency) would take custody of the site under the provisions of Section 83 of the AEA of 1954, as amended by the UMTRCA.

The 131-hectares (324-acres) of SFC's proposed ICB would be enclosed by fencing. The entity assuming responsibility for long-term custodial care of this area would restrict access to authorized individuals for monitoring or maintenance activities. The remaining 112 hectares (276 acres) of the SFC site would be released for unrestricted use. Future users of this portion of the site would be allowed access to groundwater for domestic or other uses.

2.3 Alternatives to the Proposed Action

This section examines alternatives to the proposed action described in Section 2.2. The range of alternatives was determined by considering the underlying need and purpose for the proposed action. From this analysis, a set of reasonable alternatives was developed and the impacts of the proposed action were compared with the impacts that would result if a given alternative were implemented. These alternatives include:

- A no-action alternative under which reclamation of the SFC site would not be conducted.
- Off-site disposal of all contaminated materials and groundwater restoration; and
- Partial off-site disposal of particular contaminated materials, construction of an on-site disposal cell, as in the proposed action, for the remaining materials, and groundwater restoration.

2.3.1 No-Action Alternative

The CEQ's regulations implementing NEPA require an analysis of the no-action alternative (see 40 CFR 1502.14(d)). Under the no-action alternative, SFC would not implement its proposed *Reclamation Plan.* The SFC site, including all on-site buildings and waste materials, would remain in their current condition and configuration. SFC would take corrective measures only in the event of degradation of containment structures, release of contaminated materials, or intrusion. This means that there would be no decontamination (other than for routine maintenance), dismantlement, or removal of equipment or structures. Over the long-term, SFC would be required to maintain the entire 243-hectare (600-acre) site indefinitely under restricted conditions and perform site surveillance and maintenance to ensure the facility is maintained in a safe condition and that contaminated materials are controlled (SFC 2006a).

Under the no-action alternative, SFC would not remove potential sources of additional groundwater contamination. However, SFC would continue its current programs to clean up the existing groundwater contamination and perform associated monitoring through its NRC-approved *Groundwater Monitoring Plan.*

Maintaining the SFC site in its current condition and configuration would provide negligible, if any, environmental benefit and would reduce options for future use of the property. Furthermore, the no-action alternative is not acceptable because it would not allow for the surface reclamation and ultimate decommissioning of the SFC site in accordance with the requirements of 10 CFR 40, Appendix A (Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes).

2.3.2 Off-Site Disposal of All Contaminated Materials (Alternative 2)

Under this alternative, SFC would excavate, compact, and stage all contaminated soils, sludges, residues, equipment, structures, and any other material contaminated above the cleanup levels identified in Table 2.2-1 for removal from the SFC site. Asbestos would be removed from the structures prior to demolition and packaged by a licensed contractor for disposal at a licensed disposal facility. As contaminated material is excavated, SFC would characterize it for radioactive content. Groundwater encountered by SFC during excavation or extracted from existing wells would be collected, processed, and disposed using the existing on-site wastewater treatment system (described in Section 2.2.1.5) (SFC, 2006a). After all contaminated materials were packaged and staged, SFC would arrange for their transport to a licensed off-site disposal facility (SFC, 2006a) instead of constructing and placing the materials in an on-site disposal cell. The licensee has estimated that the work force needed to accomplish all the activities required under the proposed *Reclamation Plan* would range from a minimum of 25 to a maximum of 73 employees. Only one employee would be required after these activities were completed.

Because the volume of material to be transported to an off-site disposal facility could be as much as 254,850 cubic meters (9 million cubic feet), SFC has determined that transportation by rail would be more economical than by truck (SFC, 2006a). Therefore, under this alternative, SFC proposes to construct an on-site intermodal facility for loading all contaminated materials (e.g., soils, sludges, sediments, and construction debris) into hard top railroad gondola cars. SFC would also construct a rail spur (2.6 km [1.6 miles]) to junction with the Union Pacific Railroad line. SFC's proposed route for the rail spur is shown on Figure 2.3-1. Alternatively, the intermodal facility could be located next to the Union Pacific Railroad line to the north of the SFC site, which would require SFC to load the material on trucks with construction equipment and haul it to the intermodal facility for loading onto the rail cars. The potential environmental impacts of locating the intermodal facility either on- or off-site would not be significantly different; this alternative considers only an on-site intermodal facility.

Before rail cars loaded with contaminated material left the SFC site to move along the rail spur, SFC would decontaminate the outside of the cars and place a hard top cover on each car. The disposal facility would be responsible for decontaminating the gondola cars before their return to SFC for reuse.

Potential off-site disposal locations that could be considered by SFC for the disposal of waste materials from the site, provided the SFC waste materials meet waste acceptance criteria, include the following:

- **Energy*Solutions*, Clive, Utah (2,424 km [1,505 miles]) by rail from the SFC Site)** Energy*Solutions* provides waste management, treatment, and disposal services for low-level and naturally occurring radioactive wastes, byproduct material from uranium mills (AEA Section 11e.(2) wastes), and mixed radioactive and RCRA hazardous waste. Energy*Solutions* is licensed and permitted to receive Class A LLRW, asbestos-contaminated waste, mixed waste (i.e., both radioactive and hazardous), and 11e.(2) byproduct material. Furthermore, Energy*Solutions* receives radioactive waste in all forms, including, but not limited to, soil, sludges, resins, large reactor components, dry active waste, and other radioactively contaminated debris. The facility is accessible by rail and truck and is capable of receiving both bulk (e.g., intermodals, gondolas) and non-bulk (e.g., drums, boxes) containers.

- **Waste Control Specialists (WCS), Andrews, Texas (1,221 km (759 miles) by rail from the SFC Site)** This facility, which is accessible by truck or rail, is located in southwest Texas near the New Mexico border. Currently, the WCS Andrews facility is not permitted to accept and dispose of the type of waste materials present at the SFC site. Potentially, WCS will be able to accept the SFC materials for disposal in the proposed WCS 11e.(2) tailings impoundment. This, however, is contingent upon the following: (1) WCS must first receive license approval (issuance expected in the next year or two), (2) SFC would need to get Texas Compact (Texas and Vermont) approval to dispose of the materials with a LLRW component in the proposed tailings impoundment (per Regulatory Information Summary (RIS) 200-23), and (3) DOE would need to make a commitment to take over custody of the impoundment with some LLRW in it. Therefore, in the short-term, SFC would be unable to dispose of waste materials at this facility.

Under this alternative, SFC would not construct an on-site disposal cell. After removal of the structures, equipment, concrete pads and floors, contaminated sludges and sediments from the ponds and lagoons, buried wastes, and contaminated soils from the site, all excavations would be backfilled, graded, covered with topsoil, and seeded with grass or native vegetation. The sources of clean topsoil would be from the same on-site borrow areas identified under Alternative 1. In addition, clean up of the existing groundwater contamination would be accomplished by SFC

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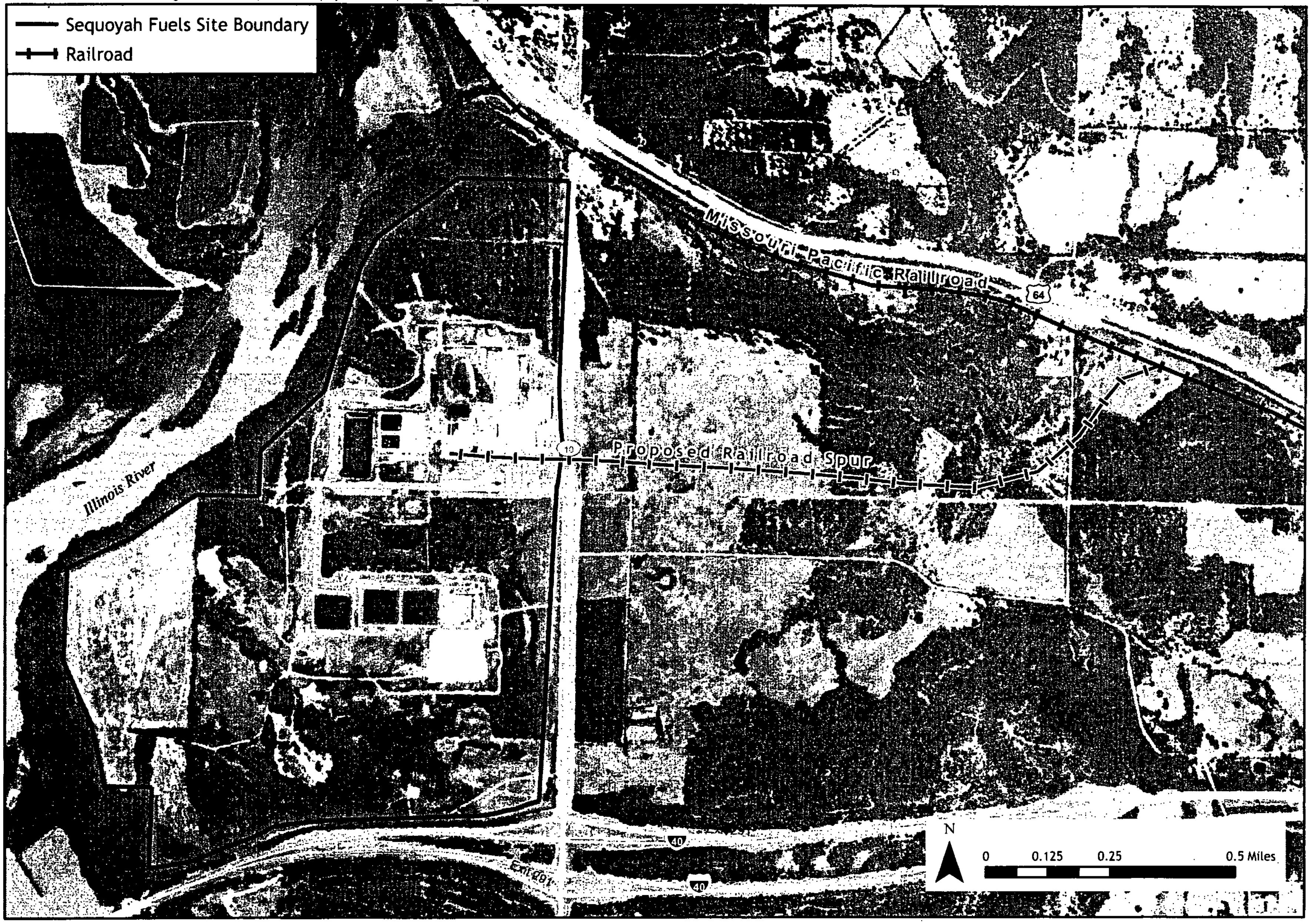

Figure 2.3-1 Proposed Rail Spur for Alternative 2

through the NRC-approved groundwater *Corrective Action Plan* and *Groundwater Monitoring Plan* as discussed for Alternative 1.

SFC would conduct final status surveys to demonstrate that the cleanup criteria identified in Table 2.2-1 had been met. The NRC staff would perform a follow-on verification radiation survey to confirm SFC's findings. If the radiation surveys confirm that residual radioactivity levels meet the cleanup criteria, SFC would seek termination of its NRC license. As part of that future termination process, SFC would release the entire 243-hectare (600-acre) site for unrestricted use. The rail spur would be left in place for potential future use with redevelopment of the SFC site. Future users of the site would be allowed to access groundwater for domestic or other uses.

2.3.3 Partial Off-Site Disposal of Contaminated Materials (Alternative 3)

Under this alternative, SFC would construct an on-site disposal cell in the same location based on the same design described for Alternative 1 (the licensee's proposed action). This alternative is based on the provisions of the agreement reached between SFC and the Cherokee Nation in 2004 (NRC 2004), which requires SFC to explore options for disposing the raffinate sludge and the sediments from the North Ditch, Emergency Basin, and Sanitary Lagoon at an appropriate off-site location, with the understanding that SFC would spend up to $3.5 million for this action.

Under Alternative 3, SFC would excavate and consolidate soils, sludges, and other contaminated material on-site and demolish/dismantle all structures and equipment on-site. Asbestos would be removed from the structures prior to demolition and packaged by a licensed contractor for disposal in the on-site disposal cell. As with Alternative 1, the licensee would not demolish the administration building, the OG&E electrical substation, or the storm water impoundment. SFC would place all of the consolidated waste materials (with the exception of the dewatered raffinate sludge and sludges and sediments from the Emergency Basin, the North Ditch, and the Sanitary Lagoon) with the residual sediments from Pond 2 and the materials previously identified for Layer B as the first layer placed in the on-site disposal cell. The height of the south side of the cell would be adjusted by SFC to conform to the reduced capacity of the disposal cell.

The dewatered raffinate sludge is already packaged in 0.76-cubic-meter (1-cubic-yard) super sacks. The consolidated materials from the Emergency Basin, North Ditch, and Sanitary Lagoon also would be packaged in super sacks. Using forklifts and loaders, SFC would load the packaged waste material, including the previously packaged raffinate sludge, into stake-sided flatbed trucks with 1.8-meter (6-foot) -high sideboards and an open top. The waste material would be covered by a tarp. Each truckload would weigh approximately 36 metric tons (40 tons). These wastes would then be transported by SFC to a licensed off-site disposal facility.

The licensee estimates that the work force needed to accomplish all the activities required would be a maximum of 96 employees, including the on-site workers (78) and off-site truck drivers. Approximately one employee would be required after these activities were completed.

Following the off-site shipment of waste materials, SFC would complete surface reclamation activities and cleanup of the existing groundwater contamination through the NRC-approved groundwater *Corrective Action Plan* and *Groundwater Monitoring Plan* as discussed for

Alternative 1. A final radiation survey would be conducted by the NRC staff to verify complete decontamination of the SFC site. Following the final site survey and monitoring of site conditions, SFC would seek termination of its NRC license. As part of that future termination process, SFC would be able to turn over approximately 131 hectares (324 acres) of the site, including the land area encompassing the disposal cell and a surrounding buffer area (see Figure 2.2-1), to the United States or the State of Oklahoma for long-term control. The State of Oklahoma would have the first option to take responsibility for long-term custodial care of the site. If the state declines this role, the Department of Energy (or other federal agency) would take custody of the site under the provisions of Section 83 of the AEA of 1954, as amended by the UMTRCA.

The 131-hectares (324-acres) of SFC's proposed ICB would be enclosed by fencing. The entity assuming responsibility for long-term custodial care of this area would restrict access to authorized individuals for monitoring or maintenance activities. The remaining 112 hectares (276 acres) of the SFC site would be released for unrestricted use.

Potential off-site options for disposition of the dewatered raffinate sludge and residual materials and sludges and sediments from the Emergency Basin, North Ditch, and Sanitary Lagoon that could be considered by SFC are:

- Use of the raffinate sludge as an alternate feed stock,
- Disposal of the waste materials at an existing uranium mill tailings impoundment, or
- Disposal of the waste materials at a licensed disposal facility.

2.3.3.1 Use of the Raffinate Sludge as Alternate Feed Stock

The dewatered raffinate sludge is estimated to contain 60,800 kilogram (kg) (133,760 lbs) of natural uranium (SFC, 2006c), of which approximately 22,727 kg (50,000 lbs) could be recovered through processing, alone or together with other metals, at a licensed uranium mill. Following processing, the residual materials (tailings) would be permanently disposed of as 11e.(2) byproduct material in the mill's tailings impoundment. SFC has considered the possibility of transporting the raffinate sludge to two potential candidate uranium mills for use as alternate feed stock: Cotter Corporation's uranium mill near Canon City, Colorado, and International Uranium Corporation's (IUC's) White Mesa uranium mill near Blanding, Utah.

The Cotter uranium mill is licensed by the State of Colorado. While the facility's current license (Colorado License No. 369-01, Amendment 42) allows it to accept, receive, possess, and handle ores and other Department of Health-approved classified materials for the commercial processing and recovery of uranium, there are strict limits on the source and quantity of materials that may be processed. SFC is not currently an approved source. For the Cotter uranium mill to obtain approval from the Colorado Department of Health to process the SFC waste, Cotter Corporation would have to obtain an amendment to its license. In January 2006, Cotter Corporation requested approval from the Colorado Department of Public Health and Environment (CDPHE) to process the SFC raffinate sludge as an alternate feedstock (Cotter, 2006). Following an exchange of correspondence on the request, Cotter Corporation and the CDPHE agreed in August 2006 to table the request until operations at the Cotter mill were more clearly defined and a readiness review process for restart of the mill had been completed (CDPHE, 2006). Because this review process could take months to years to complete, this alternative uranium processing location has not been furthered considered in this DEIS.

IUC's White Mesa uranium mill, which is located approximately 1,607 km (998 miles) by truck from the SFC site, is licensed by the State of Utah. Under the terms of the license (Utah License No. UT1900479 Amendment No. 2), IUC is required to first apply for and obtain approval from the State of a license amendment before receiving or processing any alternate feed material. Processing of the raffinate sludge at the White Mesa mill would require such an amendment. The State of Utah's review would address the appropriateness of the raffinate sludge as an alternate feedstock and the strict limits on the amount of byproduct materials that the mill can receive for processing, which is based on the tailings cell disposal capacity. In June 2006, the State of Utah approved a license amendment for the White Mesa uranium mill, allowing it to accept alternate feed materials from the Fansteel site in Muskogee, Oklahoma, for processing (UDEQ, 2007). This approval was upheld in February 2007 by the Utah Radiation Control Board in response to a petition filed by the Glen Canyon Sierra Club challenging the 2006 license decision. It is possible that this same situation and corresponding delay in final approval of a license amendment could occur if the White Mesa uranium mill sought the approval of the State of Utah to process the raffinate sludge from the SFC site. However, this alternative would still remain a reasonable alternative for disposal of the SFC raffinate sludge and is carried through this DEIS for analysis of potential environmental impacts.

Under this alternative to process the raffinate sludge as an alternate feedstock, the sediments and sludges from the Emergency Basin, North Ditch, and Sanitary Lagoon would not be processed and therefore would require disposal at an off-site, licensed disposal facility.

2.3.3.2 Disposal at Existing Uranium Mill Tailings Impoundments

It is also possible that the dewatered raffinate sludge and the sludges and sediments from the Emergency Basin, North Ditch, and Sanitary Lagoon could be disposed in an existing uranium mill tailings impoundment. Potential candidate uranium mill tailing impoundments include the Pathfinder-Shirley Basin mill tailings impoundment in Mills, Wyoming, and the Rio Algom-Ambrosia Lake mill tailings impoundment in Grants, New Mexico.

The former Shirley Basin uranium mill is owned by the Pathfinder Mines Corporation (PMC). The site, which is located approximately 1,675 km (1,040 miles) from the SFC site, has two solid tailings impoundments, the largest covering approximately 64 hectares (158 acres), and the smaller 55 hectares (135 acres) (NRC, 2007). A solution pond, which is also the disposal location for 11e.(2) byproduct material from in situ leach uranium mines, covers approximately 12 hectares (30 acres). PMC intends to operate its in situ leach disposal area for the foreseeable future under NRC License No. SUA-442, Amendment 59 (NRC, 2007). Under its NRC license, PMC is authorized to dispose of up to a total of 7,646 cubic meters (10,000 cubic yards) of byproduct material per year from all generators other than in situ leach facilities, once NRC approval is granted for each generator. Disposal of the raffinate sludge from SFC in the PMC-Shirley Basin tailings impoundment would require such a prior NRC approval. In addition, disposal of the non-11e.(2) byproduct material wastes (in the sludges and sediments from the Emergency Basin, North Ditch, and Sanitary Lagoon) at the Shirley Basin site would require prior NRC approval. This approval would require demonstration to the NRC of the acceptability of disposing of non-11e.(2) materials with the 11e.(2) materials in the Shirley Basin tailings impoundment, as required by NRC Regulatory Information Summary (RIS) 2000-23 (NRC, 2000). SFC has indicated that it would need to dispose of approximately 6,995 cubic meters (9,150 cubic yards) of raffinate sludge (i.e., 11e.(2) byproduct material) and a total of approximately 568 cubic meters (743 cubic yards) of sludges and sediments from the Emergency Basin, North Ditch, and Sanitary Lagoon (i.e., a mix of 11e.(2) and non-11e.(2) byproduct materials). Therefore, disposal of the raffinate sludge alone or with the other sludges and sediments at this location would take at least two years provided SFC was the only generator disposing of byproduct material at this site. However, the annual limitation on byproduct material disposal at this site could be increased with NRC approval.

The Rio Algom-Ambrosia Lake uranium mill site is located in McKinley County, New Mexico, approximately 1,215 km (754 miles) by truck from the SFC site. The tailings impoundment contains 30 million metric tons (33 million tons) of uranium ore and covers an area of approximately 150 hectares (370 acres). A portion of the tailings impoundment remains open for disposal of Section 11e.(2) byproduct material under NRC License No. SUA-1473, Amendment 57 (NRC, 2006). As 11e.(2) byproduct material, SFC's dewatered raffinate sludge is expected to be found acceptable for disposal at the Rio Algom-Ambrosia Lake site. The site is limited by license condition to a total annual receipt and disposal of Section 11e.(2) byproduct material not to exceed 76,456 cubic meters (100,000 cubic yards) from all generators. As with the Shirley Basin site, the disposal of non-11e.(2) materials (sludges and sediments from the Emergency Basin, North Ditch, and Sanitary Lagoon) at the Rio-Algom Ambrosia Lake site would require demonstration to the NRC of the acceptability of disposing of non-11e.(2) materials with the 11e.(2) materials in the tailings impoundment, as required by NRC RIS 2000-23. SFC would need to dispose of approximately 6,995 cubic meters (9,150 cubic yards) of raffinate sludge (i.e., 11e.(2) byproduct material) and approximately 568 cubic meters (743 cubic yards) of sludges and sediments from the Emergency Basin, North Ditch, and Sanitary Lagoon (i.e., a mix of 11e.(2) and non-11e.(2) byproduct materials). It is expected that the Rio Algom-Ambrosia Lake tailings impoundment could accommodate this amount of material for disposal.

Because both the Shirley Basin and the Rio Algom-Ambrosia Lake tailings impoundments could potentially accept for disposal the SFC raffinate sludge and the Emergency Basin, North Ditch, and Sanitary Lagoon sediments, disposal at both sites is carried through this DEIS for analysis of potential environmental impacts.

2.3.3.3 Disposal at a Licensed Disposal Facility

The SFC raffinate sludge and the sediments from the Emergency Basin, North Ditch, and Sanitary Lagoon could be accepted by Energy*Solutions* of Clive, Utah, and potentially by WCS of Andrews, Texas.

- **Energy*Solutions*, Clive, Utah (2,424 km [1,505 miles] by rail from the SFC Site).** Energy*Solutions* provides waste management, treatment, and disposal services for low-level and naturally occurring radioactive wastes, byproduct material from uranium mills (AEA Section 11e.(2) wastes), and mixed radioactive and RCRA hazardous waste. Energy*Solutions* is licensed and permitted to receive Class A LLRW, asbestos-contaminated waste, mixed waste (i.e., both radioactive and hazardous), and 11e.(2) byproduct material. Furthermore, Energy*Solutions* receives radioactive waste in all forms, including, but not limited to, soil, sludges, resins, large reactor components, dry active waste, and other radioactively contaminated debris. The facility is accessible by rail and truck and is capable of receiving both bulk (e.g., intermodals, gondolas) and non-bulk (e.g., drums, boxes) containers.

- **WCS, Andrews, Texas (1,221 km [759 miles] by rail from the SFC Site).** This facility, which is accessible by truck or rail, is located in southwest Texas near the New Mexico border. Currently, the WCS Andrews facility is not permitted to accept and dispose of the type of waste materials present at the SFC site. Potentially, WCS will be able to accept the SFC materials for disposal in the proposed WCS 11e.(2) tailings impoundment. This, however, is contingent on the following: (1) WCS must first receive license approval (issuance expected in the next year or two), (2) SFC would need to get Texas Compact (Texas and Vermont) approval to dispose of the materials with a LLRW component in the proposed tailings impoundment (per RIS 200-23), and (3) DOE would need to make a commitment to take over custody of the impoundment with some LLRW in it. Therefore, in the short-term, SFC would be unable to dispose of waste materials at this facility.

Because both Energy*Solutions* and WCS could potentially accept the raffinate sludges and the sediments from the Emergency Basin, North Ditch, and Sanitary Lagoon for disposal, disposition at both sites is carried through this DEIS for analysis of potential environmental impacts.

2.4 Alternatives Considered but Eliminated

As required by NRC regulations, the NRC staff has considered other alternatives to the surface reclamation and groundwater corrective actions proposed by SFC, the licensee. These alternatives were considered but eliminated from further analysis due to economic, environmental, national security, or maturity reasons. This section discusses these alternatives and the reasons the NRC staff eliminated them from further consideration. These alternatives can be categorized as (1) Additional Soil Remediation; (2) On-site Retrievable Storage; and (3) Alternative Treatment Technologies.

2.4.1 On-site Retrievable Storage

Under this alternative, SFC would package, stack, and cover the on-site waste materials in a manner designed to facilitate subsequent retrieval for either reuse or eventual disposal. SFC would place the waste materials in above-grade storage cells, and a surface-grade pad would be used as the base for the storage area. Alternatively, SFC could use a below-grade cell similar to the disposal cell to store packaged materials. The licensee would surround the cell with an interceptor trench and a groundwater treatment system and cover it with a weather-proof cap that also would impede access. SFC also would establish a monitoring program and security to prevent unauthorized access to the site.

An on-site retrievable storage facility would need to meet the criteria established in Appendix A to 10 CFR Part 40. These design criteria are focused on an objective of permanent isolation of tailings and associated contaminants, and transfer of the site to a government custodian.

Furthermore, the final disposition of the contaminated materials should be such that ongoing active maintenance is not necessary to preserve isolation. While licensees may propose alternatives such as retrievable storage, the alternative design must provide a level of protection that is equivalent to or more stringent than that required by the Appendix A criteria. To meet that level of protection and allow for retrievability of the materials would be economically prohibitive, especially since less than 3% of the volume of materials to be disposed (i.e., the raffinate sludge) could have any commercial value. Therefore, this alternative has not been further considered in this DEIS.

2.4.2 Alternative Treatment Technologies

SFC conducted a literature search and technical evaluation of various treatment technologies available and appropriate for remediation of soils containing radionuclides and for groundwater remediation of arsenic. The Treatment Technologies Screening Matrix available on the Federal Remediation Technologies Roundtable (FRTR) internet Web site (http://www.frtr.gov/) was used to select candidate treatment technologies for further study. The FRTR is a consortium of cleanup managers at the federal government level. Members include the EPA, the Department of Defense, Department of Energy, Department of the Interior, and the National Aeronautics and Space Administration. The FRTR has rated three treatment technologies as "average" or "better" for treatment of radionuclides:

- **Electrokinetic Remediation.** This process applies low-voltage direct current electrical power to contaminated soil. The electrical power causes the movement of certain types of contaminants (negatively charged), such as heavy metals, to migrate to a collection point where they can be removed. This technology is most applicable in low permeability soils such as saturated and partially saturated clays and silt-clay mixtures that are not readily drained. In addition, there have been few, if any, commercial applications of electrokinetic remediation in the U.S. A recent study estimated full-scale costs at $117 per cubic meter ($153 per cubic yard). For the contaminated soil at the SFC site, the cost to implement this technology would be approximately $4.5 million.

- **In situ Vitrification.** This process uses electrical power to heat and melt contaminated soil in place. The molten material cools to form a solid glassy block trapping the inorganic compounds and heavy metals from the contaminated soil. The organic contaminants are vaporized and migrate to the surface of the treated soil, where they are oxidized under a collection hood. Residual emissions are captured in an off-gas treatment system. Depth of contaminants may limit some types of application processes. Disadvantages of in situ vitrification include the fact that there could be a significant increase in the volume of treated material (up to double the original volume), and the solidified material may hinder future site use. In addition, there have been few, if any, commercial applications of this technology worldwide. One study for a site in the Midwest estimated vitrification costs at $204 per cubic meter ($267 per cubic yard), or approximately $8 million for the contaminated soil at the SFC site.

- **Chemical Extraction.** In this process, soil and contaminants are extracted and dissolved into solution, separated, treated, and reused. Acids or solvents are the chemicals used for extraction. Some soil types and moisture content levels can adversely impact process performance, with higher clay content acting to reduce extraction efficiency and requiring longer contact times. Traces of solvent also may remain in the treated solids. The process may be more economical at larger sites.

In summary, all of these technologies have been, at least for test and demonstration purposes, proven successful in treating soils contaminated with radionuclides. However, widespread commercial-scale application of these technologies has not yet been achieved in the U.S. Coupled with the disadvantages identified in the above discussion, these technologies were not deemed to be sufficiently advanced for further consideration in this DEIS.

2.5 Comparison of the Predicted Environmental Impacts

Table 2.5-1 provides a summary of the potential environmental impacts of the proposed action and other alternatives. As indicated in the table, the proposed action and Alternatives 2 and 3 would almost all have SMALL impacts, with the exceptions of land use and transportation. Alternatives 1, 2, and 3 would all have MODERATE land use impacts, differing only in the amount of the site acreage that is proposed for release for unrestricted use. Alternatives 2 and 3 would have MODERATE transportation impacts because either railcars or trucks would be used for transporting contaminated materials off-site. For all other resource areas, the magnitude of potential impacts among Alternatives 1, 2, and 3 is SMALL. In comparison, the no-action alternative would have a LARGE impact on land use and MODERATE to LARGE impacts on surface water and groundwater resources, public and occupational health, geology and soils, and visual quality of the site.

2.6 NRC Staff Preliminary Recommendation Regarding the Proposed Action

After weighing the impacts of the proposed action and comparing the alternatives, the NRC staff, in accordance with 10 CFR § 51.71(e), sets forth its NEPA recommendation regarding the proposed action. The NRC staff recommends that, unless safety issues mandate otherwise, to approve SFC's proposed action. In this regard, the NRC staff has concluded that the applicable environmental monitoring program described in Chapter 6 and the proposed mitigation measures discussed in Chapter 5 would eliminate or substantially lessen any potential adverse environmental impacts associated with the proposed action.

The NRC staff has concluded the overall benefits of the proposed surface reclamation and groundwater corrective actions outweigh the environmental disadvantages and costs based on consideration of the following:

- The need to protect public health and safety and ensure that any potential long-term radiological and nonradiological hazards or other impacts on the environment are minimized.
- The impacts on the physical environment and human communities would be small.
- Portions of the site would be made available for future unrestricted use.

Table 2.5-1 Comparison of Predicted Environmental Impacts

Resource Area	Alternative 1 On-site Disposal Cell (Proposed Action)	Alternative 2 Off-site Disposal	Alternative 3 Partial Off-site Disposal	No-Action Alternative
Land Use	MODERATE: Future use of about 131 hectares (324 acres) of the site would be restricted, including the disposal cell area; 112 hectares (276 acres) would be released for unrestricted use. SMALL: If the 131-hectare (324-acre) restricted-use portion of the SFC site is held by a nontaxable, government entity, local property taxes may be reduced slightly.	SMALL: During reclamation, there would be a small impact on land use due to land disturbance. MODERATE: After reclamation is completed, the entire 243-hectare (600-acre) site would be available for unrestricted use, which is a moderate positive impact on land use. SMALL: Construction/operation of the rail spur would affect and/or replace up to 3 hectares (7 acres) of forest and 5 hectares (12 acres) of agricultural uses with an industrial use.	MODERATE: Future use of about 131 hectares (324 acres) of the site would be restricted including the disposal cell); 112 hectares (276 acres) would be released for unrestricted use. SMALL: If the 131-hectare (324-acre) restricted-use portion of the SFC site is held by a nontaxable, government entity, local property taxes may be reduced slightly.	LARGE: SFC would not undertake site reclamation; future use of the entire site would be restricted. SMALL: SFC will continue to be responsible for paying property taxes for the site.
Water Resources (Surface)	SMALL: Collection and treatment of surface runoff by SFC using the existing wastewater treatment system to remove uranium would result in small, short-term direct and indirect impacts on water resources while the licensee conducts site reclamation activities. SFC would test the collected water before discharging it to ensure compliance with drinking water standards. SMALL: The design of the disposal cell and SFC's revegetation of the top cover following completion of site reclamation would minimize	SMALL: Collection and treatment of surface runoff by SFC using the existing wastewater treatment system to remove uranium would result in small, short-term direct and indirect impacts on water resources while the licensee conducts site reclamation activities. SFC would test the collected water before discharging it to ensure compliance with drinking water standards. SMALL: Following completion of site reclamation activities, which would consolidate and remove contaminated materials, there would be a small impact on	SMALL: Collection and treatment of surface runoff by SFC using the existing wastewater treatment system to remove uranium would result in small, short-term direct and indirect impacts on water resources while the licensee conducts site reclamation activities. SFC would test the collected water before discharging it to ensure compliance with drinking water standards. SMALL: The design of the disposal cell and revegetation of the top cover following completion of site reclamation would minimize surface water	SMALL: Measurements of surface water quality in the vicinity of the SFC site have indicated that there are no significant impacts on water quality as a result of soil and groundwater contamination on the SFC site. With no disturbance of soils or underlying bedrock, the current situation will continue. MODERATE: In the long term, without removal of existing site contamination, there is a potential for site contaminants to affect surface water resources on the SFC site.

Table 2.5-1 Comparison of Predicted Environmental Impacts

Resource Area	Alternative 1 On-site Disposal Cell (Proposed Action)	Alternative 2 Off-site Disposal	Alternative 3 Partial Off-site Disposal	No-Action Alternative
	surface water runoff and erosion.	surface water. SMALL: The implementation of best management practices to control run-on and runoff at the construction area for the rail spur would result in small impacts on surface water on the SFC site.	runoff and erosion.	
Water Resources (Groundwater)	SMALL: The consolidation of contaminated materials and their placement in the disposal cell would reduce the source of future contamination. Implementation of the groundwater *Corrective Action Plan*, *Groundwater Monitoring Plan*, and long-term surveillance plan would result in the remediation of groundwater contamination.	SMALL: The consolidation of contaminated materials and removal from the SFC site would reduce the source of future contamination. Implementation of the groundwater *Corrective Action Plan*, *Groundwater Monitoring Plan*, and long-term surveillance plan would result in the remediation of groundwater contamination.	SMALL: The consolidation of contaminated materials and their placement in the disposal cell would reduce the source of future contamination. Implementation of the groundwater *Corrective Action Plan*, *Groundwater Monitoring Plan*, and long-term surveillance plan would result in the remediation of groundwater contamination.	MODERATE: Contamination of the groundwater resources at the SFC would likely continue because the source of such contamination would not be addressed.
Public and Occupational Health	SMALL: The annual radiation dose to members of the public or workers associated with reclamation of the SFC site, long-term public doses in the unrestricted area, and loss of institutional controls within the ICB would be within regulatory limits, and the estimated probabilities of LCFs would be low. SMALL: Implementation of mitigation measures would reduce exposure to chemicals during reclamation. The disposal cell cap would prevent human	SMALL: The annual radiation dose to members of the public or workers associated with reclamation of the SFC site would be within regulatory limits, and the estimated probabilities of LCFs would be low. SMALL: Implementation of mitigation measures would reduce exposure to chemicals during reclamation. Following completion of site reclamation activities, SFC would release the 243-hectare (600-acre) site for unrestricted reuse. The overall risk of the public coming into	SMALL: The annual radiation dose to members of the public or workers associated with reclamation of the SFC site, long-term public doses in the unrestricted area, and loss of institutional controls within the ICB would be within regulatory limits, and the estimated probabilities of LCFs would be low. SMALL: Implementation of mitigation measures would reduce exposure to chemicals during reclamation. The disposal cell cap would prevent human	SMALL: The annual radiation dose to SFC workers and the public associated with ongoing activities at the SFC site would be within regulatory limits and the estimated probabilities of LCFs would be low. LARGE: The annual radiation dose to the public (in this case the residential farmer) if there were no license controls would be far in excess of the regulatory limits, and the estimated probabilities of LCFs would

Table 2.5-1 Comparison of Predicted Environmental Impacts

Resource Area	Alternative 1 On-site Disposal Cell (Proposed Action)	Alternative 2 Off-site Disposal	Alternative 3 Partial Off-site Disposal	No-Action Alternative
	exposure to the chemical contamination within the disposal cell, and the impact on the occupational worker and the public following the licensee's completion of site reclamation activities would be small. SMALL: During construction activities, a maximum of five occupational injuries per year would be expected, and no fatalities would be expected (probability less than one).	contact with any radionuclides or chemicals remaining on-site would be low. SMALL: During construction activities, a maximum of five occupational injuries per year would be expected, and no fatalities would be expected (probability less than one).	exposure to the chemical contamination within the disposal cell, and the impact on the occupational worker and the public following the licensee's completion of site reclamation activities would be small. SMALL: During construction activities, a maximum of five occupational injuries per year would be expected, and no fatalities would be expected (probability less than one).	be higher than any of the other three alternatives. SMALL: Exposure to chemicals in the short-term would be small because there would be no disturbance of chemical contaminants. LARGE: If, in the long-term, site contaminants are disturbed due to a loss of license controls, there would be a risk of potential chemical exposure to the public and occupational workers.
Transportation	SMALL: The increased numbers of commuting workers and construction deliveries to the SFC site would have a small impact on the quality of traffic flow in the area. SMALL: The increased risk of fatality from vehicular accidents resulting from licensee's site reclamation activities would be small during the year of most intensive site reclamation activities, after which the impact would be the same as baseline conditions. SMALL: The increased risk of fatality resulting from vehicle emissions from activities at the	MODERATE: The increased numbers of commuting workers, construction and use of the rail spur, and construction deliveries to the SFC site would have a moderate impact on the quality of traffic flow in the vicinity of the site. SMALL: The increased risk of fatality from vehicular and rail accidents resulting from licensee's site reclamation activities would be small during the year of most intensive site reclamation activities, after which the impact would be the same as baseline conditions. SMALL: The increased risk of	MODERATE: The increased numbers of commuting workers and construction deliveries to the SFC site, in combination with the use of trucks for off-site shipment of contaminated materials, would have moderate impacts on the quality of traffic flow in the vicinity of the site. SMALL: The increased risk of fatality from vehicular accidents resulting from licensee's site reclamation activities would be small for the year of most intensive site reclamation activities, after which the impact would be the same as baseline conditions.	SMALL: There would be no change in the quality of traffic flow for roads in the vicinity of the SFC site. SMALL: The increased risk of fatality resulting from vehicle emissions from activities at the SFC site would be the same as baseline conditions. SMALL: There would be no radiological impact from the transportation of waste because the radiological contaminated waste would not be removed from the site.

Table 2.5-1 Comparison of Predicted Environmental Impacts

Resource Area	Alternative 1 On-site Disposal Cell (Proposed Action)	Alternative 2 Off-site Disposal	Alternative 3 Partial Off-site Disposal	No-Action Alternative
	SFC site would be small for the year of most intensive site reclamation activities, after which the impact would be the same as baseline conditions.	fatality resulting from vehicle emissions from activities at the SFC site would be small for the year of most intensive site reclamation activities, after which the impact would be the same as baseline conditions. SMALL: There would be a small risk of exposure to radiological waste during off-site transport of contaminated materials.	SMALL: The increased risk of fatality resulting from vehicle emissions from activities at the SFC site would be small during the year of most intensive site reclamation activities, after which the impact would be the same as baseline conditions. SMALL: There would be a small risk of exposure to radiological waste during off-site transport of contaminated materials.	
Historic and Cultural Resources*	SMALL: Consultation with the Oklahoma Historical Society has determined there are no prehistoric or historic sites currently known at the SFC site.	SMALL: Consultation with the Oklahoma Historical Society has determined there are no prehistoric or historic sites currently known at the SFC site. (Note: An archaeological survey must be performed on the proposed rail spur route.)	SMALL: Consultation with the Oklahoma Historical Society has determined there are no prehistoric or historic sites currently known at the SFC site.	SMALL: Consultation with the Oklahoma Historical Society has determined there are no prehistoric or historic sites currently known at the SFC site.
Visual and Scenic Resources*	SMALL: During reclamation, increased traffic, dust, and noise associated with the consolidation of waste materials, including building demolition, and construction of the disposal cell would be visible to travelers along local roadways. SMALL: Following SFC's completion of site reclamation, the disposal cell would be visible; however, the surface would be revegetated to resemble the local topography. There also would be	SMALL: During reclamation, increased traffic, dust, and noise associated with the consolidation of waste materials, including building demolition, and construction of the disposal cell would be visible to travelers along local roadways. SMALL: With the exception of the rail spur, which would not intrude into the landscape, and the administration building, SFC would restore the site to near natural conditions.	SMALL: During reclamation, increased traffic, dust, and noise associated with the consolidation of waste materials, including building demolition, and construction of the disposal cell would be visible to travelers along local roadways. SMALL: Following SFC's completion of site reclamation, the disposal cell would be visible; however, the surface would be revegetated to resemble the local topography. There also would be	MODERATE: The SFC site facilities and related equipment would not be removed and further deterioration of the site would likely result in a continued reduction in the visual quality of the site.

Table 2.5-1 Comparison of Predicted Environmental Impacts

Resource Area	Alternative 1 On-site Disposal Cell (Proposed Action)	Alternative 2 Off-site Disposal	Alternative 3 Partial Off-site Disposal	No-Action Alternative
	fewer structures and tanks, improving the overall visual quality of the site.		fewer structures and tanks, improving the overall visual quality of the site.	
Geology and Soils*	SMALL: Implementation of best management practices during site reclamation activities would minimize any potential erosion impacts at the SFC site. SMALL: The licensee's excavation of on-site clay for liners would be a necessary component of the site reclamation process. SMALL: To minimize soil compaction, existing on-site roadways would be used during reclamation activities. Given the total size of the SFC site, the area where potential compaction of soils could occur is expected to be small. SMALL: The disposal cell is designed to withstand the maximum intensity earthquake likely to occur at the SFC site.	SMALL: Implementation of best management practices during site reclamation activities would minimize any potential erosion impacts at the SFC site. SMALL: The licensee's excavation of on-site clay for liners would be a necessary component of the site reclamation process. SMALL: To minimize soil compaction, existing on-site roadways would be used during reclamation activities. Given the total size of the SFC site, the area where potential compaction of soils could occur is expected to be small.	SMALL: Implementation of best management practices during site reclamation activities would minimize any potential erosion impacts at the SFC site. SMALL: The licensee's excavation of on-site clay for liners would be a necessary component of the site reclamation process. SMALL: To minimize soil compaction, existing on-site roadways would be used during reclamation activities. Given the total size of the SFC site, the area where potential compaction of soils could occur is expected to be small. SMALL: The disposal cell is designed to withstand the maximum intensity earthquake likely to occur at the SFC site.	MODERATE TO LARGE: Contaminated soils and structures would remain indefinitely at the SFC site. Deterioration and potential leaching into the surface or groundwater resources could result in further contamination of site soils.
Climate, Meteorology, and Air Quality*	SMALL: Projected construction emissions are projected to be small and short term. SMALL: Additional vehicular traffic on local highways would have a small, indirect impact on local air quality.	SMALL: Projected construction emissions are projected to be small and short term. SMALL: Additional mobile-source emissions would be generated by trucks making deliveries and railcars	SMALL: Projected construction emissions are projected to be small and short term. SMALL: Additional mobile-source emissions would be generated by trucks transporting contaminated materials from the	SMALL: Monitoring and maintenance activities at the SFC site would continue with small direct impacts on air quality.

Table 2.5-1 Comparison of Predicted Environmental Impacts

Resource Area	Alternative 1 On-site Disposal Cell (Proposed Action)	Alternative 2 Off-site Disposal	Alternative 3 Partial Off-site Disposal	No-Action Alternative
	SMALL: Demolition of facilities on the SFC site would be conducted in compliance with applicable regulatory requirements with respect to potential asbestos-containing materials. SMALL: Based on studies of similar sites and activities, the radiological air emissions during site reclamation by SFC would have a small, direct impact on local air quality. SMALL: The disposal cell cover and revegetated surface would limit soil erosion; thus, air transport of contaminated soil is not expected.	transporting contaminated wastes from the SFC site. Vehicles would be decontaminated before leaving the site to reduce the potential for fugitive radiological dust being transported from the site. SMALL: Demolition of facilities on the SFC site would be conducted in compliance with applicable regulatory requirements with respect to potential asbestos-containing materials. SMALL: Based on studies of similar sites and activities, the radiological air emissions during site reclamation by SFC would have a small, direct impact on local air quality.	SFC site. The material would be shipped in super sacks, truckbeds would be covered with tarps, and trucks would be decontaminated before leaving the site to reduce the potential for fugitive radiological dust being transported from the site. SMALL: Demolition of facilities on the SFC site would be conducted in compliance with applicable regulatory requirements with respect to potential asbestos-containing materials. SMALL: Based on studies of similar sites and activities, the radiological air emissions during site reclamation by SFC would have a small, direct impact on local air quality. SMALL: The disposal cell cover and revegetated surface would limit soil erosion; thus, air transport of contaminated soil is not expected.	
Ecological Resources*	SMALL: Due to previous disturbance of the SFC site for industrial use, there is limited diversity. Small impacts due to the small area of ecological communities and open field habitat affected.	SMALL: Due to previous disturbance of the SFC site for industrial use, there is limited diversity. Small impacts due to the small area of ecological communities and open field habitat affected.	SMALL: Due to previous disturbance of the SFC site for industrial use, there is limited diversity. Small impacts due to the small area of ecological communities and open field habitat affected.	SMALL: There would be no change in the current level of disturbance to ecological resources as there would be no construction or excavation activities on the site.

Table 2.5-1 Comparison of Predicted Environmental Impacts

Resource Area	Alternative 1 On-site Disposal Cell (Proposed Action)	Alternative 2 Off-site Disposal	Alternative 3 Partial Off-site Disposal	No-Action Alternative
	SMALL: Site reclamation activities would incorporate best management practices to control erosion and manage storm water runoff such that impacts on aquatic habitats would be small. SMALL: No jurisdictional wetlands are located on the SFC site; thus, there would be no impacts on wetlands. SMALL: Overall wildlife species numbers and diversity is low, and existing wildlife has already acclimated to a certain amount of disturbance over the years of industrial operations. Mobile species would relocate. The potential direct impact on less mobile species is considered small. SMALL: Increased noise during site reclamation would have a small impact on wildlife. SMALL: No federally or state-listed species are known to occur at the SFC site or at a distance that may experience adverse impacts from SFC's site reclamation activities. SMALL: Although not known to	SMALL: Site reclamation activities would incorporate best management practices to control erosion and manage storm water runoff such that impacts on aquatic habitats would be small. SMALL: No jurisdictional wetlands are located on the SFC site or along the route of the proposed railroad spur; thus, there would be no impacts on wetlands. SMALL: Overall wildlife species numbers and diversity is low, and existing wildlife has already acclimated to a certain amount of disturbance over the years of industrial operations. Mobile species would relocate. The potential direct impact on less mobile species is considered small. SMALL: Increased noise during site reclamation would have a small impact on wildlife. SMALL: The proposed railroad spur would traverse a previously undeveloped area, primarily consisting of pastureland, hayfields, and forestland. These ecological communities are common throughout the area and	SMALL: Site reclamation activities would incorporate best management practices to control erosion and manage storm water runoff such that impacts on aquatic habitats would be small. SMALL: No jurisdictional wetlands are located on the SFC site; thus, there would be no impacts on wetlands. SMALL: Overall wildlife species numbers and diversity is low, and existing wildlife has already acclimated to a certain amount of disturbance over the years of industrial operations. Mobile species would relocate. The potential direct impact on less mobile species is considered small. SMALL: Increased noise during site reclamation would have a small impact on wildlife. SMALL: No federally or state-listed species are known to occur at the SFC site or at a distance that may experience adverse impacts from reclamation activities. SMALL: Although not known to	

Table 2.5-1 **Comparison of Predicted Environmental Impacts**

Resource Area	Alternative 1 On-site Disposal Cell (Proposed Action)	Alternative 2 Off-site Disposal	Alternative 3 Partial Off-site Disposal	No-Action Alternative
	be present, suitable habitat exists at the SFC site for the endangered American burying beetle; however, more desirable habitat is present within large tracts of forestland and pastureland adjacent to the area where most site reclamation activities would occur. SMALL: Proposed site reclamation activities would occur 5 km (3 miles) from the Sequoyah National Wildlife Refuge (NWR). This distance would provide a suitable buffer between site reclamation activities and the wildlife and visitors on the refuge.	are currently traversed by numerous existing roadways and railroad lines; thus, any additional impact from the proposed railroad spur would be small. SMALL: Construction of the railroad spur would cross two intermittent tributaries. The small area potentially affected and lack of aquatic diversity would result in a small impact. SMALL: No federally or state-listed species are known to occur at the SFC site or at a distance that may experience adverse impacts from SFC's site reclamation activities. SMALL: Although not known to be present, suitable habitat exists at the SFC site for the endangered American burying beetle; however, more desirable habitat is present within large tracts of forestland and pastureland adjacent to the area where most site reclamation activities would occur. SMALL: Much of the proposed railroad spur corridor would cross lands considered potentially suitable habitat for the endangered American burying	be present, suitable habitat exists at the SFC site for the endangered American burying beetle; however, more desirable habitat is present within large tracts of forestland and pastureland adjacent to the area where most site reclamation activities would occur. SMALL: Reclamation activities at the SFC site would occur 5 km (3 miles) from the Sequoyah NWR. This distance would provide a suitable buffer between site reclamation activities and the wildlife and visitors on the refuge	

Table 2.5-1 Comparison of Predicted Environmental Impacts

Resource Area	Alternative 1 On-site Disposal Cell (Proposed Action)	Alternative 2 Off-site Disposal	Alternative 3 Partial Off-site Disposal	No-Action Alternative
		beetle, and a project evaluation would be completed with USFWS prior to construction to evaluate whether the species is present. SMALL: Reclamation and construction activities at the SFC site would occur 5 km (3 miles) from the Sequoyah NWR. This distance would provide a suitable buffer between site reclamation activities and the wildlife and visitors on the refuge.		
Socioeconomic Conditions*	SMALL: SFC's site reclamation activities would require only a short-term increase of approximately 72 workers. SMALL: Following reclamation and until reuse of the property released for unrestricted use (131 hectares [324 acres]), there would be no commercial activity.	SMALL: SFC's site reclamation activities would only require a short-term increase of approximately 73 workers. SMALL: Following reclamation and until reuse of the property released for unrestricted use (243 hectares [600 acres]), there would be no commercial activity.	SMALL: SFC's site reclamation activities would require only a short-term increase of approximately 78 workers on-site and an additional 18 off-site truck drivers associated with transportation of a portion of the contaminated waste. SMALL: Following reclamation and until reuse of the property released for unrestricted use (131 hectares [324 acres]), there would be no commercial activity.	SMALL: There would be no change in management or employment at the SFC site, and there would be no socioeconomic implications.
Environmental Justice*	SMALL: No disproportionately high or adverse human health or environmental effects on minority or low-income populations were identified. Impacts on plants and animal resources used as subsistence food sources and for religious purposes, which are found in proximity to the SFC site	SMALL: No disproportionately high or adverse human health or environmental effects on minority or low-income populations were identified. Impacts on plants and animal resources used as subsistence food sources and for religious purposes, which are found in proximity to the SFC site	SMALL: No disproportionately high or adverse human health or environmental effects on minority or low income populations were identified. Impacts on plants and animal resources used as subsistence food sources and for religious purposes, which are found in proximity to the SFC site	SMALL: There would be no change in management or facility maintenance at the SFC site, and there would be no disproportionately high or adverse human health or environmental effects on these populations with this alternative.

Table 2.5-1 Comparison of Predicted Environmental Impacts

Resource Area	Alternative 1 On-site Disposal Cell (Proposed Action)	Alternative 2 Off-site Disposal	Alternative 3 Partial Off-site Disposal	No-Action Alternative
	and the Lower Illinois River, and that are used by minority or low-income populations, would be small and not disproportionately high or adverse with the reclamation of the SFC site.	and the Lower Illinois River, and that are used by minority or low-income populations, would be small and not disproportionately high or adverse with the reclamation of the SFC site.	and the Lower Illinois River, and that are used by minority or low-income populations, would be small and not disproportionately high or adverse with the reclamation of the SFC site.	
Noise*	SMALL: Reclamation activities, would result in small, direct noise impacts on the nearest noise receptor. SMALL: Noise from vehicles used by workers commuting to the SFC site would have a small impact on highway noise.	SMALL: Reclamation activities, would result in small, direct noise impacts on the nearest noise receptor. SMALL: Noise from vehicles used by workers commuting to and from the SFC site would have a small impact on highway noise. SMALL: Transportation of contaminated materials via railcar would add only a very minor noise component to the existing daytime noise level in the vicinity of the SFC site.	SMALL: Reclamation activities, would result in small, direct noise impacts on the nearest noise receptor. SMALL: Noise from vehicles used by workers commuting to the SFC site would have a small impact on highway noise. SMALL: Noise from trucks transporting contaminated materials off-site would generate short-duration noise events that would add little to the average noise levels at the receptors.	SMALL: As SFC would not undertake any construction-related activities, there would be no noise impacts.
Cost**	15% (Least Impact)	100% (Greatest Impact)	18% (Second Least Impact)	Not Applicable**

*These resource areas were determined to have small to no impacts and were eliminated from the detailed study. Their associated analysis can be found in Appendix B. In addition, there are no mineral resources actively mined or exploited in the vicinity of the SFC site.

** Cost impacts are expressed in relative terms by indexing them or scaling them to the highest cost option (Alternative 2 = 100%). The no-action alternative does not comply with NRC regulations for license termination and the costs are not comparable using this scaling impact metric.

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3. AFFECTED ENVIRONMENT

3.1 Introduction

This chapter describes the existing conditions at and near the SFC facility in Gore, Oklahoma. These data and information form the basis for assessing the potential impacts of the proposed action and other alternatives, including the no-action alternative, that are evaluated in Chapter 4. This chapter describes the environment in and around the site with emphasis on those resource areas most likely to be affected by the reclamation process (i.e., land use, water resources, public and occupational health, and transportation). As discussed in Section 1.4.3, NRC has identified SMALL impacts for additional resources that could potentially be affected by reclamation activities. These resource areas are discussed in Appendix B of this DEIS, which presents information on cultural resources, visual and scenic resources, geology and soils, air quality, ecological resources, socioeconomic conditions, environmental justice, and noise.

3.2 Land Use

The SFC site is located in an unincorporated area of western Sequoyah County in eastern Oklahoma. Sequoyah County has not adopted a land use plan, nor does the county control land use development through zoning.

The SFC site is about 4 km (2.5 miles) southeast of the town of Gore, Oklahoma, and about 3 km (2 miles) east of the town of Webbers Falls, Oklahoma. Gore and Webbers Falls are both considered rural areas (USCB, 2000). The nearest urbanized areas are the cities of Muskogee, Oklahoma (40 km [25 miles] northwest), and Fort Smith, Arkansas (64 km [40 miles] east). The Sequoyah National Wildlife Refuge (NWR) is located 1.6 km (1 mile) from the SFC site. Existing land uses on the SFC site are also described in the context of Haskell and Muskogee counties, which are adjacent to Sequoyah County.

3.2.1 Land Uses at the Sequoyah Fuels Corporation Site

The SFC site is a former industrial site situated on an approximately 243-hectare (600-acre) parcel. The site is in a rural area with forested land to the north and south and agricultural land to the east. The Arkansas and Illinois rivers are to the west. The Robert S. Kerr Reservoir is located to the southeast on the Arkansas River. The reservoir is owned by the federal government and is administered by the USACE. The location of the site in relation to these resources is shown on Figure 3.2-1.

When the SFC site was active, site operations were concentrated within the 81-hectare (200-acre) Industrial Area. Existing structures are located within the smaller Process Area (see Section 2 for a more complete discussion of site history and configuration). Surrounding the Industrial Area are approximately 81 hectares (200 acres) of pastureland that have been used for forage production in conjunction with a land application program operated by SFC. In 2005 and 2006, SFC applied ammonium nitrate solution (a byproduct of the liquid portion of the former raffinate process stream) to an on-site control plot located within the 243-hectare (600-acre) site boundary in the agricultural lands to the south and southwest of the Industrial Area (see Figure 1.2-1). SFC monitors this control plot as specified in Source Materials License SUB-1010 in order to

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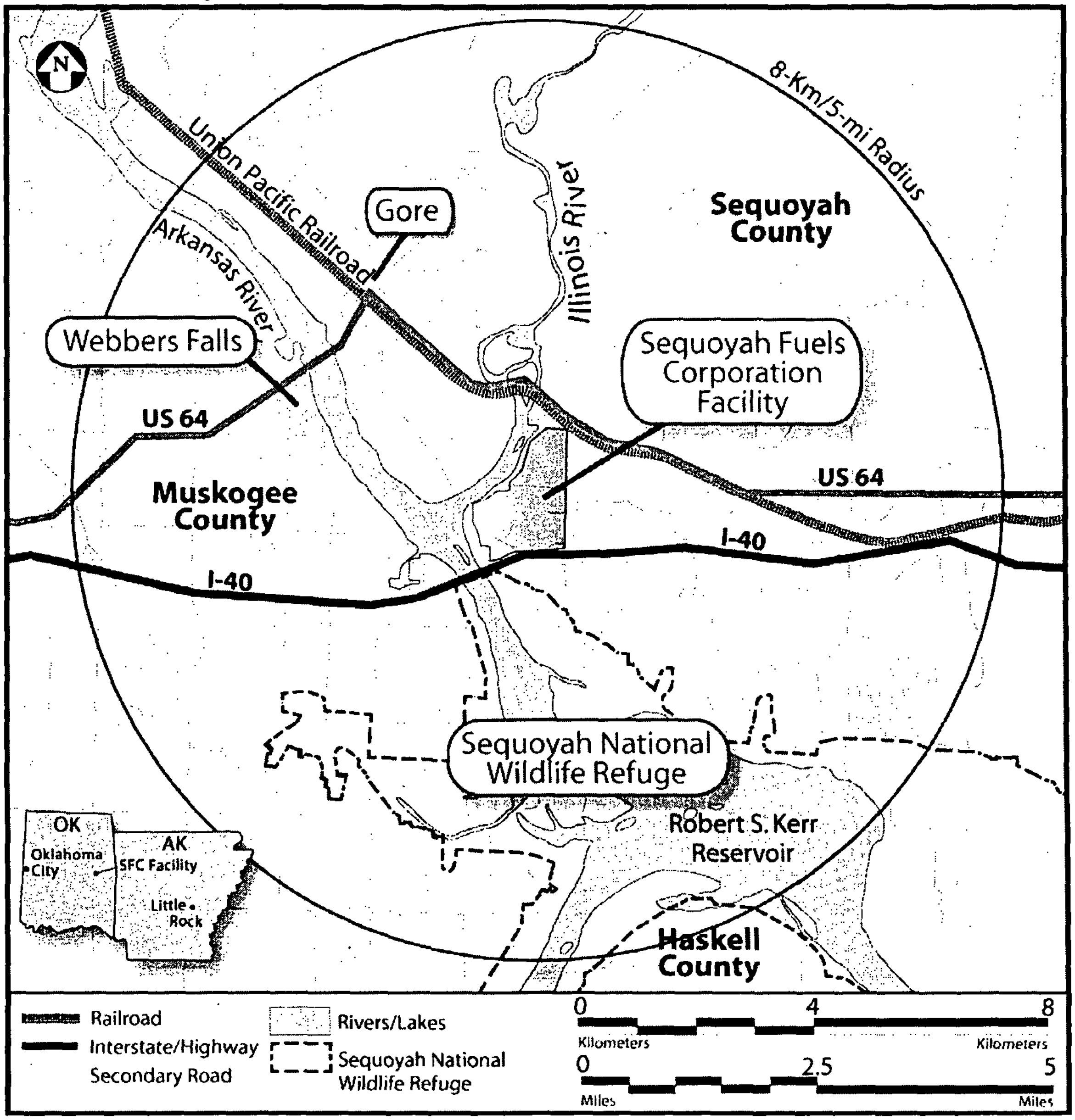

Figure 3.2-1 Land Uses within an 8-Kilometer (5-Mile) Radius of the SFC Site

implement good programmatic control and ensure that the program is being operated in accordance with best agricultural practices (SFC, 2006a). The control plot encompasses about 37 hectares (91 acres), of which approximately 24 hectares (60 acres) were used for the application. The ammonium nitrate solution also was applied to an approximately 3-hectare (8-acre) field located immediately south of the control plot and an 8-hectare (20-acre) portion located immediately east of the control plot.

3.2.2 Regional Land Use

As shown below in Table 3.2-1, agricultural uses and recreational uses represent more than 60% of the land uses found within a 16-km (10-mile) radius of the SFC site. Prior to the construction of railroads in this region of Oklahoma, cattle range was a dominant land use. After the railroads were constructed, corn and cotton became the main agricultural products. In the last several decades, however, there has been a return to cattle grazing in the region and to the production of other food crops, mainly corn and soybeans. Areas currently in cultivation are primarily located in the bottomlands along the Arkansas River. High-quality forestland has been largely eliminated from the area due to heavy cutting, fires, and uncontrolled grazing (SFC, 2001). Recreation is represented largely by the federally owned land and water areas along the Arkansas and Illinois rivers, including the 8,948-hectare (21,000-acre) Sequoyah NWR.

Table 3.2-1 Land Use within a 16-Kilometer (10-Mile) Radius of the SFC Site

Land Use Category	Percent *
Agricultural (mostly pasture)	30
Recreation	35
Residential	20
Commercial and Industrial	15
Unused Rough Terrain	25

Source: SFC, 1998.
* Due to multiple usage of some areas, the total exceeds 100%

Residential, industrial, and commercial development constitutes about one-third of the land use within 16 km (10 miles) of the SFC site, including 7 schools, 11 churches, and 32 cemeteries. No hospitals or prisons are located within a 16-km (10-mile) radius of the site. Figure 3.2-2 shows all the public facilities within a 16-km (10-mile) radius of the site.

Sequoyah County encompasses 1,852 square km (715 square miles). A majority of the county is undeveloped and consists of rangeland, pasture, and forest. As of 1997, the most recent year for which statistics are available, Sequoyah County contained 3,201 hectares (7,909 acres) of publicly and privately owned land that fell under the jurisdiction of the Bureau of Indian Affairs (DOI, 1997; SFC, 2006b). Nearly 70,000 members of the more than 200,000-member Cherokee Nation reside in this 18,130-square-km (7,000-square-mile) jurisdictional service area, which includes all of eight counties and portions of six others in northeastern Oklahoma (see Figure 3.2-3).

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Source: ESRI, 2005.

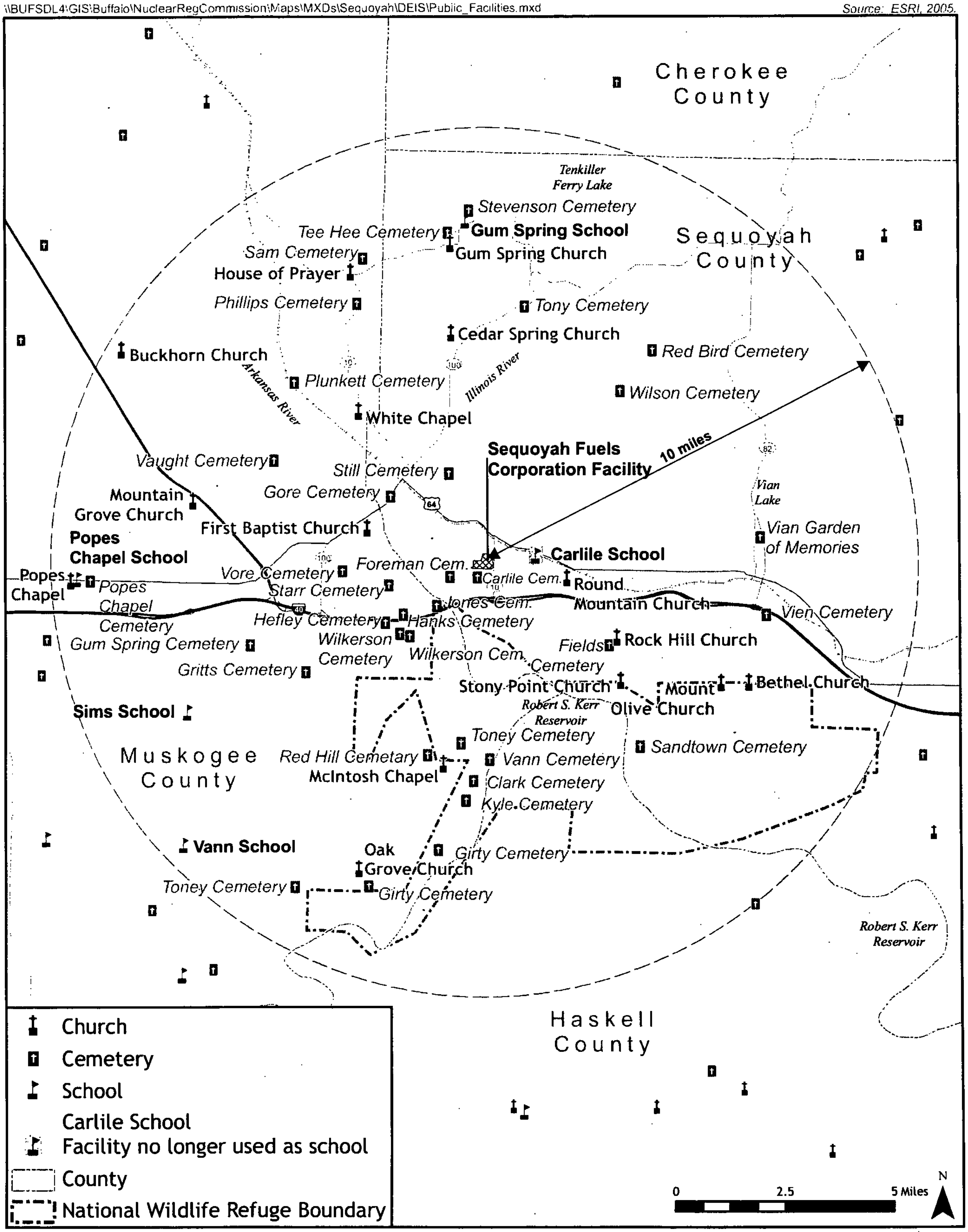

Figure 3.2-2 Public Facilities within a 16-Kilometer (10-Mile) Radius of the SFC Site

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Source: Cherokee Nation, 13 November 2006.

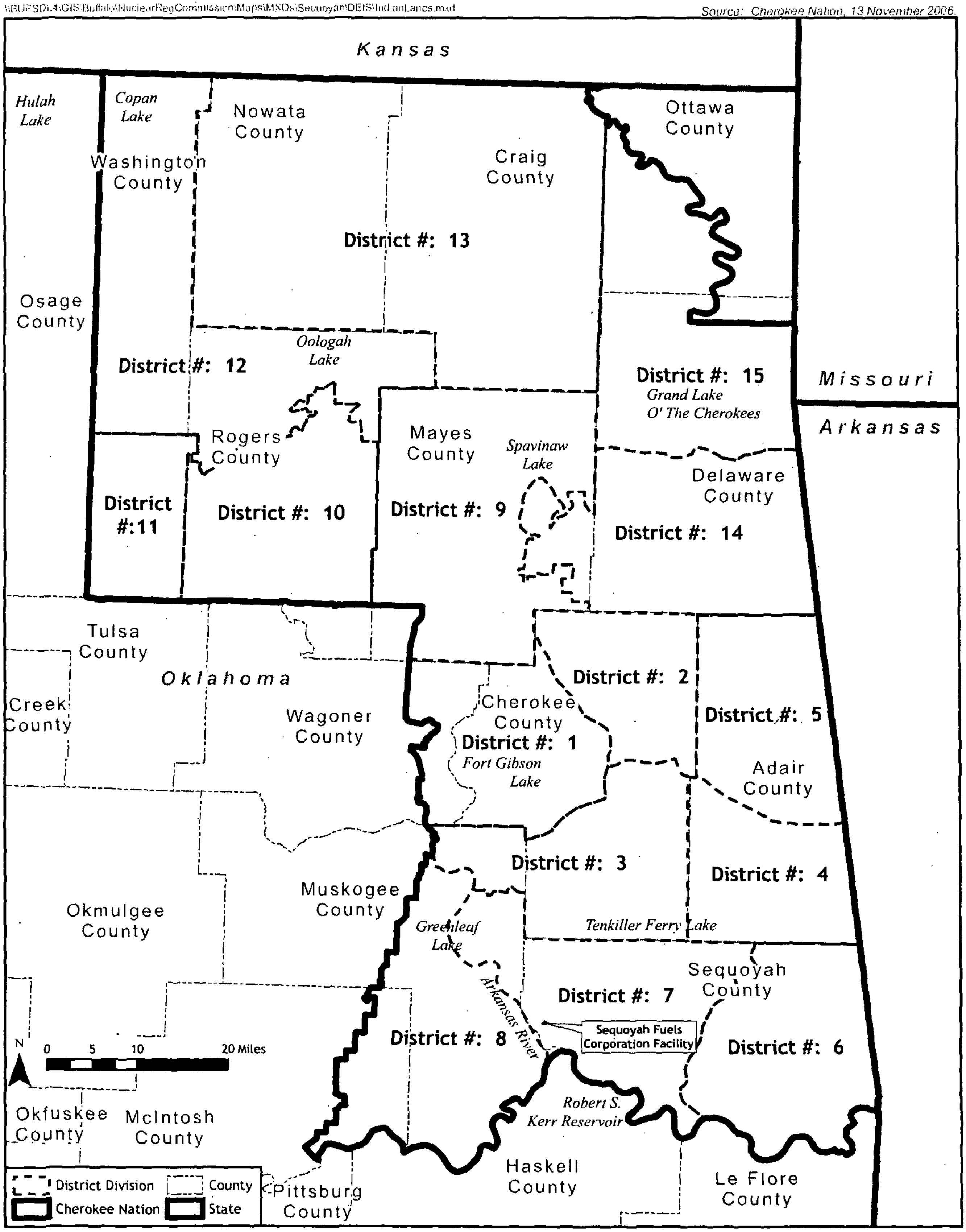

Figure 3.2-3 Cherokee Nation and Districts in Eastern Oklahoma

Approximately 26,709 hectares (66,000 acres) of Cherokee Nation tribal trust land and 155 km (96 miles) of the Arkansas riverbed are tribal assets. As a federally recognized tribe, the Cherokee Nation has both the opportunity and the sovereign right to exercise control and development over their tribal assets. All transactions with respect to tribal trust lands must be approved by the Cherokee Nation. Although the SFC site lies within the jurisdictional boundary that defines the Cherokee Nation, it is not located on tribal lands. However, the site is adjacent to the Cherokee Nation's tribal trust riverbed lands.

Haskell County's 1,590 square km (614 square miles) are primarily undeveloped pasture, rangelands, and forest. Muskogee County encompasses 2,178 square km (841 square miles), and a large percentage of the county consists of pasture, rangeland, and cropland. Table 3.2-2 summarizes the overall land uses in the three counties surrounding the SFC site.

Table 3.2-2 Land Use in Project Area Counties

Land Use	Sequoyah (%)*	Haskell (%)*	Muskogee (%)
Cropland	9	1	30
Range and Pasture	41	56	47
Forest	44	33	-
Urban	2	1	9
Water	5	8	4
Mined	-	3	< 1
Recreation	-	< 1	< 1
Other	-	< 1	< 1

Source: USDA, 1999a, 1999b, and 1999c.
* Due to multiple usage of some areas, the total exceeds 100%
\- Data unavailable

3.2.3 Recreational Resources Near the SFC Site

Five recreational facilities in the area are used by residents and visitors: Gore Landing, the Gore Summers Ferry Landing boat launch, the Webbers Falls boat launch, the Sequoyah National NWR, and the Cherokee Courthouse. Trout fishing and camping also are popular activities in the area.

Gore Landing is currently leased to and administered by the Town of Gore. The area includes 24 campsites and a boat launch. No fees are charged and there is no counter at the boat launch; thus, a precise count of visitors is unavailable, though it is estimated that approximately 15 boats are launched per day during the summer months. The average visit is 8 to 10 hours for boaters. The 24 campsites are full during some periods during the summer, and it is estimated that the average stay is three days for campers (SFC, 2001).

Gore Summers Ferry Landing boat launch on the Kerr-McClellan waterway does not charge fees for camping or boat launching and no specific count is taken. It is estimated that 20 to 25 boats are launched per day on the weekends during the summer and that there are approximately 15 campers per day. The average visit is 8 to 10 hours for boaters and three days for campers (SFC, 2001).

Webbers Falls boat launch does not charge fees and no specific count is taken. It is estimated that 25 to 30 boats are launched per day during the summer months. The average visit is 8 to 10 hours (SFC, 2001).

The entrance to the Sequoyah NWR is about 5 km (3 miles) south of Vian, Oklahoma, and about 21 kilometers (13 miles) from the SFC site. Access to the refuge also can be obtained from the waterway along the Robert S. Kerr Reservoir. The refuge is a day-use area, and no campsites are available. The average stay is 6 to 8 hours. Approximately 80,000 visitors annually enter the refuge through the main entrance (SFC, 2001).

The Cherokee Courthouse is a museum and historical site to the north of the SFC facility, along U.S. Route 64. It includes picnic tables and a gift shop. A guest book is maintained, but a precise count of visitors is not taken. During the summer months an estimated 50 to 100 people per day visit the museum. The average stay is typically one to two hours (SFC, 2001).

The 12.9-km (8-mile) stretch of the Lower Illinois River from Lake Tenkiller Dam to the Highway 64 bridge between Gore and Vian has become a destination for trout fishing and camping. Lake Tenkiller is about 11.2 km (7 miles) from the SFC site. In 1965, the Lower Illinois River was established as Oklahoma's first year-round designated trout stream. The SFC site is downstream of the designated portion of the stream. The trout stream is stocked every weekend from the end of March through the fourth of July in four locations by the Fisheries Division of the Oklahoma Department of Wildlife. Throughout the rest of the year, the trout are stocked every other week. Stocked species include rainbow trout and brown trout. Numerous camping facilities are located from Lake Tenkiller to the confluence of the Lower Illinois and Arkansas rivers. Two of these are state parks (Tenkiller and Cherokee Landing), and others are privately owned or managed by the USACE.

3.2.4 Taxes and Revenue

As a private entity, SFC pays annual property taxes to Sequoyah County. It is estimated that from 1995 to 2006, SFC paid between $123,950 and $205,286 annually to Sequoyah County in property taxes. However, portions of this annual amount were paid under protest and are being disputed with the overall valuation of the SFC property due to the fact that there were no longer operations at the facility. SFC estimated that, since the facility was not operating, the annual amount due to the county from 1995 to the present should have been $27,376.

In 2004 Sequoyah County collected approximately $1,078,483 in real property taxes (OCES, 2005). The estimated $27,376 that SFC states it is responsible for paying following stoppage of operations equates to approximately 2.5% of the total property tax revenue collected for Sequoyah County annually. These property tax revenues support county operations and the school system.

The economic benefits of trout fishing on the economy of the region surrounding the Lower Illinois River has been studied by Oklahoma State University (Prado, 2006). This study found that the Lower Illinois River trout fishery generates an estimated $2.1 million in revenue per year, assuming the 18,391 single-purpose visitors to the region in 2006 were anglers.

3.3 Water Resources

3.3.1 Surface Water Features

The SFC facility is located on the east bank of the lower Illinois River. The river flows in a southwesterly direction for about 1.6 km (1 mile) along the SFC property boundary before joining the Arkansas River to form the headwaters of the Robert S. Kerr Reservoir. Flow into the Illinois River is regulated by releases from Lake Tenkiller, which is a reservoir located approximately 11.2 km (7 miles) upstream from the SFC site. The annual flow rate of the Illinois River near the SFC facility averages 45.3 cubic meters (1,600 cubic feet) per second (OWRB, 1995).

The SFC Process Area is nearly 30.5 meters (100 feet) higher than the surface of the Robert S. Kerr Reservoir, with steep slopes separating the Process Area, the Robert S. Kerr Reservoir, and the floodplain area on the southwestern portion of the facility property (SFC, 2006a). Three surface water impoundments are located within the Process Area: Emergency Basin, North Ditch, and Sanitary Lagoon (see Figure 3.3-1). The Emergency Basin and North Ditch are primarily storm water runoff impoundments for the property. The storm water reservoir, located outside of the Process Area, receives runoff from non-process areas located on the southern and eastern portions of the property via Outfall 001 (storm water multi-sector general permit OKR050549, issued July 5, 2006). In addition, eight man-made ponds are located within the SFC property but outside the Process Area; these ponds do not receive runoff or discharge water. The former Decorative Pond (filled in with soil in 2006), which was near the administration building, had been used for aesthetic purposes only. It was fed by a raw water supply from Lake Tenkiller and did not receive storm water runoff or discharge water (SFC, 1998).

In addition to the impoundments identified above, several small intermittent streams (001, 004, 005, 007, 008, 009, and the drainage associated with the storm water reservoir) drain out from the Process Area toward the Robert S. Kerr Reservoir.

3.3.1.1 Surface Water Quality

The rugged nature of its watershed and the spring-fed streams that flow into the Illinois River are the sources of its relatively clear water. The Arkansas River has more suspended material than the Illinois River because it courses through agricultural areas in Colorado, Kansas, and Oklahoma. Samples for the years 2000 to 2006 from within the Illinois River, taken by SFC at several locations above and below the facility site where the effluents from the labeled outfalls were introduced (SFC, 2006b), are summarized in Table 3.3-1. Table 3.3-1 presents the analytical results for samples collected upstream and downstream from both the Illinois and Arkansas Rivers and from several outfall and drainages. As shown in the table, the concentrations of uranium and radium-226 were generally higher upstream than downstream on both the Illinois and Arkansas Rivers. Samples collected in 1991 and 1992 indicated elevated concentrations of uranium in the Illinois River, but these levels were less than the environmental action level for uranium (SFC, 1998). Elevated levels of uranium, however, have not been detected since 1993.

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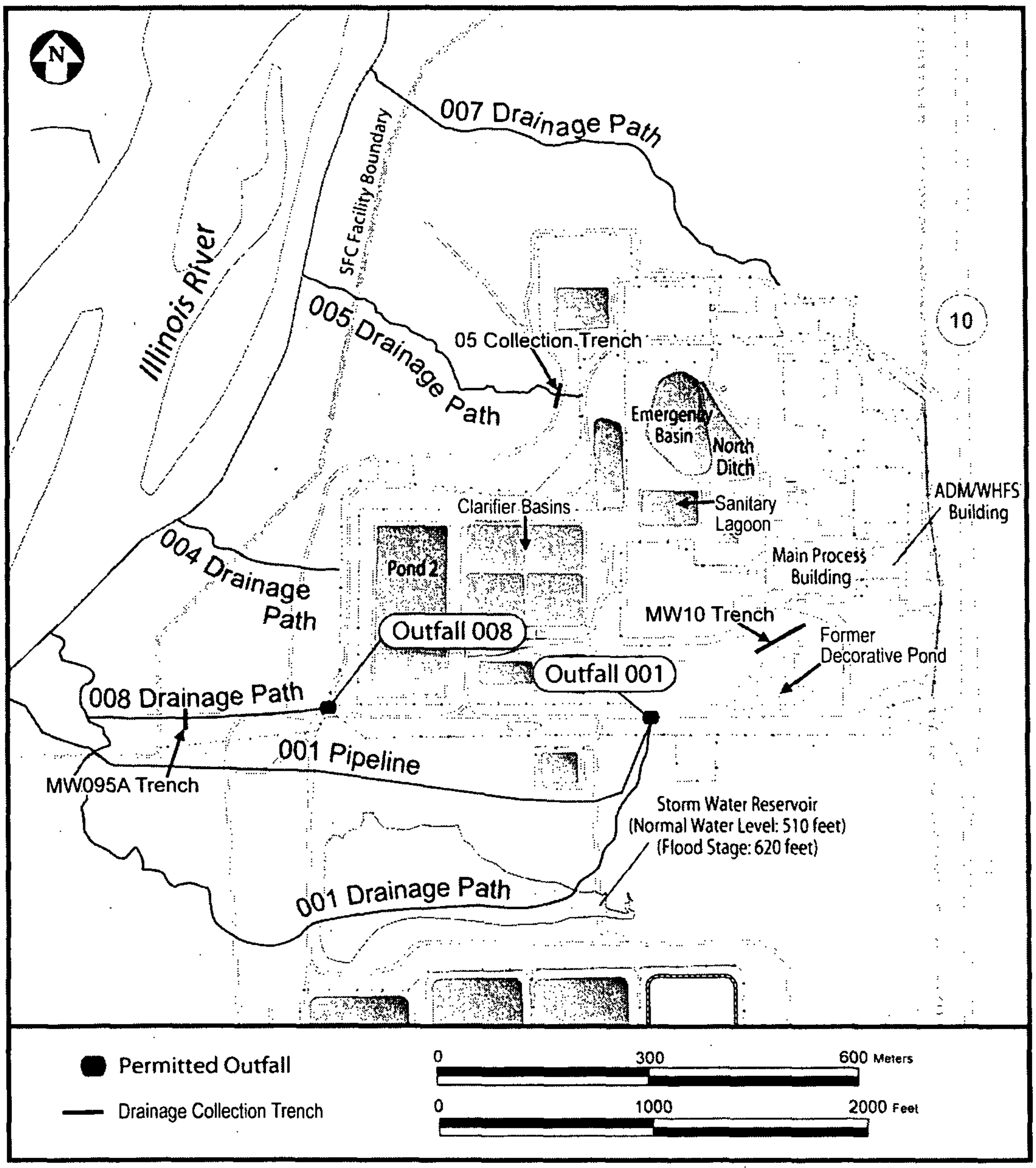

Figure 3.3.1 Sequoyah Fuels Corporation Surface Water Impoundments and Drainage

Table 3.3-1 Surface Water Sampling Summary

Parameter	Concentrations, 2000-2006							
	Illinois River Upstream	Illinois River Downstream	Arkansas River Upstream	Arkansas River Downstream	Farm Pond East of Hwy 10	Salt Branch	Outfall 008	Storm Water Reservoir
Uranium, µg/l	<1.0 - 8.64	<1.0	<1.0 - 2.15	0.1 - <1.0	<1.0 - 10.9	<1.0	<1.0 - 132	<1 - 10.0
Radium-226, pCi/l	0 - 0.255	0 - 0.303	0.116 - 0.203	0 - 0.285	0 - 3.74	0 - 0.328	0 - 3.00	0 - 0.148
Radium-228, pCi/l	0	0	0.192	0.214	0	0.133	-	-
Thorium-230, pCi/l	0	0	0	0	0	0	0 - 1.76	0
Nitrate (as N), mg/l	<1.0 - 1.6	<1.0 - 1.4	<1.0 - 1.3	<1.0 - 1.3	<1.0	<1.0	<0.2 - 13.6	<1.0 - 3.7
Ammonia (as N) mg/l	-	-	-	-	-	-	<0.2 - 1.1	-
Fluoride, mg/l	<0.2	<0.2 - 0.3	0.2 - 0.3	0.2	<1.0	<0.2	<0.2 - 0.9	0.4
TSS, mg/l	0.4	14	7.6	9.6	-	-	0.4 - 34.0	-
Antimony, mg/l	0.012	0.011	0.01	0.011	0.039	<0.030	0 - 0.007	<0.030
Arsenic, mg/l	0.005-0.010	<0.005 - 0.010	0.007 - 0.009	<0.009 - 0.010	0.007	0.004	<0.005 - 0.007	0.005
Barium, mg/l	0.046	0.075	0.093	0.085	0.053	0.028	0.04	0.008
Beryllium, mg/l	<0.001	<0.001	<0.001	<0.001	0.011	0.011	0.004	0.011
Cadmium, mg/l	<0.001	<0.001	<0.001	<0.001	<0.002	<0.002	<0.001 - 0.001	<0.002
Chromium, mg/l	<0.005	0.006	0.006	<0.005	0.003	0.002	<0.007 - 0.010	0.003
Lead, mg/l	0.009	0.022	0.007	0.005	0.006	0.006	<0.005 - 0.005	<0.004
Molybdenum, mg/l	<0.005	<0.005	<0.005	<0.005	0.011	0.008	<0.007 - 0.009	<0.002
Nickel, mg/l	0.032	0.049	0.006	0.031	0.017	0.012	<0.005 - 0.014	0.005
Selenium, mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005 - 0.012	<0.005
Thallium, mg/l	<0.002	<0.002	<0.002	<0.002	<0.013	<0.013	<0.010	<0.013
COD, mg/l	-	-	-	-	-	-	7.1 - 43.9	-
TOC, mg/l	-	-	-	-	-	-	-	-
TDS, mg/l	130	343	376	369	-	-	-	-
Sulfate, mg/l	20	78.7	85.2	78.7	-	-	-	-
Chloride, mg/l	9.5	100	114	116	-	-	-	-

Table 3.3-1 Surface Water Sampling Summary

Parameter	Concentrations, 2000-2006							
	Outfall 001 at Illinois River	005 Drainage and USACE Property line	005 Drainage at MW100B	007 Drainage N F2 Holding basin	004 Drainage East of USACE Property	Seep north of Port Road Bridge	001 Drainage North of Port Road Bridge	Combination Stream
Uranium, µg/l	<1	23.6 - 238	18.8 - 814	<1.0 - 16.9	<1.0 - 15.6	<1.0 - 6.4	<1.0 - 229	0.21 - 255
Radium-226, pCi/l	0 - 0.186	0.132	0.214	0.073	0.022	0.08	0.117	0 - 1.79
Radium-228, pCi/l	0.315	-	-	-	-	-	-	-
Thorium-230, pCi/l	0	1.83	0	0.356	0.662	0	0	0 - 1.68
Nitrate (as N), mg/l	<1 - 1.4	<1.0 - 42.3	<1.0 - 262	<1.0 - 8.5	<1.0 - 75	<1.0 - 990	<1.0 - 484	0.1 - 8.6
Ammonia (as N) mg/l	-	-	-	-	-	-	-	0 - 2.2
Fluoride, mg/l	<0.2	0.3	0.3	<0.2	0.3	<0.2 - <0.4	<0.2 - <0.5	0.1 - 2.0
TSS, mg/l	-	-	-	-	-	-	-	0 - 58.4
Antimony, mg/l	0.015	<0.005 - 0.013	<0.005 - 0.015	<0.005 - 0.011	<0.005	<0.005 - 0.008	<0.005 - 0.007	-
Arsenic, mg/l	<0.009 - 0.009	<0.004 - 0.019	<0.004 - 0.052	<0.004 - 0.017	<0.004 - 0.082	<0.004 - 0.074	<0.004 - 0.194	-
Barium, mg/l	0.078	0.06	0.08	0.038	0.08	0.072	0.026	-
Beryllium, mg/l	<0.001	<0.001	<0.001	0.001	0.001	0.001	<0.001	-
Cadmium, mg/l	<0.001	<0.001	<0.001	0.003	<0.001	0.001	<0.001	-
Chromium, mg/l	0.007	0.006	0.003	0.006	0.006	0.004	0.004	-
Lead, mg/l	0.019	<0.005 - 0.007	<0.004 - <0.005	<0.005 - 0.027	<0.004 - 0.005	<0.004 - 0.026	<0.005 - 0.017	-
Molybdenum, mg/l A	<0.005	0.006	0.002	0.004	<0.002	0.004	<0.002	-
Nickel, mg/l	0.009	0.015	0.019	0.017	0.008	0.026	0.007	-
Selenium, mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	0.008	<0.005	-
Thallium, mg/l	<0.002	<0.002 - <0.004	<0.002 - <0.004	<0.002 - <0.004	<0.002 - <0.004	<0.002 - <0.004	<0.002 - <0.013	-
COD, mg/l	-	-	-	-	-	-	-	-
TOC, mg/l	-	-	-	-	-	-	-	-
TDS, mg/l	-	-	-	-	-	-	-	-
Sulfate, mg/l	-	-	-	-	-	-	-	-
Chloride, mg/l	-	-	-	-	-	-	-	-

Source: SFC, 2006b.

Key:

COD = chemical oxygen demand
TDS = total dissolved solids
TOC = total organic carbon
TSS = total suspended solids
USACE = U.S. Army Corps of Engineers

The surface waters within the vicinity of the SFC facility have been monitored for many years, and no surface water contamination at levels above background concentrations have been measured in recent years. The storm water reservoir was sampled from 1995 to 2003, and uranium levels were generally above those in the rivers but below the action levels (SFC, 2003). Fluoride levels also were marginally elevated, although the concentrations were an order of magnitude less than the drinking water maximum contaminant level (MCL) of 4 mg/L (SFC, 2005a).

3.3.1.2 Surface Water Uses

The Illinois River is an important water body for recreational fishing. Species sought include largemouth and smallmouth bass, rainbow and brown trout, crappies, catfish, striped bass, bream, and walleye. Game animals in nearby habitat include whitetail deer, quail, geese, duck, rabbit, and squirrel. Rural District No. 5 in Gore, Oklahoma, supplies most residents and the SFC facility with water from the lower Illinois River. The Sequoyah County Water Association, Gore Utility Authority, and the East Central Oklahoma Water Authority (Webbers Falls) all supply water to the area from Lake Tenkiller, which is located approximately 11 km (7 miles) upstream of the SFC site. The cities of Vian and Sallisaw have their own water systems, and the Robert S. Kerr Reservoir, downstream of the site, is not used as a public water supply (SFC, 2006b). Two permitted stream water diversions in the area are indicated on Figure 3.3-2.

3.3.1.3 Floodplains

Floodplains are described as areas near streams or rivers that are likely to be inundated with water during times of elevated water levels. The SFC facility has not been affected by flooding of the Illinois River or the Arkansas River. The highest recorded water level—145.9 meters (479 feet) above mean sea level (amsl)—occurred in 1943. The Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map indicates that a 100-year flood would elevate water levels near the SFC site to 155.4 meters (510 feet) amsl (FEMA, 1991a; FEMA, 1991b). The elevation of the SFC facility is about 173.7 meters (570 feet) amsl, well above the reservoir's lock and dam at 147.4 meters (483.5 feet) amsl. Therefore, a catastrophic flooding event at the site is unlikely (RSA, 1997a; 1997b). Figure 3.3-2 illustrates the additive expansion of flood levels from a breach of the Webber Fall's dam, to the 100-year flood level, to a breach of the Lake Tenkiller dam.

3.3.2 Groundwater

3.3.2.1 Regional Groundwater

> An aquifer is a geologic formation, series of formations, or part of a formation capable of yielding a significant amount of groundwater to wells or springs.
> (10 CFR Part 40, Appendix A)

Groundwater in the region flows westward toward the Arkansas and Illinois Rivers, which are potential discharge locations for shallow groundwater (SFC, 1996). Regional groundwater can be found primarily in the unconsolidated deposits of sand, silt, clay, and gravel that occur along or adjacent to the Arkansas, Illinois, and Canadian Rivers. The only major bedrock aquifer (found in the Keokuk and Reed Springs Formations) is located approximately 16 km (10 miles)

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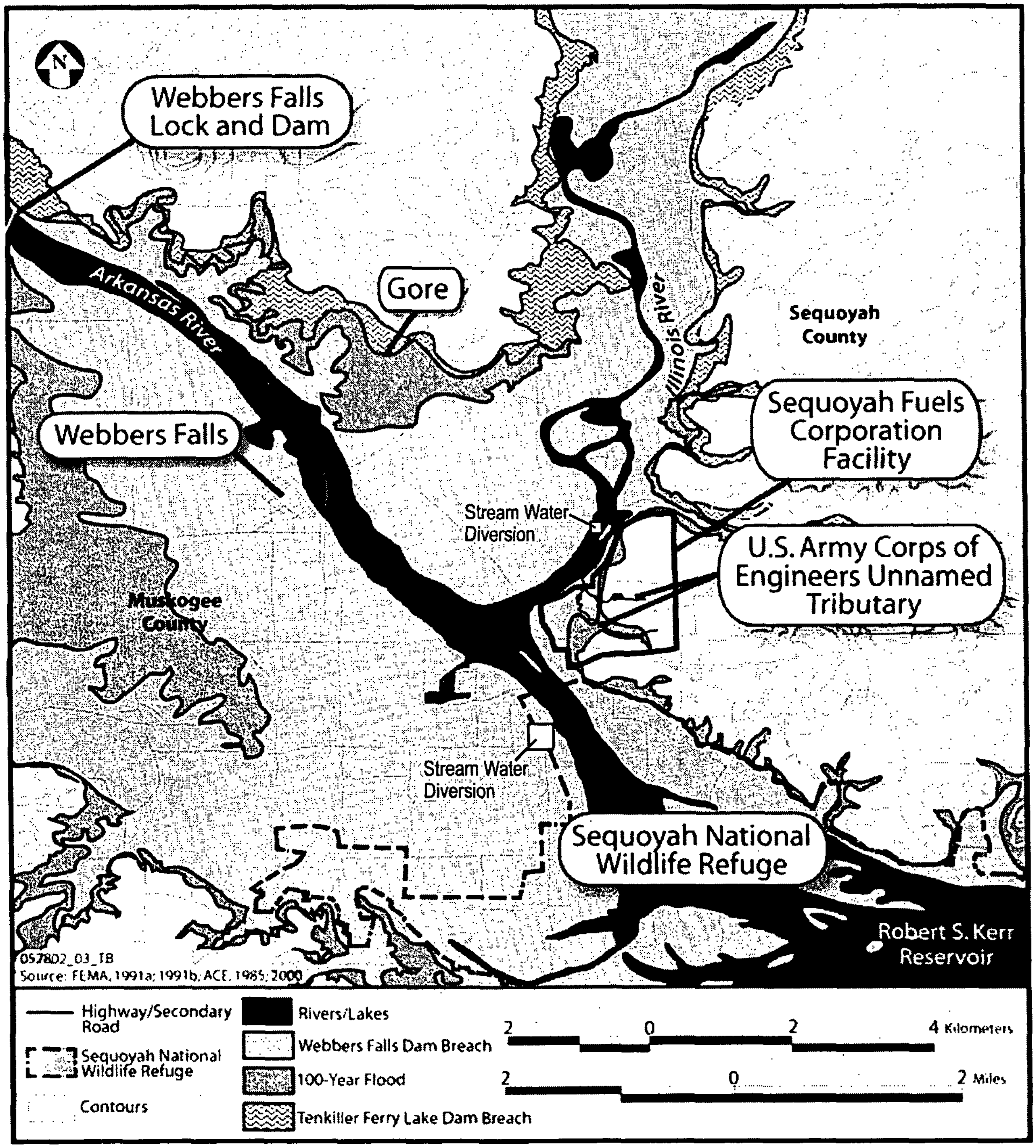

Figure 3.3.2 Sequoyah Fuels Corporation Flood Plains and 100-Year Flood

northeast and upgradient of the SFC site. This aquifer produces between 11 and 190 liters per minute (lpm) (3 to 50 gallons per minute (gpm)) of good-quality water (SFC, 1996).

The only significant freshwater aquifer in the immediate area of the SFC facility is in the alluvial deposits along the Arkansas and Illinois rivers. The lower part of the alluvium consists of a maximum of 4.9 meters (15 feet) of coarse sand and gravel capable of producing up to 3,402 lpm (900 gpm), and the water quality of the alluvium aquifer is hard to very hard (180 milligrams per liter calcium carbonate), suitable for irrigation and stock watering (SFC, 1996).

The alternating sandstones and shales of the Atoka Formation that underlie the SFC site have low permeabilities, which yield only a few gallons per minute of fair- to poor-quality water (SMI, 2001). The lower permeabilities also reduce potential yields from this formation. Groundwater in the vicinity of the site also can discharge to springs or recharge other deeper rock layers. For example, shallow groundwater discharges to the Salt Branch to the north of the SFC site and the Salt Branch tributary to the east of the site (SFC, 2003).

> "Permeability" is the capacity of a porous rock, sediment, or soil for transmitting a fluid (e.g., water) (Bates and Jackson, 1984).

The Carlile School Fault lies 1.6 km (1 mile) east of the SFC facility (see Figure 3.3-3). Any groundwater that encounters the fault is expected to flow down-drainage, away from the facility. Flow across the fault is not anticipated due to the discontinuity of rock strata across the fault and a near-vertical dip of rock layers adjacent to the fault (SMI, 2001).

Groundwater Usage

In 1991, SFC and the Oklahoma State Department of Health (OSDH) initiated a survey to identify any water wells within a 3-km (2-mile) radius of the SFC site (SFC, 1991). The locations of the wells that were identified are indicated on Figure 3.3-4, and Table 3.3-2 summarizes the uses of the wells.

Table 3.3-2 Groundwater Usage Based on 1991 Survey of Wells within 3 Kilometers (2 Miles) of the SFC Site

Location	Use	Number of Wells
On-site *	Irrigation (lawn watering)	1
On-site *	Not in use	9
Off-site	Domestic/Livestock	10
Off-site	Not in use	7
Off-site	Unknown	1

Source: SFC, 1991.

* On the SFC site or on nearby property owned by Sequoyah Fuels International Corporation

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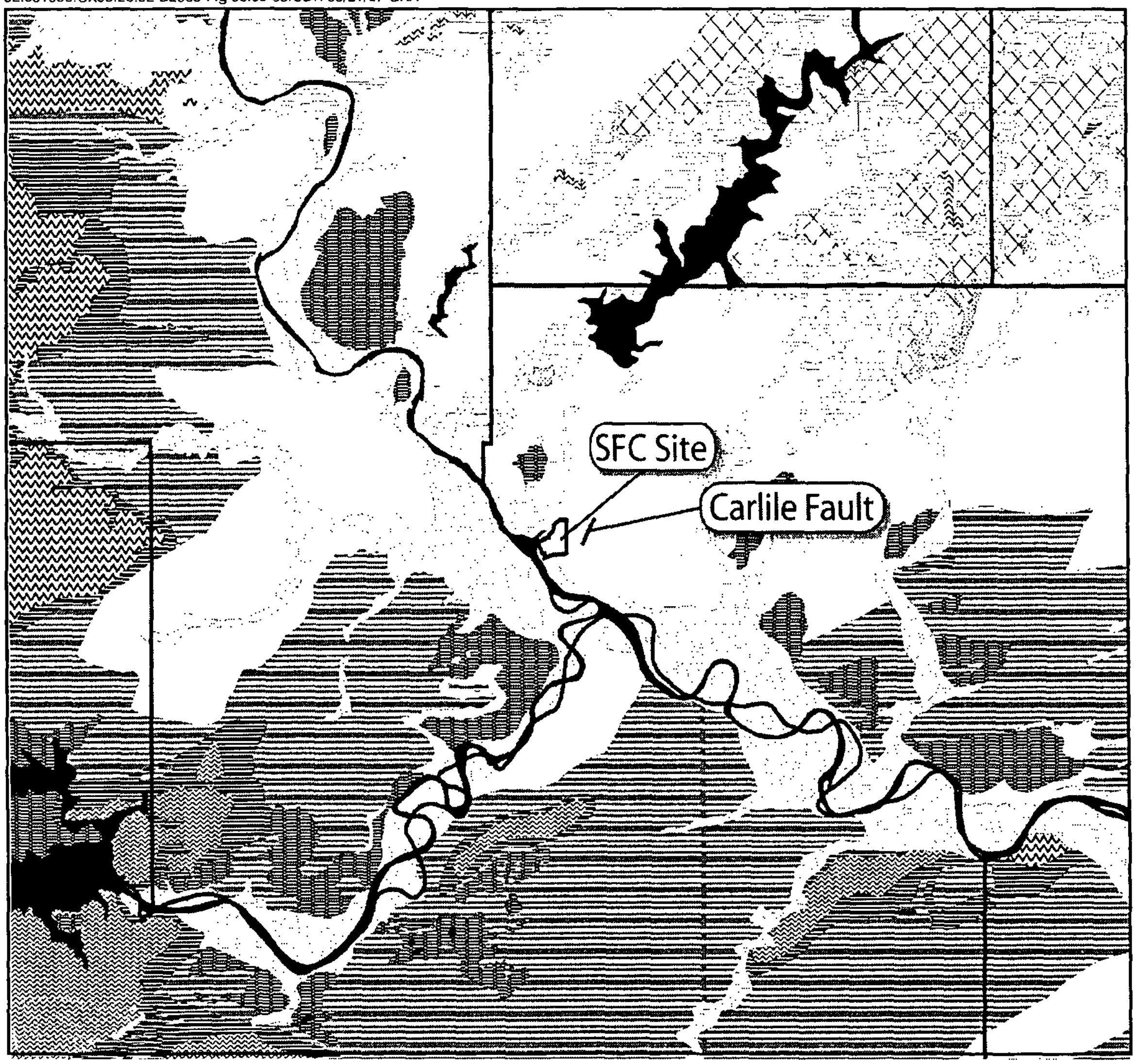

Figure 3.3-3 Location of Carlile School Fault Relative to the SFC Site

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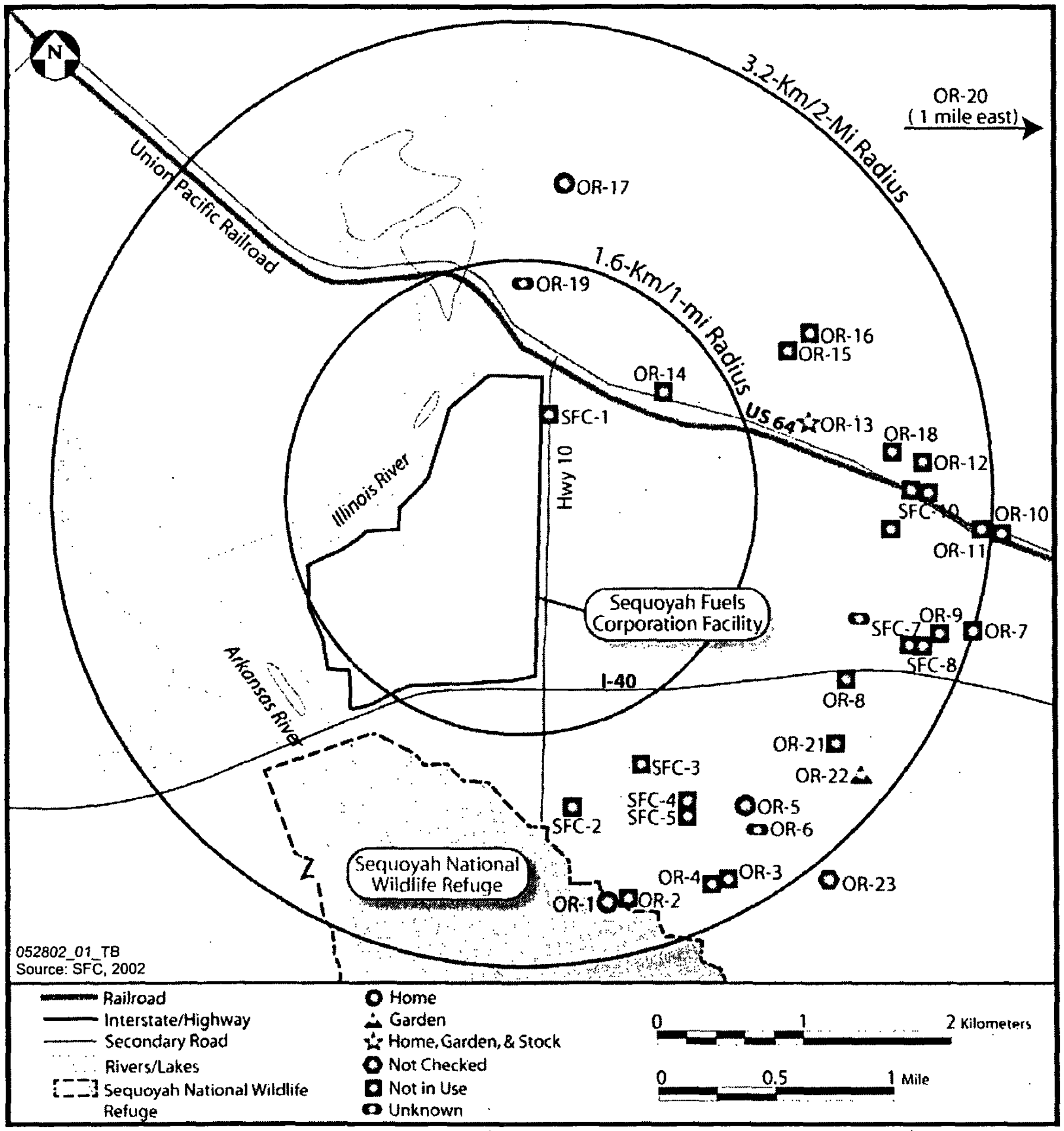

Figure 3.3-4 Groundwater Wells within 3 Kilometers (2 Miles) of the SFC Site (identified during 1991 survey by SFC and OSDH)

Based on the 1991 survey, no groundwater users were identified in the hydraulically down-gradient area between the SFC site and the Arkansas and Illinois Rivers (SFC, 1991).

In September 1990 and in May 1991, the OSDH and SFC sampled a total of 23 off-site groundwater supply wells in the site vicinity. The analytical results indicated that none of the wells exceeded drinking water standards for gross alpha, gross beta, or radium-226. In addition, uranium was not detected and fluoride concentrations were at or near background levels and did not exceed EPA drinking water limits. Nitrate concentrations were elevated in samples from several wells, but these results were likely due to landowner septic tanks and/or barnyard animals. These sampling results indicated that site operations had not impacted off-site groundwater users (SFC, 1991).

In April 2001, SFC performed a follow-up check that indicated that four wells within the 3-km (2-mile) radius of the facility were being used for home, stock, and/or garden use (SFC, 2002). No off-site groundwater users were located downgradient of the site (i.e., west and south of the site). Within 3 km (2 mile) downstream of the site, the Oklahoma Water Resources Board identified for SFC two stream water diversions, both used for irrigation purposes (SFC, 2005a).

3.3.2.2 Local Groundwater

From the alternating sandstones and shales of the Atoka Formation beneath the site, SFC has identified and characterized three groundwater systems that underlie most of the facility process and industrial areas. These systems are (from the ground surface down): the terrace, the shallow bedrock, and the deep bedrock systems (see Figures 3.3-5 and 3.3-6). In addition to these three systems, the alluvial aquifer system is found on the western portion of the site, along the Robert S. Kerr Reservoir (SFC, 1998).

Alluvial Aquifer System

The alluvial aquifer system is found in the clay and silt deposits, with lesser amounts of sand and gravel, that exist in the westernmost portion of the facility. These materials were deposited by the Arkansas and Illinois Rivers, and they range from 0 to 11.5 meters (0 to 35 feet) in thickness (SFC, 2003). Figure 3.3-7 depicts the potentiometric surface of this system. As can be seen, groundwater in the alluvial aquifer system flows to the west and south, toward the Illinois and Arkansas Rivers, respectively. This system is the only significant freshwater aquifer in the facility area (SFC, 1996). In the vicinity of the SFC site, groundwater yields from this aquifer likely range from 3.8 to 38 lpm (1 to 10 gpm) (SFC, 1998). However, there are no known users of groundwater from the alluvial deposits in the SFC facility area.

> The "potentiometric surface" for an aquifer provides an indication of the directions of groundwater flow in the aquifer. Groundwater flow is in the direction from higher water-level elevations to lower water-level elevations (Freeze and Cherry, 1979).

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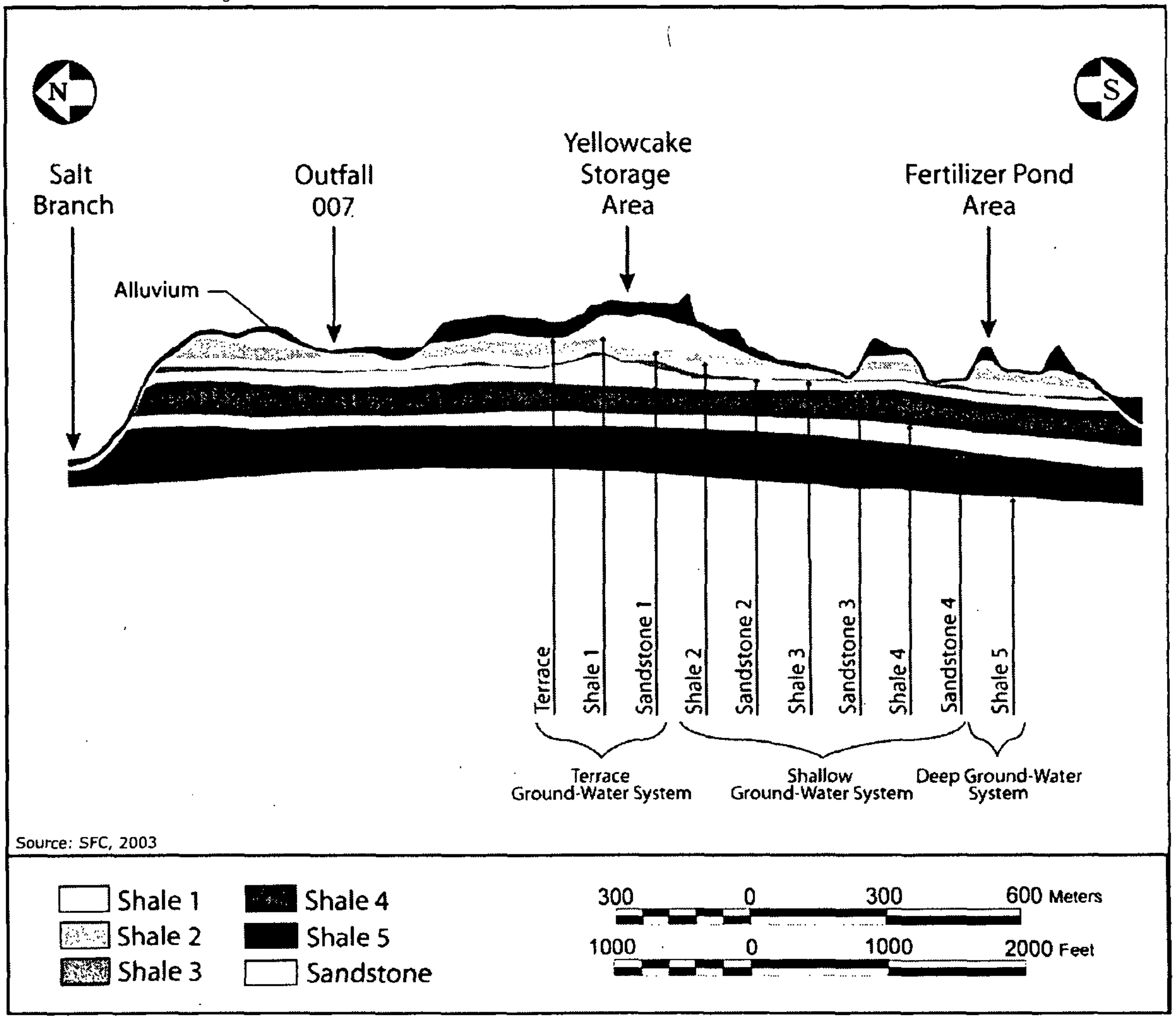

Figure 3.3-5 Schematic of Terrace, Shallow Bedrock, and Deep Bedrock Aquifers Beneath the SFC Site (North-South Orientation)

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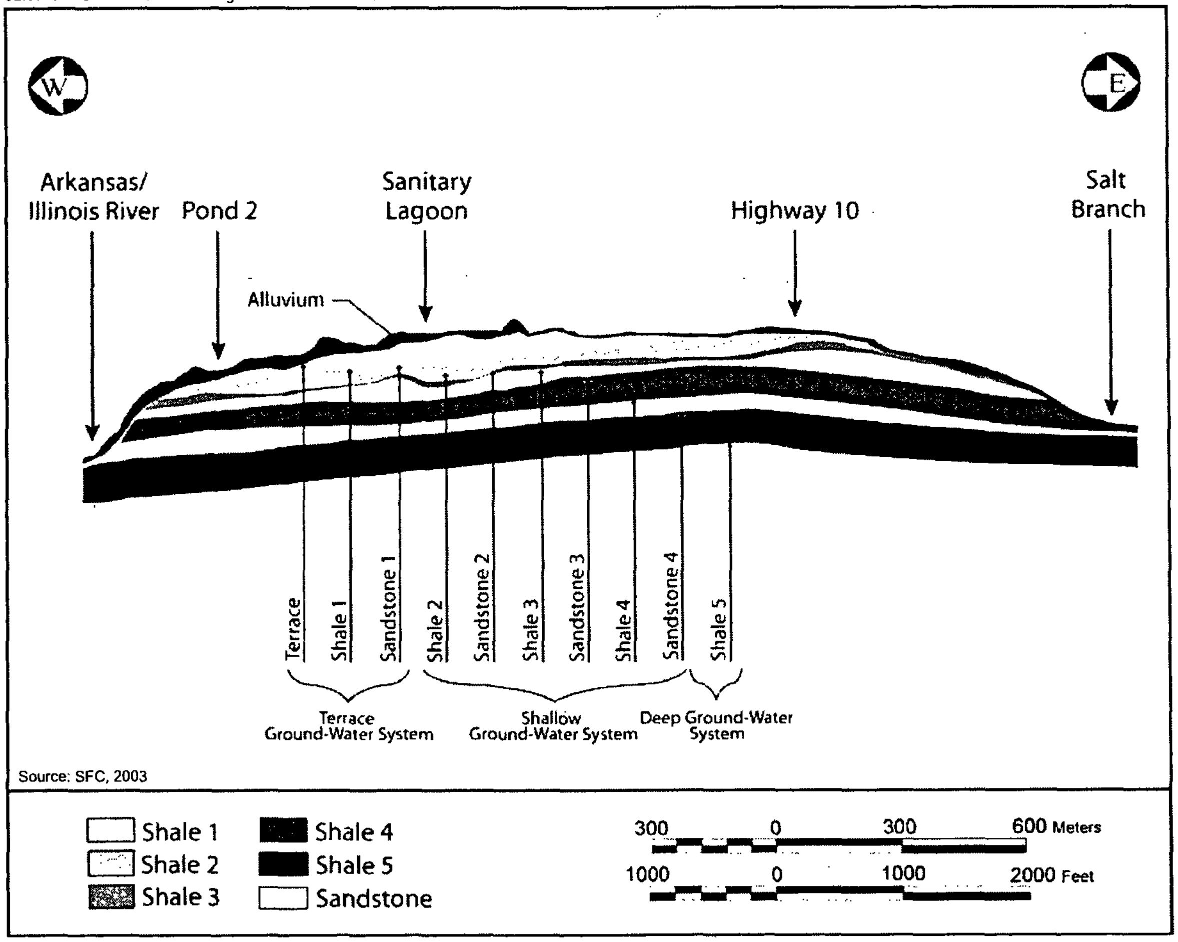

Source: SFC, 2003

Figure 3.3-6 Schematic of Terrace, Shallow Bedrock, and Deep Bedrock Aquifers Beneath the SFC Site (East-West Orientation)

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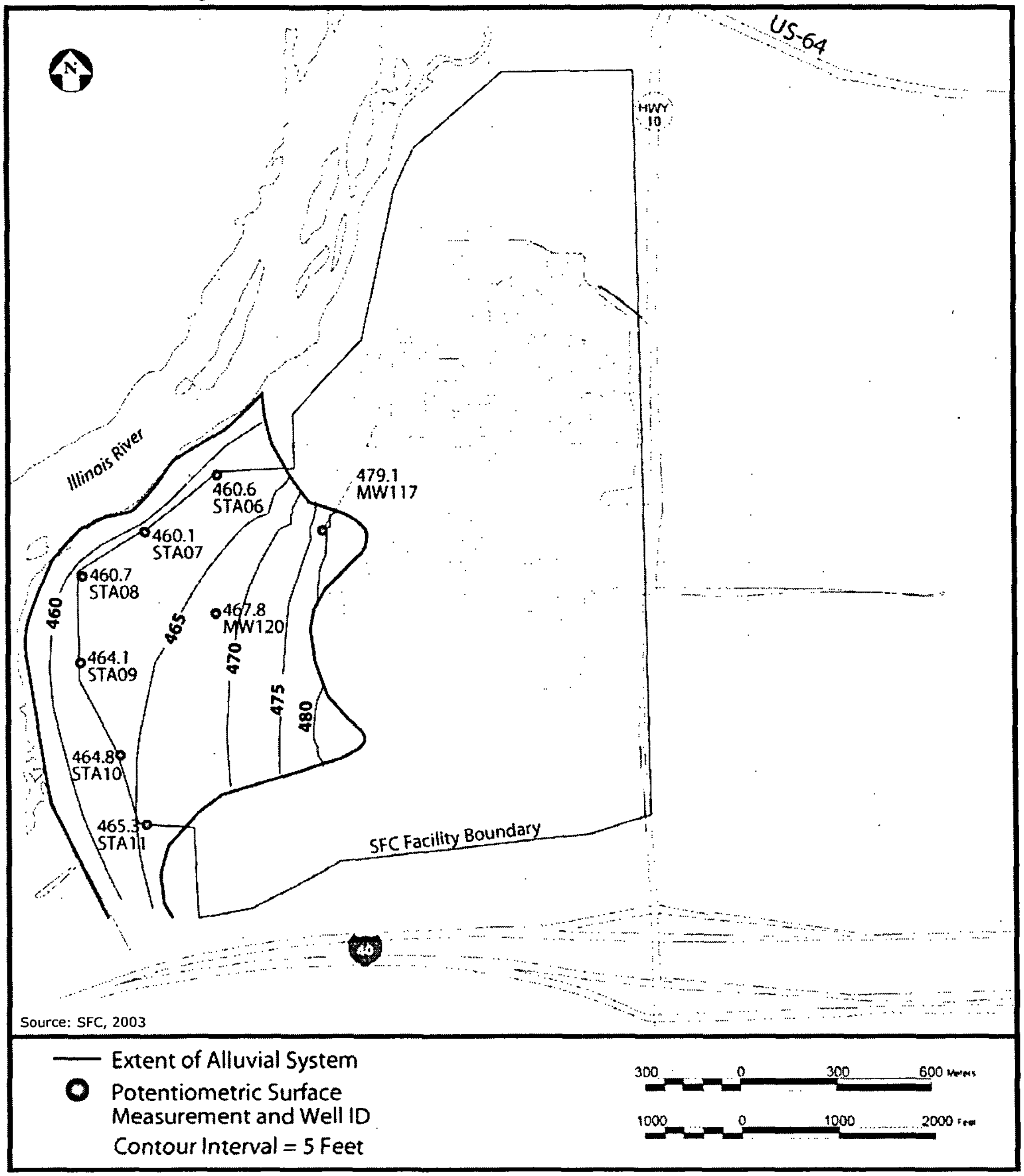

Figure 3.3-7 The Potentiometric Surface of the Alluvial Aquifer System

Terrace-Shale 1 Groundwater System

The uppermost groundwater system at the facility is the terrace-shale system. This system is unconfined and occurs in the site terrace deposits and the uppermost site shale (the "Unit 1 shale") of the Atoka Formation.

> A "confined aquifer" is bounded above and below by impermeable or distinctly less permeable rock strata. (Bates and Jackson, 1984)
>
> An "unconfined aquifer" has the water table as its upper boundary. (Freeze and Cherry, 1979)

Atoka Formation. It is first encountered at depths of 0 to 6 meters (0 to 20 feet). With calculated yields of less than 0.38 lpm (0.1 gpm), the terrace system yields little groundwater (MFG, 2002). Groundwater in this system flows radially away from the main process building, as shown on Figure 3.3-8.

Shallow Bedrock Groundwater System

Beneath the terrace groundwater system lies the interbedded shale and sandstone sequence of the shallow bedrock groundwater system. This system, which is confined and first encountered at depths of 3 to 12 meters (10 to 40 feet), extends downward from the bottom of the sandstone underlying the Unit 1 shale through the Unit 2 and 3 shales and sandstones to the bottom of the Unit 4 shale. Figure 3.3-9 depicts the potentiometric surface of the Unit 4 shale. This figure illustrates that the flow in this system is towards the southwest, west, and northwest in the Process Area and becomes more westerly as it leaves this area (SFC, 2003). Calculated yields from the Unit 2 and 3 shales are less than 0.38 lpm (0.1 gpm). The Unit 4 shale may have a limited potential to yield groundwater at slightly greater than 0.38 lpm (0.1 gpm), but the background groundwater quality of the shale is poor, with a measured sulfate concentration of 1,750 mg/L and a total dissolved solids concentration of over 3,100 mg/L (MFG, 2002).

Deep Bedrock Groundwater System

The Unit 5 water-bearing shale, which lies stratigraphically below the Unit 4 sandstone, is referred to as the deep bedrock groundwater system. This system is found at depths of 1.5 to 18 meters (5 to 60 feet) below the ground surface, depending on location at the site, and has a thickness of up to 10 meters (33 feet) (SFC, 1998).

Groundwater Flow

A conceptualized diagram of the site hydrogeology is presented on Figure 3.3-10. Lateral flow beneath the SFC site generally occurs in the shales, which are fissile (i.e., they split easily along closely spaced planes). The shales also exhibit a wide range (three orders of magnitude) in hydraulic conductivity (i.e., the rate at which water can flow through a cross-section of the rock). The sandstone units, while fractured, are highly cemented and thus do not freely conduct water. Groundwater flow through these sandstone units is considered to be primarily vertical. In general, the shale units are the primary water-bearing units in the area of the facility, while the sandstone units act as barriers to groundwater movement between the shales (SMI, 2001).

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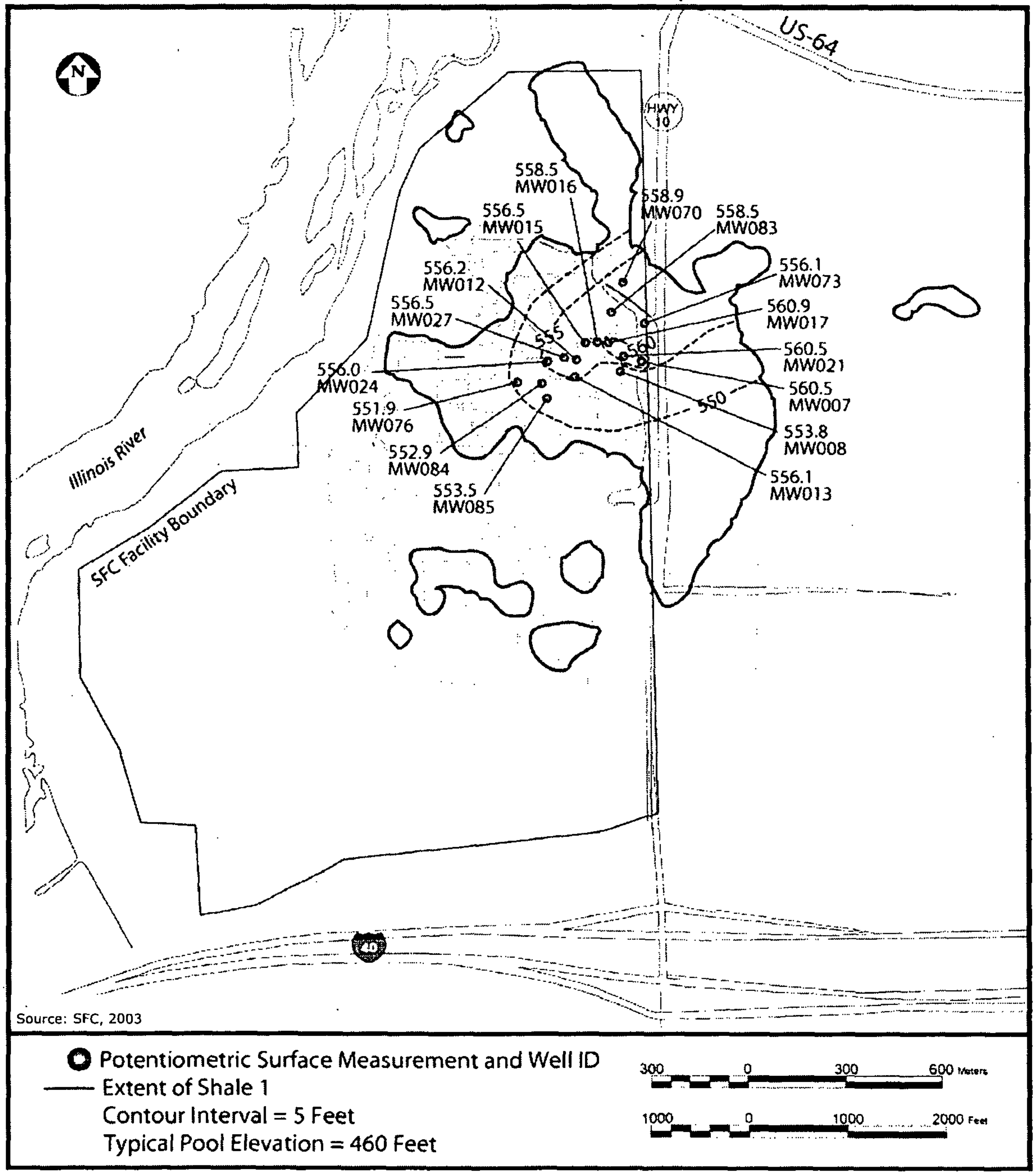

Figure 3.3-8 The Potentiometric Surface of the Terrace - Shale 1 Groundwater System

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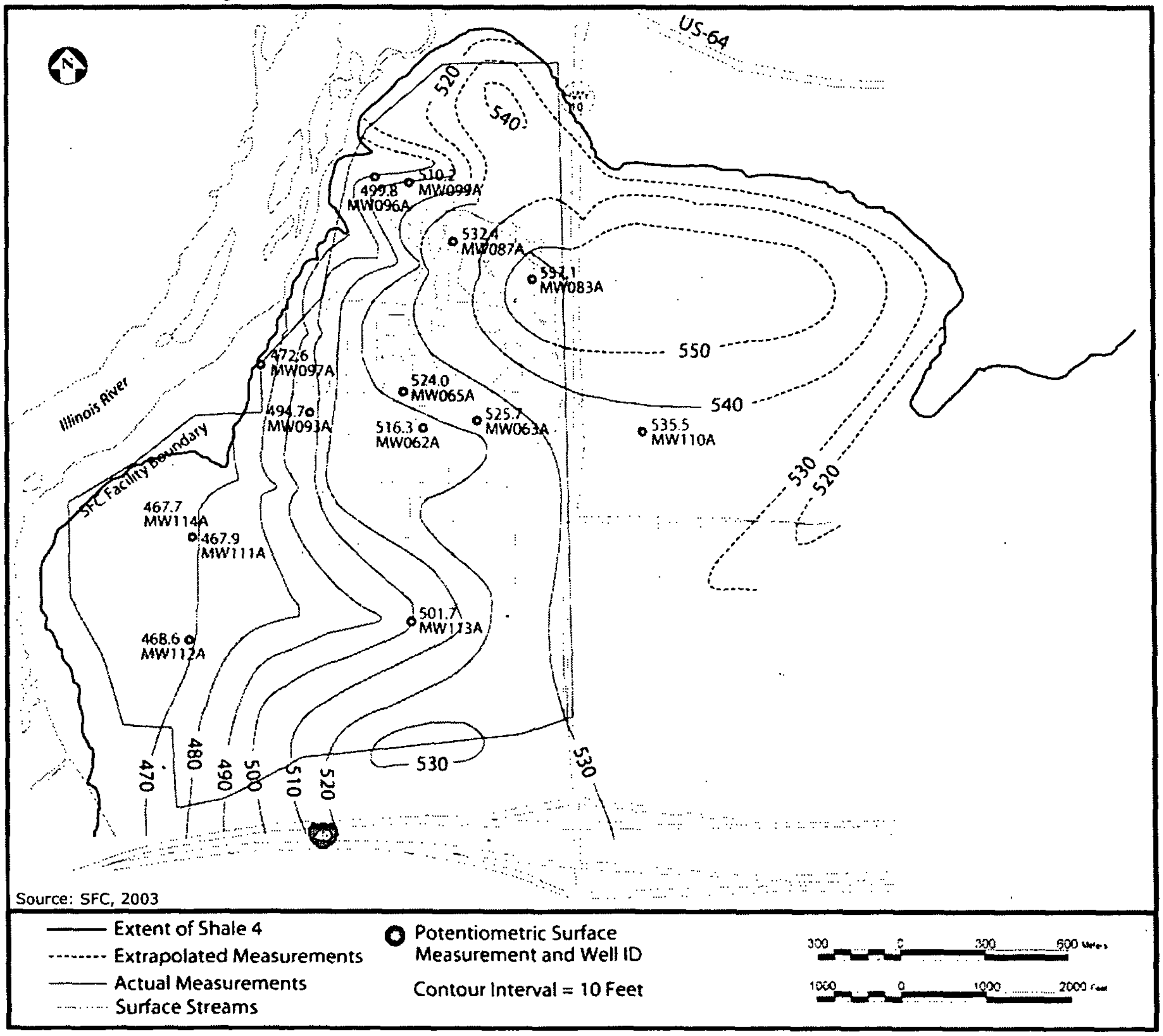

Figure 3.3-9 , The Potentiometric Surface of the Unit 4 Shale (of the shallow bedrock system)

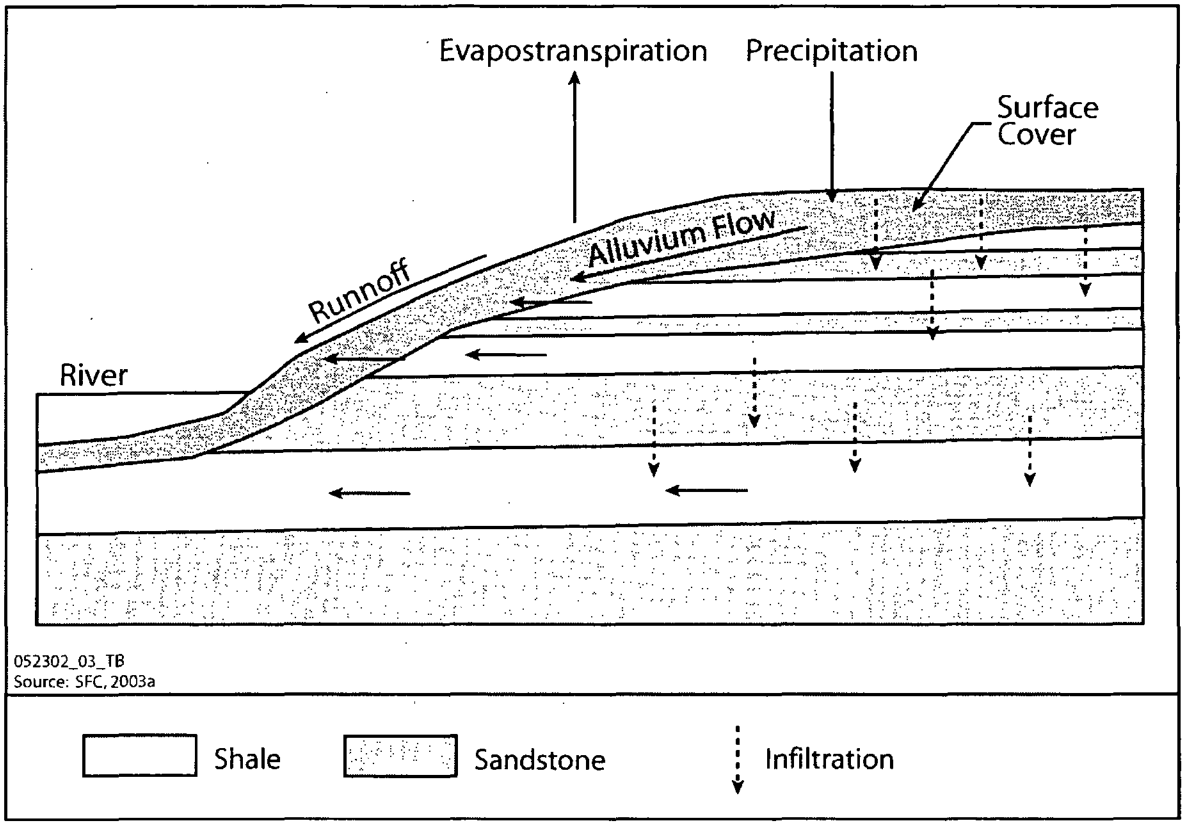

Figure 3.3-10 Conceptualized Diagram of the SFC Site Hydrogeology

Groundwater in the various shale units discharges laterally to streams that flow to the Robert S. Kerr Reservoir, hillside colluvium, and/or to Arkansas/Illinois River alluvium (MFG, 2002). ("Colluvium" is the unconsolidated sediments at the site, composed typically of silts, clays, and/or sands, with varying amounts of gravel.) In addition, the Unit 4 shale, which is continuous beneath the Salt Branch tributary to the east of the SFC site, also discharges to the Illinois River (SMI, 2001). The Unit 5 shale is partially continuous across the Salt Branch and probably discharges to it, and hydrologic modeling of the site indicates that this shale discharges directly to the Robert S. Kerr Reservoir at the north end of the SFC site (SMI, 2001).

Potentiometric surface maps for the alluvial aquifer and the terrace and shallow bedrock groundwater systems are presented on Figures 3.3-7, 3.3-8, and 3.3-9, respectively. These maps clearly indicate that groundwater flows away from the main process building (SFC, 2003).

Groundwater Quality

Background Groundwater Quality. As part of its *Groundwater Monitoring Plan* (SFC, 2005a), SFC selected nine groundwater monitoring wells (MW005, MW005A, MW007, MW007A, MW007B, MW072, MW072A, MW072B, and MW110A) from which to determine background groundwater quality for the site. SFC chose these nine wells, which are located upgradient of the facility, from the three groundwater systems beneath the site (i.e., the terrace, shallow bedrock, and deep bedrock systems). The locations of these wells are indicated on Figure 3.3-11.

SFC installed these wells after facility operations had begun; thus, samples from these wells do not provide true background concentrations. However, concentration levels for the various constituents suggest that site operations have had little to no impact on the quality of water from these wells.

The results of SFC's analysis of samples from these nine wells for the major COCs (i.e., uranium, nitrate, fluoride, and arsenic) are provided in Table 3.3-3. The results reflect SFC's removal of certain data due to (1) the change in minimum detection limits for uranium and arsenic, (2) an evaluation of outliers, and (3) impacts on the initial analyses from the installation of a new well. SFC attributed the elevated fluoride levels in the deep bedrock aquifer (elevated relative to levels in the other two systems) to a naturally occurring constituent in the Unit 5 shale (SFC, 2005b).

Table 3.3-3 SFC Site Background Groundwater Quality

Aquifer System	Mean	Standard Deviation	No. of Wells	No. of Samples
Uranium in µg/l (MCL = 30 µg/l)				
Terrace	1.07	0.41	3	21
Shallow Bedrock	1.0	0.24	4	27
Deep Bedrock	1.15	0.56	2	14
Nitrate (as Nitrogen) in mg/l (MCL = 10 mg/l)				
Terrace	1.28	0.67	3	41
Shallow Bedrock	2.16	1.27	4	46
Deep Bedrock	0.96	0.43	2	19
Fluoride in mg/l (MCL = 4.0 mg/l)				
Terrace	0.61	0.27	3	28
Shallow Bedrock	0.63	0.24	4	32
Deep Bedrock	2.25	0.61	2	15
Arsenic in mg/l (MCL = 0.01 mg/l)				
Terrace	0.006	0.003	3	30
Shallow Bedrock	0.006	0.003	4	29
Deep Bedrock	0.006	0.002	2	21

Source: SFC, 2005b.
MCL = maximum contaminant level, per EPA's National Primary Drinking Water standards.

Classification for Potential Use. SFC has classified the groundwater at the site using the EPA's draft final guidelines for such classification (EPA, 1986). These EPA guidelines established a three-tiered system that recognizes that different groundwater systems require different levels of protection (see text box below). Based on this classification scheme, SFC concurred with the EPA that the groundwater system for the site could be classified as Class IIB, signifying a potential source of drinking water (SFC, 1997). A Class IIB designation means that the groundwater can be obtained in sufficient quantity to meet the needs of an average family by

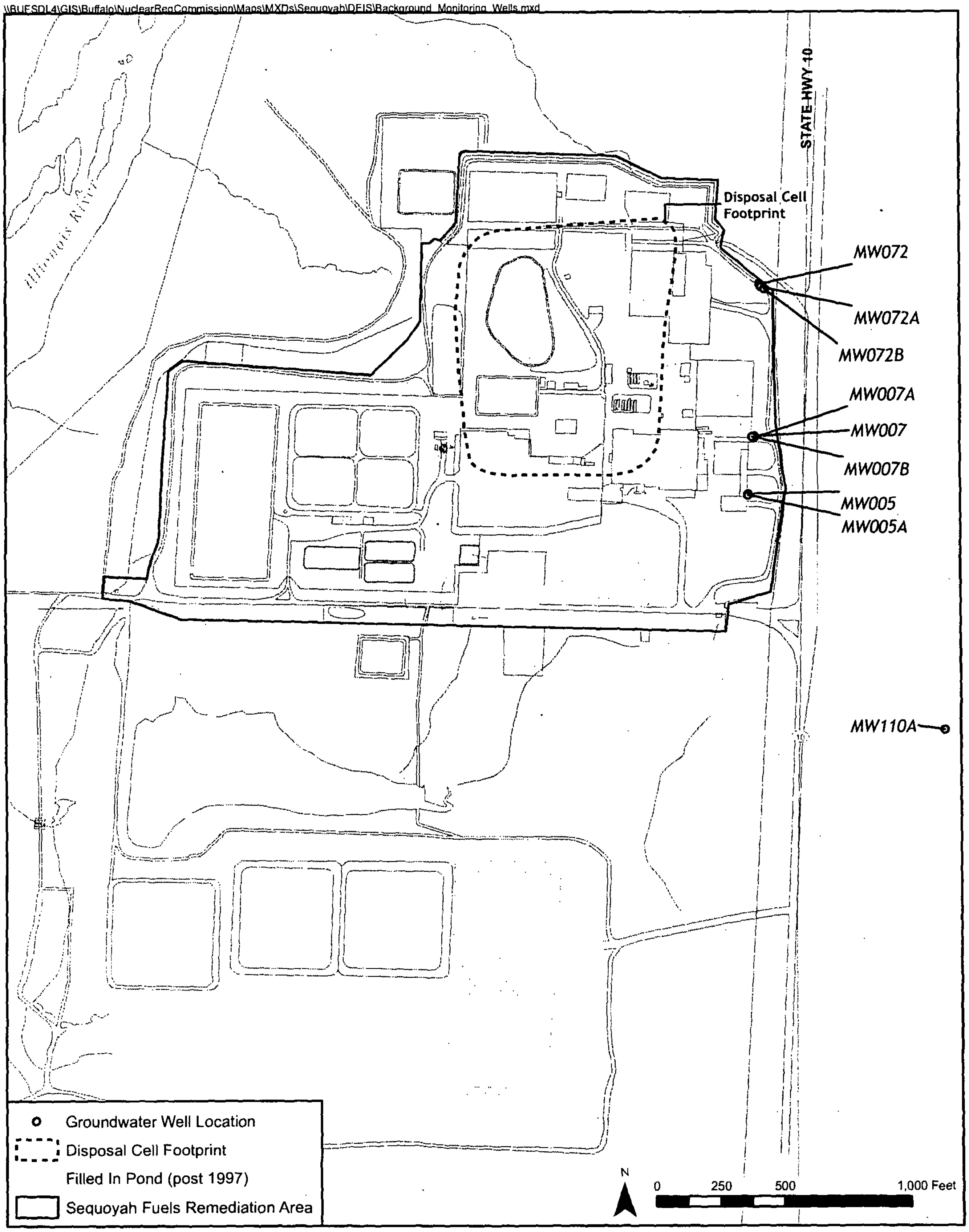

Figure 3.3-11 Sequoyah Fuels Corporation Background Monitoring Well Locations

providing approximately 568 liters (150 gallons) per day and has total dissolved solids (TDS) of less than 10,000 mg/L. Such water is considered suitable for drinking or amenable to methods reasonably employed by public water systems (EPA, 1986).

Classification of the SFC site groundwater as Class IIB was based on sustained yields from the alluvial aquifer of between 3.8 and 37.8 liters (1 and 10 gallons) per minute. Therefore, although SFC classified the other groundwater systems at the site (i.e., the terrace, shallow bedrock, and deep bedrock systems) as Class IIIA due to their insufficient yield, the overall classification of groundwater at the site is Class IIB (SFC, 1997).

EPA Classification of Groundwater

Class I	Resources of unusually high value. They are highly vulnerable to contamination and are either irreplaceable as a drinking water source to substantial populations or ecologically vital.
Class IIA	Current source of drinking water.
Class IIB	Potential source of drinking water: sufficient to yield 568 liters (150 gallons)/day with a TDS < 10,000 mg/l, which can be used without treatment or with reasonably employed treatment methods.
Class IIIA	Not a potential source of drinking water: intermediate-to-high interconnection and > 10,000 mg/L TDS, or untreatable, or not a source of drinking water due to insufficient yield.
Class IIIB	Not a source of drinking water: low interconnection and >10,000 mg/L TDS or untreatable.

Source: EPA, 1986

Existing Site Contamination. Groundwater at the facility has been contaminated by past site operations. A comprehensive well monitoring program, installed as part of a facility environmental investigation conducted in 1990 and 1991 (SFC, 1991), determined that uranium, fluoride, nitrate, and arsenic are present at concentrations above background levels. SFC has indicated that uranium contamination is chiefly centered near the main process and solvent extraction buildings (see Figures 2.1-3 and 2.1-4). Elevated levels of nitrate, arsenic, and fluoride are found throughout the process area; elevated levels of nitrate also are present in the alluvial aquifer in the western portion of the site as a result of SFC's nitrate application program. The extent and distribution of modeled current and future nitrate concentrations are shown in Figures 108 through 112 in SFC's responses to a request for additional information (SFC, 2005c). Elevated levels of barium also have been found in a localized area north of the clarifier basins.

SFC's remedial strategy for the nitrates in the northern portion of the site is the same as that for the other contaminants. They have installed interceptor trenches and will install extraction wells to remove contaminant mass from the aquifer systems. Despite the current remedial actions, some nitrate contamination will migrate off-site, and these remedial structures will not draw back contamination that has already flowed past.

Regarding the southern portion of the site, no remedial actions are planned where nitrate contamination is present. As a result, nitrates will migrate unabated into the Illinois River. This type of remedial action is essentially natural flushing, which is permitted by the DOE for long-term site control under Title I of UMTRCA. Under Title II of UMTRCA, however, the SFC site can be transferred to the DOE for long-term site control only after the groundwater standards have been met.

By license amendment 31 to SFC's NRC license, the NRC staff approved SFC's groundwater compliance monitoring plan (NRC, 2005a). The NRC staff reviewed SFC's monitoring plan in accordance with the provisions of 10 CFR Part 40, Appendix A, Criteria 5 and 7, which outline the requirements for groundwater compliance monitoring for 10 CFR Part 40 licensees, such as SFC. With that approval, hazardous constituents present in the groundwater as a result of SFC's licensed activities were identified; groundwater protection standards for those hazardous constituents were set; and the locations, frequency, and parameters for compliance monitoring were determined (NRC, 2005a).

The hazardous constituents for the SFC site and the protection standards for each of these constituents are identified in Table 3.3-4. SFC's *Groundwater Monitoring Plan* is described in greater detail in Chapter 6.

Table 3.3-4 Hazardous Constituents in Groundwater at the SFC Site and Associated Protection Standards

Hazardous Constituent	Groundwater Standard	Type of Standard
Antimony (mg/L)	0.006	ACL
Arsenic (mg/L)	0.01	MCL
Barium (mg/L)	1.0	ACL
Beryllium (mg/L)	0.004	ACL
Cadmium (mg/L)	0.01	MCL
Chromium (mg/L)	0.05	MCL
Fluoride (mg/L)	4.0	ACL
Lead (mg/L)	0.05	ACL
Mercury (mg/L)	0.002	MCL
Molybdenum (mg/L)	0.012	Background
Nickel (mg/L)	0.023	Background
Nitrate (mg/L)	10	ACL
Combined Radium-226 and 228 (ρCi/L)	5	MCL
Selenium (mg/L)	0.01	ACL
Silver (mg/L)	0.05	MCL
Thallium (mg/L)	0.005	ACL
Thorium-230 (ρCi/L)	1.2	Background
Uranium (μg/L)	30	ACL

Source: SFC 2005a.
ACL - Alternate concentration limit (derived from EPA National Primary Drinking Water regulations).
MCL - Maximum contaminant level (from EPA National Primary Drinking Water regulations).

As indicated in Table 3.3-5, uranium concentrations have been found to be elevated above the MCL in both the terrace and shallow bedrock aquifer systems. A closer look at the results from the shallow bedrock aquifer system show that the MCL was not exceeded in the lower unit of the aquifer system (i.e., the Unit 4 shale) (SFC, 2006b). In addition, concentrations above the MCL were not recorded in samples from the deep bedrock aquifer.

Table 3.3-5 Summary of Groundwater Compliance Monitoring Results for 2005 and 2006

Aquifer System	Minimum Value	Maximum Value	No. of Samples Over the MCL	No. of Samples
2005 Results				
Uranium (MCL = 30 μg/L)				
Terrace	< 1	48,400	7	23
Shallow Bedrock	< 1	3,100	6	29
Deep Bedrock	< 1	< 1	0	6
Nitrate (as Nitrogen) (MCL = 10 mg/L)				
Terrace	< 1	829	9	22
Shallow Bedrock	2	6,000	16	27
Deep Bedrock	< 1	2.9	0	6
Fluoride (MCL = 4.0 mg/L)				
Terrace	0.2	6	2	20
Shallow Bedrock	0.3	5.2	1	26
Deep Bedrock	0.5	2.5	0	6
Arsenic (MCL = 0.01 mg/L)				
Terrace	< 0.005	2.01	10	20
Shallow Bedrock	0.007	2.54	18	27
Deep Bedrock	< 0.004	0.009	0	6
2006 Results				
Uranium (MCL = 30 μg/L)				
Terrace	< 1	28,000	5	19
Shallow Bedrock	< 1	2,670	5	51
Deep Bedrock	< 1	19	0	12
Nitrate (as Nitrogen) (MCL = 10 mg/L)				
Terrace	< 1	877	6	19
Shallow Bedrock	8	6,190	27	51
Deep Bedrock	< 1	7	0	12
Fluoride (MCL = 4.0 mg/L)				
Terrace	0.2	4.5	1	19
Shallow Bedrock	0.3	4.9	1	51
Deep Bedrock	0.5	2.3	0	12
Arsenic (MCL = 0.01 mg/L)				
Terrace	< 0.005	1.09	7	19
Shallow Bedrock	< 0.005	2.95	21	51
Deep Bedrock	< 0.005	0.041	1	12

Source: SFC, 2006b.

Nitrate, fluoride, and arsenic concentrations were found to be above their respective MCLs in the terrace and shallow bedrock aquifer systems. In 2006, the MCL for arsenic was exceeded in one sample collected from the deep bedrock groundwater system (SFC, 2007). In addition, as noted previously, nitrate contamination has been found in the agricultural lands to the south, and this is attributed to its beneficial reuse as a part of SFC's land application program. The effects of nitrate loading to the Illinois River can be approximated by calculating the expected increase in nitrate loads using weighted averages. Because flows in the Illinois River far exceed the groundwater flow from the site into the river, the actual increase in concentration would likely be low. From information provided in SFC's groundwater *Corrective Action Plan* response to RAI (SFC, 2005c), NRC staff calculated the concentration increase in the Illinois River using flow as a weighting factor. NRC staff estimates the nitrate increase in the Illinois River to be relatively small, at 0.02 mg/L.

Under its NRC license, SFC is required to submit an annual groundwater report that summarizes the results of its compliance monitoring. The report is required to contain a table of results, groundwater contour maps, and groundwater isoconcentration maps for arsenic, fluoride, nitrate, and uranium (NRC, 2005b). The results of groundwater compliance monitoring for 2005 and 2006 are summarized in Table 3.3-5.

3.4 Public and Occupational Health

This section describes the radiological and chemical background in terms of public and occupational exposure and health and historical exposure levels from SFC's previous industrial operations. This section also summarizes public health studies performed in the region, which were used to establish the baseline information necessary for the analysis of impacts on public and worker health that may result from the implementation of the proposed action and its alternatives (see Chapter 4).

3.4.1 Background Radiological Exposure

Humans are exposed to ionizing radiation from many sources in the environment. One source is cosmic radiation, or charged particles, primarily protons, from extra-terrestrial sources that are incident on the earth's atmosphere. Cosmic rays directly account for a proportion of the naturally occurring radiation present in the environment. Radioactivity is also present in soil, rocks, and in living organisms from naturally occurring elements in the environment.

The average exposure from naturally occurring radionuclides in the soil in the United States has been estimated to range from 0.28 millisieverts (28 millirem) per year (NCRP 1987) to 0.60 millisieverts (60 millirem) per year (NRC, 2004). A major proportion of natural background radiation comes from naturally occurring radon in the air, which contributes about 2 millisieverts (200 millirem) per year and is related to radioactivity in the soil and rocks (NCRP, 1987). These natural radiation sources contribute to the annual background dose received by individuals.

Man-made sources of radiation also contribute to the background dose. These sources include X-rays for medical purposes, nuclear medicine, and consumer products. The current average dose to a person living in the United States from both natural and man-made radiation sources is about 3.6 millisieverts (360 millirem) per year. Figure 3.4-1 shows the relative contribution of each of these sources to the dose received by an average member of the public residing in the United States (Kathren, 1984).

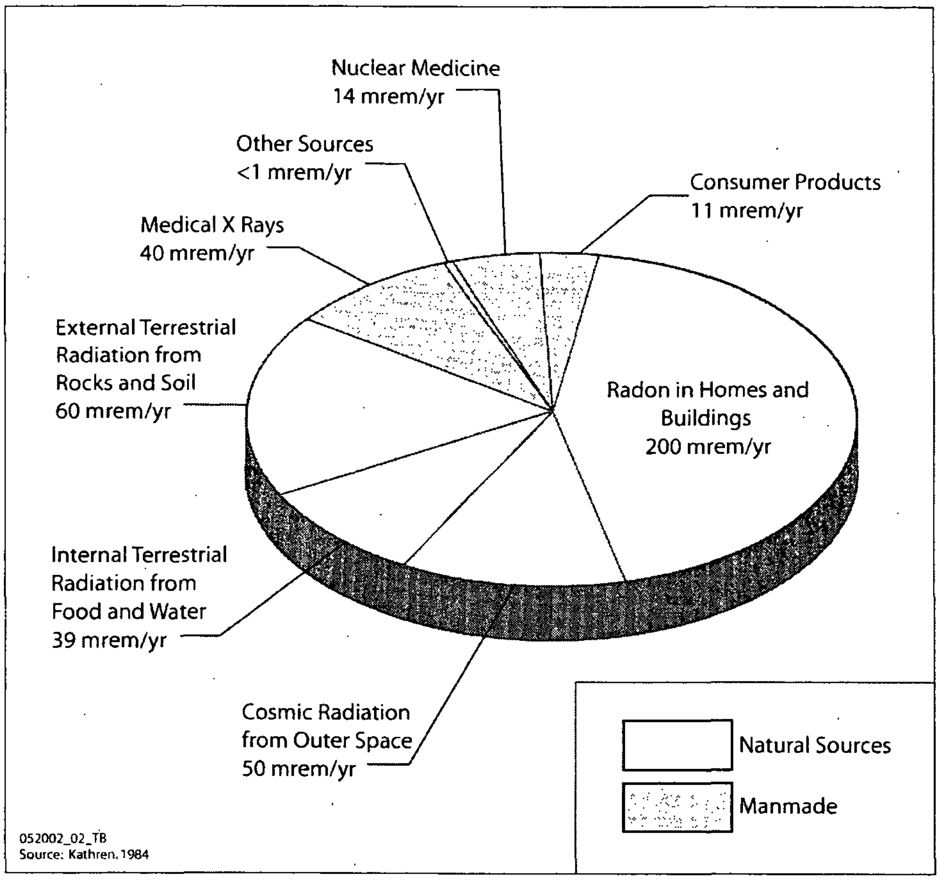

Figure 3.4-1 The Relative Contribution of Background Sources of Radiation in the United States

The major radioactive impurities in yellowcake are radium-226 and thorium-230. The SFC site has been monitored for these radioactive elements in addition to uranium. Background radiological characteristics of the SFC site have been determined from 31 soil samples taken from outside the facility boundary. These samples were analyzed for uranium, radium-226, and thorium-230, and the results are shown in Table 3.4-1 (SFC, 2001).

Table 3.4-1 Concentrations of Radionuclides in Background Soil Samples

Value	Concentration in Soil (pCi/g)		
	Natural Uranium	Radium-226	Thorium-230
Minimum	<0.684	0.1	0.4
Maximum	1.71	1.6	1.8
Average	0.99	0.91	0.9
Median	0.96	0.9	0.75

Source: SFC, 2001.

Groundwater samples collected from the background monitoring wells shown on Figure 3.3-11 were also analyzed for background radioactivity levels. Table 3.4-2 provides concentrations of radionuclides at the SFC site for terrace, shallow, and deep groundwater. These background groundwater wells were installed after plant operations began. Therefore, the levels are not "true" background levels, since it is not possible to know whether the levels have been affected by SFC's operations at the site. However, the results from wells located upgradient of the SFC site show little or no contamination.

Table 3.4-2 Concentrations of Radionuclides in Background Groundwater Samples from July 1993 to 2001

Constituent	Minimum	Maximum	Mean	Median	No. of Samples
Terrace Groundwater					
Total Uranium (mg/L)	0.57	12.40	2.92	1	24
Total Uranium (Bq/L)	0.014	0.314	0.074	0.025	24
Radium-226 (Bq/L)	0.004	0.022	0.013	0.013	2
Thorium (Bq/L)	0.019	0.337	0.129	0.030	3
Shallow Groundwater					
Total Uranium (mg/L)	0.57	500	2.11	1	27
Total Uranium (Bq/L)	0.014	0.127	0.053	0.025	27
Radium-226 (Bq/L)	0	0.004	0.003	0.004	3
Thorium (Bq/L)	0.011	0.022	0.017	0.017	2
Deep Groundwater					
Total Uranium (mg/L)	0.97	10.00	2.88	1.50	18
Total Uranium (Bq/L)	0.024	0.253	0.073	0.038	18
Radium-226 (Bq/L)	0.007	0.052	0.030	0.030	2
Thorium (Bq/L)	0.011	0.048	0.030	0.030	2

Source: SMI 2001.
To convert becquerels to picocuries, multyply by 27.

3.4.2 Background Chemical Exposure

In order to characterize the background soil metal concentrations in the area surrounding the site, soil samples were collected during the RFI investigation (SFC, 1996). Four off-site locations within 8 km (5 miles) of the site were selected to represent the three main soil series that are encountered in the Industrial Area. Sample locations were selected such that influences from human activities were minimized and drainage ways, paved surfaces, railroads, and agricultural (cropland) areas were avoided. Each borehole was advanced to a maximum depth of 1.2 meters (4 feet), and samples were collected and analyzed for metals.

The analytical results for background samples were compiled for each parameter, and calculations were performed to determine the mean and standard deviation. A background "prediction interval" was established for each metal at the 99% confidence level; the upper prediction interval is the arithmetic mean plus three standard deviations. The results of this statistical analysis are included in Table 3.4-3.

Table 3.4-3 Calculation of the Upper Prediction Interval Values for Background Soil Samples

Location		Ag	Al	As	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe	Hg	K	Li	Mg
HA223	BKG-1-B	0.6	11900	5.0	69.5	1.12	1920	4.8	6.6	20.6	14.1	33400	0.020	427	4.7	1240
HA223	BKG-1-C	0.6	9090	11.5	129.0	1.07	1950	5.0	15.3	19.5	9.7	36200	0.020	411	5.8	13.50
HA224	BKG-2-B	0.6	6000	5.0	63.3	0.78	756	3.6	13.3	16.8	5.0	25300	0.005	331	4.2	611
HA224	BKG-2-C	0.6	11400	17.2	116.0	1.25	1780	5.0	8.8	23.5	15.3	36600	0.010	585	8.7	1230
HA225	BKG-3B	0.6	10200	26.1	52.6	0.90	884	6.5	8.2	27.2	9.9	44400	0.020	435	8.5	849
HA226	BKG-4												0.030			
Mean		0.6	9718	13.0	86.1	1.0	1458	5.0	10.4	21.5	10.8	35180	0.018	438	6.4	1056
Std Dev		0.0	2347	8.9	34.1	0.2	588	1.0	3.7	4.0	4.1	6871	0.009	92	2.1	280
Mean + 3 Std Dev		0.6	16760	39.8	188.4	1.6	3221	8.1	21.5	33.5	23.1	55793	0.044	714	12.7	1895

Location		Mn	Mo	Na	Ni	P	Pb	Sb	Se	Sr	Ti	V	Zn
HA223	BKG-1-B	203	1.2	1160.0	8.2	75.6	26.2	10.0	10.0	16.70	5.0	34.2	24.9
HA223	BKG-1-C	504	1.2	1240.0	10.2	104.0	23.6	10.0	10.0	17.80	16.3	26.6	40.8
HA224	BKG-2-B	347	1.2	126.0	8.9	117.0	20.6	10.0	10.0	6.27	11.9	27.2	20.0
HA224	BKG-2-C	157	1.2	232.0	16.4	91.1	27.8	10.0	10.0	13.00	5.0	36.5	33.1
HA225	BKG-3B	178	1.2	89.7	13.1	235.0	24.1	10.0	10.0	7.69	5.0	31.3	38.4
HA226	BKG-4												
Mean		278	1.2	569.5	11.4	124.5	24.5	10.0	10.0	12.3	8.6	31.2	31.4
Std Dev		147	0.0	578.6	3.4	63.6	2.7	0.0	0.0	5.2	5.2	4.3	8.8
Mean + 3 Std Dev		718	1.2	2305.3	21.5	315.4	32.7	10.0	10.0	27.9	24.3	44.1	58.0

Notes:

1. Less than values were not deleted from the analysis. When data sets included a mixture of values that are less than a limit of detection and actual concentration measurements, less than values were analyzed at half their reported value. (This was required for As, Hg and Tl.)
2. The actual less than values were used during analysis for Ag, Mo, Sb and Se because all reported values were less than detection limits. (Data set did not include a mixture of values.)
3. Mercury analysis for BKG-4 (HA226) was not requested; however, since the laboratory ran analysis the results are included.

Background concentrations for fluoride and nitrate in soils were presented in the SFC Site Characterization Report (SFC, 1998). Data presented in this report indicated that nitrate analysis was performed on four soil samples collected at background locations HA270, HA272, HA307, and HA308. The concentration of nitrate detected in these samples ranged from 3 to 7 mg/kg nitrate. Fluoride analysis was performed on two background samples (HA270 and HA272). Fluoride concentrations of 134 mg/kg and 146 mg/kg were detected.

3.4.3 Public Health Studies

The National Vital Statistics System public-use data file includes both national and state death rate statistics. These data were calculated by the National Cancer Institute. The death rates are age-adjusted to the 2000 U.S. standard population by 5-year age groups. The new cancer data compiled for this DEIS are shown in Table 3.4-4. These data show that Sequoyah County is similar to the rest of Oklahoma and the U.S. in terms of overall cancer mortality.

New cancer data also were compiled for mortality due to renal (kidney) failure, a health endpoint of interest due to the renal toxicity of uranium. These data are summarized in Table 3.4-5. Data for the U.S. cover the period 1991 through 2003, while the data for Oklahoma cover the period 1979 through 2003 (data only available for Cherokee and Muskogee counties). Data for Sequoyah and other surrounding counties are suppressed to ensure confidentiality and stability of rate and trend estimates. When the population size for a denominator is small, the rates may be unstable; that is, a small change in the numerator (only one or two additional cases) has a dramatic effect on the calculated rate. Suppression is used to avoid misinterpretation when rates are unstable.

3.5 Transportation

This section describes the transportation routes and modes of transportation available to the SFC site.

3.5.1 Roads

U.S. Interstate 40 (I-40) runs immediately south of and adjacent to the SFC property. It is a principal east-west highway and extends from North Carolina to California.

The gates to the SFC site are on State Highway 10, which runs in a north-south direction and connects I-40 and U.S. Highway 64. U.S. Highway 64 runs just north of the SFC property in a path parallel to I-40. The primary road between Tulsa and the Gore area is the Muskogee Turnpike, a four-lane highway that extends from Webbers Falls to Tulsa, a distance of approximately 70 miles. The average daily traffic for the highways most affected by the proposed action and alternatives is provided below in Table 3.5-1.

3.5.2 Rail

The only railroad in the vicinity of the SFC site is the Union Pacific Railroad, which parallels U.S. Route 64 to the west of Gore but then heads north to a major junction at Wagoner, where connections can be made north to Kansas City and south to Fort Worth. The railroad is almost adjacent to the SFC property on the north, and its principal cargo is grain and coal.

Table 3.4-4 Death Rate/Trend Comparisons, All Cancers, Death Years Through 2003

Area	Death Rate Compared to US Rate[1]	Annual Death Rate Over Rate Period	Lower 95% Confidence Interval for Death Rate	Upper 95% Confidence Interval for Death Rate	Rate Period	Rate Ratio (County to U.S.)[2]	Recent Annual Percent Change in Death Rates[3]	Recent Trend[4]	Recent Trend Period[3,4]
United States	-	164.3	164	164.5	1999-2003	-	-0.9	Falling	1994-2003
Oklahoma	Similar	168.5	166	171.1	1999-2003	1.0	0.0	Stable	1999-2003
Sequoyah County	Similar	179.8	156.0	206.4	1999-2003	1.1	0.3	Stable	1979-2003

Notes: All rates are per 100,000 persons. When the population size for a denominator is small, the rates may be unstable. A rate is unstable when a small change in the numerator (e.g., only one or two additional cases) has a dramatic effect on the calculated rate. Suppression is used to avoid misinterpretation when rates are unstable.

1 Rate Comparison

"above" = when 95% confident the rate is above rate ratio > 1.10.
"similar" = when unable to conclude above or below with confidence.
"below" = when 95% confident the rate is below and rate ratio < 0.90.

2 The rate ratio is the county rate divided by the U.S. rate.

3 Recent trends in death rates were calculated using the Joinpoint Regression Program and are expressed as the annual percent change over the recent trend period. Recent trend period is the period since last change in trend as determined by Joinpoint.

4 Trend

"rising" = when 95% confidence interval of annual percent change is above 0.
"stable" = when 95% confidence interval of annual percent change is below 0.
"falling" = when 95% confidence interval of annual percent change is below).

Source: Death data provided by the National Vital Statistics System public-use data file. Death rates calculated by the National Cancer Institute (NCI) using SEER*Stat. Death rates are age-adjusted to the 2000 U.S. standard population by 5-year age groups. Population counts for denominators are based on census populations, as modified by NCI.

Table 3.4-5 Age-Adjusted Mortality Rates for Renal Failure

Year Range	United States	Oklahoma	Sequoyah County	Cherokee County	Muskogee County
1991-2003	4.2	-	-	-	-
1979-2003	-	5.2	--	8.2	5.3

Notes: - A dash indicates no data for the reported year range.
-- Two dashes indicates that the data has been suppressed to ensure confidentiality and stability of rate and trend estimates (too few deaths to be statistically evaluated).

Source: Death data provided by the National Vital Statistics System public-use data file. Death rates calculated by the National Cancer Institute using SEER*Stat.

Death rates are age-adjusted to the 2000 U.S. standard population by 5-year age groups. Population counts for denominators are based on census populations as modified by the National Cancer Institute.

Table 3.5-1 Average Daily Traffic on Local Highways (2005 Data, both directions)

Highway	Location	Traffic Count
Oklahoma Highway 10	Between Interstate 40 and U.S. Route 64	810
U.S. Route 64	2.4 km (1.5 miles) east of Highway 10	1,600
U.S. Route 64	Just east of Gore, Oklahoma	2,000
Interstate 40	Interstate 40 just west of Arkansas River bridge	17,100
Muskogee Turnpike (10 miles west of site)	Between Webber Falls and Tulsa	21,300

Source: OTCIS 2005; OHS 2005.

3.5.3 Water

The McClellan-Kerr Arkansas River Navigation System is a series of dams and locks used by large vessels along the Arkansas River. This river links Oklahoma to a 19,312-km (12,000-mile) inland waterway and both domestic and foreign ports (via New Orleans). The headwaters of the waterway is at the Port of Catoosa in Tulsa, Oklahoma, which contains a full intermodal terminal. The Illinois River is not navigable.

3.5.4 Air

Tulsa International Airport and the airport at Fort Smith, Arkansas, would facilitate air travel to the SFC site. Both airports are serviced by major U.S. airlines. The overland drive to Gore is approximately 129 km (80 miles) from Tulsa and 72 kilometers (45 miles) from Fort Smith. An airport and a helicopter landing pad are located within 16 km (10 miles) of the SFC site (see Table 3.5-2).

Table 3.5-2 Airports, Landing Strips, and Helicopter Landing Pads within 10 Miles of the SFC Site

Location of Airport	Airport Name	Distance and Direction from SFC Site	Airport ID
Gore, Oklahoma	Fin & Feather Resort Heliport	12.2 km (7.6 mi) NNE	25OK
Pickens, Oklahoma	Little River Ranch Airport	15.4 km (9.6 mi) SSW	79OK

Source: www.Airnav.com.

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None

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4. ENVIRONMENTAL IMPACTS

4.1 Introduction

This chapter provides an evaluation of the potential environmental impacts of the proposed action and its alternatives, including the no-action alternative. The chapter is organized by the environmentally affected areas presented in Chapter 3 (i.e., land use, water resources, public and occupational health, and transportation). Other nondiscriminating environmental resource areas for which the potential impacts were determined to be small are discussed in Appendix B. The potential environmental impacts are assigned a significance level, as defined below. This chapter also discusses the potential cumulative impacts associated the proposed action and other past, present, and reasonably foreseeable actions (Section 4.6).

Determination of the Significance of Potential Environmental Impacts

A standard of significance has been established by the NRC for assessing environmental impacts. With standards based on the Council on Environmental Quality's regulations, each impact should be assigned one of the following three significance levels:

Small. The environmental effects are not detectable or are so minor that they will neither destabilize or noticeably alter any important attribute of the resource.

Moderate. The environmental effects are sufficient to alter noticeably but not to destabilize important attributes of the resource.

Large. The environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

Source: NRC, 2003

4.2 Land Use Impacts

This section presents the potential direct and indirect impacts on land use and the associated tax revenue resulting from implementation of each of the alternatives.

4.2.1 Alternative 1: On-site Disposal of Contaminated Materials (the Licensee's Proposed Action)

The land use changes that would occur under the licensee's proposed action involve the construction of a disposal cell in the former Process Area in the northern portion of the SFC site, the dismantlement/demolition of the process buildings and equipment on the site, and placement of these materials in the disposal cell. The only exceptions to this dismantlement would be the administration building, which would be available for potential reuse, and the electrical substation. In addition, SFC would consolidate other materials such as contaminated soils, sludges, pond residues and sediments, and previously buried waste for placement in the disposal cell (see Chapter 2).

Following completion of surface reclamation, SFC has proposed that a 131-hectare (324-acre) fenced ICB be established around the disposal cell. This buffer zone surrounding the disposal cell would encompass areas that had detectable impacts from past site operations. At license termination, the disposal cell and area within the ICB would be transferred to a long-term custodian (either the State of Oklahoma or the DOE) for perpetual care. The ICB would be restricted in perpetuity from excavation, construction, and production water-well drilling. Authorized personnel would be able to access the ICB for the purposes of monitoring and maintenance.

The licensee would release the remaining 112-hectares (276-acres) of the original 243-hectare (600-acre) SFC site (46% of the SFC site) for unrestricted use. The released land could be appropriate for agricultural or residential development or be maintained as open space or park land, land uses that would be compatible with existing adjacent land uses.

The potential land use impacts of the licensee's proposed action would primarily affect the immediate vicinity of the SFC site rather than the regional area. These land use impacts could be characterized as MODERATE, in that the removal of the process facility and subsequent restrictions to and change in land use following reclamation will be noticeable but not sufficient to destabilize important attributes of the resource.

Implementation of this alternative would have indirect effects on the Sequoyah County tax base as a result of property ownership changes. Depending on future land ownership decision making, the area of the site within the ICB would remain in a custodial care status. If the DOE or another nontaxable governmental entity would assume ownership, the county tax base would be reduced since SFC currently makes an annual property tax payment to Sequoyah County at the same rate it paid when its facility was in operation. In 2004, Sequoyah County collected approximately $1,078,483 in real property taxes and, based on the estimation presented in Section 3.2 following the stoppage of operations at the site, SFC would be responsible for approximately $27,346 in property taxes, which represents about 2.5% of the county's tax revenue. When reclamation of the site is complete, SFC has estimated that $13,620 in property taxes would be due, equating to an overall loss of $13,756 in property tax revenue for the 131 hectares (324 acres) within the proposed ICB. The loss of this property tax revenue is considered a SMALL impact on the Sequoyah County tax base.

The parcels of land outside the ICB that would be released for unrestricted reuse would be subject to property taxes according to the type of reuse and the assessed value. Property tax assessments take into account property location, soil type, and land ownership classification (i.e., agricultural, commercial, residential, etc.). Agricultural land is taxed at a lower rate than commercial or residential uses. Therefore, future property tax revenues to Sequoyah County may be positively or negatively affected by an increase or reduction in future landowner payments. Given the lack of certainty in how and when the property would be redeveloped, the potential impact on the county's tax base cannot be determined at this time.

4.2.2 Alternative 2: Off-site Disposal of All Contaminated Materials

Under this alternative, the licensee would consolidate all contaminated soils, sludges, equipment, structures, and any other contaminated material and transport them via rail to a licensed off-site disposal facility. A 2.6-km (1.6-mile) railroad spur would be constructed to connect to the major railroad line north and east of the site. The railroad spur would traverse a combination of agricultural (pastureland/hayfield) and forestland. A review of recent aerial photographs (NAIP, 2003) indicates that agricultural land covers about 1.6 km (1 mile), or 63%, of the route, while forestland covers about 1 km (0.6 mile), or 27%, of the route. The forestland along the proposed route is contiguous with the forestland on the main SFC site and so is expected to be characterized as secondary growth oak-hickory forest.

The rail spur would be constructed within an approximately 30-meter (100-foot) -wide construction right-of-way (ROW). Establishment of this ROW would result in temporary disturbance of about 5 hectares (12 acres) of agricultural land and temporary removal of about 3 hectares (7 acres) of forestland. Following completion of the rail spur construction, the impacted forestland would be allowed to naturally revegetate. The rail spur would occupy an approximately 12-meter (40-foot) -wide permanently maintained ROW. Establishment of this ROW would result in the permanent removal of about 2 hectares (5 acres) of agricultural land and 1 hectare (3 acres) of forestland. Both of these land uses are common throughout the local area, and the land is currently traversed by numerous roads and existing railroad lines. In addition, the rail spur would require an at-grade crossing of State Highway 10, requiring a traffic stop. A permit would be required for this at-grade road crossing. The temporary and permanent impacts on agricultural and forested land uses associated with construction and operation of the rail spur under Alternative 2 would be considered SMALL.

After off-site transport of the contaminated materials, SFC would conduct further reclamation activities at the site such that the entire 243-hectare (600-acre) property (100% of the SFC site), including the administrative building, could be released for unrestricted future use. Future reuse of the site would likely be consistent with regional trends, which would mean that the land would be used for agricultural, industrial, residential, or recreational development, or open space or park land. The railroad spur would be left intact and could potentially be utilized by future uses on the site. The siting of the spur could be adjusted as necessary to place it outside the controlled area so that it could service the southern, unaffected area of the site for industrial development. All of these uses would be compatible with existing surrounding land uses. The potential for reuse of the site is discussed further in Section 4.7 (Cumulative Impacts).

Under this alternative, direct on-site land use impacts due to land disturbance during restoration would be SMALL. Following removal of the process facility and contaminated materials, the entire site would be available for unrestricted use, which is a MODERATE positive impact on land use.

Impacts on the tax base of Sequoyah County would depend on future land ownership and uses. Therefore, future property tax revenues to Sequoyah County may be positively or negatively affected by an increase or reduction in future landowner payments. Given the lack of certainty in how and when the property would be redeveloped, the potential impact on the county's tax base cannot be determined at this time.

4.2.3 Alternative 3: Partial Off-site Disposal of Contaminated Materials

Under Alternative 3, only the raffinate sludge and the sludges and soils from the Emergency Basin, North Ditch, and Sanitary Lagoon would be consolidated by the licensee and transported off-site for reuse (raffinate sludge) or to a licensed disposal facility. The remaining contaminated materials would be disposed of by the licensee in an on-site disposal cell, which would be constructed in the same location as the disposal cell under the proposed action. SFC proposes to establish a fenced 131-hectare (324-acre) ICB surrounding the cell and buffer area, which would be restricted in perpetuity from future reuse, including excavation, construction, and production water-well drilling. The proposed ICB and the disposal cell would be transferred to the long-term custody of the State of Oklahoma or the United States.

SFC would release the remaining land (112 hectares [276 acres]), including the administration building, for unrestricted future reuse (46% of the SFC site). The released land could be appropriate for agricultural or residential development, or it could be maintained as open space or park land.

The potential land use impacts resulting from implementation of this alternative would primarily affect the immediate vicinity of the SFC site rather than the regional area. These land use impacts could be characterized as MODERATE.

Implementation of this alternative would have indirect effects on the Sequoyah County tax base as a result of property ownership changes. Depending on future land ownership decision making for the ICB and disposal cell, the tax base of Sequoyah County could be reduced as discussed under Alternative 1, but the impacts would be SMALL.

The parcels of land outside the final ICB would be released for unrestricted reuse, they would be subject to property taxes according to the type of reuse and the assessed value. In this case, as previously stated in Alternative 1, future property tax revenues to Sequoyah County may be positively or negatively affected by an increase or reduction in future landowner payments. Given the lack of certainty in how and when the property would be redeveloped, the potential impact on the county's tax base cannot be determined at this time.

4.2.4 No-Action Alternative

Under the no-action alternative, SFC would remain responsible for control and maintenance of the entire 243-hectare (600-acre) site indefinitely. There would be no decontamination (other than for purposes of routine maintenance), dismantlement, or removal of equipment or structures, and no soils would be remediated. SFC would be able to continue its current programs of groundwater remediation and monitor the groundwater under the NRC-approved *Groundwater Monitoring Pan*. With the existing levels of contamination in the soil and groundwater, the site would not be suitable for release for redevelopment now or in the foreseeable future. SFC would continue to be responsible for allocating resources to ensure control over the site and to continue some level of maintenance of the site's infrastructure in perpetuity. Therefore, direct impacts on local or regional land use under the no-action alternative would be LARGE because the unremediated SFC site could potentially result in a wider area of off-site contamination from uncontained sources of radioactive material, thus limiting reuse of surrounding areas for the foreseeable future.

Under the no-action alternative, there would be no change in the annual property taxes paid by SFC relating to this alternatives analysis. However, one ongoing tax base issue may have an indirect fiscal effect on the local county. SFC currently makes an annual property tax payment to Sequoyah County at the same rate it paid when at full operation, and they are negotiating a property tax reduction with the county. SFC believes that the property assessment should take into account the fact that the idle facility no longer generates revenue, which should reduce its assessed value. The potential impact on the county's tax base if conditions do not change would be SMALL. Given the lack of certainty regarding the outcome of negotiations, further assessment cannot be made at this time.

4.3 Impacts on Water Resources

4.3.1 Surface Water Impacts

This section describes potential impacts on surface water that could occur during and following reclamation activities.

4.3.1.1 Alternative 1: On-site Disposal of Contaminated Materials (the Licensee's Proposed Action)

Wastewater generated by SFC during site reclamation (e.g., water from existing ponds and impoundments, storm water runoff from work areas, water used for decontamination and reclamation processes, and recovered groundwater) would be transferred to an existing wastewater treatment system (SFC, 2006a). This wastewater treatment system, which is located south of the clarifier basins, would be designed for batch treatment of wastewater to remove uranium. The system would remove uranium through precipitation, filtration, and ion-exchange processes before discharging the water to permitted Outfall 001. The water would be tested before discharge to ensure that the uranium concentrations comply with the drinking water standards (SFC, 2005). The direct and indirect impacts on surface water on the SFC site during reclamation activities and construction of the disposal cell would be short-term and SMALL.

Areas where SFC has excavated contaminated soil would be backfilled with on-site rock and soil (with concentrations of COCs below cleanup criteria). These areas also would be graded with a slight slope to provide adequate storm water drainage. The disposal cell cap would be covered with topsoil and planted with native vegetation to minimize runoff and erosion (SFC, 2006b). In addition, the majority of pavement and buildings on the site would be removed, thus decreasing site runoff and minimizing long-term effects on surface water quality. The direct and indirect impacts on surface water on the SFC site following reclamation would be SMALL.

4.3.1.2 Alternative 2: Off-site Disposal of All Contaminated Materials

The wastewater generated by SFC during site reclamation would be transferred to a wastewater treatment system (SFC, 2006a) as discussed above under Alternative 1. The treatment system would remove uranium before discharging the water to permitted Outfall 001. The water would be tested before discharge to ensure that the uranium concentrations comply with the drinking water standards (SFC, 2005). The direct and indirect impacts on surface water on the SFC site during implementation of Alternative 2 would be short-term and SMALL.

SFC proposes to build a railroad spur that would cross two streams that are intermittent tributaries to Salt Branch (Salt Branch is an intermittent tributary of the Lower Illinois River). During construction, these streams would be directly affected by increased erosion and sedimentation; however, this impact would be minimized through the use of various best management practices (see Chapter 5). Culverts would be installed in both streams to maintain the flow of water following installation of the railroad spur. Impacts would be SMALL.

Areas where SFC has excavated contaminated soil would be backfilled with on-site rock and soil. These areas also would be graded with a slight slope to provide adequate storm water drainage. In addition, contaminated pavement and buildings on the site would be removed, thus decreasing site runoff and minimizing long-term effects on surface water quality. Off-site disposal of soil would not impact the surface water or create any additional surface water waste streams. The direct and indirect impacts on surface water on the SFC site following completion of the licensee's site reclamation activities would be SMALL.

4.3.1.3 Alternative 3: Partial Off-site Disposal of Contaminated Materials

The wastewater generated by SFC during site reclamation would be transferred to a wastewater treatment system (SFC, 2006a), as discussed above under Alternative 1. The treatment system would remove uranium before discharging the water to permitted Outfall 001. The water would be tested before discharge to ensure that the uranium concentrations comply with the drinking water standards (SFC, 2005). The direct and indirect impacts on surface water during implementation of Alternative 3 would be short-term and SMALL.

Areas where SFC has excavated contaminated soil would be backfilled with on-site rock and soil. These areas also would be graded with a slight slope to provide adequate storm water drainage. The disposal cell cap would be graded with a slight slope to provide adequate storm water drainage. The cap would be covered with topsoil and planted with native vegetation to minimize runoff and erosion (SFC, 1998). In addition, the majority of contaminated pavement and buildings on the site would be removed, thus decreasing site runoff and minimizing long-term effects on surface water quality. Off-site disposal of soil would not impact the surface water or create any additional surface water waste streams. The direct and indirect impacts on surface water on the SFC site following completion of the licensee's site reclamation activities would be SMALL.

4.3.1.4 No-Action Alternative

Measurements of surface water quality in the vicinity of the site indicate that there have been no significant surface water quality impacts as a result of contamination from the SFC facility since operations ceased in 1993. Under this alternative, however, the potential source of future contamination of surface water would not be removed. In the short term, potential direct and indirect impacts on surface water resources would be SMALL. In the long-term, there is the potential for existing contamination to affect surface water resources on the SFC site. Therefore, long-term direct and indirect impacts on surface water resources on the SFC site from implementation of the no-action alternative would be MODERATE.

4.3.2 Groundwater Impacts

Section 3.3 presents a discussion of the groundwater systems underlying the SFC site. As noted in Section 3.3.1, there are no groundwater users located downgradient of the site (i.e., between the site and the Arkansas and Illinois rivers). The levels of groundwater contamination found beneath the SFC site are presented in Section 3.3.2. SFC's annual groundwater reports from 2005 (SFC, 2006c) and 2006 (SFC, 2007) provide information on the concentrations and distribution of COCs (uranium, arsenic, nitrate, and fluoride) in the different groundwater systems beneath the site. The results from the annual groundwater reports are summarized in Table 3.3-5. In the deep bedrock groundwater system (Unit 5 shale), only arsenic has been detected above the MCL in one sample. Nitrate and arsenic levels (>500mg/L and 0.1 to <0.5mg/L, respectively) have been detected at the site boundary in monitoring well MW095A (SFC, 2003).

Under each alternative except the no-action alternative, some or all of the SFC site would be released for unrestricted use following the future termination of SFC's NRC license. For example, under the alternatives that involve construction of an on-site disposal cell (i.e., Alternatives 1 and 3), SFC proposes to include 131 of the site's 243 total hectares (324 of the site's 600 total acres) within an ICB, which would be released to either the State of Oklahoma or to the United States for long-term control, while the remaining 112 hectares (276 acres) would be released for unrestricted use. Under the Off-site Disposal option (Alternative 2), the entire 243 hectares (600 acres) would be released for unrestricted use. As indicted in Section 3.2, potential future uses of the site could include agricultural, pasture, residential, or commercial/industrial uses. Therefore, there is a possibility that such future users could access the site groundwater.

This section presents the potential impacts on groundwater resources from the Proposed Action and the alternatives to that action.

4.3.2.1 Alternative 1: On-site Disposal of Contaminated Materials (the Licensee's Proposed Action)

Alternative 1 would involve (1) cleanup of contaminated soils and sediments to the cleanup levels (unrestricted release levels) identified for areas outside the proposed ICB and DCGLs identified for areas within the proposed ICB (see Table 2.2-1) and (2) construction of a disposal cell to hold these materials. In addition, during surface reclamation and disposal cell construction, SFC anticipates encountering groundwater in the terrace and shallow aquifers that has been contaminated by previous site operations. SFC would employ its existing wastewater treatment system to treat any affected groundwater that is recovered during its site reclamation activities. Removal of the contaminated soil and remediation of part of the groundwater systems would reduce the source for further groundwater contamination resulting from past operations. With respect to monitoring the integrity of the disposal cell, the cell liner will be equipped with a leak detection system, which is separate from the groundwater monitoring program. This monitoring system is designed strictly to detect leakage from the cell and serves as an important safety and environmental protection aspect of the site reclamation.

To address the existing contamination of the site groundwater, SFC has proposed a groundwater *Corrective Action Plan* (SFC, 2003), which is currently under review by the NRC staff. As discussed in Section 2.2.1.6, the purpose of the proposed groundwater *Corrective Action Plan* is to clean up existing groundwater contamination that resulted from previous SFC industrial operations. The goal of the cleanup is to reduce the concentrations of the identified hazardous constituents in the groundwater to the approved concentration limits for each constituent, which are protective of public health and safety and the environment. The hazardous constituents of interest and their respective cleanup standards are provided in Table 3.3-4. The NRC staff's technical and safety review of SFC's proposed groundwater *Corrective Action Plan* will be documented in a separate Safety Evaluation Report.

SFC would monitor the progress of groundwater corrective actions under its NRC-approved *Groundwater Monitoring Plan*, as discussed in Chapter 6. SFC's approved monitoring plan addresses identification of (1) hazardous constituents in the groundwater that resulted from licensed site operations; (2) groundwater protection standards for the hazardous constituents; and (3) monitoring locations, frequency, and parameters. SFC would collect and analyze samples from the groundwater, drainages and seeps, and surface water; the frequency of these sampling events is discussed in Chapter 6. SFC is required under its NRC license to submit by April 1 of each year the results of its monitoring analyses in a groundwater compliance monitoring summary report (NRC, 2005).

Following the completion of surface reclamation (including construction of the proposed disposal cell) and groundwater corrective actions, SFC proposes that a portion of the site within the proposed ICB be released to the State of Oklahoma or the United States for long-term restricted use. The long-term custodian would continue the groundwater monitoring program as part of its procedures to assess the performance of the proposed disposal cell. Such a groundwater monitoring program would be part of the custodian's Long-Term Surveillance Plan approved by the NRC.

Land outside the proposed ICB would be released for unrestricted use. While future land uses could involve agricultural, pasture, residential, or commercial/industrial uses, the availability and quality of site groundwater is limited (MFG, 2002). It is expected that future users of the site would make use of other water sources (e.g., obtaining it directly from the adjacent Illinois River).

In summary, as a result of SFC's proposed surface reclamation and groundwater corrective activities, concentrations of hazardous constituents in the groundwater would be returned to levels that would be protective of public health and safety and the environment. In addition, the potential future use of site groundwater is limited, and future users would be expected to obtain their water from easily obtainable, nearby sources. Therefore, the impact of Alternative 1 on groundwater resources would be SMALL.

4.3.2.2 Alternative 2: Off-site Disposal of All Contaminated Materials

Under this alternative, SFC would conduct reclamation of contaminated soils and sediments at the site, along with other process-related sludges and sediments and building materials, and transport those materials off-site to a licensed disposal facility for permanent disposal or, for selected materials, use as an alternate feed at a uranium recovery mill. An on-site disposal cell would not be constructed. Contaminated soils would be cleaned up to the unrestricted release cleanup levels identified in Table 2.1-1. Contaminated groundwater in the terrace and shallow aquifers that is encountered during surface reclamation would be treated in SFC's existing wastewater treatment system. These actions would reduce the source term for further contamination of site groundwater. To address the existing contamination, groundwater corrective actions and groundwater monitoring would be performed in accordance with plans approved by the NRC.

Following the completion of surface reclamation and groundwater corrective actions, SFC proposes to release the entire 243-hectare (600-acre) site for unrestricted future use. While future land uses could involve agricultural, pasture, residential, or commercial/industrial uses, the availability and quality of site groundwater is limited. It is expected that future users of the site would make use of other water sources (e.g., obtaining it directly from the adjacent Illinois River).

In summary, as a result of SFC's proposed surface reclamation and groundwater corrective activities, concentrations of hazardous constituents in the groundwater would be returned to levels that would be protective of public health and safety and the environment. In addition, the potential future use of site groundwater is limited, and future users would be expected to obtain their water from easily obtainable, nearby sources. Therefore, the impact of Alternative 2 on groundwater resources would be SMALL.

4.3.2.3 Alternative 3: Partial Off-site Disposal of Contaminated Materials

The potential environmental impacts associated with the partial off-site disposal alternative would be similar to those of the Proposed Action (On-site Disposal of Contaminated Materials). Under this alternative, SFC could transport the raffinate sludges to a uranium mill for processing as an alternate feed material, or it could transport the raffinate sludge and sludges and sediments from the Emergency Basin, North Ditch, and Sanitary Lagoon to an off-site uranium mill tailings impoundment or a licensed disposal facility for permanent disposal. Other contaminated soils, sludges, and sediments removed during surface reclamation would be consolidated, along with building materials, in an on-site disposal cell. SFC would apply the DCGLs and cleanup levels identified in Table 2.2-1 during surface reclamation.

Contaminated groundwater in the terrace and shallow aquifers that is encountered during surface reclamation would be treated in SFC's wastewater treatment system. These actions would reduce the source term for further contamination of site groundwater. To address the existing contamination, groundwater corrective actions and groundwater monitoring would be performed in accordance with NRC-approved plans.

Following the completion of surface reclamation, construction of the proposed disposal cell, and groundwater corrective actions, SFC proposes to release of that portion of the site within the proposed ICB for restricted use controlled by the State of Oklahoma or the United States for long-term custody. The long-term custodian would implement a groundwater monitoring program as part of its procedures to assess the performance of the proposed disposal cell. Such a groundwater monitoring program would be part of the custodian's Long-Term Surveillance Plan approved by the NRC.

SFC proposes that land outside the proposed ICB be released for unrestricted use. While future land uses could involve agricultural, pasture, residential, or commercial/industrial uses, the availability and quality of site groundwater is limited due to low yields and poor natural water quality. Future users of the site would likely make use of other water sources (e.g., obtaining it directly from the adjacent Illinois River).

In summary, as a result of SFC's proposed surface reclamation and groundwater corrective activities, concentrations of hazardous constituents in the groundwater would be returned to levels that would be protective of public health and safety and the environment. In addition, the potential future use of site groundwater is limited, and future users are expected to obtain their water from easily obtainable, nearby sources. Therefore, the impact of Alternative 3 on groundwater resources would be SMALL.

4.3.2.4 No-Action Alternative

Under the no-action alternative, SFC would not conduct remediation of existing soil contamination. Instead, SFC would continue to conduct its current program of site surveillance, groundwater remediation, and monitoring. Progress toward eventual license termination would not occur, and no portion of the SFC site would be released for restricted or unrestricted use. SFC is currently conducting groundwater corrective actions and monitoring, and these actions would continue under this alternative. The results of SFC's groundwater monitoring program during 2005 and 2006 are provided in Table 3.3-4.

Because excavation of contaminated soils and treatment of affected near-surface groundwater would not occur, contamination of the site groundwater would likely continue because the source for such contamination would not be addressed. As a result, while current groundwater corrective actions and associated monitoring would continue, contamination of site groundwater would likely continue for an extended period of time. Therefore, the impacts of the no-action alternative on groundwater would be MODERATE.

4.4 Public and Occupational Health Impacts

This section discusses potential health impacts of the proposed alternatives (with the exception of transportation impacts, which are discussed in Section 4.5) on the surrounding population and the proposed SFC reclamation workforce. The analysis considered the following radiological impacts (radiation doses and risks) and nonradiological impacts (industrial accidents and exposures to hazardous chemicals) on public health and occupational workers:

- Radiation doses and risks for members of the public during reclamation. The NRC staff considered the affected population to be that within 80 km (50 miles) of the SFC facility. The primary exposures would be from radioactive material suspended in the atmosphere by reclamation operations.

- Long-term doses and risks for individuals who inhabit the site. Because of the long half-lives of the radioactive materials at the SFC site, should there be a loss of institutional controls or license conditions, it may be possible that individuals could come to inhabit both the unrestricted and restricted portions of the site in the future.

- Potential radiological impacts on workers during site reclamation activities.
- Radiological impacts for average exposed workers during the period of custodial care.
- Exposures to hazardous chemicals.
- Injuries and fatalities in the workforce during reclamation activities.

Radiological Dose Assessment. Because there would be no high-energy sources (e.g., explosives or nuclear fuel) that could lead to accidents involving radioactive material during site reclamation, there would be little potential for off-site radiological consequences from accidents. This analysis did not include exposure of off-site members of the public to radiation from any on-site accidents because it was determined that the impacts from transportation of the waste off-site exceeded those from any on-site accident. For exposure to ionizing radiation, the impacts are expressed in terms of dose. The following fundamental definitions apply:

- **Dose Equivalent.** The product of the absorbed dose in tissue, quality factor (to account for different types of ionizing radiation), and all other necessary modifying factors at the location (organ) of interest. The units of dose equivalent are sievert and rem.
- **Deep Dose Equivalent.** The dose equivalent at a tissue depth of 1 cm for whole body exposure to ionizing radiation sources external to the body.
- **Committed Effective Dose Equivalent (CEDE).** The internal dose to the body over 50 years from sources internal to the body after inhalation or ingestion of radioactive material.
- **Total Effective Dose Equivalent.** The sum of the deep dose equivalent received for radiation from sources external to the body and the CEDE.
- **Annual Dose.** The radiation dose received in one year.
- **Lifetime Dose.** The radiation dose received in a lifetime.
- **Collective Dose.** The total radiation dose received by a population. Collective dose is expressed in units of person-sievert or person-rem. Note that the annual collective dose is the dose to a population in one year, and the collective lifetime dose is the dose to a population over their lifetimes.

Title 10, "Energy," of CFR Part 20 contains the regulations related to radiation doses during reclamation of the SFC site. This regulation provides the regulatory limits for occupational (worker) doses and radiation dose for individual members of the off-site public. For occupational doses, 10 CFR § 20.1201 states that licensees must limit the occupational dose to individual adults to an annual limit based on the more limiting of:

- The total effective dose equivalent (TEDE) being equal to 0.05 sievert (5 rem), or

- The sum of the deep dose equivalent and the committed dose equivalent to any individual organ or tissue, other than the lens of the eye, being equal to 0.5 sievert (50 rem).

The annual limits to the lens of the eye, to the skin of the whole body, and to the skin of the extremities are:

- A lens dose equivalent of 0.15 sievert (15 rem).
- A shallow-dose equivalent of 0.5 sievert (50 rem) to the skin of the whole body.
- A shallow-dose equivalent of 0.5 sievert (50 rem) to the skin of any extremity.

For members of the public during reclamation, and for industrial workers during long-term maintenance periods (who also are assumed to be members of the public), the regulation provides an explicit TEDE limit of 1.0 millisievert (100 millirem) per year from all sources. This limit includes both internal and external doses through all pathways, including food, as required by specific exposure scenarios. External dose rates cannot exceed 0.02 millisievert (2 millirem) in any 1 hour. Further, the standards in 10 CFR § 20.1101 and 40 CFR Part 190 would be generally applicable during reclamation: 40 CFR Part 190 requires that routine releases from uranium fuel-cycle facilities to the general environment do not result in annual doses above 0.25 millisievert (25 millirem) to the whole body, 0.75 millisievert (75 millirem) to the thyroid, and 0.25 millisievert (25 millirem) to any other organ.

For alternatives that would result in unrestricted release of the site, doses to members of the public are limited by determining the CLs using the benchmark dose approach in 10 CFR Part 40, Appendix A (see Section 4.4.1.1). Appendix D of this DEIS presents the detailed calculations applicable to radiation dose and risk assessment for the radiological impact analysis. As described in Appendix D, Section D.2.1.3, the analysis based the CLs on a fraction of the benchmark dose for radium of 0.54 millisievert (54 millirem) per year.

Chemical Screening-Level Risk Analysis. The NRC staff performed a screening-level risk analysis in order to assess potential adverse health effects associated with chemical (nonradiological) contamination in soils and sediments at the SFC site. Soil and sediment data from previously conducted investigations were compared to background soil concentrations and human health-based, medium-specific screening levels for residential use. Data presented in the following reports served as the basis for this comparison:

- *Sequoyah Fuels Corporation Site Characterization Report* (SFC, 1998);
- *Sequoyah Fuels Corporation Facility Environmental Investigation Findings Report*, Volumes 1-5. (SFC, 1991);
- *Sequoyah Fuels Corporation Final RCRA Facility Investigation Report* (SFC, 1996).

Soil data from these reports were compared to U.S. EPA Region 6 Human Health Medium-Specific Screening Levels for residential use (EPA, 2007a). The Region 6 values consider exposure through incidental ingestion of soil, dermal (skin) contact with soil, and inhalation of soil particulates. These values were developed using equations from EPA guidance and commonly used EPA default exposure factors. Toxicity information and other chemical factors used to develop screening levels are published by the EPA or academic sources. The Region 6 soil screening values (EPA, 2007a) are based on a noncancer hazard index of 1 and a total excess cancer risk of 1E-06 (1 in a million, or 1x10-6). If the concentrations of nonradiological contaminants at a site do not exceed the applicable screening levels, there would be no expectation of adverse health effects resulting from exposure to site contamination screened using this method. In addition to comparing site data to Region 6 screening values, concentrations of chemicals detected in soils and sediment were compared to background concentrations.

The analysis indicated that fluoride levels in soil and sediment exceeded background and Region 6 health-based screening criteria at many locations throughout the site. Exceedances of Region 6 health-based screening criteria and background levels also were noted for arsenic (five locations), lead (three locations), antimony (two locations), and lithium, molybdenum, nickel, vanadium, copper, and chromium (one location each). Appendix D provides the details of this screening-level analysis.

The following sections describe potential public and occupational health impacts associated with SFC's proposed alternative and other alternatives.

4.4.1 Alternative 1: On-site Disposal of Contaminated Materials (the Licensee's Proposed Action)

This section describes the potential health radiological and nonradiological impacts on the surrounding population and the proposed SFC reclamation workforce during implementation of the licensee's proposed action.

4.4.1.1 Public and Worker Radiation Doses and Risks

Table 4.4-1 summarizes estimated potential public and worker radiation doses for Alternative 1. The results are for individual annual radiation doses, individual lifetime doses (i.e., the total dose to an individual over their lifetime from Alternative 1), and collective lifetime doses (i.e., the total lifetime radiation dose to the affected population). The estimated bounding collective lifetime dose to members of the public during reclamation would be 0.005 person-sievert (0.5 person-rem). The average collective lifetime TEDE to workers for Alternative 1 would be 0.33 person-sievert (33 person-rem). These doses are well within the appropriate regulatory dose limits.

Table 4.4-1 Public and Worker Radiation Doses Under Alternative 1

Dose Receptor	Individual Annual Dose mSv/yr (mrem/yr)	Individual Lifetime Dose mSv (mrem)	Collective Lifetime Dose person-Sv (person-rem)
Off-site Public Doses during Reclamation	0.005 (0.5)	0.02 (2.0)	0.005 (0.5)
Average Worker Doses during Reclamation	2.2 (220)	8.8 (880)	0.33 (33)

Table 4.4-1 Public and Worker Radiation Doses Under Alternative 1

Dose Receptor	Individual Annual Dose mSv/yr (mrem/yr)	Individual Lifetime Dose mSv (mrem)	Collective Lifetime Dose person-Sv (person-rem)
Maximum Annual Worker Doses during Reclamation	7.4 (740)	N/A	N/A
Long-term Public Doses in the Restricted Area if Custodial Care of the ICB is Lost (Residential Farmer Scenario)	0.54 (54)	38 (3,800)	N/A
Long-term Public Doses in the Unrestricted Area	0.095 (9.5)	6.6 (660)	N/A
Worker Doses during the Custodial Care Period	0.002 (2)	0.6 (60)	N/A

mSv – millisievert
yr – year
mrem – millirem
Sv – sievert
N/A – Not Applicable.

To account for the long half-lives of the radionuclides within the ICB at the SFC site, SFC used the residential farmer scenario as the basis for estimating the DCGLs beyond the period of long-term custodial care.

DCGLs are residual radionuclide concentrations in soil that result in the appropriate dose limit using a computer-modeled radiation pathway analysis. The scenario that was modeled by SFC and was accepted by NRC was of a hypothetical residential farmer residing within the restricted area of the ICB (SFC, 2005). This scenario included the following radiation exposure pathways:

> **Derived Concentration Guideline Levels (DCGLs)** are the derived, radionuclide-specific, activity concentrations that correspond to the release criterion. DCGLs are derived from activity-to-dose relationships as determined through modeling of radiation exposure pathway scenarios.

- External exposure from soil.
- Inhalation of suspended soil.
- Ingestion of soil.
- Ingestion of plant products grown in contaminated soil and using potentially contaminated surface water to supply irrigation.
- Ingestion of animal products grown on the site using feed and surface water from potentially contaminated sources.
- Ingestion of fish from potentially contaminated surface water on the site.

SFC indicated that it did not consider two potential exposure pathways:

- **Groundwater usage:** SFC indicated that there are no existing active water wells near or downgradient from the facility that migrating contaminants could affect. The only active wells in the nearby region are either upgradient or so far removed that future impacts are not possible. The shallow aquifers cannot produce sufficient water to qualify as potential drinking water sources or are of such poor quality that well water would not be a suitable source for domestic purposes (MFG, 2002). Because of limited groundwater in this region of Oklahoma, there are extensive potable water distribution systems that use surface-water sources (SFC, 2005). Therefore, SFC concluded that alternative sources of water are readily available.

- **Radon inhalation:** SFC indicated that it did not consider radon inhalation because, consistent with EPA guidance, it applied the DCGLs in soil for radium found in the regulations (10 CFR Part 40, Appendix A). When the default regulatory limits are used, radon calculations are not required.

In addition, SFC indicated that it did not consider scenarios that involved the inadvertent construction of a house with a basement over the disposal cell during the licensed or custodial care periods. SFC eliminated these scenarios because basement construction is not a common feature of homes in northeast Oklahoma. Further, the SFC cell design, including the application of an outer covering of riprap to the disposal cell, would prevent human intrusion (SFC, 2005).

SFC based its development of the DCGLs on a radiation exposure scenario analysis using the RESRAD computer program (Yu et. al., 2001) and applying the benchmark dose approach in 10 CFR Part 40, Appendix A. This approach is described in Appendix D of this DEIS. In summary, benchmark doses result from a radiation pathway scenario modeling analysis of the radium soil contamination at the accepted regulatory level of 0.18 becquerel (5 pCi) per gram in surface soil (see Table 4.4-2). SFC then used the benchmark doses to define the residual contamination levels for other radionuclides that might be present. SFC then applied the sum-of-ratios requirement to ensure that the total dose for the residual mixture of radionuclides would not exceed the benchmark dose.

Sum-of-Ratio Method: When a mixture of radionuclides is present, the ratio of the concentration of each radionuclide to its calculated DCGL is determined first. These ratios are then summed over all of the radionuclides. If this sum is less than or equal to 1, then the resulting dose for the mixture is within the dose criterion.

SFC determined that the benchmark dose for radium for the restricted area would be 0.54 millisievert (54 millirem) per year, which is within the public radiation protection limit of 1 millisievert (100 millirem) per year. The individual lifetime dose, assuming the residential farmer lived within the ICB for 70 years, would then be 38 millisievert (3,800 millirem).

In a similar manner, SFC used CLs to estimate doses for habitation of the unrestricted areas of the site. SFC developed CLs that represent lower concentrations of residual radionuclides that would ensure application of the "as low as reasonably achievable (ALARA)" principle to unrestricted areas of the site. Table 4.4-2 summarizes the DCGLs and CLs developed by SFC.

Table 4.4-2 DCGLs and CLs

Condition	Natural Uranium Bq/g (pCi/g)	Thorium-230 Bq/g (pCi/g)	Radium-226 Bq/g (pCi/g)[a]
DCGL (restricted area)	21 (570)	2.4 (66)	0.18/0.56 (5.0/15)
CL (unrestricted area)	3.7 (100)	≤0.52/1.6 (14/≤43)	≤0.18/0.56 (5.0/15)

Source: SFC, 2005.

[a] As stated in 10 CFR 40, Appendix A, Criterion 6(6), the concentration of radium in the first 15-centimeter (5.9-inch) layer below surface/ followed by the concentration in subsequent 15-centimeter layers more than 15 centimeters below the surface.

The resulting estimated annual radiation dose to a member of the public in the unrestricted area of the site would be 0.095 millisievert (9.5 millirem) per year. The analysis estimated this annual dose by multiplying the ratio of the CL to the DCGL for natural uranium by the benchmark dose. This dose would be well within the public radiation protection limit of 1 millisievert (100 millirem) per year. If this individual resided in the unrestricted area for 70 years, the lifetime dose for the unrestricted area would be about 6.6 millisievert (660 millirem).

The analysis estimated worker radiation doses during the custodial care period. An industrial worker employed by or under contract to the long-term custodian would perform maintenance tasks. The applicable regulatory dose limit would be 1 millisievert (100 millirem) per year to a member of the public. SFC assumed that the concentration of residual radioactive material would be equivalent to the DCGLs. The exposure pathways include (SFC, 2005):

- External exposure to penetrating radiation from radionuclides in soil.
- Inhalation of suspended soil.
- Ingestion of soil.

SFC did not consider additional pathways because the industrial workers would not be involved in farming activities, use groundwater or surface water, or be exposed to indoor radon. SFC assumed the worker would perform maintenance activities within the proposed ICB for a total of 130 hours per year: 32 hours sampling on-site wells and 98 hours mowing (SFC, 2005). The result of the SFC dose assessment was about 0.02 millisievert (2 millirem) per year to this industrial worker. The analysis assumed that the same individual would work at the site for 30 years conducting maintenance activities. The resulting lifetime dose would be about 0.6 millisievert (60 millirem).

The NRC staff considers the estimated radiation doses after reclamation activities to be conservative bounding estimates because the land, either within the ICB or in the unrestricted area, would contain radionuclide concentrations in surface soil that would be much lower than the DCGLs or CLs. This is because SFC proposes to use clean soil to cover the contaminated areas after moving the contaminated soil to the disposal cell within the ICB. Further, facility operations have left the unrestricted areas largely unaffected; therefore, radionuclide concentrations in those unrestricted areas reflect background levels.

> **Latent cancer fatalities (LCFs)** are potential cancer deaths caused by exposure to ionizing radiation. They are derived and based on scientific evaluation of exposed populations, including survivors of nuclear weapons detonations. Multiplying the annual or lifetime radiation dose to an individual or population by a dose-to-risk conversion factor results in the estimate of LCF probability.

Table 4.4-3 summarizes public and worker radiation risks for Alternative 1 in terms of the probability of latent cancer fatalities (LCFs). The estimated probabilities of LCFs use dose-to-risk conversion factors of 4×10^{-5} (4 in 10,000) per millisievert (4×10^{-7} [4 in 10 million] per millirem) for the reclamation or industrial workers (ICRP, 1990) and 6×10^{-5} (6 in 10,000) per millisievert (6×10^{-7} [6 in 10 million] per millirem) for members of the public based on current EPA information (Eckerman et al., 1999).

Table 4.4-3 Public and Worker Estimated Probabilities of LCFs Under Alternative 1

Risk Receptor	Individual Annual Risk (LCF)	Individual Lifetime Risk (LCF)	Collective Lifetime Risk (LCF)
Off-site Public Risks during Reclamation	3.0×10^{-7}	1.2×10^{-6}	1.2×10^{-3}
Average Worker Risks during Reclamation	8.8×10^{-5}	3.5×10^{-4}	1.3×10^{-2}
Maximum Annual Worker Risks During Reclamation	3.0×10^{-4}	N/A	N/A
Long-term Public Risks if Custodial Care of the ICB is Lost	3.2×10^{-5}	2.3×10^{-3}	N/A
Long-term Public Risks in the Unrestricted Area	5.7×10^{-6}	4.0×10^{-4}	N/A
Worker Risks during Custodial Care Period	8.0×10^{-7}	2.4×10^{-5}	N/A

N/A – Not Applicable.

The estimated annual radiation doses, either to members of the public or to workers, are within the regulatory limits, and the estimated individual lifetime probabilities of LCFs are low (10^{-6} to 10^{-3}); therefore, the impacts on occupational workers and the public from exposure to radiation would be SMALL.

4.4.1.2 Exposures to Hazardous Chemicals

SFC's proposed reclamation activities would remove the vast majority of chemical (nonradiological) contamination present on the SFC site outside of the disposal cell area. As indicated on Figure 4.4-1, the chemical contamination identified during various site investigations (see Appendix D.3) is either under the disposal cell footprint or within the SFC site ponds and lagoons that will be remediated during the implementation of Alternative 1. Table 4.4-4 and Figure 4.4-2 identify the only sampling location that would have contaminant concentrations exceeding a screening criterion outside of the remediation areas. Fluoride was detected above a screening criterion (3,700 mg/kg fluoride, residential [EPA 2007b]) in sample

BH093, which was collected from subsurface soil located northwest of Fluoride Holding Basin No. 2 (SFC, 1998). Fluoride concentrations in the 0 to 6.7-meter (0 to 22-foot) below ground surface (bgs) interval did not exceed the screening criterion, but the concentrations in the 6.7- to 7.9-meter (22- to 26-foot) bgs interval did exceed the screening criterion. It is unlikely that future receptors would contact soil at this depth; therefore, this area is not of concern for adverse health effects resulting from direct contact.

Table 4.4-4 Sample Locations Exceeding a Screening Criterion after Implementation of the Proposed Action

Sample ID	Analyte	Concentration (mg/kg)	Sample Depth meters (feet)	Sample Date
BH093	Fluoride	7,480	6.1 to 6.7 (20.00) (22.00)	3/15/1991
BH093	Fluoride	21,400	6.7 to 7.3 (22.00) (24.00)	3/15/1991
BH093	Fluoride	10,000	7.3 to 7.9 (24.00) (26.00)	3/15/1991

Source: SFC. 1998.

During site reclamation activities, SFC proposes to conduct mitigation procedures to protect workers from inhalation of dust that may be contaminated with chemical or radiological contaminants (see Section 5).

As described in Chapter 2, the disposal cell would be capped, and a perimeter fence would be constructed around the ICB. For contamination to pose a human health risk, there must be a complete pathway of exposure from the contamination to human receptors. The disposal cell cap would prevent human exposure to the chemical contamination in the disposal cell and the impact on the occupational worker and the public following reclamation would be SMALL.

4.4.1.3 Potential Nonfatal and Fatal Occupational Injuries

SFC's proposed action involves major construction activities (construction, excavation, and demolition) with the potential for industrial accidents related to construction and demolition vehicle accidents, material-handling accidents, falls, etc. These accidents could result in temporary injuries, long-term injuries and/or disabilities, and even fatalities. The NRC does not anticipate any of the proposed activities to be any more hazardous than expected for a major industrial construction or demolition project.

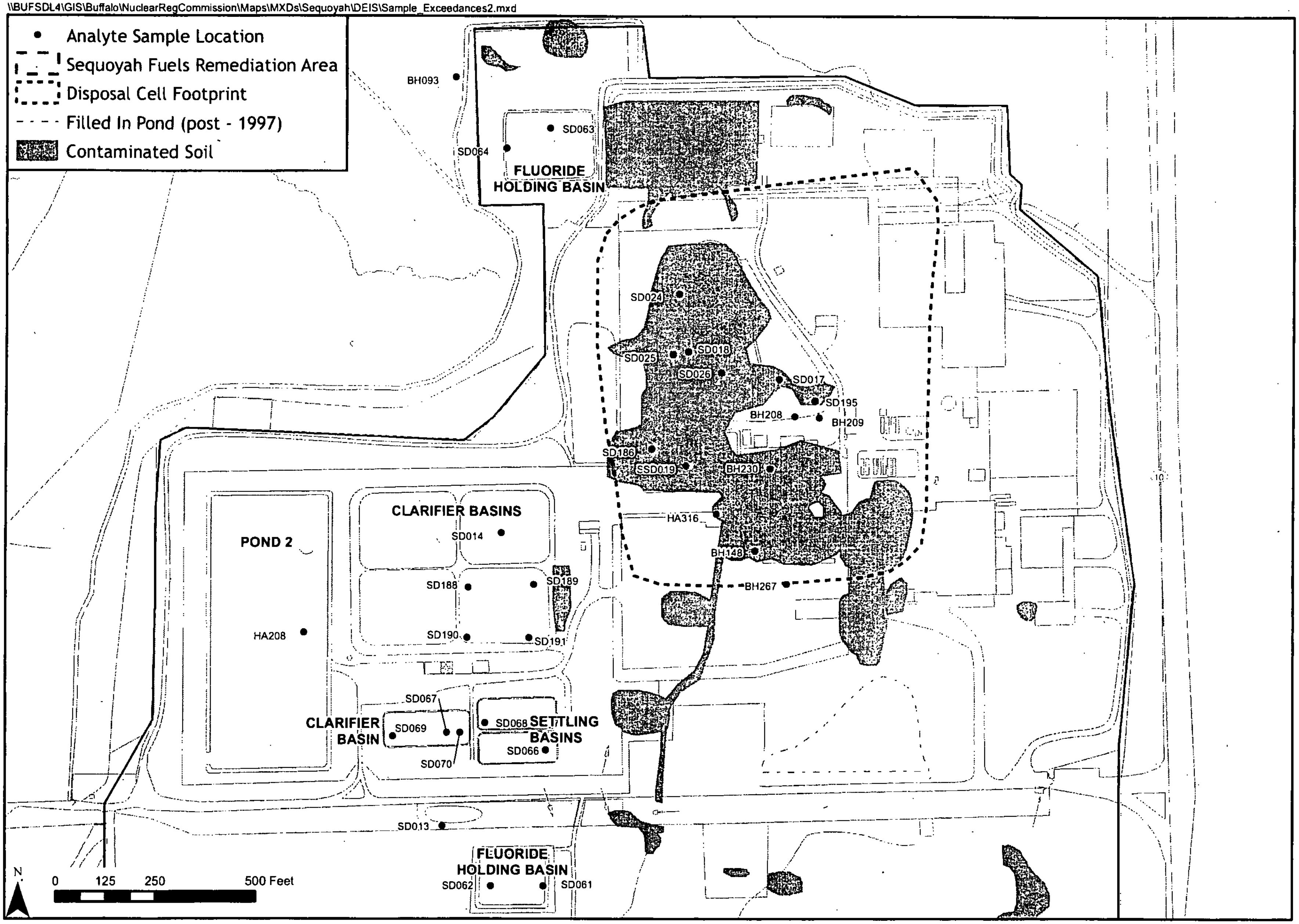

Figure 4.4-1 Sample Locations that Currently Exceed Screening Criteria, Sequoyah Site

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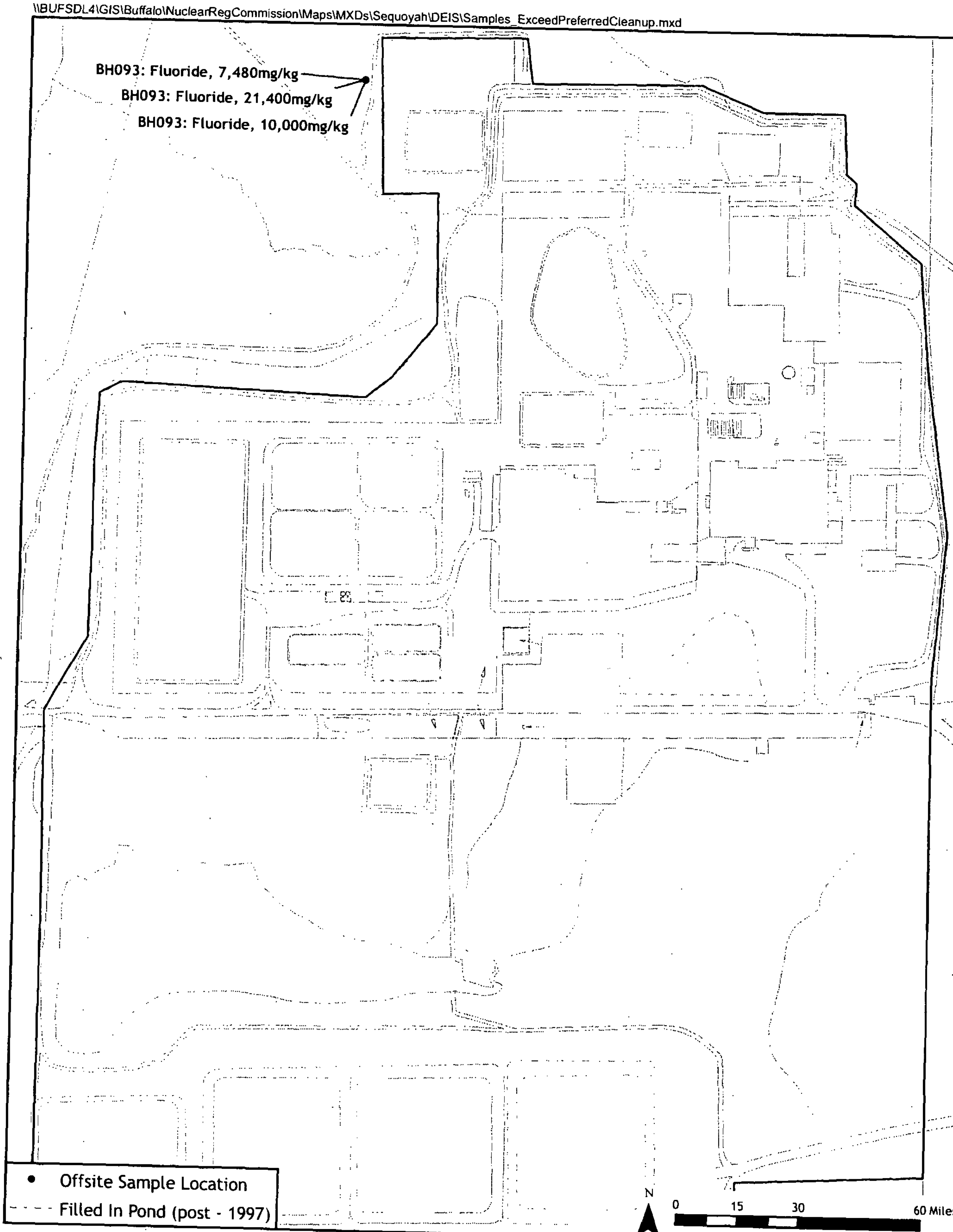

Figure 4.4-2 Soil Sample Locations Outside Soil Removal Areas and Depth of Alternative 1

To estimate the number of potential nonfatal and fatal occupational injuries that would result from implementation of Alternative 1, data on nonfatal and fatal occupational injuries per year were collected from the DOL, Bureau of Labor Statistics. Nonfatal occupational injury rates specific to Oklahoma for the year 2005 and national fatal occupational injury rates for the year 2005 for the construction industry were used to estimate the potential nonfatal and fatal injuries that could occur during implementation of Alternative 1. The expected nonfatal and fatal injuries presented in Table 4.4-5 were based on SFC's estimated peak labor force of 72 employees and a total workforce of 207.5 man-years performing construction, demolition, excavation, and recovery work over a 4-year period. An estimated 6.6% of the workforce is expected to experience nonfatal injuries, which would result in approximately five injuries during the peak period of construction and 14 injuries over the 4-year period. The number of fatalities that would be expected to occur over the 4-year period is estimated to be less than 1 (0.02). Thus, the impact from nonfatal and fatal injuries would be SMALL.

Table 4.4-5 Expected Occupational Injuries for On-site Workers Under Alternative 1

Category	Injury Rate	Peak Year	Total for 4 Years
Nonfatal Injuries	0.066	5	14
Fatal Injuries	0.00011	0.008	0.02

Source: DOL, 2005.

The NRC also has considered impacts from criteria pollutants. Criteria pollutants would be generated at the site by combustion engines used in heavy equipment. As discussed in Section 1.4.6 and Appendix B, the impacts on human health and safety from air pollutants are expected to be SMALL and, therefore, are excluded from detailed analysis.

4.4.2 Alternative 2: Off-site Disposal of All Contaminated Materials

This section describes the potential radiological and nonradiological health impacts on the surrounding population and the proposed SFC reclamation workforce during implementation of Alternative 2.

4.4.2.1 Public and Worker Radiation Doses and Risks

Table 4.4-6 summarizes the estimated potential public and worker radiation doses for Alternative 2. The analysis estimated these radiation doses using the same methods as those used for Alternative 1, with modified input for the numbers of exposed individuals, hours of labor, and duration of reclamation activities. The public and worker doses would be well within the appropriate regulatory dose limits. The estimated maximum collective lifetime dose to members of the public during reclamation would be 0.02 person-sievert (2.0 person-rem). The average collective lifetime dose to reclamation workers for Alternative 2 would be 0.34 person-sievert (34 person-rem). The doses shown in Table 4.4-6 are the same as those of the relevant dose receptors identified in Alternative 1 (shown in Table 4.4-1). The major differences between Alternatives 1 and 2 are the inclusion in Alternative 1 of long-term public doses (assuming loss of custodial care) and worker doses during the custodial care period.

Table 4.4-6 Public and Worker Radiation Doses Under Alternative 2

Dose Receptor	Individual Annual Dose mSv/yr (mrem/yr)	Individual Lifetime Dose mSv (mrem)	Collective Lifetime Dose person-Sv (person-rem)
Off-site Public Doses during Reclamation	0.005 (0.5)	0.02 (2.0)	0.02 (2.0)
Average Worker Doses During Reclamation	2.2 (220)	8.8 (880)	0.34 (34)
Maximum Annual Worker Doses during Reclamation	7.4 (740)	N/A	N/A
Long-term Public Doses Following Reclamation	0.095 (9.5)	6.6 (660)	N/A

N/A - Not Applicable.

Using the benchmark dose approach and the unrestricted CLs described for Alternative 1, the analysis determined that the estimated dose to a member of the public after unrestricted release of the site would be about 0.095 millisievert (9.5 millirem) per year. This dose would be within the public radiation protection limit of 1 millisievert (100 millirem) per year. The estimated individual lifetime dose for the unrestricted area, assuming 70 years of site residency, would be 6.6 millisievert (660 millirem).

Table 4.4-7 summarizes the estimated public and worker radiation risks for Alternative 2. The estimated public and worker radiation risks for Alternative 2 are the same as those estimated for the relevant risk receptors of Alternative 1. The major difference between Alternative 1 and Alternative 2 is the inclusion in Alternative 1 of long-term public risks if custodial care of the ICB is lost. Annual radiation doses, either to members of the public or to workers, would be within regulatory limits, and all the estimated individual lifetime probabilities of LCFs would be low (10^{-6} to 10^{-4}); therefore, the significance levels of all worker or public radiation doses and risks under Alternative 2 would be SMALL. There would be no long-term public or maintenance worker doses or risks because there would be no custodial care period under Alternative 2.

Table 4.4-7 Public and Worker Estimated Probabilities of LCFs Under Alternative 2

Risk Receptor	Individual Annual Risk (LCF)	Individual Lifetime Risk (LCF)	Collective Lifetime Risk (LCF)
Off-site Public Risks during Reclamation	3.0×10^{-7}	1.2×10^{-6}	1.2×10^{-3}
Average Worker Risks during Reclamation	8.8×10^{-5}	3.5×10^{-4}	1.4×10^{-2}
Maximum Annual Worker Risks during Reclamation	3.0×10^{-4}	NA	NA
Public Risks from the Potential Use of the Unrestricted Area	5.7×10^{-6}	4.0×10^{-4}	N/A

N/A – Not Applicable

4.4.2.2 Exposures to Hazardous Chemicals

SFC's proposed reclamation activities would remove the vast majority of chemical (nonradiological) contamination present on the SFC site. The contaminated materials would be removed from the site and there would be no disposal cell.

Table 4.4-8 and Figure 4.4-3 identify the sampling locations that would have contaminant concentrations exceeding a screening criterion outside of the remediation areas following implementation of Alternative 2. Fluoride was detected above a screening criterion (3,700 mg/kg fluoride, residential [EPA 2007b]) in sample BH093, which was collected from subsurface soil located northwest of Fluoride Holding Basin No. 2 (SFC, 1998). Fluoride concentrations in the 0 to 6.7-meter (0 to 22-foot) bgs interval did not exceed the screening criterion, but the concentrations in the 6.7- to 7.9-meter (22- to 26-foot) bgs interval did exceed the screening criterion. It is unlikely that future receptors would contact soil at this depth; therefore, this area is not of concern for adverse health effects resulting from direct contact.

Table 4.4-8 Sampling Locations Exceeding a Screening Criterion that Will Not be Removed in Alternative 2 Cleanup Implementation

Sample ID	Analyte	Concentration (mg/kg)	Sample Depth meters (feet)			Sample Date
BH093	Fluoride	7,480	6.1 (20.00)	to	6.7 (22.00)	3/15/1991
BH093	Fluoride	21,400	6.7 (22.00)	to	7.3 (24.00)	3/15/1991
BH093	Fluoride	10,000	7.3 (24.00)	to	7.9 (26.00)	3/15/1991
BH230	Fluoride	10,834	0.76 (2.50)	to	0.9 (3.00)	3/11/1991
BH230	Fluoride	11,097	1.1 (3.5)	to	1.19 (3.9)	3/11/1991
SD017	Fluoride	10,300	0 (0)	to	1.22 (4.00)	2/1/1995
SD195	Fluoride	14,800	0 (0)	to	1.22 (4.00)	10/17/1995

Source: SFC, 1996 and 1998.

Soil samples collected from 0 to 1.2 meters (0 to 4 feet) bgs at locations SD017 and SD195, and 0.76 to 1.19 meters (2.5 to 3.9 feet) bgs at location BH230 contained fluoride concentrations above the screening criterion (SFC, 1998). SFC has proposed excavating the top layer (0 to 0.3 meter [0 to 1 foot] bgs) of soil at this location, but remediation below 0.3 meter (1 foot) has not been proposed. When the SFC site is released for unrestricted use following implementation of Alternative 2, excavation and regrading of the site during future construction activities could bring this soil to the surface and potentially result in localized surface soil concentrations exceeding Region 6 screening values for residential use.

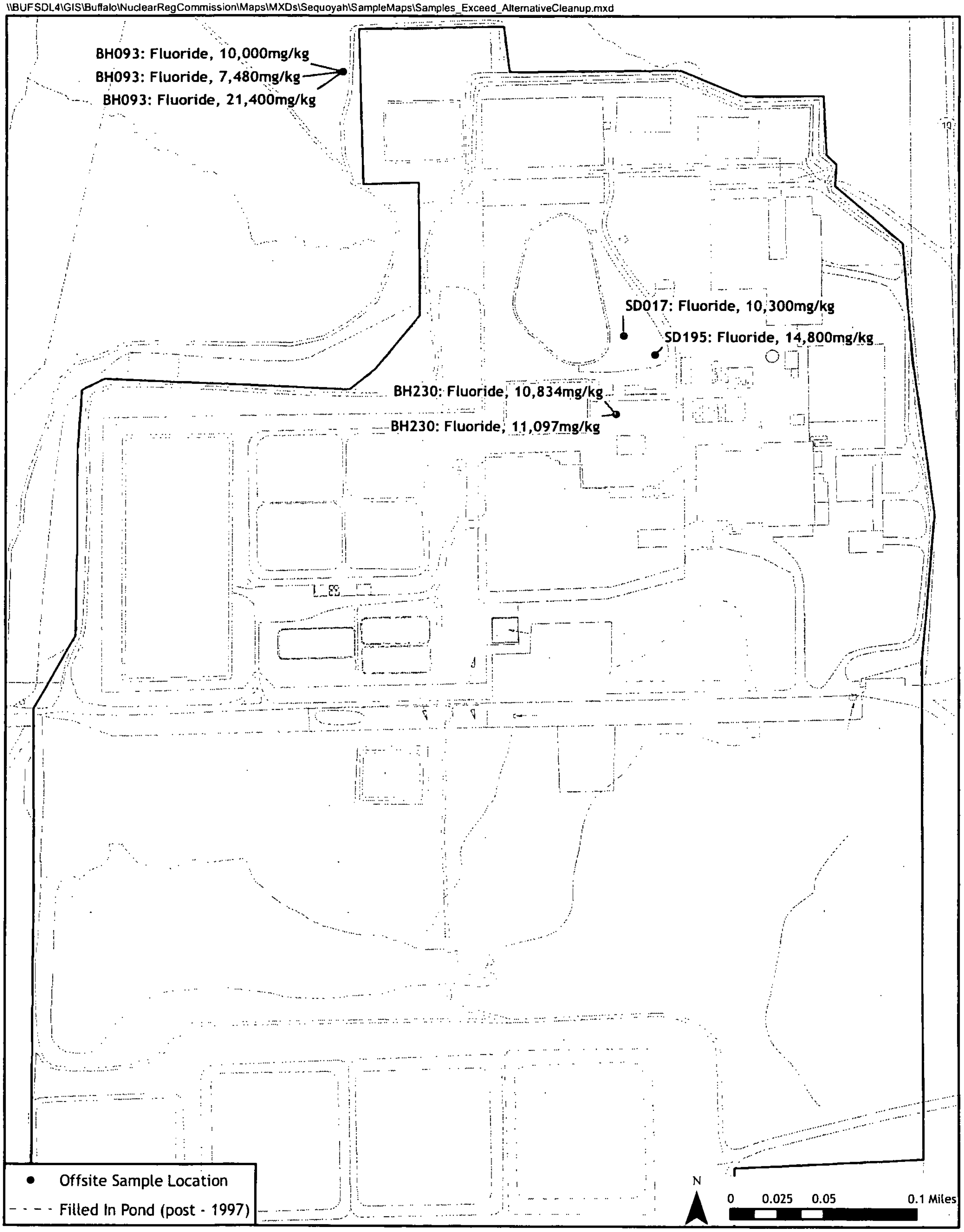

Figure 4.4-3 Soil Sample Locations Outside Soil Removal Areas and Depth of Alternative 2

During site reclamation activities, SFC proposes to conduct mitigation procedures to protect workers from inhalation of dust that may be contaminated with chemical or radiological contaminants (see Chapter 5).

Overall, the risk of the pubic coming into contact with hazardous chemicals remaining on the SFC site would be low; therefore, the impact would be SMALL.

4.4.2.3 Potential Nonfatal and Fatal Occupational Injuries

Alternative 2 involves major construction (excavation and demolition) activities in addition to the construction of an on-site rail loading facility. These activities have the same potential for industrial accidents as Alternative 1, i.e., construction vehicle and demolition equipment accidents, material-handling accidents, falls, etc. These accidents could result in temporary injuries, long-term injuries and/or disabilities, and even fatalities. The NRC does not anticipate any of the proposed activities to be any more hazardous than expected for a major industrial construction or demolition project.

To estimate the number of potential nonfatal and fatal occupational injuries that would result from implementation of Alternative 2, data on nonfatal and fatal occupational injuries per year were collected from the DOL, Bureau of Labor Statistics, for the year 2005, as described in Alternative 1 (see Section 4.4.1.3). The expected nonfatal and fatal injuries presented in Table 4.4-9 were based on SFC's estimated peak labor force of 73 employees and a total workforce of 220 man-years performing construction work over a 4-year period. An estimated 6.6% of the workforce is expected to experience nonfatal injuries, which would result in approximately five injuries during the peak period of construction and 14 injuries over the 4-year period. The number of fatalities that would be expected to occur over the 4-year period is estimated to be less than 1 (0.02). Thus, the impact from nonfatal and fatal injuries would be SMALL.

Table 4.4-9 Expected Occupational Injuries for On-site Workers Under Alternative 2

Category	Injury Rate	Peak Year	Total for 4 Years
Nonfatal Injuries	0.066	5	14
Fatal Injuries	0.00011	0.008	0.02

Source: DOL, 2005.

4.4.3 Alternative 3: Partial Off-site Disposal of Contaminated Materials

This section describes the potential radiological and nonradiological health impacts on the surrounding population and the proposed SFC reclamation workforce during implementation of Alternative 3.

4.4.3.1 Public and Worker Radiation Doses and Risks

Table 4.4-10 summarizes estimated public and worker radiation doses that would be expected under Alternative 3. The doses would be well within the appropriate regulatory dose limits. The estimated maximum collective lifetime dose to members of the public during reclamation would be 0.02 person-sievert (2.0 person-rem). The average collective lifetime dose to reclamation workers would be 0.35 person-sievert (35 person-rem). Although SFC proposes that the State of Oklahoma, the DOE, or another federal entity would be responsible for long-term custody of the ICB and the disposal cell, because of the long half-lives of the radionuclides at the SFC facility and site, at some point in the future the perpetual care provision might lapse. The estimated public and worker radiation risks for Alternative 3 are the same as those estimated for Alternative 1 since all of the dose receptors are the same, and since the same effluents, work conditions, DCGLs, and CLs were used in the analysis.

Table 4.4-10 Public and Worker Radiation Doses Under Alternative 3

Dose Receptor	Individual Annual Dose mSv/yr (mrem/yr)	Individual Lifetime Dose mSv (mrem)	Collective Lifetime Dose person-Sv (person-rem)
Off-site Public Doses during Reclamation	0.005 (0.5)	0.02 (2.0)	0.02 (2.0)
Average Worker Doses during Reclamation	2.2 (220)	8.8 (880)	0.35 (35)
Maximum Annual Worker Doses during Reclamation	7.4 (740)	N/A	N/A
Long-term Public Doses in the Restricted Area if Custodial Care of the ICB is Lost (Residential Farmer Scenario)	0.54 (54)	38 (3,800)	N/A
Long-term Public Doses in the Unrestricted Area	0.095 (9.5)	6.6 (660)	N/A
Worker Doses during the Custodial Care Period	0.002 (2)	0.6 (60)	N/A

N/A – Not Applicable.

Therefore, SFC employed the residential farmer scenario and the benchmark dose approach used for Alternative 1 (see Section 4.4.1) as the basis for estimating the DCGLs for the proposed ICB. SFC determined the benchmark dose for radium to be 0.54 millisievert (54 millirem) per year, which is within the public radiation protection limit of 1 millisievert (100 millirem) per year. The estimated individual lifetime dose, assuming the residential farmer lived in the ICB for 70 years, would be 38 millisievert (3,800 millirem).

The analysis used the CLs that SFC developed to estimate doses for habitation on the unrestricted areas of the site. The CLs represent lower concentrations of residual radionuclides that would ensure application of the ALARA principle to unrestricted areas of the site. The estimated annual dose to a member of the public in the unrestricted area of the site would be about 0.095 millisievert (9.5 millirem) per year, which is within the public radiation protection limit of 1 millisievert (100 millirem) per year. If the individual resided in the unrestricted area for 70 years, the lifetime dose would be about 6.6 millisievert (660 millirem).

Table 4.4-11 summarizes the estimated public and worker radiation risks for Alternative 3. The estimated public and worker radiation risks for Alternative 3 are the same as those estimated for Alternative 1 since all of the risk receptors are the same, and since the same effluents, work conditions, DCGLs, and CLs were used in the analysis. The annual radiation doses, either to members of the public or to workers, would be within regulatory limits, and all the estimated individual lifetime probabilities of LCFs would be low (10^{-6} to 10^{-3}); therefore, the significance levels of all public or worker radiation doses and risks for Alternative 3 would be SMALL.

Table 4.4-11 Summary of the Public and Worker Estimated Probabilities of LCFs under Alternative 3

Risk Receptor	Individual Annual Risk (LCF)	Individual Lifetime Risk (LCF)	Collective Lifetime Risk (LCF)
Off-site Public Risks during Reclamation	3.0×10^{-7}	1.2×10^{-6}	1.2×10^{-3}
Average Worker Risks during Reclamation	8.8×10^{-5}	3.5×10^{-4}	1.4×10^{-2}
Maximum Annual Worker Risks during Reclamation	3.0×10^{-4}	NA	NA
Long-term Public Risks in the Restricted Area if Custodial Care of the ICB is Lost (Residential Farmer Scenario)	3.2×10^{-5}	2.3×10^{-3}	NA
Long-term Public Risks in the Unrestricted Area	5.7×10^{-6}	4.0×10^{-4}	NA
Worker Risks during Custodial Care Period	8.0×10^{-7}	2.4×10^{-5}	NA

4.4.3.2 Exposures to Hazardous Chemicals

SFC's proposed reclamation activities would remove the vast majority of chemical (nonradiological) contamination present on the SFC site outside of the disposal cell area. The disposal cell would be in the same location as described in Alternative 1 (see Section 4.4.1.2), with potentially reduced dimensions and volume because a portion of the contaminated materials (3%) would be shipped to an off-site facility licensed to accept such materials.

As described for Alternative 1, fluoride was detected above a screening criterion in one sample (BH093) at the northwest corner of the site, but at a depth of 6.7 to 7.9 meters (22 to 26 feet) bgs. It is unlikely that future receptors would contact soil at this depth; therefore, this area is not of concern for adverse health effects resulting from direct contact.

During site reclamation activities, SFC proposes to conduct mitigation procedures to protect workers from inhalation of dust that may be contaminated with chemical or radiological contaminants (see Section 5).

The disposal cell would be capped, and a perimeter fence would be constructed around the ICB. For contamination to pose a human health risk, there must be a complete pathway of exposure from the contamination to human receptors. The cap would prevent human exposure to the chemical contamination in the disposal cell; therefore, the impact on the occupational worker and the public following reclamation would be SMALL.

4.4.3.3 Potential Nonfatal and Fatal Occupational Injuries

Alternative 3 involves major construction activities (construction, excavation, and demolition) with the potential for industrial accidents related to construction and demolition vehicle accidents, material-handling accidents, falls, etc. These accidents could result in temporary injuries, long-term injuries and/or disabilities, and even fatalities. The NRC does not anticipate any of the proposed activities to be any more hazardous than expected for a major industrial construction or demolition project.

To estimate the number of potential nonfatal and fatal occupational injuries that would result from implementation of Alternative 3, data on nonfatal and fatal occupational injuries per year were collected from the DOL, Bureau of Labor Statistics, for the year 2005, as described in Alternative 1 (see Section 4.4.1.3). The expected nonfatal and fatal injuries presented in Table 4.4-12 were based on SFC's estimated on-site peak labor force of 78 employees and a total workforce of 220 man-years performing construction work over a 4-year period. An estimated 6.6% of the workforce is expected to experience nonfatal injuries, which would result in approximately five injuries during the peak period of construction and 14 injuries over the 4-year period. The number of fatalities that would be expected to occur over the 4-year period is estimated to be less than 1 (0.03). Thus, the impact from nonfatal and fatal injuries would be SMALL.

Table 4.4-12 Expected Occupational Injuries for On-site Workers Under Alternative 3

Category	Injury Rate	Peak Year	Total for 4 Years
Nonfatal Injuries	0.066	5	14
Fatal Injuries	0.00011	0.009	0.03

Source: DOL, 2005.

4.4.4 No-Action Alternative

This section describes the potential health radiological and nonradiological impacts on the surrounding population if no action was taken at the SFC site.

4.4.4.1 Public and Worker Radiation Doses and Risks

Table 4.4-13 summarizes estimated public and worker radiation doses and risks under the no-action alternative. The doses to the off-site public would be minimal (far less than those from active reclamation) because there would be no processing or stabilization of radioactive material. If conditions deteriorated such that environmental releases of radioactivity could occur, the SFC license would require corrective measures. There would be no atmospheric release of soil suspended in air or facility effluents. Therefore, this analysis did not estimate doses or risks to the off-site public under the no-action alternative.

Table 4.4-13 Public and Worker Radiation Doses Under the No-Action Alternative

Dose Receptor	Individual Annual Dose mSv/yr (mrem/yr)	Individual Lifetime Dose mSv (mrem)	Lifetime Dose person-Sv (person-rem)
Off-site Public Doses during License Continuation	<0.005 (0.5)	<0.005 (0.5)	<0.005 (0.5)
Average Individual Worker Doses during License Continuation	0.27 (27)	8.0 (800)	0.056 (5.6)
Maximum Individual Annual Worker Doses during License Continuation	1.2 (120)	N/A	N/A
Long-term Public Doses in the Restricted Area if Custodial Care of the ICB is Lost (Residential Farmer Scenario – Average Contamination Levels)	26 (2,600)	1,800 (180,000)	N/A
Long-term Public Doses in the Restricted Area if Custodial Care of the ICB is Lost (Residential Farmer Scenario – Maximum Contamination Levels)	210 (21,000)	14,000 (1,400,000)	N/A

N/A – Not Applicable.

Under the no-action alternative, SFC workers would conduct routine maintenance and surveillance tasks during the continuing license phase. Worker radiation doses would be similar to those observed historically at the SFC site. This analysis assumed that average annual worker doses would continue at about 0.27 millisievert (27 millirem) per year as long as SFC maintained the license. The maximum worker dose, based on historical measurements for SFC workers, would be about 1.2 millisievert (120 millirem) per year. These doses are well within the NRC occupational radiation protection standard of 50 millisievert (5 rem) per year. SFC estimates that it would take seven workers to perform continued maintenance and surveillance activities under the no-action alternative (SFC, 2005, Section 2.1.1). The analysis estimated the lifetime doses to these seven workers by assuming that each worker would spend 30 years employed at the site under continuing license conditions. The lifetime TEDE to the average worker would be 8.0 millisievert (800 millirem), and the lifetime TEDE to the maximally exposed worker would be 36 millisievert (3,600 millirem). The estimated annual collective TEDE to the seven workers would be 0.002 person-sievert (0.2 person-rem) per year, and the lifetime collective dose (assuming all seven workers spent 30 years employed at the site) would be 0.056 person-sievert (5.6 person-rem). The analysis did not estimate collective doses to workers over the license continuation period because the length of the continuing license period is indeterminate. For the no-action alternative, the SFC site would be under license to the NRC in perpetuity. However, as a means of comparison to the other alternatives, the residential farmer scenario was analyzed to estimate the public doses if there was no control of the site. SFC derived DCGLs using the benchmark dose method without consideration of institutional controls and solely in relation to the dose received from pathways that relate to residual radioactive materials in surface soil. The DCGLs represent a maximum exposed individual (MEI) dose of 0.54 millisievert (54 millirem) per year for each of natural uranium, thorium-230, and radium-226. For alternatives involving the remediation or decontamination of soil, the sum-of-ratios approach would limit the dose for any mixture to 0.54 millisievert (54 millirem) per year. For the no-action alternative, however, the doses to the MEI would not be limited to 0.54 millisievert (54 millirem) per year because no remediation or decontamination would occur. The analysis estimated the MEI dose by dividing the existing contamination concentrations for each radionuclide by the appropriate DCGL (to determine how much in the residual contamination would be in excess of the DCGLs), multiplying that result by the benchmark dose of 0.54 millisievert (54 millirem) per year, then summing over the radionuclides. Because it is not possible to determine the condition of the residual radioactive contamination at the time the license would lapse, the analysis made two estimates: (1) doses based on the average soil concentrations, and (2) doses based on the maximum soil concentrations. The resulting MEI doses would be about 26 millisievert (2,600 millirem) per year for the average soil concentration condition and 210 millisievert (21,000 millirem) per year for the maximum soil concentration condition. These doses would be far in excess of the 1-millisievert (100-millirem) -per-year dose limit to members of the public. The estimated lifetime doses, assuming 70 years of site occupancy, would be about 1,800 millisievert (180,000 millirem) for the average soil concentration condition and 14,000 millisievert (1,400,000 millirem) for the maximum soil concentration condition.

Table 4.4-14 summarizes the estimated public and worker radiation risks under the no-action alternative if there were no license controls. The annual probability of an LCF to the average industrial worker would be 1.1×10^{-5}, and the estimated lifetime probability of an LCF would be 3.3×10^{-4}. The annual and lifetime probabilities of LCFs to the maximally exposed worker would be 4.8×10^{-5} and 1.4×10^{-3}, respectively. These estimated individual worker lifetime risks would be low (10^{-5} to 10^{-2}), and the annual radiation doses would be within the regulatory limit of 50 millisievert (5 rem) per year; therefore, the impact of worker radiation exposures and risks during institutional controls would be SMALL.

Table 4.4-14 Public and Worker Estimated Probabilities of LCFs Under the No-Action Alternative

Risk Receptor	Individual Annual Risk (LCF)	Individual Lifetime Risk (LCF)
Off-site Public Risks during License Continuation	N/A	N/A
Average Worker Risks during License Continuation	1.1×10^{-5}	3.3×10^{-4}
Maximum Annual Worker Risks during License Continuation	4.8×10^{-5}	N/A

Table 4.4-14 Public and Worker Estimated Probabilities of LCFs Under the No-Action Alternative

Risk Receptor	Individual Annual Risk (LCF)	Individual Lifetime Risk (LCF)
Long-term Public Risks in the Restricted Area for hypothetical Residential Farmer Scenario - Average Contamination Levels	1.3×10^{-3}	9.2×10^{-2}
Long-term Public Risks in the Restricted Area for hypothetical Residential Farmer Scenario – Maximum Contamination Levels	1.0×10^{-2}	7.2×10^{-1}

The resulting lifetime probabilities of LCFs for the residential farmer for the average and maximum soil concentrations would be 9.2×10^{-2} and 7.2×10^{-1}, respectively, which are much greater than the probabilities for the other alternatives. Further, the annual public radiation doses would be far in excess of the regulatory limit of 1 millisievert (100 millirem) per year; therefore, if there were no license controls on the site, the significance level of public radiation exposures and risks for the no-action alternative would be LARGE.

4.4.4.2 Exposures to Hazardous Chemicals

The NRC staff performed a screening-level risk analysis was performed in order to assess potential adverse health effects associated with chemical (nonradiological) contamination in soils and sediments at the SFC site. Soil and sediment data from previously conducted investigations were compared to background soil concentrations and human health-based, medium-specific screening levels for residential use. Data on this analysis is presented in Appendix D.

The data show that fluoride levels in soil and sediment exceed background concentrations and Region 6 health-based screening criteria at many locations throughout the site. Exceedances of Region 6 health-based screening criteria and background levels also were noted for arsenic (five locations), lead (three locations), antimony (two locations), and lithium, molybdenum, nickel, vanadium, copper, and chromium (one location each).

Under the no-action alternative, there would be no removal of soil; therefore, conditions at the site would remain the same and the impact of chemical exposures on the public and occupational workers would be SMALL. In the long-term, if there was a loss of license controls the impact could become LARGE.

4.4.4.3 Workforce Fatalities and Injuries

Under the no-action alternative, no work will be performed at the site other than minimal maintenance. Therefore, the risk of workforce fatalities and injuries would be SMALL.

4.5 Transportation Impacts

As a result of the surface reclamation activities proposed by SFC, there would be an increase in vehicular traffic operating on the SFC site and accessing the site from public highways. This increase in traffic would include construction workers commuting in private vehicles, earthmoving equipment operating on-site, large trucks delivering equipment and materials to the site, and, in the case of Alternatives 2 and 3, railcars or trucks transporting contaminated materials (raffinate sludge) to a uranium mill or licensed disposal facility. Potential impacts could include traffic congestion on local highways, increased air pollution from vehicle emissions, increased potential for traffic accidents, potential radiation doses to individuals who share the transportation corridor with radioactive material shipments, and radiation doses from transportation accidents that involve radioactive materials. The following sections discuss potential nonradiological local transportation impacts near the SFC site and potential radiological and nonradiological impacts from the off-site shipment of contaminated materials. Appendix E describes the analytical methodologies used in the analysis to estimate potential nonradiological impacts associated with vehicle emissions and accidents as well as radiological impacts.

4.5.1 Alternative 1: On-site Disposal of Contaminated Materials (the Licensee's Proposed Action)

Under Alternative 1, local highways would experience short-term increased use by workers commuting to and from the SFC site and by trucks delivering supplies for the site reclamation, including the geomembrane liner, rock, and other materials. Quantitative analyses were performed to determine (1) the potential for this increased traffic to reduce traffic flow, (2) the effects of vehicle emissions, and (3) the probability of fatalities occurring due to increased highway use as a result of both vehicle accidents and vehicle emissions.

4.5.1.1 Highway Capacity Impacts

The NRC staff evaluated the effects of SFC's implementation of Alternative 1 on traffic flow on State Highway 10 and other nearby roadways. The focus of the evaluation was on the quality of traffic flow on a roadway, including the ability of users to travel at the speed limit, the number and duration of traffic interruptions, and the overall comfort and convenience of the roadway to its users (TRB, 2000). SFC estimated that site reclamation would occur over a four-year period. During the start-up and finish of reclamation activities, traffic impacts would be relatively minor. To conservatively identify potential transportation impacts, the NRC staff assumed that most major construction activities could be completed within one year, during which time most of the consolidated waste materials would be placed within the disposal cell and the final engineering barrier would be installed. An estimate of the total number of vehicle trips that would be generated during this one-year period of intensive site reclamation activities was provided by SFC and is shown in Table 4.5-1. The table also identifies the overall distances that would be traveled. Trips to and from the SFC site would be associated with commuting construction workers and the delivery of construction materials. Under Alternative 1, construction-related traffic would add approximately 784 vehicles per day to the local roadways, principally State Highway 10, from which vehicles would enter and exit the SFC site.

Table 4.5-1 Estimated Daily and Total Local Transportation Traffic

Type of Vehicle Traffic	Estimated One-Way Trips (km)[a]	Alternative 1: On-Site Disposal	No-Action Alternative
Commuting Workers[b]	40.2	75	6
Normal Deliveries	40.2	75	6
Fly Ash	82.1	28	0
Riprap from Off-Site	12.9	40	0
Riprap from On-Site	1.6	40	0
Sand, Drain Layer, and Bedding	12.9	9	0
Clay Liner and Clay Cap	1.6	40	0
Clean Backfill	1.6	85	0
Topsoil	1.6	13	0
Total Daily Two-Way Vehicle Count	--	810	24
Total Daily Two-Way (km)	--	18,502	966
Total Local (km)[b]	40.2	4,625,416	241,410

Source: SFC, 2006.
[a] To convert to miles, divide by 1.6094.
[b] Assumes an average of 75 employees on site 250 working days per year.

A two-lane state highway such as State Highway 10 has a design capacity of up to 2,800 passenger cars per hour (67,200 cars per day) (HCM, 1985). While the daily addition of about 800 vehicles would nearly double the existing traffic count on this roadway (see Table 3.5-1), the estimated increased volume of about 1,600 vehicles per day represents a small percentage of the design capacity of State Highway 10. The increased traffic volume would be noticeable to users of State Highway 10, and minor traffic slowdowns or delays might occur at the entrance to the SFC site and at the intersection of State Highway 10 and U.S. Highway 64 about 1.6 km (1 mile) north of the SFC facility. These impacts on traffic flow would be SMALL in that the increased traffic would not destabilize the traffic flow along the roadway. Other highways in the vicinity (e.g., I-40 or U.S. Highway 64), which have higher capacities than State Highway 10 (typically 2,000 vehicles per hour per lane [TRB, 2000]), would be even less affected in terms of traffic flow from implementation of Alternative 1. Moreover, all impacts on traffic flow would be short term; following SFC's completion of site reclamation, traffic conditions would return to normal. In summary, the impact of Alternative 1 on the traffic flow of the local transportation network, including State Highway 10, U.S. Highway 64, and I-40, would be SMALL.

4.5.1.2 Risk of Vehicle Accidents

Motor vehicle safety is typically measured through accident rates for the type of vehicle being driven. This analysis assumes that all traffic traveling to and from the SFC site would involve the use of trucks. SFC estimates that implementation of site reclamation activities under Alternative 1 would result in an increase in vehicle miles traveled within 82 km (51 miles) of Gore, Oklahoma. Specifically, the number of local vehicle miles traveled in the region would increase from the baseline of about 241,400 km (194,750 miles) to 4.6 million km (2.7 million miles) (see Table 4.5-1). Based on DOE data, the average accident injury and fatality rates for trucks in Oklahoma are 2.85×10^{-7} per truck km (1.77×10^{-7} per truck mile) and 1.47×10^{-8} per truck km (9.13×10^{-9} per truck mile), respectively (DOE, 2002a). Multiplying the total local distance to be traveled under Alternative 1 (see Table 4.5-1) by the average accident injury and fatality rates for trucks in Oklahoma results in an estimate of the total number of potential truck-related injuries and fatalities that could potentially occur during reclamation of the SFC site. During the intensive one-year period, the predicted risk of injuries and fatalities from traffic accidents could increase to an estimated 1.3 injuries and 0.068 fatality from the baseline condition of 0.069 injury and 0.0036 fatality without the proposed action. This indicates that about one injury could occur; however, since this predicted risk of a fatality is less than one, it can be concluded that no truck-related fatalities are likely to occur as a result of SFC's reclamation activities under Alternative 1. There would be no long-term direct or indirect traffic accident-related effects because following completion of intensive site reclamation activities by SFC, the risk of fatalities would revert to at or near those identified under baseline conditions. Therefore, the impact of traffic-related accidents on the area surrounding the SFC site during site reclamation activities would be SMALL.

4.5.1.3 Nonradiological Vehicle Emissions

This analysis focuses on the incremental risks associated with inhalation exposure to nonradiological particulate emissions from vehicles used during site reclamation activities under Alternative 1. These emissions would primarily be in the form of tire/brake particulates, diesel exhaust, and fugitive dust (resuspended particulates from the roadway). Strong epidemiological evidence exists suggesting that increases in ambient air concentrations of PM_{10} (particulate matter with a mean aerodynamic diameters less than or equal to 10 microns) lead to increases in mortality (EPA, 1996a, 1996b). Currently, it is assumed that no threshold exists and that the dose-response functions for most health effects associated with PM_{10} exposure, including premature mortality, are linear over the concentration ranges investigated (EPA, 1996a). Over both the short and long terms, fatalities may result from life-shortening respiratory or cardiovascular diseases (EPA, 1996a) expressed as latent cancer fatalities (LCFs [nonradiological]).

The analysis was based on a methodology developed and accepted by the DOE (2002b), whereby the risk of fatal exposure to particulate emissions (potential for LCFs) is calculated as a function of total emissions from transportation (DOE 2002a). Unit risk factors for trucks (and railcars) are shown in Table 4.5-2. The local population of 182,192 within 40 km (25 miles) of the site (see Table B.6-1) is also an input to the analysis.

Table 4.5-2 DOE-Calculated Vehicle Emission Unit Risk Factors

Vehicle Class	Weight (tons)	Tire/Brake Particulates (g/km)	Fugitive Dust (g/km)	Diesel Exhaust (g/km)	Total Emissions (g/km)	Unit Risk Factor (fatalities/km per person/km^2)
Class VIIIB Trucks	40	0.030	0.26	0.141	0.43	1.5E-11
Railcar	N/A	N/A	0.26	0.481	0.74	2.6E-11

Source: DOE, 2002a.
Class VIIIB trucks include heavy-duty trucks with a gross vehicle weight of 27,216 kg (60,001 lbs) and up.
N/A - Not Applicable.

As previously stated for this alternative, the number of local vehicle miles traveled in the region would increase by about 4.4 million km (2.7 million miles) (see Table 4.5-1). Conservatively assuming that these additional miles would occur within a one-year intensive portion of the construction period, inhalation exposure to vehicle-related emissions could result in an additional 0.00055 LCF (a probability of 1 in 2,000). This very small risk would represent a fraction of the more than 1,500 estimated fatalities per year from all causes (CDC, 2002) that would otherwise likely occur in the population in proximity to the SFC site (see Table B.6-1). Long-term indirect effects of inhalation of vehicular-generated particulates would not occur because there would be little to no activity conducted at the restricted portions of the SFC site following completion of reclamation activities. Therefore, the impact of increased vehicle emissions is SMALL.

4.5.1.4 Radiological Impacts from Routine Transportation and Transportation Accidents

Under the on-site disposal alternative, radiologically contaminated materials would be consolidated and placed within an on-site disposal cell. No materials would be transported off-site; therefore, no off-site transportation-related radiological impacts or accidents would occur under this alternative.

4.5.2 Alternative 2: Off-site Disposal of All Contaminated Materials

Under Alternative 2, local off-site transportation would involve workers commuting to and from the SFC site, the delivery of normal supplies as well as materials for reclamation activities, and off-site shipments of contaminated materials by rail. As previously mentioned, a rail spur would be constructed to serve the SFC site. Since the SFC site is not currently served by rail, the potential transportation impacts related to Alternative 2 would address the introduction of rail traffic to the site, with a resultant analysis of potential rail-related traffic fatalities, a potential increase in LCFs from nonradiological air emissions, and a potential increase in LCFs resulting from radiation doses to workers (transportation crews), members of the public who live near transportation routes, and individuals who share the transportation corridor with radioactive material shipments. In addition, members of the public who live along the rail transportation routes could realize an increase of LCFs due to exposure to radiation released by transportation accidents that involve radioactive materials.

4.5.2.1 Highway Capacity Impacts

Under Alternative 2, during the most intensive year of site reclamation activity, about 470 vehicles per day would be added to the roadways near the SFC site, primarily due to the commuting workforce and the delivery of materials to the site (see Table 4.5-3). Even with this additional traffic volume, State Highway 10 would remain significantly below its design capacity (67,200 cars per day), and the increase would not be noticeable to users of State Highway 10 except at the entrance to the SFC site and at the intersection of State Highway 10 and U.S. Highway 64, which is about 1.6 km (1 mile) north of the SFC facility. However, another factor that would affect traffic flow along State Highway 10 would be construction of a rail grade crossing of State Highway 10 by SFC to connect the SFC site with the Union Pacific line.

During construction of the grade crossing itself, traffic along State Highway 10 likely would be reduced to one lane or stopped intermittently.

Table 4.5-3 Estimated Daily and Total Local Transportation Traffic

Type of Vehicle Traffic	Estimated One-Way Trips (km)[a]	Alternative 2: Off-site Disposal	No-Action Alternative
Commuting Workers	40.2	75	6
Normal Deliveries	40.2	75	6
Fly Ash	82.1	0	0
Riprap from Off-site	12.9	0	0
Riprap from On-site	1.6	0	0
Sand, Drain Layer, and Bedding	12.9	0	0
Clay Liner and Clay Cap	1.6	0	0
Clean Backfill	1.6	85	0
Topsoil	1.6	13	0
Total Daily Two-Way Vehicle Count	--	496	24
Total Daily Two-Way (km)[b]	--	12,386	966
Total Local (km)[b]	40.2	3,096,486	241,410

Source: SFC, 2006

[a] To convert to miles, divide by 1.6094.

[b] Assumes an average of 75 employees on site 250 working days per year.

SFC's use of the railway grade crossing of State Highway 10 would also be affected by the use of the rail spur when it is crossed by railcars entering/leaving the SFC site. To accommodate the movement of railcars entering and existing the SFC site, State Highway 10 would be subject to intermittent, short-duration closures to accommodate the movement of the empty and filled railcars. Assuming that off-site shipments of contaminated materials occur during the most intensive one year of site reclamation activities, it also was assumed that a total of about 20 railcars per day would enter or exit the SFC site (10 empty cars entering, 10 filled cars exiting). In other words, State Highway 10 could experience closure to accommodate the crossing of railcars twice per working day. The increased numbers of commuting workers, use of the rail spur, and construction deliveries to the SFC site would have a MODERATE impact on the quality of traffic flow in the vicinity of the site.

In addition, traffic flow along Interstate 40 and U.S. Route 64 under Alternative 2 would not be appreciably affected because of the small volume of vehicular traffic that would be generated compared with their significantly greater design capacities and current low traffic volumes. Therefore, the potential short-term impacts on the regional highway network would be SMALL. Long-term indirect effects would not occur because there would be no activity following SFC's completion of site reclamation and traffic conditions would return to normal.

4.5.2.2 Vehicle/Rail Accidents

The analysis assumed round-trip miles for commuters and deliveries (see Table 4.5-3), as well as for shipments of contaminated materials off the site (see Appendix E, Table E-3) under the assumption that all railcars would return from the disposal facility to the SFC site for reuse. Based on predicted local and off-site truck traffic volumes, and using the Oklahoma accident injury and fatality rates for trucks (2.85×10^{-7} per truck km [1.77×10^{-7} per truck mile] and 1.47×10^{-8} per truck km [9.13×10^{-9} per truck mile], respectively), the short-term potential for injuries and fatalities to occur from local traffic accidents could increase by 0.882 and 0.455, respectively. In the short-term, rail-related accidents could increase by 2.09 injuries and 1.39 fatalities, based on the national average rail accident injury rate of 7.82×10^{-8} per railcar km (4.86×10^{-8} per mile) and a fatality rate of 7.82×10^{-8} per railcar km (4.86×10^{-8} per mile) (DOE, 2002b). For the truck case, since the predicted risk is less than one, it can be concluded that no truck-related fatalities are likely to occur as a result of SFC's reclamation activities under Alternative 2. However, for the rail case, about two injuries and one fatality could occur. This risk represents a very small fraction of the more than 1,500 estimated fatalities per year from all causes (CDC, 2002) that would otherwise likely occur in the population in proximity to the SFC site (see Table B.6-1). There would be no long-term direct or indirect traffic accident-related effects because following completion of intensive site reclamation activities by SFC, the predicted risk of fatalities would revert to at or near those identified under baseline conditions. Therefore, the impact of traffic-related accidents on the area surrounding the SFC site during site reclamation activities would be SMALL.

4.5.2.3 Nonradiological Vehicle Emissions

The site reclamation activities proposed by SFC under Alternative 2 would result in an estimated increase in local vehicle mileage of about 3.1 million km (1.9 million miles) (see Table 4.5-3). In addition, off-site rail shipments of contaminated materials would involve the movement of 3,678 railcars (i.e., approximately 15 railcars out and 15 in per day assuming a 250-day work year). The greatest distance that these shipments would travel is about 12.4 million railcar km (77 million miles). This distance was bounded by the most distant disposal alternative feed location.

Using the same risk-based evaluation method described for Alternative 1 to evaluate impact, the short-term risk of an LCF from inhalation of increased vehicle-related emissions that would occur under Alternative 2 would be 0.00037 fatality (one in 37,000) for local truck traffic and 0.044 fatality (one in 440) for off-site rail shipments. These predicted fatalities would represent very small fractions of the more than 1,500 fatalities that occur per year from all causes within the potentially affected population of the region surrounding Gore, Oklahoma (CDC 2002). They also represent very small fractions of the more than 3,200 fatalities from all causes expected to occur in the population (see Table E-3) along the proposed rail corridor. Long-term direct effects would not occur because there would be no activity after one year. Long-term indirect effects of the inhalation of vehicular- or rail-generated particulates would not occur because there would be little to no activity conducted at the restricted portions of the SFC site following completion of reclamation activities. Therefore, the impact of increased vehicle emissions would be SMALL.

4.5.2.4 Radiological Impacts from Routine Transportation and Transportation Accidents

This section summarizes the results of an analysis of the potential for increases in the number of LCFs within the population of transportation workers (i.e., rail yard workers) and members of the general public who work and live along or share the proposed rail transportation routes to a disposal facility or alternate feed mill. The methodology used to predict these effects is described in more detail in Appendix E.

The shipment of contaminated materials off-site under Alternative 2 would result in a predicted increase in LCFs of 1.25×10^{-6} and 4.56×10^{-7} in the affected general public population and rail yard workers, respectively (see Appendix E, Table E-24). The increase in the risk of an LCF to the maximally exposed member of the public would be 5.88×10^{-7} (see Appendix E, Table E-25).

These short-term changes in LCFs from the incident-free transportation of radioactive materials would be small in that they would be very small fractions of the likely number of cancer fatalities from all sources in a population similar to the size of the population along the proposed rail corridor (369,000). The National Cancer Institute has estimated the lifetime risk of contracting a fatal cancer in the United States from all sources as 23.42% for males and 19.82% for females (NCHS, 2006). Long-term indirect effects would not occur because there would be no exposure to radiological contaminants following completion of the off-site shipment of contaminated materials.

Section E.4 describes the methodology used to estimate the radiological impacts from transportation accidents. Although all off-site shipments of contaminated materials would be by railcar under Alternative 2, accident impacts were assumed to be bounded by the truck accident scenario (see Section E.4.2.1). The increase in the number of LCFs from the maximum reasonably foreseeable accident ranges from 1.64×10^{-7} to 6.54×10^{-6} LCFs for accidents that

Latent Cancer Fatality from Exposure to Ionizing Radiation

A latent cancer fatality (LCF) is a death from cancer resulting from, and occurring an appreciable time after, exposure to ionizing radiation. Death from cancer induced by exposure to radiation may occur at any time after the exposure takes place. However, latent cancers would be expected to occur in a population from one year to many years after the exposure takes place. To place the significance of these additional LCF risks from exposure to radiation into context, the average individual has approximately 1 chance in 4 of dying from cancer (LCF risk of 0.25).

The U.S. Environmental Protection Agency has suggested (Eckerman et al., 1999) a conversion factor that for every 100 person-sievert (10,000 person-rem) of collective dose, approximately six individuals would ultimately develop a radiologically induced cancer. If this conversion factor is multiplied by the individual dose, the result is the individual increased lifetime probability of developing an LCF. For example, if an individual receives a dose of 0.00033 sieverts (0.033 rem), that individual's LCF risk over a lifetime is estimated to be 2×10^{-5}. This risk corresponds to a 1 in 50,000 chance of developing a LCF during that individual's lifetime. If the conversion factor is multiplied by the collective (population) dose, the result is the number of excess LCFs.

Because these results are statistical estimates, values for expected LCFs can be, and often are, less than 1.0 for cases involving low doses or small population groups. If a population group collectively receives a dose of 50 sieverts (5,000 rem), which would be expressed as a collective dose of 50 person-sievert (5,000 person-rem), the number of potential LCFs experienced from within the exposure group is 3. If the estimated number of LCFs is less than 0.5, on average, no LCFs would be expected.

Source: NRC, 2005

could occur in rural and suburban areas, respectively (see Table E-26). The increase in the risk of an LCF to the maximally exposed individual (MEI) from exposure to radioactive materials from an accident would be 1.43×10^{-7} (see Table E-26).

These short-term changes in potential LCFs and accident fatalities would be SMALL in that they would be small fractions of the number of cancer deaths from all sources likely to occur in the affected populations (about 21,000 cancer fatalities from all sources and about 89,000 accident fatalities in rural areas, and about 5.8 million cancer fatalities and about 25 million accident fatalities in urban areas). The increased risk of an LCF would be similarly SMALL in comparison to the national cancer rates of 23.42% for males and 19.82% for females. Long-term indirect effects would be unlikely after a radiological accident because of the requirements for cleanup by local, state, and Federal authorities.

4.5.3 Alternative 3: Partial Off-site Disposal of Contaminated Materials

Under Alternative 3, local off-site transportation would involve workers commuting to and from the SFC site, the delivery of normal supplies and materials for reclamation activities, and off-site shipments of contaminated materials by truck. The transportation impacts associated with implementation of Alternative 3 would include an increase in truck traffic over the current baseline conditions, with a resultant increase in traffic fatalities, a potential increase in fatalities from air emissions from these vehicles, and potential for an increase in LCFs from radiation doses to workers (transportation crews) and members of the public who live near or share the transportation corridor with off-site shipments.

4.5.3.1 Highway Capacity Impacts

Under Alternative 3, during the most intensive year of site reclamation activity, about 768 vehicles per day would be added to nearby roadways, primarily due to the increased workforce and construction vehicles bringing materials to the site (see Table 4.5-4). In addition, off-site shipments of contaminated materials would add seven truck trips (round trips) per day to State Highway 10. These additional trips (775) would nearly double the existing traffic count on State Highway 10, but the overall increased volume of about 1,600 vehicles per day would remain below the highway's design capacity. This increase would not be noticeable to users of State Highway 10, except at the entrance to the SFC site and at the intersection of State Highway 10 and U.S. Highway 64 north of the site. Any delays would not destabilize the traffic flow along the roadway. Traffic flows along other highways in the vicinity of the SFC site (e.g., I-40 and U.S. Route 64), which have higher design capacities than State Highway 10 (typically 2,000 vehicles per hours per lane [TRB, 2000]) would be even less affected. All traffic impacts would be short-term. Following SFC's completion of site reclamation, traffic conditions would return to normal. In summary, the impact of Alternative 3 on the traffic flow of the local transportation network, including State Highway 10, U.S. Highway 64, and I-40, would be SMALL.

Table 4.5-4 Estimated Daily and Total Local Transportation Traffic

Type of Vehicle Traffic	Estimated One-Way Trips (km)[a]	Alternative 3: Off-Site Disposal	No-Action Alternative
Commuting Workers	40.2	75	6
Normal Deliveries	40.2	75	6
Fly Ash	82.1	27	0
Riprap from Off-Site	12.9	38	0
Riprap from On-Site	1.6	38	0
Sand, Drain Layer, and Bedding	12.9	8	0
Clay Liner and Clay Cap	1.6	38	0
Clean Backfill	1.6	85	0
Topsoil	1.6	13	0
Total Daily Two-Way Vehicle Count	--	768	24
Total Daily Two-Way (km)[b]	--	18,247	966
Total Local (km)[b]	40.2	4,561,844	241,410

Source: SFC, 2006.

[a] To convert to miles, divide by 1.6094.

[b] Assumes an average of 75 employees on site 250 working days per year.

4.5.3.2 Vehicle Accidents

During the year of intensive site reclamation activities, local vehicle mileage would increase to about 4.5 million km (2.8 million miles), 4.3 million km (2.7 million miles) more than current baseline conditions. In addition to local travel, SFC would ship a portion of the on-site contaminated materials off-site, either to a licensed disposal facility or to an alternate feed mill, as appropriate. The off-site shipment of these materials would require 902 trucks (about four trucks entering and leaving the site per day). The analysis is based on round-trip miles for commuters and deliveries, as well as for the off-site shipments, assuming that all trucks would return from the off-site facility to the SFC site for reuse. Under Alternative 3, the predicted risk for the short-term increase in traffic volumes would be an additional 9.45 injuries and 0.117 fatality during the year of intensive site reclamation activities. This means that about nine injuries could occur; however, since the predicted risk is less than one, it can be concluded that no truck-related fatalities are likely to occur as a result of SFC's reclamation activities under Alternative 3. There would be no long-term direct or indirect traffic accident-related effects because following completion of site reclamation activities by SFC, the predicted risk of fatalities would revert to at or near those identified under baseline conditions. Therefore, the impact of traffic-related accidents on the area surrounding the SFC site during on-site reclamation activities would be SMALL.

4.5.3.3 Nonradiological Vehicle Emissions

During the year of reclamation activities, local vehicle mileage would increase by about 4.3 million km (2.7 million miles) over the current baseline conditions (see Table E-15). In addition, as listed in Table E-1, shipments of disposal materials to Clive, Utah, would involve 902 trucks.

These shipments would travel about 3.9 million truck km (2.4 million miles). Under Alternative 3, the short-term changes from increased vehicle emissions could result in an additional 0.0025 fatality (see Table E-16). This change in the number of fatalities would be small in that it would be a very small fraction of the more than 1,500 fatalities per year from all causes that would likely occur in the affected local population of 500,000 (see Table B.6-1) within 40 km (25 miles) of the SFC facility (CDC, 2002). This change also would be a small fraction of the more than 1,200 fatalities that likely would occur in the affected off-site population of 146,000. Long-term indirect effects would not occur because there would be no activity following reclamation activities. Therefore, the impact of increased vehicle emissions would be SMALL.

4.5.3.4 Radiological Impacts from Routine Transportation and Transportation Accidents

Using the methodology described in Appendix E, the NRC staff's analysis estimated the potential increases in the number of LCFs for transportation workers (i.e., truck crews) and members of the general public who lived along or shared the truck transportation routes. Under Alternative 3, the short-term increase in LCFs could include 3.43×10^{-6} LCFs in the affected off-site public population and 1.86×10^{-5} LCFs in the truck crews (see Table E-23). The increase in the risk of an LCF to the maximally exposed member of the public and transportation worker (i.e., a truck driver) would be 1.80×10^{-8} and 9.31×10^{-6}, respectively (see Table E-25).

These short-term changes in LCFs from the incident-free transportation of radioactive materials would be SMALL in that they would be very small fractions of the number of cancer fatalities likely to occur in the affected populations of about 146,000. Using the lifetime cancer statistic for males (NCHS, 2006), about 34,000 cancer fatalities from all causes would likely occur in the affected population. Long-term indirect effects would not occur because there would be no exposure to radiological contaminants following completion of the off-site shipment of contaminated materials.

The increase in the number of LCFs from the maximum reasonably foreseeable accident would be the same as that under Alternative 2 (2.85×10^{-5}).

4.5.4 No-Action Alternative

Local transportation for the no-action alternative (i.e., the current baseline condition) involves workers commuting to and from the SFC site and normal deliveries of supplies. Transportation impacts under the no-action alternative would include traffic on local highways, air pollution from vehicle emissions, and traffic accidents. The analysis performed quantitative assessments for fatalities from increased vehicle accidents and from vehicle emissions. There would be no radiological impacts from routine transportation or transportation accidents because SFC would not ship radiological materials off the site.

4.5.4.1 Highway Capacity Impacts

Current activities at the SFC site account for approximately 24 round trips per day. The quality of traffic flow on State Highway 10 and the surrounding roadway network is high. Therefore, the impacts on traffic flow would be SMALL.

4.5.4.2 Vehicle Accidents

The current annual vehicle mileage of commuting employees at the SFC site is estimated at 241,000 km (150,000 miles). Based on DOE data regarding the average accident injury and fatality rates for trucks in Oklahoma (2.85×10^{-7} per truck km [1.77×10^{-7} per truck mile] and 1.47×10^{-8} per truck km [9.13×10^{-9} per truck mile], respectively) (DOE, 2002b), predicted traffic accident injuries and fatalities would remain at 0.069 and 0.0036, respectively, per year (see Table E-17). Since the predicted risk is less than one, it can be concluded that traffic fatalities would be unlikely to occur in the vicinity of the SFC site. The impacts of vehicle accidents would be SMALL.

4.5.4.3 Nonradiological Vehicle Emissions

Based on the total vehicle miles traveled under this alternative as identified in Section 4.5.4.2 above, the short-term increased risk in fatalities from inhalation of vehicle emissions is predicted to be 2.86×10^{-5} fatality per year. This rate represents a very small fraction of the more than 1,500 fatalities per year that occur from all causes (CDC 2002) among the population in the vicinity of the SFC site. The impacts of vehicle emissions would be SMALL.

4.6 Cumulative Impacts

The CEQ regulations implementing NEPA define cumulative effects as:

> "the impact on the environment which results from the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR § 1508.7).

A study area within approximately 64 km (40 miles) of the SFC site of was examined to determine the potential for cumulative impacts in combination with the proposed action. Cumulative impacts are presented below for resource areas in which the licensee's proposed site reclamation activities, when considered in combination with anticipated changes related to other activities in the region, may result in additive or interactive effects.

Following completion of SFC's reclamation of its Gore, Oklahoma, site under Alternatives 1 and 3, it is proposed that about 131 hectares (324 acres) of the property be transferred in perpetuity to the custody of the State of Oklahoma or the United States. About 112 hectares (276 acres) would be released for unrestricted future redevelopment. Under Alternative 2, SFC would release the entire site for unrestricted future development. Based on information provided by SFC, a private energy group expressed some interest in building an ethanol production facility, including a port and a rail spur, on a small parcel of land on the south edge of SFC's property (SFC, 2006). The group reportedly has not pursued this inquiry any further. Given the speculative nature of the inquiry, the development of an ethanol production facility on the SFC property is not considered to be a reasonably foreseeable future action and is not considered further in this cumulative impacts analysis.

To further define the activities that could result in a cumulative impact on the various resource areas, other federal and non-federal activities in the county and region were researched, and pertinent activities were reviewed in this DEIS. This search identified proposed plans by the Cherokee Nation to construct a port on the Kerr Reservoir and two proposals involving construction of a new coal-fired electric generating power plant and an addition to an existing power plant.

In 1999, the Cherokee Nation proposed constructing a port on the Arkansas River at the former USACE Sequoyah Recreation Area (including the Sallisaw Creek Public Use Area), which was closed in the 1980s. This site is about 32 km (20 miles) downstream of the SFC site, near the confluence of Kerr Lake and Sallisaw Creek. However, the Cherokee Nation has undertaken no development on the project. Since no definite plans have proceeded beyond initial announcements for the Cherokee Nation port on the Arkansas River, it is not considered to be a reasonably foreseeable future action and is not considered further in this cumulative impacts analysis.

The proposal to construct a new coal-fired electric generating power plant in Sallisaw, Oklahoma, was cancelled by its sponsor, Tenaska, in June 2007 (Keen, 2007). Therefore, it is not considered further in this cumulative impacts analysis.

The proposal for new coal-fired generating capacity would involve expansion of the Shady Point coal-fired power plant near the Poteau River in Panama, LeFlore County, Oklahoma (AES, 2006). This site is close to the Arkansas border, about 57 km (35 miles) southeast of the SFC site. The owner of the Shady Point coal-fired power plant, AES Corporation, is proposing to add a 650-megawatt (MW) coal-fired unit to the existing 320-MW facility. Coal mined in Oklahoma is trucked to this power plant, and coal mined outside of Oklahoma is transported by rail. An application for this expansion is under review by the Oklahoma Department of Environmental Quality (ODEQ, 2007). It is possible that construction—but not operation—of the new unit at the Shady Point plant could overlap with reclamation of the SFC site.

Small or no cumulative impacts would result from the possible overlap of construction activities associated with the power plant addition when considered in combination with the proposed construction activities proposed by SFC for reclamation of its site. The rationale for this conclusion is discussed for each of the following resource areas:

- **Land Use** - The two sites that would be affected by construction activities are more than 57 km (35 miles) apart. This distance precludes the potential for cumulative land use impacts. Cumulative land use impacts would be SMALL.

- **Historic and Cultural Resources** - There would be no cumulative adverse impacts on cultural or historical resources since avoidance is the primary method of addressing impacts on these resources.

- **Visual and Scenic Resources** - At more than 57 km (35 miles) from the SFC site, the coal-fired electrical unit addition that has been proposed for development would be located too distant from the SFC site to result in cumulative visual impacts. Therefore, cumulative direct and indirect impacts on visual resources could be characterized as SMALL.

- **Climate, Meteorology, and Air Quality** - The two sites that would be affected by construction activities are more than 57 km (35 miles) apart. Best management practices would be applied at both sites to reduce fugitive dust. Moreover, the distance between the two sites precludes the potential for cumulative air quality impacts. Cumulative air quality impacts would be SMALL.

- **Geology, Minerals, and Soils** - There would be disturbance of soils and geology at all of the proposed construction sites; however, these sites are not in sufficient proximity to result in a cumulative impact on the same resources, either locally or regionally. Cumulative impacts would be SMALL.

- **Water Resources** - The two projects would be constructed within the Arkansas River drainage basin. The AES expansion of the Shady Point power plant would be more than 57 km (35 miles) from the SFC site, near the Poteau River, which drains into the Arkansas River at the Arkansas/Oklahoma state line. The application of best management practices during construction at each of the locations would significantly reduce the potential for cumulative impacts on water resources. Cumulative impacts on water resources would be SMALL.

- **Ecological Resources** - Construction-related activities that would occur during reclamation of the SFC site and the expansion of the AES power plant would result in the temporary disturbance of ecological resources. Reclamation activities at the SFC site would be restricted to the site and possibly along the route of the proposed rail spur. The affected area encompasses a negligible percentage of the habitat surrounding the site, thereby not noticeably changing the cumulative impacts already existing from other local and regional activities. The power plant is not in sufficient proximity to result in cumulative impacts on ecological resources, either locally or regionally. Cumulative impacts on ecological resources would be SMALL.

- **Socioeconomic Conditions** – Both projects under consideration would result in the employment of construction workers. SFC estimates that about 72 workers would be required to conduct the proposed reclamation activities. Construction at the AES Shady Point power plant would likely employ less than 1,000 workers. The region would benefit economically from this construction-related employment. Additional temporary or permanent housing may be needed. However, the projects are sufficiently distant from each other that the possibility for conflicts in demands for housing for commuting workers would be minimized. The Shady Point project is much closer to Fort Smith, Arkansas, and would likely draw workers from that area. The SFC site is closer to Muskogee and Tulsa, Oklahoma. The two cities are 114 km (71 miles apart). These impacts would be SMALL.

- **Environmental Justice** - Although minority and low-income populations reside in the vicinity of the two projects under consideration, there would be no overlap of construction activities that would result in disproportionately high and adverse human health and environmental effect on such populations. These impacts would be SMALL.

- **Noise** - The construction-related activities that would occur during reclamation of the SFC site and expansion of the AES power plant would result in the generation of noise. SFC's site reclamation activities would not affect any sensitive off-site receptors. Moreover, the two construction sites are not in sufficient proximity to result in cumulative impacts on local or regional noise conditions. Cumulative noise impacts would be SMALL.

- **Transportation** - As discussed under Socioeconomic Conditions, the two projects are sufficiently distant from each other that the possibility for conflicts resulting from increased traffic of commuting workers would be minimal. Cumulative transportation impacts would be SMALL.

- **Public and Occupational Health** - SFC's site reclamation activities would result in a site that would be protective of public and occupational health in the long term. The other construction project would not generate similar, if any, significant public or occupational health effects. These cumulative impacts would be SMALL.

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5. MITIGATION

Mitigation measures during the proposed SFC site reclamation would be those actions or processes (e.g., management plans) implemented by SFC to control and minimize potential impacts from demolition and construction activities. These measures would be in addition to actions taken to comply with applicable laws and regulations, including permits. This chapter summarizes the mitigation measures that were proposed by SFC for implementation of site reclamation activities. The same mitigation measures apply to the proposed action (Alternative 1) and Alternatives 2 and 3. The proposed mitigation measures described in this chapter do not include environmental monitoring activities. Environmental monitoring activities are described in Chapter 6 (Environmental Measurement and Monitoring Programs) of this DEIS.

Mitigation measures proposed by SFC are described in the *Reclamation Plan* (SFC 2006a) and briefly summarized in the *Environmental Report* (SFC 2006b). The NRC staff has reviewed the mitigation measures proposed by SFC; and the NRC did not identify additional mitigation measures that it would recommend.

5.1 Run-on/Runoff Control

Procedures proposed by SFC for control of runoff and run-on water and containment of other liquids include:

- Runoff generated from demolition operations will be contained on concrete or asphalt pads or in building sumps.
- Run-on diversion berms will be installed up-slope of the facility, as necessary, to minimize run-on of storm water into the demolition work area. The berms will be inspected periodically and modified or extended, as necessary, during demolition operations.
- Runoff retention berms will be installed down-slope of the facility, as necessary, to minimize runoff of decontamination liquids and sediment. The liquids contained will be pumped to a collection sump for removal and then be transferred to appropriate receiving ponds. The berms will be inspected periodically and modified or extended, as necessary, during demolition operations.

In addition to berms, runoff control devices that are currently in place and others, such as silt fences, will be used, if necessary, and as required by SFC's Storm Water Pollution Prevention Plan.

5.2 Dust Control

Dust generation will be minimized during all preparation, salvage, and demolition operations. A detailed dust suppression program would be included in the cleanup contractor's work plan, which would be reviewed by NRC. General procedures proposed by SFC for control of dust include the following:

- During demolition and removal operations, equipment and structure surfaces will be sprayed with water to prevent dust generation.

- A chemical fixant may be applied to surfaces prone to dust generation and high-efficiency particulate air (HEPA) vacuuming equipment may be utilized, if necessary.

- Haul roads and areas used for loading, off-loading, material evaluation, and disposal will be periodically sprayed with water to control dust generation, and a speed limit of 15 miles per hour for construction equipment and vehicles will be enforced.

- Excavation, material-handling, and stockpile development work areas will be sprayed with light applications of water using hoses with mist or fog nozzles, as necessary.

- Material stockpiles on the site will be covered with a geotextile or sprayed with a crusting agent during nonoperational periods to minimize fugitive dust emissions.

5.3 Residue Management

Procedures proposed by SFC for control of residues include:

- Liquids generated during dust control or soil moisture conditioning will be contained in the building sumps, area tanks, or on concrete or asphalt pads.

- The liquid, sediment, and solids collected in the sumps, tanks, and pads, will either be reused, transported to the disposal cell, or treated for permitted discharge.

5.4 Contamination Control

Procedures proposed by SFC for contamination control include:

- Personnel, vehicles, and testing equipment will be surveyed for contamination prior to leaving the restricted area of the facility.

- All workers involved in demolition operations will be surveyed for contamination at the exit screening station and will shower, if necessary, prior to leaving the facility.

- Only authorized personnel will be allowed access to the work area during demolition operations. Access will be restricted during active operations and at the disposal cell. Signs and/or barrier tape will be used to post areas where access is restricted.

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6. ENVIRONMENTAL MEASUREMENT AND MONITORING PROGRAMS

This chapter describes the environmental measurement and monitoring programs that would be implemented during reclamation and long-term maintenance programs for the alternatives that involve total or partial on-site disposal of contaminated materials (i.e., Alternatives 1 and 2). Measurement and monitoring programs include: (1) direct monitoring of radiological gaseous and liquid effluents from cleanup activities, and (2) monitoring and measurement of pollutants in ambient air, surface water, sediment, groundwater, soils, and direct (gamma) radiation in the near-field environment.

6.1 Radiological Measurements and Environmental Monitoring

Throughout the operating life of the SFC facility (operation began in 1970), there have been ongoing evaluations of the impacts of plant operations, including monitoring of air and liquid discharges, soil sampling, and groundwater sampling. The results of this historical monitoring are provided in SFC's *Site Characterization Report* (SFC, 1998). Historical results of monitoring also are provided in the annual groundwater monitoring report (SFC, 2006a). Since the cessation of production operations, both airborne and liquid effluents have diminished significantly. No airborne effluent release points exist; thus, no airborne effluent monitoring is required. However, perimeter air samples continue to be collected at the restricted area fence line. Soil and vegetation sampling requirements also have been reduced. Historical surface water and effluent stream monitoring locations continue to be monitored on a reduced frequency. These locations include drainages, seeps, streams, and the effluent discharge and its receiving waters. The OPDES permit (OK0000191) and OPDES Storm Water Industrial General Permit Authorization (OKGP00046) for the site prescribe surface water sampling for both the liquid effluent stream and storm water discharge from the site (see Section 1.5.4).

By license amendment 31 to SFC's NRC license, the NRC staff approved SFC's *Groundwater Monitoring Plan* (NRC, 2005). SFC's approved *Groundwater Monitoring Plan* identifies (1) hazardous constituents in the groundwater that resulted from licensed site operations; (2) groundwater protection standards for the hazardous constituents; and (3) groundwater monitoring locations, frequency, and parameters.

For the purposes of groundwater monitoring, SFC identified antimony, arsenic, barium, beryllium, cadmium, chromium, fluoride, lead, mercury, molybdenum, nickel, nitrate, radium-226, selenium, silver, thallium, thorium-230, and uranium as COCs or hazardous constituents (SFC, 2005). The main constituents with sizable groundwater contaminant plumes are arsenic, nitrate, fluoride, and uranium. For each of these 18 constituents, a groundwater protection standard was set in accordance with concentration limits found in 10 CFR Part 40, Appendix A, or in the EPA's National Primary Drinking Water regulations. The standards in 10 CFR Part 40 and in the EPA's regulations have been determined to be protective of public health and safety. The hazardous constituents present at the SFC site and the protection standards for each of those constituents are identified in Table 3.3-3. The radium standard was revised to apply to combined radium-226 and radium-228 to be consistent with Table 5C of 10 CFR Part 40, Appendix A (NRC, 2005).

Under the approved *Groundwater Monitoring Plan*, SFC will collect and analyze samples from the groundwater, drainages and seeps, and surface water. The frequency of monitoring for each location is provided in Table 6.1-1. SFC is required under its NRC license to submit by April 1 of each year the results of its monitoring analyses in a groundwater compliance monitoring summary report (NRC, 2005).

Table 6.1-1 Frequency and Locations of SFC's Groundwater Monitoring Program

Aquifer System	Wells	Parameters Analyzed
Background Groundwater Quality Monitoring (Sample Annually)		
Terrace	MW007, MW070, MW073	See Note 1
Shallow Bedrock	MW007A, MW110A	See Note 1
Deep Bedrock	MW007B	See Note 1
Compliance Monitoring (Sample Annually)		
Terrace	MW008[2], MW010[2], MW014[2], MW019[2], MW025[2], MW035[2], MW036[2], MW040, MW042, MW045, MW049, MW053[2], MW054[2], MW056, MW062, MW075[2], MW077[2], MW079[2], MW080[2], MW086[2], MW087	Uranium, Nitrate (as Nitrogen), Fluoride, Arsenic (MW040: Barium also)
Shallow Bedrock	MW012A[2], MW014A[2], MW018A[2], MW042A, MW047A, MW048, MW049A[2], MW050A[2], MW052A, MW057A[2], MW059A, MW062A, MW065A[2], MWO67A[2], MW081A, MW084A[2], MW086A[2], MW089A, MW097A, MW099A, MW107, MW108, MW111A, MW112A, MW115A, MW121A, MW122A, MW123A, MW124A, MW125A, MW126A, MW127A, MW129A, MW130A, 2303A, 2346	Uranium, Nitrate (as Nitrogen), Fluoride, Arsenic
Deep Bedrock	MW059B, MW090B, MW098B, MW100A, MW105B, MW128B	Uranium, Nitrate (as Nitrogen), Fluoride, Arsenic
Corrective Action Monitoring (Sample Quarterly)		
Terrace	MW031, 2248	Uranium, Nitrate (as Nitrogen), Fluoride, Arsenic
Shallow Bedrock	MW095A, 2224A, 2224B, 2247	Uranium, Nitrate (as Nitrogen), Fluoride, Arsenic
Deep Bedrock	None	None
Seep and Drainage Monitoring (Sample Quarterly)		
Terrace	None	None
Shallow Bedrock	2242, 2243, 2244, 2245, 2246	See Note 3
Deep Bedrock	2241	See Note 3
Surface Water Monitoring (Sample Annually)		
2201	Illinois River – 1600 feet Upstream of 001 Confluence	Uranium, Nitrate (as Nitrogen), Arsenic, Combined Radium-226 and -228
2202	Illinois River – 600 feet Downstream of 001 Confluence	Uranium, Nitrate (as Nitrogen), Arsenic, Combined Radium-226 and -228

Table 6.1-1 Frequency and Locations of SFC's Groundwater Monitoring Program

Aquifer System	Wells	Parameters Analyzed
2203	Arkansas River – Upstream toward Highway 64 Bridge	Uranium, Nitrate (as Nitrogen), Arsenic, Combined Radium-226 and -228
2204	Arkansas River – Downstream near I-40 Bridge	Uranium, Nitrate (as Nitrogen), Arsenic, Combined Radium-226 and -228

Source: SFC, 2006a.

Notes:

[1] Analyze for antimony, arsenic, barium, beryllium, cadmium, chromium, fluoride, lead, molybdenum, nickel, nitrate (as N), combined Radium-226 and -228, selenium, thallium, thorium-230, and uranium.

[2] Well will be abandoned and plugged as necessary to allow reclamation activities.

[3] Analyze for antimony, arsenic, nitrate (as N), lead, thallium, and uranium.

The monitoring locations for groundwater, surface water/storm water discharge, and air are shown on the map on Figure 6.1-1. Ecological monitoring was not conducted for baseline conditions or during operations, nor is any planned for reclamation activities.

6.2 Radiation Safety Program during Reclamation

SFC's Radiation Safety Program, which is provided as Attachment D of the SFC *Reclamation Plan* (SFC, 2006b), describes measures to protect workers, the public, and the environment during remediation. The program is designed to be flexible, recognizing that the amount of radioactivity and the associated hazards would be reduced as the project progresses. The Radiation Safety Program may be modified to be commensurate with the activities being performed. SFC would review and approve the Radiation Safety Program and any revisions that are made during the project. Any such adjustment to the requirements of the Radiation Safety Program would be made in accordance with SFC's document control procedures. This section briefly summarizes the intent and content of the Radiation Safety Program during site reclamation.

6.2.1 Air Monitoring Program

SFC's *Environmental Report* (SFC, 2006c) states that during reclamation, air samples would be collected in accordance with their NRC source material license SUB-1010 (NRC, 2006). SFC also would collect air samples in general and localized areas when and/or where there is potential for the generation of airborne radioactive material. These samples would be used to verify that the confinement of radioactive material is effective and provide warning of elevated concentrations for planning or response actions.

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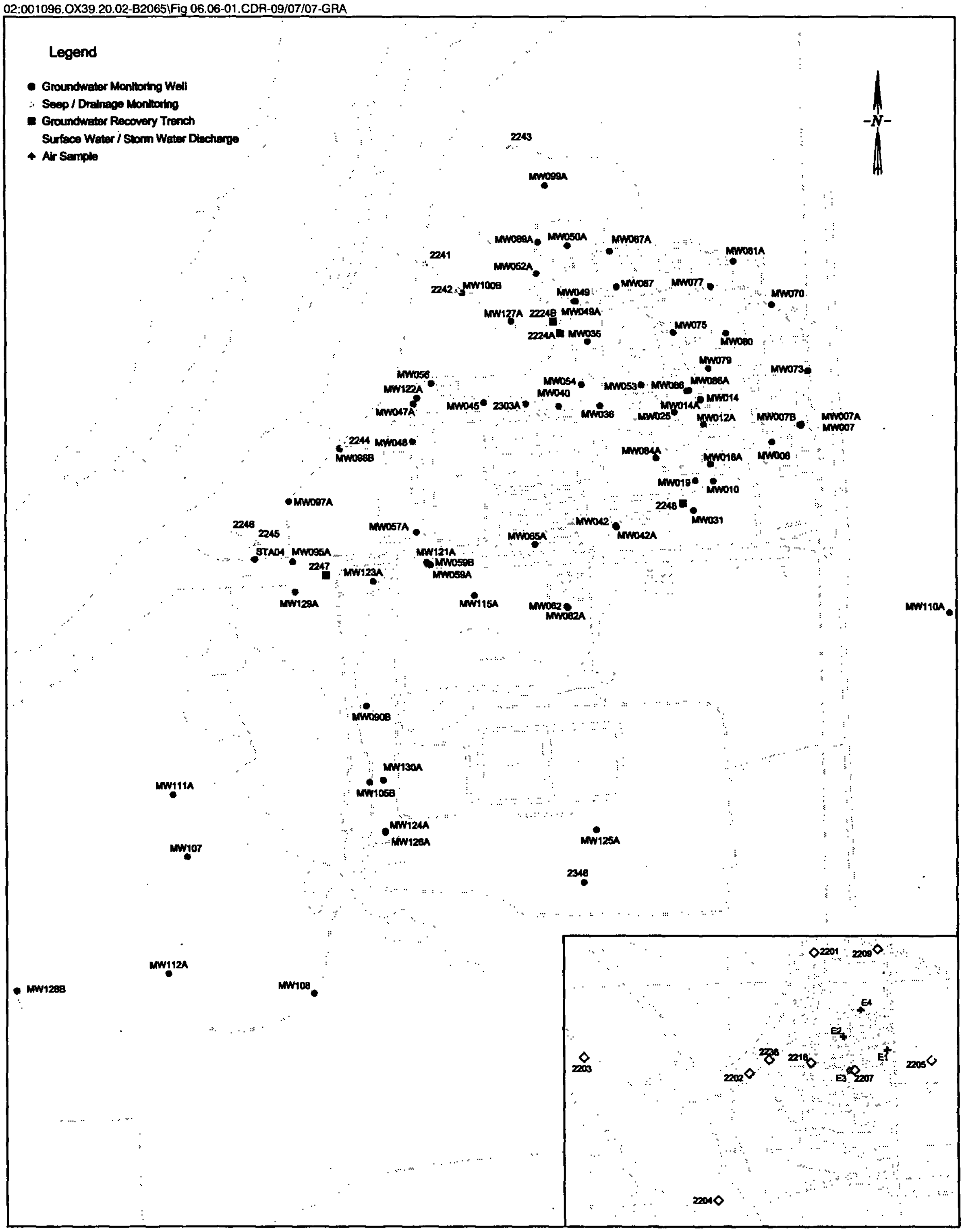

Figure 6.6-1 Environmental Sample Locations

6.2.2 Contamination Control Program

SFC would practice contamination control measures and monitor their effectiveness through the performance of radiation surveys. Personnel exposures to radioactive material would be controlled by the application of engineering, administrative, and personnel protection provisions. Engineering controls (primarily containment, isolation, ventilation, and decontamination) would be used, as practicable, to minimize or prevent the presence of uncontained radioactive material. Administrative controls (e.g., access control, postings and barriers, procedures, hazardous work permits, and establishment of action levels for radiation surveys) would be used to control work conditions and work practices. SFC has indicated that the details regarding the contamination control program would be consistent with the Radiation Safety Program maintained under the existing license.

6.2.3 Radiation Surveys

SFC would perform radiation surveys to identify the types and levels of radiation in an area or during a task. The results of the surveys would be used to identify or quantify radioactive material and evaluate potential and known radiological hazards. Radiation surveys include contamination measurements, radiation or exposure rate measurements, and measurements of radioactive materials on personnel. Measurements would be made of alpha, beta, and gamma radiation, as required for the specific situation encountered. SFC has indicated that the details regarding radiation surveys would be consistent with those described in the Radiation Safety Program maintained under the existing license.

6.2.4 Instrumentation Program

SFC would calibrate and maintain their radiation safety instrumentation in accordance with radiation safety procedures documented as part of the Radiation Safety Program.

References

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7. COST BENEFIT ANALYSIS

7.1 Introduction

This section describes the data, methods, and results of the cost benefit analysis undertaken for the SFC site reclamation alternatives evaluated in this DEIS. The analysis conforms to the guidance contained in NUREG-1748, *Environmental Guidance for Licensing Actions Associated with NMSS Programs*, Section 5.7, and procedures outlined in NUREG-1757 Vol. 2, Rev. 1, Appendix N.

A cost benefit analysis compares the full resource costs of each site reclamation alternative over the entire project lifetime to the anticipated benefits. The analysis compares each alternative to the baseline (i.e., the no-action alternative) to evaluate incremental costs and benefits. The purpose of conducting the cost benefit analysis is to assess how the proposed action will maximize net benefits to society, including potential economic, environmental, public health and safety, and other advantages. The analysis should address whether the potential benefits exceed the potential costs, recognizing that some benefit and cost flows over time cannot be monetized (assigned a dollar value) and must be considered qualitatively (OMB, 1996).

Lifecycle Costs
All costs that would occur during and after site reclamation, including the remedial action and construction costs and long-term operating, monitoring, surveillance and maintenance costs.

Opportunity Cost of Land
Represents the alternative uses and foregone benefits that can be derived from the land. For example, if land is lying fallow and not being productively cultivated or used for grazing, the opportunity cost would be represented by the loss of income that the owner would have received if the land had been put to productive use. When land use is restricted or encumbered, for whatever reason, there is an associated opportunity cost related to those restrictions.

The lifecycle costs of the proposed SFC *Reclamation Plan* and alternatives to that plan were compared to the no-action alternative. In accordance with NUREG-1757, *Consolidated Decommissioning Guidance* (NRC, 2006), the main benefits that were measured consisted of (1) collective radiation dose averted, (2) regulatory costs avoided, and (3) changes in land values (agricultural production). The benefits were compared to the total lifecycle reclamation costs, denoted as $Costs_R$, the transportation and disposal costs, and the opportunity cost of the land associated with each alternative. The opportunity cost of land recognizes the differences (and foregone benefits) between the varying acreage that would be released for unrestricted use proposed under each alternative. The net benefits for each alternative are discussed in Section 7.5.

7.2 Description and Costs of the Alternatives

7.2.1 No-Action Alternative

The no-action alternative costs reflect the cumulative present value of annual costs necessary to control erosion or other problems and the long-term maintenance of the entire 243-hectare (600-acre) SFC site. The cumulative present value of costs measures the present worth sum of all future annual costs associated with this action. Since these costs will occur annually in future years, the analysis involves summing them into the present, using discounting principles that consider the time value of money. The no-action costs reflect annual surveillance and maintenance activities to ensure that the buildings and equipment are maintained in a safe condition and that contaminated materials are controlled indefinitely. The activities that SFC would undertake under the no-action alternative would consist of sampling and analysis of monitoring wells, NRC inspection support, preparation of annual reports, mowing, and general maintenance. SFC proposed that a staff of one engineer/manager (part time), one administrative person (part time), two security guards, and two technicians (both full time) would be required to sustain these activities. In addition, the no-action alternative's cumulative present value costs also reflect 13 years of annual spending on planned groundwater treatment and recovery. SFC estimated that the annual costs of all of these activities, amounting to $359,936, could be funded by an $18 million annuity escrow fund using a 2% interest rate return expectation (SFC, 2006). The size of the fund was calculated by dividing the estimated annual costs by the interest rate of 2%.

The no-action alternative is used as a baseline against which the other alternatives can be compared under the "with project" and "without project" evaluation framework.

7.2.2 Alternative 1: On-site Disposal of Contaminated Materials (the Licensee's Proposed Action)

Alternative 1 would involve consolidating and placing all contaminated materials (soils, sludges, sediments, trash, drums, chipped pallets, etc.) in an on-site disposal cell. Due to the variability in disposed material density and the amount of soil that may actually be excavated, the disposal cell location and layout has been preliminarily designed to accommodate material volumes ranging from 5.1 million to 12 million cubic feet (i.e., a 4.05- to 8.1-hectare [10- to 20-acre] footprint) (SFC, 2006). On-site disposal of all contaminated materials is estimated to cost $31.9 million dollars. This cost represents the sum total of remediation/reclamation activities and regulatory costs.

7.2.3 Alternative 2: Off-site Disposal of All Contaminated Materials

Alternative 2 would involve excavating all contaminated materials, loading the materials onto gondola railcars, and transporting it to a disposal facility licensed to accept such materials.

The projected volume of contaminated materials to be shipped is estimated to be approximately 254,850 cubic meters (9 million cubic feet) (SFC, 2006). Option 1 would involve transporting all contaminated materials by railcar to the Energy*Solutions* facility in Clive, Utah and is estimated to cost $254 million. Option 2 would involve transporting all materials by rail to the WCS facility in Andrews, Texas. The cost of this option was estimated to be $190 million. Clive, Utah, is approximately 2,424 rail kilometers (1,505 miles) from Gore, Oklahoma, while the distance from Gore to Andrews, Texas, is approximately 1,221 rail kilometers (759 miles). The cost estimate differences reflect the different distances from Gore, Oklahoma, applying the same cost per ton kilometer first calculated from Option 1 data to the same total tonnage of materials.

7.2.4 Alternative 3: Partial Off-site Disposal of Contaminated Materials

The costs of Alternative 3 reflect a blend, or composite cost, based on disposing/reusing of the raffinate sludge (i.e., Section 11.e.(2) materials), which would be transported via truck to five possible locations. The other sediments (corresponding to the Emergency Basin, North Ditch, and Sanitary Lagoon sediments) would be disposed of at one of three locations that could accept this form of waste. Contaminated materials other than the raffinate sludge and the sediments identified in Table 7-1 would be placed in the on-site disposal cell.. The partial off-site disposal options are presented in Table 7-1.

Table 7-1 Alternative 3: Partial/Blended Disposal/Alternate Feed Options

Alternative 3 – Options					
Material Type	**White Mesa, (Blanding, Utah)**	**Rio Algom (Grants, New Mexico)**	**Pathfinder Shirley Basin (Mills, Wyoming)**	**Energy Solutions, (Clive, Utah)**	**WCS, (Andrews, Texas)**
Raffinate Sludge (11.e.(2))	√	√	√	√	√
Other Sediments*			√	√	√

* Sediment from the Emergency Basin, the North Ditch, and the Sanitary Lagoon.

The following disposal options were evaluated for the raffinate sludge and other sediments:

1. White Mesa + Pathfinder (Option 3-1-1)
2. White Mesa + EnergySolutions (Option 3-1-2)
3. White Mesa + WCS (Option 3-1-3)
4. Rio Algom + Pathfinder (Option 3-2-1)
5. Rio Algom + EnergySolutions (Option 3-2-2)
6. Rio Algom + WCS (Option 3-2-3)

In addition, the following options (Alternative 3 - Option 3) are possible and would involve disposing the raffinate sludge and the other sediments at one facility (although disposal of all materials at Rio Algom might be possible, this option was similar to the Pathfinder option and was not assessed separately):

1. EnergySolutions (Option 3-3-1)
2. WCS (Option 3-3-2)
3. Pathfinder Shirley Basin (Option 3-3-3)

The costs of each of these options are shown in Table 7-2 and Table 7-6, and the detailed unit costs and costing parameters and assumptions are provided in Appendix F, Costs Analysis.

7.3 Total Costs

Appendix N of NUREG 1757, Vol. 2, Rev. 1 specifies the categories of the total costs of an action that should be evaluated for the cost benefit analysis. Among these cost categories are the monetary cost of the remediation action ($Cost_R$), the monetary cost for transport and disposal ($Cost_{WD}$), the monetary costs of worker accidents during the remediation action ($Cost_{ACC}$), the monetary cost of traffic fatalities during transportation of the waste ($Cost_{TF}$), the monetary cost of dose received by workers performing the remediation action and transporting waste to the disposal facility ($Cost_{WDose}$), the monetary cost of the dose to the public from excavation, transport and disposal of the waste ($Cost_{PDose}$), and other costs as appropriate for the particular action ($Cost_{other}$) (NUREG-1757). The total cost analysis comparisons focus on combined remediation plus disposal and transportation costs. The other costs (besides remediation and transport and disposal) were below threshold levels and not added to total costs.

Lifecycle Costing Framework and Discounting

Discounting is a process to convert future values into present worth amounts for the purposes of comparing apples to apples, and to acknowledge the time value of money. Since some annual costs (e.g., those related to long-term site control and maintenance and groundwater remediation) will arise in future years, they are converted to present worth equivalents using the following formula and discount rate:

$$\text{Present Value of Future Costs} = \left(\frac{FV\ Cost}{1+i^n}\right)$$

A 2% discount rate was used in this section because it is consistent with regulatory guidance for the level of discount rate to be used for long-term planning horizons (3%), and because it matches the rate used to calculate the fund value for financial assurances purposes. The fund value represents the present value of a series of uniform payments for long-term site control and inspections. The 2% rate represents the return expectation on the annuity escrow fund that would pay for the annual long-term surveillance and monitoring activities for each alternative. This rate is also close to the current 3% discount rate suggested by the Office of Management and Budget (OMB) in their guidance document for programs with durations longer than 30 years.

Table 7-2 shows the total costs consisting of remediation, transport and disposal per each alternative. The average discounted lifecycle costs ($Costs_R + Cost_{WD}$) per km, per ton, and per ton/km are also shown across all options. The data in Table 7-2 show that taking advantage of the shorter distance between the SFC site and the WCS facility in Andrews, Texas, has the potential to lower the total cost of both Alternatives 2 and 3 compared to the other disposal alternatives. However, the licensee's proposed action is the least cost alternative.

7.4 Benefits of the Alternatives

The benefits of each alternative can first be assessed by how effectively each functions in removing residual radioactivity from the SFC facility site, thereby enabling either (1) release of the property for unrestricted use and termination of the license, or (2) release of the property under restricted conditions and termination of the license. Benefits also can be classified by when they could potentially arise over time.

Table 7-2 Total Costs per Alternative and Costs per Unit

Alternative	Total Cost$_{R+WD}$ (= remediation plus transport and disposal)	Distance from SFC (Gore, OK) to Disposal Site (km)	Total Cost Per Km	Total Cost Per Ton[1]	Total Cost Per Ton Km
Alternative 1: On-site Disposal (the Licensee's Proposed Action)	$31,881,571	-		$102	
Alternative 2: Off-site Disposal of All Contaminated Materials					
Option 1: Transport of all materials by rail to EnergySolutions, Clive, Utah	$253,712,899	2,424	$104,667	$813	$0.34
Option 2: Transport of all materials by rail to WCS in Andrews, Texas	$189,865,590	1,221	$155,500	$608	$0.50
Alternative 3: Partial Off-site Disposal					
Option 1: Raffinate sludge to be transported by truck to White Mesa, Blanding, Utah[3]. Other sediments to be transported by truck to either:		**Weighted Km Distance from SFC[2]**			
1. Pathfinder Shirley Basin, Mills Wyoming[2]	$38,930,061	1,619	$24,052	$125	$0.08
2. EnergySolutions, Clive, Utah[2]	$39,243,857	1,706	$22,997	$126	$0.07
3. WCS, Andrews, Texas[2]	$38,554,076	1,510	$25,534	$123	$0.08
Option 2: Raffinate sludge to be transported by truck to Rio Algom, Grants, NM. Other sediments to be transported by truck to either:					
1. Pathfinder Shirley Basin[2]	$44,087,275	1,293	$34,084	$141	$0.11
2. EnergySolutions[2]	$44,401,070	1,381	$32,143	$142	$0.10
3. WCS[2]	$43,711,289	1,185	$36,893	$140	$0.12
Option 3: Transport both sludge and combined sediments via truck to either:					
1. EnergySolutions	$40,626,458	2,190	$18,551	$130	$0.06
2. WCS	$36,770,352	1,038	$35,424	$118	$0.11
3. Pathfinder Shirley Basin	$38,365,019	1,675	$22,904	$123	$0.07
No-Action Alternative	$19,321,014				

1 Total cost per ton was calculated based on the total quantities of all materials. Includes the same total quantity for all alternatives (approximately = to 312,217 tons of materials).
2 Reflects the weighted distance (weighted by the tonnage of materials being disposed of at each option), where applicable, for those Alternative 3 options (noted) with two final disposal destinations.
3 White Mesa, in Blanding, Utah, is 1,607 truck km from Gore, Oklahoma.
4 Other sediments include Emergency Basin Sediment, North Ditch Sediment plus Sanitary Lagoon Sediment.

The future benefits that are attributable to each alternative and directly related to the future land use of the SFC property were quantified and monetized. These benefits were (1) the monetized benefit from the collective radiation dose averted (explained below) and (2) the agricultural benefit associated with the unrestricted acreage that could be used productively in the future.

Under the "with" and "without" project evaluation framework pursuant to Executive Order 12866, the radiation dose and risk assessments presented in Appendix D (Radiation Dose and Risk Assessments) were evaluated for each alternative, including the no-action alternative. The differences in radiation doses (collective person-rems over time) between the no-action alternative (without project) and the other alternatives (with project scenarios) were calculated, valued, and compared as avoided costs or the collective benefits from averted future radiation doses attributable to each alternative.

The U.S. Census of Agriculture (for Sequoyah County, Oklahoma) was used to calculate a net farm cash income per acre associated with the net acres under each alternative that could potentially be farmed under unrestricted land use conditions. The following sections provide details on how these benefits were measured.

7.4.1 Monetized Benefits of Collective Radiation Dose Averted

The direct public health and safety benefits from removing residual radioactivity relate to the avoided collective radiation doses that would no longer be experienced by the relevant population(s) at the site. These populations were taken from the Appendix D scenarios related to reclamation activities (and the number of workers/people who could be exposed) and the lifetime collective doses associated with the residential farmer scenario.

The monetized value of the collective radiation dose averted was calculated by first monetizing the collective doses associated with each respective alternative. Under NRC guidelines for cost benefit analysis, in order to incorporate the benefits associated with reclamation activities that remove residual radioactive contamination from a site (and thereby ensure the public health and safety), there is a procedure for assigning a dollar value to the physical measures of exposure to radiation. The avoided potential exposure that is attributable to reclamation and remedial safety activities, as well as the potential exposure under the no-action alternative, represents the collective radiation dose averted that is then monetized or assigned a dollar value in the cost benefit analysis. This procedure ensures that the benefits from public health and safety actions, unique to each reclamation alternative, can be compared and counted in the analysis.

Collective doses measured in person-rems per year were obtained from this DEIS, Section 4.4 (Public and Occupational Health Impacts), and Appendix D (Radiation Dose and Risk Assessments). The doses reflected both reclamation period worker exposures and the long-term potential exposure that was modeled using the residential farmer scenario. These monetized values were then subtracted from the no-action alternative's monetized collective dose (modeled using the collapse of SFC's proposed ICB and breakdown in institutional controls as a worst-case potentiality, or upper bound).

A given alternative's potential dose to select individuals represents a cost. However, the collective doses that would be avoided by the existence of that particular alternative are represented by the no-action alternative's collective dose less the collective dose of each alternative's reclamation plan. This procedure is consistent with the "with" and "without project" framework method of cost benefit analysis guidance in Executive Order 12866. Under this evaluation framework, "but for" the given disposal alternative, the worst-case collective dose associated with the no-action alternative would occur. This worst-case collective dose is averted by the given disposal alternative; consequently, it is considered a benefit associated with that alternative.

The formula used to calculate collective dose was sourced from NUREG-1757 Vol. 2, Rev. 1, Appendix N, equation (N-1), which is reproduced below.

B_{AD} = \$2,000 x $PW(AD_{collective})$, where:

- B_{AD} = benefit from averted doses for a remediation action, in current U.S. dollars
- \$2,000 = value in dollars of a person-rem averted (see NUREG/BR-0058, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission," Revision 2, November 1995), and
- $PW(AD_{collective})$ = present worth of a future collective averted dose.

Collective doses that would be experienced over time (i.e., over the course of a 70-year period corresponding to the residential farmer scenario) were multiplied by the NUREG dollar value per person-rem averted, \$2000, in each individual year and expressed as the cumulative present value. Since the number of person-rems of total exposure and the dollar value was uniform for each year, the present value of an annuity formula (a uniform series) was applied. The following formula was used to calculate the present value of future collective doses per each alternative:

Monetized Collective Dose per Alternative:

$$= value\ per\ person\ rem\ x\ person\ rems\ x \left(\frac{1-[1+i]^{-n}}{i} \right)$$

Example:

= (\$2000 x 54) x 1-[1+.02]$^{-70}$ / .02

= \$4,049,851

where i represents the discount rate of 2%. The 2% discount rate was chosen to be consistent with the 2% rate that was used to discount future long-term monitoring and site surveillance costs over the 1,000-year period used to establish the fund size, or present worth, of the financial assurance obligation. Table 7-3 presents the calculations that were performed to estimate the benefits per each alternative associated with the averted collective dose.

It should be noted that moving beyond a 70-year modeling framework (from the individual residential farmer scenario) would generate significantly larger net benefits. It is entirely plausible that, over a 1,000-year period, successive generations would farm this acreage and be exposed to radiation. If the annual averted person-rems calculation were carried out over a 1,000-year period, the net averted benefits would be significantly larger than the amounts shown in Table 7-4, which correspond to a period of 70 years. However, since the benefits measured are similar across alternatives, scaling these benefits upward would not alter the outcome or conclusions for each option considered in the cost benefit analysis. The main differences are reflected in cost measures.

Table 7-3 Monetized Value of Collective Radiation Doses per Alternative

	Person-rems	Dollar Value of Averted Person-rems	Present Worth of Future Collective Dose
Alternative 1: On-site Disposal of All Contaminated Materials (the Licensee's Proposed Action)			
Off-site public and worker doses during reclamation	33.5	$2,000	$67,000
Long-term public radiation dose	3,780	$2,000	$4,049,851
Total			$4,116,851
Alternative 2: Off-site Disposal of All Contaminated Materials			
Off-site public and worker doses during reclamation	36	$2,000	$72,000
Long-term public radiation dose	660	$2,000	$706,474
Total			$778,474
Alternative 3: Partial Off-site Disposal			
Off-site public and worker doses during reclamation	37	$2,000	$74,000
Long-term public radiation dose	3,780	$2,000	$4,049,851
Total			$4,123,851
No-Action Alternative			
Off-site public and worker doses during license cont.	6.1	$2,000	$12,200
Long-term public radiation dose	182,000	$2,000	$194,992,820
Total			$195,005,020

Table 7-4 shows the monetized value of the collective radiation dose averted per each alternative. The value of the collective radiation dose averted was calculated by subtracting each alternative's collective dose from the no-action alternative's collective dose. Taking proactive measures to protect the public's health and safety by safely disposing of contaminated sludge and sediments has a monetary value compared to the no-action alternative. This is the concept that is conveyed by the term "value of collective dose averted." According to Table 7-4, by taking no action at the SFC site, the monetized cost of future exposure from residual radioactivity would total $195 million. By taking reclamation and remediation actions at the site per each disposal alternative, the public can avoid these costs. The value of the collective dose averted measures these avoided costs that are public health and safety benefits.

Table 7-4 **Benefits Associated with Value of Collective Radiation Dose Averted per Each Disposal Alternative**

Alternative	Present Worth of Future Collective Dose	Value of Collective Dose Averted
Alternative 1: On-site Disposal of All Contaminated Materials (the Licensee's Proposed Action)	$4,116,851	$190,888,169
Alternative 2: Off-site Disposal of All Contaminated Materials	$778,474	$194,226,546
Alternative 3: Partial Off-site Disposal	$4,123,851	$190,881,169
No-Action Alternative	$195,005,020	-

7.4.2 Benefits from Future Agricultural Land Use Associated with Unrestricted Acres

Other potential economic benefits are associated with the opportunity cost of land at the SFC site. The opportunity cost of the Sequoyah Fuels land represents the next best alternative and highest use of the acreage if it were available for unrestricted use and/or development. If a particular reclamation alternative allows either a portion or all of the former facility acreage to be deemed open for unrestricted use, then in theory the hypothetical future economic benefit can be approximated by examining adjacent lands. The capitalized economic value of those acres functioning at their highest and next best alternative use would represent the benefit that could be compared to the future annual costs of the particular reclamation alternative. The capitalized economic value is a way of expressing the total cumulative value of income derived from this acreage forever, or in perpetuity. Since the NRC reclamation time horizon contemplates a 1,000-year time period, it is appropriate to use the capitalized value.

Adjacent agricultural lands have been used for rangeland and cattle grazing activities in the past (SFC, 2006), and SFC has received several offers to purchase its farmlands in the past at fair market values and has also sold several parcels and company-owned houses at market prices (SFC, 1999). The land also could be used for recreational purposes, as open parkland, as a wildlife sanctuary, or possibly for an industrial park (SFC, 2006). These other potential land uses also have associated economic benefits that can be estimated and compared to costs. However, the actual and perceived quality of the groundwater will also influence the future uses that are achievable for these lands.

Data on the value of agricultural production was obtained from the U.S. Census of Agriculture, 2002, for Sequoyah County, Oklahoma (USDA, 2004). The average dollar income of farms with net gains from production was used to estimate the future net income per acre that may be possible if select unrestricted acres were used for agriculture. Table 7-5 shows how the original data from the Census of Agriculture for the State of Oklahoma was used to measure agricultural benefits associated with each unrestricted release alternative.

Table 7-5 Economic Benefits Associated with Agricultural Use on Unrestricted Acres per Alternative

		Alternative 1: On-site Disposal	Alternative 2: Total Off-site Disposal	Alternative 3: Partial Off-site Disposal
1	Hectares released for unrestricted use	112	243	112
2	Acres released for unrestricted use	276	600	276
3	2007 net cash farm income of operations, farms with net gains (Sequoyah County)	$19,487	$19,487	$19,487
4	Average size of farm acres Sequoyah County	177	177	177
5	Net cash income per farm acre	$110	$110	$110
6	Estimated net cash income per disposal alternative acres	$30,387	$66,059	$30,387
7	Capitalized value of net cash income (i = 2%)	$1,519,351	$3,302,936	$1,519,351
8	2007 Present value of net cash income, (PV, ANN PMT, n = 1,000 yrs, i = 2%)	$1,519,351	$3,302,936	$1,519,351

Source: USDA, 2004; DOL, 2002.

The assumption used in Table 7-5 is that the unrestricted acres would be used in the long-term, over a 1,000-year period for agricultural purposes. For simplification purposes, the calculation assumes that an average yield associated with an average mix of representative crops and farm operations for Sequoyah County would apply to the unrestricted acres being released.

The present worth of future benefits associated with the off-site disposal of all contaminated materials would result in the greatest agricultural benefit because of the larger number of acres that would be released for unrestricted use. It should be noted that the cumulative value of net farm cash income associated with the off-site disposal of all contaminated materials also was applied to the no-action alternative's "Other Costs" as a measure of the opportunity cost of the no-action alternative's land footprint.

7.4.3 Benefits from Avoided Regulatory Costs

The concept of avoided regulatory costs relates back to the licensee's ability to avoid costs associated with a site that has been released for unrestricted use. For example, the licensee may avoid specific costs associated with restricted release. These costs could include additional license fees and financial assurances related to site restrictions. Avoided regulatory costs are treated as a benefit of the unrestricted release alternatives.

Benefits associated with avoided regulatory costs were calculated as the cost difference in terms of regulatory compliance between each disposal alternative and the no-action alternative. This cost difference was represented by the difference between the long-term site control plan for each disposal alternative option (off-site and partial off-site) and the more extensive site control plan (larger costs) associated with the no-action alternative. The long-term fund amount (regulatory cost) associated with both Alternative 1 and Alternative 3 (partial off-site) were modeled by referring to 10 CFR Part 40, Appendix A, Criterion 10. Criterion 10 provided a 1978 amount equal to $250,000 (in 1978 dollars) that was then escalated to 2007 dollars using the U.S. Consumer Price Index for those years. For the no-action alternative, the more extensive long-term site control plan was based on estimated annual long-term maintenance costs that would be required to conduct sampling, testing, and monitoring activities. A fund is set up at time period 0, the current time, to ensure that there will be sufficient annually recurring funds over the life of the 1,000 year period. The annual interest on the fund should provide the source for these annual costs. A 2% interest expectation was used. The sizing of the initial fund (also described as how the fund was capitalized) was determined by dividing the expected annual cost for long-term monitoring and control by the 2% interest rate. Because of discounting future amounts so far into the future, the present value (PV) of ($\$1 / [1 + i]^{n=1000}$) is virtually identical to the PV of a perpetuity, using the formula PV = ($\$1 / i$). This is the rationale for why the annual long term maintenance cost amount was divided by the interest rate in the cost template calculations provided in the appendix.

7.4.4 Other Benefits Not Quantified and Monetized

The site reclamation activities associated with SFC's proposed plan would also stimulate local employment and spending on goods and services within the Sequoyah County area (see Appendix B.6, Socioeconomics). Local resources and materials, supplies, and equipment may be purchased during site reclamation activities. These short-term, nonrecurrent activities would be beneficial, especially if they did not divert resources from other areas (i.e., they constituted a net increase to regional gross domestic product and not simply a transfer of activity within Sequoyah County).

7.5 Net Benefits: Comparing Total Costs to Total Benefits per Each Alternative

Table 7-6 combines all of the quantified and monetized costs and benefits into a single comparative statement for assessment purposes. Net benefits are equal to total benefits minus total costs. The results show that the licensee's proposed action results in the greatest net benefits of all the alternatives. This is followed by the partial off-site disposal option associated with Alternative 3-3-2.

References

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Table 7-6 Summary of Cost Benefit Analysis and Net Benefits per Each Alternative (millions of dollars)

	Costs					Benefits				
Alternative	Total $Cost_{R+WD}$ (remediation plus transport & disposal less regulatory)	Cost of Collective Dose	Opportunity Cost of Land[1]	Regulatory Costs	Total Costs	Value of Collective Dose Averted	Regulatory Costs Avoided[2]	Capitalized Value of Net Agricultural Income	Total Benefits	Net Benefits[3]
Alternative 1: On-site Disposal of All Contaminated Materials (the Licensee's Proposed Action)	$31.1	$4.1	$0.80	$1.8	$37.8	$195.0	$18.00	$1.5	$214.5	$176.7
Alternative 2: Off-site Disposal of All Contaminated Materials										
Option 1: Transport of all materials by rail to EnergySolutions, Clive, Utah	$253.7	$0.8	$-		$254.5	$195.0	$18.00	$3.3	$216.3	$(38.2)
Option 2: Transport of all materials by rail to WCS in Andrews, Texas	$189.9	$0.8	$-		$190.6	$195.0	$18.00	$3.3	$216.3	$25.7
Alternative 3: Partial Off-site Disposal										
Option 1: Raffinate sludge transported by truck to White Mesa, Blanding Utah; other sediment transported by truck to either:										
1. Pathfinder Shirley Basin, Mills, Wyoming	$38.1	$4.1	$0.80	$1.8	$44.8	$195.0	$18.00	$1.5	$214.5	$169.7
2. EnergySolutions, Clive, Utah	$38.4	$4.1	$0.80	$1.8	$45.2	$195.0	$18.00	$1.5	$214.5	$169.4
3. WCS, Andrews, Texas	$37.8	$4.1	$0.80	$1.8	$44.5	$195.0	$18.00	$1.5	$214.5	$170.1
Option 2: Raffinate sludge to be transported by truck to Rio Algom, Grants, New Mexico. Other sediments to be transported by truck to either:										
1. Pathfinder Shirley Basin	$43.3	$4.1	$0.80	$1.8	$50.0	$195.0	$18.00	$1.5	$214.5	$164.5
2. EnergySolutions	$43.6	$4.1	$0.80	$1.8	$50.3	$195.0	$18.00	$1.5	$214.5	$164.2
3. WCS	$42.9	$4.1	$0.80	$1.8	$49.6	$195.0	$18.00	$1.5	$214.5	$164.9
Option 3: Transport both sludge and combined sediments via truck to either:										
1. EnergySolutions, Clive, Utah	$39.8	$4.1	$0.80	$1.8	$46.5	$195.0	$18.00	$1.5	$214.5	$168.0
2. WCS, Andrews, Texas	$36.0	$4.1	$0.80	$1.8	$42.7	$195.0	$18.00	$1.5	$214.5	$171.8
3. Pathfinder Shirley Basin	$37.6	$4.1	$0.80	$1.8	$44.3					
No-Action Alternative	$1.3	$195.0	$18.00	$3.3	$217.6	$-	$-	$-	$-	$(217.6)

[1] Opportunity cost of land is equal to the foregone value of agricultural net income that would be forfeited by not having the available incremental acres for cultivation associated with the next best alternative. The opportunity cost was calculated by subtracting the total income associated with the On-site Disposal Alternative from the Off-site Disposal net capitalized farm income.

[2] Equal to the cost difference in terms of regulatory compliance between each disposal alternative and the no-action alternative. This cost is the difference between the long-term site control plan for this option and the more extensive site control plan for the no-action alternative.

[3] Note that values within "( )" are deficits, or costs in excess of benefits.

8. SUMMARY OF ENVIRONMENTAL CONSEQUENCES

8.1 Unavoidable Adverse Environmental Impacts

Implementing SFC's proposed action for reclamation of its Gore, Oklahoma, site or one of the reasonable alternatives, would result in unavoidable adverse environmental impacts. The unavoidable adverse environmental impacts associated with each alternative are described in detail below.

8.1.1 Alternative 1: On-site Disposal of Contaminated Materials (the Licensee's Proposed Action)

Under Alternative 1, SFC has proposed to construct an on-site disposal cell and establish an ICB of approximately 131 hectares (324 acres) in size around the disposal cell. In order to prevent potential human and ecological exposure to on-site contamination, SFC proposes transferring the area within the ICB in perpetuity to the custody of the State of Oklahoma or the United States. This unavoidable adverse environmental impact on land use would be MODERATE.

Alternative 1 also would involve unavoidable adverse environmental impacts on geology and soils through excavation of clay for the liner system and removal of contaminated soils. Visual resources would be adversely affected as a result of construction of the on-site disposal cell. All of these impacts would be mitigated through grading and revegetation of the disposal cell cover to create a more natural looking landscape and can be characterized as SMALL. In addition, other SMALL short-term, unavoidable adverse environmental impacts that would occur during implementation of reclamation activities include dust, noise, and increased traffic.

8.1.2 Alternative 2: Off-site Disposal of All Contaminated Materials

Alternative 2 would require SFC to consolidate and move the contaminated sludges, soils, and debris off-site by rail for disposal at a disposal facility licensed to accept such materials. To transport the contaminated materials off-site, a railroad spur would be constructed to connect the site with the Union Pacific rail line. The spur would pass through a previously undeveloped area of pastureland, hayfields, and forestland and would cross two intermittent streams, resulting in the loss of habitat and vegetation. It is anticipated that the railroad spur would remain in place following reclamation. The unavoidable adverse environmental impacts associated with land-use would be SMALL since the area is currently traversed by numerous existing roadways and rail lines. The unavoidable adverse environmental impacts on ecological resources associated with construction of the railroad spur (e.g., loss of habitat and vegetation) could be mitigated and, therefore, would be SMALL to MODERATE.

Alternative 2 also would involve unavoidable adverse environmental impacts on geology and soils through excavation of clay for the liner system and removal of contaminated soils. Visual resources would be adversely affected as a result of construction of the on-site disposal cell. All of these impacts would be mitigated through grading and revegetation of the disposal cell cover to create a more natural looking landscape and can be characterized as SMALL. In addition, other short-term, SMALL unavoidable adverse environmental impacts that would occur during implementation of reclamation activities include dust, noise, and increased traffic.

8.1.3 Alternative 3: Partial Off-site Disposal of Contaminated Materials

Under Alternative 3, the unavoidable adverse environmental impacts would be a combination of those associated with Alternatives 1 and 2. Following the licensee's reclamation activities to excavate and consolidate contaminated materials, a portion of the contaminated material would be transported by SFC off-site via truck for disposal, with the remainder of the contaminated materials placed in an on-site disposal cell. Following completion of site reclamation activities, SFC proposes that the area within the proposed ICB be transferred in perpetuity to the custody of the State of Oklahoma or the United States. This unavoidable adverse environmental impact on land use would be MODERATE.

Alternative 3 also would involve unavoidable adverse environmental impacts on geology and soils through excavation of clay for the liner system and removal of contaminated soils. Visual resources would be adversely affected as a result of construction of the on-site disposal cell. All of these impacts would be mitigated through grading and revegetation of the disposal cell cover to create a more natural looking landscape and can be characterized as SMALL. The size of the disposal cell under this alternative may be slightly smaller than the disposal cell described for Alternative 1; however, the size of the proposed restricted area would be the same, with only the capacity and height of the disposal cell differing. In addition, other short-term, SMALL unavoidable adverse environmental impacts that would occur during implementation of reclamation activities include dust, noise, and increased traffic.

8.1.4 No-Action Alternative

Under the no-action alternative, SFC would be required to maintain the entire 243-hectare (600-acre) site indefinitely under restricted conditions and perform site surveillance and maintenance to ensure the facility is maintained in a safe condition and that contaminated materials are controlled. However, there would be continued potential for contamination of groundwater because the source of such contamination would not be addressed. This long-term use restriction and the adverse impacts on the existing environment associated with contaminated soils and groundwater resources would indefinitely prevent future development of the site for any other purpose. The no-action alternative is an unacceptable alternative because it does not comply with the requirements of 10 CFR 40, Appendix A (Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes). The unavoidable adverse impacts associated with implementation of this alternative would be LARGE.

8.2 Relationship Between Local Short-Term Uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity

Consistent with the CEQ's definition as well as the definition provided in Section 5.8 of NUREG-1748, *Environmental Review Guidance for Licensing Actions Associated with NMSS Programs*, this DEIS defines short-term uses and long-term productivity as follows:

- Short-term uses generally affect the present quality of life for the public (e.g., the cleanup of a contaminated site).

- Long-term productivity affects the quality of life for future generations based on environmental sustainability (e.g., the period after the termination of a license to operate a facility).

The anticipated short-term uses and long-term productivity of the site under each alternative are discussed below.

8.2.1 Alternative 1: On-site Disposal of Contaminated Materials (the Licensee's Proposed Action)

Under Alternative 1, construction of the on-site disposal cell would necessitate the short-term commitment of resources (e.g., money and labor) and would permanently commit other resources (e.g., energy, water, and land). The short-term use of these materials would result in the isolation of contaminated materials and provide for groundwater corrective actions in a manner that would be protective of human health and the environment both on- and off-site. In addition, workers, the public, and the environment may be exposed to increased amounts of hazardous and radioactive materials over the short-term as a result of reclamation activities. However, short-term impacts would be minimized by the implementation of appropriate mitigation measures and resource management and the impacts would be SMALL. After completion of site reclamation activities, SFC proposes releasing 112 hectares (276 acres) for unrestricted use and development, benefiting the long-term productivity of the local area and region. These land use impacts would be MODERATE.

8.2.2 Alternative 2: Off-site Disposal of All Contaminated Materials

Under Alternative 2, SFC would conduct site cleanup, construction, transportation of contaminated materials by rail, and soil backfilling and revegetation activities. Construction of a rail spur and off-site transport of contaminated waste would involve a permanent commitment of land, energy, and water (the rail spur would not be removed by SFC following completion of site reclamation activities). These impacts would be SMALL to MODERATE.

Workers, the public, and the environment may be exposed to increased amounts of hazardous and radioactive materials over the short term as a result of reclamation activities. Short-term SMALL impacts would be minimized through the implementation of appropriate mitigation measures and resource management.

Remediation of contaminated soils and groundwater would permit long-term uses of the entire 243-hectare (600-acre) site for unrestricted use and future development. The short-term land use and socioeconomic impacts would be SMALL. However, there could be MODERATE long-term positive benefits to the long-term productivity of the local area and region.

8.2.3 Alternative 3: Partial Off-site Disposal of Contaminated Materials

Alternative 3 would combine many of the effects of Alternatives 1 and 2. Construction of the disposal cell would necessitate the short-term commitment of resources and would permanently commit certain resources (e.g., energy, water, and land). The use of these resources would result in potential SMALL long-term socioeconomic benefits to the local area and the region. This alternative would also require a portion of on-site contaminated materials to be transported by truck to an off-site location for disposal or reuse as alternative feed at a uranium mill. This would provide for the enhancement of the long-term productivity of the site by removing the most contaminated materials. The impacts of this on the environment would be SMALL.

Following completion of site reclamation activities by the licensee, up to 131 hectares (324 acres) of the site would continue to be unavailable for long-term reuse because the on-site disposal cell is designed to isolate the on-site contaminated materials within the boundaries of an area restricted from public access. SFC proposes releasing the remaining 112 hectares (276 acres) for unrestricted use and development, benefiting the long-term productivity of the local area and region. These land use impacts would be MODERATE.

Workers, the public, and the environment may be exposed to increased amounts of hazardous and radioactive materials over the short-term as a result of reclamation activities. Short-term SMALL impacts would be minimized by the implementation of appropriate mitigation measures and resource management.

8.2.4 No-Action Alternative

The no-action alternative would preclude short-term uses of nearly the entire 243-hectare (600-acre) site due to the presence of contaminated soils and groundwater. In addition, continued long-term groundwater contamination would impact groundwater resources beyond the site boundary. The no-action alternative also would adversely affect long-term productivity at the SFC site because SFC would not conduct reclamation activities or institute groundwater corrective actions. The site would continue to be out of compliance with the criteria contained in 10 CFR Part 40, Appendix A, NRC's radiological criteria for decommissioning for license termination, and the site would remain restricted. The long-term productivity of the SFC site would not be enhanced under the no-action alternative, and impacts can be characterized as LARGE.

8.3 Irreversible and Irretrievable Commitment of Resources

Irreversible and irretrievable commitment of resources includes those resources whose use, as a result of implementation of a particular alternative, could not be recovered or recycled within a reasonable time frame. These typically involve the materials, capital, labor, energy, water, and land that are committed during construction, operation, and reclamation activities associated with implementation of an alternative.

For all of the proposed alternatives, the energy expended would be in the form of fuel consumed by equipment and vehicles used to perform the proposed reclamation activities and groundwater corrective actions, and the electricity used to operate the necessary stationary and portable equipment (e.g., pumps, lighting, general construction/demolition equipment). In addition, water would be obtained from Lake Tenkiller via the Sequoyah County Rural Water Association. The electricity and fuel used during implementation of any alternative would not be recoverable, and thus, would be considered irretrievable. The licensee's use of water to conduct site reclamation activities, however, would not affect the ability of the local area or region to supply other industries in the vicinity of the SFC site with these resources. Specific resources that would be considered irreversible and irretrievable under each alternative are discussed below.

8.3.1 Alternative 1: On-site Disposal of Contaminated Material (the Licensee's Proposed Action)

Under Alternative 1, SFC proposes releasing 131 hectares (324 acres) within a proposed ICB for future restricted use. This area would include the land that would be used for the on-site disposal cell. Consequently, the land area within the proposed ICB would be unavailable for any other uses for perpetuity and thus its use would not be retrievable. Irreversible and irretrievable impacts on land use would be MODERATE.

The disposal cell would be constructed to contain the contaminated materials and would be sealed and covered with an engineered barrier topped with clean fill and topsoil. Construction of the disposal cell would not require significant amounts of off-site materials (about 3% of the total volume) because SFC would obtain a majority of the clean material from uncontaminated portions of the SFC site. A layer of clay would cap the disposal cell. The materials used in the construction of the disposal cell (clay and soil for liners and cover; rock from the quarry; polyurethane piping; and gas, oil, and other petroleum products for operation of trucks and machinery) are all considered irretrievable resources. The irreversible and irretrievable impacts of using these construction-related resources would be SMALL because the quantities would represent small quantities of the available resources.

Implementation of Alternative 1 would generate nonrecyclable radiological and nonradiological waste streams. Metals contained in demolition debris and equipment (steel, iron, copper, aluminum) may be considered unsalvageable due to radiological contamination. A large portion of these materials would be compacted into the cell and thus are considered irretrievable. These impacts would be SMALL.

8.3.2 Alternative 2: Off-site Disposal of All Contaminated Material

Under Alternative 2, buildings (except for the administration building and the electrical substation) would be demolished, contaminated materials would be excavated, and all debris and materials would be shipped off-site to a licensed disposal facility. The disposition of all these materials could be considered SMALL irretrievable impacts. SFC would use clean fill material from the SFC site to properly grade the site. The use of topsoil would be a SMALL irretrievable impact.

8.3.3 Alternative 3: Partial Off-site Disposal of Contaminated Material

Under Alternative 3, the land within the licensee's proposed ICB, including the land that would be used for the on-site disposal cell, would be transferred to the custody of the State of Oklahoma or the United States. This land, a maximum of 131 hectares (324 acres), would be unavailable for any other uses and would not be retrievable. The land use impacts of this proposal would be MODERATE. The proposed disposal cell would be constructed to contain the waste and would be sealed and graded with clean fill obtained from on-site sources. The irreversible and irretrievable impacts of the use of construction materials (clay, piping, petroleum products) would be the same as described for Alternative 1 (see Section 8.3.1).

8.3.4 No-Action Alternative

Under the no-action alternative, the SFC site could become an irretrievable resource due to contamination of land and groundwater. The property would be unavailable for any other future use or development. This irretrievable land use impact would be LARGE.

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APPENDIX A

RESCOPING SUMMARY REPORT

DOCKET NO.: 40-8027

Environmental Impact Statement Rescoping Process

Rescoping Summary Report

Reclamation of the Sequoyah Fuels Corporation Uranium Conversion Facility

Gore, Oklahoma

November, 2003

UNITED STATES NUCLEAR REGULATORY COMMISSION

U.S. Nuclear Regulatory Commission
Rockville, Maryland

1. INTRODUCTION

The Sequoyah Fuels Corporation (SFC) owns a uranium-conversion facility located near Gore, Oklahoma. In 1993, the SFC ceased its operations and notified the U.S. Nuclear Regulatory Commission (NRC) that it would pursue decommissioning of the facility. Subsequently, under Subpart E to Part 20 of Title 10 (10 CFR Part 20), the SFC conducted site characterization studies and submitted a "Final Decommissioning Alternatives Study Report" to the NRC that identifies several alternatives for SFC site reclamation. In 1999, the SFC submitted a Decommissioning Plan to the NRC. In this plan, the SFC proposed that the hazardous chemicals and radioactively contaminated material at the SFC facility be consolidated in an onsite-disposal cell. In addition, the SFC proposed that the remaining land and buildings be decontaminated, the NRC license be terminated, and sections of the property be released under restricted and unrestricted conditions.

In January 2001, the SFC requested that the NRC review whether solvent extraction process wastes could be designated as 11e.(2) byproduct material as defined in Section 11e.(2) of the *Atomic Energy Act of 1954* (AEA). A benefit of designating the wastes as 11e.(2) byproduct material is that either the U.S. Department of Energy (DOE) or the State of Oklahoma would provide the long-term custodial care for the site. In July 2002, the NRC concluded that those wastes, which comprise most of the waste at the site, could be classified as 11e.(2) material. On December 11, 2002, in response to the SFC's request[1], the NRC amended the Source Materials License SUB-1010 to authorize the SFC to possess 11e.(2) byproduct material as defined in Section 11e.(2) of the AEA[2].

The reclassification of the waste at the SFC facility transferred the regulatory oversight of the site remediation from the license termination requirements of Subpart E, 10 CFR Part 20 to the uranium mill tailings requirements of Appendix A of 10 CFR Part 40. This shift in regulatory oversight required the SFC to withdraw its Decommissioning Plan and submit, instead, a Reclamation Plan for the SFC site in January 2003. The Reclamation Plan is a requirement of Appendix A of 10 CFR Part 40, and it delineates remediation and corrective actions planned for the site. On June 12, 2003, the SFC submitted its Ground-Water Monitoring Plan to the NRC that describes the existing ground-water conditions at the site and the SFC proposed monitoring program. The Ground-Water Corrective Action Plan was submitted to the NRC in June 2003 and details the SFC strategy to remediate ground-water resources at the site.

The SFC's proposed remediation alternative continues to be an onsite-disposal cell with an engineering design similar to that previously proposed under the10 CFR Part 20 Subpart E

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[1]J.H. Ellis, Sequoyah Fuels Corporation, letter to L.W. Camper, USNRC, September 30, 2002.

[2]D.M. Gillen, USNRC, letter to J.H. Ellis, Sequoyah Fuels Corporation, December 11, 2002.

process. The State of Oklahoma would provide long-term custodial care of the site, if it chose to, but DOE would be required to assume this responsibility should the State decline the role of custodian. The SFC plans to place both the 11e.(2) materials, which constitute the majority of the wastes at the site, and non-11e.(2) materials in the proposed cell. As part of its Reclamation Plan, the SFC has addressed the eight criteria of NRC Regulatory Issue Summary (RIS) 2000-23, dated November 30, 2000, for disposing non-11e.(2) material wastes in tailings impoundments. The SFC attempted to demonstrate consistency and compliance with these criteria; for this reason, the SFC made no distinction between the 11e.(2) materials and non-11e.(2) materials in the Reclamation Plan.

The NRC is preparing an environmental impact statement (EIS) on the proposed SFC site reclamation as part of its decisionmaking process. In addition to the EIS, the NRC is preparing a Technical Evaluation Report (TER) to address safety aspects of the SFC site and reclamation activities.

The NRC, the U.S. Environmental Protection Agency (EPA), the U.S. Army Corps of Engineers (ACE); the U.S. Geological Survey (USGS), the Oklahoma Department of Environmental Quality (ODEQ), and the Cherokee Nation have an interest in the proposed reclamation of the SFC site. Because the interests of these agencies are interrelated on this project, the EPA, the ACE, the USGS, the ODEQ, and the Cherokee Nation have agreed to cooperate with the NRC in the preparation of a single EIS. Although the NRC is the lead agency in the preparation of this EIS, all the cooperating agencies are involved in its development and review. The preparation of a single EIS results in more efficient use of Federal resources.

The main purpose of the proposed action is to ensure that SFC has acceptably demonstrated to the NRC that the closure and the reclamation of the SFC site, as an 11e.(2) byproduct material site, meets the performance standards and regulatory requirements of Appendix A of 10 CFR Part 40. The performance standards in Appendix A include: 1) isolation of the waste materials in a manner that protects human health and the environment, 2) reduction of the rate of radon emanating from the cover to an average of 20 pCi/square meter-second or less, 3) effectiveness of the reclamation for a long period of time (200 to 1,000 years), and 4) minimal reliance on active maintenance.

The NRC's regulations in 10 CFR Part 51 contain requirements for conducting a scoping process prior to preparation of an EIS. On October 20, 1995, the NRC published in the *Federal Register* (60 FR 54260) a Notice of Intent (NOI) to prepare an EIS for the proposed decommissioning of the SFC facility and to conduct scoping for the EIS. At that time, the NRC regulatory oversight for the site decommissioning activities was the license termination requirements (10 CFR Part 20, Subpart E). For the scoping process, the NOI invited written comments on the proposed action, announced a public scoping meeting to be held regarding the project, offered a proposed outline for the EIS, and discussed the alternatives considered. On November 15, 1995, the NRC held a public scoping meeting in Gore, Oklahoma.

Since 1993, the SFC has informed the public of its plans and gained input from potentially affected parties through its public outreach program. The SFC presented the proposed decommissioning approach in over 35 presentations, several public meetings, and site tours. In addition, the SFC distributed an information paper to the community, incorporated the public comments in the decommissioning plan, and submitted a Decommissioning Alternatives Study, a Site Characterization Report, and a Decommissioning Plan.

On June 9, 1999, the NRC published a *Federal Register* Notice stating its consideration of a license amendment request to authorize decommissioning at the SFC facility. On October 17, 2000, the NRC staff and its consultant, Advanced Technologies and Laboratories International, Inc. (ATL), visited the site and held a public meeting to update the public on the progress of the EIS and obtain additional comments on issues related to the decommissioning of the facility.

Following the NRC's 2002 reclassification of waste at the SFC facility as 11e.(2) byproduct material and transfer of the NRC regulatory oversight to Appendix A of 10 CFR Part 40, the NRC published another *Federal Register* Notice (68 FR 20033, April 23, 2003) for a rescoping meeting. On May 13, 2003, the NRC held a public rescoping meeting in Gore, Oklahoma. This meeting was part of the continuing process to keep affected stakeholders and the public informed of plans, schedules, and milestones affecting the SFC corrective action. The objectives of the meeting were to inform interested parties and the public of the changes in classification of materials at the SFC facility, discuss the reclamation of 11e.(2) byproduct material sites, define the DEIS schedule, and conduct a rescoping session for the draft EIS (DEIS). The main subject discussed during the rescoping part of the meeting was the shift in regulatory oversight of the SFC and its effect on the DEIS. The NRC conducted this meeting to complement the previous scoping and public outreach meetings held in Gore on November 15, 1995, and October 17, 2000, respectively.

Since the license amendment was granted, SFC has submitted updated documents to NRC in 2003, including a groundwater corrective action plan and a site reclamation plan. These reports are currently being reviewed by the NRC for technical merit.

Section 2 of this report summarizes the comments and concerns raised by the meeting attendees concerning the development of the DEIS and any associated concerns that may not have been addressed in the NRC's initial scoping process. Section 3 identifies the issues the DEIS will address and those issues that are not within the scope of the DEIS. Where appropriate, Section 3 identifies other places in the decisionmaking process where issues that are outside the scope of the DEIS may be considered.

2. ISSUES RAISED DURING THE SCOPING PROCESS

2.1 OVERVIEW

A total of 36 individuals attended the May 13, 2003, public rescoping meeting. During the meeting, eight individuals offered comments concerning the reclamation activities at the SFC uranium conversion facility and the development of the DEIS. Of these eight commenters, one represented a sovereign Indian tribe and the remaining seven spoke on behalf of other organizations or as private citizens. In addition, 15 written statements from various individuals were received during the public rescoping period. Most of these submissions were written statements or summaries of the verbal testimony. This active participation by the public in the rescoping process is an important component of determining the major issues that the DEIS should assess.

Individuals providing oral and written comments addressed several subject areas related to the SFC facility reclamation and the DEIS development. The comments received during the course of the rescoping meeting were categorized into the following general topics:

- Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA) concerns.
- Accountability.
- Ground-water impacts.
- Cost of remediation.
- Ownership of site.
- Expansion of waste on the site.
- Reclassification of waste.
- Onsite disposal cell.
- Disposal options.
- Endangered species.
- Cherokee Nation involvement and concerns.
- Earthquake risk.
- Post-reclamation risk assessment.
- DEIS and rescoping process.

Written comments received during the rescoping period following the public rescoping meeting were categorized into the following general topics:

- Site Specific Advisory Board.
- Draft Environmental Impact Statement.
- Regulation concerns.

Attachment A to this report lists the commenters and, on the basis of the topics above, shows the subject areas covered by their comments. Note that Attachment A lists only the comments received (i.e., within or outside of the scope of this report) during the rescoping meeting.

Section 2.2 summarizes the oral and written comments received during the public rescoping meeting and public rescoping period. Most of the issues raised have a direct bearing on the analysis of potential environmental impacts and the NRC's related decisionmaking process.

2.2 SUMMARY OF ISSUES RAISED

Following their presentations at the public rescoping meeting, NRC representatives asked the members of the public to provide comments on the DEIS that would be recorded. These comments, both oral and written, have been consolidated and categorized by topic areas.

2.2.1 UMTRCA Concerns

A commenter stated that 24 other UMTRCA sites have been completed in the United States within the past 10 to 15 years and a pool of knowledge should be available about disposal cells concerning (1) their stability and integrity, and (2) both the expected and unanticipated problems that may have occurred. The commenter encouraged the NRC to extract this information from previous experience and compare it to what is being done at the SFC site to head off any future problems.

Another commenter expressed concern that the UMTRCA regulations may not be a good fit to the SFC site due to differences in uranium contamination at mill sites compared to the SFC site. The commenter requested that the NRC require a more protective uranium soil criterion.

A commenter indicated concern about the EPA's role under an UMTRCA reclamation and questioned whether all of the criteria that apply to UMTRCA sites apply to the SFC site.

2.2.2 Accountability

A commenter asked who will be held accountable for unforeseen problems that may arise at the SFC site.

Another commenter expressed concern about accountability in the event that contamination migrates from the restricted portion to the unrestricted portion of the site.

2.2.3 Ground-Water Impacts

Several commenters expressed concerns about the impacts to ground-water resulting from proposed reclamation at the SFC facility. One commenter suggested that a leak in the proposed cell would severely impact the ground-water, and cleanup would be almost impossible if the contaminants leak into water wells, ground-water, and the waters of the Arkansas and

Illinois Rivers.

Another commenter noted the close proximity of the proposed disposal cell to the ground-water table and worried that the site has not been properly characterized. The same commenter recommended a full characterization of deep groundwater and stated that new information about ground-water contamination on the site needs to be integrated into the site reclamation plan. This information is related to sand and gravel fill under the process area and along buried lines on the site that could provide conduit paths for movement of contaminated groundwater through and possibly off the site.

A few commenters expressed concern about well contamination. One commenter stated that the reclamation plan should specify that public water wells in the area be tested at least two times per year (i.e., in the rainy and drought seasons) for hazardous constituent levels in the ground-water. Another commenter noted that deep groundwater monitoring wells were plugged after they "became contaminated," and that mostly shallow wells currently exist to characterize groundwater contamination.

Another commenter expressed concern about uranium seepage from the Kerr-McGee deep injection test well. One commenter noted that conflicting opinions about what contaminants were put into the deep injection well may require testing in the deep aquifer to determine whether there is contamination.

One commenter noted that a drop in the initial pressure at which the 26 million gallons of waste were contained in the injection well indicates that the waste has migrated. One commenter felt that the budget for the ground-water remediation plan seems very low and appears to amount to little more than a monitoring program rather than actual remediation.

A commenter asked when the full ground-water corrective plan will be available and what the NRC will require to be included in the plan.

2.2.4 Cost of Remediation

Commenters indicated various concerns about the potential cost of remediation of the SFC site. One commenter felt that the lack of available funds will be the driving factor in deciding what sort of reclamation is performed rather than what is best for the communities in the immediate vicinity of the SFC site.

Another commenter suggested that Kerr-McGee, original owner and licensee of the SFC facility, should be held responsible for the cleanup at the SFC site due to a statement made to the *Sequoyah County Times* on December 9, 1984. The commenter also stated that, in 1965, Kerr-McGee was required to deposit $200 million for cleanup, and that money was available at one time to carry out this operation. The commenter added that the NRC has already given that money back.

A commenter expressed concern that the "astronomical" cost of the site cleanup will deplete the funds available for proper cleanup, and that the resultant economic impact for the future will leave the area and cities downstream both fiscally deprived and contaminated. The commenter added that the SFC "gets off the hook" in the case that any migrating contamination is discovered on the site, and the taxpayer will be stuck with paying for whatever cleanup has to occur.

One commenter stated that the site should be cleaned up, regardless of the cost, to protect future generations. Another commenter expressed concern that offsite disposal will be considered as an option even though it would cost several times the available budget. Another commenter stated that NRC needs to assess what is the right thing to do environmentally within the financial capacity that currently exists for reclamation on the SFC site.

2.2.5 Ownership of the Site

A commenter expressed concern over the issue of subsurface rights following reclamation of the SFC site. Within the amendment, it is not clear how much of the land DOE would own after it takes ownership for long-term stewardship under the provisions of Title 2 under the Atomic Energy Act. The same commenter also indicated concern about future contaminant migration from the restricted to unrestricted portions of the site. The commenter wanted to know who would be responsible if such migration occurred, and was especially concerned about the proximity of the unrestricted area to the disposal cell.

2.2.6 Expansion of Waste on the Site

Two commenters were concerned that DOE would be able to expand the waste site and bring in more waste (up to 20 percent additional waste) from other locations. One commenter requested clarification on this issue, and expressed concern that the public would not have a right to object. Another commenter expressed concern for "imported wastes" (i.e., fly-ash) that are proposed to be brought into the site and mixed with the onsite waste to solidify it. The same commenter also indicated concern that "bootlegged" waste (i.e., hazardous material prohibited from being in a 11.e(2) disposal cell) would be brought in.

A commenter stated that tribal "lifeways" (i.e., water wells, streams, lakes, and other sources of ground-water affecting tribes) should be evaluated in the environmental review and that no contamination from outside the site should be placed in the proposed onsite cell.

2.2.7 Reclassification of Waste

A commenter noted that, upon the change from SFC's previous permit status to the current status (which authorizes possession of 11e.(2) byproduct material), the dose level to be used changes from that of the exposure level of radium 226, thorium 230, and uranium (due to uranium conversion) to that of the exposure level of only radon. The same commenter suggested that the exposure level to the public will be lessened under UMTRCA regulations, and that this reclassification will be misleading to future generations because DOE will own the site and the public will not have the money to fight or sue for health and environmental damages. The commenter also noted that the NRC made a ruling on a change of classification (i.e., reclassification from processing to mill tailings for the SFC) prior to the end of the public comment period, and this change of classification could set a precedent.

Another commenter requested clarification as to what soil cleanup standards would apply under UMTRCA and to what constituents. The commenter was specifically concerned about standards that apply to uranium.

2.2.8 Onsite Disposal Cell

A number of commenters expressed concern and made recommendations about the proposed onsite disposal cell on the SFC site. One commenter recommended that, due to the possibility that hazardous constituents disposed of in the onsite disposal cell could have a half-life of millions of years, consideration be given for the possibility that the river could change course over time and impact the disposal cell. The same commenter also recommended that the more hazardous material be taken offsite and not disposed of in the onsite disposal cell.

Another commenter recommended that the reclamation plan look into the idea of incorporating multiple retrievable cells in the main disposal cell. In the case of cell leakage, this would enable parts of the cells that are leaking to be retrieved and removed to a place out of the ground-water table. The same commenter recommended that a lower ground-water sampling system be developed to help detect leaks in the disposal cell. In addition, the commenter suggested that a good liner of some kind be used in the disposal cell other than the compacted clay liner "that has leaked in pond 2 at this cell" and is "still leaking." The commenter also suggested that a "buffer zone" be designated (i.e., a restricted area around the disposal cell site that extends the restricted area in the case of a leak) and that "some type of vitrification system" be developed to ensure the "more contaminated materials" (i.e., the radium and thorium and the raffinate sludges) in the disposal cell cannot leach into the ground-water.

A commenter expressed concern that high concentrations of uranium products constitute a high-risk level that "calls for 20 [feet] of concrete entombment, not 4 feet of clay." Another commenter indicated his concern about the mixing of waste in disposal and suggested that barium, thorium, arsenic, and the heavy metals be separated from one another and the radiological waste in individual cells within the larger disposal cell.

A commenter requested to see a written report from the NRC on the performance of UMTRCA sites that were built in similar climates to Eastern Oklahoma (e.g., high rainfall). The same commenter pointed out the inadequacy of the plan for the liner under the cell and recommended that a plan be developed to monitor water leakage from the cell into the soil and ground-water adjacent to the cell. In addition, the commenter expressed concern that the planned vegetation on the cell cover will be incapable of absorbing the entire water load in the time-frame of a downpour, the incline of the sides of the cell will present an excessive risk of erosion, and that safety of workers and the community may be at risk during construction of the disposal cell. The commenter also recommended a full assessment of the future possibility that the Illinois River could change course and pass through or nearer the disposal cell.

A commenter expressed concern about how liquid wastes on the site will be stabilized under the new 11e.(2) plan.

2.2.9 Disposal Options

A commenter suggested that the NRC consider in its assessment of the site a range of onsite options as was presented in the draft decommissioning plan rather than just one onsite option.

2.2.10 Endangered Species

A commenter noted that having open waterways on the SFC site endangers several animal species including the Gray Bat and the Indiana Bat.

2.2.11 Cherokee Nation Involvement and Concerns

A commenter expressed concern that the Cherokee Nation is the only tribe involved with the scoping process and asked whether the Cherokee Nation plans to submit its rescoping issues separately or at the current rescoping meeting.

Another commenter noted that the Cherokee Nation is involved and affirmed that the DEIS addresses the major environmental and socioeconomic concerns. The same commenter stated that the Cherokee Nation will provide its concerns in writing to the NRC on the DEIS and has provided its concerns to the NRC regarding the reclassification of materials on the site.

2.2.12 Earthquake Risk

Two commenters expressed concern for the risk of earthquakes. One commenter discussed the proximity of the Carlisle Fault within one mile of the site and the Warner Fault located within a half mile of the site.

2.2.13 Post-reclamation Risk Assessment

A commenter voiced concern that the post-reclamation risk assessment purposefully ignored exposure to radon, disturbance of the cell, and drinking water.

2.2.14 DEIS and Rescoping Process

A commenter asked for clarification concerning the deadline for turning in written comments.

2.2.15 Site Specific Advisory Board

A commenter asked "about where the Site Specific Advisory Board idea stands for the SFC site."

2.2.16 Environmental Impact Statement (EIS)

A commenter asked about when the EIS will be released and how it will assess Environmental Justice impacts.

2.2.17 Transfer of Solid Materials Offiste

A commenter expressed concern over SFC's historical practice of releasing contaminated solid materials offsite for reuse. This comment was made in the context of the NRC's ongoing rulemaking for controlling the disposition of solid materials.

2.2.18 Regulation Concerns

A commenter requested that the EIS explicitly address what actions would be taken if the cost of the site cleanup were to exceed available private funds.

A commenter recommended that the NRC prohibit deregulation of all solid materials containing or contaminated with radiation that have been intentionally mined from the ground. The commenter stated that under no conditions should this contaminated material be dumped in unlicensed facilities that are not prepared to monitor for or contain radioactive waste.

Another commenter expressed concern about the current position of the State of Oklahoma and how their actions will affect this plan.

3. SUMMARY AND CONCLUSIONS

3.1 SCOPE OF THE DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)

To a large extent, the general content of an EIS prepared by NRC is prescribed by the National Environmental Policy Act (NEPA) (Public Law 91-90, as amended), NRC's regulations for compliance with NEPA (10 CFR Part 51), and guidance provided by the Council on Environmental Quality regulations (40 CFR Parts 1500-1508). These regulations broadly define the areas that must be considered in the assessment of potential impacts resulting from a proposed action and its alternatives. The scoping process summarized in this report (as well as previously-held scoping processes on this issue) helped to identify and refine the project-specific issues that warrant consideration in the DEIS.

The NRC identified reasonable alternatives to the proposed action during scoping and review of the licensee's submittals. The scope of the DEIS includes consideration of both radiological and nonradiological (including chemical) impacts associated with the proposed action and the reasonable alternatives. The DEIS also identifies necessary monitoring, potential mitigation measures, unavoidable adverse environmental impacts, economic impacts, the relationship between short-term uses of the environment and long-term productivity, and irreversible and irretrievable commitments of resources. In addition, it identifies several issues that could result in significant short- or long-term impacts.

3.2 ISSUES OUTSIDE THE SCOPE OF THE DEIS

Most of the comments received were within the scope of the DEIS and relate to issues that will be analyzed in-depth in the document. Potential comments that are considered out-of-scope for the DEIS involved technical issues related to Appendix A of 10 CFR Part 40 (e.g., financial responsibility, legal issues) and are more directly addressed in that context. Other comments addressed the regulatory process and jurisdiction (e.g., re-classification to 11e.(2) byproduct material, petitions for hearing, etc.). Although such issues may be analyzed in the DEIS as part of the proposed action and alternatives assessments, decisions concerning these issues are not made within the realm of the DEIS. Concerns about the roles of other parties (e.g., Oklahoma, Cherokee Nation) are, likewise, not resolved through the DEIS process.

As indicated above, some issues raised during the scoping process may be analyzed in the TER. The DEIS and the TER are related in that they may cover the same topics and may contain similar information, but the analysis in the DEIS is limited to an assessment of potential environmental impacts. In contrast, the TER primarily deals with safety evaluations and procedural requirements or license conditions to ensure the health and safety of workers and the general public.

The NRC has made a determination that some issues are associated with small or no impacts. For this reason, these issues are not considered to be of high priority among the proposed alternatives and will not be addressed in detail in the DEIS. They include: socioeconomic impacts during reclamation, impacts to historical and cultural resources, environmental justice issues, air quality impacts, noise, impacts to ecological resources, aesthetics issues, mineral resource issues, and cost.

Comment Subject Areas by Commenter
Oral Comments

Attachment A

Commenter/Affiliation	UMTRCA Past	Ground-Water Impacts	Remediation Cost	Site Ownership	Expansion of Waste	Reclassification of Waste	Onsite Disposal Cell	Disposal Options	Endangered Species	Cherokee Nation Concerns	Post-Reclamation Assessment	Earthquake Risk	Deregulation of Waste
Oral Comments													
Doug Brugge/Citizen	✓	✓	✓		✓		✓	✓			✓		
Don Carroll Laster/Citizen		✓	✓				✓					✓	
Nadine Barton/Citizens Action for a Safe Environment		✓	✓	✓	✓	✓	✓						
Ed Henshaw/Citizen		✓			✓		✓						
Jessie Collins/Citizen									✓	✓			
Pat Gwin/Cherokee Nation										✓			
Patricia Ballard/Nuclear Risk Management for Native American Communities							✓						
Kathy Carter-White/ ecoLaw Institute Staff Attorney													✓

Attachment A

APPENDIX B

ISSUES ELIMINATED FROM DETAILED STUDY

B. ISSUES ELIMINATED FROM DETAILED STUDY

The NRC has determined that detailed analysis of several issues is unnecessary because, after examination, they were found to have small impacts and were not considered to be potential discriminators among the proposed action and the reasonable alternatives. These issues and any associated impacts are discussed in this appendix.

B.1 Cultural Resources

B.1.1 Legislative Environment

The 1966 National Historic Preservation Act (NHPA) (Public Law 89-665, as amended by Public Law 96-515; 16 USC 470 *et seq.*) provides for the establishment of the National Register of Historic Places (NRHP) to include districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, and culture. Section 106 of the Act requires that federal agencies with jurisdiction over a proposed federal project take into account the effect of the undertaking on cultural resources listed, or eligible for listing, in the NRHP, and afford the State Historic Preservation Officers (SHPOs) and the Advisory Council on Historic Preservation (ACHP) an opportunity to comment with regard to the undertaking. (In Oklahoma, the role of the SHPO is fulfilled by the Oklahoma Historical Society [OHS].) The NRHP eligibility criteria have been defined by the Secretary of the Interior's Standards for Evaluation (36 CFR 60).

Cultural resources are considered to be NRHP-eligible if they display the quality of significance in American history, architecture, archaeology, engineering, and culture that are present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, workmanship, feeling, and association, and:

- Criterion A: are associated with the events that have made a significant contribution to the broad patterns of American history; or
- Criterion B: are associated with the lives of persons significant in our past; or
- Criterion C: embody the distinctive characteristic of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic value, or that represent a significant or distinguishable entity whose components may lack individual distinction; or
- Criterion D: have yielded or may likely yield information important in prehistory or history.

The process of agency reviews and assessment of the effect of an undertaking on cultural resources is set forth in the implementing regulations formulated by the ACHP (36 CFR 800, Protection of Historic Properties). In addition, other laws and guidelines are applicable to cultural resource management on federal projects. These laws and guidelines include the following:

- Executive Order 11593: Protection and Enhancement of Cultural Environment (16 USC 470 [Supp. 1, 1971]);
- Native American Graves Protection and Repatriation Act (Public Law 101-601; USC 3001-3013);

- Determination of Eligibility for Inclusion in the National Register (36 CFR 63); and
- Recovery of Scientific, Prehistoric, and Archaeological Data (36 CFR 66).

In addition, Section 101(d)(6)(B) of the 1966 NHPA requires federal agencies to consult with Native American groups that have traditional cultural interest in areas of proposed federal projects in the course of government-to-government undertakings.

B.1.2 Affected Environment

This section provides a brief review of the history of the local area surrounding the SFC site and an evaluation of the potential presence of cultural resources at the site.

B.1.2.1 Prehistoric and Historic Background

The following chronology of the cultural history of the area surrounding the SFC facility is derived from Wallis (Wallis 1974) and is summarized below in Table B.1-1. Wallis draws upon three main cultural resource projects within 24 kilometers (15 miles) of the SFC site. Surveys of the Lake Tenkiller area were made during the 1940s and 1970s by the University of Oklahoma and the Oklahoma River Basin Survey; in 1965 and 1966, work was conducted on the Webbers Falls Lock and Dam Project by the Oklahoma River Basin Survey; and from 1966 to 1969, excavations were conducted by the Oklahoma River Basin Survey for the Robert S. Kerr Reservoir on the Arkansas River..

Table B.1-1 Chronological Framework for the SFC Facility Area

Occupation	Time Period
Paleo-Indian	7,000 B.C. – 3,000 B.C.
Archaic	3,000 B.C. – 1,500 B.C.
Transitional (Woodland)	1,500 B.C. – A.D. 500
Late Prehistoric (Caddoan)	A.D. 500 – 1500
Historic	A.D. 1500 – present

Source: Wallis, 1974

The Paleo-Indian period was characterized by small bands of hunter-gatherers who used distinctive spear points and hunted a variety of now-extinct mammals. The Archaic period witnessed the emergence of hunting-gathering adaptation, with a greater emphasis on vegetative and aquatic resources. Diagnostic artifacts are dart points and other tools not present at earlier sites. The Woodland, or Transitional, period is characterized by the introduction of horticulture, pottery, the bow and arrow, and rock mounds. The Late Prehistoric, or Caddoan, period is characterized by semi-permanent villages along major river valleys, large burial and temple mounds, and diversified tool kits. The Historic period witnessed large-scale forced resettlement of Indians from their traditional lands to Oklahoma (Wallis, 1974).

In 1541, Francisco Vasquez de Coronado entered the area now known as Oklahoma in search of gold. Various Caddoan peoples and at least three major Indian language groups were present in the area at that time. In the 1700s, the Comanches and Kiowas migrated south to Oklahoma. Spanish control of the area lasted until 1800, when it passed to the French, who had established trading posts and settlements in Oklahoma during the 1700s and 1800s (ODL, 2006; Britannica Concise Encyclopedia, 2006).

In 1803, the Louisiana Purchase brought the area under the control of the United States. In 1823 a Cherokee named Sequoyah (also known as George Gist) came to Oklahoma from the southern Appalachian Mountains and settled between Fort Smith and Fort Gibson. He set up a prosperous blacksmith shop and salt works and was actively involved in the politics between the U.S. government and the area, which by then was known as the Indian Territory (Davis, 1930). His cabin, which is 40 kilometers (25 miles) east of the SFC site, is listed in the NRHP and with the National Park Service as a National Historic Landmark. In 1828, Congress reserved the Indian Territory for settlement by Native Americans, and a group of more than 2,000 Cherokee moved to the area and set up their western capital at Telonteeska. The site of this capital is listed as a location of interest by the OHS. In 1838, about 16,000 Cherokee were forced out of their homes in Georgia and Tennessee and walked the "Trail of Tears" to Oklahoma, during which 4,000 died.

Waves of white immigrants began passing through Oklahoma with the establishment of military roads in 1825. Settlement was further opened when railroads were built in the area in the 1880s. In 1890, the western part of the state was reorganized as the Oklahoma Territory. In 1907, the Indian Territory was merged with the Oklahoma Territory to become the State of Oklahoma (Foreman, 1925).

Cotton, wheat, and corn farming, along with the cattle industry, became important parts of the economy of the early twentieth century in Oklahoma, and an oil boom encouraged economic development. World War I increased the demand for agricultural products, but recurrent drought, overgrazing, and overplanting led to a decrease in agricultural productivity and resulted in abandonment of unproductive farms during the "Dust Bowl" in the 1930s. Ambitious state and federal programs for water conservation led to the building of the Tenkiller Dam (1940s and 1950s) and the Kerr Dam (1970s), which improved agricultural conditions (Britannica Concise Encyclopedia, 2006).

B.1.2.2 Known Cultural Resources within the SFC Site

Due to its location on a high terrace overlooking a major river and because there are other prehistoric resources in the general area (Wallis, 1974), the SFC site is considered to have a high potential for prehistoric resources. However, during the construction and subsequent operation of the SFC facility, the site sustained extensive disturbance, particularly the integrity of its surficial soils with consequent effects on prehistoric resources (OAS, 2000).

Historic cultural resources were also affected by the construction of the SFC facility. The Carlile House, a way station for a stagecoach route between Fort Smith and Fort Gibson, was originally located on the SFC site. This house was moved to a location on U.S. Route 64 near State Highway 10 during construction of the SFC facility, where it is currently preserved as a public attraction (SFC, 1998). Based on consultations with the Oklahoma Archeological Survey (OAS), Oklahoma Historical Society (OHS), and the Cherokee Nation, no prehistoric or historic sites are known to currently exist on the property (OAS, 2000; OHS, 2000; OHS, 2005; OHS, 2006; Cherokee Nation, 2001).

B.1.3 Alternatives Analysis

B.1.3.1 Alternative 1: On-Site Disposal of Contaminated Materials (the Proposed Action)

Under this alternative, SFC would excavate contaminated wastes and soils, but due to the severe disturbance of the surficial soils during the construction of the SFC facility, it is expected that no archaeological resources would be discovered. There are no historic architectural resources at the SFC facility that would be affected by site reclamation activities.

In accordance with the Section 106 process, the NRC staff began consulting with OHS and OAS in 2000. Letters dated June 2, 2000, and June 15, 2000, from the NRC staff requested a determination from OHS and the OAS, respectively, as to whether any historic properties on or near the SFC site would be potentially affected by decommissioning activities (NRC, 2000a and 2000b). In letters dated June 20, 2000, and June 27, 2000, the OAS and OHS respectively determined that the SFC facility does not contain archaeological resources or historic properties (OAS, 2000 and OHS, 2000). On August 29, 2001, the Cherokee Nation indicated that there are no significant prehistoric or historic properties in the project area and voiced no objection to the proposed action. The Cherokee Nation requested to be notified if buried archaeological materials, including human remains and associated funerary objects, are inadvertently discovered during decommissioning of the site (Cherokee Nation, 2001).

In 2005 the NRC began considering a groundwater monitoring plan (GWMP) for the SFC site. In a letter dated June 27, 2005, the NRC initiated consultation with OHS, referred to the previous OHS determination, and requested concurrence with "no adverse effect" determination from the OHS (NRC, 2005). In a letter dated July 26, 2005, the OHS responded to the NRC's proposed GWMP. The OHS stated that no known historic properties would be affected within the area of potential effect (APE) for the project. OHS also recommended that the NRC contact the OAS to determine whether prehistoric resources are present within the project area (OHS, 2005).

In letters dated November 27, 2006, and November 28, 2006, the NRC initiated a third round of consultations with OAS and OHS regarding the proposed reclamation plan at SFC (NRC, 2006a; NRC, 2006b). The NRC stated that the proposed reclamation activities are similar in scope and extent to those of the earlier proposed actions of decommissioning and groundwater monitoring and referred to the earlier responses to the NRC from OAS (2000), OHS (2000), and the Cherokee Nation (Cherokee Nation, 2001). In letters dated December 20, 2006 (OHS), and March 28, 2007 (OAS), the OHS and OAS stated that no historic properties would be affected by the proposed reclamation. Therefore, the impact on cultural resources would be SMALL.

If cultural materials are identified during site reclamation, SFC has indicated that construction activities would be halted, the appropriate NRC official would be notified, and the OHS would be consulted (SFC, 2006). Similarly, if Native American human remains or funerary objects are discovered during reclamation, all construction activities in the area of the discovery would be halted for up to 30 days, the appropriate NRC official would be notified, and steps would be initiated to comply with the requirements of the Native American Graves Protection and Repatriation Act.

B.1.3.2 Alternative 2: Off-site Disposal of All Contaminated Materials

Contaminated soil would be excavated during implementation of Alternative 2, but it is expected that no archaeological resources would be discovered at the facility because of the severe prior ground disturbance. In addition, there are no historic or architectural properties at the SFC facility (OHS, 2006). In the course of the Section 106 process, the NRC, in consultation with the OHS, OAS, and the Cherokee Nation, has determined that implementation of this alternative would have no adverse effect on historic cultural resources. Therefore, the impact on cultural resources from reclamation activities on the SFC site would be SMALL.

As previously mentioned in Chapter 2, this alternative would require SFC to construct a railroad spur to connect to the major railroad line east of the site (see Figure 2.3-1). In letters dated March 17, 2007, to the OAS (NRC, 2007a) and the Cherokee Nation (NRC, 2007b), the NRC requested concurrence on the determination that there are no cultural resources on the property traversed by the rail spur. In a letter dated March 28, 2007, the OAS recommended that an archeological survey be conducted of the spur line route if the off-site alternative is chosen. In a letter dated April 11, 2007, the OHS concurred with the OAS.

If cultural materials are identified during site reclamation, all activities would be halted, the appropriate NRC official would be notified, and the OHS would be consulted. If Native American human remains or funerary objects are discovered during reclamation, all construction activities in the area of the discovery would be halted for up to 30 days, the appropriate NRC official would be notified, and steps would be initiated to comply with the requirements of the Native American Graves Protection and Repatriation Act.

B.1.3.3 Alternative 3: Partial Off-site Disposal of Contaminated Materials

Similar to Alternatives 1 and 2, contaminated soil would be excavated during implementation of Alternative 3, but it is expected that no archaeological resources would be discovered at the facility because of the severe prior ground disturbance. In addition, there are no historic or architectural properties at the SFC facility. In the course of the Section 106 process, the NRC, in consultation with the OHS and OAS, has determined that implementation of this alternative would have no adverse effect on cultural resources. Therefore, the impact on cultural resources would be SMALL.

If cultural materials are identified during site reclamation, all activities would be halted, the appropriate NRC official would be notified, and the OHS would be consulted. If Native American human remains or funerary objects are discovered during reclamation, all construction activities in the area of the discovery would be halted for up to 30 days, the appropriate NRC official would be notified, and steps would be initiated to comply with the requirements of the Native American Graves Protection and Repatriation Act.

B.1.3.4 No-Action Alternative

If no action were taken, SFC would maintain the site as it currently exists. The impacts on cultural resources from implementation of the no-action alternative would be SMALL.

B.2 Visual and Scenic Resources and Impacts

Visual and scenic resources comprise those features that relate to the overall impression a viewer receives of an area. The value of the affected setting is highly dependent on existing land use. Therefore, the evaluation of visual and scenic resources focuses on the visibility of the site and its facilities from various locations outside the site from which the facility is visible, and how that visibility will change.

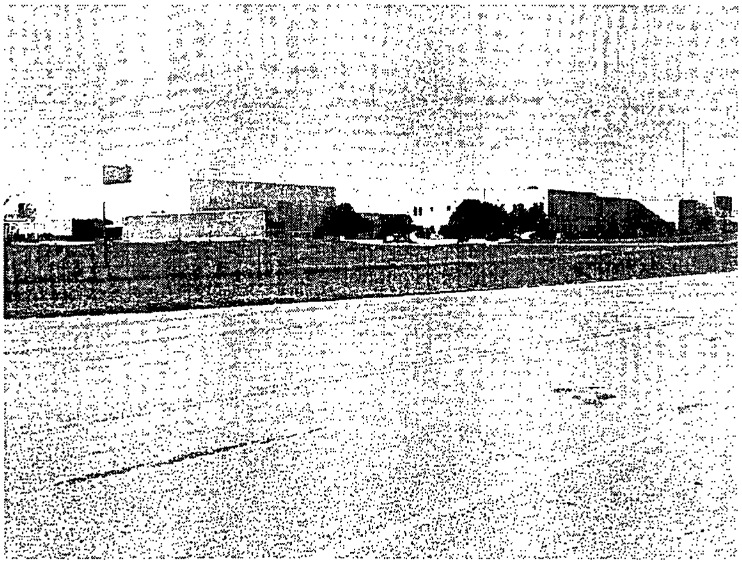
B.2.1 Affected Visual Environment

The SFC site is an industrial facility on 243 hectares (600 acres) of land; however, only 81 hectares (200 acres) were used in industrial operations. The portions of the site not used in industrial operations have been leased to local ranchers for cattle and crop production. All of the site is surrounded by a mix of forest and pastureland on a rolling topography. The area can be characterized as rural. The waterways adjacent to or near the site (the Illinois and Arkansas rivers, including the Robert S. Kerr Reservoir) are used by the public for recreation. Significant visual elements in the study area primarily include roadways (State Highway 10, I-40, and U.S. Route 64) and views from the Arkansas and Illinois rivers.

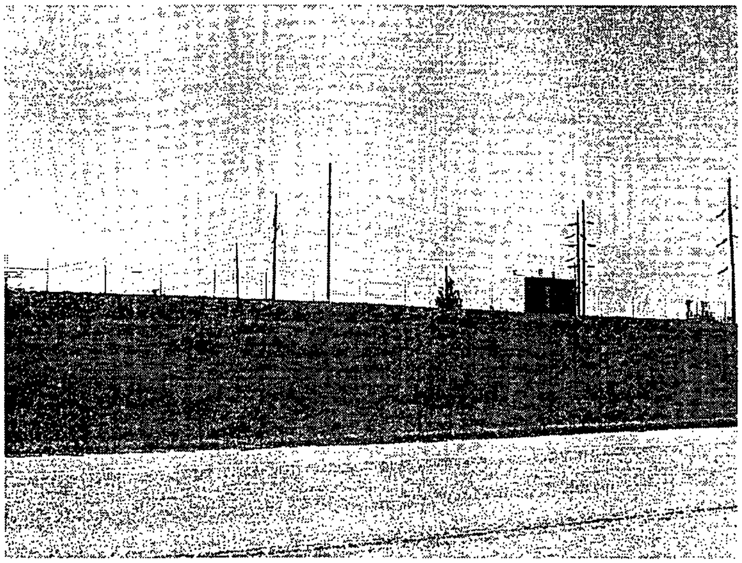
Existing buildings are one, two, or three stories high and are constructed primarily with tan or light blue metal siding. Unlike the administrative building, few of the process buildings have windows, and they show signs of neglect and disrepair. A chain-link fence topped with barbed wire surrounds the Industrial Area. Stacks of dewatered raffinate sludge of about 3 to 6 meters (10 to 20 feet) high are covered with a black tarp on the south side of the Process Area. The Process Area and associated ponds and disposal areas are surrounded by grassy areas with a few small trees.

The SFC facility is visible from State Highway 10 and, to a lesser extent, from the I-40 bridge. From State Highway 10 on the east side of the site, the view toward the site is obstructed by changes in topography and earthen berms between the road and the site. Only power lines, fencing, and the DUF4 building are visible from this location. The administration building and other buildings along the southern perimeter of the site are visible from Highway 10 south of the site (see photos). Approximately 0.01 km (35 feet) of I-40 westbound has an unobstructed view of the southern perimeter of the site.

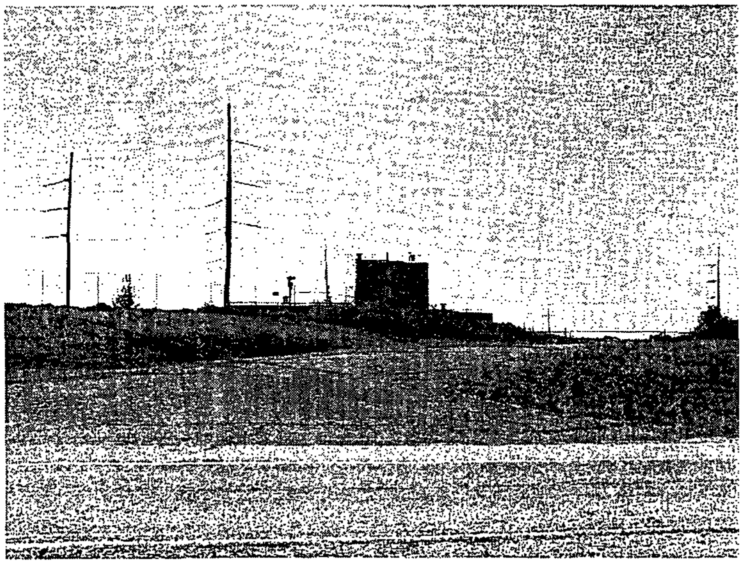
In summary, the SFC facility itself currently contrasts with the rural and natural character of the surrounding area.



Southeast side of SFC Process Area from Highway 10



Looking northwest at Proposed Disposal Cell Area from Highway 10



Looking west at Proposed Disposal Cell Area from Highway 10

B.2.2 Alternatives Analysis

The following sections describe the potential direct and indirect impacts on visual quality resulting from the implementation of the proposed action and its alternatives.

B.2.2.1 Alternative 1: On-site Disposal of Contaminated Materials (the Licensee's Proposed Action)

Under the proposed action, SFC would demolish site buildings and equipment, remove contaminated soil and sludges, and construct an on-site disposal cell. During construction, the site and nearby roadways would experience an increase in traffic. The movement of heavy equipment on the site would generate dust and noise, and open earth might be visible to travelers on State Highway 10, U.S. Route 64, and I-40. However, construction-related activities would be temporary. Therefore, the direct and indirect visual and scenic impacts resulting from SFC conducting its reclamation activities and the constructing the disposal cell would only be short-term and SMALL.

Following completion of reclamation activities, the only structures that would remain on the SFC site would be the administration building and the electrical substation. The licensee's disposal cell would occupy 4 hectares (10 acres) of the former Industrial Area of the SFC site, rising to about 12 meters (40 feet) above the existing grade. The top of the disposal cell would slope at 5% and the sides would slope at 20%. The cap of the cell would be covered in topsoil and planted with native grassy vegetation. The disposal cell may be visible from State Highway 10, U.S. Route 64, and the I-40 bridge. However, after reclamation, the site would contain fewer structures and all exterior equipment and tanks would be removed, improving the visual quality of the site. In addition, the site would be revegetated and generally present a rolling and grassing hillside appearance and blend into the existing natural landscape, although the surrounding fence would be visible to passersby. The direct or indirect visual or scenic impacts with implementation of Alternative 1 would be SMALL.

B.2.2.2 Alternative 2: Off-site Disposal of All Contaminated Materials

Under this alternative, SFC would demolish existing buildings and remove waste materials from the SFC site as described above for Alternative 1. However, because all wastes would be entirely removed from the site, SFC would not construct a disposal cell. Instead, SFC would construct a railroad spur to connect with the major rail line east of the site (see Figure 2.3-1) and an on-site transfer facility to load soils, sludges, sediments, and construction debris into railroad gondola cars. During the construction period, construction-related activities at the east side of the property, including increased traffic, dust, noise and the movement of heavy equipment, would be visible to travelers along State Highway 10, U.S. Route 64, and I-40. The rail line would not be visible from , U.S. Route 64, and I-40, and operations along this rail line would likely be obstructed from most views. It is unlikely that the rail spur or rail facility would be visible from the Arkansas or Illinois Rivers. Therefore, direct or indirect visual or scenic impacts would be SMALL.

Similar to Alternative 1, after SFC completes site reclamation, the site would contain fewer structures, and all existing exterior equipment and tanks would be removed. Following removal of the structures, equipment, and contaminated materials, SFC would backfill and place topsoil on all excavations, and revegetate the disturbed areas. The administration building and the electrical substation would be retained on the site following reclamation as would the railroad line and transfer facility. The visual quality of the site would remain industrial or commercial in nature. Therefore, direct or indirect visual or scenic impacts due to implementation of Alternative 2 would be SMALL.

B.2.2.3 Alternative 3: Partial Off-site Disposal of Contaminated Materials

Under this alternative, SFC would construct an on-site disposal cell similar to Alternative 1. In addition, a portion of the waste (3%) would be taken off-site, so it is possible that the on-site disposal cell would be slightly smaller. Waste materials not placed by SFC in the on-site disposal cell would be loaded onto trucks and shipped to an off-site disposal facility licensed to accept such materials.

Following reclamation, the administration building and electrical substation and disposal cell would be visible to travelers of the nearby highways. SFC would backfill and place topsoil on all excavations, and revegetate the disturbed areas. Similar to Alternative 1, the site would contain fewer structures after reclamation and all exterior equipment and tanks would be removed; however, the visual quality of the site would remain industrial in nature. Therefore, direct or indirect visual or scenic impacts due to implementation of Alternative 3 would be SMALL.

B.2.4 No-Action Alternative

Under the no-action alternative, SFC would not demolish buildings and equipment, and the visual quality of the site would remain industrial in nature. In the long-term, the existing buildings and equipment are likely to fall further into disrepair. This alternative would likely result in a continued reduction in the visual quality of the site. In the long-term, this would represent a MODERATE direct impact on visual and scenic resources.

B.3 Geology and Soils Resources and Impacts

This section provides a brief description of the regional and local geology, including bedrock and soil characteristics. Also discussed are the frequency, intensity, and history of earthquakes and active geologic processes. The literature reviewed while preparing this section included available geologic publications pertinent to the region or site (e.g., federal and state geological survey reports), contracted geologic studies, documents submitted by SFC to regulatory agencies, and reports prepared by the NRC staff.

As described in Chapter 1 of this DEIS, the NRC process for reviewing the license application includes an examination of the ability of the proposed disposal cell to withstand geologic hazards. The discussion of geology in this section, however, is not intended to support a detailed safety analysis of the proposed disposal cell. The NRC staff has documented its analysis of hazards related to geology in their Safety Evaluation Report (NRC, 2005a).

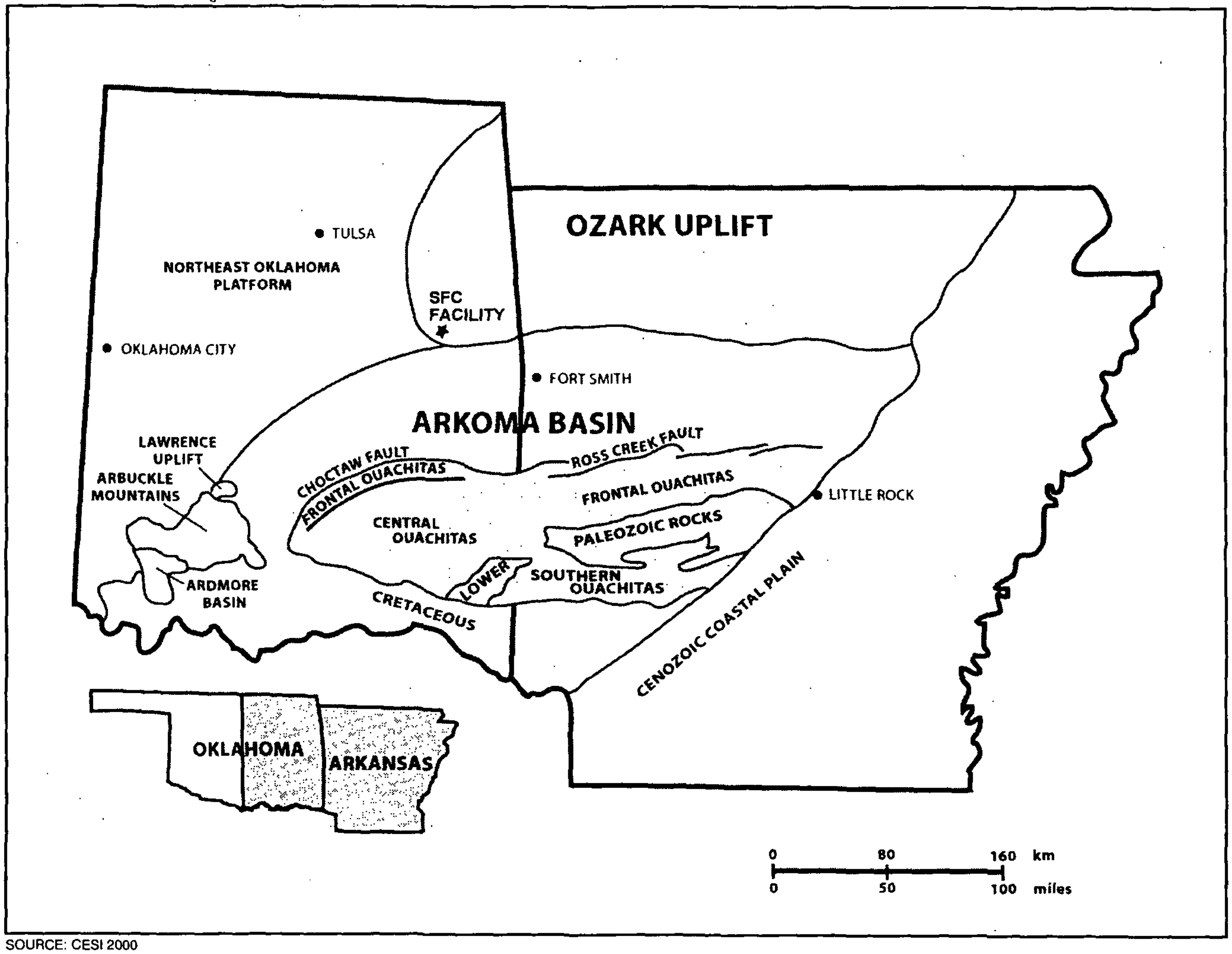
B.3.1 Affected Environment

B.3.1.1 Regional Geology, Structure, and Seismicity

The SFC site is located in the interior of the North American continent, near the boundary of three physiographic provinces (large-scale geologic features). The SFC site itself is located on the southwestern portion of a major geologic feature known as the Ozark Uplift (Luza and Lawson, 1981; Sutherland, 1988). Immediately to the south and west are two other major geologic features—the Arkoma Basin and Northeast Oklahoma Platform (see Figure B.3-1). The southwestern portion of the Ozark Uplift is characterized as generally gently dipping layers of sedimentary rock (cemented sediments). The Uplift has been and continues to be incised, or cut down, by streams, which expose the underlying bedrock. The bedrock in this region was deposited between 500 million and 280 million years ago and consists mostly of limestones, shales, siltstones, and sandstones. The region was located under a shallow sea between 500 million and 320 million years ago, during which time mainly limestone bedrock was deposited. After that time, a land mass collided with the North American continent, causing the land of this region to warp, resulting in fracturing, faulting, and folding of the bedrock. As a result, the dominant locations of sediment deposition became rivers, deltas, and tidal flats, where largely shales, siltstones, and sandstones were deposited (MFG, Inc., 2003).

The NRC staff have studied historical earthquakes and faults within the region to determine probable future earthquake activity and intensity (SFC, 2006; NRC, 2005). The details of this analysis are available in the NRC Safety Evaluation Report. The following is a summary of the findings.

The SFC site is located in the south-central part of the United States, which is not considered to be an area at risk from earthquake activity. Most earthquakes are associated with movement along faults in bedrock. The bedrock of the region is disrupted by northeast-trending faults (extensional features) and folds (compressional features) (Arbenz, 1956; Van Ardsdale, 1998). Faults that are potential sources of earthquakes may be identified from evidence of movement, 02:001096.OX39.20.02-B2065-Fig B.03-01.CDR-05/08/07-GRA



SOURCE: CESI 2000

Figure B.3-1 Regional Geologic Structures

association with recorded earthquakes, or by structural association with known active faults. A fault is generally considered active if it has experienced recent recurrent movement, usually within the last 11,000 years. There are no known active faults within 100 kilometers (62 miles) of the SFC site (LaForge, 1997). Another type of fault is a capable fault that may produce an earthquake. A capable fault is one in that has one or more of the following characteristics (10 CFR Part 100, Appendix A, definition [g]):

- movement at or near the ground surface at least once in the past 35,000 years, or more than once in the last 500,000 years;
- earthquake recordings that clearly show a relationship to a particular fault; and
- a structural relationship to a capable fault such that movement on one could be reasonably expected to be accompanied by movement on the other.

The closest known capable fault is the Meers Fault, which is located in south-central Oklahoma about 300 kilometers (186 miles) southwest of the SFC site (LaForge, 1997). The most recent movement along this fault is estimated to have occurred about 2,000 years ago. Three additional faults have been identified within a 8-kilometer (5-mile) radius of the site: the Carlisle School Fault, the Marble City Fault, and the South Fault of the Warner Uplift. All three of these faults have been determined to be non-capable faults by the NRC staff according to the definition described above (NRC, 2005).

Although distant earthquakes may produce shocks strong enough to be felt in this area, the region is considered to be at minor risk for earthquakes. The earthquake history of this region includes several small and moderate earthquakes. A review of the records spanning almost 200 years for events within 640 kilometers (400 miles) of the site identified six large earthquakes, ranging in magnitude from 5.1 to 7.2 (Richter scale). The closest of these earthquakes was centered approximately 186 kilometers (116 miles) from the SFC site (MFG, Inc., 2003). The strongest and best known earthquakes to occur in the greater region were centered over 480 kilometers (300 miles) northeast of the SFC site in New Madrid, Missouri. Two earthquakes of magnitude 7.0 and 7.2 occurred there in December of 1811.

The ground motion from earthquakes (intensity) is measured as a percent of the acceleration of gravity. At 10% gravity (0.1g), some damage may occur in poorly constructed buildings. At 0.1g to 0.2g, most people have trouble keeping their footing. The NRC staff has determined that the maximum intensity earthquake likely to occur at the SFC site would produce a ground motion equal to 0.25g, with a 1 in 10,000 probability of exceeding that each year. SFC designed the proposed disposal cell to withstand a ground motion of 0.27g, which has been deemed acceptable by the NRC staff (NRC, 2005a).

B.3.1.2 Minerals

Minerals in the area consist of coal, limestone/sandstone, sand/gravel from the Arkansas River floodplain, clay, and shale. The area of commercial coal production in Oklahoma surrounds the SFC site to the south and west (see Figure B.3-2). The commercial coal belt contains coal beds equal to or greater than 25.4 cm (10 inches) thick, which are considered economically mineable

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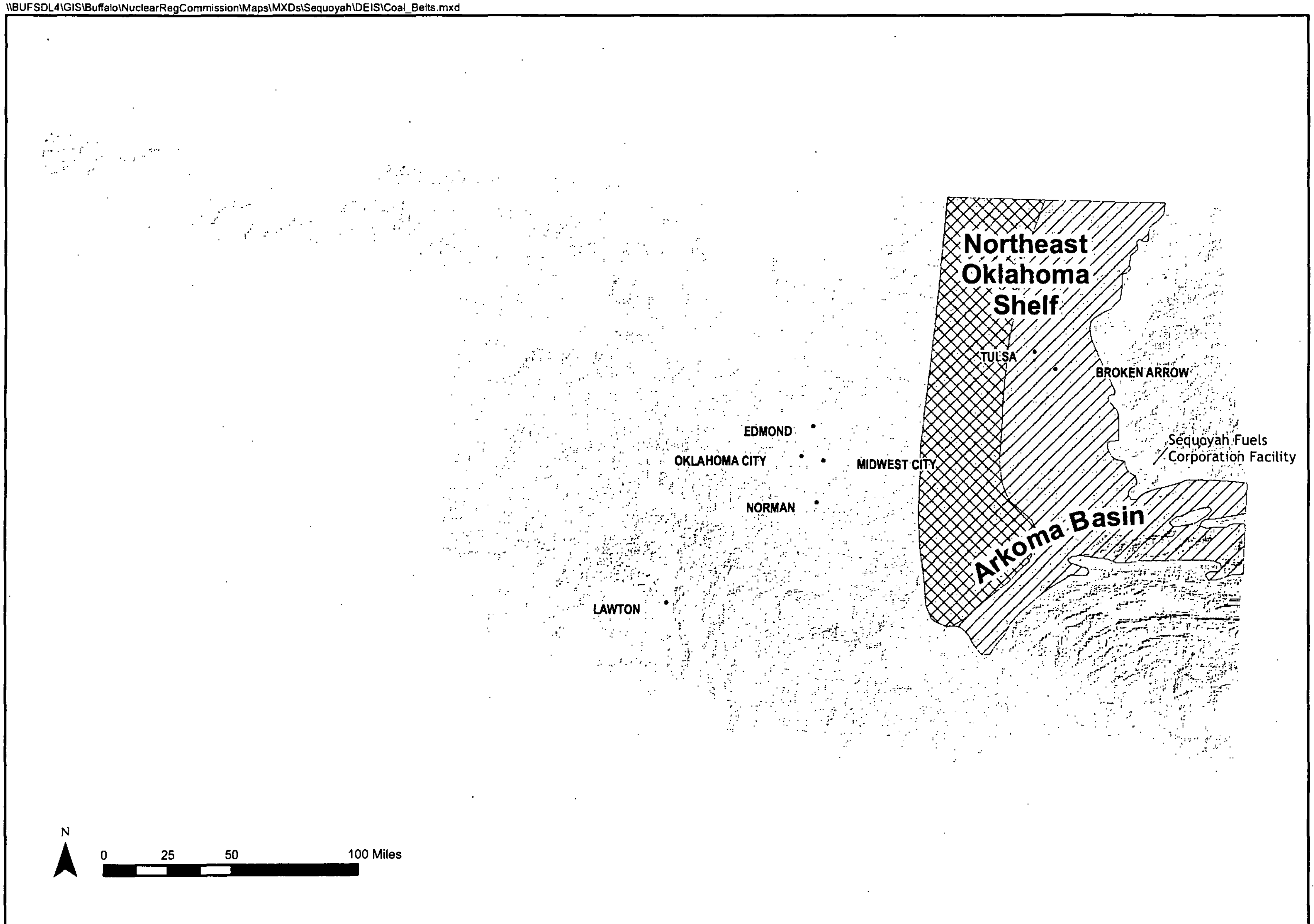

Figure B.3-2 Coal Belt Areas, Oklahoma

deposits (ODM, 2006). The coal production area nearest the SFC site (now closed) was approximately 14.5 (9 miles) to the west; several other coal mining operations are currently operating approximately 40 km (25 miles) southwest of the SFC site (SFC, 1998b). Geologic studies conducted at the SFC site have not identified coal beds in the near subsurface.

Limestone is one of the most widely available mineral resources in Oklahoma and accounts for about 60% of the reported tonnage of all non-fuel minerals mined in the state. Three major limestone production areas exist in Oklahoma—the Tulsa-Rogers-Mayes County region in northeastern Oklahoma, the Arbuckle Mountains region of Murray County and extending into Pontotoc County, and the Wichita Mountains area of Comanche and Kiowa counties. In Sequoyah County, over 1 million metric tons (1.1 million tons) of limestone was mined in 2005. Most limestone is crushed for use as concrete aggregate for building highways and other structures, as railroad ballast, in glass manufacturing, cement production, preparation of lime, and agricultural purposes. Limestone is not present at shallow depths at the SFC site.

Sand and gravel is produced in most counties in Oklahoma from deposits that are found near the many rivers and streams. Sand and gravel are used principally in the production of concrete for highway construction and other projects, and as railroad ballast. Silica sands, used in the manufacture of various grades of glass and other chemical and industrial activities, are found chiefly in the Arbuckle Mountain region of south-central Oklahoma (ODM, 2006).

There are no known oil or gas fields in the immediate area of the SFC site (SFC, 1998b). No economically valuable mineral resources that could be recovered have been identified within the site boundaries.

B.3.1.3 Site Geology

The bedrock at the SFC site is overlain with unconsolidated soils/sediments, generally to depths less than 6 meters (20 feet). These soils/sediments were largely deposited during high-water stages of the Illinois and Arkansas Rivers during the melting of glaciers at the end of the last Ice Age (approximately 10,000 years ago). Subsequent downcutting of the rivers have left these deposits above the current river elevations (SFC, 2006). The bedrock beneath the unconsolidated sediments at the SFC site includes sandstones and shales of the Atoka Formation, which extend to a depth of approximately 119 meters (390 feet) below ground surface (MFG, Inc., 2002). The first 30.5 meters (100 feet) of this formation (bedrock of similar composition) has been studied extensively through various environmental investigations at the SFC site. Alternating layers of shale and sandstone have been encountered over this interval. A geologic cross-section of the SFC site area is provided in Figure B.3-3.

The SFC site lies on an upland surface adjacent to and east of the confluence of the Illinois and Arkansas Rivers and is approximately 30.5 meters (100 feet) above the flood-stage of these rivers (SFC, 2006; NRC, 2005a). The Arkansas River is dammed below the SFC and forms the Robert S. Kerr Reservoir. The land surface drops steeply to the north, west, and southwest of the SFC facility property and is drained by short streams or gullies to the north, west, and south. (Surface water features are described in greater detail in Section 3.7.1.) These streams, as with all streams, are in a continual state of flux through erosion of their streams banks and bottoms.

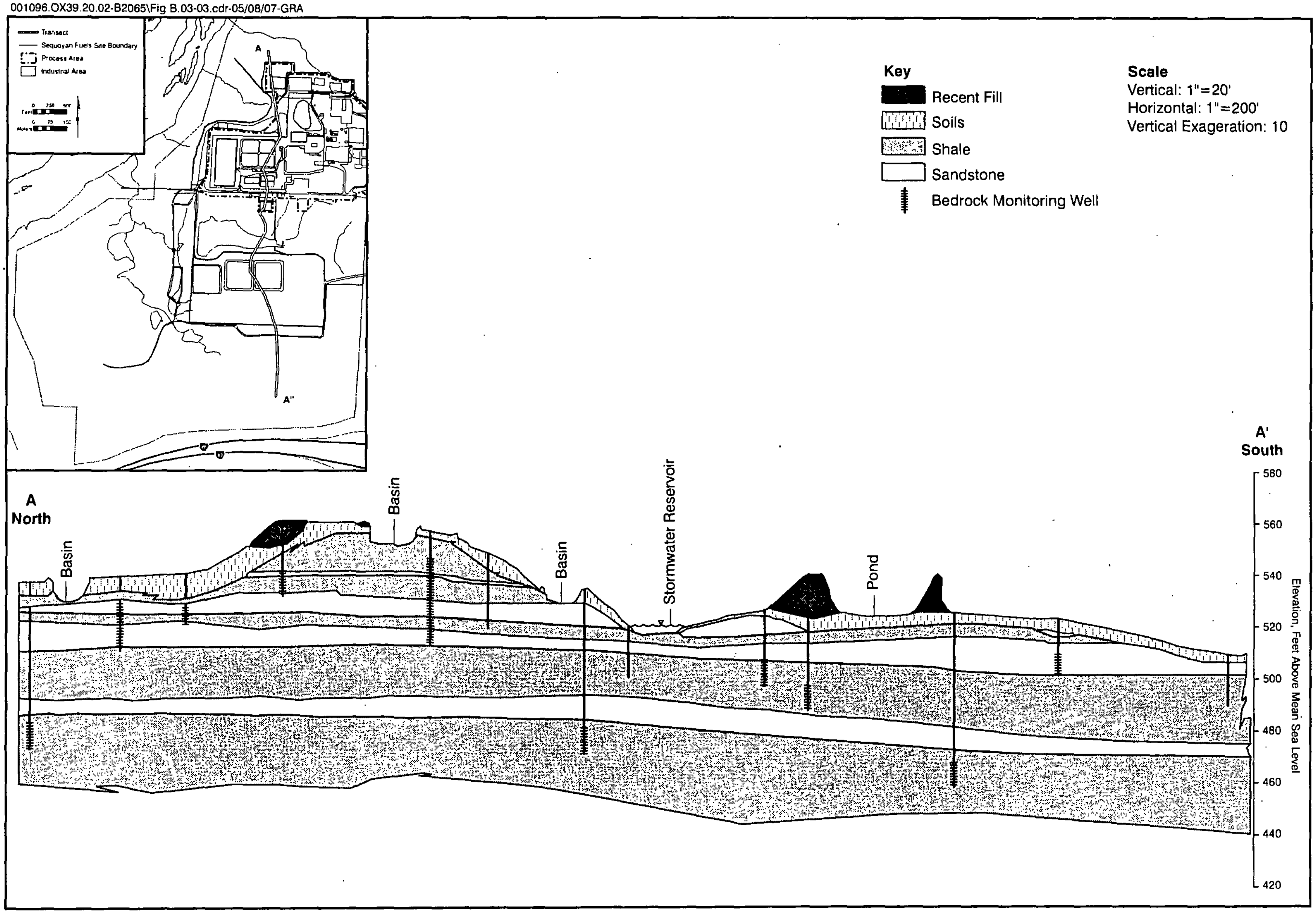

Figure B.3-3 Geological Cross Sections and Location Map

The NRC staff has evaluated the potential for these streams to encroach upon the proposed disposal cell through erosion; the NRC's Safety Evaluation Report details its findings. Mitigation methods, including the installation of rock armor in stream beds, can significantly reduce the rate of erosion of stream beds.

B.3.1.4 Soils

The site is underlain by surface soils consisting of the Pickwick, Hector, Linker, Lonoke, Kiomatia, Mason, Muldrow, Robinsonville, Rosebloom, Stigler, Spiro, Ender, Brewer, Collinsville, Yahola, and Vian series (SFC, 1998b). According to the U.S. Department of Agriculture (USDA) Soil Conservation Service (SCS), most of the Process Area is situated on Pickwick Series soils. The Pickwick Series consists of deep, moderately permeable, well-drained soils on uplands. The Pickwick Series and other soil types found at SFC are summarized in Table B.3-1. Surface soils at the SFC site are described as having low to high potentials for being corrosive to both steel and unprotected concrete. The Pickwick Series is moderately corrosive if in contact with uncoated steel and highly corrosive to unprotected concrete (SFC, 1998b). Factors affecting corrosion of steel and concrete in soils include the pH of the soil, moisture content, stray electrical current, certain chemicals, etc. A corrosive soil can "eat away" at steel and cause spalling (breaking into pieces) in concrete (Cunat, 2001).

Table B.3-1 Soils of Interest at the SFC Site and Surrounding Area

Formation	Description
Brewer Series (Bw)	Located along the Arkansas River. Consists of deep, slowly permeable, and moderately well drained soils on bottom lands. Has a surface layer of silt loam and a subsoil of silty clay loam. Moderate corrosivity to uncoated steel, and low corrosivity to unprotected concrete.
Collinsville Series (Cn)	Formed in material weathered from sandstone. Has a surface layer of sandy loam. Below this is a thin layer of sandstone and fine sandy loam. Acid sandstone occurs at a depth of 10 inches. Low corrosivity to uncoated steel, and moderate corrosivity to unprotected concrete.
Hector Series (He) Hector-Linker-Enders complex;	Located on uplands; shallow, rapidly permeable, excessively drained. Typically fine sandy loam to about 36 cm (14 inches). Moderate corrosivity to uncoated steel, and high corrosivity to unprotected concrete.
Kiomatia Series (Cr)	Located in sandy alluvial sediments. Consists of deep, well-drained, rapidly permeable soils. Has a surface layer of fine sandy loam.
Linker Series (Ln) Linker-Hector complex; and Linker and Stigler soils	Located on upland areas from weathered sandstone. Consist of moderately deep to deep, permeable, well-drained loam; clay loam to 76 cm (30 inches). Low to moderate corrosivity to uncoated steel, and low to moderate corrosivity to unprotected concrete.
Lonoke Series (Lr)	Located on bottomlands along the Arkansas River. Consists of deep, moderately to slowly permeable, well-drained soils. Surface layer of loam or silty clay loam and a subsoil of loam. Low corrosivity to uncoated steel, and low to moderate corrosivity to unprotected concrete.

Table B.3-1 Soils of Interest at the SFC Site and Surrounding Area

Formation	Description
Mason Series (Ma)	Located in bottomlands. Deep, moderately permeable, and well-drained. Typically has a surface layer of silt loam about 30 cm (12 inches) thick, with subsoil of silty clay loam extending to 180 cm (72 inches). Typically has slopes of 0 to 2%.
Muldrow Series (Mu)	Located along the Arkansas River; seldom flooded. Consists of deep, very slowly permeable, somewhat poorly drained soils on bottom lands. Has a surface layer of silty clay loam. The subsoil consists of silty clay loam and silty clay. High corrosivity to uncoated steel, and low corrosivity to unprotected concrete.
Pickwick Series (Pc)	Located throughout most of the Process Area. Consists of deep, moderately permeable, well-drained soils on uplands; forms from weathered sandstone. Typically has a surface layer of loam from 0 to 25 cm (0 to 10 inches), with a clay loam layer from 25 to 170 cm (10 to 68 inches). Moderate corrosivity to uncoated steel, and high corrosivity to unprotected concrete.
Robinsonville Series (Ro)	Located along bottomlands of the Arkansas River. Deep, moderately rapidly permeable, and well drained. Surface soils are sandy fine loam with a subsoil of sandy loam, below which is loamy fine sand. Low corrosivity to uncoated steel, and moderate corrosivity to unprotected concrete.
Rosebloom Series (Rs)	Located along bottomland of major streams. Deep, slowly permeable, poorly drained. Typically has a subsurface layer of silt loam, and subsoil consists of silty clay loam. Has 0 to 15% slopes. Lower sloped soils occasionally flooded. High corrosivity to uncoated steel, and high corrosivity to unprotected concrete.
Rosebloom and Ennis (Ru)	Located along bottomlands of the Arkansas River. Deep, moderately rapidly permeable, and well drained. Surface soils are sandy fine loam with a subsoil of sandy loam, below which is loamy fine sand. Low corrosivity to uncoated steel, and moderate corrosivity to unprotected concrete.
Spiro Series (Sn)	Located on uplands; formed from weathered sandstone, siltstone, and shale. Moderately deep to deep, moderately permeable, and well drained. Generally consists of a silt loam surface and a silty clay loam subsoil. Low to moderate corrosivity to uncoated steel, and moderate to high corrosivity to unprotected concrete.
Stigler Series (Sr)	Located on uplands. Very slowly permeable, somewhat poorly drained. Surface layer consists of silt loam to 51 cm (20 inches) with subsoil of silty clay loam that grades to clay at 110 to 150 cm (45 to 60 inches). Severely eroded with 2% to 8% slopes. High corrosivity to uncoated steel, and high corrosivity to unprotected concrete.
Vian Series (Va)	Consists of deep, moderately slowly permeable, moderately well drained upland soils that form in loamy alluvium or loess. Surface layer of silt loam underlain by silty clay loam. Occurs on 1% to 5% slopes. Moderate corrosivity to uncoated steel, and high corrosivity to unprotected concrete.

Table B.3-1 Soils of Interest at the SFC Site and Surrounding Area

Formation	Description
Yahola Series (Ya)	Located on floodplains along the Arkansas River. Consists of deep, moderately rapidly permeable, well-drained soils on bottom lands. Has a surface layer of fine sandy loam. Low to high corrosivity to uncoated steel, and low corrosivity to unprotected concrete.

B.3.1.5 Soil Quality

The uranium recovery operations conducted by SFC at its facility involved many steps and chemical processes. During these operations, radiological and other contaminants were released to site soils through spills, leaks, and disposal operations. The following is a summary discussion of contaminants detected in SFC site soils.

Radiological Contaminants

As previously discussed, natural uranium was the primary form of uranium processed at the SFC site and is, therefore, the predominant form of uranium present as a contaminant at the site. The uranium feed material also contained the decay products of uranium, primarily radium-226 and thorium-230, but not in equal proportions. Depleted uranium was the only other form of uranium processed at the facility. Processing was essentially a dry, closed-loop process and did not result in significant releases at the SFC site (SFC, 1998b).

A review of uranium contamination in soil at specific depth intervals indicates that concentrations of uranium decrease with depth. Most of the high concentrations of uranium are found in the upper 15 cm (6 inches) of soil. The uranium found in soils at depths below 3 meters (10 feet) were generally located in the area around the Solvent Extraction Building and the Main Process Building. Uranium levels in a sandstone more than 12 meters (40 feet) below ground surface have been measured at background concentrations. This sandstone is believed to effectively limit the vertical extent of contamination in soils and bedrock (SFC 1998b). Section 3.4, Public and Occupational Health, of this report provides a detailed discussion of the extent and concentrations at which these radiological contaminants were detected.

Other Contaminants

The chemical conversion of the feed material during the uranium processing operations at the SFC facility required the use of nonradiological chemicals. The major process chemicals utilized in these steps included nitric acid, tributylphosphate, hexane, anhydrous ammonia, anhydrous hydrofluoric acid, potassium bifluoride, elemental fluorine, and calcium oxide. Ammonium nitrate, raffinate sludge, and calcium fluoride were major byproducts of this operation. SFC performed numerous environmental investigations in order to identify the extent to which contaminants were released to site soils (SFC, 1991; SFC, 1996; SFC, 1997a; SFC, 1997b; SFC, 1998b et al.). Based on the data included in SFC's 1996 Final RCRA Facility Investigation Report and 1998 Site Characterization Report, the following contaminants were detected in site soils at concentrations above USEPA Region 6 Human Health Medium-Specific Screening Levels for residential use: arsenic, nitrates, fluoride, lead, copper, lithium, nickel, iron, molybdenum, vanadium, and antimony. Section 3.4, Public and Occupational Health, of this report provides a detailed discussion of the extent and concentrations at which these nonradiological contaminants were detected.

B.3.2 Geology and Soils Impacts

This section presents the potential direct and indirect impacts on geologic resources and soils that would result from the implementation of each alternative. As described in Chapter 1 of this DEIS, the NRC process for reviewing the license application includes an examination of the ability of the proposed disposal cell to withstand geologic hazards. The discussion of geology in this section, however, is not intended to support a detailed safety analysis of the proposed disposal cell. The NRC staff has documented its analysis of hazards related to geology in the Safety Evaluation Report (NRC, 2005a).

No economically valuable mineral resources that could be recovered from the study area have been identified.

B.3.2.1 Alternative 1: On-Site Disposal of Contaminated Materials (the Licensee's Proposed Action)

Under the licensee's proposed action, SFC would construct an on-site disposal cell to contain all contaminated materials on-site, including soils, buildings, and equipment. SFC would excavate soils outside the footprint of the disposal cell that contain uranium, radium, or thorium in excess of the proposed site-specific cleanup criteria. The cleanup criteria for soils at the surface are:

- Uranium – 100 pCi/g for uranium;
- Radium – 5 pCi/g; and
- Thorium – 14 pCi/g.

SFC would also excavate soils under the footprint of the disposal cell that exceed 560 pCi/g uranium. Suitable clayey soils from the southern portion of the SFC site would be excavated by SFC for use as a liner in both the base and cover layers of the disposal cell. In addition, SFC would place soils collected and stored on-site from prior cleanup activities into the disposal cell (SFC, 2006).

Erosion of soils is a common concern during any construction activity that disturbs soils and vegetation. During construction of the proposed disposal cell, SFC would use existing roads as much as possible to transport excavated soils for placement into the disposal cell. However, it may be necessary to construct short-term haul roads in order to effectively transport soils to the disposal cell. Increased soil erosion could result from the action of wind and precipitation on soils stripped of vegetation in the excavation and construction areas. Short-term direct but moderate effects on soils would arise from an increase in erosion. However, SFC would employ mitigation measures in the form of best management practices (e.g., the use of earthen berms, dikes, and silt fences) to minimize this impact. The excavation areas would be backfilled as necessary, graded, and planted with native grasses, which would mitigate any long-term impacts associated with soil erosion. The long-term direct and indirect impacts of soil erosion would be SMALL.

Land use in the region surrounding the SFC site includes agriculture, primarily in the form of pasture. The proposed action would cause a permanent disturbance and burial of natural soils existing at the site and likely necessitate backfilling with non-native materials. This would not, however, preclude the future use of unrestricted areas for agriculture. The industrial operations at the site resulted in radiological and nonradiological contamination of site soils as described in Sections 3.4 and Appendix B.3 of this report. An overall improvement of soil quality at the SFC site would occur as a result of the removal of contaminated soils. Therefore, the direct and indirect impacts from excavation of native soils would be SMALL.

Compaction of soils could result from the construction of roads and the repeated use of heavy equipment in any given area. Compaction can reduce the ability of a soil to sustain vegetation or limit the types of vegetation that can grow in these areas. However, existing on-site roadways would be used, and other areas of the site where additional compaction of soils could occur would be small in comparison to the site as a whole. Therefore, the direct impacts of soil compaction would be SMALL.

The NRC staff has evaluated the potential impacts of geologic hazards on the proposed disposal cell. These hazards include potential ground motion produced by earthquakes and potential stream encroachment. A detailed discussion of these potential hazards is provided in the NRC Safety Evaluation Report (NRC, 2005a). The NRC staff has determined that potential geologic hazards have been adequately addressed to protect public safety and, therefore, impacts would be SMALL.

B.3.2.2 Alternative 2: Off-site Disposal of All Contaminated Materials

Under Alternative 2, all wastes at the SFC facility would be excavated, consolidated, packaged, and transported off-site for disposal at a licensed facility. As part of this alternative, a rail spur would be constructed (see Section 2.3.2) to facilitate removal of all wastes. After the removal of contaminated soils, these areas would be backfilled (where necessary) and graded with non-native, clean soils.

Short-term impacts would arise from an increase in soil erosion during excavation, construction of the rail spur, and backfilling activities. However, SFC would employ best management practices (e.g., the use of earthen berms, dikes, and silt fences) to minimize this impact, resulting in a moderate and direct short-term impact. SFC would employ appropriate long-term erosion control measures (e.g., planting with native grasses) to minimize long-term impacts, resulting in SMALL indirect impacts.

Land use in the region surrounding the SFC site includes agriculture, primarily in the form of pasture. Alternative 2 would cause a permanent disturbance and burial of natural soils existing at the site and necessitate backfilling with non-native materials. This, however, would not preclude the future use of unrestricted areas for agriculture. In addition, the industrial operations at the site resulted in radiological and nonradiological contamination of site soils as described in Sections 3.4 and Appendix B.3 of this report. An overall improvement of soil quality at the SFC site would occur as a result of the removal and disposal of contaminated soils. The direct and indirect impacts from excavation of native soils would be SMALL.

Compaction of soils could result from construction of the rail spur, construction of haul roads, and the repeated use of heavy equipment in any given area. Compaction can reduce the ability of a soil to sustain vegetation or limit the types of vegetation that can grow in these areas. However, existing on-site roadways would be used, and other areas of the site where additional compaction of soils could occur would be small in comparison to the site as a whole. Therefore, the direct impacts of soil compaction would be SMALL.

B.3.2.3 Alternative 3: Partial Off-site Disposal of Contaminated Materials

Under Alternative 3, all wastes would be consolidated into an on-site disposal cell as described under Alternative 1 (the proposed action). However, SFC would package and transport the most contaminated materials (dewatered raffinate sludge and sediment from the North Ditch, Emergency Basin, and Sanitary Lagoon) for reuse (raffinate sludge) or disposal at an off-site facility licensed to accept such materials. It is possible that the disposal cell would be slightly smaller.

Soil erosion could occur during construction activities associated with implementation of Alternative 3. During construction of the disposal cell, SFC would use existing roads as much as practicable to transport excavated soils for placement into the disposal cell. However, it may be necessary for SFC to construct short-term haul roads in order to effectively transport soils to the disposal cell. Increased soil erosion could result from the action of wind and precipitation on soils stripped of vegetation in excavation and road construction areas. Short-term direct but moderate effects on soils would arise from an increase in erosion of soils during excavation, haul road construction, and construction of the proposed disposal cell. However, implementation of best management practices such as the use of earthen berms, dikes, and silt fences would minimize this impact. The excavation areas would be backfilled as necessary, graded, and planted with native grasses, which would mitigate any long-term impacts associated with soil erosion. The long-term direct and indirect impacts of soil erosion would be SMALL.

Land use in the region surrounding the SFC site includes agriculture, primarily in the form of pasture. Alternative 3 would cause a permanent disturbance and burial of natural soils existing at the site and likely necessitate backfilling with non-native materials. This, however, would not preclude the future use of unrestricted areas for agriculture. In addition, industrial operations at the site resulted in radiological and nonradiological contamination of site soils as described in Sections 3.4 and Appendix B.3 of this report. An overall improvement of soil quality at the SFC site would occur as a result of the removal and disposal of contaminated soils. Therefore, the direct and indirect impacts from excavation of native soils would be SMALL.

Compaction of soils could result from the construction of roads and the repeated use of heavy equipment in any given area. Compaction can reduce the ability of a soil to sustain vegetation or limit the types of vegetation that can grow in these areas. However, existing on-site roadways would be used, and other areas of the site where additional compaction of soils could occur would be small in comparison to the site as a whole. Therefore, the direct impacts of soil compaction would be SMALL.

The NRC staff has evaluated the potential impacts of geologic hazards on the proposed disposal cell. These evaluations would also apply under Alternative 3. These hazards include potential ground motion from earthquakes and potential stream encroachment. A detailed discussion of these potential hazards is provided in the NRC Safety Evaluation Report (NRC, 2005a). The NRC staff has determined that potential geologic hazards have been adequately accounted for in the proposed action and, therefore, impacts would be expected to be SMALL.

B.3.2.4 No-Action Alternative

The no-action alternative would result in contaminated soils and structures remaining indefinitely at the SFC site. Contaminants in the site soil or remaining pond sludges could eventually leach to surface water or groundwater resources, causing a moderate to large impact. In addition, if the raffinate sludge packaging deteriorates over time, the sludge could leak from the package and the contaminants could leach to surface water or groundwater resources, causing a contamination and exposure hazard for site workers. These impacts could range from MODERATE to LARGE.

B.4 Climate, Meteorology, and Air Quality Resources and Impacts

This section describes the existing climatology, meteorology, and air quality in the vicinity of the SFC site and impacts resulting from implementation of the proposed action and alternatives.

B.4.1 Affected Environment

B.4.1.1 Regional Climate

Sequoyah County is part of the Great Plains and its climate is continental. The Gulf of Mexico, however, exerts an influence on the climate, bringing in warm moist air that causes more cloudiness and precipitation than in the western and northern sections of the state. Summers are long and hot, but winters are shorter and less cold than in states in the northern plains. The prevailing winds are from a south to southeasterly direction from spring through autumn. In winter, winds are from a northerly or southerly direction.

B.4.1.2 Site and Regional Meteorology

The nearest National Weather Service Class 1 station (professional staff taking hourly observations) is located approximately 64 km (40 miles) away at Fort Smith Regional Airport in Arkansas. Weather conditions are monitored and recorded continuously at this station. Some of the key meteorological parameters collected at the station include wind speed, wind direction, temperature, cloud cover, and ceiling height (cloud base above local terrain). For the period 1971 through 2000, the annual mean temperature was 16.2 degrees Celsius (61.2 degrees Fahrenheit), the annual average precipitation was 111.8 cm (43.8 inches), and the annual average snowfall was 18 cm (7.1 inches).

Tornados are frequent in Oklahoma, occurring an average of 52 time per year. Tornados can develop anytime during the year, but they occur most frequently in the spring. Hailstorms and thunderstorms in the area can be severe. Snow is infrequent, but at times conditions can lead to strong winds and large snowfalls, resulting in severe drifting and blizzard conditions.

B.4.1.3 Air Quality

The Federal Clean Air Act (CAA) (U.S.C. § 7401) requires the adoption of National Ambient Air Quality Standards (NAAQS) to protect the public health, safety, and welfare from known or anticipated effects of air pollution. Current standards are set for sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate matter equal to or less than 10 microns in size (PM_{10}), fine particulate matter equal to or less than 2.5 microns in size ($PM_{2.5}$), and lead (Pb). These pollutants are collectively referred to as criteria pollutants. Criteria pollutants are those pollutants for which acceptable levels of exposure can be determined and for which an ambient air quality standard has been set. The State of Oklahoma established standards that are the same as the NAAQS. The federal standards are shown in Table B.4-1.

Table B.4-1 Background Ambient Concentrations Compared to NAAQS

Pollutant	Averaging Time	NAAQS ($\mu g/m^3$)		SFC Area ($\mu g/m^3$)[b]
		Primary	Secondary[a]	
Sulfur dioxide	Annual	80		8
	24-hour[c]	365		56
	3-hour[c]		1,300	203
Nitrogen dioxide	Annual	100	100	17
Ozone	8-hour[d]	235 (0.08 ppm)	235 (0.08 ppm)	158
Carbon monoxide	8-hour[c]	10,000	10,000	2,677
	1-hour[c]	40,000	40,000	3,376
PM_{10}[e]	Annual	50		140
	24-hour[d]	150		
$PM_{2.5}$[f]	Annual	15	15	12.8
	24-hour[d]	35		30
Lead	3-month[g]	1.5	1.5	0.06

[a] If no value is listed, there is no corresponding standard.
[b] Source: EPA AirData database highest monitored readings for the period 2003 through 2006 with parts per million (ppm) values converted to $\mu g/m^3$.
[c] The standard cannot be exceeded more than once per year.
[d] The standard cannot be exceeded on more than 1 day/year on average over 3 years.
[e] Particulate matter less than 10 µm in diameter.
[f] Particulate matter less than 2.5 µm in diameter. To attain the 24-hour standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m3 (effective December 17, 2006).
[g] Calendar quarter.

The locations nearest the SFC site where ambient concentrations of criteria air pollutants are measured by the Oklahoma Department of Environmental Quality (ODEQ) include Muskogee, McAlester, and Lawton, Oklahoma. Air quality in the vicinity of the SFC site is within the NAAQS for all the criteria pollutants (CO, Pb, NO_2, O_3, PM_{10}, $PM_{2.5}$, and SO_2). Monitored concentrations for the most recently available three years (2003 to 2005) are presented in Table B.4-1.

A study performed by Oak Ridge Associated Universities in 1986 during facility operations showed less-than-detectable levels of nitrogen oxides in the ambient air at sample locations around the SFC site (ORAU 1986). Since the cessation of production operations, criteria air emissions are no longer emitted from the facility.

Radiological air emissions from the site would be regulated by the federal government under NRC and National Emissions Standards for Hazardous Air Pollutants (NESHAP) regulations. Since the cessation of production operations, however, radiological air emissions from the facility and air emissions source (stack) monitoring are no longer conducted. Perimeter air samples continue to be collected by SFC at four locations along the fenceline (SFC, 2006b). Previous SFC monitoring results have shown that emissions from the facility were below established regulatory standards for radiological air emissions (SFC, 2006). A description of radiological air emissions is incorporated in Section 4.4, Public and Occupational Health.

B.4.2 Alternatives Analysis

Air quality impacts could be caused by reclamation of the SFC facility through the use of vehicles and equipment and the disturbance of sediment and surface soils.

B.4.2.1 Alternative 1: On-site Disposal of Contaminated Materials (the Licensee's Proposed Action)

Nonradiological Impacts. SFC's proposed reclamation activities, including the construction of the disposal cell, would result in the generation of mobile-source emissions and fugitive dust. Mobile-source emissions would include engine emissions from light-duty and heavy-duty vehicles, privately owned vehicles, and heavy-duty construction vehicles. Fugitive dust would be generated by construction vehicles excavating and removing contaminated soil, dismantling buildings and equipment, placing soils in the disposal cell, and moving on paved roads or unpaved soil surfaces.

The total annual construction-related emissions that would result under this alternative were estimated to determine the potential for air quality impacts. Guidelines published by the El Dorado County, California, Air Pollution Control District (El Dorado County, 2002), which use EPA's emission standards, were used to provide guidance on the estimated types and numbers of equipment and hours of operations needed for a project of this size. Equipment to be used was determined based on the types of operations expected and detailed in the Demolition Plan (MFG, 2004). While the types and numbers of equipment will vary during the course of the project, the operation of construction equipment has been conservatively generalized, assuming that, at any given time, one of each type of equipment would be operating on the SFC site, 8 hours a day, 250 days per year. Particulate emissions from SFC site preparation activities have been estimated assuming typical construction activities and dust control. Total projected annual construction emissions are listed below in Table B.4-2. These emissions represent a SMALL direct impact on local air quality.

Table B.4-2 Projected Annual Construction-Related Air Emissions

Activity	Emissions (metric tons/year (tons per year))				
	NO_x	VOC	CO	SO_2	PM_{10}
Equipment Operation	43.84 (48.34)	4.65 (5.13)	28.87 (31.83)	2.04 (2.25)	2.32 (2.55)
Fugitive Dust	0.00	0.00	0.00	0.00	0.80 (0.88)
Total	43.84 (48.34)	4.65 (5.13)	28.87 (31.83)	2.04 (2.25)	3.11 (3.43)

Indirect emissions also would result from transportation increases associated with this action. The SFC site would be subject to a greater number of commuting construction workers, and transportation of construction materials and equipment also would result in increased emissions. The quality of traffic flow along regional roadways has been evaluated within the transportation analysis and is discussed in Sections 3.5, 4.5, and Appendix D. The increase in traffic volumes associated with implementation of this alternative would be minimal because the number of vehicles that would be involved per day (see Table 4-5.1) would cause only minor impacts on the typically free-flowing conditions of the local highways. Air pollution resulting from the increase in transportation associated with this alternative would not be expected to have a significant impact on local air quality because the number of vehicles involved per day is relatively small compared to existing road traffic; therefore, their contribution would represent only a SMALL indirect impact on local air quality.

Some areas within the facility may contain asbestos. SFC will identify, remove, and dispose of asbestos prior to demolition of the facilities in accordance with applicable regulatory requirements. Therefore, the asbestos-related impact on local air quality would be SMALL.

SFC proposes to mitigate air quality impacts by managing dust associated with demolition and construction activities and ensuring all equipment is well maintained and operating properly. Soils from excavation areas would be transported to the disposal cell via existing roads by haul trucks or loaders. Construction of new roads is not anticipated. Haul roads, loading and off-loading areas, and disposal areas would regularly be sprayed with water to control fugitive dust in accordance with a dust and erosion control plan. Equipment and structural surfaces would be sprayed with water during demolition and removal. Perimeter air monitoring for dust and radiological contamination would be established as a part of the Site Monitoring Plan.

Radiological Impacts. Activities associated with this action have the potential to release radiological air emissions. The Department of Energy's Weldon Spring uranium conversion facility was decommissioned in the late 1990s, and the experience from this site is considered to be relevant to the reclamation of the SFC facility. The Weldon Spring site handled materials similar to the materials at the SFC site and used the same solvent extraction process. While the Weldon Spring site was larger and the final disposal volumes were higher than those at the SFC site, reclamation activities at Weldon Spring were conducted using a method similar to that proposed for the SFC site. In addition, the average wind speeds in Weldon Spring, Missouri, are reported to be higher than those in Gore, Oklahoma.

The Weldon Spring site is currently being maintained as a disposal cell. Air sampling (for radon, Rn -220, and radiological particulates) and radiological perimeter monitoring (for gamma radiation) were performed at Weldon Spring during and after remediation. Data reported in the site's Environmental Report in 1997, the year the cell was completed, showed that Department of Energy and CAA regulatory limits had not been exceeded during remediation of the project and the highest receptor activity was below the annual NESHAPSs standards of 0.1 millisievert (10 millirem) (DOE, 1997).

Quarterly isotopic analyses for uranium, thorium, and radium have been conducted at SFC since NRC approved this method to adequately monitor site activities in the license amendment in 1998 (NRC, 1998). Radiological data collected at the fenceline from 2000 to 2006 show that emissions from the site are well below current standards (SFC, 2006c). The results of monitoring performed during previous decommissioning activities at the SFC site, including during placement of soils in the Interim Storage Cell and in the Pond 1 Spoils Pile, were similar to those from the Weldon Spring site (SFC, 2006b). Therefore, it is assumed that impacts at the SFC site during decommissioning would be similar to those of the Weldon Spring site and not exceed regulatory limits. Therefore, radiological air emissions would represent a SMALL direct impact on local air quality.

Following site reclamation, the final conditions at the SFC facility would include maintenance of the administration building and monitoring and site maintenance of the disposal cell and surrounding facilities. The use of vehicles and maintenance equipment during these activities would be minimal and result in SMALL impacts on air quality.

A full description of radiological air emissions (including radon) and potential impacts are included in Section 4.4, Public and Occupational Health.

B.4.2.2 Alternative 2: Off-site Disposal of All Contaminated Materials

The potential air quality impacts of implementing Alternative 2 would be similar to those described above for Alternative 1; however, construction emissions from SFC's proposed reclamation activities would be less. Potential transportation impacts are discussed in Section 4.6, Transportation. Vehicle emissions and fugitive dust would be generated by vehicles operating on the SFC site. Vehicles leaving the SFC site would be thoroughly decontaminated before leaving the SFC site, thereby reducing the potential for fugitive radiological dust to be transported off-site. Air pollution associated with the increase in traffic volumes as a result of this alternative would not be expected to have a significant impact because the number of vehicles involved per day would be relatively small compared to existing road traffic; therefore, their contribution would represent only a SMALL indirect impact on local air quality.

Under this alternative, all wastes designated for disposal in the on-site disposal cell would be packaged and transported to an off-site facility licensed to accept such materials. Following decommissioning of the SFC facility, the site would be graded and seeded. Transportation impacts are discussed in Section 4.5, Transportation. Post-reclamation conditions at the SFC facility would result in SMALL direct impacts on air quality.

B.4.2.2 Alternative 3: Partial Off-site Disposal of Contaminated Materials

The potential air quality impacts from construction under Alternative 3 would be similar to those described above for Alternative 1; however, there would be an increased potential impact from additional transportation of site materials. Transportation impacts are discussed in Section 4.5, Transportation.

Final conditions at the facility under this alternative would be similar to those described for Alternative 1, including maintenance of the administration building and monitoring and site maintenance of the disposal cell and surrounding facilities. During the post-reclamation period, direct impacts on air quality would be SMALL.

B.4.7 No-Action Alternative

Under the no-action alternative, SFC would maintain the site in its current state. SFC would provide limited maintenance of the buildings and surrounding facilities. These activities would require the use of vehicles and maintenance equipment. However, direct impacts on air quality would be SMALL.

B.5 Ecological Resources and Impacts

This section describes the ecological resources on or near the SFC site, including terrestrial resources (vegetation and wildlife); rare, threatened, and endangered species; wetlands; and other environmentally sensitive areas. It also provides an assessment of the potential environmental impacts on these resources as a result of implementation of the proposed action and alternatives.

B.5.1 Affected Environment

The study area for terrestrial resources, wetlands, and environmentally sensitive areas includes the SFC site and the immediately surrounding area. Rare, threatened, and endangered species are evaluated in the context of a larger area encompassing the SFC site and surrounding portions of Sequoyah, Muskogee, and Haskell counties.

Information presented in this section is based on a review of ecological literature (Peterson, 1980; Caire et al., 1989; Choate et al., 1994; American Society of Mammalogists [ASM], 2006; U.S. Fish and Wildlife Service [USFWS], 2006); recent aerial photographs (NAIP, 2003); review of a federal agency database (USFWS, 2007a); correspondence with a state natural resource agency (OBS, 2006); and a site reconnaissance walk-over completed in 2006.

B.5.1.2 Ecological Communities

The SFC site lies in an area where three physiographic provinces converge: the Oak-Hickory Ozark Plateau, the Oak-Hickory-Pine Ouachita Highlands, and the Tall Grass Prairie-Rolling Hills). The vegetative cover in the region consists mostly of hardwood forests, grasslands, and pasturelands (Caire et al., 1989).

Approximately 200 hectares (500 acres) of the SFC site are undeveloped and include a mixture of upland and aquatic habitats. The remaining 40 hectares (100 acres) of the site are developed and largely void of vegetative cover. Ecological communities on the SFC site are described below.

B.5.1.2.1 Upland Habitats

Upland habitats on the SFC site include forestlands, pastureland/hayfields, and open fields. Approximately 60 hectares (150 acres) of forestland are present on the site, primarily along the northern and southern site boundaries. The forestland in the southern portion of the site extends along the eastern site boundary and into part of the Industrial Area. Forestlands on the site are generally secondary-growth oak-hickory forests. This community type is typically located on well-drained upland soils and is dominated by white oak and shagbark hickory.

Pastureland/hayfields cover approximately 80 hectares (200 acres) of the SFC site. A relatively large, contiguous area of pastureland covers approximately 40 hectares (100 acres) along the western site boundary; the remaining pastureland/hayfields are interspersed with the forested areas throughout the remainder of the site. The pasturelands include a mixture of Bermuda grass, rye grass, and fescue.

Open fields cover approximately 20 hectares (50 acres) of the SFC site. This community primarily occurs in small clusters adjacent to the surface water impoundments and over solid waste burial areas. The open fields are dominated by herbaceous vegetation, including ragweed and various species of goldenrod, aster, and grasses.

B.5.1.2.2 Aquatic Habitats

Aquatic habitats on the SFC site include four storm water impoundments within the Process Area; a storm water reservoir; eight man-made farm ponds; an unnamed tributary of the lower Illinois River; and several intermittent drainages that flow to the lower Illinois River. The storm water impoundments, reservoir, and farm ponds on the SFC site provide minimal aquatic habitat because of their isolated and disturbed nature. In contrast, the intermittent stream and drainages would have relatively higher aquatic habitat value because of their connection with the lower Illinois River and linear nature through upland forestlands.

B.5.1.2.3 Wetland Habitats

The USACE Tulsa District examined the SFC site in 2002 and determined that the property contains no jurisdictional wetlands (Hogue, 2002). A recent conversation with the USACE (Davison, 2006) indicated that the 2002 wetland determination remains valid through 2007. Consequently, no jurisdictional wetlands are located on the SFC site.

According to USFWS National Wetlands Inventory (NWI) maps, forested wetlands associated with the lower Illinois River floodplain are located just outside of the western site boundary. Based on a review of recent aerial photographs, these wetlands are bottomland hardwood forests likely comprised of sphagnum moss, rushes, and sedges, with an overstory of water oak, willow oak, and green ash (OCC, 1996).

B.5.1.3 Wildlife

The woodland and pastureland communities on the SFC site provide habitat for a number of wildlife species, many of which would be expected to move between the two habitats. A review of the ecological literature and published surveys indicates that wooded areas on the site likely support various passerine birds such as the Carolina wren, Carolina chickadee, Northern cardinal, wood warbler, and vireo; game birds such as wild turkey; birds of prey such as the Eastern screech owl and barred owl; woodpeckers; and small to large mammals such as the chipmunk, fox squirrel, skunk, gray fox, raccoon, white-tailed deer, and coyote. Pasturelands on the SFC site likely provide habitat for a number of ground-foraging and ground-nesting birds such as the killdeer, horned lark, meadow lark, common bobwhite, and mourning dove; waterfowl such as ducks and geese; and small mammals such as the Eastern cottontail and deer mouse. Birds of prey, including the American kestrel and Red-tailed hawk, likely forage in the pasturelands on the site. Wildlife species in the developed areas on the site are limited to those that tolerate a high degree of human disturbance and managed habitats, including the American robin, European starling, house sparrow, skunk, opossum, and gray squirrel (Peterson, 1980; Caire et al., 1989; Choate et al., 1994; ASM] 2006; USFWS, 2006).

The small size and intermittent flow of the tributary and drainages on the site likely limit the diversity of aquatic species in these habitats. However, some species of amphibians and reptiles likely inhabit these surface waters. The western boundary of the site is less than 1.6 kilometers (1 mile) from the lower Illinois River, which supports populations of largemouth and smallmouth bass, white bass, crappies, catfish, striped bass, bream, and walleye (USFWS, 2006), and possibly some warm-water aquatic invertebrates.

B.5.1.4 Rare, Threatened, and Endangered Species

Endangered and threatened species are protected by the Endangered Species Act (ESA) of 1973. Oklahoma has no endangered species act; however, the Oklahoma Department of Wildlife Conservation (ODWC) can list threatened or endangered wildlife under provisions of state wildlife laws (Okla. Stat. tit. 29, §5-412, 412.1; 7-206).

The Oklahoma Ecological Services Field Office (OESFO) of the USFWS and Oklahoma Biological Survey (OBS) provided data regarding the known occurrences of threatened and endangered species in the vicinity of the SFC site (USFWS, 2007a; OBS, 2006). Databases are maintained by these agencies to track species that are protected by law as well as unprotected species that are identified as species of concern. The OBS tracks species occurrences on a township level, whereas the OESFO provides a species list by county. Table B.5-1 lists the threatened and endangered species identified through the database reviews that potentially occur in the vicinity of the project.

Table B.5-1 Federally and State-Listed Threatened and Endangered Species Identified in the Vicinity of the SFC Site

Species Name	Status	Habitat
American burying beetle	Federally - Endangered Oklahoma - Endangered	Mosaic of vegetation types, from oak-hickory and coniferous forests on lowlands, slopes, and uplands to deciduous riparian corridors and pasturelands in valleys (USFWS, 1991; USFWS, 2005)
Indiana bat	Federally - Endangered Oklahoma - Endangered	Hibernation occurs in limestone caves with stable temperatures of 39 degrees to 49 degrees F. During summer, this species is found under bridges, in old buildings, under tree bark, or in hollow trees. Foraging occurs above small- to medium-sized streams (USFWS, 2007b).
Interior least tern	Federally - Endangered Oklahoma - Endangered	Islands or sandbars along large rivers for nesting. Shallow surface water is preferred for foraging (USFWS, 2007c).
Ozark big-eared bat	Federally - Endangered Oklahoma - Endangered	Hibernation occurs in caves in karst regions dominated by oak-hickory forests. Foraging occurs along forest edges (USFWS, 2007d).
Bald eagle	Federally - Threatened (proposed for delisting) Oklahoma - Threatened	Nesting occurs in large trees or cliffs near waters with abundant fish. Wintering occurs along oceans, rivers, lakes, or in areas where carrion is present (USFWS, 2007e).
Piping plover	Federally - Threatened Oklahoma - Threatened	Nesting occurs on sandy beaches along the ocean or lakes and on bare areas of islands or sandbars (USFWS, 2007f).
Whooping crane	Federally - Endangered Oklahoma - Endangered	Marshes and prairie potholes in the summer; coastal marshes and prairies in the winter (USFWS, 2007g)

Based on this information, habitat does not exist on the SFC site to support nesting, hibernating, or foraging populations of Indiana bat, interior least tern, Ozark big-eared bat, bald eagle, piping plover, or whooping crane. The interior least tern is commonly present in the summer and the bald eagle is commonly present in the fall and winter in the vicinity of the SFC site on the Sequoyah NWR. The piping plover is occasionally sighted on the refuge in spring and fall (USFWS, 2007h).

Since 1995, confirmed sightings of the American burying beetle have been documented in Sequoyah, Muskogee, and Haskell counties (USFWS, 2007h). A population of this species is also known to occur in proximity to the SFC site on the Sequoyah NWR (USFWS, 2005). While the American burying beetle has been found within a variety of vegetation types in Oklahoma, sites where this species have been captured generally had the following common characteristics: well-drained, sandy-loam and silt-loam soils; level topography; and a well-formed detritus layer (USFWS, 2005).

Some of the undeveloped forestlands and pasturelands on the SFC site are underlain by moderately to well-drained sandy-loam soils and are characterized by level to gently rolling topography. These areas could potentially support populations of American burying beetle based on the species' habitat requirements described above and the proximity of the site to a known population on Sequoyah NWR.

B.5.1.5 Environmentally Sensitive Areas

The Sequoyah NWR is located approximately 1.6 kilometers (1 mile) south of the SFC site (see Figure 1.2-2). Approximately half of the 20,800 acres encompassing the refuge is aquatic habitat that includes an open water reservoir, the Arkansas and Canadian Rivers, an oxbow lake, wooded slough, and wetlands. The remaining habitat consists of agricultural lands, bottomland hardwoods, river bluffs, and scrub-shrub grasslands. The refuge supports high numbers of migratory waterfowl during winter and a population of nesting bald eagles (USFWS, 2006).

The potential impacts of SFC's site preparation, construction activities, and post-reclamation activities on ecological resources are described below for each of the project alternatives.

B.5.2 Ecological Resources Impacts

B.5.2.1 Alternative 1: On-site Disposal of Contaminated Materials (the Licensee's Proposed Action)

SFC's site preparation and construction of the disposal cell would take place within the Process Area next to existing structures. This portion of the SFC site is largely void of vegetation cover, the only exceptions being the area designated as the North Ditch and the area adjacent to the Emergency Basin. The vegetation community in these areas is primarily open field, with an isolated area of emergent wetland vegetation present in the North Ditch. Construction of the disposal cell would remove approximately 0.8 hectare (2 acres) of open field habitat. Given the small area and previously disturbed nature of the affected habitats, this direct impact on ecological communities would be considered SMALL.

Construction activities would occur 1.6 kilometers (1 mile) or less from the lower Illinois River and a tributary of this water body. Site preparation and construction activities within the Process Area would result in temporary increases in erosion and sedimentation during the construction period. The runoff, if not controlled, could eventually enter the tributary and/or lower Illinois River, although the distance between the construction areas and water bodies would likely be sufficient to significantly reduce the amount of sediment that would enter these water bodies. In addition, SFC would implement various best management practices during site preparation and construction to control erosion and manage storm water runoff. Consequently, site preparation and construction activities associated with the proposed action would have SMALL direct and indirect effects on aquatic habitats.

As discussed in Section B.5.1.3, no jurisdictional wetlands are located on the SFC site. Therefore, site preparation and construction activities would have no direct effects on wetlands. Potential indirect impacts on off-site wetlands associated with erosion and sedimentation would be avoided through implementation of various best management practices during site preparation and construction. Therefore, the impacts on wetlands would be SMALL.

Some wildlife species likely use the open field habitats in the Process Area; however, overall species numbers and diversity are likely low based on the disturbed nature of these areas and their proximity to developed land. Most wildlife in these habitats would relocate to nearby suitable habitat during construction activities, thereby avoiding direct impacts. However, less mobile species, such as small reptiles and mammals, could be impacted. Due to the limited diversity of wildlife species and small area disturbed, the potential direct impacts on these less mobile species would be considered SMALL.

Wildlife in woodland and pastureland areas adjacent to the Process Area would be intermittently disturbed by construction activity and noise over the 3- to 4-year period when the proposed action is implemented. Although noise levels would be relatively low outside the immediate area of construction, the combination of construction noise and human activity would likely displace small numbers of animals that forage, feed, nest, rest, or den in adjacent woodlands and pasturelands. Because wildlife in the area is likely already acclimated to a certain amount of disturbance from current activities on the site and because most displaced species would likely return to the area following the disturbance, indirect noise impacts on local wildlife would be considered SMALL.

Site preparation and construction activities would not impact any habitats potentially used by the federally and state-listed Indiana bat, interior least tern, Ozark big-eared bat, bald eagle, piping plover, or whooping crane. Because of the distance of the work area from the Sequoyah NWR, construction noise would not indirectly affect any populations of piping plover, interior least tern, or bald eagle that occur in the refuge in the vicinity of the site. Consequently, site preparation and construction associated with the proposed action would have SMALL impacts on these federally and state-listed species.

Suitable habitat exists on the SFC site that could potentially support populations of the federally and state-listed endangered American burying beetle. If present, this species would most likely occur in the larger tracts of forestland and pastureland on the site, as opposed to within the Process Area in proximity to developed areas (USFWS, 2005). Consequently, site preparation and construction associated with the proposed action is not likely to adversely affect the American burying beetle and potential impacts would be SMALL. All construction activities associated with Alternative 1 would be located within the Process Area, which is located approximately 5 kilometers (3 miles) north of the Sequoyah NWR boundary. This distance would provide a suitable buffer such that SMALL or no direct or indirect effects on wildlife or visitors to the refuge would be expected from construction activities on the SFC site.

Following site reclamation, SFC would grade and seed much of the former Process Area with native grasses and wildflowers as part of the site restoration. This in turn would provide up to approximately 34 hectares (85 acres) of additional habitat for some wildlife species in the area. Potential exposures of wildlife to radiological and nonradiological contaminants would be reduced because sediments, sludges, and soils containing contaminants would be isolated in the disposal cell.

B.5.2.2 Alternative 2: Off-site Disposal of All Contaminated Materials

SFC's construction and demolition activities associated with the removal of contaminated materials would occur within the Process Area and along the proposed 2.6-kilometer (1.6-mile) -long new railroad spur. Since the Process Area is largely void of vegetative cover, any direct impacts on ecological communities from site preparation and construction in this area under Alternative 2 would be SMALL.

The proposed railroad spur would traverse an undeveloped area comprising a mix of pastureland/hayfield and forestland. Based on a review of recent aerial photographs (NAIP, 2003), the pastureland/hayfield community covers approximately 1.6 kilometers (1 mile), or 63%, of the route, while forestland covers approximately 1 kilometer (0.6 mile), or 27%, of the route. The forestland along the route is contiguous with the forestland on the main SFC site and so is expected to be characterized as secondary growth oak-hickory forest.

It has been estimated that the rail spur would be constructed within an approximately 30-meter (100-foot) -wide construction right of way (ROW). Establishment of this ROW would result in temporary disturbance impacts on approximately 5 hectares (12 acres) of pastureland/hayfield and temporary removal of approximately 3 hectares (7 acres) of forestland. The rail spur would occupy an approximately 12-meter (40-foot) -wide permanently maintained ROW. Establishment of this ROW would result in the permanent removal of approximately 2 hectares (5 acres) of pastureland/hayfield and 1 hectare (2.5 acres) of forestland. Both ecological communities that would be directly affected are common throughout the local area and are currently traversed by numerous roads and existing railroad lines. Consequently, the temporary and permanent impacts on the pastureland/hayfield and forestland ecological communities associated with construction and operation of the rail spur under Alternative 2 would be considered SMALL.

SFC's construction activities within the Process Area would occur 1.6 kilometers (1 mile) or less from the Lower Illinois River and a tributary of this water body. Site preparation and construction activities within this area would result in temporary increases in erosion and sedimentation during the construction period. The runoff, if not controlled, could eventually enter the tributary and/or Lower Illinois River, although the distance between the construction areas and water bodies would likely be sufficient to significantly reduce the amount of sediment that would enter these water bodies. In addition, SFC would implement various best management practices during site preparation and construction to control erosion and manage storm water runoff. Consequently, site preparation and construction associated with Alternative

2 would have SMALL impacts on the aquatic habitats associated with the Lower Illinois River and its tributary.

The railroad spur would cross two intermittent tributaries to Salt Branch, which is an intermittent tributary of the Lower Illinois River. Based on their small size and intermittent flow, neither of these tributaries would be expected to support a diverse aquatic community. During construction, aquatic habitats in these streams would be directly affected by increased erosion and sedimentation; however, this impact would be minimized through the use of various best management practices. Culverts would be installed in both streams to maintain the flow of water following installation of the railroad spur. This, in turn, may result in the permanent loss of less than 0.2 hectare (0.5 acre) of natural aquatic habitat. Based on the small area affected and lack of aquatic habitat diversity in both streams, this direct impact would be considered SMALL.

As discussed in Section B.5.1.3, no jurisdictional wetlands are located on the SFC site. Therefore, site preparation and construction activities within the Process Area under Alternative 2 would have SMALL impacts on wetlands. Potential indirect impacts on off-site wetlands associated with erosion and sedimentation would be avoided through implementation of various best management practices during site preparation and construction.

No NWI wetlands or hydric soils are mapped along the route of the proposed railroad spur (see Figure B.5-1) (note: the presence of hydric soils is used as an indicator to evaluate the potential occurrence of wetlands in a given area). Consequently, construction and operation of the railroad spur under Alternative 2 would not be expected to have any direct or indirect affects on wetlands. However, if Alternative 2 is selected as the preferred alternative, a field survey would be conducted prior to construction to document the absence of wetlands within the railroad spur corridor. Depending on the results of the field investigation, follow-up consultation with the USACE Tulsa District may be necessary to comply with Section 404 wetland permitting requirements.

Some wildlife species likely use the open field habitats in the Process Area; however, overall species numbers and diversity are likely low based on the disturbed nature of these areas and their proximity to developed land. Various mammals, amphibians, reptiles, and bird species likely use the pastureland/hayfield and forestland habitats along the rail spur corridor. Most wildlife in all construction areas would relocate to adjacent suitable habitat during construction activities, thereby avoiding any direct impacts. However, less mobile species such as small reptiles and mammals could be impacted. Due to the limited diversity of wildlife in the Process Area and the relatively small area that would be disturbed for construction of the railroad spur, the potential direct impacts on these less mobile species would be considered SMALL.

Wildlife in woodland and pastureland areas adjacent to the Process Area and railroad spur corridor would be intermittently disturbed by construction activity and noise over the 3- to 4-year period when Alternative 2 is implemented. Although noise levels would be relatively low outside the immediate area of construction, the combination of construction noise and human activity would likely displace small numbers of animals that forage, feed, nest, rest, or den in adjacent woodlands and pasturelands. Because wildlife in the area is likely already acclimated to a certain amount of disturbance from current activities on the site and because most displaced species would likely return to the area following the disturbance, indirect noise impacts on local wildlife would be considered SMALL.

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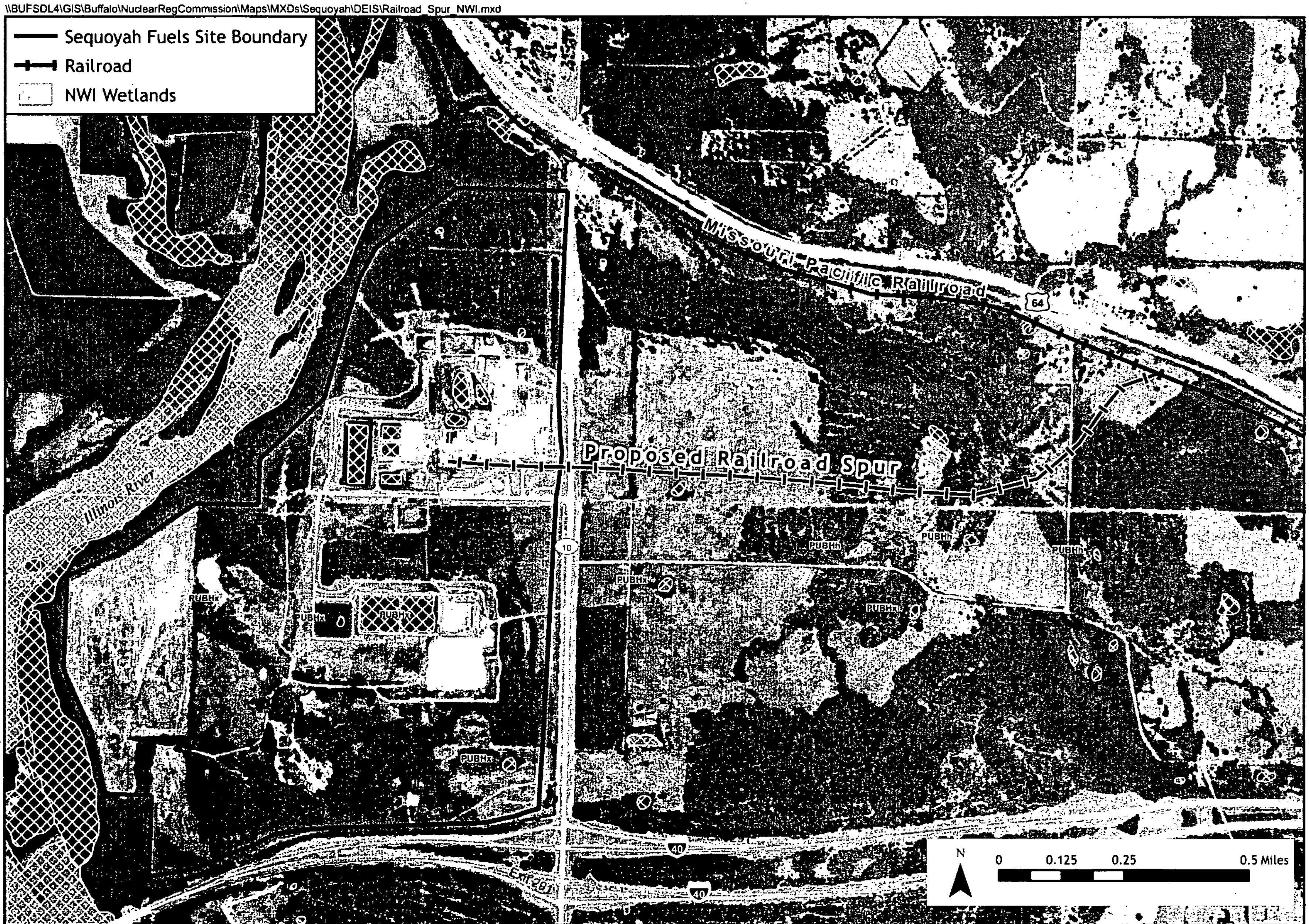

Figure B.5-1 Rail Spur and USFWS National Wetland Inventory

SFC's site preparation and construction activities would not impact any habitats potentially used by the federally and state-listed Indiana bat, interior least tern, Ozark big-eared bat, bald eagle, piping plover, or whooping crane. Because of the distance of the work area from the Sequoyah NWR, construction noise would not indirectly affect any populations of piping plover, interior least tern, or bald eagle that occur on the refuge in the vicinity of the site. Consequently, site preparation and construction associated with Alternative 2 would have SMALL or no effect on these federally and state-listed species.

Much of the proposed railroad spur corridor would cross land that is considered potentially suitable habitat for the federally and state-listed endangered American burying beetle. Specifically, the railroad spur would cross secondary growth forests and open field habitats on level to gently sloping terrain underlain by loam soils. As discussed in Section B.5.1.3, populations of American burying beetle have been found in Oklahoma on sites with similar habitat features. If Alternative 2 is selected as the preferred alternative, a project evaluation would be completed with USFWS prior to construction in accordance with Section 7 of the ESA. Following this initial evaluation, a pre-construction field survey may be required to determine whether American burying beetle populations are present within the railroad spur construction ROW. Depending on the results of the survey, additional consultation with the USFWS may be required to comply with Section 7 permitting requirements.

All construction activities associated with Alternative 2 would be at least 5 kilometers (3 miles) north of the Sequoyah NWR boundary. This distance would provide a suitable buffer such that SMALL impacts on wildlife or visitors to the refuge would be expected from construction activities on the SFC site.

Under the off-site disposal alternative, SFC would excavate and remove from the Process Area all contaminated soil, equipment, and structures. After removal, SFC would backfill and revegetate all the affected areas. Restoration of the Process Area would result in up to approximately 34 hectares (85 acres) of new herbaceous habitat in an area mostly void of vegetative cover. This in turn would provide additional habitat for some wildlife species in the area. In addition, potential exposures of wildlife to radiological and nonradiological contaminants would be reduced because sediments, sludges, and soils containing contaminants would be transported off-site.

B.5.2.3 Alternative 3: Partial Off-site Disposal of Contaminated Materials

SFC's construction activities associated with the partial off-site disposal alternative would occur within the Process Area. Since the Process Area is largely void of vegetative cover, any direct impacts on ecological communities from site preparation and construction in this area under Alternative 3 would be SMALL.

Construction activities would occur 1.6 kilometers (1 mile) or less from the Lower Illinois River and a tributary of this water body. Site preparation and construction activities within the Process Area would result in temporary increases in erosion and sedimentation during the construction period. The runoff, if not controlled, could eventually enter the tributary and/or Lower Illinois River, although the distance between the construction areas and water bodies would likely be sufficient to significantly reduce the amount of sediment that would enter these water bodies. In addition, SFC would implement various best management practices during site preparation and construction to control erosion and manage storm water runoff. Consequently, site preparation and construction associated with the proposed action would have SMALL impacts on aquatic habitats.

As discussed in Section B.5.1.3, no jurisdictional wetlands are located on the SFC site. Therefore, site preparation and construction activities would have no direct effects on wetlands. Potential indirect impacts on off-site wetlands associated with erosion and sedimentation would be avoided through implementation of various best management practices during site preparation and construction.

Some wildlife species likely use the open field habitats in the Process Area; however, overall species numbers and diversity are likely low based on the disturbed nature of these areas and their proximity to developed land. Most wildlife in these habitats would relocate to nearby suitable habitat during construction activities, thereby avoiding direct impacts. However, less mobile species such as small reptiles and mammals could be impacted. Due to the limited diversity of wildlife species and small area disturbed, the potential direct impacts on these less mobile species would be considered SMALL.

Wildlife in woodland and pastureland areas adjacent to the Process Area would be intermittently disturbed by construction activity and noise over the 3- to 4-year period when the proposed action is implemented. Although noise levels would be relatively low outside the immediate area of construction, the combination of construction noise and human activity would likely displace small numbers of animals that forage, feed, nest, rest, or den in adjacent woodlands and pasturelands. Because wildlife in the area is likely already acclimated to a certain amount of disturbance from current activities on the site and because most displaced species would likely return to the area following the disturbance, indirect noise impacts on local wildlife would be considered SMALL.

SFC's site preparation and construction activities would not impact any habitats potentially used by the federally and state-listed Indiana bat, interior least tern, Ozark big-eared bat, bald eagle, piping plover, or whooping crane. Because of the distance of the work area from the Sequoyah NWR, construction noise would not indirectly affect any populations of piping plover, interior least tern, or bald eagle that occur on the refuge in the vicinity of the site. Consequently, site preparation and construction associated with the proposed action would have no effect on these federally and state-listed species.

Suitable habitat exists on the SFC site that could potentially support populations of the federally and state-listed endangered American burying beetle. If present, this species would most likely occur in the larger tracts of forestland and pastureland on the site, as opposed to within the Process Area in proximity to developed areas (USFWS 2005). Consequently, site preparation and construction associated with the proposed action is not likely to adversely affect the American burying beetle. All of SFC's construction activities associated with Alternative 3 would be located within the Process Area, which is located approximately 5 kilometers (3 miles) north of the Sequoyah NWR boundary. This distance would provide a suitable buffer such that no direct or indirect effects on wildlife or visitors to the refuge would be expected from construction activities on the SFC site.

Under the partial off-site disposal alternative, SFC would excavate and remove from the Process Area all contaminated soil, equipment, and structures to be placed in the on-site disposal cell. After removal, SFC would backfill and revegetate all the affected areas. Restoration of the

Process Area in areas not covered by the disposal cell would result in up to approximately 34 hectares (85 acres) of new herbaceous habitat in an area mostly void of vegetative cover. This in turn would provide additional habitat for some wildlife species in the area.

Potential exposures of wildlife to radiological and nonradiological contaminants would be reduced because sediments, sludges, and soils containing contaminants would be isolated in the disposal cell.

B.5.2.4 No-Action Alternative

Under the no-action alternative, there would be no change in the current level of disturbance associated with surveillance and monitoring activities. Vegetation and wildlife would not be affected because there would be no construction activities or removal of equipment or buildings. However, no additional habitat areas would be created. Therefore, the impacts on ecological resources would be SMALL.

B.6 Socioeconomic Conditions and Impacts

B.6.1 Affected Environment

The SFC site is located in a largely rural area with generally low population density. This section provides population and employment statistics for the surrounding municipalities that could potentially be impacted by the implementation of the proposed action or alternative actions for site reclamation.

B.6.1.1 Population

The SFC site is located in Sequoyah County, Oklahoma, which has a population of 38,972 according to the 2000 U.S. census (U.S. Bureau of the Census, 2000). The study area defined for the SFC site comprises Sequoyah County and the adjacent counties of Cherokee, Haskell, McIntosh, and Muskogee. The boundaries of the study area were determined based upon the estimated commuting area for the site (see Figure B.6-1). In 2000 the total population for the entire study area was 182,192 (see Table B.6-1). These counties experienced an 11% total increase in population from 1990 to 2000, compared with a 25% increase for the entire state of Oklahoma during the same period (U.S. Bureau of the Census, 2000).

Table B.6-1 Historic Population in the Study Area

Area	1990	2000	% Change
Cherokee County	34,049	42,521	25%
Haskell County	10,940	11,792	8%
McIntosh County	16,779	19,456	16%
Muskogee County	68,078	69,451	2%
Sequoyah County	33,828	38,972	15%
Study Area Total	163,674	182,192	11%

Source: U.S. Bureau of the Census, 2000

Specific population centers located within the study area include the towns of Gore, Vian, Warner, and Webber Falls, and the city of Muskogee. These are all located within 40.2 kilometers (25 miles) of the SFC site.

The town closest to the SFC facility is Gore, which is approximately 4 kilometers (2.5 miles) away. The population of Gore in 2000 was 850, which represents a 20% increase from 1990. The largest population center in the study area is the city of Muskogee, located approximately 40.2 kilometers (25 miles) northwest of the site in Muskogee County. The city of Muskogee had 38,317 people in 2000, which comprised more than half of the total population of the County of Muskogee (U.S. Bureau of the Census, 2000). Table B.6-2 shows the populations of towns near the SFC site in 1990 and 2000.

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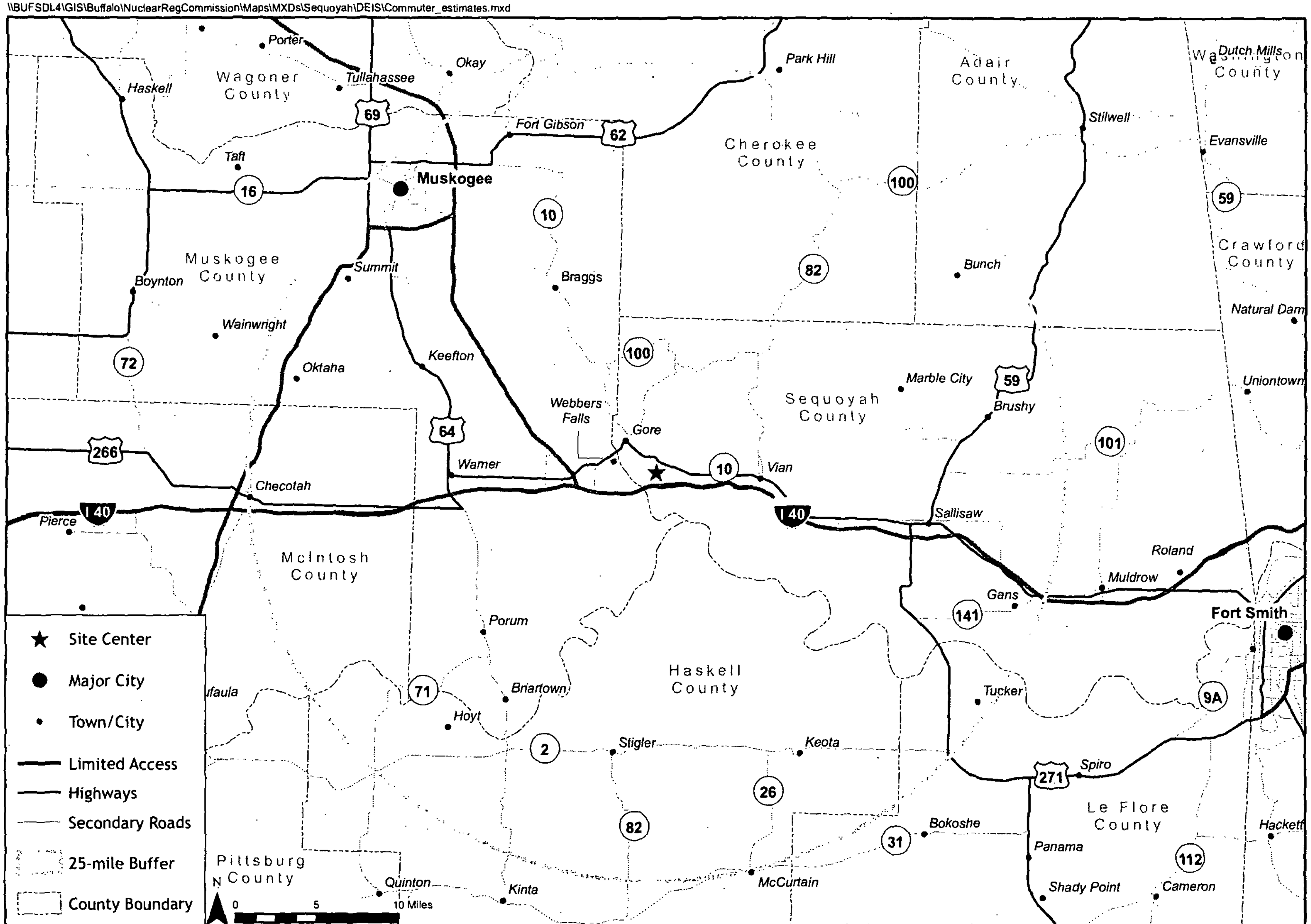

Source: ESRI, 2006

Figure B.6-1 Socioeconomic Study Area

Table B.6-2 Population Centers Near the SFC Facility

Population Center	1990	2000	% Change
Gore	710	850	20%
Muskogee	37,708	38,317	2%
Vian	1,367	1,362	<1%
Warner	1,462	1,430	-2%
Webber Falls	767	726	-5%

Source: U.S. Bureau of the Census, 2000

The majority of the population in Sequoyah County is white (68%), which is consistent with the entire State of Oklahoma. Among the 77 counties in Oklahoma, Sequoyah County has the fifth highest percentage of American Indian residents (20% of the total population) (U.S. Bureau of the Census 2000). Table B.6-3 shows the racial composition of the population of Sequoyah County in 2000. The large American Indian population is primarily due to the presence of the Cherokee Nation in Tahlequah, Oklahoma, which is located approximately 80.4 kilometers (50 miles) northeast of Gore, Oklahoma. The Cherokee people populate the entire region, with concentrations in Cherokee and Sequoyah counties.

Table B.6-3 Population of Sequoyah County by Race in 2000

Race	Persons	% of Total
White	26,548	68%
American Indian	7,654	20%
Black or African American	725	2%
Other (includes Asian, Native Hawaiian, other, and two or more races)	4,045	10%
Total Population of Sequoyah County	38,972	100%

Source: U.S. Bureau of the Census, 2000

Appendix B.7, Environmental Justice, describes the distribution of minority and low-income populations in the vicinity of the SFC site.

B.6.1.2 Employment

The industries employing the highest percentage of people in the study area are retail trade, manufacturing, education, health care, and social assistance. Unemployment rates within the study area range from 4.7% (Haskell County) to 8.2% (Cherokee County), with an average of 7.0% (U.S. Bureau of the Census, 2000). The total labor force is 78,252, with 5,516 people unemployed throughout the study area.

Six individuals are currently employed at the SFC site to perform routine maintenance and surveillance. It is assumed that these individuals live in the general vicinity of the SFC site (primarily the study area described above) and commute to work on a daily basis. Additional personnel are brought in as needed to support special activities or work projects (SFC, 2001).

B.6.2 Population and Employment Impacts

This section presents the potential direct and indirect impacts on socioeconomics that would result from the implementation of each alternative.

B.6.2.1 Alternative 1: On-Site Disposal of Contaminated Materials (the Licensee's Proposed Action)

Under this alternative, SFC projects that the local population will be increased by approximately 72 workers during the peak level of activity, which would be the first two years of reclamation activities (SFC, 2001). The type of manpower projected under Alternative 1 would include the management team, cell closure workers, health and safety technicians, equipment operators, truck drivers, welders and riggers, and general laborers.

The overall number of short-term workers that would be needed is small compared with the total labor force of the study area (i.e., 72 short-term workers divided by 78,252 workers in the local labor force (from Section B.6.2) equals a less than 1%). The majority of the workers would be drawn from the local labor force, while the balance would consist of specialty contractors that would reside in hotels during construction. Thus, there would be a SMALL short-term, direct impact on the population, but there would be no permanent population impacts under this alternative.

Appendix B.7 describes any foreseeable impacts of Alternative 1 on minority and/or low-income populations in the vicinity of the SFC site.

Once site reclamation is completed, the NRC would terminate the SFC's source material license and the State of Oklahoma or the United States would take control of the area within a proposed 131-hectare (324 acre) ICB. The remaining 112 hectares (276 acres) would be released for unrestricted use. The short-term socioeconomic impacts after reclamation of the SFC site and prior to reuse would be SMALL. Following reclamation and until reuse of the property released for unrestricted use (131 hectares [324 acres]), there would be no commercial activity and the impacts would be SMALL.

B.6.2.2 Alternative 2: Off-Site Disposal of All Contaminated Materials

For the off-site disposal alternative, SFC projects a peak requirement of 73 workers during the first two years of reclamation activities (SFC, 2001). The overall number of short-term workers that would be needed is less than 1% of the local labor force. The majority of the workers would be drawn from the local labor force, while the balance would consist of specialty contractors who would reside in hotels during construction. Thus, it is estimated there would be a SMALL impact on the local permanent population during implementation of this alternative. The off-site disposal alternative is similar to the on-site disposal alternative in that there would be a short-term, direct impact on the population, but there would be no permanent population impacts.

Appendix B.7 describes any foreseeable impacts of Alternative 2 on minority and/or low-income populations in the vicinity of the SFC site.

Once the contaminated materials have been transported from the SFC site, the NRC would terminate the SFC's source material license and the entire site (approximately 243 hectares [600 acres]) would be released for unrestricted use. The short-term socioeconomic impacts of post-reclamation conditions until reuse of the property would be SMALL. Following reclamation and until reuse of the property released for unrestricted use (243 hectares [600 acres]), there would be no commercial activity and the socioeconomic impacts would be SMALL.

B.6.2.3 Alternative 3: Partial Off-Site Disposal of Contaminated Materials

For the partial off-site disposal alternative, SFC projects an increase of approximately 96 workers during peak activity associated with construction of the on-site disposal cell. Of these 96 workers, 18 will be off-site truck drivers responsible for transportation of contaminated waste for disposal who may or may not live in the immediate vicinity of the SFC site. Thus, the true number of on-site workers would be closer to 78 during peak reclamation activities, which would occur during the first two years.

The number of short-term workers (approximately 96) required for both on-site cell construction and off-site transportation would represent less than 1% of the total local labor force. Therefore, there would be short-term, direct impacts from construction of the on-site disposal cell and the transportation of contaminated materials.

Appendix B.7 describes any foreseeable impacts of Alternative 3 on minority and/or low-income populations in the vicinity of the SFC site.

Once site reclamation has been completed, the NRC would terminate the SFC's source material license, and the Department of Energy would take control of the area within the 131-hectare (324 acre) ICB. The remaining 112 hectares (276 acres) would be released for unrestricted use. The short-term socioeconomic impacts of post-reclamation conditions until reuse of the property would be SMALL. Following reclamation and until reuse of the property released for unrestricted use (131 hectares [324 acres]), there would be no commercial activity and the socioeconomic impacts would be SMALL.

B.6.2.4 No-Action Alternative

Under the no-action alternative, there will be no change to the existing management system and no change in the operations or employment at the SFC site. The lack of any change in employment would result in no change in the overall population of the study area and the impact would be SMALL.

B.7 Environmental Justice

> **Executive Order 12898:**
> Environmental justice is described, in essence, as "disproportionately high and adverse human health or environmental effects of . . . programs, policies, and activities on minority populations and low-income populations."

Consistent with NUREG -1748, the demographics of the SFC site were reviewed with respect to environmental justice concerns. Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, was issued by President Clinton in 1994. This Executive Order directs all federal agencies to develop strategies for considering environmental justice in their programs, policies, and activities.

On December 10, 1997, the CEQ issued *Environmental Justice Guidance Under the National Environmental Policy Act* (CEQ, 1997). The NRC considered the CEQ's guidance in developing guidance for the Federal and State Materials and Environmental Management Program on conducting environmental justice reviews (Appendix B of NUREG-1748).

For the purpose of this analysis, a minority is defined as members of the following population groups: Black or African American (non-Hispanic), American Indian or Alaska Native (non-Hispanic), Asian (non-Hispanic), Native Hawaiian or other Pacific Islander (non-Hispanic), some other race (non-Hispanic), two or more races (non-Hispanic), and Hispanic or Latino (of any race). Low income is defined as being below the poverty level as defined by the U.S. Census Bureau.

If a facility is located outside the city limits or in a rural area, NUREG-1748 recommends that all geographic units (in this case, census tracts) within or partially within a 50-mile radius should be evaluated. However, the guidance is flexible with regard to the zone of potential impacts as long as the geographic area encompasses all of the alternative sites. This analysis only includes one geographic site (the SFC site). In addition, there are no LARGE impacts associated with any of the proposed alternatives (with the exception of the no-action alternative) that would help to define an appropriate EJ analysis study area. In fact, with the exception of transportation impacts for Alternatives 2 and 3, all potential environmental impacts are geographically restricted to the region surrounding the SFC site. Potential transportation impacts are characterized as SMALL and are limited to the transportation route. It is for these reasons that this analysis utilizes a 25-mile radius study area. Furthermore, this study area will include those communities that would have the greatest potential to be affected by the impacts of the proposed action. This 25-mile study area encompasses portions of seven counties and includes the closest city with a significant population (Muskogee).

In conducting this environmental justice analysis, the percentage of minority population and low-income populations was compared with state and county percentages. According to NUREG-1748, if the study area percentages significantly exceed county/state percentages (i.e., by more than 20 percentage points) or exceed 50%, environmental justice "should be considered in greater detail." If neither criterion is met, no further evaluation is necessary unless additional relevant information is discovered during scoping.

B.7.1 Minority Populations

Table B.7-1 describes the racial distribution in the census tracts within 25 miles of the SFC site, which is located in Sequoyah County, Oklahoma. Figure B.7-1 identifies census tracts within a 25-mile radius of the SFC site. As shown on the figure, the 25-mile radius also encompasses portions of Cherokee and Adair counties to the north; Haskell County and the northwestern tip of Le Flore County to the south; and Muskogee and McIntosh counties to the northwest and west. A small portion (approximately 5.2 square kilometers [2 square miles]) of one census tract in Wagoneer County is encompassed by the 25-mile boundary but was excluded from the analysis due to the small size (see Figure B.7-1).

As shown in the table, the majority of the 34 census tracts within 25 miles of the site do not present an environmental justice concern with regard to race or ethnicity. Minority populations in most census tracts do not exceed 50% and are not 20 percentage points higher than in their respective counties. There are no census tracts where the population of American Indian and Alaska Natives exceed 50% of the county/state populations. The county with the highest percentage of American Indian and Alaska Native population is Adair County. This county is located to the northeast of the SFC site, approximately 32 kilometers (20 miles) from the Lower Ilinois River, which is significantly upgradient of all potential impacts of the proposed action.

As shown in Table B.7-1, four census tracts require further evaluation due to the fact that minority populations exceed 50% of state/county populations. These census tracts are in Muskogee County (tracts 3, 4, and 6) and Adair County (tract 9768). A more detailed analysis of these census tracts is presented in Section B.7.3.

B.7.2 Low-income Populations

Table B.7-2 describes the poverty status of persons living within 25 miles of the SFC site. As shown in the table, median household incomes were similar among the counties within 25 miles of the site. Poverty rates were generally similar among the counties and were not significantly higher in the census tracts compared with their respective counties, with the exception of one tract. None of the census tracts or counties had poverty rates that exceeded 50%. A more detailed analysis of census tract 2 in Muskogee County is presented in Section B.7.3.

B.7.3 Examination of Potential Minority and Low-Income Census Tracts

Minority Status

Muskogee County census tracts 3, 4, and 6 have minority populations (Black/African American) that exceed 50% of the total population at 66.8%, 68.5%, and 54.2%, respectively (see Table B.7-1). Census tracts 3 and 4 are a significant 30 percentage points above the county minority population. However, these tracts are nearly 25 miles to the northwest of the site, and the proposed reclamation of the site by SFC would not be expected to affect populations in these areas.

Table B.7-1 Preliminary Screening for Minority Status

State/County/ Census Tract	Total Population	Percent Non-white	Percent Hispanic	White Alone	Non-White	Black or African American Alone	American Indian and Alaska Native Alone	Asian Alone	Native Hawaiian and Other Pacific Islander Alone	Some Other Race Alone	Two or More Races
State of Oklahoma	**3,450,654**	**23.9**	**5.2**	**2,624,679**	**825,975**	**258,532**	**266,801**	**45,546**	**1,840**	**84,830**	**168,426**
Sequoyah County	**38,972**	**32.0**	**2.0**	**26,510**	**12,462**	**613**	**7,913**	**68**	**15**	**250**	**3,603**
Tract 303.01	4,291	42.4	1.4	2,473	1,818	32	1,200	0	5	15	566
Tract 301.02	8,421	30.3	2.3	5,873	2,548	269	1,480	17	7	84	691
Tract 302.01	2,794	30.8	1.2	1,934	860	16	553	0	0	11	280
Tract 302.02	5,335	37.3	1.5	3,346	1,989	116	1,416	10	0	12	435
Tract 303	8,426	31.2	2.4	5,800	2,626	65	1,766	34	3	47	711
Tract 304.01	3,553	23.0	1.2	2,736	817	24	561	2	0	23	207
Muskogee County	**69,451**	**36.3**	**2.7**	**44,210**	**25,241**	**8,958**	**10,284**	**351**	**8**	**939**	**4,701**
Tract 1	4,812	44.6	3.0	2,667	2,145	1,254	546	0	0	93	252
Tract 2	1,892	65.4	1.7	654	1,238	1,044	162	0	0	0	32
Tract 3	3,483	66.8	2.8	1,155	2,328	1,837	251	19	0	12	209
Tract 4	1,806	68.5	6.3	569	1,237	834	156	0	0	113	134
Tract 6	1,878	54.2	5.1	861	1,017	546	245	0	0	126	100
Tract 7	5,252	32.2	6.4	3,563	1,689	225	985	13	0	157	309
Tract 8	7,358	23.8	2.1	5,608	1,750	262	851	119	0	61	457
Tract 9	5,232	28.2	3.3	3,759	1,473	167	954	9	0	32	311
Tract 10	4,414	33.6	1.4	2,932	1,482	541	319	46	0	33	543
Tract 11	3,667	32.2	1.4	2,486	1,181	347	597	3	0	7	227
Tract 12	5,424	41.2	1.7	3,188	2,236	1,152	638	92	7	30	317
Tract 13	6,321	27.1	1.9	4,605	1,716	60	1,070	12	0	88	486
Tract 14	7,207	29.9	3.4	5,055	2,152	74	1,391	17	0	112	558
Tract 15	6,423	34.4	1.4	4,215	2,208	86	1,596	21	1	57	447
Haskell County	**11,792**	**20.7**	**1.5**	**9,348**	**2,444**	**92**	**1,615**	**21**	**8**	**27**	**681**
Tract 9791	1,893	17.3	2.4	1,566	327	0	251	9	0	3	64
Tract 9792	4,243	18.9	2.3	3,440	803	5	586	10	8	6	188
Tract 9793	3,329	23.9	0.5	2,534	795	81	464	2	0	2	246
Tract 9794	2,327	22.3	0.7	1,808	519	6	314	0	0	16	183

Table B.7-1 Preliminary Screening for Minority Status

State/County/ Census Tract	Total Population	Percent Non-white	Percent Hispanic	White Alone	Non-White	Black or African American Alone	American Indian and Alaska Native Alone	Asian Alone	Native Hawaiian and Other Pacific Islander Alone	Some Other Race Alone	Two or More Races
Adair County	**21,038**	**51.7**	**3.1**	**10,167**	**10,871**	**22**	**9,023**	**4**	**16**	**249**	**1,557**
Tract 9768	4,531	59.7	1.7	1,827	2,704	0	2,305	0	11	28	360
McIntosh County	**19,456**	**27.7**	**1.3**	**14,071**	**5,385**	**734**	**2,984**	**26**	**17**	**67**	**1,557**
Tract 9796	4,335	23.7	1.5	3,306	1,029	92	494	0	0	35	408
Tract 9797	3,748	30.9	1.2	2,589	1,159	246	533	0	0	4	376
Tract 9803	3,191	17.4	1.2	2,636	555	16	359	6	0	6	168
Cherokee County	**42,521**	**43.8**	**4.1**	**23,908**	**18,613**	**403**	**13,534**	**87**	**0**	**1,010**	**3,579**
Tract 9777	5,603	38.2	2.4	3,464	2,139	44	1,696	5	0	56	338
Tract 9778	4,690	48.6	3.7	2,409	2,281	33	1,624	0	0	122	502
Tract 9782	5,631	47.4	1.7	2,963	2,668	13	2,130	0	0	44	481
Tract 9783	5,704	45.5	3.0	3,110	2,594	15	1,950	8	0	54	567
LeFlore County	**48,109**	**20.0**	**3.8**	**38,479**	**9,630**	**909**	**5,166**	**118**	**10**	**921**	**2,506**
Tract 402.98	8,008	21.4	1.7	6,297	1,711	469	551	0	0	71	620
Tract 403.01	5,234	16.7	1.5	4,359	875	2	545	33	0	26	269

Source: U.S. Bureau of the Census, 2000.

Note: Shaded rows identify census tracts with a 50+% minority population.

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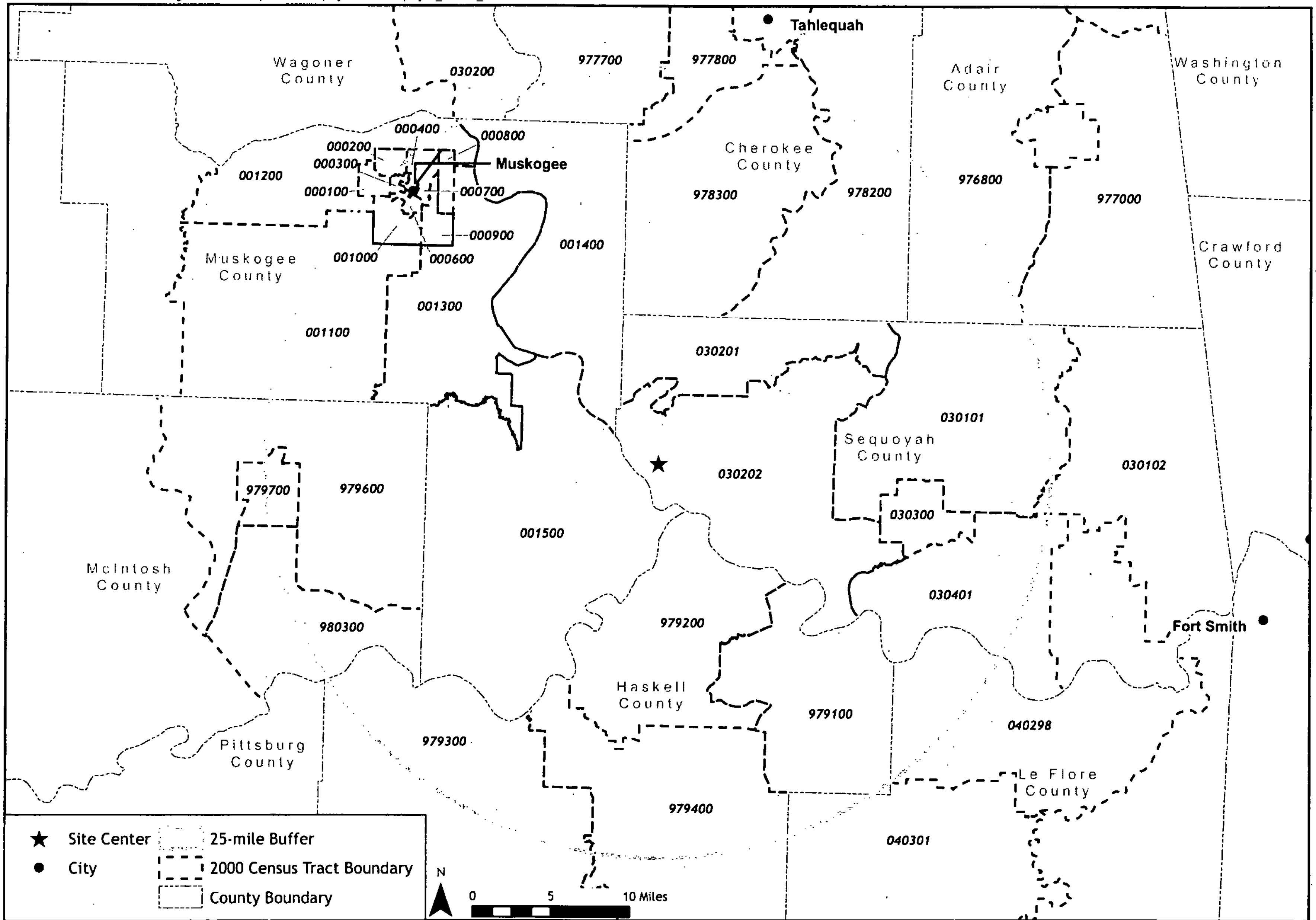

Source: US Census 2000

Figure B.7-1 Census Tracts within 25 miles of the Sequoyah Fuels Corporation Site

Table B.7-2 Preliminary Screen for Poverty Status

Geography State/County/Census Tract)	Median Household Income in 1999 (Dollars)	Total Population for whom Poverty Status is Determined[1]	Persons With Income in 1999 Below Poverty Level	Poverty Rate (Percent)
Oklahoma	**$33,400**	**3,336,224**	**491,235**	**14.7**
Sequoyah County	**$27,615**	**38,445**	**7,613**	**19.8**
Tract 303.01	$27,352	4,270	905	21.2
Tract 301.02	$29,843	8,345	1,621	19.4
Tract 302.01	$28,925	2,766	500	18.1
Tract 302.02	$25,438	5,186	1,154	22.3
Tract 303	$25,332	8,267	1,865	22.6
Tract 304.01	$26,378	3,512	595	16.9
Muskogee County	**$28,438**	**66,136**	**11,846**	**17.9**
Tract 1	$21,189	4,596	944	20.5
Tract 2	$19,911	1,892	745	39.4
Tract 3	$22,258	3,444	976	28.3
Tract 4	$20,265	1,448	439	30.3
Tract 6	$20,485	1,878	540	28.8
Tract 7	$20,344	5,086	1,218	23.9
Tract 8	$38,997	7,058	623	8.8
Tract 9	$24,626	5,111	890	17.4
Tract 10	$37,325	4,401	618	14.0
Tract 11	$36,524	3,651	449	12.3
Tract 12	$32,786	3,856	552	14.3
Tract 13	$40,181	6,271	466	7.4
Tract 14	$32,712	7,088	1,131	16.0
Tract 15	$22,837	6,110	1,443	23.6
Haskell County	**$24,553**	**11,594**	**2,377**	**20.5**
Tract 9791	$24,848	1,891	428	22.6
Tract 9792	$22,238	4,082	908	22.2
Tract 9793	$26,644	3,309	578	17.5
Tract 9794	$24,430	2,312	463	20.0
Adair County	**$24,881**	**20,552**	**4,770**	**23.2**
Tract 9768	$24,496	4,479	1,028	23.0
McIntosh County	**$25,964**	**19,026**	**3,459**	**18.2**
Tract 9796	$30,074	4,292	525	12.2
Tract 9797	$22,593	3,552	718	20.2
Tract 9803	$27,534	3,191	457	14.3
Cherokee County	**$26,536**	**40,920**	**9,355**	**22.9**
Tract 9777	$31,630	5,584	969	17.4
Tract 9778	$28,315	4,668	1,046	22.4
Tract 9782	$26,840	5,576	973	17.4
Tract 9783	$26,491	5,678	1,495	26.3

Table B.7-2 Preliminary Screen for Poverty Status

Geography State/County/Census Tract)	Median Household Income in 1999 (Dollars)	Total Population for whom Poverty Status is Determined[1]	Persons With Income in 1999 Below Poverty Level	Poverty Rate (Percent)
LeFlore County	**$27,278**	**46,443**	**8,857**	**19.1**
Tract 402.98	$27,301	7,876	1,395	17.7
Tract 403.01	$28,657	5,192	1,044	20.1

Source: U.S. Bureau of the Census, 2000.

[1] Poverty status was determined for all people except institutionalized people, people in military group quarters, people in college dormitories, and unrelated individuals under 15 years old. These groups also were excluded from the numerator and denominator when calculating poverty rates. They are considered neither "poor" nor "non-poor."

Note: Shaded rows identify census tracts with a poverty rate more than 20 percentage points greater than the poverty rate of the county as a whole.

Census tract 9768 in Adair County, has a minority population of 59.7% (American Indian/ Alaska Native), which slightly exceeds the NUREG-1748 criteria of 50%; however, this percentage is not significantly higher than the county as a whole, which has a minority population of 51.7%. The American Indian/Native Alaska population comprises 42.9% of the county's population. Census tract 9768 is nearly 20 miles from the SFC site and, at this distance, residents in Adair County would not be expected to experience any direct adverse impacts from the SFC reclamation.

Low-Income Status

Census tract 2 in Muskogee County had a poverty rate of 39.4%, which was slightly more than 20 percentage points higher than the poverty rate of the county (17.9%). The median income of this census tract, $19,911, was lower than the county's median income of $28,438. While this figure would typically present a concern with regard to environmental justice, the majority of this census tract is more than 25 miles from the SFC site, and residents within this census tract are not expected to experience impacts from the SFC reclamation.

Conclusion

Minority and low income populations would not be directly affected by the potential impacts resulting from the reclamation of the SFC site, mainly due to the distance that these populations reside from the site. However, because minority and low income populations are more likely to be subsistence fishers or hunters, or gatherers of edible plant material, there is a possibility that these populations could be indirectly affected by implementation of the proposed action and its alternatives. Also, American Indian populations commonly use plants and animals that inhabit the area for religious ceremonies. Plants and animal resources used as food sources and for religious purposes could be found in proximity to the SFC site and the Lower Illinois River. Any disproportionate impacts on these ecological and surface water resources would be SMALL as the proposed reclamation of the SFC site would result in the containment of site contamination either in a disposal cell or by removal from the site.

Therefore, based on the NRC environmental justice guidelines (NUREG 1748) and this impact analysis, the NRC staff has concluded that proposed reclamation of the site would be SMALL and not have disproportionately high or adverse human health or environmental impacts on minority and low-income populations. Therefore, no further analysis or action is required.

B.8 Noise

B.8.1 Affected Environment

The SFC site is located in a rural area, and the land surrounding the site is used primarily for agricultural and recreational activities. Residential, industrial, and commercial development constitutes about one-third of the land use near the SFC site. The study area comprises the SFC site and the nearest noise receptors, which are less than 5,000 feet to the north and northwest of the site. Background noise at the site results mostly from light traffic in the area. This noise level would be comparable to that of a quiet residential area, which is about 45 to 55 decibels (dB) in the normal (A-scale) auditory frequency band dB(A).

Although there is no state or local noise ordinance for Gore, Oklahoma, in 1974 the EPA published "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety." This document provides information to state and local governments for use in developing their own ambient noise standards. The EPA determined that a day-night noise level of 55 dBA protects the public from noise interfering with indoor and outdoor activities.

> The day-night noise level is the average sound level during a 24-hour period with 10 dBA added to nighttime sound levels from 10 p.m. to 7 a.m. to account for people's greater sensitivity to sound during that period.

The noise receptors closest to the SFC site include a residence on State Highway10 near the intersection of Highway 64, and a museum on U.S. Route 64 west of its intersection with State Highway 10 (see Figure B.8-1). The residence on State Highway 10 is more than 732 meters (2,400 feet) to the northeast of the site boundary, and the museum is more than 1,524 meters (5,000 feet) north of the proposed reclamation area and location of the disposal cell construction.

B.8.2 Alternatives Analysis

A noise analysis was performed for the nearest of these receptors to identify any potential noise impacts.

B.8.2.1 Alternative 1: On-Site Disposal of Contaminated Materials (the Proposed Action)

During the reclamation process and construction of the on-site disposal cell, the primary sources of noise would be from demolition of the existing buildings, the movement of heavy equipment during soil excavation, the placing the liner materials, and filling and capping the disposal cell.

The following elements of the reclamation process are expected to generate noise levels above background:

- Construction of an above-grade disposal cell;
- Removal of sludge and sediment;
- Excavation of buried low-level wastes;
- Dismantlement of process equipment;

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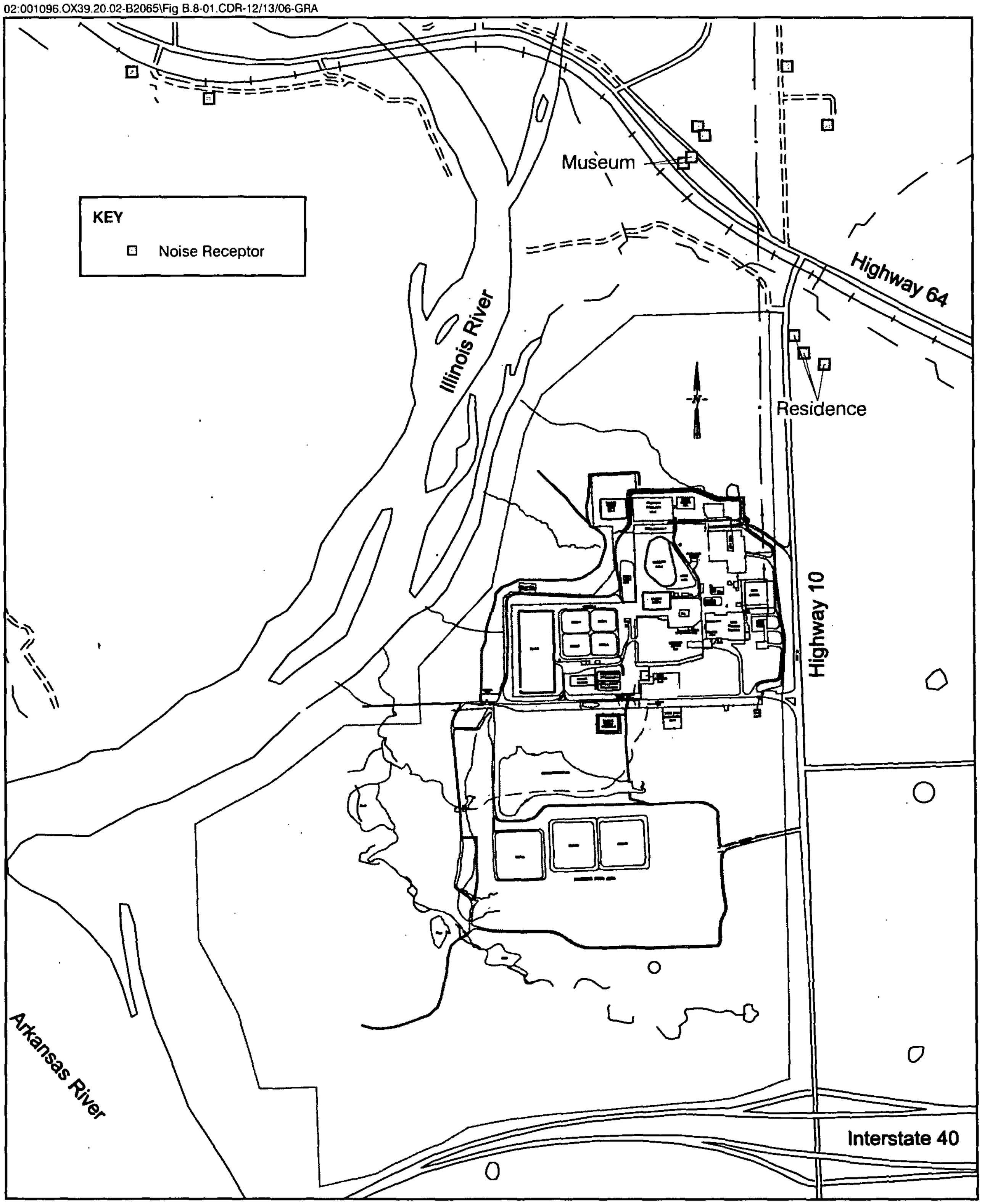

SOURCE: SFC, 2006

Figure B.8-1 Noise Receptors Near SFC Site

- Dismantlement/demolition of structures;
- Demolition of concrete floors, foundations, and storage pads;
- Excavation of underground utilities;
- Excavation of contaminated soils; and
- Regrading the site.

It is anticipated that the majority of the construction noise would be generated during daylight hours. Blasting is not anticipated to occur during reclamation or construction activities.

Reclamation activities would generate temporary increases in outdoor noise levels, especially if heavy trucks or other construction vehicles are accelerating frequently around the site. The levels of noise attributable to these activities would generally be comparable to the normal industrial activities previously carried out at the SFC site.

Table B.8-1 identifies typical noise emission levels for the construction equipment that would be used during demolition and cell construction activities, as well as a percent usage (FHWA, 2006), which accounts for the percentage of time that the equipment would typically be in use during these types of activities. The expected noise contribution at the location of the nearest receptor was calculated for each type of equipment using the FHWA Roadway Construction Noise Model (RCNM), version 1.0, 2006. The model results, as well as the maximum combined noise level expected from all of the construction equipment, is provided in Table B.8-1.

Table B.8-1 Demolition and Cell Construction Noise

Construction Equipment	Sound Pressure Level (SPL) at 50 feet (dBA)	Usage %	Noise Level at nearest Receptor (dBA)
Jack Hammer	89	20	48
Concrete Joint Cutter	90	20	49
Bulldozer	82	40	44
Crane	81	16	39
Front-end Loader	79	40	42
Truck	76	40	39
Pump	81	50	44
Maximum Noise Level			54

Source: FHWA, 2006.

The maximum noise level calculated for the nearest residential receptor, located 2,400 feet to the northeast of the site boundary, was 54 dBA, and it is likely that the typical noise levels from most construction equipment would be below 54 dBA over this distance. This is a conservative estimate, as additional reduction in noise level would be expected due to noise shielding by hills and vegetation and air absorption. Construction-related noise levels at the museum would be lower due to its greater distance from the site. Since no activity would be conducted in the evening hours, a noise level of 54 dB(A) during the day would not exceed the EPA day-night level of 55 dB(A), which is recommended for protecting the public from interference with indoor and outdoor activities. Therefore, the excavation of soil and demolition of on-site buildings would result in SMALL, direct noise impacts.

Changes in modes and times of transportation would be involved in all of the alternatives except the no-action alternative. Site workers commuting to and from the SFC site and the transport of equipment and materials to the site by truck can generate noise. Waste shipped from the site for off-site disposal also would create additional truck traffic and noise. However, this noise would be transient in nature and is not expected to create a significant increase over existing traffic noise levels. Therefore, the noise impact is expected to be SMALL.

Since very little activity would be necessary to maintain the disposal cell after the reclamation activity has been completed, noise levels in the site area would be expected to be near background noise levels, resulting in a SMALL impact.

B.8.2.2 Alternative 2: Off-site Disposal of All Contaminated Materials

Under Alternative 2, noise would be generated primarily by demolition of the existing buildings and equipment, the movement of heavy equipment during soil excavation, and the transport of materials to an off-site disposal facility. The elements of the reclamation process that would be expected to generate noise levels above background are the same as under Alternative 1, with the addition of the construction of a rail spur and an on-site loading facility.

It is anticipated that the majority of construction-related noise would be generated during daylight hours. Blasting is not anticipated to occur during reclamation or construction activities.

Reclamation activities would generate temporary increases in outdoor noise levels, especially if heavy trucks or other construction vehicles are accelerating frequently around the site. The levels of noise attributable to these activities would generally be comparable to the normal industrial activities previously carried out at the SFC site. The typical noise emission levels for construction equipment identified in Table B.8-1 also apply to Alternative 2. The maximum noise level predicted for the nearest residential receptor, located 2,400 feet to the northeast of the site boundary, is 54 dBA, and it is likely that the typical noise levels from most construction equipment would be reduced to below 55 dBA over this distance.

This alternative includes the construction and operation of a 2.57-km (1.6-mile) rail spur to junction with the Union Pacific Railroad line. The spur would pass within 366 meters (1,200 feet) of the nearest residences on N447 Road near U.S. Highway 64. To maximize the potential noise impact, it is assumed that one train trip per day, involving an estimated 60 to 80 rail cars joined into a train, would be required to ship waste from the site to a disposal facility. Based on FHWA noise evaluation guidance, it is predicted that the noise level at the nearest receptor to the spur would average 47 dBA during the hour when the train is traveling along the spur. This level would add very little to the existing daytime noise level of 45 to 55 dBA for a quiet residential area. In addition, the existing Union Pacific rail line is closer to these receptors than the proposed rail spur location and, therefore, would be expected to contribute more noise than the spur.

Therefore, the excavation of soil, demolition of on-site buildings and equipment, and transportation of all contaminated materials to an off-site disposal facility would result in SMALL, direct noise impacts.

B.8.2.3 Alternative 3: Partial Off-Site Disposal of Contaminated Materials

Under Alternative 3, noise would be generated primarily by demolition of the existing buildings, the movement of heavy equipment during soil excavation, placing the liner materials, filling and capping the disposal cell, and transport of the sludge and sediment to an off-site facility licensed to accepted such materials. The elements of the reclamation process that would be expected to generate noise levels above background are the same as under Alternative 1, with the addition of the truck noise that would result from the loading and transport of the sludges and sediments.

It is anticipated that the majority of the construction noise would be generated during daylight hours. Blasting is not anticipated to occur during reclamation or construction activities.

Reclamation activities would generate temporary increases in outdoor noise levels, especially if heavy trucks or other construction vehicles are accelerating frequently around the site. The levels of noise attributable to these activities would generally be comparable to the normal industrial activities previously carried out at the SFC site. The typical noise emission levels for construction equipment identified in Table B.8-1 also apply to Alternative 3. Additional truck noise would result from the loading and transport of the sludges and sediments (in super sacks) at the same time as the cell construction or building demolition. However, the additional truck traffic is expected to generate short duration noise events that would add little to the average noise levels at the receptors, and the impact would be SMALL. The maximum noise level predicted for the nearest residential receptor is 54 dBA, and it is likely that the typical noise levels from most construction equipment would be reduced to below 55 dBA over this distance.

Therefore, the excavation of soil, demolition of on-site buildings, and transportation of contaminated materials would result in SMALL, direct noise impacts.

B.8.2.4 No-Action Alternative

Since there would be no dismantling, excavation, construction, or transportation of contaminated materials under the no-action alternative, there would be no impacts from noise levels at the SFC site.

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(USFWS, 2007a) United States Fish and Wildlife Service. County Occurrences of Oklahoma Federally Listed Endangered, Threatened, Proposed, and Candidate Species, August 8, 2006, http://www.fws.gov/southwest/es/oklahoma/document.htm

(USFWS, 2007b) United States Fish and Wildlife Service. Federally-Listed Species in Oklahoma, "Indiana Bat", http://www.fws.gov/southwest/es/oklahoma/indnbat.htm

(USFWS, 2007c) United States Fish and Wildlife Service. Federally-Listed Species in Oklahoma, "Interior Least Tern", http://www.fws.gov/southwest/es/oklahoma/lestern.htm

(USFWS, 2007d) United States Fish and Wildlife Service. Federally-Listed Species in Oklahoma, "Ozark Big-eared Bat", http://www.fws.gov/southwest/es/oklahoma/bgerbat.htm

(USFWS, 2007e) United States Fish and Wildlife Service. Federally-Listed Species in Oklahoma, "Bald Eagle," http://www.fws.gov/southwest/es/oklahoma/eagle1.htm

(USFWS, 2007f) United States Fish and Wildlife Service. Federally-Listed Species in Oklahoma, "Piping Plover," http://www.fws.gov/southwest/es/oklahoma/plover.htm

(USFWS, 2007g) United States Fish and Wildlife Service. Federally-Listed Species in Oklahoma, "Whooping Crane," http://www.fws.gov/southwest/es/oklahoma/whooper.htm

(USFWS, 2007h) United States Fish and Wildlife Service. Federally-Listed Species in Oklahoma, "American Burying Beetle," http://www.fws.gov/southwest/es/oklahoma/beetle1.htm

B.6 Socioeconomics

(Bureau of the Census, 2000) United States Bureau of the Census. American FactFinder website accessed on November 13, 2006. http://factfinder.census.gov/home/saff/main.html?_lang=en.

(ESRI, 2006) Environmental Systems Research Institute, Inc. Series name: ESRI Data & Maps. Environmental Systems Research Institute, Inc. (ESRI), Redlands, California. April 4, 2006.

(SFC, 2001) Sequoyah Fuels Corporation. April 30, 2001. "Response to Request for Additional Information Concerning Environmental Review of Decommissioning." Gore, Oklahoma.

B.7 Environmental Justice

(CEQ, 1997) Council on Environmental Quality. December 10, 1997. *Environmental Justice Guidance Under the National Environmental Policy Act*

(Bureau of the Census, 2000) United States Bureau of the Census. American FactFinder website accessed on November 13, 2006. http://factfinder.census.gov/home/saff/main.html?_lang=en.

B.8 Noise

(FHWA, 2006) United States Department of Transportation, Federal Highway Administration, Roadway Construction Noise Model User's Guide, January 2006

(SFC, 2006) Sequoyah Fuels Corporation. *Environmental Report [for the] Reclamation Plan.* October 13, 2006.

APPENDIX C

CONSULTATION LETTERS

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 27, 2006

Mr. Robert L. Brooks, State Archeologist
Oklahoma Archeological Society
111 E. Chesapeake, # 102
Norman, OK 73019-5111

SUBJECT: DETERMINATION OF NO ADVERSE AFFECT ON PREHISTORIC RESOURCES FROM PROPOSED RECLAMATION OF SEQUOYAH FUELS CORPORATION'S SITE IN GORE, OKLAHOMA

Dear Mr. Brooks:

By letter dated January 28, 2003, Sequoyah Fuels Corporation (SFC) submitted to the U.S. Nuclear Regulatory Commission (NRC), a proposed reclamation plan for its facility in Gore, OK. SFC has revised this proposed reclamation plan several times in response to questions raised by the NRC staff. The NRC staff is preparing an Environmental Impact Statement (EIS) to document its evaluation of the potential environmental impacts from SFC's proposed plan and alternatives to that plan. The EIS is being prepared in accordance with the requirements of the National Environmental Policy Act of 1969, as amended, as specified in 10 CFR Part 51 of the NRC's regulations. As part of its environmental review, the NRC staff also is considering the potential impact of the proposed plan on historic and cultural resources in accordance with the National Historic Preservation Act.

The present undertaking is the proposed reclamation of wastes produced by past site operations and of site soils and groundwater impacted by those operations. SFC is proposing to construct an onsite disposal cell to contain these wastes and impacted soils. Materials used for cell construction would be obtained from onsite sources or from nearby quarries. Maps of the site and vicinity are enclosed (Enclosure 1).

In the past, the NRC staff has consulted with your office regarding SFC's proposed decommissioning and reclamation of its site. Enclosed is your response of June 20, 2000 (Enclosure 2), in which you stated that you had no objection to decommissioning of the SFC site. Also enclosed are letters from prior consultation with the Deputy State Historic Preservation Officer (June 27, 2000), and the Cherokee Nation (August 29, 2001), regarding that proposed project (Enclosures 3 and 4). Those letters stated that there were no historic or prehistoric properties that would be affected by site reclamation. SFC's current proposed reclamation activities are similar in scope and extent to those evaluated in these earlier consultation letters.

Therefore, the NRC staff requests your concurrence with our determination that SFC's proposed action does not adversely affect any historic or prehistoric properties.

If you have any questions, please contact Mr. James Park of my staff. Mr. Park can be reached at 301-415-5835 or by email to jrp@nrc.gov.

Sincerely,

B. Jennifer Davis, Chief
Environmental Review Section
Division of Waste Management
and Environmental Protection
Office of Federal and State Materials
and Environmental Management Programs

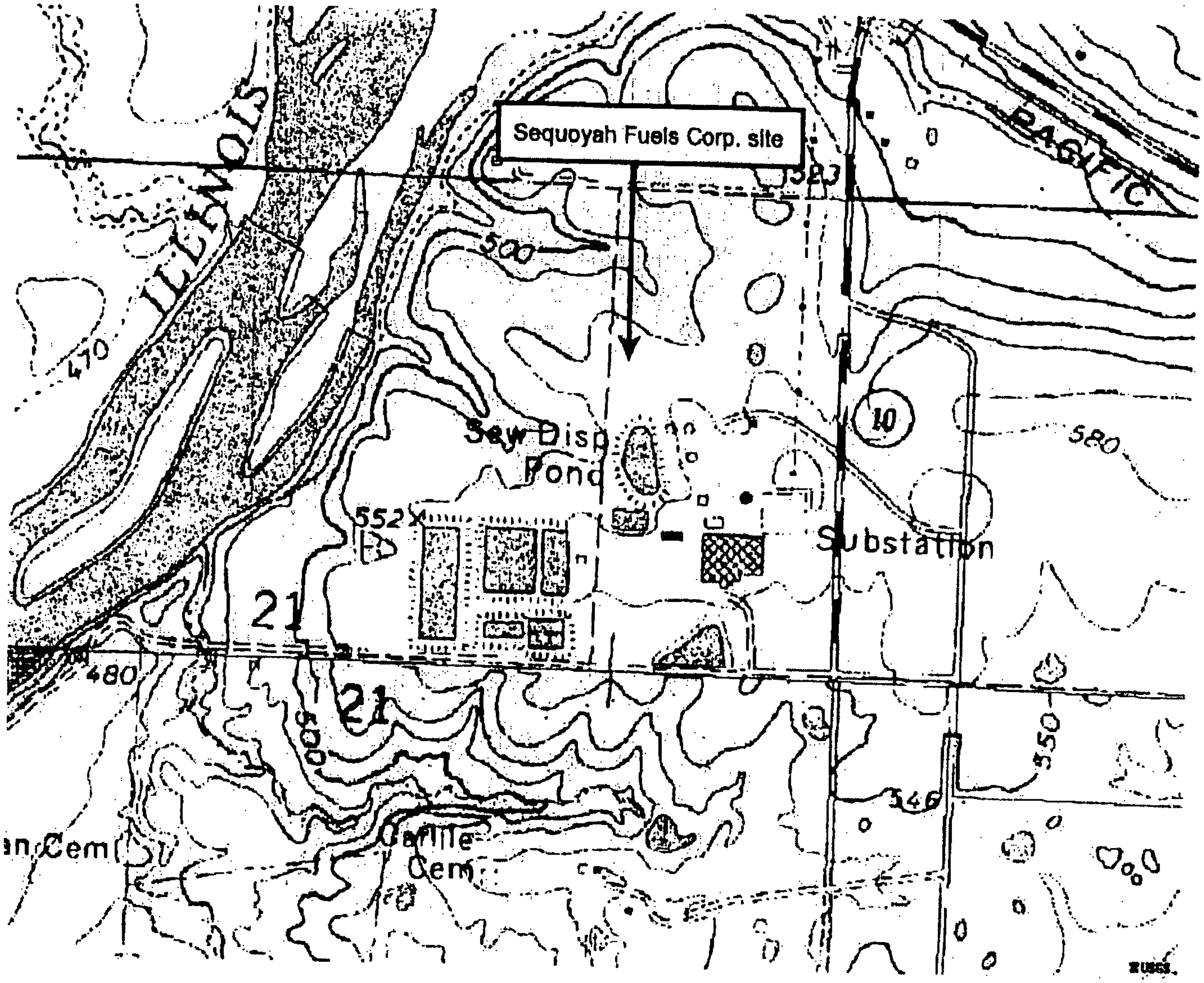
Docket No. 40-8027
License No. SUB-1010

Enclosures: As stated

cc:
Craig Harlin, SFC
Melvena Heisch, OK State Historic Preservation Office
Jeannine Hale, Esq., Cherokee Nation

Enclosure 1

Maps of Sequoyah Fuels Corporation Site and Vicinity



Sequoyah Fuels Corp. site
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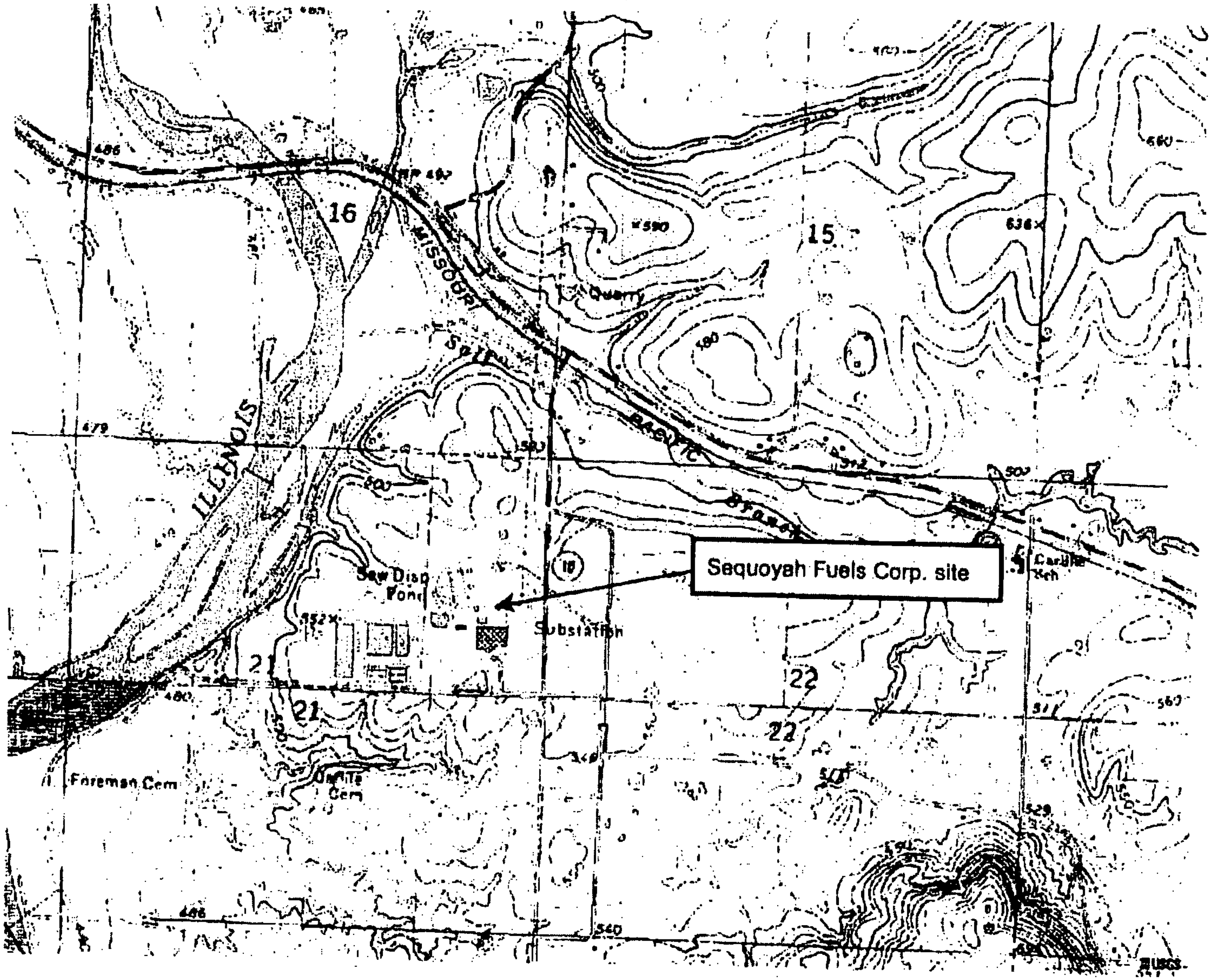
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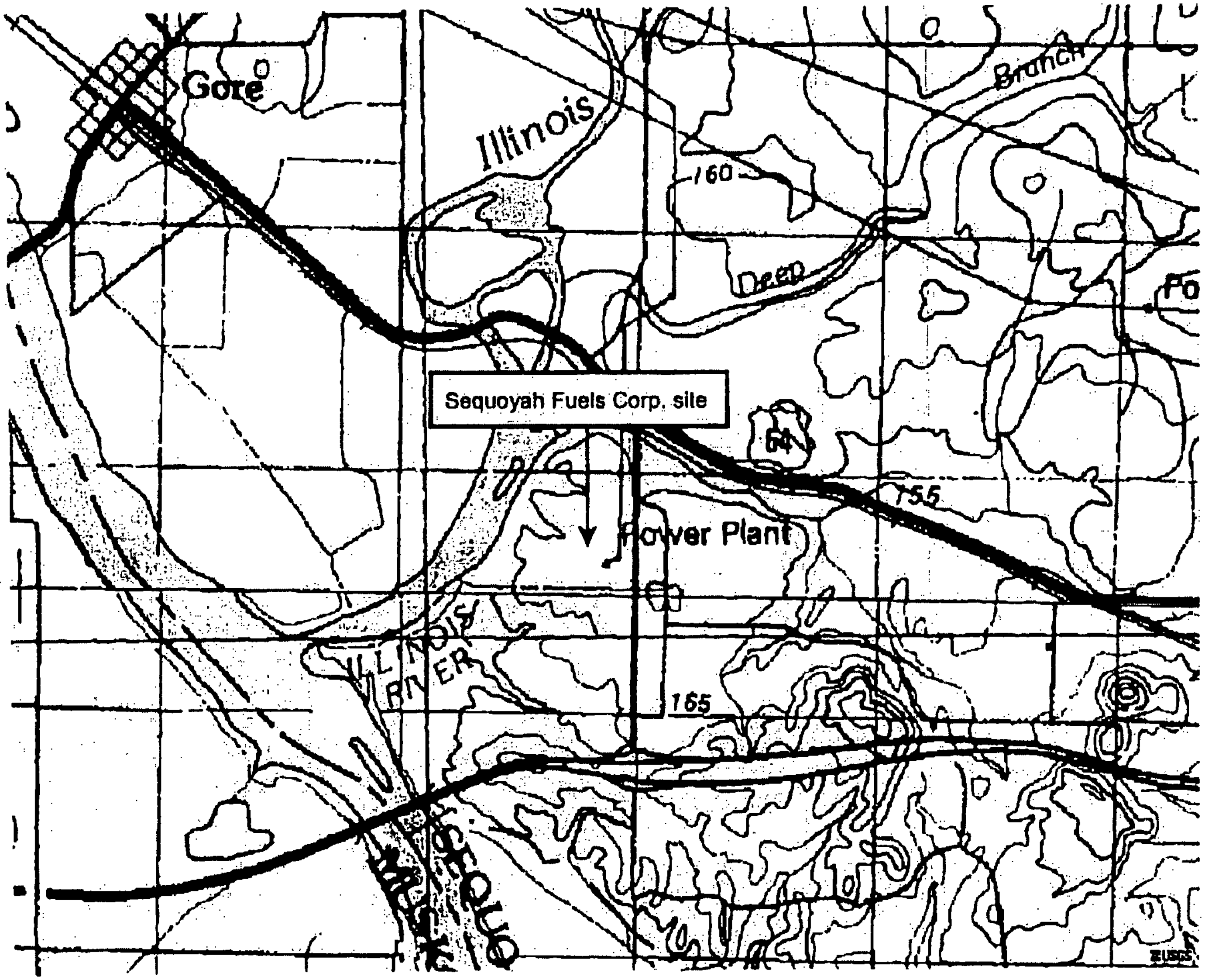
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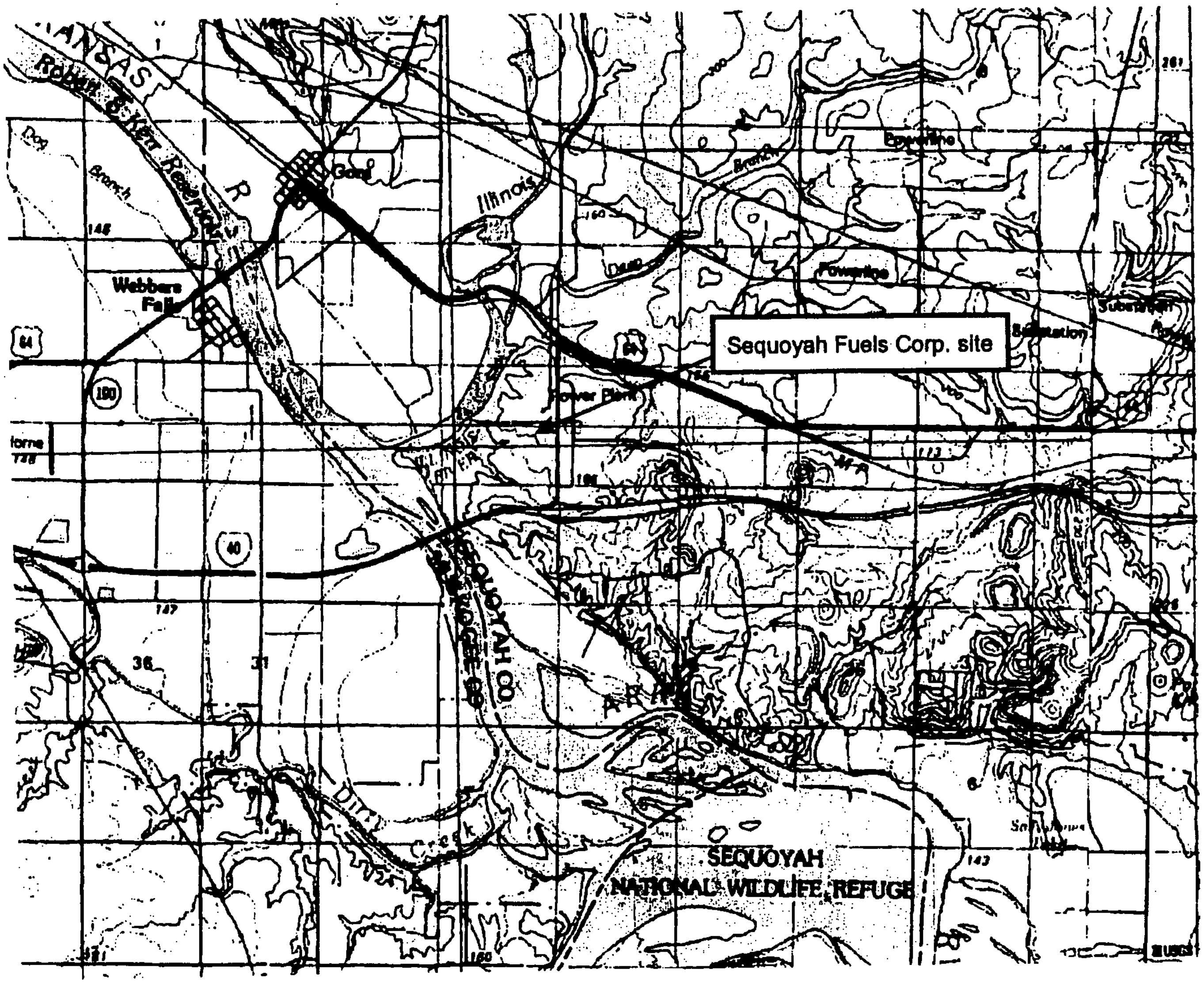


Sequoyah Fuels Corp. site
SEQUOYAH
NATIONAL WILDLIFE REFUGE
Webbers Falls
Gore
Illinois
Power Plant
Powerline
Substation
SEQUOYAH CO
Dirty Creek

Enclosure 2

June 20, 2000 Letter from Robert L. Brooks, Oklahoma State Archeologist
to Thomas Essig, NRC

Oklahoma Archeological Survey
THE UNIVERSITY OF OKLAHOMA

June 20, 2000

Thomas H. Essig, Chief
Environmental & Performance Assessment Branch
Division of Waste Management
Office of Nuclear Material Safety and Safeguards
Nuclear Energy Regulatory Commission
Washington, DC 20555-0001

Re: Proposed decommissioning of the Sequoyah Fuels Corporation Facility near Gore. Legal Description: Section 21 T12N R21E, Sequoyah County, Oklahoma.

Dear Mr. Essig:

I have completed an evaluation of the above referenced undertaking. A review of the site files maintained by this agency revealed that there is one previously recorded archaeological site near the plant site. This is 34SQ25, the Cemetery Site, located in the NW1/4 SW1/4 SW1/4 of Section 21. SQ25 is reportedly just west of the Sequoyah Fuels Plant fence on Corps of Engineers property. The Cemetery site contains prehistoric as well as probable historic Cherokee materials and has potential eligibility to the National Register. Based on the location of the site, it is unlikely that contamination has affected the site. The area where contamination hazards may be higher - in the northeastern and northern portion of Section 21, we have no information pertaining to the existence of archaeological resources. Furthermore, the extensive disturbance of the processing area makes it unlikely that undisturbed resources would be present.

I have no objection to decommissioning of the Sequoyah Fuels Plant. However, consultation should also be accomplished with the various indigenous and removal tribes that hold an interest with these lands. This review has been conducted in cooperation with the State Historic Preservation Office, Oklahoma Historical Society.

Sincerely,

Robert L. Brooks
State Archaeologist

Cc: SHPO

111 E. Chesapeake, Norman, Oklahoma 73019-0575 PHONE: (405) 325-7211 FAX: (405) 325-7604
A UNIT OF ARTS AND SCIENCES SERVING THE PEOPLE OF OKLAHOMA

Enclosure 3

June 27, 2000 Letter from Meleva Heisch, Deputy State Historic Preservation Officer to Thomas Essig, NRC

Oklahoma Historical Society *Founded May 27, 1893*

State Historic Preservation Office • 2704 Villa Prom • Shepherd Mall • Oklahoma City, OK 73107-2441
Telephone 405/521-6249 • Fax 405/947-2918

June 27, 2000

Mr. Thomas Essig, Chief
Uranium Recovery/Waste Branch
Division of Waste Management
Office of Nuclear Material Safety
U.S. NUCLEAR REGULATORY COMMISSION
Washington, D.C. 20555-0001

RE: File #1933-00; Sequoyah Fuels Corp. Proposed Decommission Project near Gore, Oklahoma

Dear Mr. Essig:

We have received and reviewed the documentation submitted on the referenced project in Sequoyah County. Additionally, we have examined the information contained in the Oklahoma Landmarks Inventory (OLI) files and other materials on historic resources available in our office.

In addition to our review, you must contact the Oklahoma Archeological Survey (OAS), 111 East Chesapeake, Room #102, Norman, OK 73019-5111 (#405/325-7211), to obtain a determination about the presence of prehistoric resources that may be eligible for the National Register of Historic Places. Should the OAS conclude that there are no archaeological sites or other types of historic properties, as defined in 36 CFR Part 800.16(l), which are eligible for inclusion in the National Register of Historic Places within the project area and that such sites are unlikely to occur, we find that there are no historic properties affected within the referenced project's area of potential effect.

The OAS may conclude that an on-site investigation of all or part of the project impact area is necessary to determine the presence of archaeological resources. In the event that such an investigation reveals the presence of archaeological sites, we will defer to the judgment of the OAS concerning whether or not any of the resources should be considered "historic properties" under the Section 106 review process.

Should further correspondence pertaining to this project be necessary, the above underlined file number must be referenced. If you have any questions, please contact Mr. Marshall Gettys, Historical Archaeologist, at 405/521-6381. Thank you.

Sincerely,

Melvena Heisch

Melvena Heisch
Deputy State Historic
Preservation Officer

MH:pm

Enclosure 4

August 31, 2001 Letter from David Comingdeer Rabon, Cherokee Nation
to Phyllis Sobel, NRC

40-8027

Chad "Corntassel" Smith
ᏬᏰᏩᏗ
Principal Chief

Hastings Shade
ᏬᏩᏅᏑᏂ
Deputy Principal Chief

CHEROKEE NATION

P.O. Box 948
Tahlequah, OK 74465-0948
918-456-0671

August 29, 2001

Phyllis Sobel, PH. D.
Project Manager
US Nuclear Regulatory Commission
Washington, DC 20555

Re: The proposed decommissioning of Sequoyah Fuels Site in Sequoyah County, OK

Dear Ms. Sobel,

The Cherokee Nation does not object to your proposed project. We are unaware of any significant historic or pre-historic sites in your project area. However, Native American human remains and associated funerary items may exist in the area, as well as isolated archaeological sites.

Please contact this office if buried archaeological materials such as chipped stone tools, pottery, bone, historic crockery, glass, metal items, or building materials are inadvertently discovered during decommissioning of the site.

If you have any further questions or concerns, please feel free to contact me at the number below.

Wa-do,

David Comingdeer Rabon

David Comingdeer Rabon
Historic Preservation Specialist
Department of Natural Resources
Phone: (918) 456-0671 ext. 2631
Fax: (918) 458-7673

NMSS01Public

Rec'd from NMSS 12/31/01

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 27, 2006

Data Coordinator
Oklahoma Natural Heritage Inventory
Oklahoma Biological Survey
111 East Chesapeake Street
Norman, Oklahoma 73019-0575

SUBJECT: SPECIES OCCURRENCES FOR SEQUOYAH FUELS CORPORATION'S GORE, OKLAHOMA SITE

Dear Sir or Madam:

By letter dated January 28, 2003, Sequoyah Fuels Corporation (SFC) submitted to the U.S. Nuclear Regulatory Commission (NRC), a proposed reclamation plan for its facility in Gore, OK. SFC has revised this proposed reclamation plan several times in response to questions raised by the NRC staff. The NRC staff is preparing an Environmental Impact Statement (EIS) to document its evaluation of the potential environmental impacts from SFC's proposed plan and alternatives to that plan. The EIS is being prepared in accordance with the requirements of the National Environmental Policy Act of 1969, as amended, as specified in 10 CFR Part 51 of the NRC's regulations. In conjunction with its review, the NRC staff also is considering the potential impact of the proposed plan on endangered and threatened species or on critical habitat within the area of influence for the proposed action, in accordance with the Endangered Species Act.

The SFC site is located near the confluence of the Arkansas and Illinois Rivers, 2.5 miles east of Gore, Oklahoma, and 25 miles southeast of Muskogee. The SFC site is on the east bank of a tributary of the Illinois River, the headwaters of the Robert S. Kerr Reservoir. SFC is proposing to reclaim radioactive wastes produced by past site operations and to remediate buildings, site soils, and groundwater impacted by those operations. SFC would construct an engineered onsite disposal cell to contain these wastes and impacted structures and soils, with materials used for cell construction obtained from onsite sources or from nearby quarries. Following reclamation, disturbed areas would be re-graded and re-vegetated. Maps of the site and vicinity are enclosed (Enclosure 1). Orthophotographs of the site and vicinity are provided in Enclosure 2. The site is located in the southeastern corner of the Gore quadrangle (scale 1:24,000).

By this letter, the NRC staff is requesting the locations of species occurrences for the SFC site. This information will be used in assessing the potential impact to rare, endangered, and threatened species from SFC's proposed reclamation activities.

If you have any questions concerning this matter, please contact Mr. James Park of my staff. Mr. Park can be reached by phone at (301) 415-5835 of by email at jrp@nrc.gov.

Sincerely,

B. Jennifer Davis, Chief
Environmental Review Section
Division of Waste Management
and Environmental Protection
Office of Federal and State Materials
and Environmental Management Programs

Docket No. 40-8027

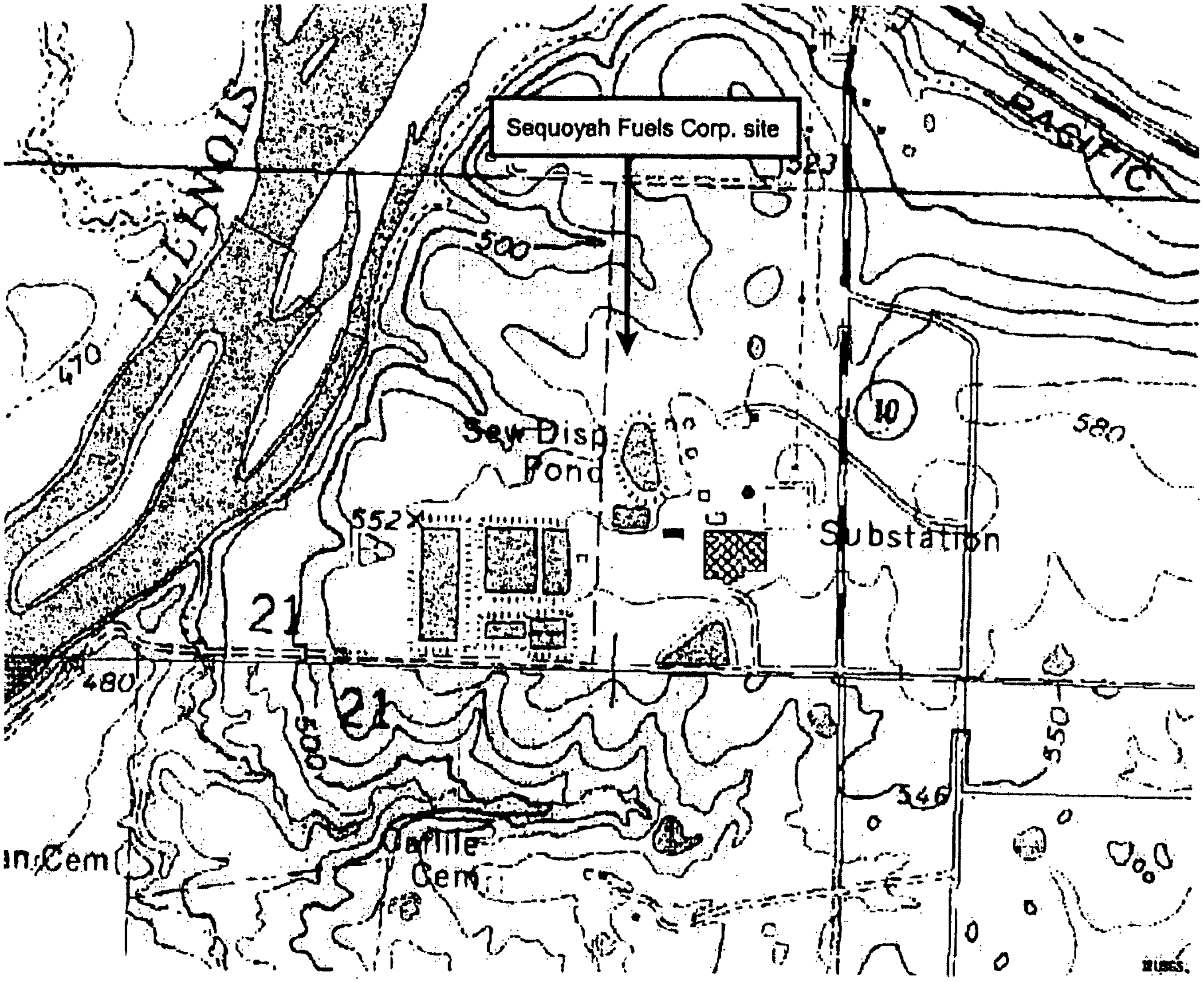
License No. SUB-1010

Enclosures:
1. Maps
2. Orthophotographs

cc:
Craig Harlin, SFC

Enclosure 1

Maps of Sequoyah Fuels Corporation Site and Vicinity


Sequoyah Fuels Corp. site
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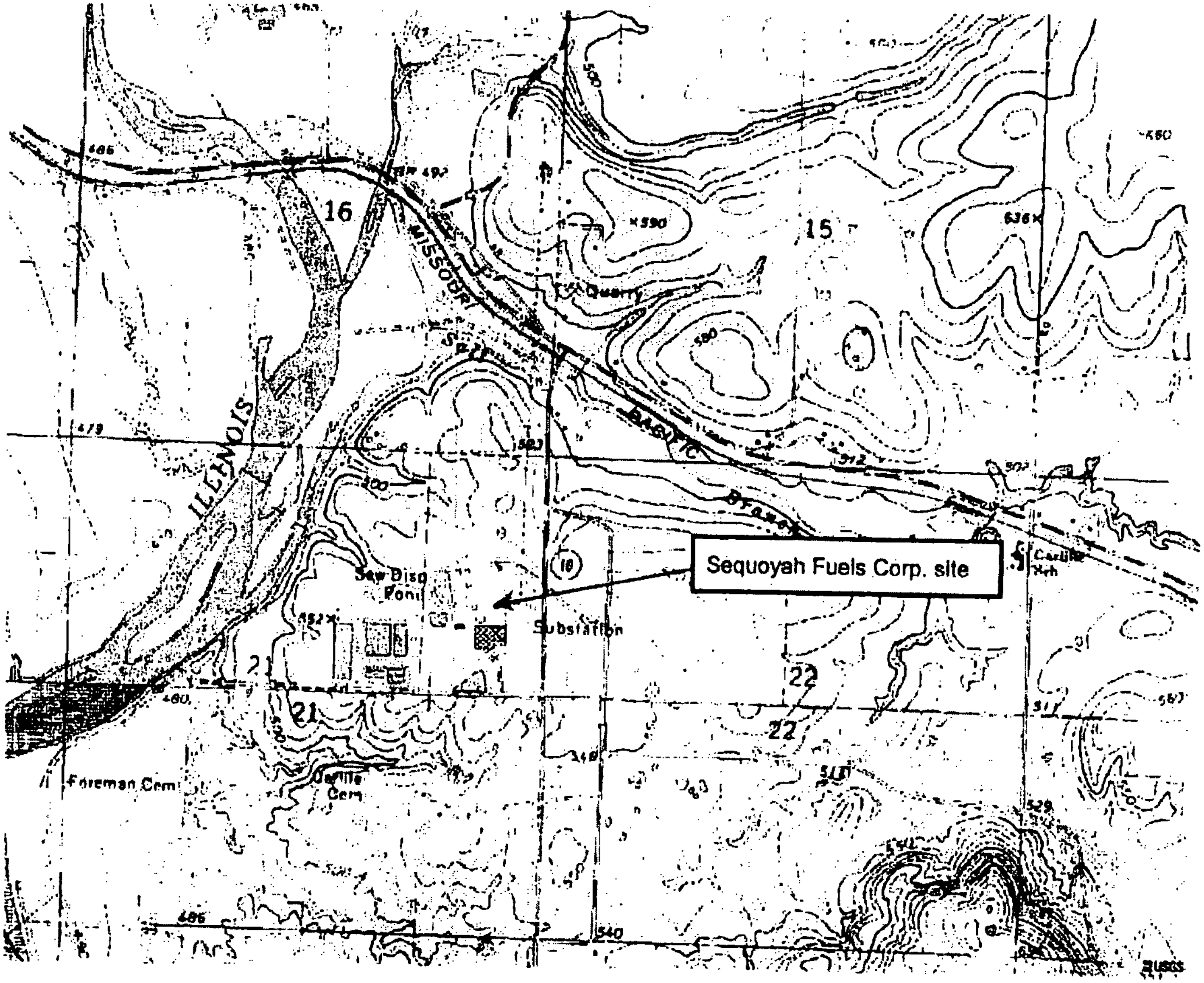

Sequoyah Fuels Corp. site
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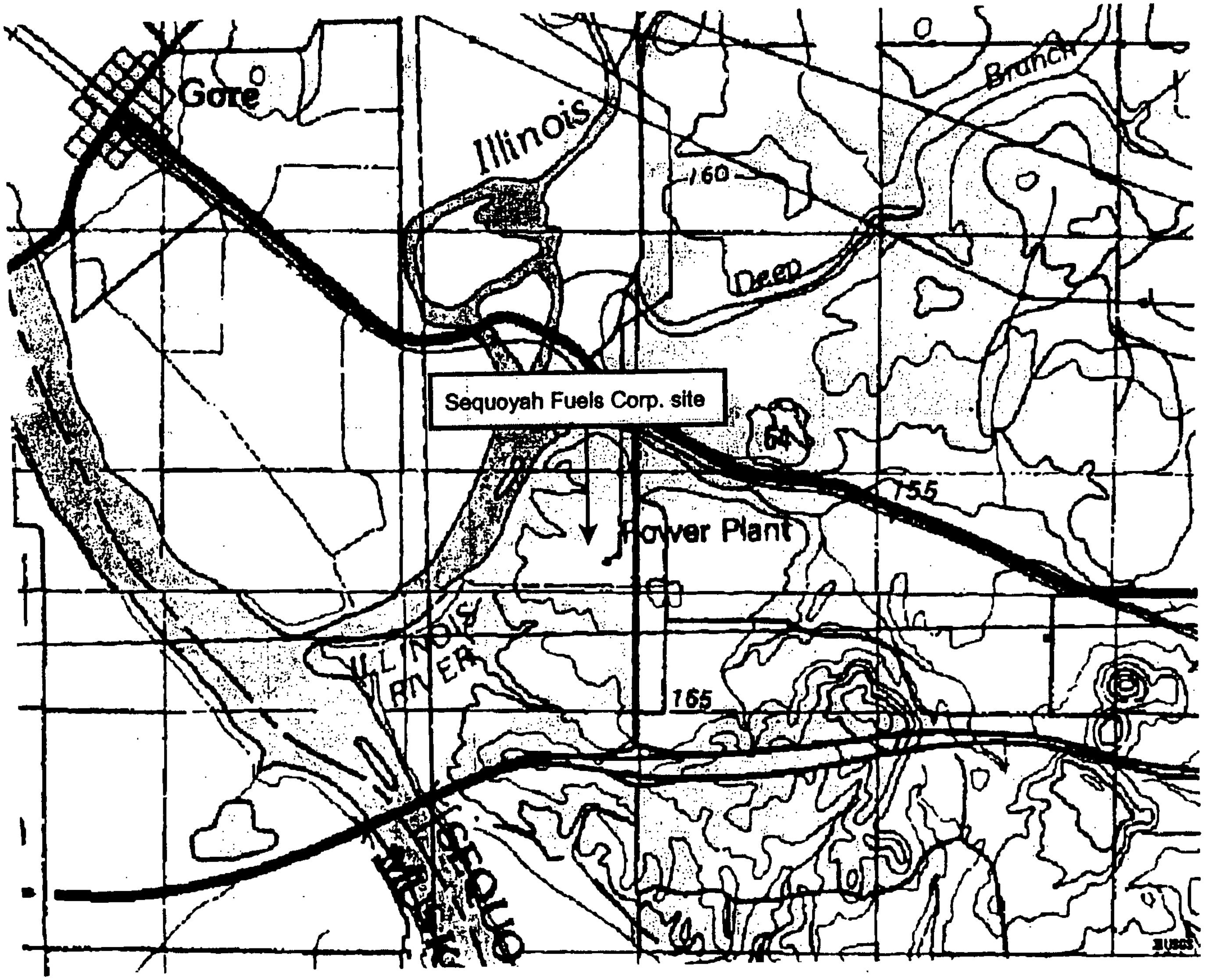
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Sequoyah Fuels Corp. site
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Power Plant
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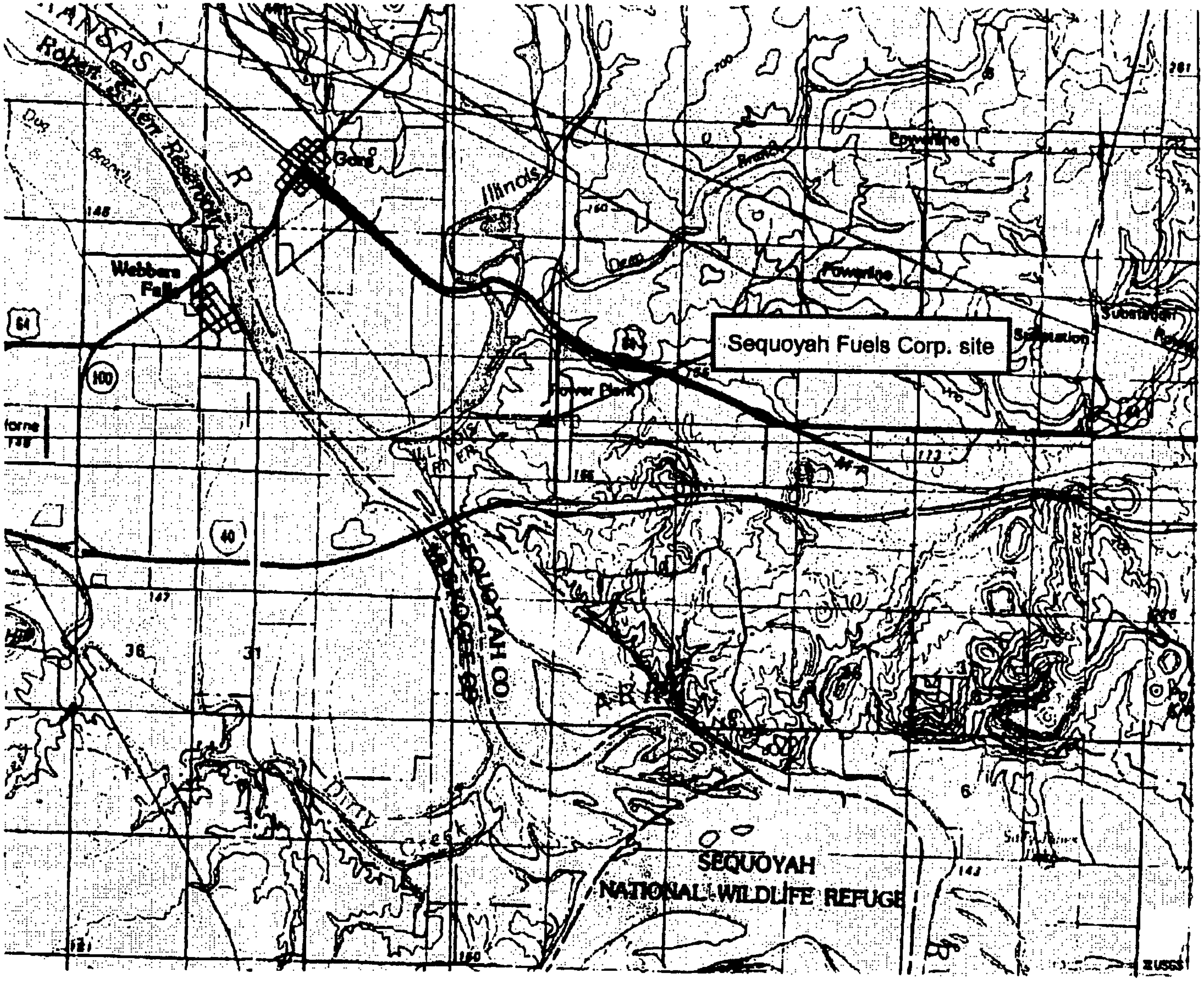
Sequoyah Fuels Corp. site
Webbers Falls
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Powerline
Substation
Power Plant
Dirty Creek
SEQUOYAH CO
SEQUOYAH
NATIONAL WILDLIFE REFUGE

Enclosure 2

Orthophotographs of Sequoyah Fuels Corporation Site and Vicinity

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 28, 2006

Mr. Jerry Brabander, Field Supervisor
U.S. Fish & Wildlife Service
Oklahoma Ecological Services Field Office
9014 E. 21st Street
Tulsa, Oklahoma 74129

SUBJECT: CONCURRENCE WITH DETERMINATION OF NO ADVERSE AFFECT ON LISTED OR PROPOSED SPECIES OR CRITICAL HABITAT FOR PROPOSED RECLAMATION OF SEQUOYAH FUELS CORPORATION'S GORE, OKLAHOMA SITE

Dear Mr. Brabander:

By letter dated January 28, 2003, Sequoyah Fuels Corporation (SFC) submitted to the U.S. Nuclear Regulatory Commission (NRC), a proposed reclamation plan for its facility in Gore, OK. SFC has revised this proposed reclamation plan several times in response to questions raised by the NRC staff. The NRC staff is preparing an Environmental Impact Statement (EIS) to document its evaluation of the potential environmental impacts from SFC's proposed plan and alternatives to that plan. The EIS is being prepared in accordance with the requirements of the National Environmental Policy Act of 1969, as amended, as specified in 10 CFR Part 51 of the NRC's regulations. In conjunction with its review, the NRC staff also is considering the potential impact of the proposed plan on endangered and threatened species or on critical habitat within the area of influence for the proposed action, in accordance with the Endangered Species Act.

The SFC site is located near the confluence of the Arkansas and Illinois Rivers, 2.5 miles east of Gore, Oklahoma, and 25 miles southeast of Muskogee. The SFC site is on the east bank of a tributary of the Illinois River, the headwaters of the Robert S. Kerr Reservoir. SFC is proposing to reclaim radioactive wastes produced by past site operations and to remediate buildings, site soils, and groundwater impacted by those operations. SFC would construct an engineered onsite disposal cell to contain these wastes and impacted structures and soils, with materials used for cell construction obtained from onsite sources or from nearby quarries. Following reclamation, disturbed areas would be re-graded and re-vegetated. Maps of the site and vicinity are enclosed (Enclosure 1). Orthophotographs of the site and vicinity are provided in Enclosure 2.

Based on information obtained from your office's website (www.fws.gov/ifw2es/Oklahoma), the American burying beetle, the Indiana bat, the interior least tern, the Ozark big-eared bat, the bald eagle, and the piping plover are the Federally-listed endangered and threatened species in Sequoyah County, OK. Based on species-specific information gathered from your office's website, it does not appear likely that the American burying beetle, the Indiana bat, or the Ozark big-eared bat are present on the SFC site or in its vicinity. From sighting lists on the website (www.fws.gov/southwest/refuges/oklahoma/sequoyah/index.html) for the Sequoyah National

Wildlife Refuge, the interior least tern is commonly seen in the summer and the bald eagle commonly observed in the fall and winter, while the piping plover is only rare sighted.

Because SFC's proposed reclamation and remediation activities would be conducted within its site boundaries, the NRC staff considers that these activities would not adversely affect endangered and threatened species or critical habitat within the area of influence for the proposed action. Therefore, the NRC staff hereby informs your office of this determination and considers that consultation under Section 7 of the Endangered Species Act is not required.

If you have any questions concerning this matter, please contact Mr. James Park of my staff. Mr. Park can be reached by phone at (301) 415-5835 of by e-mail at jrp@nrc.gov.

Sincerely,

B. Jennifer Davis, Chief
Environmental Review Section
Division of Waste Management
and Environmental Protection
Office of Federal and State Materials
and Environmental Management Programs

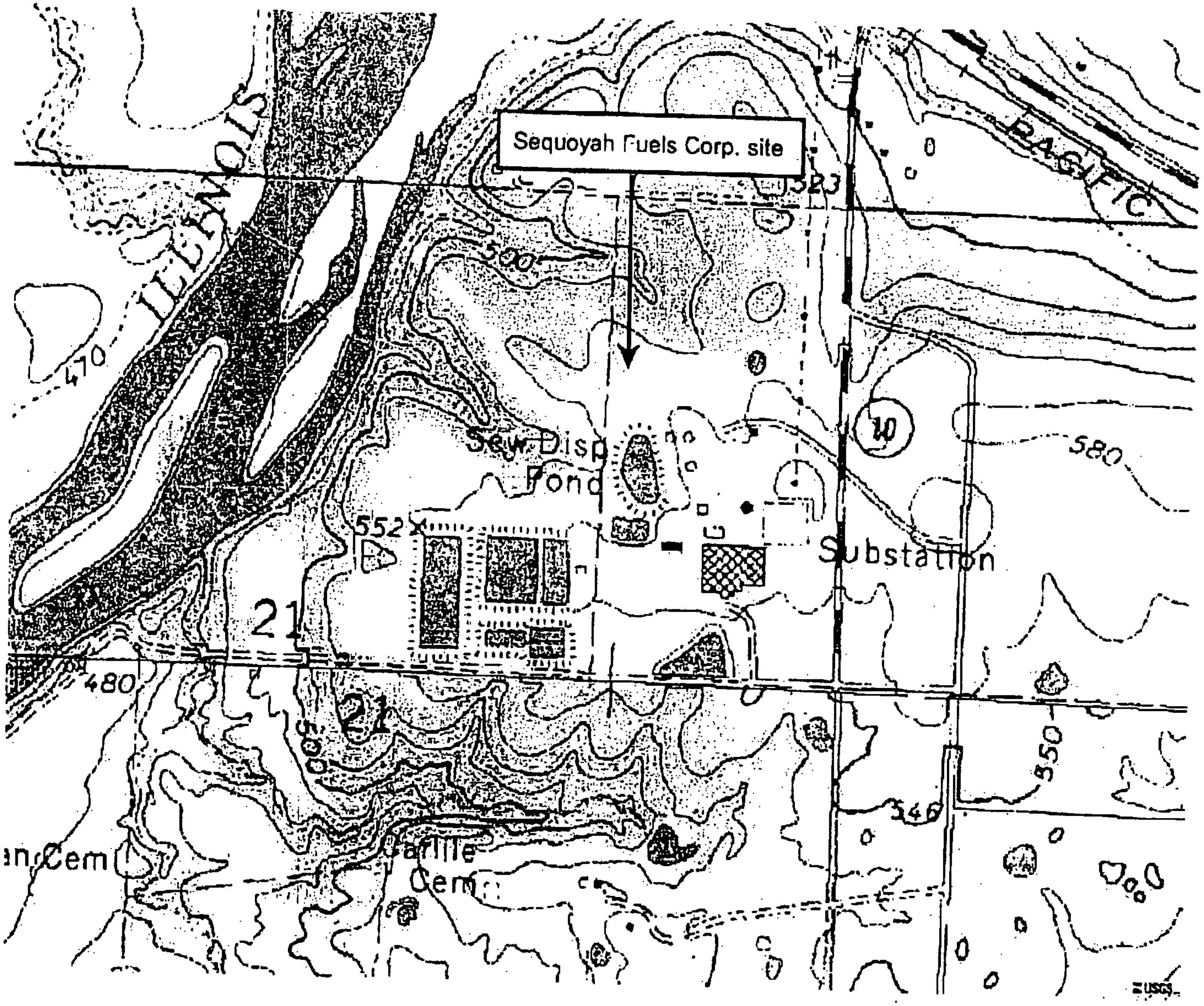
Docket No: 40-8027
License No: SUB-1010

Enclosures:
1. Maps
2. Orthophotographs

cc:
Craig Harlin, SFC
Robert Brooks, OK Archeological Survey
Jeannine Hale, Esq., Cherokee Nation

Enclosure 1

Maps of Sequoyah Fuels Corporation Site and Vicinity


Sequoyah Fuels Corp. site
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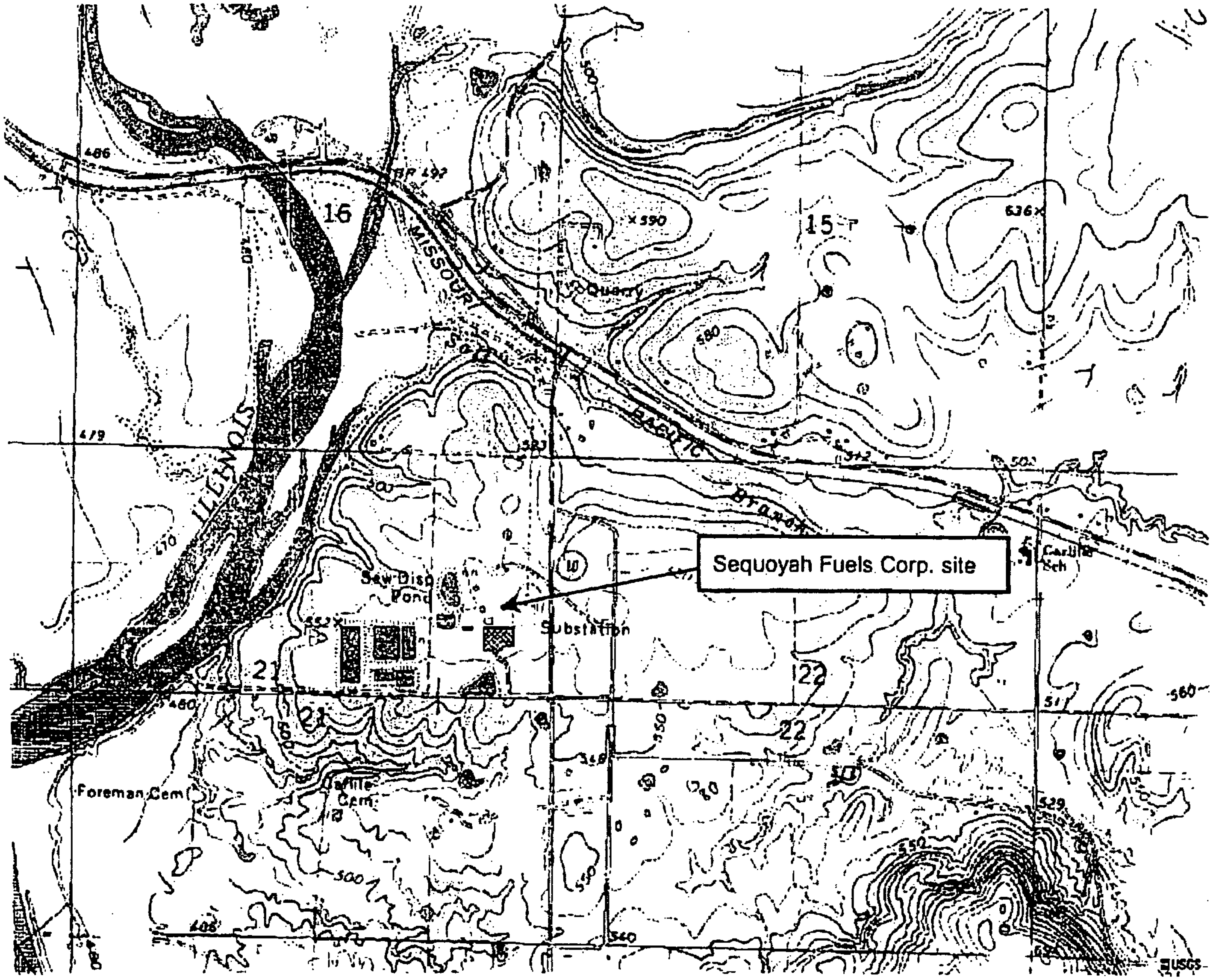
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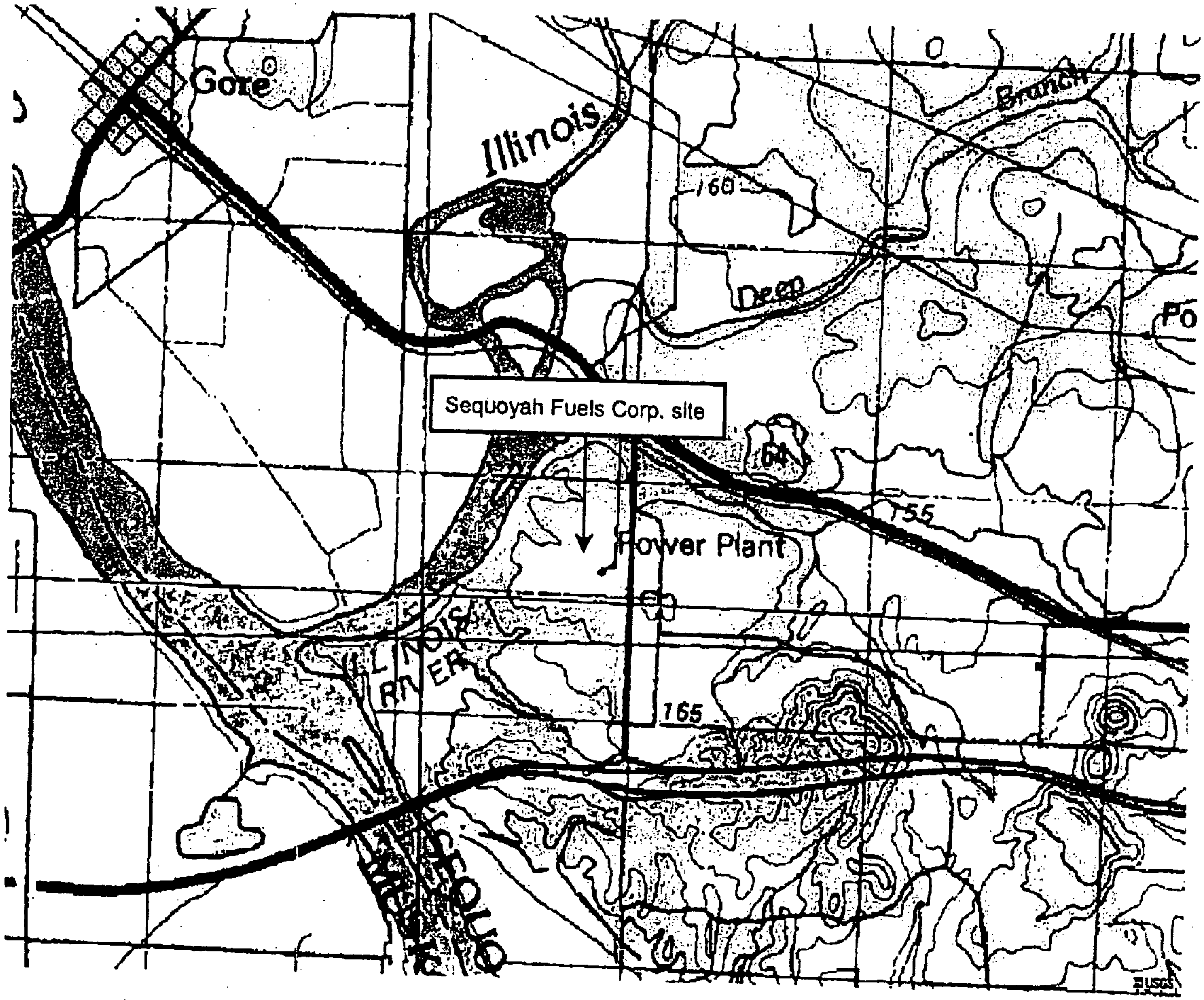
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Sequoyah Fuels Corp. site
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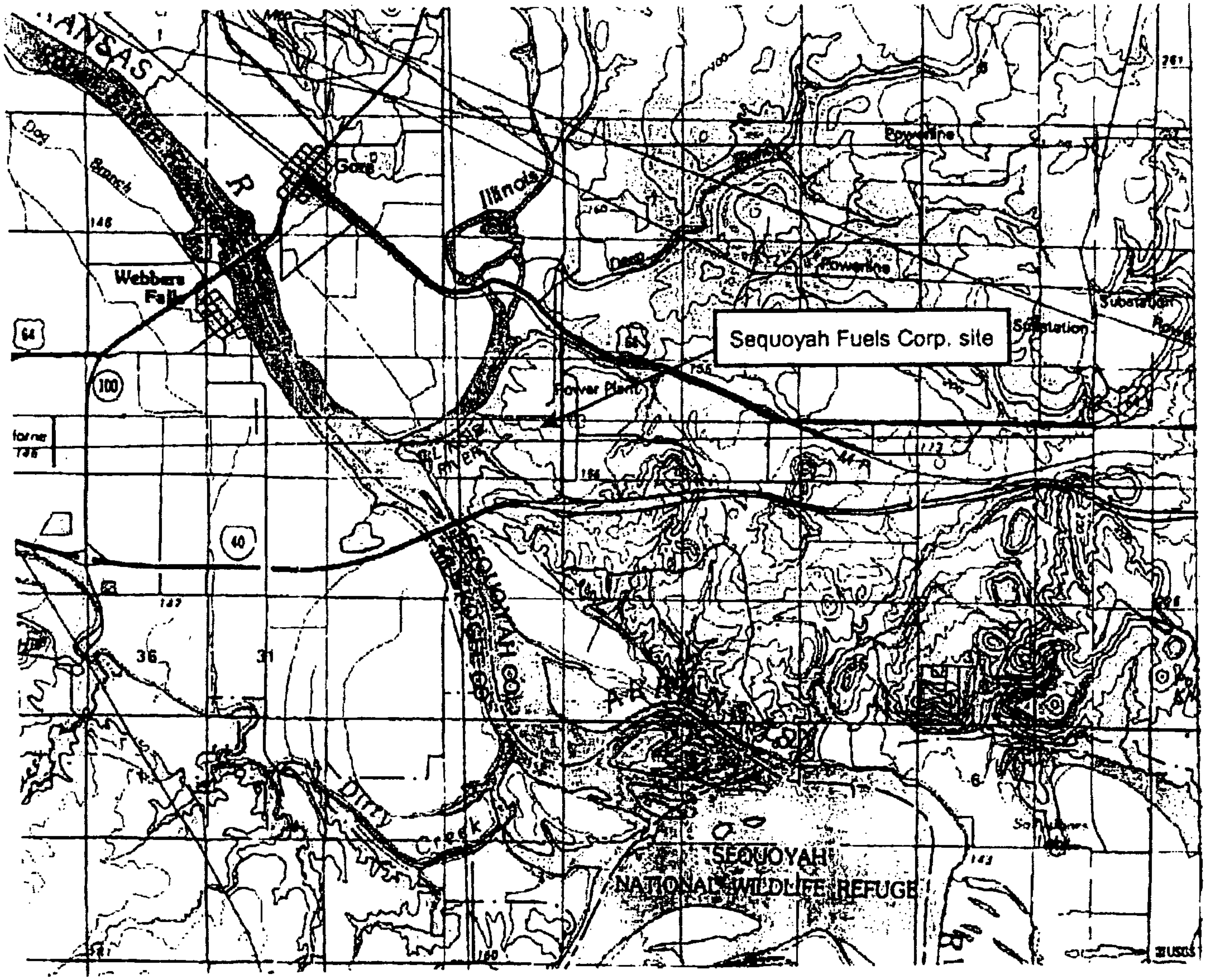
Sequoyah Fuels Corp. site
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NATIONAL WILDLIFE REFUGE
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Enclosure 2

Orthophotographs of Sequoyah Fuels Corporation Site and Vicinity

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 30, 2006

Greg Duffy, Director
Oklahoma Department of Wildlife Conservation
P.O. Box 53465
Oklahoma City, Oklahoma 73152-3465

SUBJECT: CONCURRENCE WITH DETERMINATION OF NO ADVERSE AFFECT ON LISTED OR PROPOSED SPECIES OR CRITICAL HABITAT FOR PROPOSED RECLAMATION OF SEQUOYAH FUELS CORPORATION'S GORE, OKLAHOMA SITE

Dear Mr. Duffy:

By letter dated January 28, 2003, Sequoyah Fuels Corporation (SFC) submitted to the U.S. Nuclear Regulatory Commission (NRC), a proposed reclamation plan for its facility in Gore, OK. SFC has revised this proposed reclamation plan several times in response to questions raised by the NRC staff. The NRC staff is preparing an Environmental Impact Statement (EIS) to document its evaluation of the potential environmental impacts from SFC's proposed plan and alternatives to that plan. The EIS is being prepared in accordance with the requirements of the National Environmental Policy Act of 1969, as amended, as specified in 10 CFR Part 51 of the NRC's regulations. In conjunction with its review, the NRC staff also is considering the potential impact of the proposed plan on endangered and threatened species or on critical habitat within the area of influence for the proposed action, in accordance with the Endangered Species Act.

The SFC site is located near the confluence of the Arkansas and Illinois Rivers, 2.5 miles east of Gore, Oklahoma, and 25 miles southeast of Muskogee. The SFC site is on the east bank of a tributary of the Illinois River, the headwaters of the Robert S. Kerr Reservoir. SFC is proposing to reclaim radioactive wastes produced by past site operations and to remediate buildings, site soils, and groundwater impacted by those operations. SFC would construct an engineered onsite disposal cell to contain these wastes and impacted structures and soils, with materials used for cell construction obtained from onsite sources or from nearby quarries. Following reclamation, disturbed areas would be re-graded and re-vegetated. Maps of the site and vicinity are enclosed (Enclosure 1). Orthophotographs of the site and vicinity are provided in Enclosure 2.

Based on information obtained from the U.S. Fish and Wildlife/Oklahoma Ecological Services Field Office's website (www.fws.gov/ifw2es/Oklahoma), the American burying beetle, the Indiana bat, the interior least tern, the Ozark big-eared bat, the bald eagle, and the piping plover are the Federally-listed endangered and threatened species in Sequoyah County, OK. Based on species-specific information gathered from that website, it does not appear likely that the American burying beetle, the Indiana bat, or the Ozark big-eared bat are present on the SFC site or in its vicinity.

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If you have any questions concerning this matter, please contact Mr. James Park of my staff. Mr. Park can be reached by phone at (301) 415-5835 of by email at jrp@nrc.gov.

Sincerely,

B. Jennifer Davis, Chief
Environmental Review Section
Division of Waste Management
and Environmental Protection
Office of Federal and State Materials
and Environmental Management Programs

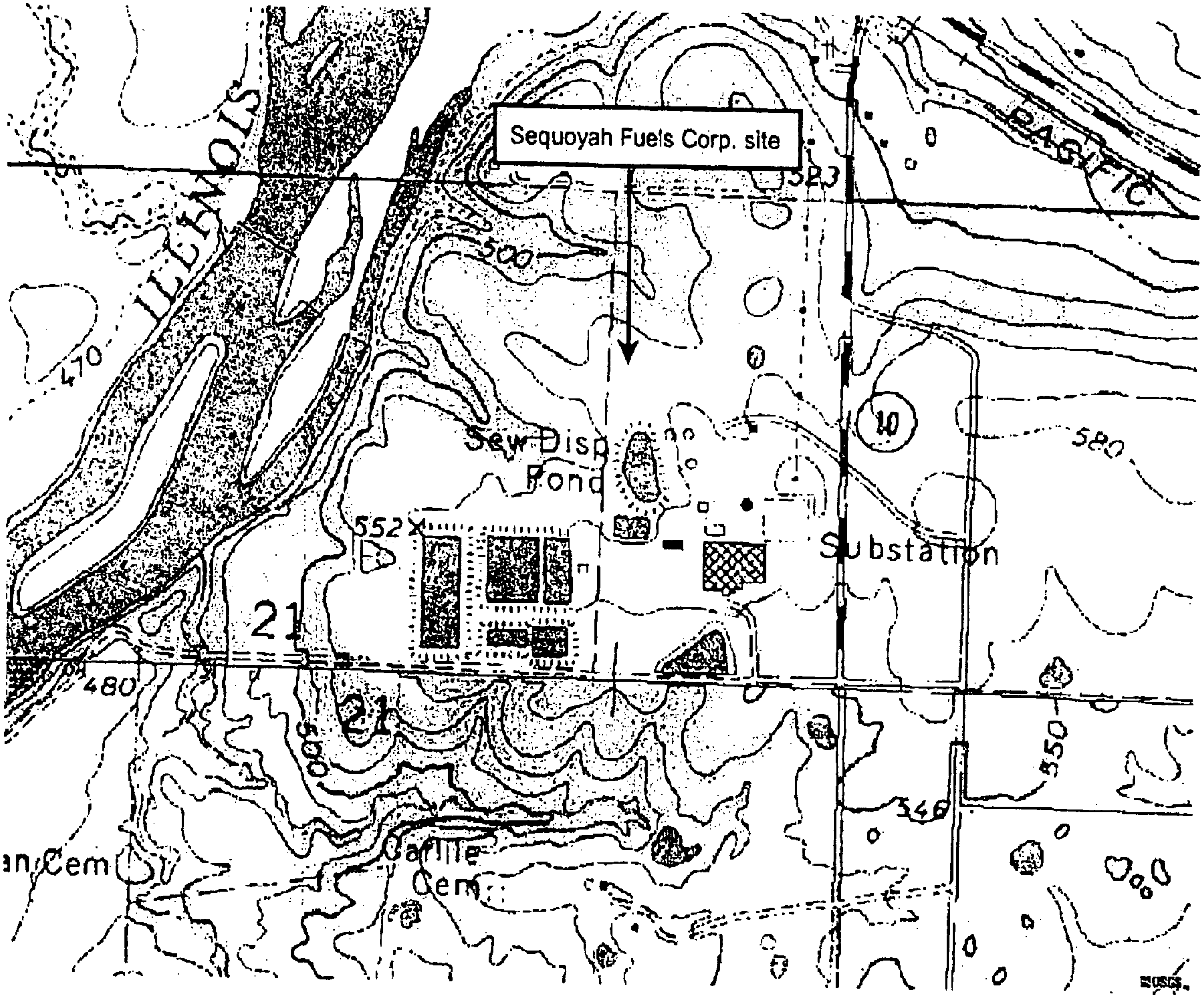
Docket No. 40-8027
License No. SUB-1010

Enclosures:
1. Maps
2. Orthophotographs

cc: Craig Harlin, SFC

Enclosure 1

Maps of Sequoyah Fuels Corporation Site and Vicinity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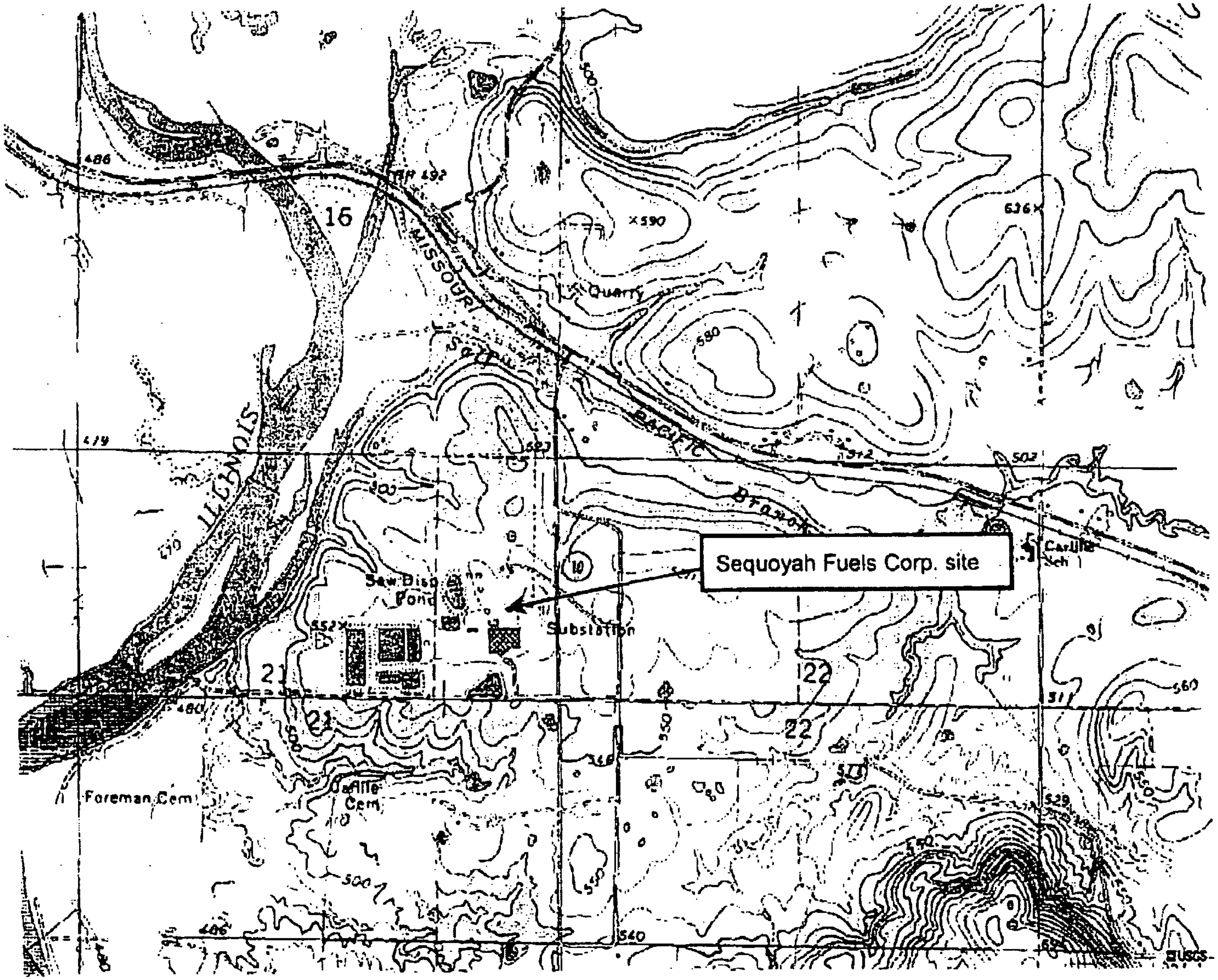
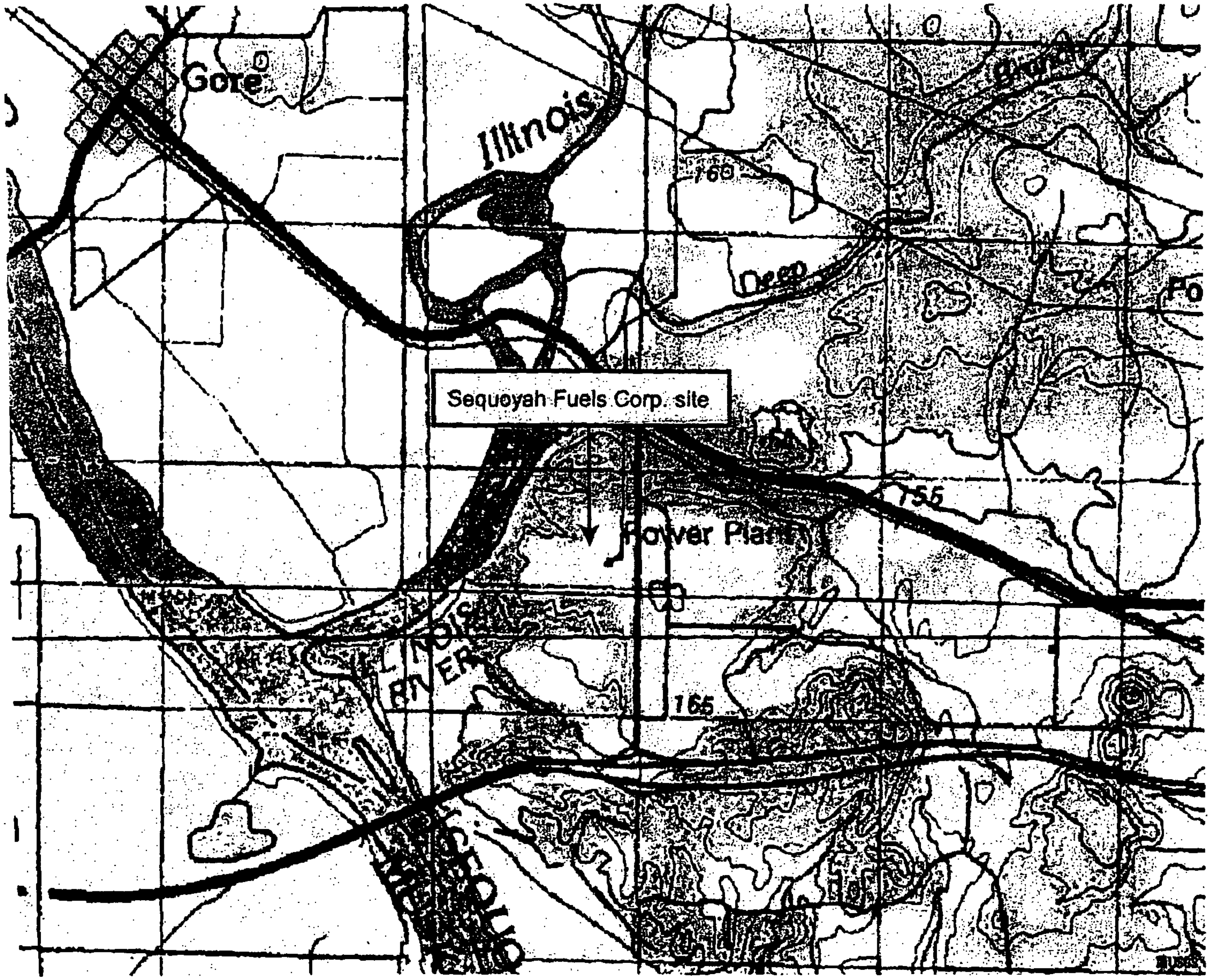
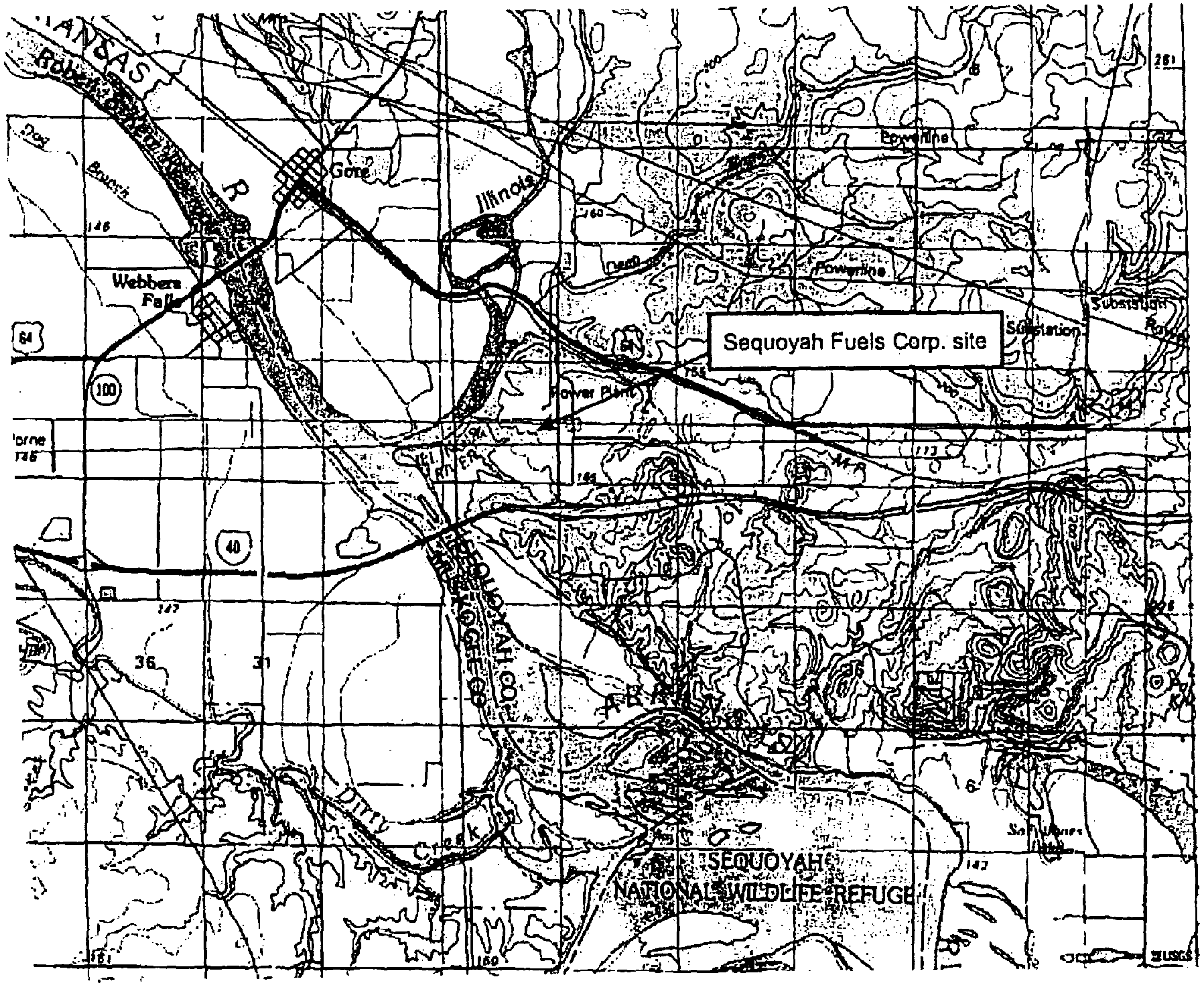

Sequoyah Fuels Corp. site
Substation
Quarry
MISSOURI
PACIFIC
ILLINOIS
16
21
22
Foreman Cem


Gore
Illinois
Sequoyah Fuels Corp. site
Power Plant
Deep
160
155
166
RIVER


Sequoyah Fuels Corp. site
Gore
Webbers Falls
Illinois
Powerline
Powerline
Substation
Substation
Power Plant
SEQUOYAH CO
MUSKOGEE CO
Dirty Creek
SEQUOYAH NATIONAL WILDLIFE REFUGE
64
100
40
36
31

Enclosure 2

Orthophotographs of Sequoyah Fuels Corporation Site and Vicinity

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

March 19, 2007

Mr. Robert L. Brooks, State Archeologist
Oklahoma Archeological Society
111 E. Chesapeake, # 102
Norman, OK 73019-5111

SUBJECT: REVISED DETERMINATION OF NO ADVERSE AFFECT ON PREHISTORIC RESOURCES FROM PROPOSED RECLAMATION OF SEQUOYAH FUELS CORPORATION'S SITE IN GORE, OKLAHOMA

Dear Mr. Brooks:

By letter to your attention dated November 27, 2006, the U.S. Nuclear Regulatory Commission (NRC) staff re-initiated consultation under Section 106 of the National Historic Preservation Act of 1966, as amended, for the proposed reclamation of Sequoyah Fuels Corporation's (SFC's) site in Gore, Oklahoma. The NRC staff is preparing an Environmental Impact Statement (EIS) to document its evaluation of the potential environmental impacts from SFC's proposed site reclamation plan and reasonable alternatives to that plan.

In its November 2006 letter, the NRC staff identified the present undertaking as SFC's proposed reclamation of wastes produced by its past site operations and the construction of an onsite disposal cell to contain these wastes and impacted soils. Based on SFC's proposed reclamation activities, the NRC staff determined the "area of potential effect" (APE) to be defined by the boundaries of the SFC site.

The NRC staff also enclosed in its November 2006 letter copies of previous correspondence from you, the Deputy State Historic Preservation Officer, and the Cherokee Nation regarding that proposed project. Based on that correspondence, which stated that there were no historic properties that would be affected by the proposed site reclamation, the NRC staff determined that SFC's proposed reclamation of its Gore, OK site do not adversely affect any historical or cultural properties. The NRC staff requested your concurrence with that determination by that November 2006 letter; however, we are still awaiting your reply.

As part of its EIS process, the NRC staff has identified a reasonable alternative to SFC's proposed reclamation plan. This alternative would involve the shipment offsite of all of the contaminated wastes and soils reclaimed by SFC. Such offsite shipment would necessitate the construction of a three-mile rail spur from the SFC site to the nearest main rail line. Enclosed is a figure showing the approximate route of this potential rail spur.

Based on this alternative, the NRC staff is revising its APE to include the potential route of the rail spur. However, given the correspondence noted above, the NRC staff has determined that there are no historic or cultural resources within the expanded APE that would be adversely affected. Therefore, the NRC staff requests your concurrence with this determination.

If you have any questions, please contact Mr. James Park of my staff. Mr. Park can be reached at 301-415-6935 or by email to jrp@nrc.gov.

Sincerely,

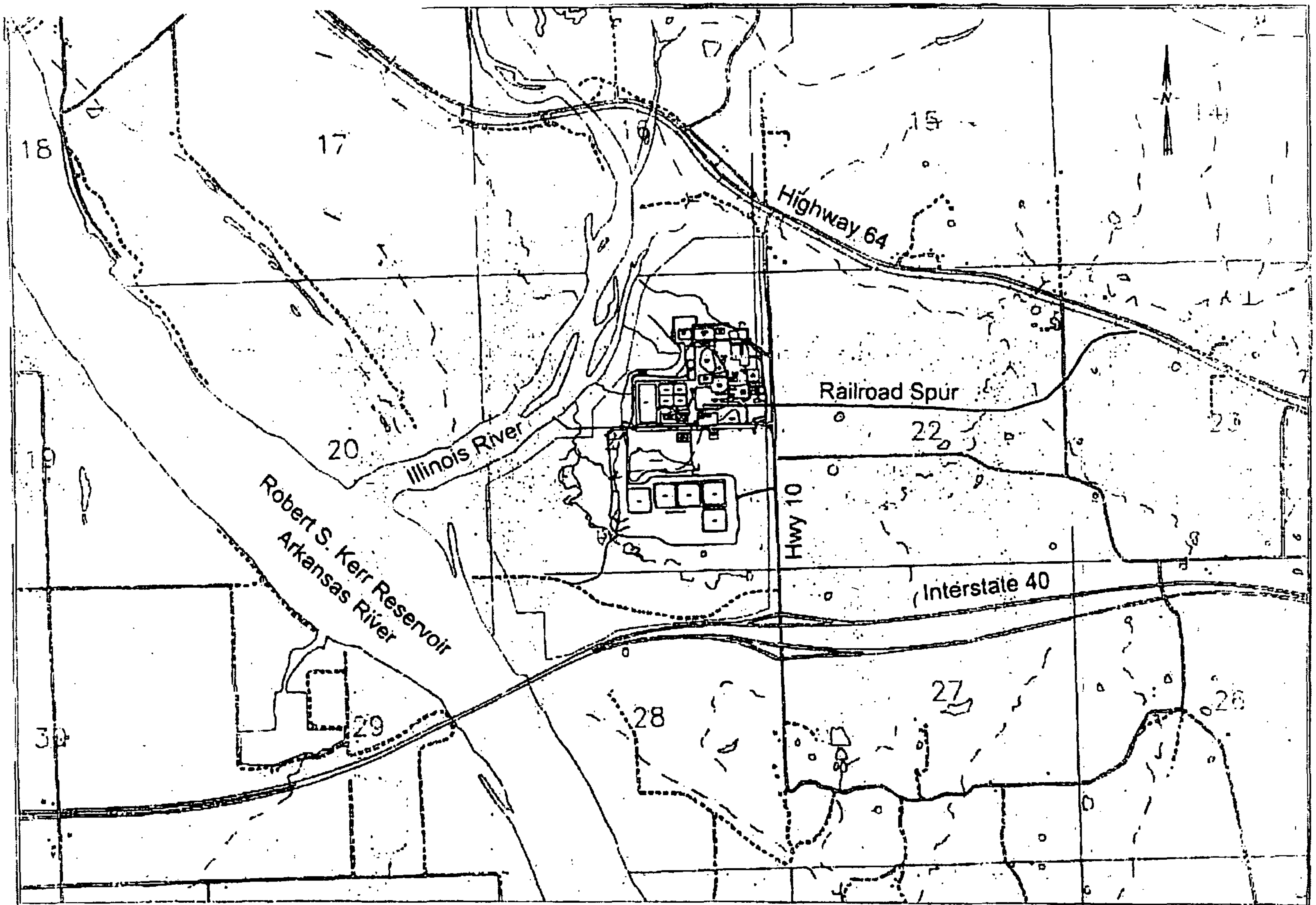
Gregory F. Suber, Acting Chief
Environmental Review Branch
Division of Waste Management
and Environmental Protection
Office of Federal and State Materials
and Environmental Management Programs

Docket No.: 40-8027
License No.: SUB-1010

Enclosure:
Map of Potential Rail Spur Route

cc:
Craig Harlin, SFC
Melvena Heisch, OK State Historic Preservation Office
Jeannine Hale, Esq., Cherokee Nation

Enclosure
Map of Potential Rail Spur Route
(ML070730141)



SEQUOYAH FUELS CORPORATION
Environmental Report

TITLE	Proposed Location of Railroad Spur Railroad Access to Site
PREPARED BY: SCM	FILENAME: RailroadSpur.dwg
REVIEWED BY: CLH	FIGURE NO. 01
DATE: 16 Feb 2007	

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

March 19, 2007

Ms. Jeannine Hale
Acting Administrator
Environmental Protection Programs
Cherokee Nation
P.O. Box 948
Tahlequah, OK 74464

SUBJECT: REQUEST FOR IDENTIFICATION OF HISTORIC OR PRE-HISTORIC RESOURCES ON OR NEAR THE SEQUOYAH FUELS CORPORATION SITE IN GORE, OKLAHOMA

Dear Ms. Hale:

By letter dated January 28, 2003, Sequoyah Fuels Corporation (SFC) submitted to the U.S. Nuclear Regulatory Commission (NRC) staff a proposed reclamation plan for SFC's site in Gore, OK. SFC has revised this proposed reclamation plan several times in response to questions raised by the NRC staff. The NRC staff is preparing an Environmental Impact Statement (EIS) to document its evaluation of the potential environmental impacts from SFC's proposed plan and reasonable alternatives to that plan. The EIS is being prepared in accordance with the requirements of the National Environmental Policy Act of 1969, as amended, as specified in 10 CFR Part 51 of the NRC's regulations. As part of its environmental review, the NRC staff also is considering the potential impact of the proposed plan on historic and cultural resources in accordance with the National Historic Preservation Act.

The present undertaking is the proposed reclamation of wastes produced by past site operations and of site soils and groundwater impacted by those operations. SFC is proposing to construct an onsite disposal cell to contain these wastes and impacted soils. Materials used for cell construction would be obtained from onsite sources or from nearby quarries. Maps of the site and vicinity are enclosed (Enclosure 1).

In the past, the NRC staff has consulted with the Cherokee Nation regarding SFC's proposed decommissioning and reclamation of its site. Enclosed is a response of Mr. David Comingdeer Rabon, dated August 29, 2001 (Enclosure 2), in which he stated that the Cherokee Nation had no objection to decommissioning of the SFC site and that the Cherokee Nation was not aware of any significant historic or pre-historic sites in the project area. SFC's current proposed reclamation activities are similar in scope and extent to those evaluated in that earlier consultation letter

In addition, as part of its EIS process, the NRC staff has identified a reasonable alternative to SFC's proposed reclamation plan. This alternative would involve the shipment offsite of all of the contaminated wastes and soils reclaimed by SFC. Such offsite shipment would necessitate the construction of a three-mile rail spur from the SFC site to the nearest main rail line. Enclosed is a figure showing the approximate route of this potential rail spur (Enclosure 3).

By this letter, the NRC staff is asking if the Cherokee Nation is aware of any historic or pre-historic resources within the SFC site or along the route of the potential rail spur that could be adversely affected by the proposed reclamation of the Gore site.

If you have any questions, please contact Mr. James Park of my staff. Mr. Park can be reached at 301-415-6935 or by e-mail to jrp@nrc.gov.

Sincerely,

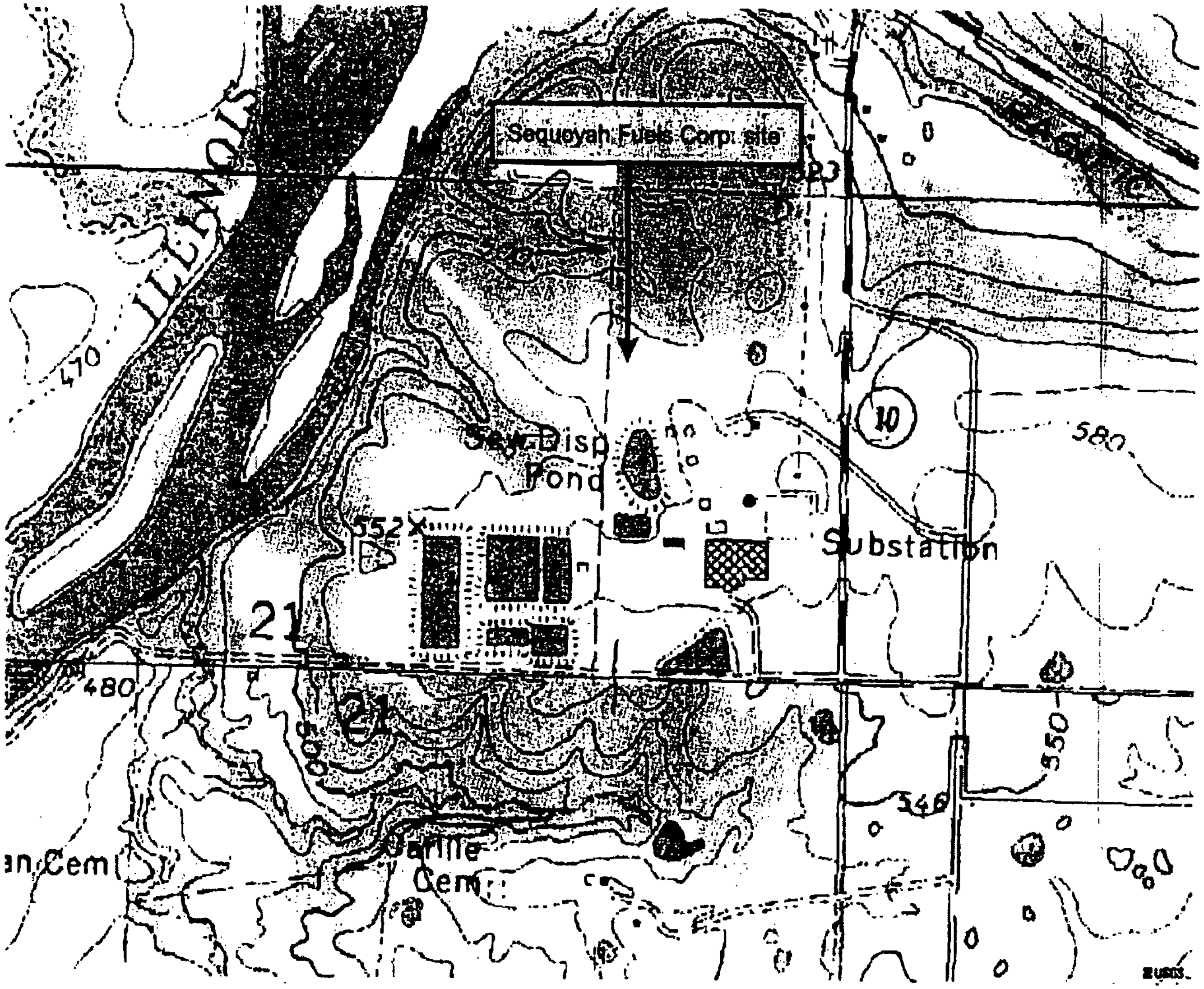
Gregory F. Suber, Acting Chief
Environmental Review Branch
Division of Waste Management
and Environmental Protection
Office of Federal and State Materials
and Environmental Management Programs

Docket No.: 40-8027
License No.: SUB-1010

Enclosures:
1. Maps of the SFC site and vicinity
2. August 29, 2001 letter from David Comingdeer Rabon
3. Map of Potential Rail Spur Route

cc:
Craig Harlin, SFC
Melvena Heisch, OK SHPO
Robert Brooks, OK Archeological Survey

Enclosure 1
Maps of Sequoyah Fuels Corporation Site and Vicinity
(ML063110539)



Sequoyah Fuels Corp. site
ILLINOIS
470
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Pond
552X
Substation
10
580
21
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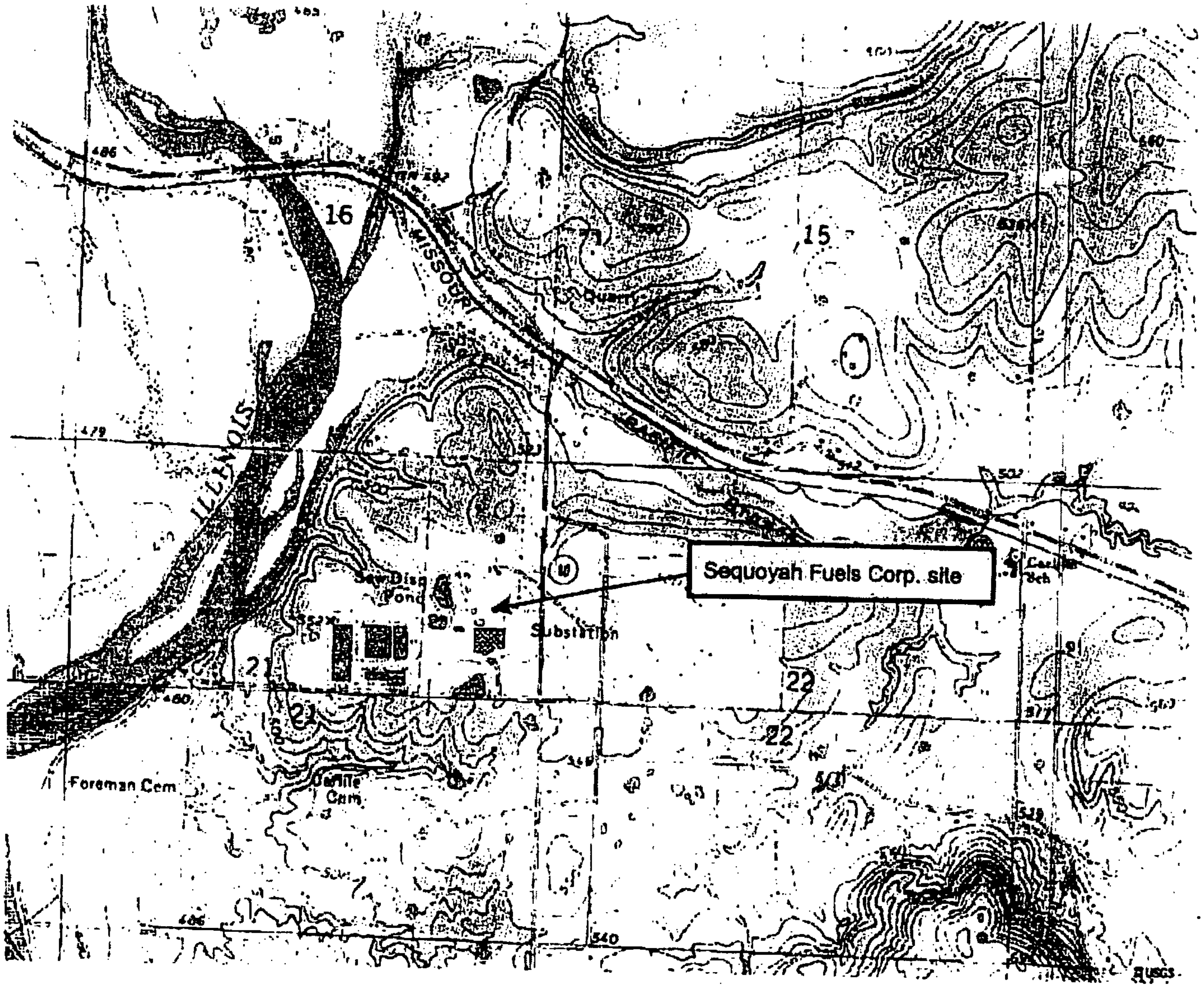
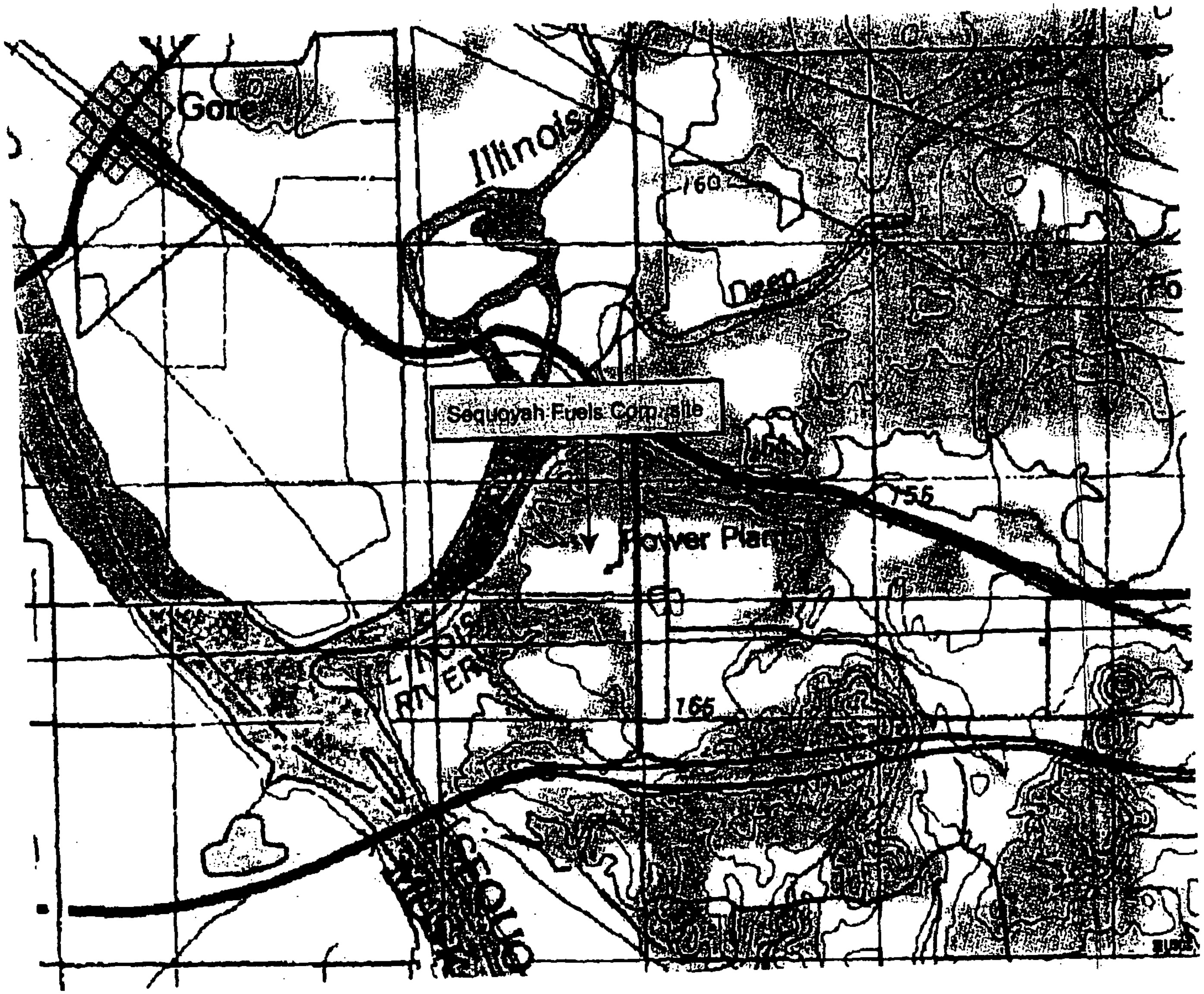
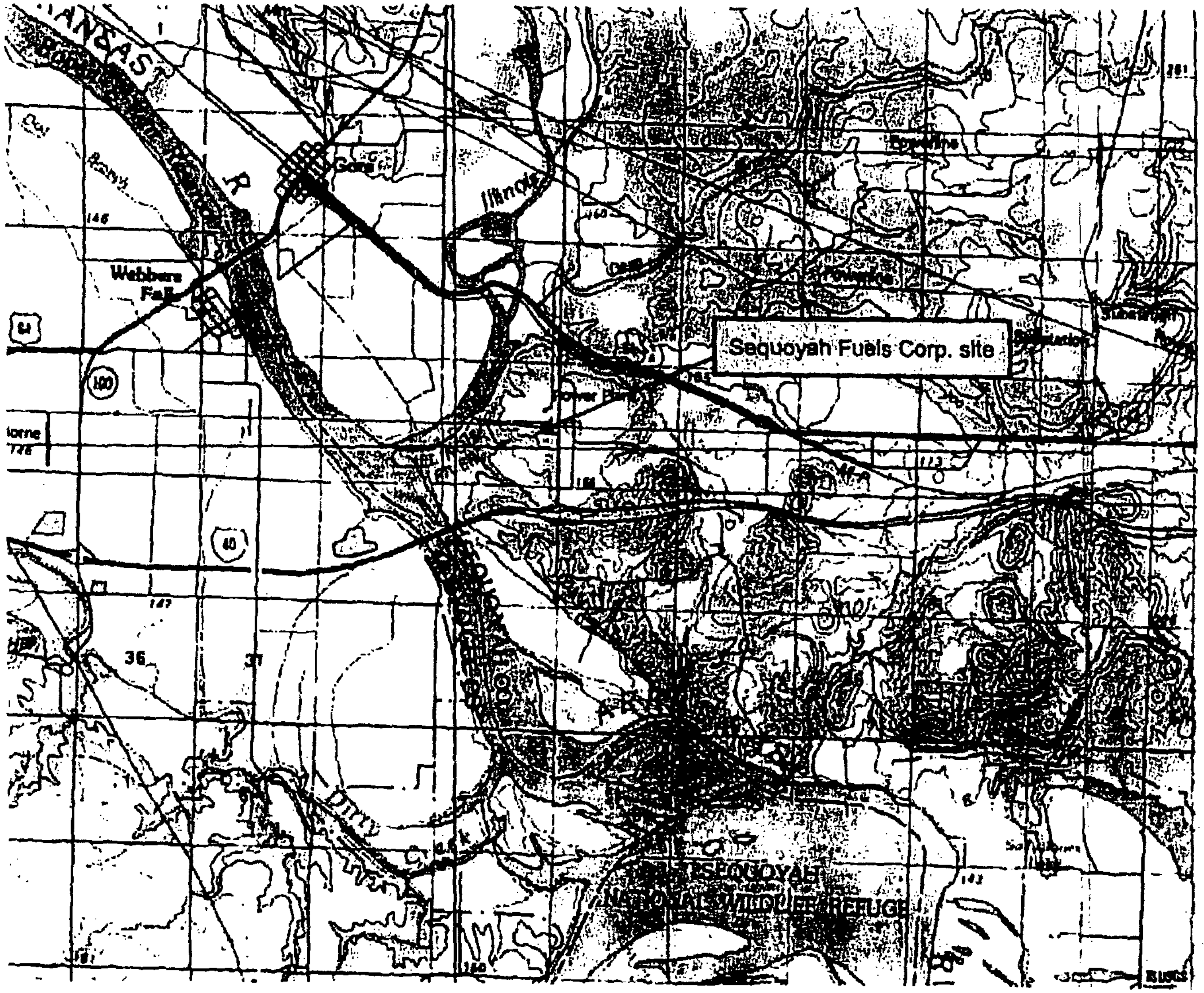
546
an Cem
Cem


Sequoyah Fuels Corp. site
16
15
21
22
MISSOURI
ILLINOIS
Substation
Foreman Cem
USGS


Gore
Illinois
160
Deep
Sequoyah Fuels Corp. site
156
Power Plan
165


Sequoyah Fuels Corp. site
Webbers Falls
Gore
Illinois
Dirty Creek

Enclosure 2
August 29, 2001, Letter from David Comingdeer Rabon,
Cherokee Nation
to Phyllis Sobel, NRC
(ML013650373)

40-8027

CHEROKEE NATION

P.O. Box 948
Tahlequah, OK 74465-0948
918-456-0671

Chad "Corntassel" Smith
Principal Chief

Hastings Shade
Deputy Principal Chief

August 29, 2001

Phyllis Sobel, PH. D.
Project Manager
US Nuclear Regulatory Commission
Washington, DC 20555

Re: The proposed decommissioning of Sequoyah Fuels Site in Sequoyah County, OK

Dear Ms. Sobel,

The Cherokee Nation does not object to your proposed project. We are unaware of any significant historic or pre-historic sites in your project area. However, Native American human remains and associated funerary items may exist in the area, as well as isolated archaeological sites.

Please contact this office if buried archaeological materials such as chipped stone tools, pottery, bone, historic crockery, glass, metal items, or building materials are inadvertently discovered during decommissioning of the site.

If you have any further questions or concerns, please feel free to contact me at the number below.

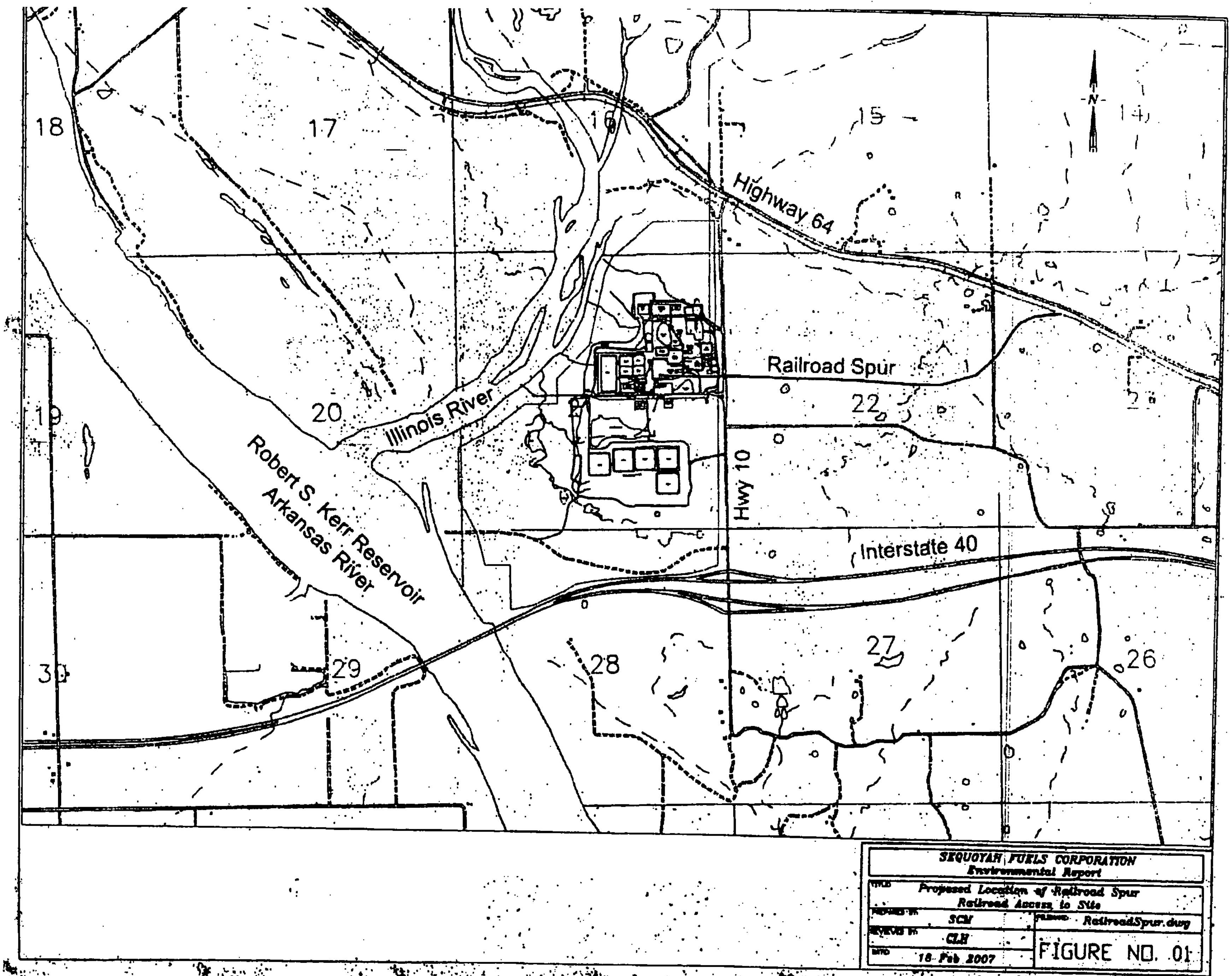
Wa-do,

David Comingdeer Rabon
Historic Preservation Specialist
Department of Natural Resources
Phone: (918) 456-0671 ext. 2631
Fax: (918) 458-7673

NMSS01 Public

Rec'd from NMSS 12/31/01

Enclosure 3
Map of Potential Rail Spur Route
(ML070730141)


18
17
16
15
14
N
Highway 64
Railroad Spur
22
20
19
Illinois River
Robert S. Kerr Reservoir
Arkansas River
Hwy 10
Interstate 40
30
29
28
27
26
SEQUOYAH FUELS CORPORATION
Environmental Report
Proposed Location of Railroad Spur
Railroad Access to Site
SCM
CLH
18 Feb 2007
RailroadSpur.dwg
FIGURE NO. 01

Oklahoma Historical Society *Founded May 27, 1893*

State Historic Preservation Office
Oklahoma History Center • 2401 North Laird Ave. • Oklahoma City, OK 73105-7914
(405) 521-6249 • Fax (405) 522-0816 • www.okhistory.org/shpo/shpom.htm

April 11, 2007

Mr. Gregory Suber, Acting Chief
Environmental Review Branch
Div. of Waste Mgmt. & Env. Protection
Office of Federal & State Materials
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

File #0426-07; Revised Sequoyah Fuels Reclamation Project in Grove, Sequoyah County, Oklahoma

Mr. Suber:

In reply to your revised determination of no adverse affect on prehistoric resources from proposed reclamation of materials associated with the Sequoyah Fuels Corporation's site in Gore, Oklahoma, you mention that you are still awaiting our reply to your letter of November 27, 2006, for review of the initial onsite disposal option. Your letter (from Ms. Jennifer Davis), dated November 28, 2006 was received in our office on December 4, 2006. We did respond to Ms. Davis on December 20, 2006, with a finding that no historic properties would be affected. A copy of our response is attached.

In regard to your revised proposal to ship materials off site by way of a three-mile rail spur connected to the nearest main rail line, we concur with Dr. Robert Brooks' recommendation that an archeological survey be conducted of the spur line route. In the event that such an investigation reveals the presence of prehistoric archeological sites, we will defer to the judgment of the OAS concerning whether or not any of the resources should be considered "historic properties" under the Section 106 review process. If sites dating from the historic period are identified during the survey or are encountered during implementation of the project, additional assessments by the State Historic Preservation Office will be necessary.

Thank you for the opportunity to review this project. If you have any questions, please call Charles Wallis, RPA, Historical Archeologist, at 405/521-6381. Please reference the above underlined file number when responding. Thank you.

Sincerely,

Melvena Heisch
Deputy State Historic
Preservation Officer

MH:pm
Attachment

Oklahoma Historical Society *Founded May 27, 1893*

State Historic Preservation Office

Oklahoma History Center • 2401 North Laird Ave. • Oklahoma City, OK 73105-7914

(405) 521-6249 • Fax (405) 522-0816 • www.okhistory.org/shpo/shpom.htm

December 20, 2006

COPY

Ms. B. Jennifer Davis, Chief
Environmental Review Section
Office of Federal & State Materials
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

RE: File 0426-07; Sequoyah Fuels Reclamation Project in Gore, Oklahoma

Dear Ms. Davis:

We have received and reviewed the documentation concerning the referenced project in Sequoyah County. Additionally, we have examined the information contained in the Oklahoma Landmarks Inventory (OLI) files and other materials on historic resources available in our office. We find that there are no historic properties affected by the referenced project.

Thank you for the opportunity to comment on this project. We look forward to working with you in the future.

If you have any questions, please contact Charles Wallis, RPA, Historical Archaeologist, at 405/521-6381.

Should further correspondence pertaining to this project be necessary, the above underlined file number must be referenced. Thank you

Sincerely,

Melvena Heisch
Deputy State Historic
Preservation Officer

MH:pm

Oklahoma Archeological Survey

THE UNVERSITY OF OKLAHOMA

March 28, 2007

Gregory F. Suber
Acting Chief
Environmental Review Branch
Division of Waste Management
& Environmental Protection
Office of Federal and State Materials
& Environmental Management Programs
Nuclear Regulatory Commission
Washington, DC 20555-0001

Re: Revised determination of No Adverse Affect on Prehistoric Resources From Proposed Reclamation of Sequoyah Fuels Corporation's Site in Gore, Oklahoma. Legal Description: N ½ Section 22 and NW ¼ Section 23 T12N R21E, Sequoyah County, Oklahoma.

Dear Mr. Suber:

I have examined the above referenced action pertaining to its potential affect on Oklahoma's cultural heritage. I concur with the finding that on-site reclamation of the Sequoyah Fuel's locality will have no effect on archaeological and/or historic cultural resources eligible for the National Register of Historic Places. In regard to the proposed alternative plan of shipping contaminated soils and wastes off-location by rail, I have examined the proposed railroad spur line for the presence of previousl recorded archaeological sites. There are no known or previously recorded sites within the proposed spur corridor although an historic site (34SQ337) does exist to the south of the spur in Section 22. However, the right-of-way for the railroad spur has not been examined for cultural resources. Considering the sensitivity of this setting (confluence of the Illinois and the Arkansas rivers) and the potential for post-removal Cherokee settlements, it is my opinion that the spur should be examined for cultural resources if this alternative is selected.

This review has been conducted in cooperation with the State Historic Preservation Office, Oklahoma Historical Society.

Sincerely,

Robert L. Brooks
State Archaeologist

Cc: SHPO

111 E. Chesapeake, Room 102, Norman, Oklahoma 73019-5111 PHONE: (405) 325-7211 FAX: (405) 325-7604
A UNIT OF ARTS AND SCIENCES SERVING THE PEOPLE OF OKLAHOMA

APPENDIX D

RADIATION DOSE AND RISK ASSESSMENTS

D. RADIATION DOSE AND RISK ASSESSMENTS

This appendix describes the analysis of potential health impacts from the licensee's proposed action to conduct surface reclamation of its Gore, Oklahoma, site and alternatives to the proposed action. This appendix contains two major sections—a discussion of the residual contamination present at the Sequoyah Fuels Corporation (SFC) site (Section D.1); and the radiation dose and risk modeling for workers and members of the public (Section D.2).

D.1 Residual Contamination

Table D-1 lists the six areas on the SFC site that are contaminated with radioactive materials. SFC had already completed remediation activities on contamination in two additional areas, Areas 7 and 8, before development of this DEIS; therefore, this analysis did not consider those areas (Camper, 2000). Table D-2 lists the surface area and depth of each contaminated area. The analysis used the monitoring and sampling data that Roberts/Schnorinick collected at the SFC site (RSA, 1996) to determine the level of contamination in each of the six areas and soil source terms for contiguous areas of relatively homogeneous contamination. In addition, RSA identified subareas of specific contamination that are dissimilar to the homogeneous soil source term for the contaminated area. Based on the evaluation of soil contamination data, the staff of the U.S. Nuclear Regulatory Commission (NRC) determined that the constituents of concern (COC) are arsenic, fluoride, nitrate, and uranium. The NRC staff made this determination based on the concentrations and potential environmental impacts of the contaminants. In addition, NRC staff included thorium-230 and radium-226 to enable a more complete evaluation of potential radiation doses. Table D-3 summarizes the COC concentrations at the SFC site and provides overall average concentrations of the radioactive constituents in units of becquerels (picocuries) per gram.

Table D-1 Contaminated Areas on the SFC Site

Contaminated Area	Description
1	Fluoride Clarifier, two Fluoride Settling Basins, Fluoride Holding Basin No. 1, four Fluoride Sludge Burial Areas
2	Four Clarifier A Basins, Pond 1 and 2, Spoils Pile, Former Raffinate Treatment Area, Former BaCl Mixing Area, Centrifuge Building, Injection Well
3	Main Process Building, Solvent Waste Building, Emergency Basin, Sanitary Lagoon, North Ditch, Incinerator, Solid Waste Building, South Yellow Cake Sump, Yellow Cake Storage Pad, Combination Stream, Present Lime Neutralization Area, Sanitary Sewer, Line, North Tank Farm, South Tank Farm, Cooling Tower, ADU/Miscellaneous Digestion Bldg., Bechtel Storage Building, Oil Storage Building, RCC Evaporator
4	Two Solid Waste Burial Areas, Interim Storage Cell, Scrap Metal Storage Area
5	Four Fertilizer Storage Ponds, Fertilizer Loadout Area, Pond 4
6	Fluoride Holding Basin No. 2

Source: SFC, 1998.

Table D-2 Size of Contaminated Areas

Contaminated Area	Surface Area (m^2)	Soil Depth (m)
1 – No Data from the Source	N/A	N/A
2 – Soils	26,110	1.0
Pond 2	18,835	2.6
Clarifiers	12,030	1.5
3 – Soils	26,110	1.5
North Ditch	1,212	0.5
Emergency Basin	3,542	0.1
Sanitary Lagoon	2,883	0.2
10a Source	10	1.0
4 – Soils	21,500	1.5
5 – Soils	18,950	1.5
6 - Soils	1,160	1.5
Sludges	3,340	1.6

Source: RSA, 1996.
m^2 - square meter
m – meter
N/A - Not Available.

Table D-3 Existing Contamination Concentrations by Contaminated Area

Contaminated Area	Arsenic (mg/kg)	Fluoride (mg/kg)	Nitrate (mg/kg)	Uranium (mg/kg)	Uranium Bq/g (pCi/g)	Thorium-230 Bq/g (pCi/g)	Radium -226 Bq/g (pCi/g)
1 – Soils	5	460	55.7	26.5	0.37 (10)	0.13 (3.5)	0.0054 (0.2)
Sludges	133	31,800	205	460	0.63 (173)	6.9 (186)	0.011 (0.3)
2 – Soils	5	529	507.7	15.0	0.21 (5.6)	1.8 (49.7)	0.77 (2.1)
Pond 2	--	1,640	5,450	607	4.4 (118)	72 (1,950)	2.5 (66.3)
Clarifiers	1,350	33,100	27,300	15,900	221 (5,978)	756 (20,400)	12 (317)
3 – Soils	--	572	65.4	424	5.9 (159)	2.1 (56)	0.11 (2.92)
North Ditch	37.5	9,100	510	17,600	245 (6,618)	86 (2,320)	4.4 (120)
Emergency Basin	97.5	6,840	24.9	7,470	104 (2,809)	103 (2,785)	9.1 (245)
Sanitary Lagoon	440	2,680	228	24,300	338 (9,137)	14 (384)	0.25 (6.7)
10a Source	--	1,050	2.4	3,970	55 (1,493)	19 (525)	1 (27)
4 - Soils	5	396	36	432.6	6 (163)	1.1 (28.8)	0.037 (0.99)
5 - Soils	5	258	4.4	10.7	0.15 (4)	0.85 (2.3)	0.67 (1.8)

Table D-3 Existing Contamination Concentrations by Contaminated Area

Contaminated Area	Arsenic (mg/kg)	Fluoride (mg/kg)	Nitrate (mg/kg)	Uranium (mg/kg)	Uranium Bq/g (pCi/g)	Thorium-230 Bq/g (pCi/g)	Radium -226 Bq/g (pCi/g)
6- Soils	18.5	507	45.5	22.9	0.32 (8.6)	0.11 (3.0)	0.0074 (0.2)
Sludges	7.3	39,900	242	1,280	18 (481)	7 (190)	0.59 (1.6)
Overall Average	**N/A**	**N/A**	**N/A**	**5,180**	**72 (1,940)**	**76 (2,063)**	**2.6 (71)**

Source: RSA, 1996.
mg – milligram
kg – kilogram
Bq – Becquerel
g – gram
pCi – picocurie
N/A - Not Available
-- - not sampled.

D.2 Radiation Dose and Risk Modeling

The analysis for this draft environmental impact statement (DEIS) considered the following potential public and occupational impacts:

- Radiation doses and risks for members of the public during reclamation. The NRC staff considered the affected population to be that within 80 kilometers (50 miles) of the SFC facility; the primary exposure pathway would be from radioactive material suspended in the air from reclamation operations.
- Long-term doses and risks for individuals who inhabit the site. Because of the long half-lives of the radioactive materials at SFC, it may be possible that individuals could potentially inhabit both the unrestricted and restricted portions of the site if loss of institutional controls or license conditions occurs, depending on the alternative.
- Potential impacts on radiation workers during reclamation for the average and maximally exposed workers and the average collective workforce.
- Impacts on workers during institutional controls for average workers.
- Exposures to hazardous chemicals.
- Fatalities and injuries in the workforce during reclamation activities.

No high-energy sources (e.g., explosives or nuclear fuel) capable of driving off-site releases that could lead to criticality accidents would be involved during reclamation, unlike normal facility operations; therefore, there would be little potential for off-site consequences from accidents during reclamation. This analysis of public health impacts concluded that the impacts for transportation of radioactive wastes off the site would bound those from any on-site accidents. Therefore, this analysis did not consider accidents during on-site reclamation activities that could involve off-site members of the public.

Title 10, "Energy," of *the U.S. Code of Federal Regulations* (CFR), Part 20 (10 CFR Part 20), contains the regulations that govern reclamation of the SFC facility and remediation of the site before license termination. This regulation provides the regulatory limits for occupational doses and radiation dose for individual members of the off-site public. For occupational doses, 10 CFR § 20.1201 states that licensees must limit the occupational dose to individual adults to an annual limit based on the more limiting of:

- The total effective dose equivalent (TEDE) being equal to 0.05 sievert (5 rem), or
- The sum of the deep dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 0.5 sievert (50 rem).

The annual limits to the lens of the eye, to the skin of the whole body, and to the skin of the extremities are:

- A lens dose equivalent of 0.15 sievert (15 rem).
- A shallow-dose equivalent of 0.5 sievert (50 rem) to the skin of the whole body.
- A shallow-dose equivalent of 0.5 sievert (50 rem) to the skin of any extremity.

In addition to the annual occupational dose limits, 10 CFR § 20.1201 limits the soluble uranium intake by an individual to 10 milligrams in a week because of chemical toxicity.

For members of the public during reclamation, and for industrial workers during long-term maintenance periods who are assumed to be members of the public, the regulation provides an explicit TEDE limit of 1.0 millisievert (100 millirem) per year from all sources. This limit includes both internal and external doses through all pathways, including food, as required by specific exposure scenarios. External dose rates cannot exceed 0.02 millisievert (2 millirem) in any 1 hour. Further, the standards in 10 CFR § 20.1101 and 40 CFR Part 190 would be generally applicable during reclamation; 40 CFR Part 190 requires that routine releases from uranium fuel-cycle facilities to the general environment do not result in annual doses above 0.25 millisievert (25 millirem) to the whole body, 0.75 millisievert (75 millirem) to the thyroid, and 0.25 millisievert (25 millirem) to any other organ.

For alternatives that would result in unrestricted release of the site, doses to members of the public are limited by determining the cleanup levels (CLs) using the benchmark dose approach in 10 CFR Part 40, Appendix A. As described in Section D.2.1.3, the analysis based the CLs on a fraction of the benchmark dose for radium of 0.54 millisievert (54 millirem) per year.

The following sections present the methods, models, and data the analysis used to estimate potential public and occupational health impacts. Section D.2.1 discusses the impacts from on-site disposal of only contaminated materials (Alternative 1, which is the proposed action); Section D.2.2 addresses off-site disposal of all contaminated materials (Alternative 2); Section D.2.3 addresses partial off-site disposal of contaminated materials (Alternative 3); and Section D.2.4 addresses the impacts of the no-action alternative.

D.2.1 Alternative 1: On-site Disposal of Contaminated Materials (the Licensee's Proposed Action) – Doses to Members of the Public

SFC proposes to decontaminate, dismantle, and decommission its licensed activities at its site near Gore, Oklahoma. The facility was a chemical plant that converted uranium ore concentrate (yellowcake) to UF_6 and depleted UF_6 to depleted UF_4. SFC's proposed action is on-site disposal of all contaminated materials (Alternative 1). For Alternative 1, SFC would place contaminated soils and other sources (building rubble, sludge, residue, and sediment) with concentrations that exceeded the Derived Concentration Guideline Levels (DCGLs) within an institutional control boundary (ICB) in an on-site disposal cell (SFC, 1999). The estimated concentrations of specific radionuclides are provided in Table D-4. SFC proposes to maintain all contaminated areas within a restricted area. The above-grade disposal cell would cover about 4 hectares (10 acres). The ICB would restrict unauthorized personnel access to the area. SFC would design the engineered disposal cell to comply with the NRC performance standards, which are outlined in Appendix A of 10 CFR Part 40.

Table D-4 On-site Disposal Material Summary

Layer	Description	Natural Uranium Bq/g (pCi/g)	Radium-226 Bq/g (pCi/g)	Thorium-230 Bq/g (pCi/g)
A	Sludge and Sediment	13-448 (17-587)	0.22-12 (0.29-16)	7.8-604 (10-791)
B	Liner Soils and Subsoils	0.19-3.5 (0.25-4.6)	0.019-0.78 (0.025-1.0)	1.7-2.6 (47-70)
C	Calcium Fluoride Sediments, Debris	6.2-19 (8.1-14.5)	0.0074-0.029 (0.0084-0.038)	0.078-0.18 (0.10-0.24)
D	Contaminated Site Soils	9.3 (12.2)	– –	– –

Source: Reclamation Plan, Attachment E, Table 2.1 (SFC, 2005).

D.2.1.1 Alternative 1: Off-site Public Radiation Doses and Risks during Reclamation

Off-site public exposures would occur because of the atmospheric release of radionuclides in soil suspended in air. This would occur during the movement of material from the known contaminated areas to the disposal cell in the ICB. SFC collected off-site air samples during previous reclamation activities at the site. The determination of potential public doses used these samples in an inhalation modeling analysis to provide a reasonable basis for the estimation of the potential off-site public radiation doses for Alternative 1. The analysis used SFC air-monitoring data from the nearest residence air sampler for the period from 1995 through 1998 (SFC, 2005; see Table D-5) to estimate inhalation committed effective dose equivalents (CEDEs). The NRC staff consider this location to be the location of the maximally exposed individual (MEI) in the public. These estimated inhalation doses range from 0.003 to 0.005 millisievert (0.3 to 0.5 millirem) per year. These doses are a small fraction of the 0.25-millisievert-per-year (25-millirem-per-year) limit for site operations and are considered to be as low as reasonably achievable (ALARA). This analysis used 0.005 millisievert (0.5 millirem) per year as the annual dose to the MEI in the public during reclamation. For comparison, an average individual living in Oklahoma receives a radiation dose of about 3.6 millisievert (360 millirem) per year from all sources (NCRP, 1987). The lifetime doses the MEI would receive during the four-year reclamation period, and assuming constant off-site public doses over this period, would be about 0.02 millisievert (2 millirem) under Alternative 1.

Table D-5 Inhalation doses (CEDE) at the Nearest Resident Air-Monitoring Station of SFC

Year	CEDE mSv/yr (mrem/yr)
1995	0.005 (0.5)
1996	0.004 (0.4)
1997	0.003 (0.3)
1998	0.003 (0.3)

Source: SFC, 2005, Table 4-3.
mSv - millisievert; yr - year; mrem - millirem.

The analysis next compared inhalation dose assessments for a similar reclamation project that involved similar radionuclides and mixtures. Table D-6 lists the Weldon Spring Site reclamation inhalation dose estimates for 1994 through 1997. The analysis concluded that the Weldon Spring doses are comparable to those based on air concentration measurements at SFC during previous reclamation activities, and that they are less than 0.01 millisievert (1 millirem) per year.

Because the estimated public radiation dose rapidly decreases with distance downwind due to dispersion of the airborne contaminants, the assumption that 1,000 individuals would receive the MEI dose would bound the total collective population dose. This would equal 0.005 person-sievert (0.5 person-rem) per year. Again, the analysis assumed that reclamation activities would occur over a four-year period, so the estimated potential total collective dose to the off-site population would be 0.02 person-sievert (2 person-rem) for Alternative 1.

Table D-6 Inhalation Doses (CEDE) to the Hypothetical MEI Member of the Public at the Weldon Spring Site Remedial Action Project

Year	CEDE mSv/yr (mrem/yr)
1994	0.002 (0.2)
1995	0.002 (0.2)
1996	0.009 (0.9)
1997	0.002 (0.2)

Source: Environmental Report (SFC, 2005), Table 4-4.
mSv – millisievert
yr – year
mrem - millirem.

The analysis estimated the probabilities of latent cancer fatalities (LCFs) for members of the public using a dose-to-risk conversion factor of 6×10^{-5} per millisievert (6×10^{-7} per millirem) for members of the public during the four-

> **Latent cancer fatalities (LCFs)** are potential cancer deaths caused by exposure to ionizing radiation. They are derived and based on scientific evaluation of exposed populations, including the Japanese survivors of nuclear weapons detonations. Multiplying the annual or lifetime radiation dose to an individual or population by a dose-to-risk conversion factor results in the estimate of LCF probability.

year reclamation period. The U.S. Environmental Protection Agency (EPA) recommended this factor for the general population of the United States (Eckerman et al., 1999). This factor considers all age groups within the population, including infants and children, who are more sensitive to radiation than adults. Because workers are 18 years of age or older, the analysis used a separate, smaller dose-to-risk conversion factor for workers, as recommended by the International Commission on Radiological Protection (ICRP), of 4×10^{-5} per millisievert (4×10^{-7} per millirem) (ICRP, 1990, p. 22).

Table D-7 lists the estimated probabilities of LCFs to the MEI and the off-site collective population, both for a single year and for the total reclamation period. The estimated total population probability of an LCF would be low (1.2×10^{-3}), and the annual radiation doses would be within the regulatory limit on annual doses, i.e., less than 0.25 millisievert (25 millirem) per year; therefore, the significance level of public radiation exposures and risks for reclamation activities for Alternative 1 would be SMALL.

Table D-7 Estimated Probabilities of LCFs for the MEI and the Collective Population for Alternative 1

Individual Annual Risk	Individual Lifetime Risk[a]	Collective Annual Risk	Collective Lifetime Risk[a]
3.0×10^{-7}	1.2×10^{-6}	3.0×10^{-4}	1.2×10^{-3}

[a] Over the four years of reclamation activities.

D.2.1.2 Alternative 1: Worker Radiation Doses and Risks during Reclamation

Derived air concentration (DAC) means the concentration of a given radionuclide in air that, if breathed by the reference person for a working year of 2,000 hours under conditions of light work (at an inhalation rate of 1.2 cubic meters [42 cubic feet] of air per hour), results in an intake of the annual limit on intake (ALI). The ALI is the derived limit for the amount of radioactive material taken into the body of an adult worker that would result in a CEDE of 50 millisievert (5 rem) per year.

The analysis based the estimates of radiation doses to reclamation workers for Alternative 1 on measured doses to workers during the raffinate sludge dewatering project, a previous reclamation activity at the SFC site. The worker doses from this previous reclamation project will bound the worker doses from other reclamation activities since the radionuclide concentrations were higher than will be encountered for other reclamation activities. Table D-8 summarizes the SFC exposures for the raffinate sludge dewatering project during the second and third quarters of 2005. The table lists the work activities, external deep dose equivalents, and the derived air concentration (DAC)-hours of inhalation intake. The DAC is the air concentration of a specific radionuclide that, if inhaled for a normal work year (2,000 hours), would result in the occupational dose limit of 50 millisievert (5 rem per year). Table D-8 lists the average doses and DAC-hours for each quarter, the averages over the two quarters, and the estimated annual average worker external doses and DAC-hours. The annual average DAC-hours translate into dose through division of the average DAC-hours by 2,000 hours of exposure in a year and multiplication by 50 millisievert (5 rem) per year—the basis of the DAC calculation. The maximum annual worker dose would be for the Press Washdown work activity.

Table D-8 SFC Raffinate Sludge Dewatering Project Exposure and Alternative 1: Estimated Average and Maximum Worker Doses and Intakes

Work Activity	Average Worker Exposure	
	External[a] mSv (mrem)	Internal DAC-hr
Second Quarter - 2005		
Sludge Transfer	0.31 (31)	47
Press Operation	0.37 (37)	122
Press Washdown	0.25 (25)	104
Filter Cake Bagging	0.26 (26)	46
Forklift Operation	0.33 (33)	0.5
Bag Stacking	0.47 (47)	0.7
Health and Safety Support	0.22 (22)	0
Second Quarter Average	**0.32 (32)**	**46**
Third Quarter - 2005		
Sludge Transfer	0.28 (28)	98.8
Press Operation	0.55 (55)	141
Press Washdown	0.35 (35)	152
Filter Cake Bagging	0.47 (47)	131
Forklift Operation	0.27 (27)	2
Bag Stacking	0.29 (29)	5.7
Health and Safety Support	0.19 (19)	1.1
Third Quarter Average	**0.34 (34)**	**76**
Second and Third Quarter Average	**0.33(33)**	**61**
Estimated Annual Totals	**1.32 (132)**	**244**

[a] As measured by thermoluminescent dosimeters.
mSv – millisievert
mrem – millirem
hr - hour.

As listed in Table D-9, the estimated annual TEDE to workers for Alternative 1, based on measured worker doses and intakes from the raffinate sludge-dewatering project, would be 7.47 millisievert (747 millirem) per year. This annual TEDE would bound the annual doses to reclamation workers for Alternative 1 because the average radionuclide concentrations at the site are only about 30% of the concentrations encountered during the raffinate sludge-dewatering project. The best estimate of annual worker doses using average radionuclide concentrations would be 30% of the raffinate sludge dewatering project doses, or about 2.2 millisievert (220 millirem) per year. Both the bounding and best-estimate worker annual TEDEs are within the NRC occupational radiation protection standard of 50 millisievert (5 rem) per year. Total doses to a worker during the four years of reclamation activities, assuming a worker is employed at the same task for the entire period, and assuming that the annual average TEDEs remain constant, would result in a worker lifetime TEDE of about 8.8 millisievert (880 millirem).

The analysis estimated the total collective dose to the workforce and the probabilities of LCFs to that workforce for Alternative 1, using the radiation worker labor force summarized by quarter and labor category in Table D-10. The resulting estimated TEDEs by quarter and year, and the estimated probabilities of LCFs by year, are presented in Table D-11. The estimated probabilities of LCFs were developed using a dose-to-risk conversion factor of 4×10^{-5} per millisievert (4×10^{-7} per millirem) for industrial workers (ICRP, 1990). Table D-12 summarizes the estimated annual probabilities of LCFs to the average and maximum individual worker, the lifetime probability of an LCF to the average worker, and the collective worker population for the four-year reclamation period.

The estimated total worker probability of an LCF would be low (1.3×10^{-2}), and the annual worker radiation doses would be within the regulatory limit of 50 millisievert (5 rem) per year; therefore, the significance level of worker radiation exposures and risks for reclamation activities for Alternative 1 would be SMALL.

Table D-9 Estimated Bounding Worker Annual TEDEs for Alternative 1

Dose Estimate	External[a] mSv/yr (mrem/yr)	Internal Exposure DAC-hr/yr	Internal Dose mSv/yr (mrem/yr)[b]	Annual TEDE mSv/yr (mrem/yr)
Raffinate Sludge Dewatering Project - Projected Annual Totals	1.32 (132)	244	6.1 (610)	7.4 (740)
Estimated Annual Averages for Alternative 1[c]	0.4 (40)	73	1.8 (180)	2.2 (220)

[a] As measured by thermoluminescent dosimeters.
[b] Converted from DAC-hours per year by dividing by 2,000 and multiplying by 50 millisievert (5 rem) per year.
[c] Estimated assuming annual worker doses are 30% of the annual doses that SFC recorded for the raffinate sludge dewatering project, accounting for the average waste concentrations encountered.
mSv – millisievert
yr – year
mrem – millirem
hr - hour.

Table D-10 Radiation Worker Manpower Estimates for Alternative 1

Quarter	Cell Closure	H&S Technicians	Equipment Operators	On-site Truck Drivers	Welders and Riggers	Laborers	Total
1	0	10	8	8	6	25	57
2	0	10	8	8	6	25	57
3	0	10	8	8	6	25	57
4	0	10	8	8	6	25	57
5	0	10	8	8	6	25	57
6	0	10	8	8	6	25	57
7	0	10	8	8	6	25	57
8	0	10	8	8	6	25	57
9	0	4	3	3	0	15	33
10	8	4	3	3	0	15	33
11	8	4	3	3	0	10	20
12	0	4	3	3	0	10	20
13	0	4	1	1	0	5	11
14	0	4	1	1	0	5	11
15	0	4	1	1	0	5	11
16	0	4	1	1	0	5	11

Table D-11 Collective Radiation Worker TEDEs and Estimated Probabilities of LCFs for Alternative 1

Quarter/Year	Estimated TEDE person-Sv (person-rem)	Estimated Total Collective Worker Risk
1	0.031 (3.1)	-
2	0.031 (3.1)	-
3	0.031 (3.1)	-
4	0.031 (3.1)	-
Total Year 1	**0.124 (12.4)**	**5.0×10^{-3}**
5	0.031 (3.1)	-
6	0.031 (3.1)	-
7	0.031 (3.1)	-
8	0.031 (3.1)	-
Total Year 2	**0.124 (12.4)**	**5.0×10^{-3}**
9	0.018 (1.8)	
10	0.018 (1.8)	
11	0.011 (1.1)	
12	0.011 (1.1)	
Total Year 3	**0.058 (5.8)**	**2.3×10^{-3}**
13	0.0060 (0.6)	-
14	0.0060 (0.6)	-
15	0.0060 (0.6)	-
16	0.0060 (0.6)	-
Total Year 4	**0.024 (2.4)**	**9.6×10^{-4}**
Total Over 4 Years	**0.33 (33)**	**1.3×10^{-2}**

person-Sv – person-Sievert

Table D-12 Estimated Probabilities of LCFs for Reclamation Workers and the Collective Worker Population for Alternative 1

Average Individual Worker Annual Risk	Average Individual Worker Lifetime Risk[a]	Maximum Individual Worker Annual Risk[b]	Total Collective Average Worker[c]
8.8×10^{-5}	3.5×10^{-4}	3.0×10^{-4}	1.3×10^{-2}

a Over four years of reclamation activities.

b Assuming the doses received during the SFC raffinate sludge dewatering project represent the maximum worker doses.

c Over the entire radiation worker workforce during four years of reclamation activities.

D.2.1.3 Alternative 1: Long-term Public Radiation Doses and Risks

SFC derived the CLs for the restricted and unrestricted areas of the site. For the restricted areas of the site, SFC derived the DCGLs without consideration of any institutional controls for the dose received from pathways related to residual radioactive materials in surface soil. SFC based the derivation of the DCGLs on a radiation exposure scenario analysis using the RESRAD computer program (Yu et. al., 2001) and applied the benchmark dose approach.

Appendix A, "Radiological Criteria for License Termination of Uranium Recovery Facilities," of 10 CFR Part 40 outlines the process for applying a benchmark dose. The following paragraph from 10 CFR Part 40, Appendix A, describes the "radium in soil" criterion (Criterion 6[6]):

> *Byproduct material containing concentrations of radionuclides other than radium in soil, and surface activity on remaining structures, must not result in a total effective dose equivalent (TEDE) exceeding the dose from cleanup of radium contaminated soil to the above standard (benchmark dose), and must be at levels which are as low as is reasonably achievable. If more that one residual radionuclide is present in the same 100-square-meter area, the sum of the ratios for each radionuclide of concentration present to the concentration limit, will not exceed 1 (unity). A calculation of the peak potential annual TEDE within 1,000 years to the average member of the critical group that would result from applying the radium standard (not including radon) on the site, must be submitted for approval. The use of reclamation plans with benchmark doses which exceed [1 millisievert per year] 100 [millirem per year], before application of as low as is reasonably achievable, requires the approval of the Commission after consideration of the recommendation of NRC staff.*

For the benchmark dose method, the SFC-selected scenario represented a resident farmer with the following radiation exposure pathways (Reclamation Plan, Appendix G, SFC, 2005):

- External exposure from soil.
- Inhalation of suspended soil.
- Ingestion of soil.
- Ingestion of plant products grown in contaminated soil and using potentially contaminated surface water to supply irrigation.
- Ingestion of animal products grown on the site using feed and surface water from potentially contaminated sources.
- Ingestion of fish from potentially contaminated surface water on the site.

SFC indicated that it did not consider two potential exposure pathways:

- **Groundwater usage** - SFC indicated that there are no existing active water wells near or downgradient from the facility that migrating contaminants could affect. The only active wells in the nearby region are either upgradient or so far removed that future impacts are not possible. The shallow aquifers cannot produce sufficient water to qualify as potential drinking water sources or are of such poor quality that the well water would not be suitable for domestic purposes. Because of limited groundwater in this region of Oklahoma, there are extensive potable water distribution systems that use surface-water sources (Reclamation Plan, Appendix G, SFC, 2005). Therefore, SFC concluded that alternative sources of water are readily available.

- **Radon inhalation** - SFC indicated that it did not consider radon inhalation because, consistent with EPA guidance, it applied the default DCGLs for radium.

In addition, SCF indicated that it did not consider scenarios that involved inadvertent human intrusion into the disposal cell during the licensed or institutional control periods, with construction of a house with a basement over the waste. SFC eliminated these scenarios because basement construction is not a common feature of homes in northeast Oklahoma. Further, the SFC cell design, including the application of a riprap outer cover over the disposal cell, would prevent human intrusion (Reclamation Plan, Appendix G, SFC, 2005).

In summary, to derive the benchmark dose, SFC applied the resident farmer scenario for the ICB. SFC assumed that this farmer would be exposed to residual radioactivity in surface soil without digging into the disposal cell. During a year, this farmer would spend 25% of the time indoors on the site, 50% of the time outdoors on the site, and 25% of the time away from the site. The contaminated land would produce half of the farmer's entire diet (i.e., vegetables, grain, fruit, milk, and meat). SFC assumed the water source for irrigation and farm animals would be a pond immediately downgradient from the contaminated area. Half of the farmer's aquatic food (fish) diet would be from the pond (Reclamation Plan, Appendix G, SFC, 2005). SFC estimated the resulting dose from radium-226 at the regulatory limit concentration of 0.185 becquerels (5 picocuries) per gram of radium-226 would be 0.54 millisievert (54 millirem) per year. Using the benchmark dose approach, SFC calculated the natural uranium and thorium-230 concentrations in soil that would equal the dose from radium-226 (see Table D-13). SFC would apply these values as DCGLs for soils from the contaminated areas within the ICB. The sum-of-ratios requirement would ensure that the resident farmer dose did not exceed the benchmark dose of 0.54 millisievert (54 millirem) per year for any combination of concentrations of natural uranium, thorium-230, and radium-226. Assuming that this individual resided on the site for 70 years should loss of institutional control of the ICB occur, the resulting lifetime dose would be about 38 millisievert (3,800 millirem). SFC noted that the value for the natural uranium concentration is high for surface soils for applications outside the ICB. To ensure application of the ALARA principal to the unrestricted areas of the site, SFC developed the CLs in Table D-13.

Table D-13 DCGLs and CLs

Condition	Natural Uranium Bq/g (pCi/g)	Thorium-230 Bq/g (pCi/g)	Radium-226 Bq/g (pCi/g)[a]
DCGL (restricted area)	21 (570)	2.4 (66)	0.18/0.56 (5.0/15)
CL (unrestricted release)	3.7 (100)	≤ 0.52/1.6 (14/≤ 43)	≤ 0.18/0.56 (5.0/15)

Source: SFC, 2005.

[a] First 15-centimeter (5.9-inch) layer below surface divided by the number of 15-centimeter layers more than 15 centimeters below the surface.

Bq – Becquerel

g – gram

pCi - picocurie.

Applying the same residential farmer scenario to unrestricted areas using the CLs, the natural uranium in the mixture would control the resulting radiation doses because the CLs for thorium-230 and radium-226 are less-than values. The analysis estimated the dose from natural uranium to be about 0.095 millisievert (9.5 millirem) per year by multiplying the ratio of the CL to the DCGL by the benchmark dose. Again, the sum-of-ratios method would ensure that the estimated dose from all three radionuclides was less than or equal to 0.095 millisievert (9.5 millirem) per year. This dose would be less than the public dose limit of 1 millisievert (100 millirem) per year. If this individual resided on the unrestricted area of the site for 70 years, the lifetime dose would be 6.6 millisievert (660 millirem).

Both the land within the ICB and in the unrestricted area would contain radionuclide concentrations in surface soil much lower than those in Table D-13. This is because SFC proposes to use clean soil to cover the contaminated areas after moving the contaminated soil to the disposal cell within the ICB. Further, facility operations have left the unrestricted area largely unaffected; therefore, the radionuclide concentrations reflect natural background levels. Therefore, the doses to members of the public following institutional controls estimated for the restricted and unrestricted areas for Alternative 1 are bounding estimates.

Table D-14 lists the estimated individual probabilities of LCFs for the restricted and unrestricted areas for Alternative 1. These estimates use a dose-to-risk conversion factor of 6×10^{-5} per millisievert (6×10^{-7} per millirem) (Eckerman et al., 1999) and an assumed residency time of 70 years. The lifetime risks to the resident farmers in the restricted and unrestricted areas would be low (2.3×10^{-3} and 4.0×10^{-4}, respectively), and the annual doses would be within regulatory limits (the benchmark dose); therefore, the significance level of public radiation exposures and risks after completion of Alternative 1 would be SMALL.

Table D-14 Estimated Probabilities of LCFs for the Resident Farmer Scenario in the Restricted and Unrestricted Areas for Alternative 1

Annual Restricted Area after Loss of Institutional Controls	Lifetime Restricted Area after Loss of Institutional Controls	Annual Unrestricted Area	Lifetime Unrestricted Area
3.2×10^{-5}	2.3×10^{-3}	5.7×10^{-6}	4.0×10^{-4}

D.2.1.4 Alternative 1: Worker Radiation Doses and Risks during Institutional Control

In a manner similar to that used to calculate the DCGLs for the resident farmer scenario, SFC estimated the annual doses to industrial workers during the long-term maintenance and control of the site. These industrial workers, employed or under contract to the long-term custodian, would perform the maintenance tasks, on a limited, part-time basis (i.e., a total of 130 hours per year).. The applicable regulatory dose limit to a worker would be 1 millisievert (100 millirem) per year to a member of the public. SFC assumed that the source term would be equivalent to the DCGLs in Table D-13, since this would be the maximum radionuclide concentrations that would be encountered following remediation. The exposure pathways include (Reclamation Plan, Appendix G, SFC, 2005):

- External exposure from soil.
- Inhalation of suspended soil.
- Ingestion of soil.

SFC did not consider additional pathways for the industrial workers because of the nature of their long-term maintenance activities and the limited number of hours worked during a year. These maintenance workers would not be involved in farming activities, use groundwater or surface water since water would be provided by municipal sources, or be exposed to indoor radon since no buildings would be built in the restricted area. SFC assumed the worker would perform maintenance activities within the ICB for a total of 130 hours per year: 32 hours sampling on-site wells and 98 hours mowing (SFC, 2005). The maintenance activities did not include time maintaining the cover since, per the requirements of 10 CFR 40, Appendix A, Criteria 6, site closure requires that reasonable assurance be provided of the control of radiological hazards for 1,000 years, and in any case for at least 200 years. This means that the final cover must be shown to perform without requiring maintenance for at least 200 years, and for up to 1,000 years. The result of the SFC dose assessment was about 0.02 millisievert (2 millirem) per year to this industrial worker. The analysis assumed that the same individual would work at the site for an entire career of 30 years conducting maintenance activities. Although it is unlikely that an individual would perform these activities over an entire 30-year career, it provides a conservative basis for the estimation of lifetime dose to this worker. The resulting lifetime dose would be about 0.6 millisievert (60 millirem). The NRC staff consider these values to be a conservative bounding dose estimate because the land within the ICB would contain radionuclide concentrations in surface soil much lower than those in Table D-13. This is because SFC indicated that it would use clean soil to cover the contaminated areas after moving the contaminated soil to the disposal cell within the ICB. The analysis used a dose-to-risk conversion factor of 4×10^{-5} per millisievert (4×10^{-7} per millirem) (ICRP, 1990) and an assumed residency time of 30 years to estimate the individual annual and lifetime probabilities of LCFs for the restricted area industrial worker under Alternative 1. Table D-15 lists the estimated probabilities of LCFs. The estimated annual probability of an LCF to this industrial worker would be 8×10^{-7}, and the estimated lifetime probability of an LCF would be 2.4×10^{-5}. The estimated risks would be low, and the annual radiation doses would be within the regulatory limit of 1 millisievert (100 millirem) per year; therefore, the significance level of worker radiation exposures and risks during institutional controls would be SMALL.

Table D-15 Estimated Probabilities of LCFs for the Long-term Maintenance Industrial Worker Scenario in the Restricted Areas for Alternative 1

Annual	Lifetime
8×10^{-7}	2.4×10^{-5}

D.2.2 Alternative 2: Off-site Disposal of All Contaminated Materials

Under Alternative 2, SFC would excavate and remove all contaminated soil, sludge, equipment, building rubble, and other contaminated materials from the site and send it to licensed low-level radioactive waste (LLRW) disposal facilities (SFC, 2005). This alternative would not require the construction of an on-site disposal cell. SFC would decontaminate the entire site to meet the CLs in Table D-11. SFC would backfill all excavations, cover them with topsoil, and revegetate them. After completion of reclamation activities, SFC would perform radiation surveys to verify compliance with the CLs before license termination and unrestricted release of the 243-hectare (600-acre) site. There would be no further license or institutional control period.

D.2.2.1 Alternative 2: Off-site Public Radiation Doses and Risks during Reclamation

Off-site public exposures would occur because of the atmospheric release of radionuclides in soil suspended in air. This would occur during the excavation and movement of contaminated soil, building demolition and movement of building rubble, and movement of other materials for off-site disposal. Because the reclamation activities for Alternatives 1 and 2 are similar, the same methods apply to the estimation of off-site radiation exposures during reclamation. As for Alternative 1, off-site air samples served as the basis for estimated public doses during reclamation. The estimated inhalation doses to the MEI would range from 0.003 to 0.005 millisievert (0.3 to 0.5 millirem) per year. These doses would be a small fraction of the 0.25-millisievert-per-year (25-millirem-per-year) public dose limit for site operations, and they are ALARA. For this analysis, 0.005 millisievert (0.5 millirem) per year represented the annual dose to the MEI in the public during reclamation. The lifetime doses the MEI would receive during the four-year reclamation period, assuming constant off-site public doses over this period, would be about 0.02 millisievert (2 millirem) under Alternative 2.

Because radiation dose rapidly decreases with distance downwind because of dispersion of the airborne contaminants, the total collective population dose would be bounded under the assumption that 1,000 individuals would receive the MEI dose. This would equal 0.005 person-sievert (0.5 person-rem) per year. Over the four-year period, the collective dose would be 0.02 person-sievert (2 person-rem) for Alternative 2.

The analysis estimated the probabilities of LCFs for members of the public from Alternative 2, assuming reclamation activities would occur over a four-year period, using a dose-to-risk conversion factor of 6×10^{-5} per millisievert (6×10^{-7} per millirem) for members of the public (Eckerman et al., 1999). Table D-16 lists the estimated probabilities of LCFs to the MEI and the collective population, both for a single year and for the total reclamation period. The estimated total population risks would be low (1.2×10^{-3}) and the annual radiation doses would be within the regulatory limit for the public of 0.25 millisievert (25 millirem) per year; therefore, the significance level of public radiation exposures and risks for reclamation activities for Alternative 2 would be SMALL.

Table D-16 Estimated Probabilities of LCFs for the MEI and the Collective Population for Alternative 2

Individual Annual Risk	Individual Lifetime Risk[a]	Collective Annual Risk	Collective Lifetime Risk[a]
3.0×10^{-7}	1.2×10^{-6}	2.0×10^{-4}	1.2×10^{-3}

[a] Over four years of reclamation activities.

D.2.2.2 Alternative 2: Worker Radiation Doses and Risks During Reclamation

The annual average radiation doses to reclamation workers under Alternative 2 are likely to be the same as those estimated for Alternative 1 because both alternatives would require the relocation of contaminated materials for disposal. The choice of on-site or off-site disposal would not significantly change the expected work conditions, dose rates, or exposure durations for reclamation workers. Only the number of workers and the duration of work would differ.

As listed in Table D-9, the average annual TEDE to workers, based on measured worker doses and intakes from the raffinate sludge dewatering project, would be about 7.47 millisievert (747 millirem) per year. This annual TEDE would bound the annual doses to reclamation workers for Alternative 2 because the average radionuclide concentrations at the site are only about 30% of the concentrations in the raffinate sludge dewatering project. The best estimate of annual worker doses would be 30% of the raffinate sludge dewatering project doses using average radionuclide concentrations, or about 2.2 millisievert (220 millirem) per year. Both the bounding and best-estimate worker annual TEDEs are within the NRC occupational radiation protection standard of 50 millisievert (5 rem) per year. Total doses to a worker during four years of reclamation activities, assuming that the annual average TEDEs remain constant, would result in a worker lifetime TEDE of about 8.8 millisievert (880 millirem).

The analysis estimated worker probabilities of LCFs for Alternative 2, using the radiation worker labor force summarized by quarter and labor category in Table D-17. The resulting estimated TEDEs by quarter and year, and the estimated probabilities of LCFs by year, are shown in Table D-18. The estimated probabilities of LCFs were developed using a dose-to-risk conversion factor of 4×10^{-5} per millisievert (4×10^{-7} per millirem) for industrial workers (ICRP, 1990). Table D-19 summarizes the estimated annual probabilities of LCFs to the average and maximum individual worker, the lifetime probability of an LCF to the average worker, and the collective worker population for the four-year reclamation period. The estimated total worker probabilities of LCFs would be low (1.4×10^{-2}) and the annual worker radiation doses would be within the regulatory limit of 50 millisievert (5 rem) per year; therefore, the significance level of worker radiation exposures and risks for reclamation activities for Alternative 2 would be SMALL.

Table D-17 Radiation Worker Manpower Estimates for Alternative 2

Quarter	H&S Technicians	Equipment Operators	On-Site Truck Drivers	Welders and Riggers	Laborers	Total
1	12	12	8	6	20	58
2	12	12	8	6	20	58
3	12	12	8	6	20	58
4	12	12	8	6	20	58
5	12	12	8	6	20	58
6	12	12	8	6	20	58
7	12	12	8	6	20	58
8	12	12	8	6	20	58
9	6	12	8	0	15	41
10	6	12	8	0	15	41
11	6	12	8	0	10	36
12	4	3	0	0	10	17

Table D-17 Radiation Worker Manpower Estimates for Alternative 2

Quarter	H&S Technicians	Equipment Operators	On-Site Truck Drivers	Welders and Riggers	Laborers	Total
13	4	1	0	0	5	10
14	4	1	0	0	5	10
15	4	1	0	0	5	10
16	4	1	0	0	5	10

Table D-18 Collective Radiation Worker TEDEs and Estimated Probabilities of LCFs for Alternative 1

Quarter/Year	Estimated TEDE person-Sv (person-rem)	Estimated Total Collective Worker Risk
1	0.033 (3.3)	-
2	0.033 (3.3)	-
3	0.033 (3.3)	-
4	0.033 (3.3)	-
Total Year 1	**0.13 (13)**	**5.2×10^{-3}**
5	0.033 (3.3)	-
6	0.033 (3.3)	-
7	0.033 (3.3)	-
8	0.033 (3.3)	-
Total Year 2	**0.13 (13)**	**5.2×10^{-3}**
9	0.022 (2.2)	
10	0.022 (2.2)	
11	0.020 (2.0)	
12	0.0094 (0.94)	
Total Year 3	**0.075 (7.5)**	**3.0×10^{-3}**
13	0.00055 (0.055)	-
14	0.00055 (0.055)	-
15	0.00055 (0.055)	-
16	0.00055 (0.055)	-
Total Year 4	**0.0022 (0.22)**	**8.8×10^{-5}**
Total Over Four Years	**0.34 (34)**	**1.4×10^{-2}**

person-Sv – person-Sievert

Table D-19 Estimated Probabilities of LCFs for Reclamation Workers and the Collective Worker Population for Alternative 2

Average Individual Worker Annual Risk	Average Individual Worker Lifetime Risk[a]	Maximum Worker Annual Risk[b]	Total Collective Average Worker[c]
8.8×10^{-5}	3.5×10^{-4}	3.0×10^{-4}	3.5×10^{-3}

[a] Over four years of reclamation activities.
[b] Assuming the doses received during the SFC raffinate sludge dewatering project represent the maximum worker doses.
[c] Over the entire radiation worker workforce for four years of reclamation activities.

D.2.2.3 Alternative 2: Long-term Public Radiation Doses and Risks

As discussed in Section D.2.1.3, SFC developed CLs to ensure application of the ALARA principle to the unrestricted areas of the site (SFC, 2005) (see Table D-13 in Section D.2.1.3). Application of the residential farmer scenario to unrestricted areas using the CLs provides radiation doses that are controlled by the natural uranium in the mixture because the CLs for thorium-230 and radium-226 are less-than values. The analysis estimated that the dose from natural uranium would be about 0.095 millisievert (9.5 millirem) per year by multiplying the ratio of the CL to DCGL by the benchmark dose. The sum-of-ratios method ensures that the dose from all three radionuclides would be less than or equal to 0.095 millisievert (9.5 millirem) per year. This dose would be within the current regulatory limit for members of the public of 1 millisievert (100 millirem) per year. If this individual resided on the unrestricted area of the site for 70 years, the lifetime dose would be 6.6 millisievert (660 millirem).

After completion of Alternative 2, the land in the unrestricted area would contain radionuclide concentrations in surface soil much lower than the CLs. This is because SFC proposes to use clean soil to fill and cover the contaminated areas after moving the contaminated soil and other radioactive material off the site for disposal. Further, facility operations have left the majority of the 243-hectare (600-acre) site largely unaffected; therefore, the radionuclide concentrations reflect natural background levels. Therefore, the estimated unrestricted area doses to members of the public of 0.095 millisievert (9.5 millirem) per year after completion of Alternative 2 would bound the potential impacts.

Table D-20 lists the estimated annual and lifetime individual probabilities of LCFs for unrestricted release of the site after completion of Alternative 2. The analysis estimated the probabilities of LCFs using a dose-to-risk conversion factor of 6×10^{-5} per millisievert (6×10^{-7} per millirem) (Eckerman et al., 1999) and an assumed residency time of 70 years. The resulting lifetime probability of an LCF to the resident farmer would be low (4.0×10^{-4}), and the annual radiation doses would be within the public radiation dose regulatory limits of 1 millisievert (100 millirem) per year; therefore, the significance level of public radiation exposures and risks following completion of Alternative 2 would be SMALL. In addition, there would be no institutional control period for Alternative 2, so there would be no long-term worker doses or risks because unrestricted release would occur immediately upon completion of Alternative 2.

Table D-20 Estimated Probabilities of LCFs for the Resident Farmer Scenario in the Unrestricted Area for Alternative 2

Annual Unrestricted Area	Lifetime Unrestricted Area
5.7×10^{-6}	4.0×10^{-4}

D.2.3 Alternative 3: Partial Off-site Disposal of Contaminated Materials

Under Alternative 3, SFC would excavate and remove selected waste and contaminated materials from the site and send them to licensed LLRW disposal facilities (SFC, 2005). This waste would include some of the more concentrated radioactive sources at the site. SFC would dispose of the remainder of the radioactive material, including soil and other sources that exceed the DCGLs, in an on-site disposal cell similar to that for Alternative 1 (SFC, 1999). The disposal cell would be in the same location but with reduced dimensions and volume to account for the volume of waste shipped off the site. SFC would maintain all of the contaminated areas within a 81-hectare (200-acre) restricted area. The above-grade disposal cell would cover about 4 hectares (10 acres). SFC would consolidate and dispose of all Atomic Energy Act Section 11e.(2) byproduct materials and non-Section 11e.(2) source material wastes, which would remain on the site in this cell. After capping and closure, SFC would establish a fenced ICB around the disposal cell. The ICB would restrict unauthorized access to the area. After capping and closure, SFC would initiate a long-term monitoring plan (SFC, 2005). The design of the engineered disposal cell would comply with NRC performance standards. These standards are outlined in Appendix A of 10 CFR Part 40. SFC would then cover the completed cell surface with riprap to prevent human intrusion. SFC would decontaminate the remainder of the site, the unrestricted area, to meet the CLs in Table D-13. SFC proposes to backfill all excavations, cover them with topsoil, and revegetate them. After completion of reclamation activities, SFC would conduct radiation surveys to verify that the contamination levels did not exceed the CLs. After license termination, SFC would transfer long-term custody of the site to the United States or the State of Oklahoma.

The material that SFC would send off the site for disposal would include the dewatered raffinate sludge, North Ditch sediment, Emergency Basin soil, and Sanitary Lagoon soil. Table D-21 lists the estimated volumes and radionuclide contents of that waste. In comparison with the estimated waste volume in Table D-4, the total on-site disposal volume for Alternative 2 would be about 196,000 cubic meters (256,760 cubic feet).

Table D-21 Off-site Waste Disposal Summary for Alternative 3

Description	Volume m^3 (yd^3)	Natural Uranium Bq/g (pCi/g)	Thorium-230 Bq/g (pCi/g)	Radium-226 Bq/g (pCi/g)
Raffinate Sludge	30,129 (39,469)	13-448 (357-12,100)	7.8-604 (211-16,300)	0.22-12.3 (6-332)
North Ditch Sediment	588 (770)	245 (6,618)	86 (2,320)	4.4 (120)
Emergency Basin	413	104	103	9.1

Table D-21 Off-site Waste Disposal Summary for Alternative 3

Description	Volume m^3 (yd^3)	Natural Uranium Bq/g (pCi/g)	Thorium-230 Bq/g (pCi/g)	Radium-226 Bq/g (pCi/g)
Soil	(541)	(2,809)	(2,785)	(245)
Sanitary Lagoon Soil	294 (385)	338 (9,137)	14 (384)	0.25 (6.7)
Total Volume	**31,424 (41,165)**			

m – meter
yd – yard
Bq – Becquerel
g – gram
pCi - picocurie.

D.2.3.1 Alternative 3: Off-site Public Radiation Doses and Risks during Reclamation

Off-site public exposures would occur because of the atmospheric release of radionuclides in soil suspended in air. This would occur during the excavation and movement of contaminated soil, building demolition and movement of building rubble, and movement of other materials for on- or off-site disposal. Because the reclamation activities for Alternatives 1 and 3 are similar and would involve the same material, the same methods apply to the estimation of off-site radiation exposures during reclamation. This approach uses off-site air sample data that SFC collected during previous reclamation activities at the site. Table D-5 in Section D.2.1.1 summarizes the estimated inhalation radiation doses from data that SFC collected at the nearest residence air sampler for the period from 1995 through 1998 (SFC, 2005). The NRC staff considers this location to be the location of the MEI in the public. The estimated inhalation doses range from 0.003 to 0.005 millisievert (0.3 to 0.5 millirem) per year. These doses are a small fraction of the 0.25-millisievert (25-millirem)-per-year public dose limit for site operations and are considered to be ALARA. This analysis used 0.005 millisievert (0.5 millirem) per year to represent the annual dose to the MEI in the public during reclamation. For comparison, an average individual living in Oklahoma receives a radiation dose of about 3.6 millisievert (360 millirem) per year from all sources (NCRP, 1987). The lifetime doses the MEI would receive during the four-year reclamation period, assuming constant off-site public doses over this period, would be about 0.02 millisievert (2 millirem) under Alternative 3.

Because radiation dose rapidly decreases with distance downwind because of dispersion of the airborne contaminants, the assumption that 1,000 individuals would receive the MEI dose would bound the total collective population dose. This would equal 0.005 person-sievert (0.5 person-rem) per year. Again, assuming that reclamation activities would occur over a four-year period, the collective dose would be 0.02 person-sievert (2 person-rem) for Alternative 3.

The analysis estimated the probabilities of LCFs for members of the public for Alternative 3, assuming reclamation activities would occur over a four-year period, using a dose-to-risk conversion factor of 6×10^{-5} per millisievert (6×10^{-7} per millirem) for members of the public (Eckerman et al., 1999). Table D-22 lists the probabilities of LCFs to the MEI and the collective population both for a single year and for the total reclamation period. The estimated total population risks would be low (1.2×10^{-3}), and the annual radiation doses would be within the regulatory limit for the public of 0.25 millisievert (25 millirem) per year; therefore, the significance level of public radiation exposures and risks for reclamation activities for Alternative 3 would be SMALL.

Table D-22 Estimated Probabilities of LCFs for the MEI and the Collective Population during Reclamation for Alternative 3

Individual Annual Risk	Individual Lifetime Risk[a]	Collective Annual Risk	Collective Lifetime Risk[a]
3.0×10^{-7}	1.2×10^{-6}	3.0×10^{-4}	1.2×10^{-3}

[a] Over four years of reclamation activities.

D.2.3.2 Alternative 3: Worker Radiation Doses and Risks During Reclamation

The estimated annual average radiation doses to reclamation workers for Alternative 3 are likely to be the same as those for Alternative 1. This is because both alternatives require demolition of buildings and excavation of soil with the relocation of the contaminated materials for disposal. Disposal off the site would not significantly reduce the dose to reclamation workers because the same reclamation activities would occur up to the point of disposal. Only the number of workers and the duration of work would differ.

As listed in Table D-9, the analysis estimated the average annual TEDE to a worker, based on measured worker doses and intakes from the raffinate sludge dewatering project, would be 7.47 millisievert (747 millirem) per year. This annual TEDE would bound the annual doses to reclamation workers for Alternative 3 because the average radionuclide concentrations at the site are only about 30% of the concentrations in the raffinate sludge dewatering project. The best estimate of annual worker doses would be 30% of the raffinate sludge dewatering project doses using average radionuclide concentrations, or about 2.2 millisievert (220 millirem) per year. Both the bounding and best-estimate worker annual TEDEs would be within the NRC occupational radiation protection standard of 50 millisievert (5 rem) per year. Total doses to a worker during four years of reclamation activities, assuming that the annual average TEDEs remain constant, would result in an average worker lifetime TEDE of about 8.8 millisievert (880 millirem).

The analysis estimated the total collective dose to the workforce and the probabilities of LCFs to that workforce for Alternative 3 using the radiation worker labor force summarized by quarter and labor category in Table D-23. The resulting estimated TEDEs by quarter and year, and the estimated probabilities of LCFs by year, are shown in Table D-24. The estimated probabilities of LCFs were developed using a dose-to-risk conversion factor of 4×10^{-5} per millisievert (4×10^{-7} per millirem) for industrial workers (ICRP, 1990). Table D-25 summarizes the estimated probability of an LCF to the average and maximum individual worker, the lifetime probability of an LCF to the average worker, and the collective worker population for the total reclamation period. The total estimated average worker probability of an LCF would be low (1.4×10^{-2}), and the annual worker radiation doses would be within the regulatory limit of 50 millisievert (5 rem) per year; therefore, the significance level of worker radiation exposures and risks for reclamation activities for Alternative 3 would be SMALL.

Table D-23 Radiation Worker Manpower Estimates for Alternative 3

Quarter	Cell Closure	H&S Technicians	Equipment Operators	On-Site Truck Drivers	Welders and Riggers	Laborers	Total
1	0	11	8	8	6	29	62
2	0	11	8	8	6	29	62
3	0	11	8	8	6	29	62
4	0	11	8	8	6	29	62
5	0	11	8	8	6	29	62
6	0	11	8	8	6	29	62
7	0	11	8	8	6	29	62
8	0	11	8	8	6	29	62
9	0	4	3	3	0	15	25
10	8	4	3	3	0	15	25
11	8	4	3	3	0	10	20
12	0	4	3	3	0	10	20
13	0	4	1	1	0	5	11
14	0	4	1	1	0	5	11
15	0	4	1	1	0	5	11
16	0	4	1	1	0	5	11

Table D-24 Collective Radiation Worker TEDEs and Estimated Probabilities of LCFs for Alternative 3

Quarter/Year	Estimated TEDE person-Sv (person-rem)	Estimated Total Collective Worker Risk
1	0.034 (3.4)	-
2	0.034 (3.4)	-
3	0.034 (3.4)	-
4	0.034 (3.4)	-
Total Year 1	**0.14 (14)**	**5.6×10^{-3}**
5	0.034 (3.4)	-
6	0.034 (3.4)	-
7	0.034 (3.4)	-
8	0.034 (3.4)	-
Total Year 2	**0.14 (14)**	**5.6×10^{-3}**
9	0.013 (1.3)	
10	0.013 (1.3)	
11	0.011 (1.1)	
12	0.011 (1.1)	
Total Year 3	**0.048 (4.8)**	**1.9×10^{-3}**
13	0.0060 (0.6)	-
14	0.0060 (0.6)	-
15	0.0060 (0.6)	-
16	0.0060 (0.6)	-
Total Year 4	**0.024 (2.4)**	**9.6×10^{-4}**
Total Over Four Years	**0.35 (35)**	**1.4×10^{-2}**

person-Sv – person-Sievert

Table D-25 Estimated Probabilities of LCFs for Reclamation Workers and the Collective Worker Population for Alternative 3

Average Individual Worker Annual Risk	Average Individual Worker Lifetime Risk[a]	Maximum Worker Annual Risk[b]	Total Collective Average Worker[c]
8.8×10^{-5}	3.5×10^{-4}	3.0×10^{-4}	1.4×10^{-2}

[a] Over four years of reclamation activities.
[b] Assuming the doses received during the SFC raffinate sludge dewatering project represent the maximum worker doses.
[c] Over the entire radiation worker workforce during four years of reclamation activities.

D.2.3.3 Alternative 3: Long-term Public Radiation Doses and Risks

As discussed in Section D.2.1.3, SFC developed DCGLs for the restricted area and CLs for the unrestricted area of the site (see Table D-13 in Section D.2.1.3). The analysis used application of the DCGLs and CLs based on the residential farmer scenario to restricted and unrestricted areas as the basis for the radiation dose estimates for Alternative 3. Because partial off-site disposal would still leave a significant inventory in the ICB, and because the residual soil contamination cleanup within the ICB would be the same for Alternatives 1 and 3, the long-term radiation dose and probability of LCF estimates would be the same for both alternatives. The DCGLs would apply to soils from the contaminated areas within the ICB. The sum-of-ratios requirement would ensure that the resident farmer dose would not exceed 0.54 millisievert (54 millirem) per year for any combination of concentrations of natural uranium, thorium-230, and radium-226. If this individual resided at the site for 70 years after loss of institutional control of the ICB, the resulting lifetime dose would be 37.8 millisievert (3,780 millirem).

The NRC staff determined that the residential farmer scenario applied to unrestricted areas using the CLs would result in radiation doses controlled by the natural uranium in the mixture because the CLs for thorium-230 and radium-226 are less-than values. The analysis estimated the dose from natural uranium by multiplying the ratio of the CL to DCGL by the benchmark dose; the dose would be about 0.095 millisievert (9.5 millirem) per year. The sum-of-ratios method would ensure that the dose from all three radionuclides would be less than or equal to 0.095 millisievert (9.5 millirem) per year. This dose would be less than the public radiation dose limit of 1 millisievert (100 millirem) per year. If this individual resided on the unrestricted area of the site for 70 years, the resulting lifetime dose would be 6.6 millisievert (660 millirem).

The NRC staff noted that both the land within the ICB and in the unrestricted area would contain radionuclide concentrations in surface soil much lower than those in Table D-13. This is because SFC proposes to use clean soil to cover the contaminated areas after moving the contaminated soil to the disposal cell within the ICB.. Further, facility operations have left the unrestricted area largely unaffected; therefore, the radionuclide concentrations reflect natural background levels. Therefore, the estimated doses to members of the public after lapse of institutional controls for the restricted and unrestricted areas for Alternative 3 would bound the impacts.

Table D-26 lists the individual probabilities of LCFs for the restricted and unrestricted areas for Alternative 3. These estimates use a dose-to-risk conversion factor of 6×10^{-5} per millisievert (6×10^{-7} per millirem) (Eckerman et al., 1999) and an assumed residency time of 70 years.

Table D-26 Estimated Probabilities of LCFs for the Resident Farmer Scenario in the Restricted and Unrestricted Areas for Alternative 3

Annual Restricted Area Following Loss of Institutional Controls	Lifetime Restricted Area Following Loss of Institutional Controls	Annual Unrestricted Area	Lifetime Unrestricted Area
3.2×10^{-5}	2.3×10^{-3}	5.7×10^{-6}	4.0×10^{-4}

The estimated lifetime risks would be low (2.3×10^{-3} and 4.0×10^{-4}), and the annual radiation doses would be within the regulatory limit of 1 millisievert (100 millirem) per year; therefore, the significance level of public radiation exposures and risks after completion of Alternative 3 would be SMALL.

D.2.3.4 Alternative 3: Worker Radiation Doses and Risks during Institutional Control

In a manner similar to that for the DCGLs for the resident farmer scenario (see Section D.2.1.3), SFC estimated annual doses to an industrial worker during the long-term maintenance and control of the site. Because Alternatives 1 and 3 would require the same long-term maintenance and surveillance activities, the estimated radiation doses and LCFs to the workers would be the same. The analysis assumed an industrial worker employed or under contract to the long-term custodian would perform the maintenance tasks for a total of 130 hours per year (32 hours sampling on-site wells and 96 hours mowing). The applicable annual regulatory dose limit would be 1 millisievert (100 millirem) per year to a member of the public. The resulting SFC dose assessment would be about 0.02 millisievert (2 millirem) per year to this industrial worker. Assuming that this individual worked at the site for 30 years conducting maintenance activities, the resulting lifetime dose would be about 0.6 millisievert (60 millirem). The NRC staff considers these values to be conservative bounding dose estimates because the land within the ICB would contain radionuclide concentrations in surface soil much lower than those in Table D-13. This is because SFC proposes to use clean soil to cover the contaminated areas after moving the contaminated soil to the disposal cell within the ICB. The analysis estimated the individual annual and lifetime probabilities of LCFs for the restricted area industrial worker under Alternative 3 using a dose-to-risk conversion factor of 4×10^{-5} per millisievert (4×10^{-7} per millirem) (ICRP, 1990) and an assumed residency time of 30 years. Table D-27 lists the estimated probabilities of LCFs. The estimated annual probability of an LCF to this industrial worker would be 8×10^{-7}, and the estimated lifetime probability of an LCF would be 2.4×10^{-5}. The estimated risks would be low, and the annual radiation doses would be within the annual regulatory limits of 1 millisievert (100 millirem) per year; therefore, the significance level of worker radiation exposures and risks during institutional controls would be SMALL.

Table D-27 Estimated Probabilities of LCFs for the Long-term Maintenance Industrial Worker Scenario in the Restricted Areas for Alternative 3

Annual	Lifetime
8.0×10^{-7}	2.4×10^{-5}

D.2.4 No-Action Alternative

The no-action alternative would retain the site in its current configuration. There would be no additional processing or stabilization of radioactivity and no decontamination of buildings or land. All on-site buildings and waste materials would remain in their current condition and configuration. Under this alternative, the NRC would not terminate SFC's source material license but would require SFC to maintain a portion of the 81-hectare (200-acre) industrial area indefinitely under restricted conditions. The site would not undergo cleanup and reclamation in accordance with 10 CFR Part 40, Appendix A. SFC would take corrective measures in the event of degradation of containment structures, release of contaminated materials, or intrusion. Over the long term, NRC would require SFC to perform surveillance and maintenance to ensure safe conditions and control of contaminated materials.

D.2.4.1 No-Action Alternative: Off-site Public Radiation Doses and Risks

For the no-action alternative, the estimated off-site public exposures would be minimal (far less than those from active reclamation) because there would be no processing or stabilization of radioactive material. If conditions deteriorated such that environmental releases of radioactivity could occur, NRC would require SFC to take corrective measures. There would be no atmospheric release of radionuclides in soil suspended in air or facility effluents. Therefore, this analysis did not estimate off-site public doses or risks for the no-action alternative.

D.2.4.2 No-Action Alternative: Worker Radiation Doses and Risks

Under the no-action alternative, trained radiation workers employed by or under contract to SFC would conduct routine maintenance and surveillance tasks during the continuing license phase. Worker radiation doses would be similar to those observed historically at the SFC site. Table D-28 lists the annual occupational TEDEs for SFC employees for the period from 1995 through 2004 (SFC, 2005; Table 4-5). The annual TEDE would account for radiation from external sources as well as internal sources that resulted from inhalation of airborne radioactive material. As listed in Table D-28, the average worker TEDE would be 0.27 millisievert (27 millirem rem) per year. This analysis assumed that average annual worker doses would continue for as long as SFC maintained the license. The analysis assumed that the maximum annual worker dose would be the highest average value in Table D-28 – 1.2 millisievert (120 millirem) per year. These doses are well within the NRC occupational radiation protection standard of 50 millisievert (5 rem) per year. SFC estimates that it would take seven workers to perform continuing maintenance and surveillance activities under the no-action alternative (SFC, 2005; Section 2.1.1). The analysis estimated lifetime doses to these workers by assuming that each worker would spend 30 years employed at the site under continuing license conditions. The lifetime TEDE to the average worker would be 8.0 millisievert (800 millirem), and the lifetime TEDE to the maximally exposed worker would be 36 millisievert (3,600 millirem). The estimated annual collective TEDE to the seven workers would be 0.002 person-sievert (0.20 person-rem) per year, and the lifetime collective dose (assuming all seven workers spent 30 years at the site) would be 0.056 person-sievert (5.6 person-rem). Table D-29 summarizes these occupational doses. The analysis did not estimate collective doses over the license continuation period because the length of the continuing licensing period is indeterminate.

Table D-28 Measured Occupational Dose for Sequoyah Fuels Corporation

Year	Number of Individuals in Each Range				Average Dose (TEDE) mSv/yr (mrem/yr)
	Less than Measurable	0 to 1 mSv/yr (0 to 100 mrem/yr)	1 to 2.5 mSv/yr (100 to 250 mrem/yr)	>2.5 mSv/yr (>250 mrem/yr)	
1995	34	18	0	0	0.14 (14)
1996	7	3	0	1	1.19 (119)
1997	7	3	4	0	0.16 (16)
1998	8	17	1	0	0.27 (27)
1999	15	7	0	0	0.23 (23)
2000	1	4	0	0	0.04 (4)
2001	0	5	0	0	0.28 (28)
2002	1	4	0	0	0.21 (21)
2003	3	3	0	0	0.16 (16)
2004	6	0	0	0	0
Overall Average Dose					**0.27(27)**

mSv – millisievert
yr – year
mrem - millirem.

Table D-29 Estimated Worker Radiation Doses for the No-Action Alternative

Dose Receptor	Individual Annual Dose mSv/yr (mrem/yr)	Individual Lifetime Dose mSv/yr (mrem)	Collective Annual Dose person-sievert/yr (person-rem/yr)	Collective Lifetime Dose person-sievert (person-rem)
Average Worker Doses during License Continuation	0.27 (27)	8.0 (800)	0.002 (0.20)	0.056 (5.6)
Maximum Worker Doses during License Continuation	1.2 (120)	36 (3,600)	N/A	N/A

mSv – millisievert
yr – year
mrem - millirem.

The analysis estimated individual annual and lifetime probabilities of LCFs for the industrial workers under the no-action alternative using a dose-to-risk conversion factor of 4×10^{-5} per millisievert (4×10^{-7} per millirem) (ICRP, 1990) and an assumed employment time of 30 years. Table D-30 lists the estimated probabilities of LCFs. The estimated annual probability of an LCF to the average industrial worker would be 1.1×10^{-5}, and the estimated lifetime probability of an LCF would be 3.3×10^{-4}. The annual and lifetime probabilities of an LCF to the maximally exposed worker would be 4.8×10^{-5} and 1.4×10^{-3}, respectively. The estimated risks would be low, and the annual radiation doses would be within the regulatory limit of 50 millisievert (5 rem) per year; therefore, the significance level of worker radiation exposures and risks during institutional controls would be SMALL.

Table D-30 Estimated Probabilities of LCFs to Workers for the No-Action Alternative

Dose Receptor	Individual Annual Risk	Individual Lifetime Risk
Average Worker Risks during License Continuation	1.1×10^{-5}	3.3×10^{-4}
Maximum Worker Risks during License Continuation	4.8×10^{-5}	1.4×10^{-3}

D.2.4.3 No-Action Alternative: Long-term Public Doses after Loss of License Controls

Because of the long half-lives of the radionuclides at the SFC facility and site, it may be possible that at some point in the future the license conditions could lapse. In this event, members of the public could have access to the site, which could result in the resident farmer scenario described for Alternative 1. SFC derived CLs and DCGLs for the site (see Section D.2.1.3) without consideration of any institutional controls and solely in relation to the dose from pathways that relate to residual radioactive materials in surface soil. SFC developed the derivation of DCGLs based on a radiation exposure scenario analysis using the RESRAD computer program (Yu et. al., 2001) and applying the benchmark dose approach. The DCGLs served as the starting point for the analysis of public doses and risks for the no-action alternative. The DCGLs represent an MEI dose of 0.54 millisievert (54 millirem) per year for each of natural uranium, thorium-23, and radium-226. For alternatives involving the remediation or decontamination of soil, the sum-of-ratios approach would limit the dose for any mixture to 0.54 millisievert (54 millirem) per year. For the no-action alternative, however, the doses to the MEI would not be limited to 0.54 millisievert (54 millirem) per year because no remediation or decontamination would occur. The analysis estimated the MEI dose by dividing the existing contamination concentrations for each radionuclide by the appropriate DCGL (to determine how much in the residual contamination would be in excess of the DCGLs), multiplied that result by the benchmark dose of 0.54 millisievert (54 millirem) per year, then summed over the radionuclides. Because it is not possible to determine the condition of the residual radioactive contamination when the license conditions could lapse, the analysis made two estimates: (1) doses based on the average soil concentrations, and (2) doses based on the maximum soil concentrations. Table D-31 lists the average and maximum soil contamination concentrations, summarizes them, and provides the sum of ratios to the DCGLs for the three radionuclides.

Table D-31 Average and Maximum Soil Concentrations Used in the No-Action Alternative Public Dose Evaluation

Contamination Level	Natural Uranium Bq/g (pCi/g)	Thorium-230 Bq/g (pCi/g)	Radium-226 Bq/g (pCi/g)	Sum of Ratios to DCGLs[a]
Average Site	72 (1,940)	76 (2,063)	2.6 (71)	49
Maximum (Contaminated Area 2, Clarifiers)	221 (5,978)	756 (20,400)	12 (317)	383

[a] The sum of the ratio of the radionuclide concentration to the DCGL, summed over each radionuclide.
Bq – Becquerel
g – gram
pCi - picocurie.

The analysis estimated the MEI dose for the average and maximum contamination levels by multiplying the sum of ratios in Table D-31 by the benchmark dose of 0.54 millisievert (54 millirem) per year. The resulting MEI doses would be about 26 millisievert (2,600 millirem) per year for the average soil concentration and 210 millisievert (21,000 millirem) per year for the maximum soil concentration. These doses are far in excess of the 1-millisievert-per-year (100-millirem-per-year) dose limit for members of the public. The estimated lifetime doses, assuming 70 years of site occupancy, would be about 1,800 millisievert (180,000 millirem) for the average soil concentration condition, and 14,000 millisievert (1,400,000 millirem) for the maximum soil concentration condition.

Table D-32 lists the estimated individual probabilities of LCFs for the no-action alternative. These estimates use a dose-to-risk conversion factor of 6×10^{-5} per millisievert (6×10^{-7} per millirem) (Eckerman et al., 1999) and an assumed residency time of 70 years.

Table D-32 Estimated Probabilities of LCFs for the Public Radiation Risks for the No-Action Alternative after License Conditions Lapse

Contamination Level	Individual Annual Risk	Individual Lifetime Risk
Average Contamination Level Risks to the Public	1.6×10^{-3}	1.1×10^{-1}
Maximum Contamination Level Risks to the Public	1.2×10^{-2}	8.7×10^{-1}

The estimated lifetime probability of an LCF for the average soil concentration would be 1.1×10^{-1}, and that for the maximum soil concentration would be 8.7×10^{-1}. The estimated probabilities of LCFs would be more significant than for the other alternatives and, for the maximum soil concentration, they would be more likely than not to result in an LCF (a probability greater than 0.5). Further, the annual radiation doses would be far in excess of the regulatory limit of 1 millisievert (100 millirem) per year; therefore, the significance level of public radiation exposures and risks for the no-action alternative would be HIGH.

D.3 Screening Level Risk Analysis for Chemicals

A screening-level risk analysis was performed in order to assess potential adverse health effects associated with chemical (nonradiological) contamination in soils and sediments at the SFC site. Soil and sediment data from previously conducted investigations were compared to background soil concentrations and human health-based, medium-specific screening levels for residential use. Data presented in the following reports serves as the basis for this comparison:

- *Sequoyah Fuels Corporation Site Characterization Report* (SFC, 1998b);
- *Sequoyah Fuels Corporation Facility Environmental Investigation Findings Report*, Volumes 1-5. (SFC, 1991);
- *Sequoyah Fuels Corporation Final RCRA Facility Investigation Report* (SFC, 1996).

Soil data from these reports were compared to EPA Region 6 Human Health Medium-Specific Screening Levels for residential use (EPA, 2007). The Region 6 values consider exposure via incidental ingestion of soil, dermal contact with soil, and inhalation of soil particulates. These values were developed using equations from EPA guidance and commonly used EPA default exposure factors (EPA, 2007). Toxicity information and other chemical factors used to develop screening levels are published by the EPA or academic sources. The Region 6 soil screening values (EPA, 2007) are based on a noncancer hazard index of 1 and a total excess cancer risk of 1E-06 (1 in a million, or 1×10^{-6}). If the concentrations of nonradiological contaminants at a site do not exceed the applicable screening levels, there would be no expectation of adverse health effects resulting from exposure to site contamination screened using this method. Table D-33 below presents the screening values used for this assessment.

Table D-33 EPA Region 6 Human Health Medium-Specific Screening Levels

Analytes	Residential Soil Screening Level (mg/kg)
Aluminum	7.6E+04
Antimony and compounds	3.1E+01
Arsenic (cancer endpoint)	3.9E-01
Barium and compounds	1.6E+04
Beryllium and compounds	1.5E+02
Cadmium and compounds	3.9E+01
Total Chromium (1/6 ratio Cr VI/Cr III)	2.1E+02
Cobalt	9.0E+02
Copper and compounds	2.9E+03
Fluoride	3.7E+03
Iron	5.5E+04
Lead	4.0E+02
Lithium	1.6E+03
Manganese and compounds	3.2E+03
Mercury and compounds	2.3E+01
Molybdenum	3.9E+02

Table D-33 EPA Region 6 Human Health Medium-Specific Screening Levels

Analytes	Residential Soil Screening Level (mg/kg)
Nickel and compounds	1.6E+03
Nitrate[a]	1.3E+05
Selenium	3.9E+02
Silver and compounds	3.9E+02
Strontium, stable	4.7E+04
Thallium	5.5E+00
Vanadium	3.9E+02
Zinc	2.3E+04

[a] Region 6 does not publish a value for nitrate in soil. This value is the Region 3 Risk-Based Screening Level for residential exposure (EPA, 2007b).

In addition to comparing site data to Region 6 screening values, concentrations of chemicals detected in soils and sediment were compared to background concentrations. A soil background evaluation was conducted as part of the Sequoyah Fuels Corporation Final RCRA Facility Investigation (RFI; SFC, 1996, section 4.1). To briefly summarize, background soil samples were collected from four off-site locations within 8 kilometers (5 miles) of the SFC facility. The background soil sample locations were selected to represent the three main soil series that are encountered in the Industrial Area. Sample locations were selected such that anthropogenic influences were minimized. Drainage ways, paved surfaces, railroads, and agricultural (cropland) areas were avoided. At three of the four background locations, soil samples were collected from three boreholes, which were approximately 30.5 meters (100 feet) apart in a triangular pattern. Samples from two profiles from each of the three boreholes were collected and composited for analyses. The fourth background sample was collected from a single location. Each borehole was advanced to a maximum depth of 1.2 meters (4 feet). The background soil samples were analyzed for the list of metals described in the RFI (SFC, 1996, Table D-34). From the results presented in the RFI, SFC determined there were no apparent differences in metals concentrations for the various soil series sampled. Therefore, all background soil samples were grouped together for determination of background soil concentrations (SFC, 1996). Background sample analytical results were compiled for each parameter, and calculations were performed to determine the mean and standard deviations. The RFI established a "prediction interval" for each metal at the 99% confidence level. The upper prediction interval is the arithmetic mean plus three standard deviations. The results of this statistical analysis are presented in Table D-34.

Table D-34 Background Concentrations of Metals

Analyte	Background Value (mg/kg)
Aluminum	16,760
Antimony	10
Arsenic	39.8
Barium	188.4
Beryllium	1.6
Cadmium	8.1

Table D-34 Background Concentrations of Metals

Analyte	Background Value (mg/kg)
Chromium	33.5
Cobalt	21.5
Copper	23.1
Lead	32.7
Lithium	12.7
Manganese	718
Mercury	0.044
Molybdenum	1.2
Nickel	21.5
Selenium	10
Silver	0.6
Strontium	27.9
Thallium	24.3
Vanadium	44.1
Zinc	58
Source: SCF, 1996.	

Background concentrations for fluoride and nitrate in soils are presented in the *Sequoyah Fuels Corporation Site Characterization Report* (SCR; SFC, 1998b). The SCR states that a total of 31 background locations outside of the facility were sampled. However, the emphasis of the background investigation presented in the SCR was the characterization of background conditions for radiological components. Data presented in Table 6 of the SCR indicates that nitrate analysis was performed on four of the 31 background samples collected. The concentration of nitrate detected ranged from 3 to 7 mg/kg. Data presented in Table 6 of the SCR indicate that fluoride analysis was performed on two background samples. Fluoride concentrations of 134 mg/kg and 146 mg/kg were detected in these samples.

Screening was not performed for essential elements such as calcium, iron, potassium, magnesium, and sodium. Detected concentrations of these elements on the site were well below levels of concern.

Table D-35 presents the sample location, depth, and coordinates of all the sample locations that exceed either EPA Region 6 Human Health Medium-Specific Screening Levels for residential use (EPA, 2007) or established background concentrations for metals (SFC, 1996) or for fluoride and nitrate (SFC, 1998b). Figure 4.4-1 in Chapter 4 identifies the locations of samples in which exceedances were detected.

Table D-35 shows that fluoride levels in soil and sediment exceed background and Region 6 health-based screening criteria at many locations throughout the site. Exceedances of Region 6 health-based screening criteria and background levels also were noted for arsenic (five locations), lead (three locations), antimony (two locations), and lithium, molybdenum, nickel, vanadium, copper, and chromium (one location each).

Table D-35 Sample Locations Exceeding Screening Criteria

Sample ID	Location Description	Easting	Northing	Analyte	Concentration (mg/kg)	Sample Depth (feet)			Sample Date
BH093	MW-89A, NORTHWEST OF FL.SLDGE HLDG BASIN NO2 BH-93	2835978.9	196905.1	Fluoride	7,480	20.00	to	22.00	3/15/1991
				Fluoride	21,400	22.00	to	24.00	3/15/1991
				Fluoride	10,000	24.00	to	26.00	3/15/1991
BH148	NORTHWEST OF ADU/MISC DIGESTION BUILDING	2836727.1	195728.6	Antimony	43	0.00	to	2.00	3/22/1995
BH208	NORTH OF COOLING TOWER, SC-234	2836824.2	196065.9	Fluoride	5,850	0.00	to	0.50	4/8/1991
BH209	NORTH OF COOLING TOWER, SC-235	2836884.4	196062.5	Fluoride	6,000	0.00	to	0.50	4/4/1991
BH230	SX-8, NORTH EAST CORNER OF SX YARD, C-8	2836764.4	195934.2	Fluoride	10,834	2.50	to	3.00	3/11/1991
				Fluoride	11,097	3.50	to	3.90	3/11/1991
BH267	EAST WEST TRENCH NORTH OF SX, Top 6", SX-18	2836806.2	195644.8	Fluoride	7,020	0.00	to	0.50	3/6/1991
BH268	EAST WEST TRENCH NORTH OF SX, Top 6", SX-19	2836806.2	195644.8	Fluoride	5,010	1.50	to	2.00	3/6/1991
HA208	POND 2 HOLE10	2835603	195521.5	Fluoride	3,750	0.00	to	0.50	7/18/1991
				Fluoride	7,490	1.50	to	2.00	7/18/1991
HA316	NORTHWEST CORNER OF LIME NEUT SILO NEAR VENT	2836630	195820	Fluoride	9,230	0.00	to	0.50	11/16/1995
SD001	N0RTHWEST QUADRANT OF POND 4	2836609	193971	Fluoride	32,400	0.00	to	15.00	3/24/1994
SD002	N0RTHEAST QUADRANT OF POND 4	2836749	193971	Fluoride	9,370	0.00	to	15.00	3/24/1994
SD003	SOUTHWEST QUADRANT OF POND 4	2836638	193804	Fluoride	25,200	0.00	to	15.00	3/24/1994
SD004	SOUTHEAST QUADRANT OF POND 4	2836735	193790	Fluoride	25,500	0.00	to	15.00	3/24/1994
SD013	FLUORIDE SLUDGE-SOUTHWEST AREA	2835951	195044	Arsenic	133	0.00	to	10.00	1/24/1995
				Fluoride	34,300	0.00	to	10.00	1/24/1995

Table D-35 Sample Locations Exceeding Screening Criteria

Sample ID	Location Description	Easting	Northing	Analyte	Concentration (mg/kg)	Sample Depth (feet)			Sample Date
SD014	COMPOSITE FROM 4 QUADRANTS OF CLARIFIER 1A	2836096	195772	Arsenic	1,350	0.00	to	10.00	1/25/1995
				Chromium	259	0.00	to	10.00	1/25/1995
				Fluoride	34,200	0.00	to	10.00	1/25/1995
				Lead	515	0.00	to	10.00	1/25/1995
				Molybdenum	556	0.00	to	10.00	1/25/1995
				Vanadium	3,950	0.00	to	10.00	1/25/1995
SD017	COMPOSITE FROM 3 SECTIONS OF NORTH DITCH	2836786	196158	Fluoride	10,300	0.00	to	4.00	2/1/1995
SD018	COMPOSITE FROM 3 SECTIONS OF EMERGENCY BASIN	2836559	196226	Antimony	117	0.00	to	0.50	2/1/1995
				Arsenic	98	0.00	to	0.50	2/1/1995
				Fluoride	3,930	0.00	to	0.50	2/1/1995
SD019	COMPOSITE FROM 3 SECTIONS OF SANITARY LAGOON	2836554	195941	Arsenic	440	0.00	to	0.60	2/1/1995
				Lead	555	0.00	to	0.60	2/1/1995
SD024	EMERGENCY BASIN, EMERGENCY BASIN #1, SC 131	2836535.8	196370.1	Fluoride	8,140	0.00	to	0.50	4/11/1991
SD025	EMERGENCY BASIN, EMERGENCY BASIN #2, SC 172	2836520.8	196219.5	Fluoride	9,880	0.00	to	0.50	4/11/1991
SD026	EMERGENCY BASIN, EMERGENCY BASIN #3, SC 189	2836642.4	196173.6	Fluoride	7,040	0.00	to	0.50	4/11/1991
SD061	FLUORIDE HOLDING BASIN #1 (SOUTH) - EAST END	2836202	194894	Fluoride	27,700	0.00	to	10.00	9/28/1995
SD062	FLUORIDE HOLDING BASIN #1 (SOUTH) - WEST END	2836072	194894	Fluoride	22,100	0.00	to	10.00	9/28/1995
SD063	FLUORIDE HOLDING BASIN #2 (NORTH) - EAST END	2836213	196778	Fluoride	11,200	0.00	to	10.00	9/28/1995

Table D-35 Sample Locations Exceeding Screening Criteria

Sample ID	Location Description	Easting	Northing	Analyte	Concentration (mg/kg)	Sample Depth (feet)			Sample Date
SD064	FLUORIDE HOLDING BASIN #2 (NORTH) - WEST END	2836106	196728	Fluoride	39,600	0.00	to	10.00	9/28/1995
SD066	FLUORIDE SETTLING BASIN #2 (SOUTH) - WEST END	2836207	195232	Fluoride	17,400	0.00	to	10.00	9/28/1995
SD067	FLUORIDE SETTLING BASIN #1 (NORTH) - EAST END	2835961	195275	Fluoride	14,700	0.00	to	10.00	9/28/1995
SD068	FLUORIDE SETTLING BASIN #1 (NORTH) - WEST END	2836057	195299	Fluoride	50,800	0.00	to	10.00	9/28/1995
SD069	FLUORIDE CLARIFIER - WEST END	2835826	195266	Fluoride	23,300	0.00	to	0.50	9/28/1995
SD070	FLUORIDE CLARIFIER - EAST END	2835995	195275	Fluoride	8,740	0.00	to	0.50	9/28/1995
SD186	SANATARY LAGOON NORTH WEST 1/4	2836468	195984	Fluoride	5,160	0.00	to	0.50	10/17/1995
SD188	CLARIFIER 2A NORTH EAST	2836014	195635	Fluoride	24,400	0.00	to	10.00	10/16/1995
SD189	CLARIFIER 2A NORTH WEST	2836177	195642	Fluoride	31,900	0.00	to	10.00	10/16/1995
SD190	CLARIFIER 2A SOUTH EAST	2836012	195497	Fluoride	19,500	0.00	to	10.00	10/16/1995
SD191	CLARIFIER 2A SOUTH WEST	2836165	195497	Fluoride	29,000	0.00	to	10.00	10/16/1995
SD195	NORTH DITCH SOUTH EAST 1/4	2836874	196104	Fluoride	14,800	0.00	to	4.00	10/17/1995

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APPENDIX E

TRANSPORTATION ANALYSIS: METHODOLOGY, ASSUMPTIONS, AND IMPACTS

E.1 Introduction and Background

This appendix documents the assumptions, input data, methods, results, and references used in the evaluation of potential transportation impacts associated with the shipment off site of contaminated materials during decommissioning activities at the Sequoyah Fuels Corporation (SFC) facility. The analysis focused on the radiological and nonradiological human health impacts associated with the shipment of up to 142,000 cubic meters (5 million cubic feet) of contaminated materials. The analysis evaluated projected shipments of materials from the SFC facility in Gore, Oklahoma, to three potential disposal sites in Utah and New Mexico (see Section 2.4.1).

Section E.2 provides (1) contaminated material inventories for each material type, (2) assumptions made regarding shipping configurations (e.g., package characteristics for truck and rail shipments), (3) package radiological characteristics (e.g., radiological constituent concentrations and radiation dose rates), and (4) the routing assumptions for shipments to disposal facilities. Section E.3 presents the assumptions, methods, and computer codes used to evaluate potential impacts from the incident-free transport of contaminated materials and lists the detailed impact estimates. Section E.4 presents the assumptions, methods, and computer codes used to evaluate impacts from potential transportation accidents and lists the results for the maximum reasonably foreseeable radiological accident as well as fatalities from vehicle emissions and traffic accidents. Section E.5 summarizes transportation-related human health impacts. Section E.6 lists the references for the analyses.

E.2 Disposal Information

This section describes the information used to evaluate radiological and nonradiological transportation impacts. The U.S. Nuclear Regulatory Commission (NRC) provided most of the information; however, if specific information was unavailable, conservative assumptions were used to provide reasonable assurance that impacts would not be underestimated. Section E.2.1 describes the disposal inventories by type for all materials that SFC would ship off site under Alternative 2 (Off-site Disposal of All Contaminated Materials) and Alternative 3 (Partial Off-site Disposal of Contaminated Materials. Section E.2.2 describes the shipping configurations, including the volumes that SFC would ship off site under these alternatives. Section E.2.3 provides routing information, including affected populations along the route to the disposal site.

E.2.1 Inventory

Evaluation of transportation impacts requires knowledge of the current and projected contaminated material inventory at the SFC facility. Table E-1 provides the inventories evaluated for each material type.

E.2.2 Shipping Configurations

The transportation impact analysis evaluated potential radiological and nonradiological impacts on transportation workers and members of the public from incident-free (i.e., routine) transportation as well as the postulated maximum reasonably foreseeable radiological transportation accident. Potential radiological impacts from incident-free transportation would depend upon, among other things, the level of penetrating radiation that emanated from the complete shipping package, which includes dump-type trucks and gondola railcars, the total number of shipments by mode (i.e., truck and rail), and the distance of each shipment. The analysis used the MicroShield® program (Grove Engineering, 1998) to calculate the radiation dose rates based on the package radionuclide content, overall size of the package (i.e., length, height, and depth), density of the material, and the amount of shielding material (e.g., the thickness of the gondola and truck side walls). The analysis assumed that, under Alternative 2 (Off-site Disposal of All Contaminated Materials), the contaminated materials would be shipped off-site using rail gondola cars. Under this alternative, all contaminated materials would be shipped as bulk except for the raffinate sludge and the sediments from the Emergency Basin, North Ditch, and Sanitary Lagoon, which would be shipped in super sacks (see below for description).

Under Alternative 3 (Partial Off-site Disposal of Contaminated Materials), the analysis assumed that only the raffinate sludge and the sediments from the Emergency Basin, North Ditch, and Sanitary Lagoon would be shipped off-site in super sacks using dump-type trucks. The distance for each shipment would depend on the destination; however, because SFC expects to ship most of the material to the Energy Solutions facility in Clive, Utah, and because this facility involves the longest travel distance, the assumption that all contaminated materials would be transported to the Clive, Utah, facility provided an upper bound of potential transportation impacts.

To simplify, the analysis assumed that truck shipments would consist of 14 supersacks with a total weight of about 12,700 kilograms (kg) (28,000 pounds) of contaminated material transported in a standard dump-type truck and that rail shipments would be in typical gondola railcars about 16.5 meters (54 feet) long. Table E-1 summarizes the number of rail and truck shipments for Alternatives 2 and 3, respectively.

This analysis used a dose rate of 1 milliroentgen per hour at a distance of 1 meter (3.3 feet) from the vehicle to generate unit dose factors. To produce material-specific results, the analysis modified these unit dose rate factors by the estimated dose rates from each radionuclide mixture and for each shipment mode (i.e., truck and rail). The analysis used the MicroShield® computer program (Grove Engineering, 1998) to calculate the dose rates for specific contaminated material mixtures for each type of shipping container, as discussed in Section E.3.1.2. Table E-2 lists the specific radionuclide mixtures for each contaminated material.

Table E-1 Contaminated Material Volume and Weight and Numbers of Truck and Rail Shipments

			Alternative 2 All Off-site Disposal	Alternative 3 Partial Off-site Disposal
Description	Disposal Volume (cubic feet)[a]	Total Weight (g)	No. of Railcars[b]	No. of Trucks[c]
Sludges and Sediments				
Raffinate Sludge[d,e]	247,009	9.51E+09	97	748
Pond 2 Residual Materials[d]	762,000	3.69E+10	305	NA
Emergency Basin Sediment[d]	14,600	6.25E+08	6	49
North Ditch Sediment[d]	20,770	8.89E+08	9	70
Sanitary Lagoon Sediment[d]	10,365	4.44E+08	5	35
Fluoride Holding Basin No. 1	171,400	7.48E+09	69	NA

Table E-1 Contaminated Material Volume and Weight and Numbers of Truck and Rail Shipments

Description	Disposal Volume (cubic feet)[a]	Total Weight (g)	Alternative 2 All Off-site Disposal No. of Railcars[b]	Alternative 3 Partial Off-site Disposal No. of Trucks[c]
Fluoride Holding Basin No. 2	186,000	8.11E+09	74	NA
Fluoride Settling Basins and Clarifier	114,300	4.98E+09	46	NA
Buried Calcium Fluoride	96,380	4.20E+09	39	NA
Buried Fluoride Holding Basin No. 1	57,200	2.49E+09	23	NA
Liner Soils and Subsoils				
Clarifier Liners	332,400	1.66E+10	133	NA
Calcium Fluoride Basin Liner	95,285	4.75E+09	38	NA
Emergency Basin Soils	162,500	8.10E+09	65	NA
North Ditch Soils	87,500	4.36E+09	35	NA
Sanitary Lagoon Liner	56,356	2.81E+09	23	NA
Buried Material/Drums				
Pond 1 Spoils Pile	437,400	2.18E+10	175	NA
Interim Storage Cell	154,887	7.72E+09	62	NA
Solid Waste Burials (No. 1)	43,000	2.14E+09	17	NA
Solid Waste Burials (No. 2)	8,100	4.04E+08	3	NA
DUF_4 Drummed Container Trash	2,200	3.40E+07	1	NA
Other Drummed Container Trash	5,000	7.72E+07	2	NA
Empty Contaminated Drum	2,000	5.00E+07	1	NA
Structural Materials[f]				
Main Process Building	436,600	3.96E+10	397	NA
Solvent Extraction Building	36,000	3.27E+09	33	NA
DUF_4 Building	56,200	5.10E+09	51	NA
ADU/Misc Digestion Building	2,500	2.27E+08	2	NA
Laundry Building	3,000	2.72E+08	3	NA
Centrifuge Building	6,000	5.44E+08	5	NA
Bechtel Building	5,400	4.90E+08	5	NA
Solid Waste Building	3,600	3.27E+08	3	NA
Cooling Tower	6,000	5.44E+08	5	NA
RCC Evaporator	3,750	3.40E+08	3	NA
Incinerator	1,500	1.36E+08	1	NA
Concrete and Asphalt	511,795	4.64E+10	465	NA
Contaminated material	50,000	1.25E+09	45	NA
Chippel Pallets	3,000	2.55E+07	1	NA

Table E-1 Contaminated Material Volume and Weight and Numbers of Truck and Rail Shipments

Description	Disposal Volume (cubic feet)[a]	Total Weight (g)	Alternative 2 All Off-site Disposal No. of Railcars[b]	Alternative 3 Partial Off-site Disposal No. of Trucks[c]
Subsoils and Bedrock				
Contaminated Materials	3,574,000[g]	1.78E+11	1,430	NA
TOTALS	7,456,470	4.21E+11	3,678	902

[a] To convert to cubic meters, multiply by 0.02832.

[b] Railcars assumed to be typical 16.46-meter (54-foot) gondolas with a 71-cubic-meter (2,500-cubic-foot) capacity and a corrugated effective wall thickness of 0.48 centimeter (0.1875 inch). Railcars are assumed to carry 108 super sacks.

[c] Trucks assumed to be typical dump-type trucks loaded with 14 super sacks and with corrugated effective wall thickness of 0.48 centimeter (0.1875 inch).

[d] Assumed to be shipped off-site under Alternative 3.

[e] For shipping calculations, assumed that the raffinate sludge is LSA-II and is shipped in IP-2 packaging (i.e., super sacks) as per 39 CFR 173.427.

[f] Structural materials, because of their high density, are weight limited to 99,880 kilograms (220,000 pounds), or 31.2 cubic meters (1,100 cubic feet).

[g] Represents estimated quantity of soil to be excavated under Alternative 2 only. This is the only alternative that applies to off-site shipment by rail.

NA = Not Applicable

Table E-2 Radionuclide Quantities for Truck and Rail Shipments

Description	Curies[a] per Truck					Curies[a] per Railcar				
	U-234	U-235	U-238	Ra-226	Th-230	U-234	U-235	U-238	Ra-226	Th-230
Sludges and Sediments										
Raffinate Sludge	2.09E-02	9.85E-04	2.06E-02	1.35E-03	3.19E-01	1.61E-01	7.60E-03	1.59E-01	1.04E-02	2.46E+00
Pond 2 Residual Materials	NA	NA	NA	NA	NA	1.78E-02	8.37E-04	1.75E-02	5.25E-03	1.57E-01
Emergency Basin Sediment	5.52E-03	2.60E-04	5.42E-03	2.44E-03	9.56E-02	4.26E-02	2.00E-03	4.18E-02	1.88E-02	7.38E-01
North Ditch Sediment	5.52E-03	2.60E-04	5.42E-03	4.29E-04	1.43E-03	4.26E-02	2.00E-03	4.18E-02	3.31E-03	1.10E-02
Sanitary Lagoon Sediment	1.84E-02	8.67E-04	1.81E-02	2.87E-04	1.43E-02	1.42E-01	6.69E-03	1.40E-01	2.21E-03	1.11E-01
Fluoride Holding Basin No. 1	NA	NA	NA	NA	NA	6.01E-03	2.83E-04	5.90E-03	2.92E-05	1.90E-04
Fluoride Holding Basin No. 2	NA	NA	NA	NA	NA	6.89E-03	3.24E-04	6.76E-03	2.69E-05	1.88E-04
Fluoride Settling Basins and Clarifier	NA	NA	NA	NA	NA	1.00E-02	4.73E-04	9.87E-03	2.19E-05	1.75E-04
Buried Calcium Fluoride	NA	NA	NA	NA	NA	1.98E-02	9.32E-04	1.94E-02	1.56E-04	6.23E-04
Buried Fluoride Holding Basin No. 1	NA	NA	NA	NA	NA	5.94E-03	2.80E-04	5.84E-03	4.37E-05	1.75E-04
Liner Soils and Subsoils										
Clarifier Liners	NA	NA	NA	NA	NA	1.76E-03	8.30E-05	1.73E-03	7.52E-05	9.03E-03
Calcium Fluoride Basin Liner	NA	NA	NA	NA	NA	1.01E-03	4.74E-05	9.89E-04	NIL	NIL
Emergency Basin Soils	NA	NA	NA	NA	NA	7.21E-03	3.40E-04	7.09E-03	NIL	NIL
North Ditch Soils	NA	NA	NA	NA	NA	5.15E-03	2.42E-04	5.05E-03	NIL	NIL
Sanitary Lagoon Liner	NA	NA	NA	NA	NA	2.11E-03	9.95E-05	2.08E-03	NIL	NIL
Buried Material/Drums										
Pond 1 Spoils Pile	NA	NA	NA	NA	NA	3.02E-04	1.42E-05	2.97E-04	2.86E-04	5.72E-03
Interim Storage Cell	NA	NA	NA	NA	NA	2.35E-02	1.11E-03	2.31E-02	NIL	NIL
Solid Waste Burials	NA	NA	NA	NA	NA	1.85E-02	8.70E-04	1.82E-02	NIL	NIL

Table E-2 **Radionuclide Quantities for Truck and Rail Shipments**

Description	Curies[a] per Truck					Curies[a] per Railcar				
	U-234	U-235	U-238	Ra-226	Th-230	U-234	U-235	U-238	Ra-226	Th-230
(No. 1)										
Solid Waste Burials (No. 2)	NA	NA	NA	NA	NA	6.23E-03	2.93E-04	6.12E-03	NIL	NIL
DUF_4 Drummed Container Trash	NA	NA	NA	NA	NA	3.94E-01	7.73E-03	3.89E-01	NIL	NIL
Other Drummed Container Trash	NA	NA	NA	NA	NA	3.70E-03	1.74E-04	3.64E-03	NIL	NIL
Empty Contaminated Drum	NA	NA	NA	NA	NA	9.26E-03	4.36E-04	9.09E-03	NIL	NIL
Structural Materials										
Main Process Building	NA	NA	NA	NA	NA	8.40E-03	3.96E-04	8.25E-03	NIL	NIL
Solvent Extraction Building	NA	NA	NA	NA	NA	8.40E-03	3.96E-04	8.25E-03	NIL	NIL
DUF_4 Building	NA	NA	NA	NA	NA	8.40E-03	1.65E-04	8.29E-03	NIL	NIL
ADU/Misc Digestion Building	NA	NA	NA	NA	NA	8.40E-03	3.96E-04	8.25E-03	NIL	NIL
Laundry Building	NA	NA	NA	NA	NA	8.40E-03	3.96E-04	8.25E-03	NIL	NIL
Centrifuge Building	NA	NA	NA	NA	NA	8.40E-03	3.96E-04	8.25E-03	NIL	NIL
Bechtel Building	NA	NA	NA	NA	NA	8.40E-03	3.96E-04	8.25E-03	NIL	NIL
Solid Waste Building	NA	NA	NA	NA	NA	8.40E-03	3.96E-04	8.25E-03	NIL	NIL
Cooling Tower	NA	NA	NA	NA	NA	8.40E-03	3.96E-04	8.25E-03	NIL	NIL
RCC Evaporator	NA	NA	NA	NA	NA	8.40E-03	3.96E-04	8.25E-03	NIL	NIL
Incinerator	NA	NA	NA	NA	NA	8.40E-03	3.96E-04	8.25E-03	NIL	NIL
Concrete and Asphalt	NA	NA	NA	NA	NA	8.40E-03	3.96E-04	8.25E-03	NIL	NIL
Contaminated material	NA	NA	NA	NA	NA	1.68E-03	7.91E-05	1.65E-03	NIL	NIL
Chippel Pallets	NA	NA	NA	NA	NA	NIL	NIL	NIL	NIL	NIL

Table E-2 Radionuclide Quantities for Truck and Rail Shipments

Description	Curies[a] per Truck					Curies[a] per Railcar				
	U-234	U-235	U-238	Ra-226	Th-230	U-234	U-235	U-238	Ra-226	Th-230
Subsoils and Bedrock										
Contaminated Materials	NA	NA	NA	NA	NA	7.42E-03	3.49E-04	7.28E-03	NIL	NIL

[a] To convert to becquerels, multiply by 3.7E10.

E.2.3 Routing

To assess the impacts of radioactive materials transportation, the analysis first had to define the characteristics of transportation routes between the origin of the shipments and their destinations. These route characteristics are values such as distance, exposed populations, and weighted population densities. This type of analysis often divides population density into three zones–rural, suburban, and urban–where rural is defined as an area with a density of less than about 54 people per square kilometer (139 people per square mile), suburban is defined as an area with a density between 54 and about 1,284 people per square kilometer (139 and 3,326 people per square mile), and urban is defined as an area with a density greater than 1,284 people per square kilometer (3,326 people per square mile) (Johnson and Michelhaugh, 2003). The analysis typically estimates the distance traveled within each population zone along with the total distance.

For shipments from the SFC site to a low-level radioactive waste disposal site (assumed to be Clive, Utah), the analysis used the WebTRAGIS computer program (Johnson and Michelhaugh, 2003) and 2000 Census data to examine the highway and rail routes. Route characteristics include total shipment distance between the SFC site and Clive, Utah; the distances traveled in rural, suburban, and urban population density zones; and the weighted population densities in these zones.

SFC considered the following potential off-site disposal locations for the dewatered raffinate sludge and sediments (SFC, 2005):

- Energy Solutions in Clive, Utah, is 2,190 truck kilometers (1,361 miles) from the SFC facility.
- The International Uranium Corporation's White Mesa Mill in Blanding, Utah, is 1,607 truck kilometers (998.5 miles) from the facility.
- Waste Control Specialists near Andrews, Texas, is 1,038 truck kilometers (645 miles) from the facility.

The analysis chose routes by minimizing the total impedance of each route, which is a function of distance and driving time between the origin and destination. WebTRAGIS can identify routes that maximize the use of interstate highways. This analysis used the commercial route setting to generate highway routes that commercial trucks generally use. While these might not be the actual routes that SFC would use, their application in the analysis provides best estimates of the potential impacts. The producers of WebTRAGIS periodically update the highway function to reflect current road conditions. The analysis used the population summary module of WebTRAGIS to determine the exposed populations within 800 meters (0.5 mile) of either side of the route.

The analysis also used WebTRAGIS to simulate routing for rail shipments. The WebTRAGIS database describes the U.S. railroad system and includes all rail lines except industrial spurs, and it includes inland and intracoastal waterways and deep-water routes. The database contains more than 15,000 rail and barge segments known as links (although this analysis does not include barging) and more than 13,000 stations, interchange points, ports, and other locations known as nodes. As with the highway function, the rail function of WebTRAGIS includes nodes for NRC-and Agreement State-licensed facilities and DOE nuclear facilities. For the railroad routes, the origin was a node (402117507) near the SFC facility, and the destination nodes were near Clive and Blanding, Utah, and Andrews, Texas. Table E-3 summarizes the distance and population density data for this analysis for truck and rail shipments.

Table E-3 Distance and Exposed Populations within 800 Meters of Truck and Rail Routes[a]

	Kilometers[a]			Persons per Square Kilometer[b]			Totals	
	Rural	Suburban	Urban	Rural	Suburban	Urban	Kilometers[a]	Affected Population
Truck								
Clive, Utah	1,209	134.0	18.2	7.9	315.2	2,174	2,190	146,168
Blanding, Utah	1,401	180.6	25.9	7.0	318.9	2,296	1,607	202,987
Andrews, Texas	859.8	157.6	20.4	9.2	349.8	2.228	1,038	100,935
Rail								
Clive, Utah	2,118	257.3	49.4	6.5	421.5	2,195	2,424	369,043
Blanding, Utah	1.809	259.8	37.9	6.7	398.8	2.166	2,107	316,512
Andrews, Texas	976.1	219.3	26.5	8.8	425.9	2,067	1,221	250,824

Source: WebTRAGIS.
[a] To convert to miles, multiply by 0.62137
[b] To convert to persons per square mile, multiply by 2.57.

The producers of WebTRAGIS periodically update the rail function to reflect mergers, abandonments, and current track conditions and to benchmark reported mileage and observations of commercial rail firms.

Because SFC has not determined the actual disposal site for all materials, the analysis and the detailed discussion in the following sections are limited to shipments to Clive, Utah, the longest route. Although, this assumption maximizes all of the potential rail impacts, some of the impacts from truck shipments (e.g., latent cancer fatalities in exposed populations) could be higher for shipments to Blanding, Utah. A comparison of all potential impacts for each of the possible disposal sites is provided in Section E.5.3, Tables E-27 through E-29.

E.3 Incident-Free Transportation

This section discusses the calculation of potential radiological exposures from shipments of contaminated material off the site. Such shipments can emit some ionizing radiation through the shipping container during routine, incident-free transportation. Persons exposed to this radiation would receive an external radiation dose. The exposed population would include truck and train crews, rail yard workers, and members of the public.

Section E.3.1 provides an overview of the methods and assumptions used to calculate collective doses, including the estimated doses, and Section E.3.2 describes the methods and assumptions used to calculate doses to individuals. Section E.3.3 discusses the determination of vehicle emission unit risk factors and their use in estimating potential nonradiological impacts.

E.3.1 Incident-Free Collective Dose

Figure E-1 shows the flow of information through RADTRAN 5 and the Sequoyah RiskModel, which were used to estimate radiation doses to receptors.

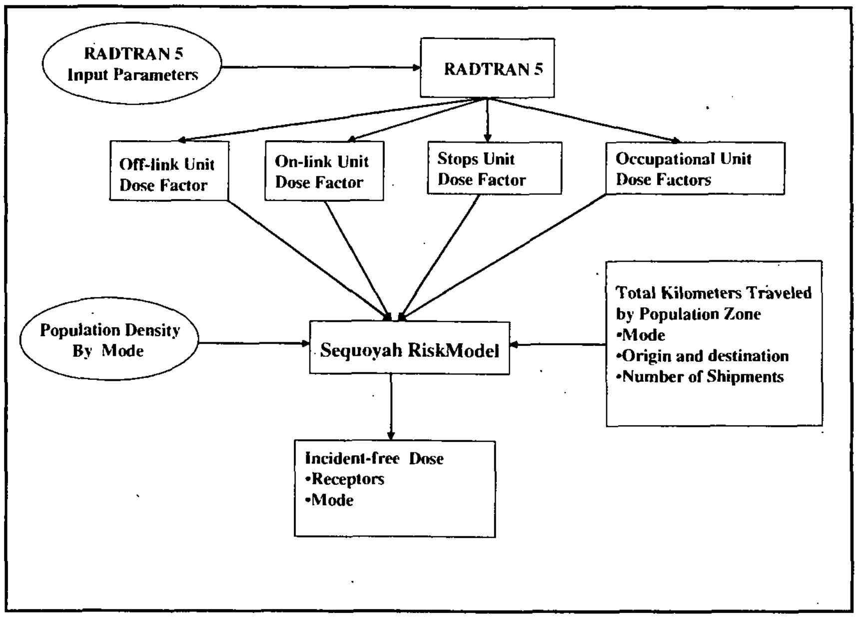

Figure E-1 Information Flow for Calculation of Collective Doses from Incident-Free Transportation

The analysis calculated incident-free collective doses under the assumption that the external dose rate from the shipping package would be the radiation source that exposed receptors at various distances from the package. The MicroShield® computer program (Grove Engineering, 1998) calculated the radiation exposure from the shipping package based on the radionuclide content of the package. The analysis then used a combination of these estimated exposure rates at 1 meter (3.3 feet; referred to as transport indexes, or TIs), RADTRAN 5, and the Sequoyah RiskModel to calculate the doses. The analysis considered exposures from moving and stationary vehicles. RADTRAN 5 calculates incident-free doses to the highest exposed member of the public, to workers (except truck drivers), and members of the general public ("public doses"). The analysis performed separate calculations for the following receptors:

- The *off-link* population dose applies to members of the general public who resided or were pedestrians along the transportation routes and who were exposed by moving railcars and trucks.
- The *on-link* population dose applies to occupants of motor vehicles or trains that shared the transportation route with the shipment while it was moving.
- The *resident rest stop* dose applies to members of the public who lived within 800 meters (0.5 mile) of a rest stop area where a truck stopped for crew rest or refueling. This dose applies only for truck shipments.

- The *crew dose* applies to truck crew members when a truck was moving. This dose is only for truck shipments.
- The *truck driver* dose applies to individuals driving trucks who were 1.5 meters (4.9 feet) from the end of the shipping package. This dose is only for truck shipments.
- The *truck stop* population dose applies to members of the public who were at rest and refueling stops when a truck carrying the shipment stopped for crew rest or refueling. This dose is only for truck shipments.
- The *maximally exposed resident along route* dose applies to a member of the public who lived within 30 meters (98 feet) of a truck or rail route who was exposed to in-transit shipments (both rail and truck shipments).
- The *maximally exposed resident at stop* dose applies to a member of the public who lived within 30 meters (98 feet) of locations where trucks or rail shipments stopped (for rest/refuel, classification, etc.).
- The *rail workers at classification stop* dose applies to rail yard workers, crew, and inspectors who loaded and organized (classified) and inspected trains at both the origin and destination of each rail shipment. This dose is only for rail shipments.
- The *distance-dependent rail worker* dose applies to rail yard workers at in-transit rail stops along the route. This dose is only for rail shipments.

The incident-free dose to a receptor is an external dose and depends on the dose rate external to the package. These external dose rates, or TIs, are a function of the radionuclide mix, metal type, and package type; the analysis used conservative assumptions for the estimations to maximize the calculated doses to provide reasonable assurance that incident-free doses would not be underestimated.

E.3.1.1 Assumptions

The model used to calculate collective population incident-free doses incorporates several general assumptions that apply to both transportation modes. The calculated doses are directly proportional to the number of shipments that move past the receptor (Neuhauser et al., 2000, p. 23). The collective incident-free population dose is proportional to the number of receptors. For truck and rail transportation-related exposures, the assumed receptors occupy an 800-meter (0.5-mile) -wide corridor on either side of the route, and the population density in each corridor reflects the population density of the census block group that abuts or contains the route. Section E.2.3 discusses population assumptions and calculations.

The following sections describe the assumptions and parameters the analysis used with RADTRAN 5 to calculate off- and on-link doses. RADTRAN 5 includes a table of standard parameter values, as well as suggested values for other parameters. This section provides the input parameters for calculating collective and individual doses from a moving truck and doses to individuals and nearby populations when the truck stops for refueling and crew rest.

Parameters and Assumptions for Doses from Moving Trucks. Table E-4 lists the assumptions and input parameters, including national average traffic counts, used to calculate incident-free doses from moving truck shipments. The model assumes freeway truck speeds are constant in the absence of rush-hour traffic. Vehicles sharing the route would provide no shielding from the shipping package external radiation. However, buildings in suburban and urban areas would have shielding factors of 0.87 and 0.018, respectively. The model used national average one-way vehicle speeds to calculate the on-link dose for national truck shipments. The following receptors were evaluated along the modeled route in the incident-free truck transportation analysis:

- Members of the public who reside along the route and pedestrians (off-link).
- Occupants of vehicles that share the route (on-link).
- Crew dose (truck drivers).

Table E-4 Assumptions and Parameters for Incident-Free Doses from Moving Trucks

Parameter	Parameter Value	Comments and Reference
Package		
Package dimension	6.40 meters[a]	Length of truck
Dose rate	Assumed to be 1 millirad per hour for calculation of unit dose factors	Actual values used for dose estimations
Fraction of emitted radiation that is gamma	1	
Fraction of emitted radiation that is neutrons	0	
Crew		
Number of crew	2	Analytical assumption
Distance from source to crew	1.5 meters[a]	Neuhauser et al., 2000
Route-specific parameters		
Rural	88.49 kilometers per hour[b]	Neuhauser et al., 2000
Suburban	40.25 kilometers per hour	Neuhauser et al., 2000
Urban	24.16 kilometers per hour	Neuhauser et al., 2000
Number of people per vehicle sharing route	2	
One-way traffic volumes		
Rural	283 vehicles per hour	Neuhauser et al., 2000
Suburban	590 vehicles per hour	Neuhauser et al., 2000
Urban	1,575 vehicles per hour	Neuhauser et al., 2000
Minimum and maximum distances to exposed resident off-link population	30 to 800 meters[a]	Neuhauser et al., 2000
Population densities[c] (persons per square kilometer)[d]		
Rural	(b)	
Suburban	(b)	

[a] To convert meters to feet, multiply by 3.2808.
[b] To convert kilometers to miles, multiply by 0.62137.
[c] Population densities along transportation routes from WebTRAGIS using 2000 Census data. See Table E-3.
[d] To convert to persons per square mile, multiply by 2.57.

Parameters and Assumptions for Calculating Truck Stop Doses. Section E.3.1.3 describes the rest and refueling stop model. Stop doses are proportional to the exposure time; they are inversely proportional to the distance to nearby receptors and to the square of the distance for distant receptors. Residences near stops would provide no shielding. The receptors at modeled stops in the incident-free truck transportation analysis are:

- Members of the public at rest and refueling stops (e.g., truck stops).
- Residents of the area in the vicinity of the truck stops.

Table E-5 lists the assumptions about package type and dimensions, external dose rate, and ratio of gamma to neutron radiation (this analysis assumed all radiation is gamma, so the gamma-to-neutron fraction is 1).

Table E-5 Assumptions and Parameters for Incident-Free Doses at Truck Stops

Parameter	Parameter Value	Comments and Reference
Members of the public at truck stops		
Area of public exposure at the truck stop	Annulus of inner radius 1 meter[a], outer radius 20 meters[a]	DOE, 2002a
Number of members of the public exposed at the truck stop	25	This is entered in RADTRAN 5 as 19,900 persons per square kilometer (DOE, 2002a)
Area of public exposure: residents near the truck stop	30 to 800 meters[a] from source	Neuhauser et al., 2000
Crew		
Crew members exposed at truck stops	2	Analytical assumption
Crew distance to package	2 meters[a]	Analytical assumption
Stop time	1.69 hours (104 minutes)[b]	DOE, 2002a
Distance between stops	1,206 kilometers[c]	Sprung et al., 2000

[a] To convert meters to feet, multiply by 3.2808.
[b] Assumes distance-dependant stop time of 0.0014 hours per kilometer.
[c] To convert kilometers to miles, multiply by 0.62137.

Parameters and Assumptions for Doses from a Moving Railcar. Table E-6 lists the assumptions used to calculate incident-free doses from moving rail shipments.

Table E-6 Assumptions and Parameters for Incident-Free Doses of Moving Railcars

Parameter	Parameter Value	Comments and Reference
Package		
Package dimension	16.46 meters[a]	Length of rail gondola
Dose rate	Assumed to be 1 millirad per hour for calculation of unit dose factors.	Actual values used for dose estimators.

Table E-6 Assumptions and Parameters for Incident-Free Doses of Moving Railcars

Parameter	Parameter Value	Comments and Reference
Fraction of emitted radiation that is gamma	1	
Fraction of emitted radiation that is neutrons	0	
Route parameters		
Speed		
Rural	64 kilometers per hour[b]	Neuhauser et al., 2000
Suburban	40.25 kilometers per hour	Neuhauser et al., 2000
Urban	24 kilometers per hour	Neuhauser et al., 2000
Number of people per vehicle sharing route	3	Neuhauser et al., 2000
Minimum and maximum distances to exposed resident off-link population	30 meters to 800 meters[a]	Neuhauser et al., 2000
Population densities (persons per square kilometer)[c]		
Rural	(c)	
Suburban	(c)	
Urban	(c)	
One-way traffic count (vehicles per hour) on national highways		
Rural	1	Neuhauser et al., 2000
Suburban	5	Neuhauser et al., 2000
Urban	5	Neuhauser et al., 2000
Crew	--	Crew assumed to be too distant and too well-shielded from external radiation from the cargo when the train is moving.

[a] To convert meters to feet, multiply by 3.2808.
[b] To convert kilometers to miles, multiply by 0.62137.
[c] Population densities along transportation routes from WebTRAGIS using 2000 Census data. See Table E-3.

Parameters and Assumptions for Doses from a Stopped Railcar. The receptors at modeled rail stops in the incident-free analysis are:

- Residents of the areas near all stops.
- Rail crew and rail yard workers at classification stops and in-transit stops.

Table E-6 lists the assumptions about package type and package dimensions, external dose rate, and the ratio of gamma to neutron radiation. Tables E-7 and E-8 summarize additional assumptions used to calculate potential doses to populations at terminal and in-transit rail stops, respectively.

Table E-7 Assumptions and Parameters for Incident-Free Doses from Rail Terminal/Classification Stops

Parameter	Parameter Value	Comments and Reference
Occupational classification stop dose		
Terminal classification stop dose	From Neuhauser et al., 2000, Appendix B	Neuhauser et al. (2000) calculates an occupational dose for a classification stop based on the dimensions and external dose rate of the shipping package. This dose is embedded in RADTRAN 5.
Terminal classification stop time	30 hours	Neuhauser et al., 2000
Number of terminal classification stops per trip	One	For unit dose factor calculation. Neuhauser et al., 2000
Residents near terminal classification stops		
Stop in suburban area	(a, b)	
Area of public exposure	400 to 800 meters from source[c]	RISKIND: Neuhauser and Kanipe, 2000
Maximally exposed resident at stop		
Stop time	30 hours	Neuhauser et al., 2000
Distance to resident	400 meters[c]	Neuhauser et al., 2000

[a] Population densities along transportation routes from WebTRAGIS,using 2000 Census data. See Table E-3.
[b] Classification stops would be in rural or suburban areas.
[c] To convert meters to feet, multiply by 3.2808.

Table E-8 Assumptions and Parameters for Incident-Free Doses from In-Transit Rail Stops

Parameter	Parameter Values	Comments and Reference
Occupational dose		
In-transit classification stop dose	From Neuhauser et al., 2000, Appendix B	Neuhauser et al. (2000) calculates an occupational dose for an in-transit classification stop based on the dimensions and external dose rate of the shipping package. This dose is embedded in RADTRAN 5.
Distance-dependent worker exposure factor	0.0018 per kilometer[a]	According to Neuhauser et al. (2000), the in-transit classification stop occupational dose is multiplied by a distance-dependent worker exposure factor to estimate the occupational dose at in-transit stops.
Residents near in-transit stops		
Stop time	(b)	Neuhauser et al., 2000
Distance between stops	555 kilometers	Neuhauser et al., 2000
Stop in rural area	(c)	
Stop in suburban area	(c)	
Stop in urban area	(c)	
Area of public exposure	30 to 800 meters[d]	Exposure distance on either side of the route. Neuhauser et al., 2000

Table E-8 Assumptions and Parameters for Incident-Free Doses from In-Transit Rail Stops

Parameter	Parameter Values	Comments and Reference
Maximally exposed resident at stop		
Stop time	10 hours	Analytical assumption
Distance to resident	30 meters[d]	Neuhauser et al., 2000

a To convert kilometers to miles, multiply by 0.62137.
b Embedded in RADTRAN – not user defined.
c Population densities along transportation routes from WebTRAGIS using 2000 Census data. See Table E-3.
d To convert meters to feet, multiply by 3.2808.

The Sequoyah RiskModel provides RADTRAN 5 input and output files for the calculation of unit dose factors. The RiskModel also includes the values for route segment lengths, population densities, and numbers of shipments from the SFC site to disposal facilities (see Section E.2). The RADTRAN 5 calculation includes all other factors in the calculation of the appropriate unit dose factor. Therefore:

- The off-link unit dose factor is per shipment, per kilometer, per unit population density (persons per square kilometer), per millirem, and per hour (package TI). The off-link dose is then the product of this unit dose factor multiplied by the number of shipments and the appropriate combination of route distance and population density.
- The on-link unit dose factor is per shipment, per kilometer, per millirem, and per hour. The on-link dose is then the product of this unit dose factor multiplied by the number of shipments and the appropriate route distance (*not* the population density).

The unit dose factors do not include the number of shipments, but Table E-1 lists those for the contaminated material type and alternative. Tables E-9 and E-10 list the per-shipment unit dose factors for incident-free truck and rail transportation, respectively. In addition to the other multiplying factors in the tables, the Sequoyah RiskModel multiplies these unit dose factors by the number of shipments appropriate for each alternative. Tables E-11 and E-12 list the public and worker population doses, by alternative, for the entire shipping campaign, including doses to maximally exposed individuals (MEIs). The Sequoyah RiskModel contains a more detailed presentation of consequences (i.e., dose) and calculated risks (latent cancer fatalities, or LCFs) (see Section E.5).

The analysis used RADTRAN 5 to calculate radiological unit dose factors, which were entered into the Sequoyah RiskModel to calculate collective incident-free population doses. The *RADTRAN 5 Technical Manual* (Neuhauser et al., 2000) and *RADTRAN 5 User Guide* (Neuhauser and Kanipe, 2000) provide detailed descriptions of the theoretical bases and application of this program.

Table E-9 Per-Shipment Unit Dose Factors, Units, and Multipliers for Incident-Free Truck Transportation

Receptor	Value	Units[a]	Multiply by
Public		**person-millisievert per external dose rate per**	**external dose rate × ...**
Off-link rural	3.16E-08	unit population density per kilometer	rural population density × rural kilometers
Off-link suburban	6.92E-08	unit population density per kilometer	suburban population density × suburban kilometers
Off-link urban	1.15E-07	unit population density per kilometer	urban population density × rural kilometers
On-link rural	4.69E-06	per kilometer	rural kilometers
On-link suburban	4.91E-05	per kilometer	suburban kilometers
On-link urban	3.85E-04	per kilometer	urban kilometers
Residents near rural stop	1.92E-09[b]	unit population density per kilometer	rural population density × rural kilometers
Residents near suburban stop	1.92E-09[b]	unit population density per kilometer	suburban population density × suburban kilometers
Residents near urban stop	1.92E-09[b]	unit population density per kilometer	urban population density × rural kilometers
Public at rural highway rest/refuel stops	1.63E-05[b]	per kilometer	rural kilometers
Public at suburban highway rest/refuel stops	1.63E-05[b]	per kilometer	suburban kilometers
Public at urban highway rest/refuel stops	1.63E-05[b]	per kilometer	urban kilometers
Workers		**person-millisievert per external dose rate per**	**external dose rate × ...**
Truck crew rural rest/refuel	5.12E-05[b]	per kilometer	rural kilometers
Truck crew suburban rest/refuel	5.12E-05[b]	per kilometer	suburban kilometers
Truck crew urban rest/refuel	5.12E-05[b]	per kilometer	urban kilometers
Truck crew rural in-transit	4.07E-04	per kilometer	rural kilometers
Truck crew suburban in-transit	8.90E-04	per kilometer	suburban kilometers
truck crew urban in-transit	1.48E-03	per kilometer	urban kilometers
Highest exposed public individual			**external dose rate × ...**
Resident closest to the route	5.12E-07	rem per external dose rate per trip	total trips
Resident near stop	2.08E-07	rem per external dose rate per kilometer	total kilometers

Source: Sequoyah RiskModel; see Section E.5 for details.
[a] To convert kilometers to miles, multiply by 0.62137.
[b] RADTRAN 5 output for single stop divided by 1,206 kilometers (725 miles) per stop.

Table E-10 Per-Shipment Unit Dose Factors, Units, and Multipliers for Incident-Free Rail Transportation

Receptor	Value	Units[a]	Multiply by
Public		**person-millisievert per external dose rate per**	**external dose rate × ...**
Off-link rural	1.17E-07	unit population density per kilometer	rural population density × rural kilometers
Off-link suburban	1.63E-07	unit population density per kilometer	suburban population density × suburban kilometers
Off-link urban	5.62E-09	unit population density per kilometer	urban population density × rural kilometers
On-link rural	2.74E-07	kilometer	rural kilometers
On-link suburban	3.51E-06	kilometer	suburban kilometers
On-link urban	9.73E-06	kilometer	urban kilometers
Residents near rural in-transit stop	6.70E-08[b]	unit population density per kilometer	rural population density × rural kilometers
Residents near suburban in-transit stop	6.70E-08[b]	unit population density per kilometer	suburban population density × suburban kilometers
Residents near urban in-transit stop	6.70E-08[b]	unit population density per kilometer	urban population density × rural kilometers
Residents near suburban classification stop	3.14E-05	per stop	2 × trip number
Workers		**person-millisievert per external dose rate per**	**external dose rate × ...**
Rail crew rural in-transit stops	3.32E-8[b]	per kilometer	rural kilometers
Rail crew suburban in-transit stops	3.32E-8[b]	per kilometer	suburban kilometers
Rail crew urban in-transit stops	3.32E-8[b]	per kilometer	urban kilometers
Worker classification stop	1.02E-02	per classification stop	2 × number of trips
Highest exposed public individual			**external dose rate ×**
Resident closest to the route	1.39E-06	rem per external dose rate per trip	total trips
Resident at stop	7.26E-06[b]	rem per external dose rate kilometer	total kilometers

Source: Sequoyah RiskModel – see Section E.5 for details.

[a] To convert kilometers to miles, multiply by 0.62137.

[b] RADTRAN 5 output for single stop divided by 555 kilometers (333 miles) per stop.

Table E-11 TIs, Population Doses, and Doses to MEIs for Alternative 3 for Truck Transportation

	Truck TI	Public Dose (person-millisievert)[b]					MEI (millisievert)[c]		Workers (person-millisievert)[b]		
Material Type	msV/hr at 1 meter[a]	On-Link	Off-Link	Residents Near Stops	Public at Stops	Total Public Dose	Resident Near Route	Resident Near Stop	Truck Crew in Transit	Truck Crew at Stops	Crew Total
Sludges and Sediments											
Raffinate sludge	8.22E-04	1.19E-02	4.79E-03	1.08E-04	3.68E-02	5.35E-02	3.15E-07	2.80E-04	3.93E-01	4.29E-02	4.36E-01
Emergency basin sediment	2.59E-04	2.45E-04	9.90E-05	2.23E-06	7.61E-04	1.11E-03	6.52E-09	5.80E-06	8.13E-03	8.88E-04	9.02E-03
North ditch sediment	1.64E-04	2.21E-04	8.92E-05	2.01E-06	6.85E-04	9.97E-04	5.87E-09	5.22E-06	7.32E-03	7.99E-04	8.12E-03
Sanitary lagoon sediment	5.21E-04	3.50E-04	1.41E-04	3.19E-06	1.09E-03	1.58E-03	9.30E-09	8.27E-06	1.16E-02	1.27E-03	1.29E-02
TOTALS		**1.27E-02**	**5.11E-03**	**1.15E-04**	**3.93E-02**	**5.72E-02**	**3.37E-07**	**3.00E-04**	**4.20E-01**	**4.58E-02**	**4.66E-01**

[a] To convert to mrem/hr, multiply by 100.
[b] To convert to person-rem, divide by 10.
[c] To convert to rem, divide by 10.

Table E-12 TIs, Population Doses, and Doses to MEIs for Alternative 2 for Rail Transportation

	Rail TI	Public Dose (person-millisievert)[b]					MEI (millisievert)[c]		Workers (person-millisievert)[b]		
Material Type	msV/hr at 1 meter[a]	On-Link	Off-Link	Residents Near Stops	Public at Stops	Total Public Dose	Resident Near Route	Resident Near Stop	Rail Crew in Transit	Rail Crew at Stops	Crew Total
Sludges and sediments											
Raffinate sludge	1.44E-05	2.75E-04	2.79E-03	2.16E-03	8.79E-06	5.23E-03	1.95E-07	2.46E-03	1.13E-05	2.86E-03	2.87E-03
Pond 2 residual materials	1.33E-06	7.98E-05	8.09E-04	6.28E-04	2.55E-06	1.52E-03	5.65E-08	7.15E-04	3.27E-06	8.29E-04	8.33E-04
Emergency Basin sediment	4.63E-06	5.79E-06	5.86E-05	4.55E-05	1.85E-07	1.10E-04	4.10E-09	5.19E-05	2.37E-07	6.01E-05	6.04E-05
North Ditch sediment	2.93E-06	5.22E-06	5.29E-05	4.11E-05	1.67E-07	9.94E-05	3.70E-09	4.68E-05	2.14E-07	5.42E-05	5.45E-05
Sanitary Lagoon sediment	9.31E-06	8.27E-06	8.38E-05	6.51E-05	2.64E-07	1.57E-04	5.85E-09	7.41E-05	3.39E-07	8.59E-05	8.62E-05
Fluoride holding basin No. 1	3.54E-07	4.77E-06	4.83E-05	3.75E-05	1.52E-07	9.07E-05	3.37E-09	4.27E-05	1.95E-07	4.95E-05	4.97E-05
Fluoride holding basin No. 2	4.05E-07	5.92E-06	6.00E-05	4.66E-05	1.89E-07	1.13E-04	4.19E-09	5.31E-05	2.43E-07	6.15E-05	6.18E-05
Fluoride settling basins and clarifier	5.91E-07	5.30E-06	5.37E-05	4.17E-05	1.70E-07	1.01E-04	3.75E-09	4.75E-05	2.17E-07	5.51E-05	5.53E-05
Buried calcium fluoride	1.17E-06	8.86E-06	8.98E-05	6.97E-05	2.83E-07	1.69E-04	6.27E-09	7.94E-05	3.63E-07	9.20E-05	9.24E-05
Buried fluoride holding basin No. 1	3.51E-07	1.58E-06	1.60E-05	1.24E-05	5.04E-08	3.00E-05	1.12E-09	1.41E-05	6.47E-08	1.64E-05	1.65E-05
Liner soils and subsoils											
Clarifier liners	1.85E-07	4.84E-06	4.90E-05	3.81E-05	1.55E-07	9.20E-05	3.42E-09	4.33E-05	1.98E-07	5.02E-05	5.04E-05
Calcium fluoride basin liner	1.02E-07	7.60E-07	7.70E-06	5.98E-06	2.43E-08	1.45E-05	5.38E-10	6.81E-06	3.12E-08	7.90E-06	7.93E-06
Emergency Basin soils	7.28E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
North Ditch soils	5.19E-07	9.29E-06	9.41E-05	7.31E-05	2.97E-07	1.77E-04	6.58E-09	8.33E-05	3.81E-07	9.65E-05	9.69E-05
Sanitary Lagoon liner	2.13E-07	3.57E-06	3.62E-05	2.81E-05	1.14E-07	6.79E-05	2.53E-09	3.20E-05	1.46E-07	3.71E-05	3.72E-05
Buried material/drums											
Pond 1 spoils pile	3.50E-08	1.20E-07	1.22E-06	9.47E-07	3.85E-09	2.29E-06	8.51E-11	1.08E-06	4.93E-09	1.25E-06	1.25E-06
Interim storage cell	2.37E-06	1.20E-06	1.22E-05	9.47E-06	3.85E-08	2.29E-05	8.51E-10	1.08E-05	4.93E-08	1.25E-05	1.25E-05
Solid waste burials (No. 1)	1.87E-06	2.88E-05	2.92E-04	2.27E-04	9.22E-07	5.49E-04	2.04E-08	2.58E-04	1.18E-06	2.99E-04	3.01E-04

Table E-12 TIs, Population Doses, and Doses to MEIs for Alternative 2 for Rail Transportation

Material Type	Rail TI	Public Dose (person-millisievert)[b]					MEI (millisievert)[c]		Workers (person-millisievert)[b]		
	msV/hr at 1 meter[a]	On-Link	Off-Link	Residents Near Stops	Public at Stops	Total Public Dose	Resident Near Route	Resident Near Stop	Rail Crew in Transit	Rail Crew at Stops	Crew Total
Solid waste burials (No. 2)	6.29E-07	6.30E-06	6.39E-05	4.96E-05	2.02E-07	1.20E-04	4.46E-09	5.65E-05	2.58E-07	6.55E-05	6.57E-05
DUF_4 drummed container trash	2.26E-05	4.00E-07	4.05E-06	3.15E-06	1.28E-08	7.62E-06	2.83E-10	3.59E-06	1.64E-08	4.16E-06	4.17E-06
Other drummed container trash	5.09E-07	3.91E-06	3.96E-05	3.08E-05	1.25E-07	7.44E-05	2.77E-09	3.50E-05	1.60E-07	4.06E-05	4.08E-05
Empty Contaminated Drum	8.07E-07	2.00E-07	2.02E-06	1.57E-06	6.39E-09	3.80E-06	1.41E-10	1.79E-06	8.19E-09	2.08E-06	2.08E-06
Structural materials											
Main process building	2.27E-06	1.77E-04	1.79E-03	1.39E-03	5.65E-06	3.36E-03	1.25E-07	1.58E-03	7.25E-06	1.84E-03	1.84E-03
Solvent extraction building	2.27E-06	1.46E-05	1.48E-04	1.15E-04	4.66E-07	2.77E-04	1.03E-08	1.31E-04	5.97E-07	1.51E-04	1.52E-04
DUF_4 building	9.51E-07	9.55E-06	9.67E-05	7.51E-05	3.05E-07	1.82E-04	6.76E-09	8.55E-05	3.91E-07	9.92E-05	9.95E-05
ADU/Misc. digestion building	2.27E-06	1.01E-06	1.03E-05	7.97E-06	3.24E-08	1.93E-05	7.16E-10	9.07E-06	4.15E-08	1.05E-05	1.06E-05
Laundry building	2.27E-06	1.21E-06	1.23E-05	9.56E-06	3.88E-08	2.31E-05	8.60E-10	1.09E-05	4.98E-08	1.26E-05	1.27E-05
Centrifuge building	2.27E-06	2.43E-06	2.46E-05	1.91E-05	7.77E-08	4.62E-05	1.72E-09	2.18E-05	9.96E-08	2.52E-05	2.53E-05
Bechtel building	2.27E-06	2.19E-06	2.22E-05	1.72E-05	6.99E-08	4.16E-05	1.55E-09	1.96E-05	8.96E-08	2.27E-05	2.28E-05
Solid waste building	2.27E-06	1.46E-06	1.48E-05	1.15E-05	4.66E-08	2.77E-05	1.03E-09	1.31E-05	5.97E-08	1.51E-05	1.52E-05
Cooling tower	2.27E-06	2.43E-06	2.46E-05	1.91E-05	7.77E-08	4.62E-05	1.72E-09	2.18E-05	9.96E-08	2.52E-05	2.53E-05
RCC evaporator	2.27E-06	1.52E-06	1.54E-05	1.19E-05	4.86E-08	2.89E-05	1.07E-09	1.36E-05	6.22E-08	1.58E-05	1.58E-05
Incinerator	2.27E-06	6.07E-07	6.15E-06	4.78E-06	1.94E-08	1.16E-05	4.30E-10	5.44E-06	2.49E-08	6.31E-06	6.33E-06
Concrete and asphalt	2.27E-06	2.07E-04	2.10E-03	1.63E-03	6.63E-06	3.94E-03	1.47E-07	1.86E-03	8.49E-06	2.15E-03	2.16E-03

Table E-12 TIs, Population Doses, and Doses to MEIs for Alternative 2 for Rail Transportation

	Rail TI	Public Dose (person-millisievert)[b]					MEI (millisievert)[c]		Workers (person-millisievert)[b]		
Material Type	**msV/hr at 1 meter[a]**	**On-Link**	**Off-Link**	**Residents Near Stops**	**Public at Stops**	**Total Public Dose**	**Resident Near Route**	**Resident Near Stop**	**Rail Crew in Transit**	**Rail Crew at Stops**	**Crew Total**
Contaminated material	1.46E-07	1.31E-06	1.32E-05	1.03E-05	4.18E-08	2.49E-05	9.26E-10	1.17E-05	5.36E-08	1.36E-05	1.36E-05
Chippel Pallets	0.00E+00	1.77E-04	1.79E-03	1.39E-03	5.65E-06	3.36E-03	1.25E-07	1.58E-03	7.25E-06	1.84E-03	1.84E-03
Subsoils and bedrock											
Contaminated materials	7.48E-07	2.10E-04	2.13E-03	1.65E-03	6.72E-06	4.00E-03	1.49E-07	1.88E-03	8.61E-06	2.18E-03	2.19E-03
TOTALS		**1.09E-03**	**1.11E-02**	**8.60E-03**	**3.50E-05**	**2.08E-02**	**7.74E-07**	**9.80E-03**	**4.48E-05**	**1.14E-02**	**1.14E-02**

[a] To convert to mrem/hr, multiply by 100.

[b] To convert to person-rem, divide by 10.

[c] To convert to rem, divide by 10.

E.3.1.2 Analysis of Doses from Moving Vehicles

This section briefly describes the RADTRAN 5 model and deals only with specific details of the application of RADTRAN 5 in the moving-vehicle analysis. The analysis used a dose rate of 0.1 millisievert (1 millirem) per hour at a distance of 1 meter (3.3 feet) from the vehicle to generate unit dose factors, then multiplied the unit dose factors by the package-specific external dose rate and other factors (see Tables E-9 and E-10 for details).

RADTRAN 5 was used to calculate unit dose factors using the appropriate input parameters. Basic features of the RADTRAN 5 model are (1) the shipping package and truck bed combination are spherically symmetric and (2), while the actual radiation source is the shipping package external dose rate, the model uses an isotropic emission at the center of the sphere as the source (i.e., a point source) (Neuhauser et al., 2000, p.20). The dose to a distant receptor is directly proportional to the dose rate buildup, which is the product of a buildup factor and an attenuation factor. For gamma radiation, this product is equal to unity in RADTRAN 5 because it is always less than or equal to 1 (Neuhauser et al., 2000, pp. 29–30).

The dose is inversely proportional to the square of the distance between the receptor and the center of the cargo (the truck bed). When the receptor is within about a package length, as could be the case for crew members and inspectors, the model bases external dose rate on a line source, and the dose to the receptor is inversely proportional to the distance between the receptor and the center of the cargo.

Dose is directly proportional to exposure time. The dose to a stationary receptor from a moving vehicle carrying radioactive cargo, i.e., the off-link dose, is inversely proportional to the speed of the vehicle.

This analysis assigned values of 1 to some variables in the RADTRAN 5 input for the calculation of unit dose factors for rural, suburban, and urban segments of the various routes for each mode (truck and rail). The products of the resulting table of unit dose factors, multiplied by the applicable shipment kilometers, exposed populations, etc., are then the off-link, incident-free doses for each segment of each route. This analysis then combines these doses to determine total collective dose.

To calculate potential in-transit doses to truck crews, the analysis assumed that the crew would remain at a fixed distance (1.5 meters [4.9 feet]) from the package for the duration of the route. RADTRAN 5 bases the end-on radiation dose rate on the given TI.

Doses to occupants of other vehicles sharing the transportation corridor, i.e., the on-link doses, require a more complex set of assumptions about vehicle speed (Neuhauser et al., 2000, p.42). RADTRAN 5 bases the calculation of on-link doses on Equations 31 to 34 of Neuhauser et al., (2000, pp. 42–45). In RADTRAN 5, the relative speed of vehicles that move in the same direction as the contaminated material shipment is twice the contaminated material vehicle speed when the vehicle is passing the contaminated material vehicle (contaminated material vehicle is stationary), and zero if the vehicle is traveling in a lane next to the contaminated material vehicle. In addition, the density of vehicles that move in the opposite direction is inversely proportional to the vehicle speed. Overall, the on-link dose is inversely proportional to the square of the vehicle speed (Neuhauser et al., 2000, p. 42).

RADTRAN 5 calculated national per-kilometer, on-link unit dose factors for each mode and shipment for each population zone using national average vehicle densities. The Sequoyah RiskModel then multiplied each unit dose factor by route segment length, number of shipments, and package length. Vehicles that shared the route with the radioactive cargo would provide no radiation shielding for their occupants.

E.3.1.3 Analysis of Doses at Stops

Figure E-2 shows the rest and refueling stop model for the analysis for truck shipments. RADTRAN 5 allows each stop, or type of stop, along a route to be modeled individually. The modeled stops and affected populations in this analysis are:

- Truck stops for rest and refueling and the nearby truck crews and residents.
- Classification stops at the origin and destination of a rail trip and the nearby rail crews, inspectors, and residents.
- In-transit classification stops for a rail trip and the nearby rail crews, inspectors, and residents.

DOE (2002a) provided the exposure data for members of the public at rest and refueling stops. RADTRAN 5 calculates a population dose per stop. Calculation of a unit dose factor, in units of person-rem per kilometer, requires an estimate of the number of stops per kilometer of travel, which in turn requires an estimate of how many kilometers the trucks travel between rest and refueling stops.

The model uses the appropriate rural, suburban, or urban population density (depending on whether the stop is in a rural, suburban, or urban area) and the same distance from the shipment as for the off-link dose calculation (30 to 800 meters [about 100 feet to 0.5 mile]) to estimate potential doses to residents who live near the truck stops.

In addition to the model for a rest and refueling stop, for which RADTRAN 5 calculates the dose to a population that is evenly distributed in an area around the source, the RADTRAN 5 stop model allows calculation of dose to receptors at a fixed distance from the source (e.g., dose to an individual at an assumed distance from the vehicle).

The Sequoyah RiskModel uses unit dose factors per kilometer of route length and Equations 37 and 38 or 39 to 41 of Neuhauser et al. (2000, p. 47) to calculate stop dose. The model then divides the result by the average distance between stops to derive a per-kilometer unit dose factor. To convert the unit dose factor to a per-kilometer number, the model divides it either by 1,206 kilometers (725 miles) for trucks, which is the average distance between truck stops, or by 555 kilometers (333 miles) for rail. The Sequoyah RiskModel then multiplies the per-kilometer factor by the distance from each origin to destination and by the number of shipments from each origin site.

Appendix B of Neuhauser et al. (2000) describes the classification stop model of RADTRAN 5. This analysis evaluated two types of classification stops:

- **Terminal classification stop.** The analysis assumed two terminal classification stops per trip (one at the beginning and one at the end of each trip) that last for 30 hours each.

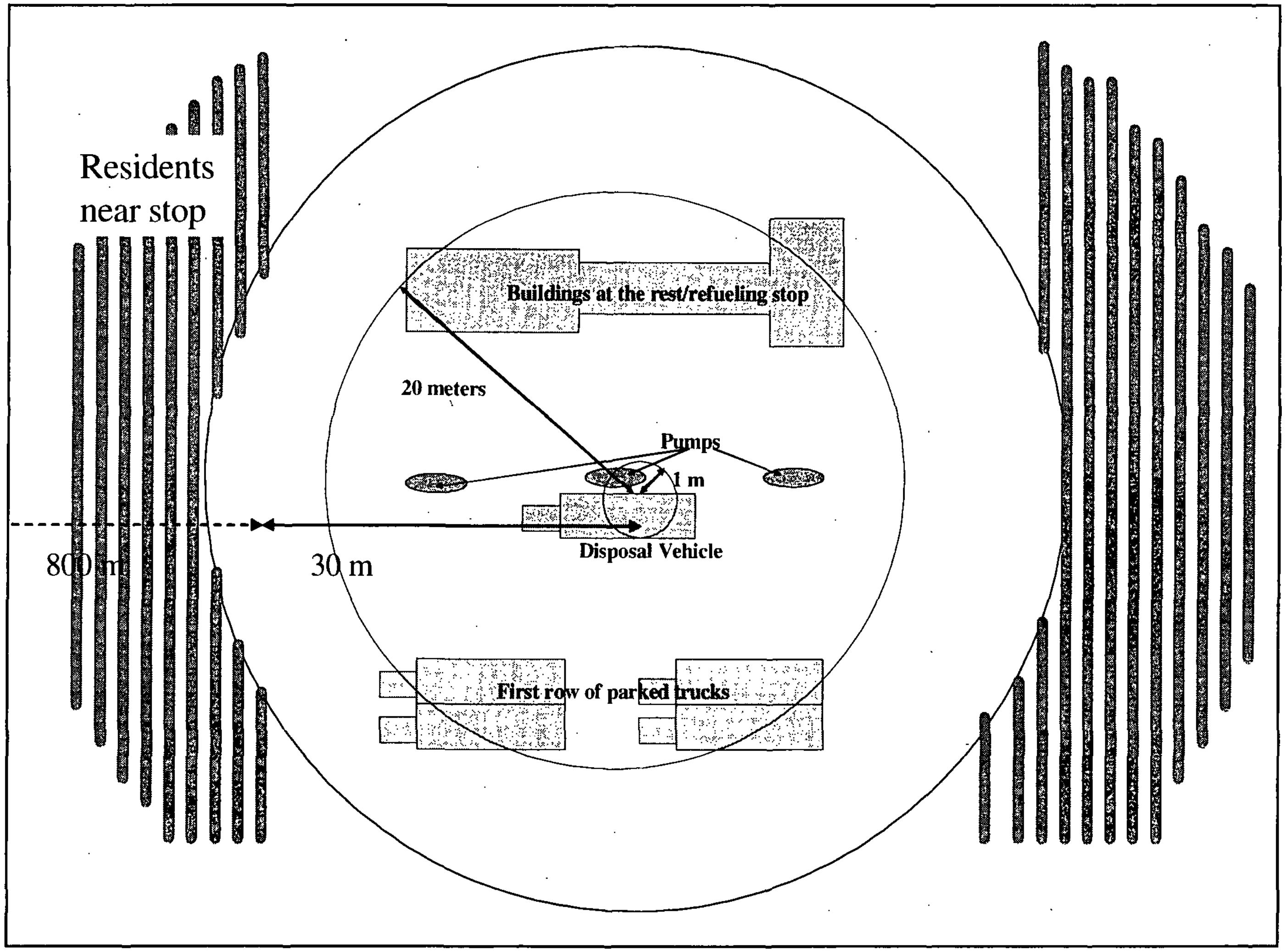

Figure E-2 Rest and Refueling Stop Model

- **In-transit classification stop.** This category represents classification stops that could occur along the route (adding and dropping railcars). The analysis conservatively assumed that in-transit classification stops would total 33 hours for each 555 kilometers traveled.

RADTRAN 5 incorporates the occupational dose at a classification stop, and the user inputs the number of classification stops per trip. This analysis assumed there would be one classification stop at the origin site (or at the closest railhead if the origin site has no rail access) and a second classification stop at the destination. The calculation of doses to residents near the rail stops used the same methods as those for doses to residents near truck stops.

E.3.2 Incident-Free Doses to Individuals

This section describes the scenarios for and calculation of potential incident-free radiological impacts on individuals during the transportation of contaminated material to disposal facilities.

The analysis used RADTRAN 5 to estimate exposures to individuals and based them on transportation of the total number of shipments by both truck and by rail. For public exposures, the analysis assumed an individual could be exposed to all shipments along a route. In addition, the estimates of maximum annual exposures to individuals used the conservative assumption that all shipments would occur during one year.

The MEI is a hypothetical person who would receive the highest dose. Because different individuals could receive the highest doses under different exposure scenarios, the analysis evaluated the following exposure scenarios:

- **Truck driver.** A truck driver is the MEI for all alternatives and exposure scenarios. This individual would be 1.5 meters (4.9 feet) from the shipping package during transport. Exposure from transport of the contaminated material depends upon the travel time to the off-site disposal site (e.g., Clive, Utah). The Sequoyah RiskModel performs this calculation.

- **Resident near route.** The analysis assumed a resident who lives 30 meters (100 feet) from a point where shipments would pass (truck and rail). The resident would be exposed to all truck and rail shipments along a particular route.

- **Resident near rail terminal classification and in-transit rail stops.** The analysis assumed a resident who lives within 30 meters (100 feet) of a switchyard and an exposure time of 30 hours for classification stops and 10 hours for in-transit stops.

- **Resident near truck stop.** The analysis assumed a member of the public would be exposed to shipments for 1.69 hours for each occurrence at a distance of 30 meters (100 feet).

RADTRAN 5 estimates values for exposure to one shipment for each of the individual exposure scenarios. The dose to the MEIs is then the product of these estimated exposures and the number of shipments that might pass or stop at the assumed locations. Table E-13 lists potential MEI doses for rail and truck shipments for the entire shipping campaign.

Table E-13 Radiation Doses to MEIs by Alternative[a]

Doses	Alternative 2 All Off-site Disposal (millisievert)[b]	Alternative 3 Partial Off-site Disposal (millisievert)[b]
Rail		
Resident near rail route	7.74E-07	NA[c]
Resident near a rail stop	9.80E-03	NA[c]
Truck		
Truck driver – **MEI**	NA[c]	2.33E-01
Resident near truck route	NA[c]	3.37E-07
Resident near truck stop	NA[c]	3.00E-04

[a] Calculated by RADTRAN 5 and Sequoyah RiskModel.
[b] To convert to rem, divide by 10.
[c] Not Applicable

E.3.3 Vehicle Emission Unit Risk Factors

This section describes the development of unit risk factors for estimating potential fatalities from exhaust and fugitive dust emissions from highway and rail transportation. These risk factors, which were obtained from the Yucca Mountain Repository environmental impact statement (EIS) (DOE, 2002b), were deemed appropriate for use in this analysis because they account for heavy truck traffic and freight rail traffic for any cargo. To bound potential impacts, this analysis used the conservative assumption that emissions from personal (i.e., commuter) vehicles would be equal to those from trucks. This assumption ensured the analysis did not underestimate potential impacts.

Table E-14 lists the unit risk factors in units of fatalities per kilometer per person per square kilometer. The analysis multiplied these factors by the appropriate population-weighted distances (see Tables E-3 and E-15) and the number of shipments (see Table E-1) to calculate the number of potential vehicle emissions fatalities. Table E-16 lists the vehicle emissions fatalities and the vehicle traffic accident injuries and fatalities by alternative.

Table E-14 Vehicle Emission Unit Risk Factors

Vehicle Class	Weight (tons)	Tire/Brake Particulates (g/km)	Fugitive Dust (g/km)	Diesel Exhaust (g/km)	Total Emissions (g/km)	Unit Risk Factor (fatalities/km per person/km^2)
Class VIIIB Trucks	40	0.030	0.26	0.141	0.43	1.5E-11
Railcar	N/A	N/A	0.26	0.481	0.74	2.6E-11

Source: DOE, 2002a.

Table E-15 Daily Local and Off-Site Traffic, Number of Trips, and Total Mileage by Alternative – Number of Estimated Trips and Mileage[a]

Type of Vehicle Traffic	Estimated One-Way (kilometers)[a]	No-Action Alternative	Alternative 1 On-site Disposal	Alternative 2 Off-site Disposal	Alternative 3 Partial Off-site Disposal[a]
Daily local traffic					
Commuting workers	40.2	6	75	75	75
Normal deliveries	40.2	6	75	75	75
Fly ash	82.1	0	28	0	27
Riprap from off-site	12.9	0	40	0	38
Riprap from on-site	1.6	0	40	0	38
Sand, drain layer, and bedding	12.9	0	9	0	8
Clay liner and clay cap	1.6	0	40	0	38
Clean backfill	1.6	0	85	85	85
Topsoil	1.6	0	13	13	13
Total daily two-way vehicle count		24	784	470	768
Total daily two-way kilometers[b]		966	18,502	12,386	18,247
Total local kilometers[b]		241,410	4,625,416	3,096,486	4,561,844
Off-site traffic					
Daily two-way off-site radioactive material truck shipments		0	0	0	7
Daily two-way off-site radioactive material railcar shipments		0	0	21	0
Total two-way off-site radioactive material truck kilometers[b]		0	0	0	3,952,292
Total two-way off-site radioactive material rail kilometers[b]		0	0	17,829,238	0

Source: SFC, 2005.
[a] To convert to miles, divide by 1.6094.
[b] Assumes 250 working days per year.

Table E-16 Local and Off-site Nonradiological Impacts (Injuries and Fatalities) by Alternative

Mode	Alternative 1 On-site Disposal		Alternative 2 All Off-site Disposal		Alternative 3 Partial Off-site Disposal		No-Action Alternative	
	Vehicle Emissions Fatalities	Traffic Accident Injuries/ Fatalities	Vehicle Emissions Fatalities	Traffic Accident Injuries/ Fatalities	Vehicle Emissions Fatalities	Traffic Accident Injuries/ Fatalities	Vehicle Emissions Fatalities	Traffic Accident Injuries/ Fatalities
Nonradiological impacts of off-site transportation								
Trucks	NA	NA	NA	NA	2.47E-03[a]	9.45E-01/ 5.61E-02	NA	NA
Railcar	NA	NA	4.41E-02	2.09/ 1.39E+00	NA	NA	NA	NA
Nonradiological impacts of local transportation								
	Vehicle Emissions Fatalities[b]	Traffic Accident Injuries/ Fatalities[c]	Vehicle Emissions Fatalities[b]	Traffic Accident Injuries/ Fatalities[c]	Vehicle Emissions Fatalities[b]	Traffic Accident Injuries/ Fatalities[c]	Vehicle Emissions Fatalities[b]	Traffic Accident Injuries/ Fatalities[c]
Trucks	5.48E-04	1.32/ 6.80E-02	3.67E-04	8.82E-01/ 4.55E-02	5.41E-04	1.30/ 6.71E-02	2.86E-05	6.88e-02/ 3.55E-03

[a] Assumes population densities along the route: see Table E-3.
[b] Assumes rural population density of 7.9 people per square kilometer: see Table E-3.
[c] Assumes Oklahoma truck accident rate of 1.47E-08 fatalities per kilometer (DOE, 2002a).
NA = Not Applicable

E.4 Transportation Accidents

E.4.1 Nonradiological Transportation Accidents

This section describes the analysis of nonradiological transportation accident impacts (e.g., traffic fatalities) that could result from accidents that involve contaminated materials. The analysis used truck and railcar injury rates per kilometer of 2.39×10^{-7} and 6.56×10^{-8}, respectively (DOE, 2002a, Tables 6.38 and 6.40), to estimate the total number of injuries that could occur for the truck and rail cases for all alternatives. The analysis used truck and railcar fatality rates per kilometer of 1.42×10^{-8} and 7.82×10^{-8}, respectively (DOE, 2002a, Tables 6.39 and 6.40), to estimate the total number of fatalities that could occur for the truck and rail cases for all alternatives. The analysis multiplied the distance to be traveled by the national composite fatal accident rates to obtain an estimate of the total number of potential fatalities for each case.

The Sequoyah RiskModel calculated potential traffic fatalities from contaminated material transportation by multiplying the appropriate accident rates by the kilometers per shipment and the number of shipments. Table E-17 lists the calculated estimates of fatalities for each alternative.

Table E-17 Potential Truck or Rail Traffic Accident Injuries and Fatalities by Alternative

Mode	Alternative 1 On-site Disposal (Injuries/ Fatalities)	Alternative 2 Off-site Disposal (Injuries/ Fatalities)	Alternative 3 Partial Off-site Disposal (Injuries/ Fatalities)	No-Action Alternative (Injuries/ Fatalities)
Truck	1.32/ 6.80E-02	8.82E-01/ 4.55E-02	9.45/ 1.23E-01	6.88E-02/ 3.55E-03
Rail	NA	2.09/ 1.39	NA	NA

NA = not applicable.

E.4.2 Radiological Transportation Accidents

This section describes the analysis of collective population and individual doses from potential accidents during contaminated material transpiration. The radiation doses that could result from a transportation accident involving radioactive material depend on the amount of radioactive material the accident releases into the environment. The amount of released material depends in turn on (1) the ability of the shipping package to withstand the mechanical and thermal stresses of an accident and (2) the physical behavior of the contaminated material in an accident.

Section E.4.2.1 describes the characteristics of the disposal package that the analysis assumed for the accident. Section E.4.2.2 discusses the analysis methods. Section E.4.2.3 discusses the assumptions and presents the results.

E.4.2.1 Radionuclide Content and Source Term

To define the maximum reasonably foreseeable accident, the analysis screened the radionuclide-specific unit dose factors (from RADTRAN 5 unit accident runs in the Sequoyah RiskModel) to determine the shipping package that could contain the radionuclide mix with the highest potential radiotoxicity, which would represent the highest potential for radiation dose under any accident scenario. The Sequoyah RiskModel screening analysis determined that shipments of raffinate sludge would have the radionuclide mix and quantities with the highest potential radiotoxicity. Table E-18 lists the potential quantities of radionuclides. Although railcars carry more material per car than trucks, the analysis assumed the maximum reasonably foreseeable accident would involve a truck because the truck accident rate is higher and the atmospheric dispersion of radioactive materials would be greater due to the larger amount of kinetic energy likely to be imparted to the contaminated material.

Table E-18 Shipping Package Radionuclide Content for the Maximum Reasonably Foreseeable Truck Accident

Radionuclide	Activity per Truck Load[a] (curies)[b]
U-234	2.09E-02
U-235	9.85E-04
U-238	2.06E-02
Ra-226	1.35E-03
Th-230	3.19E-01
Total Activity	2.09E-02

[a] Assumes 14 supersacks per load.
[b] To convert to becquerels, multiply by 3.7E10.

The assumptions of the maximum reasonably foreseeable accident include a release fraction of 1 (i.e., all material in the package), an aerosol fraction of 0.1 (DOE 2002a, pg. 105, small powder), and a respirable fraction (particles small enough to inhale into the lungs) of the radionuclides of 0.05 (DOE 2002a, loose chunks).

E.4.2.2 Method

The analysis calculated the radionuclide-specific unit dose factors in terms of dose per released curie. The analysis assumed the maximum reasonably foreseeable accident would result in the release of all of the radioactive material, of which 10% would be in aerosol form, dispersed into the air with 5% of respirable particle size. The analysis used RADTRAN 5 to calculate the dose per curie of each radionuclide, i.e., the radionuclide-specific unit dose factor.

The analysis calculated inhalation, resuspension, groundshine, and cloudshine unit dose factors for 1 curie of each radionuclide by applying the curie-to-rem, radionuclide-specific dose conversion factors in the RADTRAN 5 internal library. RADTRAN 5 calculated the total accident dose for each pathway and the fraction of that dose attributable to each radionuclide. Section E.4.2.3 discusses other parameters that are part of the unit dose factors.

The analysis modeled the exposed population for a release of radioactive material by assuming that the population density in the 800-meter (0.5-mile) -wide corridor on either side of the route was the same population density under the entire plume, out to 120 kilometers (75 miles) from the accident. RADTRAN 5 calculates both short- and long-term (50-year) doses; the unit dose factor is the sum of the short-term and long-term unit dose factors.

E.4.2.3 Assumptions

To determine the dose factors in terms of dose per curie of a released radionuclide, the analysis calculated atmospheric dispersion to obtain the downwind airborne and ground concentrations from cloud depletion. The analysis made the following major assumptions for the development of dose factors for the radionuclide-specific unit dose factors for the assumed contaminated material shipment:

- Meteorological conditions would be U.S. national average (50^{th}-percentile meteorology).
- Deposition velocity (for groundshine and ingestion doses) would be 0.01 meter per second (0.023 mile per hour) for volatiles and particulates.
- All receptors would breath outside air that contained radionuclides from the accident.
- Evacuation would occur within 24 hours.
- Interdiction (i.e., cleanup) after an accident would prevent additional exposures after evacuation.
- Released and dispersed radioactive material would have a 100% release fraction, a 10% aerosol fraction, and a 5% respirable fraction.

The analysis used RADTRAN 5 default values for other parameters such as breathing rate.

This section describes the development of unit collective dose factors (person-rem per curie released) for each radionuclide. Tables E-19 and E-20 list the unit dose factors for each radionuclide for rural/suburban and urban accidents, respectively. The analysis developed separate factors to account for the shielding of buildings in suburban and urban areas. Table E-21 lists the total unit dose factors for individual doses, which includes doses from inhalation, cloudshine, and groundshine during evacuation.

The analysis estimated the collective and individual doses from a given accident by multiplying each unit dose factor from Table E-19, E-20, or E-21 (depending on assumed location and receptor) by the released quantity of that radionuclide (package content multiplied by its release fraction). The sum of these products is the total collective dose in person-rem or the individual dose in rem.

Table E-19 Population Unit Dose Factors for Rural and Suburban Accidents by Radionuclide and Exposure Pathway

	Rural and Suburban Accident Dose Factors (person-millisievert[a] per curie released)				
Radionuclide	**Inhalation**	**Resuspended**	**Groundshine**	**Cloudshine**	**Total**
U-234	1.73E-02	1.44E-04	7.16E-04	2.20E-09	1.82E-02
U-235	1.53E-02	1.28E-04	1.42E-01	2.10E-06	1.57E-01
U-238	1.42E-02	1.19E-04	5.20E-04	1.02E-09	1.49E-02
Ra-226	1.73E-02	1.44E-04	6.11E-03	9.44E-08	2.36E-02
Th-230	2.12E-01	1.77E-03	7.19E-04	5.20E-09	2.14E-01

Source: RADTRAN 5 calculation.
[a] To convert to person-rem, divide by 10.

Inhalation Dose: Dose resulting from inhalation of radioactive particles in the plume.
Resuspended Dose: Dose resulting from inhalation of radioactive particles resuspended from the ground.
Groundshine Dose: Dose resulting from exposure to radioactive particles deposited on the ground.
Cloudshine Dose: Dose resulting from exposure to radioactive particles suspended in the plume.

Table E-20 Population Unit Dose Factors for Urban Accidents by Radionuclide and Exposure Pathway

	Urban Accident Dose Factors (person-milisievert[a] per curie released)				
Radionuclide	**Inhalation**	**Resuspended**	**Groundshine**	**Cloudshine**	**Total**
U-234	5.03E-02	4.20E-04	2.08E-03	6.61E-09	5.28E-02
U-235	4.45E-02	3.71E-04	4.12E-01	6.24E-06	4.57E-01
U-238	4.14E-02	3.46E-04	1.53E-03	2.95E-09	4.33E-02
Ra-226	5.03E-02	4.20E-01	1.78E-02	2.74E-07	6.85E-02
Th-230	6.15E-01	5.14E-03	2.09E-03	1.51E-08	6.22E-01

Source: RADTRAN 5 calculation.
[a] To convert to person-rem, divide by 10.

Table E-21 Individual Unit Dose Factors by Radionuclide (millisievert[a] per curie released)

Radionuclide	Total
U-234	5.450
U-235	4.820
U-238	4.610
Ra-226	5.660
Th-230	0.796

Source: RADTRAN 5 calculation.
[a] To convert to rem, divide by 10.

The analysis calculated the collective and individual doses under the conservative assumption that the accident would release all radioactive material in the shipment (see Table E-20). Table

E-22 summarizes the collective doses for rural and urban locations and the individual doses from the maximum accident.

Table E-22 Collective and Individual Doses Resulting from the Maximum Reasonably Foreseeable Accident

Radionuclide	Activity Released (curies)[a]	Rural Population Dose (person-millisievert)[b]	Urban Population Dose (person-millisievert)[b]	Individual Dose (millisievert)[c]
U-234	1.05E-04	1.50E-05	6.00E-04	4.14E-03
U-235	4.92E-05	6.11E-06	2.44E-04	1.68E-03
U-238	1.03E-04	1.21E-05	4.83E-04	3.33E-03
Ra-226	6.75E-06	1.26E-06	5.02E-05	3.46E-04
Th-230	1.60E-03	2.70E-03	1.08E-01	7.43E-01
Total	1.82E-03	2.73E-03	1.09E-01	7.52E-01

Source: Sequoyah RiskModel.
[a] To convert to becquerels, multiply by 3.7E10.
[b] To convert to person-rem, divide by 10.
[c] To convert to person-rem, divide by 10.

E.5 Summary of Transportation Impacts

This section discusses the conversion of collective and individual radiation doses to the potential for (or risk of) adverse health effects. Section E.5.1 provides the method for conversion of dose to LCFs, and Section E.5.2 summarizes potential radiological and nonradiological transportation impacts.

E.5.1 Radiation Dose and Latent Cancer Fatalities

The NRC staff estimated the probability of LCFs for members of the public by using a dose-to-risk conversion factor of 6×10^{-9} per millisievert (6×10^{-7} per millirem) for members of the public. The U.S. Environmental Protection Agency (EPA) recommends this factor for the general population (Eckerman et al., 1999). This factor considers all age groups in the population, including infants and children, who are more sensitive to radiation than adults. Because workers would be 18 or more years old, the analysis used a separate, smaller dose-to-risk conversion factor for workers of 4×10^{-9} per millisievert (4×10^{-7} per millirem) (ICRP, 1990, p. 22).

The analysis used these factors to estimate the effects of exposing a population to radiation. For example, if each of 100,000 people was exposed only to background radiation (3 millisievert, or 0.03 millirem per year), an estimated 18 LCFs would occur as a result of one year of exposure (100,000 persons multiplied by 3 millisievert per year multiplied by 6×10^{-9} LCF per person-millisievert).

This DEIS expresses radiological health impacts as incremental changes in the number of expected LCFs for the off-site public and for transportation workers. Because of the uncertainties in dose response to low dose rates, the impact estimates provide a general indication of possible health impacts (the potential number of induced cancers), but readers should not interpret these estimates as exact numbers of induced cancers or as an indication of who could contract a cancer.

E.5.2 Transportation-Related Human Health Impacts

The analysis multiplied the population and individual doses (see Tables E-11 to E-13 and E-22) by the dose-to-health-effect conversion factors (see Section E.5.1) to estimate (1) the number of fatal cancers in the affected populations and (2) the individual incremental probability of contracting a fatal cancer. Tables E-23 and E-24 list the estimated radiological impacts for the various alternatives from transportation activities for the entire contaminated material shipping campaign, which the analysis assumed would last one year. Table E-25 lists the increased risks of LCFs for the MEIs (public and workers) by alternative. Table E-26 summarizes collective and individual impacts from the maximum foreseeable accident.

Table E-23 Radiological Impacts for Alternative 3 by Material Type for Truck Transport

Material Type	General Population (LCF)					MEI (Increased Risk of LCF)		Workers (LCF)		
	On-Link	Off-Link	Residents Near Stops	Public at Stops	Total Public	Resident Near Route	Resident Near Stop	Truck Crew in Transit	Truck Crew at Stops	Crew Total
Sludges and Sediments										
Raffinate sludge	7.11E-07	2.87E-07	6.48E-09	2.21E-06	3.21E-06	1.89E-11	1.68E-08	1.57E-05	1.72E-06	1.74E-05
Emergency Basin sediment	1.47E-08	5.94E-09	1.34E-10	4.57E-08	6.65E-08	3.91E-13	3.48E-10	3.25E-07	3.55E-08	3.61E-07
North Ditch sediment	1.32E-08	5.35E-09	1.21E-10	4.11E-08	5.98E-08	3.52E-13	3.13E-10	2.93E-07	3.20E-08	3.25E-07
Sanitary Lagoon sediment	2.10E-08	8.47E-09	1.91E-10	6.51E-08	9.48E-08	5.58E-13	4.96E-10	4.64E-07	5.06E-08	5.14E-07
TOTAL	**7.60E-07**	**3.07E-07**	**6.92E-09**	**2.36E-06**	**3.43E-06**	**2.02E-11**	**1.80E-08**	**1.68E-05**	**1.83E-06**	**1.86E-05**

Table E-24 Radiological Impacts for Alternative 2 by Material Type for Rail Transport

Material Type	General Population (LCF)					MEI (Increased Risk of LCF)		Workers (LCF)		
	On-Link	Off-Link	Residents Near Stops	Public at Stops	Total Public	Resident Near Route	Resident Near Stop	Rail Crew in Transit	Rail Crew at Stops	Crew Total
Sludges and sediments										
Raffinate sludge	1.65E-08	1.67E-07	1.30E-07	5.27E-10	3.14E-07	1.17E-11	1.48E-07	4.51E-10	1.14E-07	1.15E-07
Pond 2 residual materials	4.79E-09	4.85E-08	3.77E-08	1.53E-10	9.12E-08	3.39E-12	4.29E-08	1.31E-10	3.32E-08	3.33E-08
Emergency Basin sediment	3.47E-10	3.52E-09	2.73E-09	1.11E-11	6.61E-09	2.46E-13	3.11E-09	9.49E-12	2.40E-09	2.41E-09
North Ditch sediment	3.13E-10	3.17E-09	2.47E-09	1.00E-11	5.96E-09	2.22E-13	2.81E-09	8.56E-12	2.17E-09	2.18E-09
Sanitary Lagoon sediment	4.96E-10	5.03E-09	3.90E-09	1.59E-11	9.44E-09	3.51E-13	4.44E-09	1.36E-11	3.44E-09	3.45E-09
Fluoride holding basin No. 1	2.86E-10	2.90E-09	2.25E-09	9.14E-12	5.44E-09	2.02E-13	2.56E-09	7.81E-12	1.98E-09	1.99E-09
Fluoride holding basin No. 2	3.55E-10	3.60E-09	2.80E-09	1.14E-11	6.76E-09	2.52E-13	3.18E-09	9.71E-12	2.46E-09	2.47E-09
Fluoride settling basins and clarifier	3.18E-10	3.22E-09	2.50E-09	1.02E-11	6.05E-09	2.25E-13	2.85E-09	8.69E-12	2.20E-09	2.21E-09
Buried calcium fluoride	5.32E-10	5.39E-09	4.18E-09	1.70E-11	1.01E-08	3.76E-13	4.76E-09	1.45E-11	3.68E-09	3.70E-09
Buried fluoride holding basin No. 1	9.47E-11	9.59E-10	7.45E-10	3.03E-12	1.80E-09	6.70E-14	8.48E-10	2.59E-12	6.55E-10	6.58E-10
Liner soils and subsoils										
Clarifier liners	2.90E-10	2.94E-09	2.28E-09	9.28E-12	5.52E-09	2.05E-13	2.60E-09	7.93E-12	2.01E-09	2.02E-09
Calcium fluoride basin liner	4.56E-11	4.62E-10	3.59E-10	1.46E-12	8.68E-10	3.23E-14	4.09E-10	1.25E-12	3.16E-10	3.17E-10
Emergency Basin soils	5.58E-10	5.65E-09	4.39E-09	1.78E-11	1.06E-08	3.95E-13	5.00E-09	1.52E-11	3.86E-09	3.88E-09
North Ditch soils	2.14E-10	2.17E-09	1.69E-09	6.85E-12	4.08E-09	1.52E-13	1.92E-09	5.85E-12	1.48E-09	1.49E-09
Sanitary Lagoon liner	5.67E-11	5.74E-10	4.46E-10	1.81E-12	1.08E-09	4.01E-14	5.08E-10	1.55E-12	3.92E-10	3.94E-10
Buried material/drums										
Pond 1 spoils pile	7.22E-11	7.31E-10	5.68E-10	2.31E-12	1.37E-09	5.11E-14	6.47E-10	1.97E-12	5.00E-10	5.02E-10

Table E-24 Radiological Impacts for Alternative 2 by Material Type for Rail Transport

Material Type	General Population (LCF)					MEI (Increased Risk of LCF)		Workers (LCF)		
	On-Link	Off-Link	Residents Near Stops	Public at Stops	Total Public	Resident Near Route	Resident Near Stop	Rail Crew in Transit	Rail Crew at Stops	Crew Total
Interim storage cell	1.73E-09	1.75E-08	1.36E-08	5.53E-11	3.29E-08	1.22E-12	1.55E-08	4.73E-11	1.20E-08	1.20E-08
Solid waste burials (No. 1)	3.78E-10	3.83E-09	2.98E-09	1.21E-11	7.20E-09	2.68E-13	3.39E-09	1.03E-11	2.62E-09	2.63E-09
Solid waste burials (No. 2)	2.40E-11	2.43E-10	1.89E-10	7.68E-13	4.57E-10	1.70E-14	2.15E-10	6.56E-13	1.66E-10	1.67E-10
DUF_4 drummed container trash	2.35E-10	2.38E-09	1.85E-09	7.50E-12	4.46E-09	1.66E-13	2.10E-09	6.41E-12	1.62E-09	1.63E-09
Other drummed container trash	1.20E-11	1.21E-10	9.43E-11	3.83E-13	2.28E-10	8.48E-15	1.07E-10	3.28E-13	8.30E-11	8.33E-11
Empty contaminated drum	7.61E-12	7.70E-11	5.98E-11	2.43E-13	1.45E-10	5.38E-15	6.81E-11	2.08E-13	5.27E-11	5.29E-11
Structural Materials										
Main process building	1.06E-08	1.07E-07	8.35E-08	3.39E-10	2.02E-07	7.51E-12	9.50E-08	2.90E-10	7.35E-08	7.37E-08
Solvent extraction building	8.75E-10	8.86E-09	6.88E-09	2.80E-11	1.66E-08	6.19E-13	7.84E-09	2.39E-11	6.06E-09	6.08E-09
DUF_4 building	5.73E-10	5.80E-09	4.51E-09	1.83E-11	1.09E-08	4.05E-13	5.13E-09	1.57E-11	3.97E-09	3.98E-09
ADU/Misc. digestion building	6.07E-11	6.15E-10	4.78E-10	1.94E-12	1.16E-09	4.30E-14	5.44E-10	1.66E-12	4.21E-10	4.22E-10
Laundry building	7.29E-11	7.38E-10	5.73E-10	2.33E-12	1.39E-09	5.16E-14	6.53E-10	1.99E-12	5.05E-10	5.07E-10
Centrifuge building	1.46E-10	1.48E-09	1.15E-09	4.66E-12	2.77E-09	1.03E-13	1.31E-09	3.98E-12	1.01E-09	1.01E-09
Bechtel building	1.31E-10	1.33E-09	1.03E-09	4.19E-12	2.50E-09	9.28E-14	1.18E-09	3.58E-12	9.08E-10	9.12E-10
Solid waste building	8.75E-11	8.86E-10	6.88E-10	2.80E-12	1.66E-09	6.19E-14	7.84E-10	2.39E-12	6.06E-10	6.08E-10
Cooling tower	1.46E-10	1.48E-09	1.15E-09	4.66E-12	2.77E-09	1.03E-13	1.31E-09	3.98E-12	1.01E-09	1.01E-09
RCC evaporator	9.11E-11	9.23E-10	7.17E-10	2.91E-12	1.73E-09	6.45E-14	8.16E-10	2.49E-12	6.31E-10	6.33E-10
Incinerator	3.64E-11	3.69E-10	2.87E-10	1.17E-12	6.94E-10	2.58E-14	3.27E-10	9.96E-13	2.52E-10	2.53E-10
Concrete and asphalt	1.24E-08	1.26E-07	9.78E-08	3.98E-10	2.37E-07	8.80E-12	1.11E-07	3.40E-10	8.61E-08	8.64E-08
Contaminated material	7.85E-11	7.95E-10	6.17E-10	2.51E-12	1.49E-09	5.55E-14	7.03E-10	2.14E-12	5.43E-10	5.46E-10
Chippel Pallets	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table E-24 Radiological Impacts for Alternative 2 by Material Type for Rail Transport

Material Type	General Population (LCF)					MEI (Increased Risk of LCF)		Workers (LCF)		
	On-Link	Off-Link	Residents Near Stops	Public at Stops	Total Public	Resident Near Route	Resident Near Stop	Rail Crew in Transit	Rail Crew at Stops	Crew Total
Subsoils and Bedrock										
Contaminated materials	1.26E-08	1.28E-07	9.92E-08	4.03E-10	2.40E-07	8.92E-12	1.13E-07	3.44E-10	8.73E-08	8.76E-08
TOTAL	**6.56E-08**	**6.65E-07**	**5.16E-07**	**2.10E-09**	**1.25E-06**	**4.64E-11**	**5.88E-07**	**1.79E-09**	**4.54E-07**	**4.56E-07**

Table E-25 Increased Risk of LCF to the MEI for Alternatives 2 and 3

Mode/Receptor	Alternative 2 All Off-site Disposal (increased risk of LCF)	Alternative 3 Partial Off-site Disposal (increased risk of LCF)
Rail		
Resident near rail route	4.64E-11	NA
Resident near a rail stop	5.88E-07	NA
Truck		
Truck driver – **MEI**	NA	5.17E-07[a]
Resident near truck route	NA	2.02E-11
Resident near truck stop	NA	1.80E-08

NA = Not Applicable.
[a] Assumes 18 truck crews of two drivers each.

Table E-26 Collective and Individual Impacts from the Maximum Reasonably Foreseeable Accident

Radionuclide	Rural Population (LCFs)	Urban Population (LCFs)	Individual (increased risk of LCF)
U-234	9.03E-10	3.60E-08	3.42E-08
U-235	3.67E-10	1.46E-08	1.42E-09
U-238	7.26E-10	2.90E-08	2.84E-08
Ra-226	7.55E-11	3.01E-09	2.29E-09
Th-230	1.62E-07	6.46E-06	7.63E-08
Total	**1.64E-07**	**6.54E-06**	**1.43E-07**

E.5.3 Impact Comparison by Off-site Contaminated material Destination

As discussed in Section E.2.2, the previous sections have presented transportation-related human health impacts assuming that all off-site shipments were to be sent to the Energy Solutions facility in Clive, Utah. This was done because of the likelihood that the contaminated material would actually be sent to Clive and because the distance traveled would be greater than to either of the facilities in Blanding, Utah, or Andrews, Texas. Impacts such as vehicle emission and traffic fatalities, which are dependant only on the total number of miles traversed, would be reduced by about 27% and 53% for truck transport for Blanding, Utah, and Andrews, Texas, respectively; these impacts would be reduced by about 13% and 50% for rail transport for Blanding, Utah, and Andrews, Texas, respectively. The potential impacts from radiological accidents would not be different for any of the proposed destinations.

Other impacts provided in Section E.5 are dependant on both the total number of miles traveled and the populations living along the transportation corridors. Although the distance from the SFC facility to Clive, Utah, is greater than that to either Blanding, Utah, or Andrews, Texas, the populations potentially affected along the truck transportation corridor is greater for Blanding than for Clive or Andrews. Therefore, collective population impacts are greater for truck transportation to Blanding than for Clive or Andrews, while impacts on the MEI remain the same or are less. Tables E-27 through E-29 provide comparisons for all of the radiological impacts for each destination.

Table E-27 Partial Off-site Disposal Alternative: Radiological Impacts for Disposition by Truck Transport of Contaminated Material from SFC, by Destination

Destination	General Population (LCF)					MEI (Increased Risk of LCF)		Workers (LCF)		
	On-Link	Off-Link	Residents Near Stops	Public at Stops	Total Public Dose	Resident Near Route	Resident Near Stop	Truck Crew in Transit	Truck Crew at Stops	Crew Total
Clive, Utah	7.60E-07	3.07E-07	6.92E-09	2.36E-06	3.43E-06	2.02E-11	1.80E-08	1.68E-05	1.83E-06	1.86E-05
Blanding, Utah	1.00E-06	4.39E-07	9.61E-09	3.93E-06	5.38E-06	2.02E-11	1.32E-08	2.02E-05	2.17E-06	2.24E-05
Andrews, Texas	7.75E-07	1.61E-07	4.78E-09	2.63E-06	3.57E-06	2.02E-11	8.52E-09	1.37E-05	1.40E-06	1.51E-05

Table E-28 Off-site Disposal Alternative: Radiological Impacts for Disposition by Rail Transport of Contaminated Material from SFC, by Destination

Destination	General Population (LCF)					MEI (Increased Risk of LCF)		Workers (LCF)		
	On-Link	Off-Link	Residents Near Stops	Public at Stops	Total Public Dose	Resident Near Route	Resident Near Stop	Rail Crew in Transit	Rail Crew at Stops	Crew Total
Clive, Utah	6.56E-08	6.65E-07	5.16E-07	2.10E-09	1.25E-06	4.64E-11	5.88E-07	1.79E-09	4.54E-07	4.56E-07
Blanding, Utah	5.93E-08	6.27E-07	4.43E-07	2.10E-09	1.13E-06	4.64E-11	5.11E-07	1.56E-09	4.54E-07	4.56E-07
Andrews, Texas	4.33E-08	5.52E-07	3.51E-07	2.10E-09	9.48E-07	4.64E-11	2.96E-07	9.03E-10	4.54E-07	4.55E-07

Table E-29 Increased Risk to Individuals of Contracting an LCF, by Alternative and Destination

	Off-site Disposal Alternative (increased risk of LCF)	Partial Off-site Disposal Alternative (increased risk of LCF)	Off-site Disposal Alternative (increased risk of LCF)	Partial Off-site Disposal Alternative (increased risk of LCF)	Off-site Disposal Alternative (increased risk of LCF)	Partial Off-site Disposal Alternative (increased risk of LCF)
Destination	**Clive, UT**	**Clive, UT**	**Blanding, UT**	**Blanding, UT**	**Andrews, TX**	**Andrews, TX**
Rail Impacts						
Resident near Rail Route	4.64E-11	NA	4.64E-11	NA	4.64E-11	NA
Resident near a Rail Stop	5.88E-07	NA	5.11E-07	NA	2.96E-07	NA
Truck Impacts						
Truck Driver – MEI[b]	NA	5.19E-07[a]	NA	6.22E-07[a]	NA	4.195E-07[a]
Resident near Truck Route	NA	2.02E-11	NA	2.02E-11	NA	2.02E-11
Resident near Truck Stop	NA	1.80E-08	NA	1.32E-08	NA	8.52E-09

[a] Assumes 18 truck crews of two drivers each.

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APPENDIX F

COSTS ANALYSIS

No-Action Alternative

Estimated Direct Costs for The No Action Alternative

Activity	Direct Cost (000$)	Notes			2007
1. Long term site control fund	$ 17,997	Assumes an escrow fund at 1% interest to generate funds for the annual long-term maintenance costs of $ 359,936. Costs include annual sampling of 25 monitoring wells and analysis for uranium, nitrate and arsenic, preparation of an annual report, and mowing 6 times per year. Note the original 1% used was changed to 2% (12/6/06) to be consistent with Onsite Alternative.			
		Derivation of Annual Long-Term Maintenance Costs			
		Staff			**2007**
		Manager/Engineer	0.25 FTE		$ 30,558
		Technicians	2 FTE		$ 71,303
		Security Guards	2 FTE		$ 81,489
		Administration	0.25 FTE		$ 10,186
		O&M			
		Utilities			$ 10,186
		Analytical Cost			$ 50,931
		Materials, supplies			$ 50,931
		NRC fees			$ 50,931
		Mowing			
		6 mowings (96 h @ $35)	96	$ 35.65	$ 3,423
		Total:			$ 359,936
2. Long-term Groundwater	$ 1,324	13 yrs. @ $101,861/yr. (undiscounted)			
Total Cost	$ 19,321				

Alternative 1: On-site Disposal of Contaminated Materials (the Licensee's Proposed Action)

Alternative 1: Onsite Disposal (Licensee's Proposed Action)

Estimated Costs for On-Site Disposal

Cost Element	Direct Costs 2007 $ (000s)		Note/Comment
1. Complete Reclamation Plan and Supporting Documents	$	446	See note (1)
2. NRC Charges for Reclamation Plan Review, EIS Preparation	$	900	See note (2)
3. Contractor mobilization and demobilization	$	678	5% of lines, 4, 5, 6, 7, 8, 9 and 11.
4. Monitoring Well Removal and Replacement	$	-	Task Complete
5. Disposal Cell Construction / Closure	$	3,003	See note (3)
6. Cost for placing Super Sacks in Disposal Cell	$	50	
7. Other Sludge, Removal, Treatment and On-Site Disposal	$	3,051	See note (4)
8. Soil Remediation	$	1,677	See Table 8 a, with detail
9. Building and Equip. Demolition	$	3,902	See note (5)
10. Termination Survey	$	382	See note (6)
11. Site Restoration	$	1,887	See note (7)
12. Groundwater Remediation	$	1,171	See note (8)
13. Engineering Construction Management	$	2,194	15% of lines 3 through 11.
14. Post-Closure Monitoring Program	$	83	See note (9)
15. SFC Staff	$	7,437	See note (10)
16. Long-Term Site Control Fund	$	798	Per 10 CFR 40, Appendix A, Criterion 10
17. Long-term Groundwater Recovery and Treatment	$	1,324	13 years @ $100,000/year
Subtotal:	$	28,983	
Contingency (@ 10% of direct costs)	$	2,898	
Grand Total:	**$**	**31,882**	

Notes:

(1) Includes Responses to RAIs and Revisions to the Reclamation Plan, Groundwater Corrective Action Plan and Preparation of an Alternate Concentration Limit Application.

(2) Includes Review and Approval Reclamation Plan and Groundwater Corrective Action Plan and Completion of EIS

(3) Updated to reflect 2004 Settlement Agreement revisions to Cell Design

(4) Excavation, treatment and placement of other sludges in the cell (1,433,015 cu-ft cu-ft @ $2.13/cu-ft.). Sum of non-raffinate sludge and sediments from Material Characteristics sheet.

(5) SFC Environmental Report

(6) 2000 soil samples @ $100 each plus gamma walkover survey - 500 hours @ $50/hr plus $150K assessment / NRC confirmation

(7) Cost to grade, place topsoil and re-vegetate excavations and other affected areas. Based on dozing approximately 17,500,000 cf of dike material into impoundments at $0.072 per cf, grading 83 acres @ $3056/acre, applying 6 inches of topsoil to 124 acres (2,701,000 cf at $0.112/cf) and seeding 124 acres at $522/acre.

(8) $100,000 per year for 7 years plus $100,000 for recovery systems installation plus $350,000 for intercept trench expansion. Includes treatment of stormwater and waste water as necessary.

(9) Post-closure monitoring includes the cost of purging, sampling and analysis for 25 wells for an additional sampling event for the first three to five years after cell closure, cell settlement monitoring, radon emission measurement and cell cover inspection and repair.

(10) SFC at current level of 6 plus management augmentation during decommissioning.

Alternative 1: On-site Disposal of Contaminated Materials - continued

Table 8 a
Derivation of Soil Remediation and Consolidated Debris Costs

Waste Element	Cubic ft.		Unit Cost per cu ft. 2007$		Total Cost
Contaminated Subsoils & Bedrock	811,685	$	0.76	$	620,094
DUF4 Trash Drums	2,200	$	12.22	$	26,891
CaF2 Basin Clay Liners	95,290	$	0.67	$	64,062
Solid Waste Burials	51,100	$	1.49	$	75,995
Pond 1 Spoils Pile	437,000	$	0.67	$	293,788
Interim Soils Storage Cell	154,887	$	0.67	$	104,128
Clarifier Clay Liners	332,400	$	0.67	$	223,467
Drummed LLW	5,000	$	12.22	$	61,117
Sanitary Lagoon Soil	56,400	$	0.67	$	37,917
Emergency Basin Soil	162,500	$	0.67	$	109,246
North Ditch Soil	87,500	$	0.67	$	58,825
Crushed Drums	2,000	$	0.67	$	1,345
Total	2,197,962			$	1,676,873

Alternative 2:1: Off-site Disposal of All Contaminated Materials

Option 1: transport of all materials by rail to EnergySolutions, Clive, Utah

Estimated Direct Costs For The Offsite Disposal Alternative (Alternative 2)

Activity		2007 Direct Cost (000$)	Notes
1. Complete Reclamation Plan and Supporting Documents	$	446	Includes Responses to RAIs and Revisions to the Reclamation Plan, Groundwater Corrective Action Plan and Preparation of an Alternate Concentration Limit Application.
2. NRC Charges for Reclamation Plan Review, EIS Preparation	$	900	Includes Review and Approval Reclamation Plan and Groundwater Corrective Action Plan and Completion of EIS
3. Contractor mobilization and demobilization	$	556	5% of lines, 4, 5, 6, 7, 8, 9 and 11.
4. Monitoring Well Removal and Replacement	$	-	Task Complete
5. Disposal Cell Construction / Closure	$	-	Not required for the offsite disposal option
6. Dewater Raffinate Sludge	$	-	Task Complete
7. Other Sludge, Removal & Treatment & Loading for Transport	$	3,051	(1,433,015 cu-ft x $2.13 cf)
8. Soil Remediation	$	3,788	(see detail below)
9. Building and Equip. Demolition	$	3,902	SFC Environmental Report
10. Shipping and Offsite Disposal	$	177,191	463,850 tons @ 382/ton. Note: Per EnergySolutions email of 8/23/07
11. Termination Survey	$	382	2000 soil samples @ $100 each plus gamma walkover survey - 500 hours @ $50/hr plus $150K assessment / NRC confirmation
12. Site Restoration	$	1,887	Cost to grade, place topsoil and re-vegetate excavations and other affected areas. Based on dozing approximately 17,500,000 cf of dike material into impoundments at $0.072 per cf, grading 83 acres @ $3056/acre, applying 6 inches of topsoil to 124 acres (2,701,000 cf at $0.112/cf) and seeding 124 acres at $522/acre.
13. Groundwater remediation	$	1,171	$100,000 per year for 7 years plus $100,000 for recovery systems installation plus $350,000 for intercept trench expansion. Includes treatment of stormwater and waste water as necessary.
14. Engineering Construction Management	$	28,613	15% of lines 3 through 12.

8. Soil Remediation (detail):

	Quantity			2006		2007		2007 $
DUF4 Trash Drums	2,200	cf @	$	12.05	$	12.27	$	27,003
Subsoils and Bedrock	3,574,000	cf @	$	0.75	$	0.76	$	2,730,387
CaF_2 Basin Clay Liners	95,290	cf @	$	0.66	$	0.67	$	64,062
Solid Waste Burials	51,100	cf @	$	1.46	$	1.49	$	75,995
Pond 1 Spoils Pile	437,000	cf @	$	0.66	$	0.67	$	293,788
Interim Soils Storage Cell	154,887	cf @	$	0.66	$	0.67	$	104,128
Clarifier Clay Liners	332,400	cf @	$	0.66	$	0.67	$	223,467
Drummed LLW	5,000	cf @	$	12.05	$	12.27	$	61,371
Sanitary Lagoon Soil	56,400	cf @	$	0.66	$	0.67	$	37,917
Emergency Basin Soil	162,500	cf @	$	0.66	$	0.67	$	109,246
North Ditch Soil	87,500	cf @	$	0.66	$	0.67	$	58,825
Crushed Drums	2,000	cf @	$	0.66	$	0.67	$	1,345
Total	4,960,277							3,787,533

12. Site Restoration (detail):

Quantity		2006		2006		2007		2007
17,500,000	$	0.071	$	1,242,500	$	0.072	$	1,265,624
83	$	3,000	$	249,000	$	3,056	$	253,634
2,701,000	$	0.110	$	297,110	$	0.112	$	302,640
124	$	512	$	63,488	$	522	$	64,670
			$	1,852,098			$	1,886,568

1 **Alternative 2:1: Off-site Disposal of All Contaminated Materials – continued**

Activity	Direct Cost (000$)	Notes
15. SFC Staff	$ 7,437	SFC at current level of 6 plus management augmentation during decommissioning (SFC Environmental Report, 2006)
16. Long-term Groundwater Recovery and Treatment	$ 1,324	13 years @ $100,000/year
Total Direct Cost	$ 230,648	
Contingency (@ 10% of direct costs)	$ 23,065	
Grand Total:	$ 253,713	

Alternative 2:2: Off-site Disposal of All Contaminated Materials

Option 2: transport of all materials by rail to WCS in Andrews, Texas

Option 2: transport of all materials by rail to WCS in Andrews, Texas (Alternative 2)

This options assumes that most of the costs are similar to Alt 2-Option 1. Therefore, the option was estimated based on taking the unit cost per ton kilometer derived from for Option 2:1 transport of all materials by rail to EnergySolutions, Clive, Utah and multiplying this unit cost by the shorter Distance to WCS in Andrews, Texas and the grand total tons being transported.

		Tons	Source
Grand Total		463,850	Materials Sheet
Sludge & Sediments:		83,307	Materials Sheet
Other		184,355	Materials Sheet
Soils		196,189	See Alt 2-1, (3,574,000 cf,
x		x	converted to tons @ 109.8 lb/cf.)
Cost per ton km	$	0.34	
x		x	
km distance from SFC		1,221	rail distance
=			
Total Cost	$	189,865,590	

Alternative 3-1-1: Partial Off-site Disposal of Contaminated Materials

Raffinate sludge transported by truck to White Mesa (Blanding, Utah) and other sludge/ sediment transported by truck to Pathfinder Shirley Basin (Mills, Wyoming)

Estimated Direct Costs For The Partial Offsite Disposal Alternative (Alternative 3)
Option 3-1-1:
Raffinate Sludge Transported by Truck to White Mesa, (Blanding UT)
Other Sludge / Sediment Transport by Truck to Pathfinder, Shirley Basin (Mills, WY)

Activity	2007 Direct Cost (000$)	Notes
1. Complete Reclamation Plan and Supporting Documents	$ 446	Includes Responses to RAIs and Revisions to the Reclamation Plan, Groundwater Corrective Action Plan and Preparation of an Alternate Concentration Limit Application.
2. NRC Charges for Reclamation Plan Review, EIS Preparation	$ 900	Includes Review and Approval Reclamation Plan and Groundwater Corrective Action Plan and Completion of EIS
3. Contractor mobilization and demobilization	$ 940	5% of lines, 4, 5, 6, 7, 8, 9, 10 and 12.
4. Monitoring Well Removal and Replacement	$ -	Task Complete
5. Disposal Cell Construction / Closure	$ 3,003	
6. Other Sludge, Removal, Treatment and On-Site Disposal	$ 2,953	Excavation, treatment and placement of other sludges in the cell (1,387,280 cu-ft @ $2.13/cu-ft.). Sum of non-raffinate sludge and other sediments from Material Characteristics sheet.
7. Dewater Raffinate Sludge	$ -	Task Complete
8a. Transport raffinate sludge to White Mesa for acceptance as alternate feed material	$ 4,435	White Mesa quote of $423/ton times 10,478 tons, See Material Sheet
8b. Shipping and Offsite Disposal of other sediment to Pathfinder	$ 936	= 2,155 tons of sediment (includes Emergency Basin + North Ditch + Sanitary Lagoon) going 1675 km using $434/ton
9. Soil Remediation and On-site Disposal	$ 1,677	(see below)
10. Building and Equip. Demolition	$ 3,902	Source: SFC Environmental Report 2006, includes demolition and placement in cell.
11. Termination Survey	$ 382	2000 soil samples @ $100 each plus gamma walkover survey - 500 hours @ $50/hr plus $150K assessment / NRC confirmation
12. Site Restoration	$ 1,887	Cost to grade, place topsoil and re-vegetate excavations and other affected areas. Based on dozing approximately 17,500,000 cf of dike material into impoundments at $0.072 per cf, grading 83 acres @ $3056/acre, applying 6 inches of topsoil to 124 acres (2,701,000 cf at $0.112/cf) and seeding 124 acres at $522/acre.
13. Groundwater remediation	$ 1,171	$100,000 per year for 7 years plus $100,000 for recovery systems installation plus $350,000 for intercept trench expansion. Includes treatment of stormwater and waste water as necessary.
14. Engineering Construction Management	$ 3,017	15% of lines 3 through 12

9. Soil Remediation and On-site Disposal:

			2006 $	2007 $	(cf * 2007 $ unit cost)
DUF4 Trash Drums	2,200	cf @	$ 12.05	$ 12.27	$ 27,003
Contaminated Subsoils & Bedrock	811,685	cf @	$ 0.75	$ 0.76	$ 620,094
CaF_2 Basin Clay Liners	95,290	cf @	$ 0.66	$ 0.67	$ 64,062
Solid Waste Burials	51,100	cf @	$ 1.46	$ 1.49	$ 75,995
Pond 1 Spoils Pile	437,000	cf @	$ 0.66	$ 0.67	$ 293,788
Interim Soils Storage Cell	154,887	cf @	$ 0.66	$ 0.67	$ 104,128
Clarifier Clay Liners	332,400	cf @	$ 0.66	$ 0.67	$ 223,467
Drummed LLW	5,000	cf @	$ 12.05	$ 12.27	$ 61,371
Sanitary Lagoon Soil	56,400	cf @	$ 0.66	$ 0.67	$ 37,917
Emergency Basin Soil	162,500	cf @	$ 0.66	$ 0.67	$ 109,246
North Ditch Soil	87,500	cf @	$ 0.66	$ 0.67	$ 58,825
Crushed Drums	2,000	cf @	$ 0.66	$ 0.67	$ 1,345
Total	2,197,962				$ 1,677,240

12. Site Restoration:

	2006	2006	2007	2007
17,500,000	$ 0.071	$ 1,242,500	$ 0.072	$ 1,265,624
83	$ 3,000	$ 249,000	$ 3,056	$ 253,634
2,701,000	$ 0.110	$ 297,110	$ 0.112	$ 302,640
124	$ 512	$ 63,488	$ 522	$ 64,670
		$ 1,852,098		$ 1,886,568

Alternative 3-1-1: Partial Off-site Disposal of Contaminated Materials – continued

Activity	Direct Cost (000$)	Notes
15. Post-Closure Monitoring Program	$ 83	Post-closure monitoring includes the cost of purging, sampling and analysis for 25 wells for an additional sampling event for the first three to five years after cell closure, cell settlement monitoring, radon emission measurement and cell cover inspection and repair.
16. SFC Staff	$ 7,437	SFC at current level of 6 plus management augmentation during decommissioning. Source SFC Environmental Report 2006.
17. Long-Term Site Control Fund	$ 798	Per 10 CFR 40, Appendix A, Criterion 10 ($250K, 1978 escalated to 2007 $).
18. Long-term Groundwater Recovery and Treatment	$ 1,324	13 years @ $100,000/year
19. White Mesa License Amendment	$ 100	
Total Direct Cost	$ 35,391	
Contingency (@ 10% of direct costs)	$ 3,539	
Grand Total:	$ 38,930	

Alternative 3-1-2: Partial Off-site Disposal of Contaminated Materials

Raffinate sludge transported by truck to White Mesa (Blanding, Utah) and sediment transported by truck to Energy*Solutions* (Clive, Utah)

Estimated Direct Costs For The Partial Offsite Disposal Alternative (Alternative 3)
Option 3-1-2:
Raffinate Sludge Transported by Truck to White Mesa, (Blanding UT) and
Other Sludge / Sediment Transported by Truck to EnergySolutions (Clive Utah)

Activity		2007 Direct Cost (000$)	Notes
1. Complete Reclamation Plan and Supporting Documents	$	446	Includes Responses to RAIs and Revisions to the Reclamation Plan, Groundwater Corrective Action Plan and Preparation of an Alternate Concentration Limit Application.
2. NRC Charges for Reclamation Plan Review, EIS Preparation	$	900	Includes Review and Approval Reclamation Plan and Groundwater Corrective Action Plan and Completion of EIS
3. Contractor mobilization and demobilization	$	951	5% of lines, 4, 5, 6, 7, 8, 9, 10 and 12.
4. Monitoring Well Removal and Replacement	$	-	Task Complete
5. Disposal Cell Construction / Closure	$	3,003	
6. Other Sludge, Removal, Treatment and On-Site Disposal	$	2,953	Excavation, treatment and placement of other sludges in the cell (1,387,280 cu-ft @ $2.13/cu-ft.). Sum of non-raffinate sludge and other sediments from Material Characteristics sheet.
7. Dewater Raffinate Sludge	$	-	Task Complete
8a. Transport raffinate sludge to White Mesa for acceptance as alternate feed material	$	4,435	White Mesa quote of $423/ton times 10,478 tons, See Material Sheet
8b. Shipping and Offsite Disposal of other sediment to EnergySolutions	$	1,172	= 2,155 tons of sediment (includes Emergency Basin + North Ditch + Sanitary Lagoon) going 1675 km using $544/ton.
9. Soil Remediation and On-Site Disposal	$	1,677	

				2006 $		2007 $		(cf * 2007 $ unit cost)
DUF4 Trash Drums	2,200	cf @	$	12.05	$	12.27	$	27,003
Contaminated Subsoils & Bedrock	**811,685**	cf @	$	0.75	$	0.76	$	620,094
CaF_2 Basin Clay Liners	**95,290**	cf @	$	0.66	$	0.67	$	64,062
Solid Waste Burials	**51,100**	cf @	$	1.46	$	1.49	$	75,995
Pond 1 Spoils Pile	**437,000**	cf @	$	0.66	$	0.67	$	293,788
Interim Soils Storage Cell	**154,887**	cf @	$	0.66	$	0.67	$	104,128
Clarifier Clay Liners	**332,400**	cf @	$	0.66	$	0.67	$	223,467
Drummed LLW	**5,000**	cf @	$	12.05	$	12.27	$	61,371
Sanitary Lagoon Soil	**56,400**	cf @	$	0.66	$	0.67	$	37,917
Emergency Basin Soil	**162,500**	cf @	$	0.66	$	0.67	$	109,246
North Ditch Soil	**87,500**	cf @	$	0.66	$	0.67	$	58,825
Crushed Drums	**2,000**	cf @	$	0.66	$	0.67	$	1,345
Total	2,197,962						$	1,677,240

Activity		2007 Direct Cost (000$)	Notes
10. Building and Equip. Demolition	$	3,902	Source: SFC Environmental Report 2006, includes demolition and placement in cell.
11. Termination Survey	$	382	2000 soil samples @ $100 each plus gamma walkover survey - 500 hours @ $50/hr plus $150K assessment / NRC confirmation
12. Site Restoration	$	1,887	Cost to grade, place topsoil and re-vegetate excavations and other affected areas. Based on dozing approximately 17,500,000 cf of dike material into impoundments at $0.072 per cf, grading 83 acres @ $3056/acre, applying 6 inches of topsoil to 124 acres (

		2006		2006		2007		2007
17,500,000	$	0.071	$	1,242,500	$	0.072	$	1,265,624
83	$	3,000	$	249,000	$	3,056	$	253,634
2,701,000	$	0.110	$	297,110	$	0.112	$	302,640
124	$	512	$	63,488	$	522	$	64,670
			$	1,852,098			$	1,886,568

Activity		2007 Direct Cost (000$)	Notes
13. Groundwater remediation	$	1,171	$100,000 per year for 7 years plus $100,000 for recovery systems installation plus $350,000 for intercept trench expansion. Includes treatment of stormwater and waste water as necessary.
14. Engineering Construction Management	$	3,054	15% of lines 3 through 12.

1 **Alternative 3-1-2: Partial Off-site Disposal of Contaminated Materials – continued**

Activity		Direct Cost (000$)	Notes
15. Post-Closure Monitoring Program	$	83	Post-closure monitoring includes the cost of purging, sampling and analysis for 25 wells for an additional sampling event for the first three to five years after cell closure, cell settlement monitoring, radon emission measurement and cell cover inspectio
16. SFC Staff	$	7,437	SFC at current level of 6 plus management augmentation during decommissioning.
17. Long-Term Site Control Fund	$	798	Per 10 CFR 40, Appendix A, Criterion 10 ($250K, 1978 escalated to 2007 $).
18. Long-term Groundwater Recovery and Treatment	$	1,324	13 years @ $100,000/year
19. White Mesa License Amendment	$	100	
Total Direct Cost	$	35,676	
Contingency (@ 10% of direct costs)	$	3,568	
Grand Total:	$	39,244	

Alternative 3-1-3: Partial Off-site Disposal of Contaminated Materials

Raffinate sludge transported by truck to White Mesa (Blanding Utah) and other sediment transported by truck to WCS (Andrews, Texas)

Estimated Direct Costs For The Partial Offsite Disposal Alternative (Alternative 3)
Option 3-1-3:
Raffinate Sludge Transported by Truck to White Mesa, (Blanding UT)
Other Sludge / Sediment Transported by Truck to WCS, (Andrews, TX)

Activity		2007 Direct Cost (000$)	Notes
1. Complete Reclamation Plan and Supporting Documents	$	446	Includes Responses to RAIs and Revisions to the Reclamation Plan, Groundwater Corrective Action Plan and Preparation of an Alternate Concentration Limit Application.
2. NRC Charges for Reclamation Plan Review, EIS Preparation	$	900	Includes Review and Approval Reclamation Plan and Groundwater Corrective Action Plan and Completion of EIS
3. Contractor mobilization and demobilization	$	925	"5% of lines, 4, 5, 6, 7, 8, 9, 10 and 12.
4. Monitoring Well Removal and Replacement	$	-	Task Complete
5. Disposal Cell Construction / Closure	$	3,003	
6. Other Sludge, Removal, Treatment and On-Site Disposal	$	2,953	Excavation, treatment and placement of other sludges in the cell (1,387,280 cu-ft @ $2.13/cu-ft.). Sum of non-raffinate sludge and other sediments from Material Characteristics sheet.
7. Dewater Raffinate Sludge	$	-	Task Complete
8a. Transport raffinate sludge to White Mesa for acceptance as alternate feed material	$	4,435	White Mesa quote of $423/ton times 10,478 tons. See Material Sheet.
8b. Shipping and Offsite Disposal of other sediment to WCS	$	653	'= 2,155 tons of sediment (includes Emergency Basin + North Ditch + Sanitary Lagoon) going 1675 km using $303/ton.
9. Soil Remediation and On-Site Disposal	$	1,677	

				2006 $		2007 $		(cf * 2007 $ unit cost)
DUF4 Trash Drums	2,200	cf @	$	12.05	$	12.27	$	27,003
Contaminated Subsoils & Bedrock	811,685	cf @	$	0.75	$	0.76	$	620,094
CaF_2 Basin Clay Liners	95,290	cf @	$	0.66	$	0.67	$	64,062
Solid Waste Burials	51,100	cf @	$	1.46	$	1.49	$	75,995
Pond 1 Spoils Pile	437,000	cf @	$	0.66	$	0.67	$	293,788
Interim Soils Storage Cell	154,887	cf @	$	0.66	$	0.67	$	104,128
Clarifier Clay Liners	332,400	cf @	$	0.66	$	0.67	$	223,467
Drummed LLW	5,000	cf @	$	12.05	$	12.27	$	61,371
Sanitary Lagoon Soil	56,400	cf @	$	0.66	$	0.67	$	37,917
Emergency Basin Soil	162,500	cf @	$	0.66	$	0.67	$	109,246
North Ditch Soil	87,500	cf @	$	0.66	$	0.67	$	58,825
Crushed Drums	2,000	cf @	$	0.66	$	0.67	$	1,345
Total	2,197,962						$	1,677,240

Activity		2007 Direct Cost (000$)	Notes
10. Building and Equip. Demolition	$	3,902	Source: SFC Environmental Report 2006, includes demolition and placement in cell.
11. Termination Survey	$	382	2000 soil samples @ $100 each plus gamma walkover survey - 500 hours @ $50/hr plus $150K assessment / NRC confirmation
12. Site Restoration	$	1,887	Cost to grade, place topsoil and re-vegetate excavations and other affected areas. Based on dozing approximately 17,500,000 cf of dike material into impoundments at $0.072 per cf, grading 83 acres @ $3056/acre, applying 6 inches of topsoil to 124 acres (

		2006		2006		2007		2007
17,500,000	$	0.071	$	1,242,500	$	0.072	$	1,265,624
83	$	3,000	$	249,000	$	3,056	$	253,634
2,701,000	$	0.110	$	297,110	$	0.112	$	302,640
124	$	512	$	63,488	$	522	$	64,670
			$	1,852,098			$	1,886,568

Activity		2007 Direct Cost (000$)	Notes
13. Groundwater remediation	$	1,171	$100,000 per year for 7 years plus $100,000 for recovery systems installation plus $350,000 for intercept trench expansion. Includes treatment of stormwater and waste water as necessary.
14. Engineering Construction Management	$	2,973	15% of lines 3 through 12.

1 **Alternative 3-1-3: Partial Off-site Disposal of Contaminated Materials – continued**

Activity	Direct Cost (000$)		Notes
15. Post-Closure Monitoring Program	$	83	Post-closure monitoring includes the cost of purging, sampling and analysis for 25 wells for an additional sampling event for the first three to five years after cell closure, cell settlement monitoring, radon emission measurement and cell cover inspectio
16. SFC Staff	$	7,437	SFC at current level of 6 plus management augmentation during decommissioning.
17. Long-Term Site Control Fund	$	798	Per 10 CFR 40, Appendix A, Criterion 10 ($250K, 1978 escalated to 2007 $).
18. Long-term Groundwater Recovery and Treatment	$	1,324	13 years @ $100,000/year
19. White Mesa License Amendment	$	100	
Total Direct Cost	$	35,049	
Contingency (@ 10% of direct costs)	$	3,505	
Grand Total:	$	38,554	

Alternative 3-2-1: Partial Off-site Disposal of Contaminated Materials

Raffinate sludge transported by truck to Rio Algom (New Mexico) and sediment transported to Pathfinder Shirley Basin (Mills, Wyoming)

Estimated Direct Costs For The Partial Offsite Disposal Alternative (Alternative 3)
Option 3-2-1:
Raffinate Sludge Transported by Truck to Rio Algom (Grants, New Mexico) and
Other Sludge / Sediment Transported by Truck to Pathfinder Shirley Basin (Mills, Wyoming)

Activity		2007 Direct Cost (000$)	Notes
1. Complete Reclamation Plan and Supporting Documents	$	446	Includes Responses to RAIs and Revisions to the Reclamation Plan, Groundwater Corrective Action Plan and Preparation of an Alternate Concentration Limit Application.
2. NRC Charges for Reclamation Plan Review, EIS Preparation	$	900	Includes Review and Approval Reclamation Plan and Groundwater Corrective Action Plan and Completion of EIS
3. Contractor mobilization and demobilization	$	1,138	"5% of lines, 4, 5, 6, 7, 8, 9, 10 and 12.
4. Monitoring Well Removal and Replacement	$	-	Task Complete
5. Disposal Cell Construction / Closure	$	3,003	
6. Other Sludge, Removal, Treatment and On-Site Disposal	$	2,953	Excavation, treatment and placement of other sludges in the cell (1,387,280 cu-ft @ $2.13/cu-ft.). Sum of non-raffinate sludge and other sediments from Material Characteristics sheet.
7. Dewater Raffinate Sludge	$	-	Task Complete
8. Transport& disposal of raffinate sludge at Rio Algom	$	8,400	Rio Algom quote of $500/ton times 10,478 tons, See Material Sheet. Price quote range $80-$800, close to midpoint. Used transport quote of $302/t.
8b. Shipping and Offsite Disposal of other sediment to Pathfinder	$	936	= 2,155 tons of sediment (includes Emergency Basin + North Ditch + Sanitary Lagoon) going 1675 km using $ 434 per ton.
9. Soil Remediation and On Site Disposal	$	1,677	

				2006 $		2007 $		(cf * 2007 $ unit cost)
DUF4 Trash Drums	2,200	cf @	$	12.05	$	12.27	$	27,003
Contaminated Subsoils & Bedrock	**811,685**	cf @	$	0.75	$	0.76	$	620,094
CaF_2 Basin Clay Liners	**95,290**	cf @	$	0.66	$	0.67	$	64.062
Solid Waste Burials	**51,100**	cf @	$	1.46	$	1.49	$	75,995
Pond 1 Spoils Pile	**437,000**	cf @	$	0.66	$	0.67	$	293,788
Interim Soils Storage Cell	**154,887**	cf @	$	0.66	$	0.67	$	104,128
Clarifier Clay Liners	**332,400**	cf @	$	0.66	$	0.67	$	223,467
Drummed LLW	**5,000**	cf @	$	12.05	$	12.27	$	61,371
Sanitary Lagoon Soil	**56,400**	cf @	$	0.66	$	0.67	$	37,917
Emergency Basin Soil	**162,500**	cf @	$	0.66	$	0.67	$	109.246
North Ditch Soil	**87,500**	cf @	$	0.66	$	0.67	$	58,825
Crushed Drums	**2,000**	cf @	$	0.66	$	0.67	$	1,345
Total	2,197,962						$	1,677,240

Activity		2007 Direct Cost (000$)	Notes
10. Building and Equip. Demolition	$	3,902	Source: SFC Environmental Report 2006, includes demolition and placement in cell.
11. Termination Survey	$	382	2000 soil samples @ $100 each plus gamma walkover survey - 500 hours @ $50/hr plus $150K assessment / NRC confirmation
12. Site Restoration	$	1,887	Cost to grade, place topsoil and re-vegetate excavations and other affected areas. Based on dozing approximately 17,500,000 cf of dike material into impoundments at $0.072 per cf, grading 83 acres @ $3056/acre, applying 6 inches of topsoil to 124 acres (

		2006		2006		2007		2007
17,500,000	$	0.071	$	1,242,500	$	0.072	$	1,265.624
83	$	3,000	$	249,000	$	3,056	$	253.634
2,701,000	$	0.110	$	297,110	$	0.112	$	302,640
124	$	512	$	63,488	$	522	$	64.670
			$	1,852,098		-	$	1,886,568

Activity		2007 Direct Cost (000$)	Notes
13. Groundwater remediation	$	1,171	$100,000 per year for 7 years plus $100,000 for recovery systems installation plus $350,000 for intercept trench expansion. Includes treatment of stormwater and waste water as necessary.
14. Engineering Construction Management	$	3.642	15% of lines 3 through 12.

Alternative 3-2-1: Partial Off-site Disposal of Contaminated Materials – continued

Activity	Direct Cost (000$)	Notes
15. Post-Closure Monitoring Program	$ 83	Post-closure monitoring includes the cost of purging, sampling and analysis for 25 wells for an additional sampling event for the first three to five years after cell closure, cell settlement monitoring, radon emission measurement and cell cover inspectio
16. SFC Staff	$ 7,437	SFC at current level of 6 plus management augmentation during decommissioning.
17. Long-Term Site Control Fund	$ 798	Per 10 CFR 40, Appendix A, Criterion 10 ($250K, 1978 escalated to 2007 $).
18. Long-term Groundwater Recovery and Treatment	$ 1,324	13 years @ $100,000/year
Total Direct Cost	$ 40,079	
Contingency (@ 10% of direct costs)	$ 4,008	
Grand Total:	$ 44,087	

Alternative 3-2-2: Partial Off-site Disposal of contaminated Materials

Raffinate sludge transported to Rio Algom (New Mexico) and sediment transported to Energy*Solutions* (Clive, Utah)

Estimated Direct Costs For The Partial Offsite Disposal Alternative (Alternative 3)
Option 3-2-2:
Raffinate Sludge Transported by Truck to Rio Algom (Grants, New Mexico) and
Other Sludge / Sediment Transported by Truck to EnergySolutions (Clive, Utah)

Activity		2007 Direct Cost (000$)	Notes
1. Complete Reclamation Plan and Supporting Documents	$	446	Includes Responses to RAIs and Revisions to the Reclamation Plan, Groundwater Corrective Action Plan and Preparation of an Alternate Concentration Limit Application.
2. NRC Charges for Reclamation Plan Review, EIS Preparation	$	900	Includes Review and Approval Reclamation Plan and Groundwater Corrective Action Plan and Completion of EIS
3. Contractor mobilization and demobilization	$	1,150	"5% of lines, 4, 5, 6, 7, 8, 9, 10 and 12.
4. Monitoring Well Removal and Replacement	$	-	Task Complete
5. Disposal Cell Construction / Closure	$	3,003	
6. Other Sludge, Removal, Treatment and On-Site Disposal	$	2,953	Excavation, treatment and placement of other sludges in the cell (1,387,280 cu-ft @ $2.13/cu-ft.). Sum of non-raffinate sludge and other sediments from Material Characteristics sheet.
7. Dewater Raffinate Sludge	$	-	Task Complete
8. Transport& disposal of raffinate sludge at Rio Algom	$	8,400	Rio Algom quote of $500/ton times 10,478 tons, See Material Sheet Price quote range $80-$800, close to midpoint. Used transport quote of $302/t.
8b. Shipping and Offsite Disposal of other sediment to EnergySolutions	$	1,172	= 2,155 tons of sediment (includes Emergency Basin + North Ditch + Sanitary Lagoon) going 1675 km using $544/ton.
9. Soil Remediation and On-Site Disposal	$	1,677	
10. Building and Equip. Demolition	$	3,902	Source: SFC Environmental Report 2006, includes demolition and placement in cell.
11. Termination Survey	$	382	2000 soil samples @ $100 each plus gamma walkover survey - 500 hours @ $50/hr plus $150K assessment / NRC confirmation
12. Site Restoration	$	1,887	Cost to grade, place topsoil and re-vegetate excavations and other affected areas. Based on dozing approximately 17,500,000 cf of dike material into impoundments at $0.072 per cf, grading 83 acres @ $3056/acre, applying 6 inches of topsoil to 124 acres
13. Groundwater remediation	$	1,171	$100,000 per year for 7 years plus $100,000 for recovery systems installation plus $350,000 for intercept trench expansion. Includes treatment of stormwater and waste water as necessary.
14. Engineering Construction Management	$	3.679	15% of lines 3 through 12.

Item 9 detail:

				2006 $		2007 $		(cf * 2007 $ unit cost)
DUF4 Trash Drums	2,200	cf @	$	12.05	$	12.27	$	27,003
Contaminated Subsoils & Bedrock	811,685	cf @	$	0.75	$	0.76	$	620,094
CaF_2 Basin Clay Liners	95,290	cf @	$	0.66	$	0.67	$	64,062
Solid Waste Burials	51,100	cf @	$	1.46	$	1.49	$	75,995
Pond 1 Spoils Pile	437,000	cf @	$	0.66	$	0.67	$	293,788
Interim Soils Storage Cell	154,887	cf @	$	0.66	$	0.67	$	104,128
Clarifier Clay Liners	332,400	cf @	$	0.66	$	0.67	$	223,467
Drummed LLW	5,000	cf @	$	12.05	$	12.27	$	61,371
Sanitary Lagoon Soil	56,400	cf @	$	0.66	$	0.67	$	37,917
Emergency Basin Soil	162,500	cf @	$	0.66	$	0.67	$	109,246
North Ditch Soil	87,500	cf @	$	0.66	$	0.67	$	58,825
Crushed Drums	2,000	cf @	$	0.66	$	0.67	$	1,345
Total	2,197,962						$	1,677,240

Item 12 detail:

		2006		2006		2007		2007
17,500,000	$	0.071	$	1,242,500	$	0.072	$	1,265,624
83	$	3,000	$	249,000	$	3,056	$	253,634
2,701,000	$	0.110	$	297,110	$	0.112	$	302,640
124	$	512	$	63,488	$	522	$	64,670
			$	1,852,098			$	1,886,568

Alternative 3-2-2: Partial Off-site Disposal of Contaminated Materials – continued

Activity	Direct Cost (000$)	Notes
15. Post-Closure Monitoring Program	$ 83	Post-closure monitoring includes the cost of purging, sampling and analysis for 25 wells for an additional sampling event for the first three to five years after cell closure, cell settlement monitoring, radon emission measurement and cell cover inspectio
16. SFC Staff	$ 7,437	SFC at current level of 6 plus management augmentation during decommissioning.
17. Long-Term Site Control Fund	$ 798	Per 10 CFR 40, Appendix A, Criterion 10 ($250K, 1978 escalated to 2007 $).
18. Long-term Groundwater Recovery and Treatment	$ 1,324	13 years @ $100,000/year
Total Direct Cost	$ 40,365	
Contingency (@ 10% of direct costs)	$ 4,036	
Grand Total:	$ 44,401	

Alternative 3-2-3: Partial Off-site Disposal of Contaminated Materials

Raffinate sludge transported to Rio Algom (New Mexico) and sediment transported to WCS (Andrews, Texas)

Estimated Direct Costs For The Partial Offsite Disposal Alternative (Alternative 3)
Option 3-2-3:
Raffinate Sludge Transported by Truck to Rio Algom (Grants. NM) and
Other Sludge / Sediment Transported by Truck to WCS (Andrews, TX)

Activity	2007 Direct Cost (000$)	Notes
1. Complete Reclamation Plan and Supporting Documents	$ 446	Includes Responses to RAIs and Revisions to the Reclamation Plan, Groundwater Corrective Action Plan and Preparation of an Alternate Concentration Limit Application.
2. NRC Charges for Reclamation Plan Review, EIS Preparation	$ 900	Includes Review and Approval Reclamation Plan and Groundwater Corrective Action Plan and Completion of EIS
3. Contractor mobilization and demobilization	$ 1,124	5% of lines, 4, 5, 6, 7, 8, 9, 10 and 12.
4. Monitoring Well Removal and Replacement	$ -	Task Complete
5. Disposal Cell Construction / Closure	$ 3,003	
6. Other Sludge, Removal, Treatment and On-Site Disposal	$ 2,953	Excavation, treatment and placement of other sludges in the cell (1,387,280 cu-ft @ $2.13/cu-ft.). Sum of non-raffinate sludge and other sediments from Material Characteristics sheet.
7. Dewater Raffinate Sludge	$ -	Task Complete
8. Transport & disposal of raffinate sludge at Rio Algom	$ 8,400	Rio Algom quote of $500/ton times 10,478 tons, See Material Sheet. Price quote range $80-$800, close to midpoint. Used transport quote of $302/t.
8b. Shipping and Offsite Disposal of other sediment to WCS	$ 653	= 2,155 tons of sediment (includes Emergency Basin + North Ditch + Sanitary Lagoon) going 1675 km using $303/ton.
9. Soil Remediation and On-Site Disposal	$ 1,677	

			2006 $	2007 $	(cf * 2007 $ unit cost)
DUF4 Trash Drums	2,200	cf @	$ 12.05	$ 12.27	$ 27,003
Contaminated Subsoils & Bedrock	811,685	cf @	$ 0.75	$ 0.76	$ 620,094
CaF_2 Basin Clay Liners	95,290	cf @	$ 0.66	$ 0.67	$ 64,062
Solid Waste Burials	51,100	cf @	$ 1.46	$ 1.49	$ 75,995
Pond 1 Spoils Pile	437,000	cf @	$ 0.66	$ 0.67	$ 293,788
Interim Soils Storage Cell	154,887	cf @	$ 0.66	$ 0.67	$ 104,128
Clarifier Clay Liners	332,400	cf @	$ 0.66	$ 0.67	$ 223,467
Drummed LLW	5,000	cf @	$ 12.05	$ 12.27	$ 61,371
Sanitary Lagoon Soil	56,400	cf @	$ 0.66	$ 0.67	$ 37,917
Emergency Basin Soil	162,500	cf @	$ 0.66	$ 0.67	$ 109,246
North Ditch Soil	87,500	cf @	$ 0.66	$ 0.67	$ 58,825
Crushed Drums	2,000	cf @	$ 0.66	$ 0.67	$ 1,345
Total	2,197,962				$ 1,677,240

Activity	2007 Direct Cost (000$)	Notes
10. Building and Equip. Demolition	$ 3,902	Source: SFC Environmental Report 2006, includes demolition and placement in cell.
11. Termination Survey	$ 382	2000 soil samples @ $100 each plus gamma walkover survey - 500 hours @ $50/hr plus $150K assessment / NRC confirmation
12. Site Restoration	$ 1,887	Cost to grade, place topsoil and re-vegetate excavations and other affected areas. Based on dozing approximately 17,500,000 cf of dike material into impoundments at $0.072 per cf, grading 83 acres @ $3056/acre, applying 6 inches of topsoil to 124 acres

	2006	2006	2007	2007
17,500,000	$ 0.071	$ 1,242,500	$ 0.072	$ 1,265,624
83	$ 3,000	$ 249,000	$ 3,056	$ 253,634
2,701,000	$ 0.110	$ 297,110	$ 0.112	$ 302,640
124	$ 512	$ 63,488	$ 522	$ 64,670
		$ 1,852,098		$ 1,886,568

Activity	2007 Direct Cost (000$)	Notes
13. Groundwater remediation	$ 1,171	$100,000 per year for 7 years plus $100,000 for recovery systems installation plus $350,000 for intercept trench expansion. Includes treatment of stormwater and waste water as necessary.
14. Engineering Construction Management	$ 3,597	15% of lines 3 through 12.

1 **Alternative 3-2-3: Partial Off-site Disposal of Contaminated Materials – continued**

Activity		Direct Cost (000$)	Notes
15. Post-Closure Monitoring Program	$	83	Post-closure monitoring includes the cost of purging, sampling and analysis for 25 wells for an additional sampling event for the first three to five years after cell closure, cell settlement monitoring, radon emission measurement and cell cover inspectio
16. SFC Staff	$	7,437	SFC at current level of 6 plus management augmentation during decommissioning.
17. Long-Term Site Control Fund	$	798	Per 10 CFR 40, Appendix A, Criterion 10 ($250K, 1978 escalated to 2007 $).
18. Long-term Groundwater Recovery and Treatment	$	1,324	13 years @ $100,000/year
Total Direct Cost	$	39,738	
Contingency (@ 10% of direct costs)	$	3,974	
Grand Total:	$	43,711	

Alternative 3-3-1: Partial Off-site Disposal of Contaminated Materials

Transport both sludge and combined sediments via truck to Energy*Solutions* (Clive, Utah)

Estimated Direct Costs For The Partial Offsite Disposal Alternative (Alternative 3)
Option 3-3-1
Transport both Raffinate Sludge and Combined Sediments by Truck to EnergySolutions (Clive, UT)

Activity		2007 Direct Cost (000$)	Notes
1. Complete Reclamation Plan and Supporting Documents	$	446	Includes Responses to RAIs and Revisions to the Reclamation Plan, Groundwater Corrective Action Plan and Preparation of an Alternate Concentration Limit Application.
2. NRC Charges for Reclamation Plan Review, EIS Preparation	$	900	Includes Review and Approval Reclamation Plan and Groundwater Corrective Action Plan and Completion of EIS
3 Contractor mobilization and demobilization	$	867	5% of lines, 4, 5, 6, 7, 8, 9 and 11.
4. Monitoring Well Removal and Replacement	$	-	Task Complete
5. Disposal Cell Construction / Closure	$	3,003	
6. Other Sludge, Removal, Treatment and On-Site Disposal	$	2,953	Excavation, treatment and placement of other sludges in the cell (1,387,280 cu-ft @ $2.13/cu-ft.). Sum of non-raffinate sludge and other sediments from Material Characteristics sheet.
7. Dewater Raffinate Sludge	$	-	Task Complete
8. Transport both raffinate sludge and combined sediments to EnergySolutions	$	6,871	= 10,478 Raffinate + 2,155 tons of sediment (includes Emergency Basin + North Ditch + Sanitary Lagoon) going 1675 km using $544/ton.
9. Soil Remediation and On-Site Disposal	$	1,677	

				2006 $		2007 $		(cf * 2007 $ unit cost)
DUF4 Trash Drums	2,200	cf @	$	12.05	$	12.27	$	27,003
Contaminated Subsoils & Bedrock	811,685	cf @	$	0.75	$	0.76	$	620,094
CaF_2 Basin Clay Liners	95,290	cf @	$	0.66	$	0.67	$	64,062
Solid Waste Burials	51,100	cf @	$	1.46	$	1.49	$	75,995
Pond 1 Spoils Pile	437,000	cf @	$	0.66	$	0.67	$	293,788
Interim Soils Storage Cell	154,887	cf @	$	0.66	$	0.67	$	104,128
Clarifier Clay Liners	332,400	cf @	$	0.66	$	0 67	$	223,467
Drummed LLW	5,000	cf @	$	12.05	$	12.27	$	61,371
Sanitary Lagoon Soil	56,400	cf @	$	0.66	$	0.67	$	37,917
Emergency Basin Soil	162,500	cf @	$	0.66	$	0.67	$	109,246
North Ditch Soil	87,500	cf @	$	0.66	$	0.67	$	58.825
Crushed Drums	2,000	cf @	$	0.66	$	0.67	$	1,345
Total	2,197,962						$	1,677,240

Activity		2007 Direct Cost (000$)	Notes
10. Building and Equip. Demolition	$	3,902	Source: SFC Environmental Report 2006, includes demolition and placement in cell.
11. Termination Survey	$	382	2000 soil samples @ $100 each plus gamma walkover survey - 500 hours @ $50/hr plus $150K assessment / NRC confirmation
12. Site Restoration	$	1,887	Cost to grade, place topsoil and re-vegetate excavations and other affected areas. Based on dozing approximately 17,500,000 cf of dike material into impoundments at $0.072 per cf, grading 83 acres @ $3056/acre, applying 6 inches of topsoil to 124 acres (

		2006		2006		2007		2007
17,500,000	$	0.071	$	1,242,500	$	0.072	$	1,265,624
83	$	3,000	$	249,000	$	3,056	$	253,634
2,701,000	$	0.110	$	297,110	$	0.112	$	302,640
124	$	512	$	63,488	$	522	$	64,670
			$	1,852,098			$	1,886,568

Activity		2007 Direct Cost (000$)	Notes
13. Groundwater remediation	$	1,171	$100,000 per year for 7 years plus $100,000 for recovery systems installation plus $350,000 for intercept trench expansion. Includes treatment of stormwater and waste water as necessary.
14. Engineering Construction Management	$	3,231	15% of lines 3 through 12.

Alternative 3-3-1: Partial Off-site Disposal of Contaminated Materials – continued

Activity		Direct Cost (000$)	Notes
15. Post-Closure Monitoring Program	$	83	Post-closure monitoring includes the cost of purging, sampling and analysis for 25 wells for an additional sampling event for the first three to five years after cell closure, cell settlement monitoring, radon emission measurement and cell cover inspectio
16. SFC Staff	$	7,437	SFC at current level of 6 plus management augmentation during decommissioning.
17. Long-Term Site Control Fund	$	798	Per 10 CFR 40, Appendix A, Criterion 10 ($250K, 1978 escalated to 2007 $).
18. Long-term Groundwater Recovery and Treatment	$	1,324	13 years @ $100,000/year
Total Direct Cost	$	36,933	
Contingency (@ 10% of direct costs)	$	3,693	
Grand Total:	$	40,626	

Alternative 3-3-2: Partial Off-site Disposal of Contaminated Materials

Transport both sludge and combined sediments via truck to WCS (Andrews, Texas)

Estimated Direct Costs For The Partial Offsite Disposal Alternative (Alternative 3)
Option 3-3-2
Both Raffinate Sludge and Sediments Transported by Truck to WCS (Andrews, TX)

Activity		2007 Direct Cost (000$)	Notes
1. Complete Reclamation Plan and Supporting Documents	$	446	Includes Responses to RAIs and Revisions to the Reclamation Plan, Groundwater Corrective Action Plan and Preparation of an Alternate Concentration Limit Application.
2. NRC Charges for Reclamation Plan Review, EIS Preparation	$	900	Includes Review and Approval Reclamation Plan and Groundwater Corrective Action Plan and Completion of EIS
3. Contractor mobilization and demobilization	$	862	5% of lines, 4, 5, 6, 7, 8, 9, 10 and 12.
4. Monitoring Well Removal and Replacement	$	-	Task Complete
5. Disposal Cell Construction / Closure	$	3,003	
6. Other Sludge, Removal, Treatment and On-Site Disposal	$	2,953	Excavation, treatment and placement of other sludges in the cell (1,387,280 cu-ft @ $2.13/cu-ft.). Sum of non-raffinate sludge and other sediments from Material Characteristics sheet.
7. Dewater Raffinate Sludge	$	-	Task Complete
8. Transport raffinate sludge and sediments to WCS	$	3,827	= 10,478 Raffinate + 2,155 tons of sediment (includes Emergency Basin + North Ditch + Sanitary Lagoon) going 1038 km using $303/ton.
9. Soil Remediation and On-Site Disposal	$	1,677	

				2006 $		2007 $		(cf * 2007 $ unit cost)
DUF4 Trash Drums	2,200	cf @	$	12.05	$	12.27	$	27,003
Contaminated Subsoils & Bedrock	811,685	cf @	$	0.75	$	0.76	$	620,094
CaF_2 Basin Clay Liners	95,290	cf @	$	0.66	$	0.67	$	64,062
Solid Waste Burials	51,100	cf @	$	1.46	$	1.49	$	75,995
Pond 1 Spoils Pile	437,000	cf @	$	0.66	$	0.67	$	293,788
Interim Soils Storage Cell	154,887	cf @	$	0.66	$	0.67	$	104,128
Clarifier Clay Liners	332,400	cf @	$	0.66	$	0.67	$	223,467
Drummed LLW	5,000	cf @	$	12.05	$	12.27	$	61,371
Sanitary Lagoon Soil	56,400	cf @	$	0.66	$	0.67	$	37,917
Emergency Basin Soil	162,500	cf @	$	0.66	$	0.67	$	109,246
North Ditch Soil	87,500	cf @	$	0.66	$	0.67	$	58,825
Crushed Drums	2,000	cf @	$	0.66	$	0.67	$	1,345
Total	2,197,962						$	1,677,240

Activity		2007 Direct Cost (000$)	Notes
10. Building and Equip. Demolition	$	3,902	Source: SFC Environmental Report 2006, includes demolition and placement in cell.
11. Termination Survey	$	382	2000 soil samples @ $100 each plus gamma walkover survey - 500 hours @ $50/hr plus $150K assessment / NRC confirmation
12. Site Restoration	$	1,887	Cost to grade, place topsoil and re-vegetate excavations and other affected areas. Based on dozing approximately 17,500,000 cf of dike material into impoundments at $0.072 per cf, grading 83 acres @ $3056/acre, applying 6 inches of topsoil to 124 acres

		2006		2006		2007		2007
17,500,000	$	0.071	$	1,242,500	$	0.072	$	1,265,624
83	$	3,000	$	249,000	$	3,056	$	253,634
2,701,000	$	0.110	$	297,110	$	0.112	$	302,640
124	$	512	$	63,488	$	522	$	64,670
			$	1,852,098			$	1,886,568

Activity		2007 Direct Cost (000$)	Notes
13. Groundwater remediation	$	1,171	$100,000 per year for 7 years plus $100,000 for recovery systems installation plus $350,000 for intercept trench expansion. Includes treatment of stormwater and waste water as necessary.
14. Engineering Construction Management	$	2,774	15% of lines 3 through 12.

Alternative 3-3-2: Partial Off-site Disposal of Contaminated Materials - continued

Activity		Direct Cost (000$)	Notes
15. Post-Closure Monitoring Program	$	83	Post-closure monitoring includes the cost of purging, sampling and analysis for 25 wells for an additional sampling event for the first three to five years after cell closure, cell settlement monitoring, radon emission measurement and cell cover inspectio
16. SFC Staff	$	7,437	SFC at current level of 6 plus management augmentation during decommissioning.
17. Long-Term Site Control Fund	$	798	Per 10 CFR 40, Appendix A, Criterion 10 ($250K, 1978 escalated to 2007 $).
18. Long-term Groundwater Recovery and Treatment	$	1,324	13 years @ $100,000/year
Total Direct Cost	$	33,428	
Contingency (@ 10% of direct costs)	$	3,343	
Grand Total:	$	36,770	

Alternative 3-3-3: Partial Off-site Disposal of Contaminated Materials

Both Raffinate Sludge and Sediments Transported by Truck to Pathfinder Shirley Basin, (Mills WY)

Estimated Direct Costs For The Partial Offsite Disposal Alternative (Alternative 3)
Option 3-3-3
Both Raffinate Sludge and Sediments Transported by Truck to Pathfinder Shirley Basin, (Mills WY)

Activity		2007 Direct Cost (000$)	Notes
1. Complete Reclamation Plan and Supporting Documents	$	446	Includes Responses to RAIs and Revisions to the Reclamation Plan, Groundwater Corrective Action Plan and Preparation of an Alternate Concentration Limit Application.
2. NRC Charges for Reclamation Plan Review, EIS Preparation	$	346	Includes Review and Approval Reclamation Plan and Groundwater Corrective Action Plan and Completion of EIS
3. Contractor mobilization and demobilization	$	945	5% of lines, 4, 5, 6, 7, 8, 9,10 and 12.
4. Monitoring Well Removal and Replacement	$	-	Task Complete
5. Disposal Cell Construction / Closure	$	3,003	
6. Other Sludge, Removal, Treatment and On-Site Disposal	$	2,953	Excavation, treatment and placement of other sludges in the cell (1,387,280 cu-ft @ $2.13/cu-ft.). Sum of non-raffinate sludge and other sediments from Material Characteristics sheet.
7. Dewater Raffinate Sludge	$	-	Task Complete
8. Transport sludge and sediments to Pathfinder Shirley Basin	$	5,487	'= 10,478 Raffinate + 2,155 tons of sediment (includes Emergency Basin + North Ditch + Sanitary Lagoon) going 1675 km using $434/ton.
9. Soil Remediation	$	1,677	(see detail below)
10. Building and Equip. Demolition	$	3,902	Source: SFC Environmental Report 2006, includes demolition and placement in cell.
11. Termination Survey	$	382	2000 soil samples @ $100 each plus gamma walkover survey - 500 hours @ $50/hr plus $150K assessment / NRC confirmation
12. Site Restoration	$	1,887	Cost to grade, place topsoil and re-vegetate excavations and other affected areas. Based on dozing approximately 17,500,000 cf of dike material into impoundments at $0.072 per cf, grading 83 acres @ $3056/acre, applying 6 inches of topsoil to 124 acres
13. Groundwater remediation	$	1,171	$100,000 per year for 7 years plus $100,000 for recovery systems installation plus $350,000 for intercept trench expansion. Includes treatment of stormwater and waste water as necessary.
14. Engineering Construction Management	$	3,035	15% of lines 3 through 12.

9. Soil Remediation detail:

				2006 $		2007 $		(cf * 2007 $ unit cost)
DUF4 Trash Drums	2,200	cf @	$	12.05	$	12.27	$	27,003
Contaminated Subsoils & Bedrock	811,685	cf @	$	0.75	$	0.76	$	620,094
CaF_2 Basin Clay Liners	95,290	cf @	$	0.66	$	0.67	$	64,062
Solid Waste Burials	51,100	cf @	$	1.46	$	1.49	$	75,995
Pond 1 Spoils Pile	437,000	cf @	$	0.66	$	0.67	$	293,788
Interim Soils Storage Cell	154,887	cf @	$	0.66	$	0.67	$	104,128
Clarifier Clay Liners	332,400	cf @	$	0.66	$	0.67	$	223,467
Drummed LLW	5,000	cf @	$	12.05	$	12.27	$	61,371
Sanitary Lagoon Soil	56,400	cf @	$	0.66	$	0.67	$	37,917
Emergency Basin Soil	162,500	cf @	$	0.66	$	0.67	$	109,246
North Ditch Soil	87,500	cf @	$	0.66	$	0.67	$	58,825
Crushed Drums	2,000	cf @	$	0.66	$	0.67	$	1,345
Total	2,197,962						$	1,677,240

12. Site Restoration detail:

		2006		2006		2007		2007
17,500,000	$	0.071	$	1,242,500	$	0.072	$	1,265,624
83	$	3,000	$	249,000	$	3,056	$	253,634
2,701,000	$	0.110	$	297,110	$	0.112	$	302,640
124	$	512	$	63,488	$	522	$	64,670
			$	1,852,098			$	1,886,568

Alternative 3-3-3: Partial Off-site Disposal of Contaminated Materials (continued)

Both Raffinate Sludge and Sediments Transported by Truck to Pathfinder Shirley Basin, (Mills WY)

Activity	Direct Cost (000$)	Notes
15. Post-Closure Monitoring Program	$ 83	Post-closure monitoring includes the cost of purging, sampling and analysis for 25 wells for an additional sampling event for the first three to five years after cell closure, cell settlement monitoring, radon emission measurement and cell cover inspectio
16. SFC Staff	$ 7,437	SFC at current level of 6 plus management augmentation during decommissioning.
17. Long-Term Site Control Fund	$ 798	Per 10 CFR 40, Appendix A, Criterion 10 ($250K, 1978 escalated to 2007 $).
18. Long-term Groundwater Recovery and Treatment	$ 1,324	13 years @ $100,000/year
Total Direct Cost	$ 34,877	
Contingency (@ 10% of direct costs)	$ 3,488	
Grand Total:	$ 38,365	

Transportation and Disposal Costs Per Ton Assumptions and Applicable Material Quantities Used in the Costing

Transportation & Disposal Costs Per Ton -- Assumptions Used				
		$/ton	Material Tons	Mode
Alt 2-1 Offsite Disposal	$	382	463,850	Rail
Alt 2-2 Offsite Disposal	$	409	463,850	Rail
Alt 3-1-1				
Raffinate Sludge to White Mesa:	$	423	10,478	Truck
Other Sediment to Pathfinder	$	434	2,155	Truck
Alt 3-1-2				
Raffinate Sludge to White Mesa:	$	423	10,478	Truck
Other Sediment to EnergySolutions	$	544	2,155	Truck
Alt 3-1-3				
Raffinate Sludge to White Mesa:	$	423	10,478	Truck
Other Sediment to WCS	$	303	2,155	Truck
Alt 3-2-1				
Raffinate Sludge to Rio Algom	$	802	10,478	Truck
Other Sediment to Pathfinder	$	434	2,155	Truck
Alt 3-2-2				
Raffinate Sludge to Rio Algom	$	802	10,478	Truck
Other Sediment to EnergySolutions	$	544	2,155	Truck
Alt 3-2-3				
Raffinate Sludge to Rio Algom	$	802	10,478	Truck
Other Sediment to WCS	$	303	2,155	Truck
Alt 3-3-1				
Both Raffinate Sludge & Sediment to EnergySolutions	$	544	12,633	Truck
Alt 3-3-2				
Both Raffinate Sludge & Sediment to WCS	$	303	12,633	Truck
Alt 3-3-3				
Both Raffinate Sludge & Sediment to Pathfinder	$	434	12,633	Truck

APPENDIX G

SEQUOYAH FUELS CORPORATION RAFFINATE DISPOSITION PROGRAMS

G.1 Introduction

The Sequoyah Fuels Corporation (SFC) facility in Gore, Oklahoma, used large quantities of nitric acid in a solvent extraction process for uranium purification and conversion. From this process, significant volumes of process waste liquid (called raffinate) would be generated requiring proper waste management. This untreated raffinate was a solution of nitric acid, metallic salts, and minute quantities of uranium and its long-lived radioactive daughter products, such as the radionuclides Radium-226 and Thorium-230. The raffinate was pumped to holding basins or ponds; however, the net yearly evaporation rate was not sufficient to remove the water component of the untreated raffinate. Quantities of upward to 18,927,000 liters (5 million gallons) per year of raffinate were being generated and stored in the holding ponds from the solvent extraction system used at the SFC facility. Thus, Kerr-McGee Nuclear Corporation (KMNC), the original owner and operator of the uranium conversion facility, recognized that they would have to periodically build additional holding basins to store this raffinate over the lifetime of the facility unless another process for safely disposing of the raffinate could be developed and implemented.

At the beginning of site operations, KMNC initially pursued raffinate disposition through deep-well injection. However, ultimately this was not approved by the regulatory agencies (i.e., the U.S. Nuclear Regulatory Commission (NRC), the U.S. Environmental Protection Agency (EPA), or the State of Oklahoma) under its various phases of development (1969 through 1984). Subsequently, KMNC and then SFC pursued and received approval for using treated raffinate as a liquid fertilizer on the Sequoyah International or SFC-controlled lands. This appendix describes both programs and subsequent impacts to the farmlands where the liquid raffinate was applied as fertilizer.

G.2 Deep-Well Injection Program

In late 1967, prior to the construction of the uranium conversion facility, KMNC began evaluating the option of disposing of the anticipated untreated raffinate into a deep injection well. Following a feasibility study, it was determined that subsurface geological conditions could allow for disposal of fluids via an injection well drilled into the deep bedrock ground-water system, a geological unit called the Arbuckle Formation, which is located from about 408 to 948 meters (1,337 to 3,109 feet) below ground level in the facility area. On September 26, 1969, KMNC began drilling the deep injection well just west of the Main Process Building (SE 1 /4, SW 1 /4, NE 1 /4, Section 21, Township 12N, Range 21 East). Drilling was concluded on October 28, 1969, and the well itself was completed in the next month. Limited injection tests using fresh water began immediately after completion. From such tests, KMNC concluded that the Arbuckle Formation could accept significant volumes of fluids.

In April 1970, KMNC applied to the Atomic Energy Commission (AEC) for an amendment to their license to allow liquid waste disposal through the deep injection well (Wuller, 1970). Six months later, the AEC responded that insufficient information had been provided by KMNC concerning the deep injection well and denied use of the deep injection well. KMNC subsequently requested and was granted

AEC approval to withdraw their deep injection well license application without prejudice to a future application until a more detailed study of the Arbuckle Formation was completed.

KMNC subsequently performed an evaluation of the Arbuckle Formation and its ground-water reservoir. The purpose of the study was to define the lateral and vertical boundaries and determine the hydrodynamics of the Arbuckle Reservoir. This evaluation included conducting a longer-term pilot injection test into the Arbuckle with fresh water. Also, between 1970 and 1984, four monitoring wells (Well No. 2307, 2331, 2332, and 2333) were installed for purposes of monitoring any potential impact to shallow ground water associated with the deep injection well.

The second pilot injection test was conducted in June and July of 1971. During this period, 3,165,000 liters (836,143 gallons) of fresh water were injected into the deep injection well over four separate time intervals at rates that varied from 1.6 to 5.7 liters per second (25 to 91 gallons per minute, or gpm). Based upon this study, KMNC reapplied to the AEC on May 10, 1972, for an amendment to their license to allow the use of the deep injection well. In April 1973, the AEC again denied KMNC use of the deep injection well based upon the AEC's conclusion that the Arbuckle Reservoir study did not conclusively prove that the injected liquids could be contained in the reservoir. However, KMNC disputed the ruling by requesting and being granted a hearing before the Atomic Safety and Licensing Board (ASLB).

In October 1973, KMNC presented the deep injection well information to the ASLB. In January 1974, the ASLB supported the AEC and denied KMNC the use of the deep injection well. KMNC conducted no further activities regarding the deep injection well from January 1974 to July 1981.

Between 1973 and 1981, KMNC implemented process changes that resulted in the raffinate being treated and neutralized by reacting the raw raffinate with gaseous ammonia to neutralize the free nitric acid and to precipitate metal ions as hydroxides or hydrated oxides removing a majority of the residual uranium and thorium. KMNC also treated the raffinate with soluble barium to remove radium. The resulting treated raffinate is an ammonia-nitrate solution that was retained in surface impoundments at the facility.

On July 17, 1981, KMNC applied to the Oklahoma State Department of Health (OSDH), Industrial Waste Division, for use of the deep injection well for disposal of treated raffinate as a controlled industrial waste. On July 29, 1982, KMNC also submitted an application to the AEC's successor, the NRC, requesting a license amendment to permit disposal of treated raffinate into the deep injection well. On October 19, 1982, the OSDH issued a permit to operate the deep injection well. The permit was for a five-year period and allowed injection of up to 18,927,000 liters (5 million gallons) of treated raffinate each year. The injection schedule allowed the injection of 3.8 liters per second (60 gpm) for a period of 60 consecutive days, with no injection during the remainder of the year.

On May 18, 1983, the NRC issued an amended license to authorize injection of treated raffinate into the deep injection well. However, the NRC stipulated that the use of the deep injection well be limited to injection of 18,927,000 liters (5 million gallons) during a pilot test and requested that KMNC submit results of the pilot test to the NRC before additional volumes would be approved for injection.

The pilot test was conducted from June 6, 1983, to August 2, 1983. Approximately 18,927,000 liters (5 million gallons) of treated raffinate were injected at an average rate of 3.8 liters per second (60.7 gpm) (RSA, 1995). During the test, a monitoring program was conducted that included a seismicity study by the University of Oklahoma, a ground-water monitoring program, and pressure monitoring of the injection well during and after the test injection.

With respect to the potential environmental impacts of the pilot test program, the treated raffinate injected in the test was well below the maximum permissible concentrations (MPC) for unrestricted releases as specified by 10 CFR Part 20, Appendix B, Table 2 (in effect at that time) and as shown in Table G-1. The average radionuclide concentrations in the raffinate to be injected were 3.5 percent of the MPC for Radium-226, 0.1 percent of the MPC for natural uranium, and less than 0.01 percent of the MPC for Thorium-230 (Page, 1983). The radionuclides were also well below the EPA National Primary Drinking Water Standards of 5 pCi/L for Radium-226 and 15 pCi/L for gross alpha particle activity (Warner, 1983). The raffinate was shown to be of a better water quality than that found in the Arbuckle Formation (the Radium-226 concentration in the Arbuckle Formation is about 1400 pCi/L as shown in Table G-1).

Table G-1 Water Quality Information of Concern to the Deep-Well Injection Program

Item	MPC1 (µCi/ml)	MCL* or TT** Action Level[2]	Untreated Raffinate[5]	Treated Raffinate	Arbuckle Formation
Sample/Report Date	--	--	April 1970	1980	Nov. 1969
Chlorine	--	250 mg/L [3]	--	--	88,300 mg/L
Sodium	--	--	--	--	39,700 mg/L
TDS	--	500 mg/L	--	--	142,000 mg/L
pH	--	6.5 to 8.5 3	Not Given	7.65	--
Copper	--	TT Action Level: 1.3 mg/L [2]	Not Given	5.4 mg/L	--
Molybdenum	--	--	Not Given [5]	9.65 mg/L	--
Nickel	--	--	Not Given [5]	12.0 mg/L	--
Nitrates	--	10 mg/L [2]	Not Given [5]	36,500 mg/L	--
Radium-226	6E-8	5 pCi/L [2]	210 pCi/L [5]	1.07 pCi/L	1,400 pCi/L
Thorium-230	1E-7	15 pCi/L [2,4]	600 pCi/L [5,6]	0.065 pCi/L	--
Nat. Uranium	3E-7	30 µg/L [2]	150 pCi/L [5]	45 □g/L	--

[1] Source: 10 CFR Part 20, Appendix B, Table 2 and, to convert to pCi/L, multiply by 1.0E+09.

[2] Source: EPA, National Primary Drinking Water Regulations, http://www.epa.gov/safewater/mcl.html, (February 7, 2002) last updated: January 23, 2002.

[3] Source: EPA, National Secondary Drinking Water Regulations, http://www.epa.gov/safewater/mcl.html, (February 7, 2002), last updated: January 23, 2002.

[4] The 15 pCi/L limit is for all alpha emitting radionuclides present in the water.

[5] Source: Wuller, 1970 and only provides radiological pollutants. It is assumed that the non-radiological pollutants are similar to the quantities given under the Treated Raffinate column.

[6] KMNC also would have injected 45,000 pCi/L of Thorium-234. With a half-life of 24.1 days, this radioisotope would decay to below allowable radioactivity limits after 235 days (Wuller, 1970).

* MCL = Maximum Contaminant Level

** TT = Treatment Technique

In February 1984, SFC[1] submitted all monitoring results and reports from the pilot injection test to the NRC. These reports indicated the deep injection well performed satisfactorily and that the Arbuckle Reservoir was capable of accepting the injected liquids. Also, at this time, the SFC requested permission from the OSDH and the NRC to inject an additional 132,500 liters (35 million gallons) of treated raffinate over a 14-month period. On July 10, 1984, the NRC's consultant indicated to the NRC that SFC had provided sufficient information, and recommended that the requested injection of 132,500 liters (35 million gallons) be approved. On August 31, 1984, the OSDH issued a draft permit for injection of this amount of treated raffinate. A final permit was not to be issued until public comment was obtained. In the fall of 1985, a public hearing was held, and the injection project was abandoned due to overwhelming public opposition.

In December 1985, the SFC decided to plug the deep injection well in response to the negative public opinion received during the public comment period, and the plugging process was overseen by representatives of the OSDH and Oklahoma Water Resources Board (OWRB). In December 1987, the OSDH granted the SFC approval to also plug and abandon the four monitoring wells associated with the deep injection well that were installed between 1970 and 1984. These ground-water monitoring wells were shortly plugged and abandoned by the SFC.

In September 1994, the SFC requested a review of the relevant documents by Roberts/Schornick & Associates (RSA). RSA concluded that the well casings were properly installed and had sufficient seals between the casing and borehole wall to prevent vertical migration of fluids behind the casing during the pilot test or from natural formation pressures (RSA, 1995). There was no significant boundary leakage, no vertical interconnection between layers forming the reservoir, and no significant horizontal heterogeneity within each layer. Injection of fluids could occur with little risk of fluid movement out of the Arbuckle Formation Reservoir. Injection of this fluid could not increase the Arbuckle Formation pressures sufficiently to bring natural brines into contact with fresh ground-water horizons.

G.3 Ammonium Nitrate Fertilizer Program

G.3.1 Introduction

Once the raffinate was neutralized and the impurities were precipitated, the resulting liquid, designated as SFC-N, was a dilute ammonium nitrate solution. In fact, chemical analysis of the SFC-N showed it to contain fewer impurities than commercial ammonium nitrate fertilizers (SFC, 1994). The SFC-N was stored in open ponds on the site and sprayed as nitrogen fertilizer principally between 1973 and 1994 on farmland used to grow forage crops for livestock. Periodic application of this fertilizer onto the

Aglands in the south portion of the SFC site has occurred since 1994 as given in annual reports with the latest one for the year 2001 (SFC, 2002). Figures G-1 and G-2 identify the land areas treated with SFC-N fertilizer between 1973 and 1994.

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[1] In October 1983, KMNC divided its assets and became two new subsidiary companies with the SFC the designated owner of the uranium conversion facility at Gore, Oklahoma.

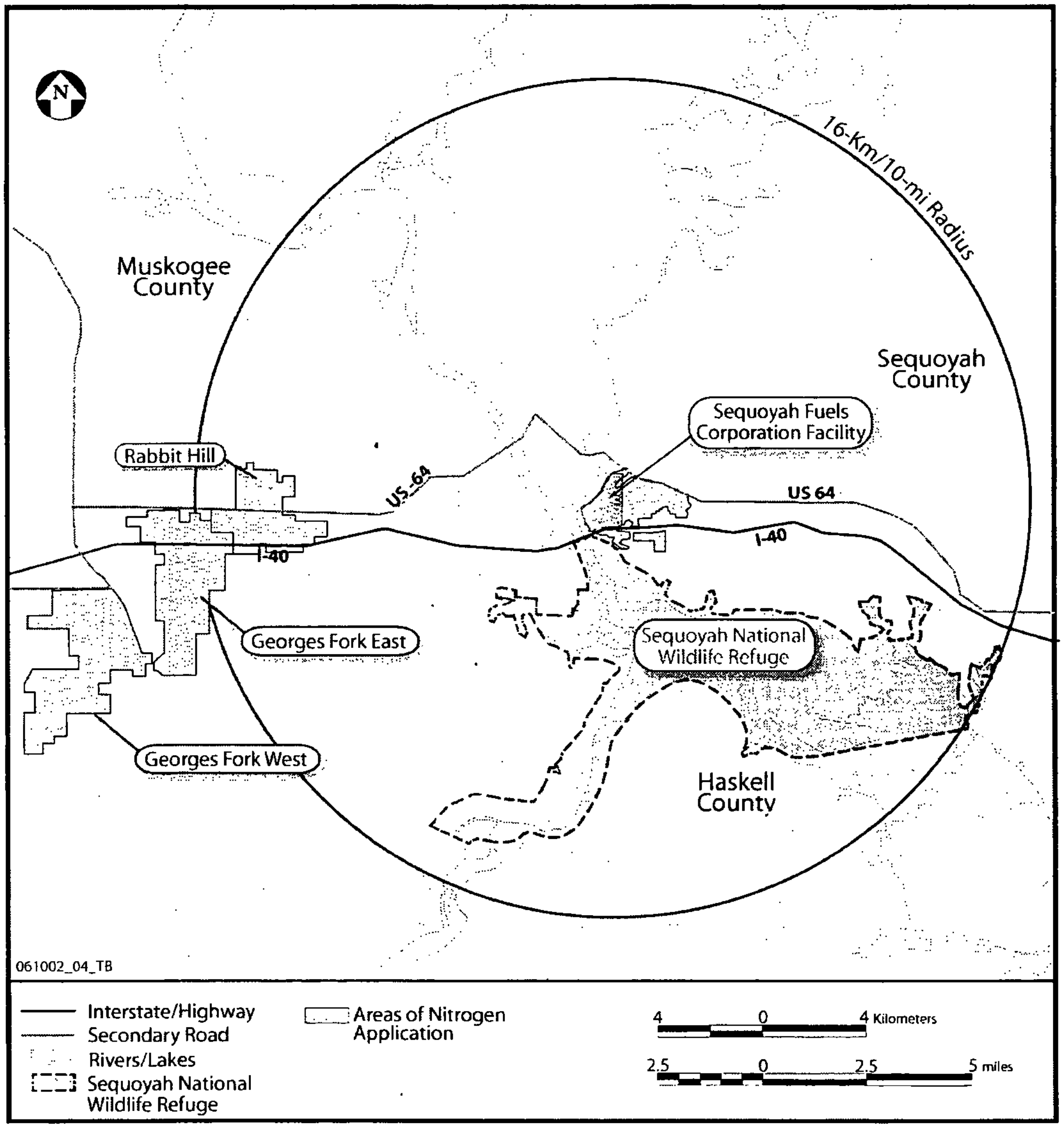

Figure G-1 Properties Treated with SFC-N Fertilizer Between 1973 and 1994

The NRC, Oklahoma State University, and the EPA monitored the program and reviewed the results of chemical and radiological analyses of the fertilizer, soil, ground water, surface water, forage crops, and grazing livestock. While a few of the individual test reports showed unusually high concentrations of certain heavy metals, re-sampling of the same area did not reproduce similar concentration levels. The high readings were considered sampling error or sample contamination (Oklahoma State Department of Health, 1985). The vast majority of the studies reflect no adverse impact from the SFC-N.

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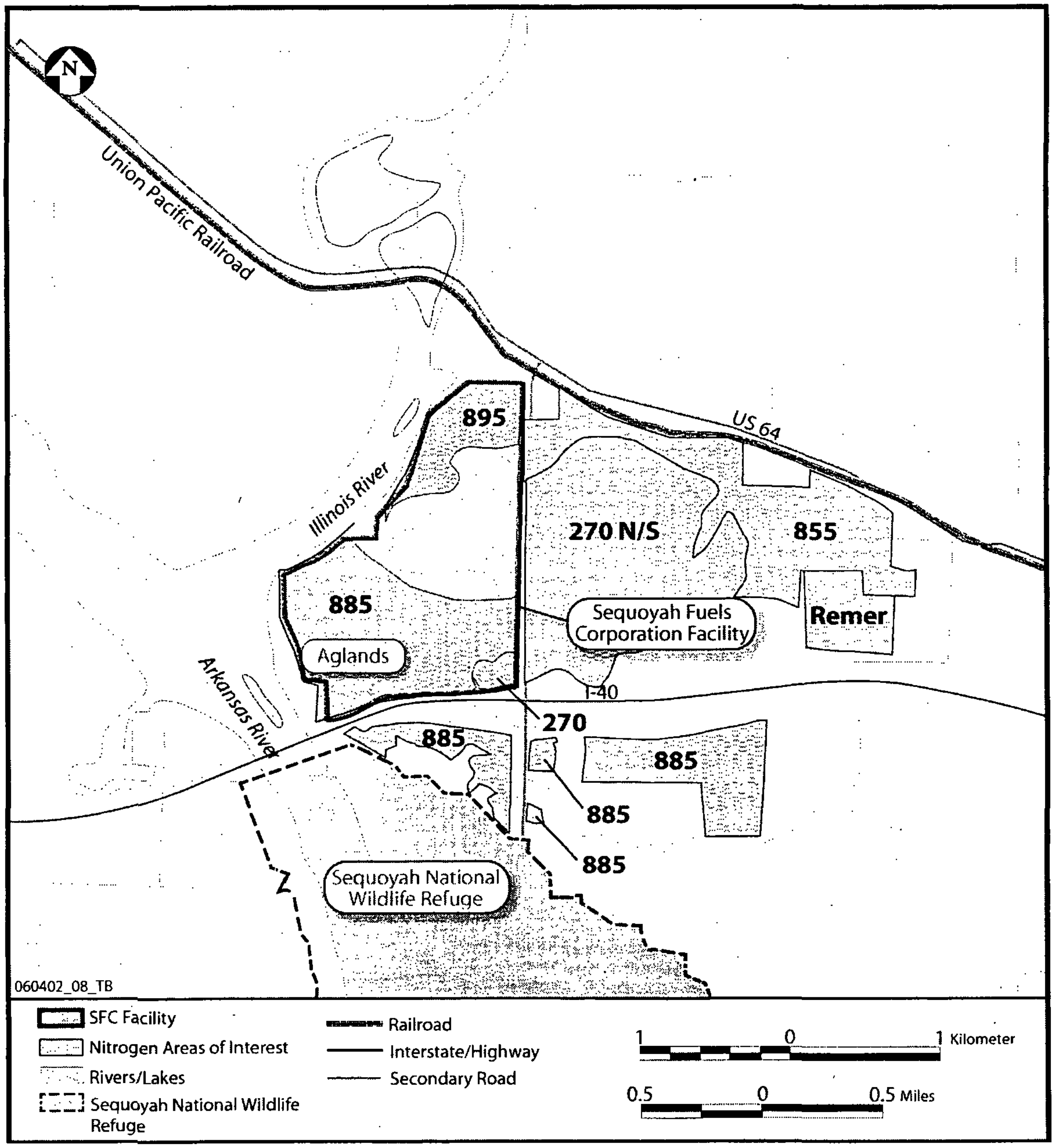

Figure G-2 Properties Treated with SFC-N Fertilizer Between 1973 and 1994

contamination (Oklahoma State Department of Health, 1985). The vast majority of the studies reflect no adverse impact from the SFC-N.

G.3.2 Initial Test Plots

The fertilizer spray program began in 1973 after the licensee (KMNC until 1987) showed that the waste nitric acid solution could be neutralized with anhydrous ammonia and treated with barium nitrate to precipitate almost all of the trace metals and contaminates (Tucker, 1988). The resultant liquid was a 2- to 5-percent ammonium nitrate solution similar to commercially available nitrate fertilizer.

In 1972, the licensee (until 1987, Kerr-McGee Corporation) applied to the AEC to test the viability of using SFC-N as fertilizer. The AEC granted permission in 1973, and testing began with a 400 feet by 400 feet (122 m by 122 m) plot. Table G-2 contains the chemical analyses of the SFC-N as first applied, and mean chemical analysis of soil and vegetation from the 1973 experiment. The original application of SFC-N contained trace amounts of uranium (0.64 to 0.86 μg/g) and radium (0.29 to 2.9 pCi/L). Multiple samples of runoff water, soil, and vegetation were taken before, during, and after the application of SFC-N and compared to similar samples from an untreated area. Analysis of these samples showed very low levels of nitrate in the runoff water (a maximum of 5.6 mg/L) and very low levels of other contaminates in the soil and vegetation.

Table G-2 Analyses of Applied SFC-N Fertilizer, Soil, and Vegetation Preliminary Test (1973)

Analysis of SFC-N	NH4 -N (μg/g)	NO3 -N (μg/g)	Ca (μg/g)	F (μg/g)	Na (μg/g)	U (μg/g)	Ra (pCi/L)
8/8/73 to 9/4/73	1,800	6,600.00	7,000.00	13.00	1,150.00	0.64	2.900
9/21/73 to 11/6/73	1,860	6,700.00	7,000.00	9.00	--	0.86	0.290
Amt. applied (lbs./acre)*	280	1,017.00	1,071.00	0.14	176.00	0.01	--
<u>Soil Analysis</u>							
Control - 5/17/73	--	18.90	--	98.00	--	2.50	0.330
Control - 9/8/73	--	10.00	2,000.00	33.00	--	3.80	--
Control - 1/10/74	--	<10.00	2,000.00	39.00	--	1.80	<0.005
Test Plot - 5/17/73	--	11.00	--	79.00	--	0.80	0.100
Test Plot - 9/8/73	--	<10.00	890.00	31.00	--	0.80	--
Test Plot - 1/10/74	--	<10.00	1,290.00	47.00	--	1.20	0.010
<u>Vegetation Analysis</u>							
Control - 5/17/73	--	--	1,850.00	4.00	--	1.10	0.080
Control - 9/8/73	--	25.00	1,850.00	2.20	--	2.70	--
Control - 1/10/74	--	<10.00	1,820.00	17.00	--	0.40	0.005
Standard deviation	--	12.60	--	--	--	1.18	0.053
Test Plot - 5/17/73	--	--	--	2.00	--	0.60	0.200
Test Plot - 9/8/73	--	225.00	2,880.00	7.80	--	0.50	--
Test Plot - 1/10/74	--	<10.00	1,360.00	3.00	--	0.40	0.010
Standard deviation	--	152.00	--	--	--	0.10	0.134

* To convert lbs./acre to kg/hectare multiply lbs./acre by 1.12.
Source: Tucker, 1988.

Because of the success of the 1973 test plots, the NRC approved Kerr-McGee's request to expand the testing. From 1974 through 1976, four demonstration plots were established in the same area as the 1973 test. One plot was used as a control and received no treatment, two of the test plots received SFC-N, and one plot received an equivalent level of commercial nitrogen fertilizer. Runoff water from each plot was directed into separate catch basins for volume measurement and sampling. Periodic soil and vegetation analyses were performed and are reported in Table G-3.

Table G-3 Analysis of SFC-N and Commercial Ammonium Nitrate on Four Test Plots From 1974 to 1976

	Test Plot Number			
	1	2	3	4
Fertilizer Type	**SFC-N**	**SFC-N**	**Commercial**	**Control**
1974 Growing Season				
Nitrogen (N) in SFC-N (lbs. N/acre)*	1,080.0	519.0	--	--
N in Commercial Fertilizer (lbs. N/acre)*	--	--	466.0	--
Radium applied with N (pCi X 103)	49.3	34.8	104.9	--
Bermuda grass yield (lbs./acre)*	6,179.7	7,793.0	6,815.0	4,800.0
N uptake in Bermuda grass (lbs. N/acre)*	187.4	161.1	184.8	173.6
1975 Growing Season				
Nitrogen (N) in SFC-N (lbs. N/acre)*	980.0	516.0	--	--
N in Commercial Fertilizer (lbs. N/acre)*	--	--	517.0	--
Radium applied with N (pCi X 103)	3.1	9.1	9.2	--
Bermuda grass yield (lbs./acre)*	13,804.5	11,214.1	11,681.6	6,688.2
N uptake in Bermuda grass (lbs. N/acre)*	317.0	203.1	247.0	81.6
1976 Growing Season				
Nitrogen (N) in SFC-N (lbs. N/acre)*	906.0	531.0	--	--
N in Commercial Fertilizer (lbs. N/acre)*	--	--	524.0	--
Radium applied with N (pCi/L)	N/A	N/A	N/A	--
Bermuda grass yield (lbs./acre)*	9,086.0	6,066.1	6,936.0	2,529.3
N uptake in Bermuda grass (lbs. N/acre)*	269.4	188.2	215.5	43.8
Three-Year Average (1974 to 1976)				
Nitrogen (N) in SFC-N (lbs. N/acre)*	988.7	522.0	--	--
N in Commercial Fertilizer (lbs. N/acre)*	--	--	502.3	--
Radium applied with N (pCi/L)	26.2	22.0	57.1	--
Bermuda grass yield (lbs./acre)*	9,690.1	8,357.7	8,477.5	4,672.4
N uptake in Bermuda grass (lbs. N/acre)*	257.9	184.1	215.8	66.3

* To convert lbs./acre and lbs. N/acre to kg./hectare and kg. N/hectare, multiply lbs./acre by 1.12.
Source: Tucker, 1988.

The 1974 to 1976 studies showed that SFC-N was equivalent to commercial ammonium nitrate fertilizer in its effects on soil processes and plant growth (Tucker, 1988). Forage produced by fertilization with SFC-N was normal, and concentrations of radionuclides and trace elements were well within animal diet standards. As can be seen in Table G-3, equivalent amounts of nitrogen from commercial ammonium nitrate fertilizer and SFC-N produced almost twice as much bermuda grass as the untreated control plot. Additionally, the quantity of radium in the commercial fertilizer was more than twice that of the SFC-N. After review of this information, the NRC approved Kerr-McGee's request to expand its testing to a 160-acre plot south of the Sequoyah facility (Tucker, 1988).

G.3.3 160-Acre Test

Between 1977 and 1984, Kerr-McGee divided a 64.7-hectares (160-acre) section of Kerr-McGee land into six provinces according to the soil type and vegetation. This section of land and the fertilizer-spreading program was designated as the 160-acre test tract. Each province was segregated with runoff control dikes and perimeter diversion ditches to collect rain water. Shallow monitoring wells were installed, and a detailed soil analysis was performed to provide baseline data before the initial application of SFC-N.

In 1977, provinces 1 and 2 received nitrogen loadings equivalent to what a farmer would use on normal grazing land, while provinces 3, 4, 4a, and 5 received 2 to 3 times the normal nitrogen loading. Nitrogen monitoring of both ground water and runoff showed most samples below the 10 mg/L limit for human consumption. The few water samples that exceeded the 10 mg/L drinking water limit had values of 14 to 44 mg/L, which was still within acceptable limits for animal consumption. One sample showed 79 mg/L in 1979 — this abnormally high reading may have been caused by accidental contamination of the monitoring well or sample.

Of course, good soil requires more than just nitrogen to produce good crops. Commercial phosphate, potash, and agricultural lime (aglime) were added as determined by soil analyses. These loadings constituted the total inputs for pasture management of the 160-acre test tract excluding mineral supplements and grain fed to grazing cattle, and material from rain, snow, and windstorms.

During 1978 and 1979, Kerr-McGee developed a cattle-testing program in conjunction with the Oklahoma State University Animal Disease Diagnostic Laboratory, the Oklahoma Department of Agriculture, and the NRC. The program was designed to compare the effects of SFC-N with commercial ammonium nitrate fertilizer on grazing animals and the human food chain. There was no significant difference in average weight gain between the two groups, and all of the heavy metal and radionuclides analyses were within expected normal background levels for both the experimental and control groups. A summary of these findings is shown in Table G-4.

Table G-4 Average Heavy Metal and Radionuclide Content of Blood and Selected Tissue From Cattle Grazing in Pastures Fertilized with SFC-N and Commercial Urea Nitrogen Sources (1978-1979)

Material		Blood	Kidney	Liver	Brain	Heart	Bone	Muscle
Pb	SFC-N	0.0340	0.2300	0.0650	--	--	--	0.2000
(mg/L)	Urea	0.0300	0.4100	0.5800	--	--	--	0.1100
Zn	SFC-N	2.3000	19.9000	33.9300	--	--	--	36.1000
(mg/L)	Urea	2.4000	18.2800	42.6500	--	--	--	45.7300
Cu	SFC-N	1.0230	7.7250	20.8500	--	--	--	5.0750
(mg/L)	Urea	0.9900	6.3630	35.3500	--	--	--	3.6250

Table G-4 Average Heavy Metal and Radionuclide Content of Blood and Selected Tissue From Cattle Grazing in Pastures Fertilized with SFC-N and Commercial Urea Nitrogen Sources (1978-1979)

Material		Blood	Kidney	Liver	Brain	Heart	Bone	Muscle
Cd	SFC-N	--	1.2500	0.2250	--	--	--	0.0600
(mg/L)	Urea	--	0.8750	0.2500	--	--	--	0.0800
Mo	SFC-N	0.0350	1.3550	1.8280	--	--	--	0.9050
(mg/L)	Urea	0.0480	5.0400	5.0400	--	--	--	3.8930
As	SFC-N	--	0.2000	0.0200	--	--	--	0.0200
(mg/L)	Urea	--	0.4000	0.0400	--	--	--	0.1000
Ni	SFC-N	--	0.1007	0.1035	--	--	--	0.1600
(mg/L)	Urea	--	0.1600	0.0650	--	--	--	0.1500
U	SFC-N	0.0013	0.0173	0.0015	0.0015	0.0020	0.0128	0.0025
(mg/L)	Urea	0.0072	0.0175	0.0035	0.0010	0.0027	0.0013	0.0010
Ra	SFC-N	--	0.0025	0.0018	0.0040	0.0015	0.0625	0.0008
(pCi/g)	Urea	--	0.0052	0.0015	0.0030	0.0020	0.0950	0.0015
Th	SFC-N	--	0.0040	0.0030	0.0007	0.0004	0.0011	0.0003
(pCi/g)	Urea	--	0.0030	0.0020	0.0006	0.0002	0.0013	0.0002

Source: Tucker, 1988.

The 160-acre experiment showed that SFC-N was an effective source of nitrogen for forage production, and it reacted like commercially available ammonium nitrate fertilizer. There was no statistical difference in cattle feed grass grown with SFC-N, and the use of SFC-N had no adverse affect on the soil, water, or cattle (Coleman, 1985).

G.3.4 270-Acre Test

In 1979, Kerr-McGee expanded the fertilizer program to include an additional 109 hectares (270 acres) of Kerr-McGee land adjacent to the Kerr-McGee facility designating this additional program as the 270-acre test tract. As with the 160-acre field test, the area was surrounded with a perimeter diversion ditch, and pre-application soil samples were taken to establish a baseline reference for various chemicals. The testing program continued for 8 years and included monitoring of water, soil, and vegetation for metals and radionuclides.

Like the 160-acre test, the 270-acre test involved a comprehensive forage production program using SFC-N as the nitrogen fertilizer source and commercially available phosphate, potash, and aglime. Eight years of application effects were reviewed and summarized. Effects of treatments on soil, surface and ground water, and forage were tested. Nitrogen application rates, even though higher than average for the area, allowed for maximum grazing and haying use of the land. Forage yields over the 8-year period were very good, and the test plot was successful in assessing environmental impacts of the program (Tucker, 1988).

The SFC-N proved to be an effective source of nitrogen for growing grass, reacting like other available nitrogen fertilizers. As shown in Table G-5, the forage produced was no different than that forage produced using other nitrogen fertilizers, and there was no adverse affect on soils or water (Tucker, 1988).

Table G-5 Average of 8 Years of Chemical and Radiological Analysis of 270-Acre Test Plot

	Element Concentrations					
Pasture	**Ra (pCi/g)**	**Th (pCi/g)**	**U (µg/g)**	**Cu (mg/g)**	**Mo (mg/g)**	**Ni (mg/g)**
Control (not treated)	0.0240	0.0180	0.0800	0.0037	0.0044	0.0062
Rye (treated with SFC-N)	0.0250	0.0140	0.1000	0.0036	0.0040	0.0067

Source: Coleman, 1985.

G.3.5 885-Acre Expansion Tract

Based on the results of the previous experiments, the NRC allowed another expansion of the testing program. In June 1980, Kerr-McGee added an additional 358 hectares (885 acres) to the SFC-N testing program designated as the 885-acre expansion tract. The 885-acre expansion tract includes shallow soils with limited production capability. The soils are underlain with clay subsoil that overlies layers of gravelly sandstone and shale. Most of the area was timbered. To facilitate application of the fertilizers, Kerr-McGee cut access roads 6.1 m (20 ft.) wide and 30.5 m (100 ft.) apart and seeded them with fescue. They divided the 358 hectares (885 acres) into 27 subplots and selected six of the subplots for intensive monitoring. Kerr-McGee chose the six selected areas because they represented the soil samples in the total area.

All of the 358 hectares (885 acres) received uniform quantities of SFC-N and commercial phosphate, potash, and aglime from 1980 through 1982. Thereafter, residual soil testing was used to determine application rates for all of the fertilizers. The area received SFC-N as nitrogen fertilizer for 7 years, from 1980 to 1987. Nitrogen content of the SFC-N varied from 2.18 to 5.0 percent, and the applied quantity of the SFC-N was adjusted to maintain a constant application rate in pounds of nitrogen per acre as determined by soil samples and nitrogen concentration.

The fertilizer program on the 885-acre tract continued to exhibit the results noted in previous areas. Fescue grew profusely in the cleared strips and invaded the uncleared areas. Kerr-McGee noted greatly improved production from the native grass in the timbered areas. Cattle grazing on this land was successful, and no problems were encountered (Tucker, 1995).

G.3.6 Rabbit Hill Field Monitoring

In 1982, the NRC authorized the continued use of SFC-N ammonium nitrate on the 160-, 270-, and 885-Acre test tracts and allowed expansion of the program to another area—a 283 hectare (700-acre) company-owned tract known as Rabbit Hill near Warner, Oklahoma. Rabbit Hill's soil is primarily deep clay-pan prairie-type soil with some shallow and steep soils similar to the 885-acre tract. Vegetation on Rabbit Hill is mainly bermuda grass and fescue with some small timbered areas.

Analysis of the existing soil at Rabbit Hill showed it to be acidic and very low in phosphorus and potassium. Correcting these deficiencies required the application of large quantities of K2O, P2O5, and aglime along with the SFC-N. All of these materials were applied annually in accordance with recommendations from the Oklahoma State University and based on soil tests.

Table G-6 depicts the average loading rates of SFC-N, concentrated superphosphate, and sulfate of potash-magnesia fertilizers and aglime applied to Rabbit Hill between 1982 and 1986, along with a chemical analysis of each of the fertilizers. As Table G-6 shows, the percentage quantity of each trace element contributed by SFC-N is quite small compared to the amounts added from the other sources (Tucker, 1995). Detailed analyses of soil, vegetation, and ground water from the Rabbit Hill area showed nothing unusual, and all values were below the standards set for safe use of the material (Tucker, 1995).

Table G-6 Average Yearly Quantity and Analysis of Fertilizers Applied to Rabbit Hill From 1982 to 1986

Material	SFC-N	P_2O_5	K_2O	Aglime
SFC-N (Nitrogen) - lbs./acre*	304			
P_2O_5 - (0-45-0) - lbs./acre*		43		
K_2O - (0-0-22-20) - lbs./acre*			42	
Aglime - lbs./acre*				2,364
Chemical Analysis	**SFC-N**	**P_2O_5**	**K_2O**	**Aglime**
As, median measured level in mg/L	0.95	33.50	42.80	18.00
B, median measured level in mg/L	0.87	40.10	35.75	25.60
Ba, median measured level in mg/L	0.40	20.58	6.80	29.50
Cd, median measured level in mg/L	0.11	17.05	9.08	10.65
Cu, median measured level in mg/L	5.42	32.60	13.00	3.50
Mo, median measured level in mg/L	11.63	13.00	3.05	7.50
N, median measured level in g/L	29.97			
Ni, median measured level in mg/L	10.62	24.00	19.58	5.50
Pb, median measured level in mg/L	0.30	14.10	21.01	41.30
U, median measured level in mg/L	0.02	76.55	0.37	0.69
Ra-226, median level	0.32 pCi/L	7,260 pCi/kg	342.5 pCi/kg	61.5 pCi/kg
Th-230, median level	0.26 pCi/L	4,750 pCi/kg	909 pCi/kg	190 pCi/kg

* To convert lbs./acre to kg./hectare, multiply the lbs./acre by 1.12.
Source: Oklahoma State Department of Health, 1985.

The Rabbit Hill farm is a commercial hay and livestock enterprise. The result of the fertilizer program at Rabbit Hill was that good hay yields were obtained, and grazing performance on the pastures was superb. Ground-water quality was very good, and no buildup of any trace elements or radionuclides was found in the soil or vegetation (Coleman, 1985).

G.3.7 Remer Tract

Kerr-McGee added a 30.4-hectare (75-acre) tract east of the 885-acre tract to the fertilization program in 1984. This property, known as the Remer tract, was included as part of the 885-acre tract for operations. Tract monitoring consisted of soil and forage analysis. Fertilizer application methods were similar to those previously described for other areas. Deficiencies in plant food elements were supplied in response to soil tests. The average quantity and quality of fertilizers and aglime applied to the Remer tract between 1984 and 1986 are shown in Table G-7.

Table G-7 Average Yearly Quantity and Analysis of Fertilizers Applied to Remer Property From 1984 to 1986

Material	SFC-N	P_2O_5	K_2O	Aglime
SFC-N (Nitrogen) - lbs./acre*	256.00			
P_2O_5 - (0-45-0) - lbs./acre*		20.00		
K_2O - (0-0-22-20) - lbs./acre*			38.33	
Aglime - lbs./acre*				666.67
Chemical Analysis	**SFC-N**	**P_2O_5**	**K_2O**	**Aglime**
As, median measured level in mg/L	1.15	32.50	43.00	32.75
B, median measured level in mg/L	1.25	39.91	27.50	28.10
Ba, median measured level in mg/L	0.34	20.58	2.25	29.50
Cd, median measured level in mg/L	0.07	17.30	9.18	10.65
Cu, median measured level in mg/L	5.89	27.60	12.00	2.33
Mo, median measured level in mg/L	12.37	14.00	5.50	7.50
N, median measured level in g/L	27.53			
Ni, median measured level in mg/L	9.98	23.50	8.50	3.98
Pb, median measured level in mg/L	0.33	13.75	4.00	41.25
U, median measured level in mg/L	0.03	94.75	0.60	0.20
Ra-226, median level	0.378 pCi/L	13,490 pCi/kg	81.5 pCi/kg	56.5 pCi/kg
Th-230, median level	0.213 pCi/L	66,800 pCi/kg	80 pCi/kg	202 pCi/kg

* To convert lbs./acre to kg./hectare, multiply the lbs./acre by 1.12.
Source: Oklahoma State Department of Health, 1985.

All farming practices such as fertilizer and aglime application procedures and timing, hay harvesting, and cattle grazing management described earlier were followed on the Remer tract. Kerr-McGee collected and analyzed both pre-season and post-season soil samples for each of the three years. These analyses were used to determine fertilizer application recommendations and monitor for metal and radionuclide concentration. No buildup of any of the parameters was noted (Tucker, 1995).

Hay produced on the tract underwent comprehensive analytical testing. All concentrations of trace elements and radionuclides were low (i.e., many below detectable limits) and well within established limits for livestock feed. This tract has responded to the fertilizer program as predicted. Hay growth and yields have been good and equivalent to hay production from similar soils in eastern Oklahoma using similar forage management and fertilizer programs. No problems were encountered with hay quality or buildup of any deleterious substances (Tucker, 1995).

G.3.8 Georges Fork Ranch Field Monitoring

Kerr-McGee added the 3,100-hectare (7,660-acre) Georges Fork Ranch to its fertilizer application program in 1986. Georges Fork Ranch is southwest of the Rabbit Hill area, and Kerr-McGee owned and operated it as a commercial cattle production facility. Stocker cattle were grazed from fall until early summer, and excess summer forage was harvested for high-quality hay. Summer hay was fed to the cattle in the winter or sold.

As with the other acreage treated with SFC-N fertilizer, Kerr-McGee sampled the soil prior to treatment to determine background levels and recommended fertilizer applications. The Oklahoma State University Agronomic Services Laboratory provided recommended application guidelines for nitrogen, phosphorous, and potassium fertilizer and aglime. Five representative pastures in the 3,100 hectares (7,660 acres) were selected for intensive monitoring. One pasture was used as a "control" pasture and treated with commercial ammonium nitrate in lieu of the SFC-N ammonium nitrate fertilizer.

Extensive monitoring of ground water, surface water, soil, and forage from 1986 through 1993 showed increased forage production and no adverse impacts from the SFC-N fertilizer. Table G-8 shows the average annual application rate of fertilizers and aglime as well as the mean chemical analysis of the material applied to the Georges Fork Ranch between 1986 and 1993. Results of these analyses demonstrate findings similar to all of the earlier fertilizer assessments—SFC-N can be used in place of commercial ammonium nitrate fertilizer without adversely impacting the soil, water, vegetation, or grazing livestock (SFC, 1994).

Table G-8 Average Yearly Quantity and Analysis of Fertilizers Applied to Georges Fork From 1986 to 1993

Material	SFC-N	P_2O_5	K_2O	Aglime
SFC-N (Nitrogen) - lbs./acre*	345.5			
P_2O_5 - (0-45-0) - lbs./acre*		60		
K_2O - (0-0-22-20) - lbs./acre*			80	
Aglime - lbs./acre*				3,000
Chemical Analysis	**SFC-N**	**P_2O_5**	**K_2O**	**Aglime**
As, median measured level in mg/L	0.83	550.00	0.60	5.50
B, median measured level in mg/L	1.65	1.20	21.00	1.20
Ba, median measured level in mg/L	0.26	46.50	1.20	1.00
Cd, median measured level in mg/L	0.05	4.40	0.30	1.00
Cu, median measured level in mg/L	6.53	4.65	5.80	1.00
Mo, median measured level in mg/L	8.30	10.50	5.00	1.00
N, median measured level in g/L	21.50			
Ni, median measured level in mg/L	14.00	11.50	11.00	3.50
Pb, median measured level in mg/L	0.15	12.50	0.01	2.50
U, median measured level in mg/L	0.01	71.00	0.64	0.31
Ra-226, median level	0.345 pCi/L	12,750 pCi/kg	680 pCi/kg	0.08 pCi/kg
Th-230, median level	0.036 pCi/L	82,000 pCi/kg	140 pCi/kg	0.16 pCi/kg

* To convert lbs./acre to kg./hectare, multiply the lbs./acre by 1.12.
Source: Oklahoma State Department of Health, 1985.

G.3.9 EPA Review

In 1995, the EPA reviewed SFC test data and performed independent confirmatory sampling of the soil, ground water, surface water, and forage in the areas treated with SFC-N (PRC, 1997). The 1995 EPA sampling data indicated that the application of SFC-N fertilizer did not affect the soil, ground water, or surface water within the fertilizer application areas or surrounding offsite farmland.

It was assumed that, if the SFC-N fertilizer had affected the soil, various metal concentrations would be elevated in most, if not all, of the soil samples. However, all of the observed metal concentrations were either within or only slightly above the RFI (RCRA Facility Investigation) upper prediction intervals. The data indicate that the presence of these metals in a few area samples was not caused by the application of SFC-N fertilizer, but rather was the result of naturally occurring metal constituents in the soil (PRC, 1997).

Most of the ground-water samples from monitoring wells showed nitrogen levels well below the 10 mg/L limit for human consumption. However, two monitoring wells (MR-1 and MR-4) at Georges Fork Ranch have continually reported concentrations of nitrate above the 10 mg/L limit. One well, MR-1, is in the control plot for Georges Fork Ranch and has never received SFC-N fertilizer. The source of the high-nitrate concentration in these wells was never clearly established.

Surface-water samples were collected from ponds on the 270-Acre tract, Rabbit Hill, and Georges Fork Ranch and analyzed for hazardous metals and nitrate. None of the samples contained concentrations above livestock standards (PRC, 1997).

Increased crop yields demonstrate the viability of SFC-N as a nitrogen fertilizer. However, the data also indicate that SFC-N contains trace element impurities—particularly copper, nickel, and molybdenum. Trace element concentrations in forage produced using SFC-N fertilizer were compared to livestock dietary standards. The comparison indicates that molybdenum was the most critical of the three trace elements because its concentration in the SFC-N was about equal to the dietary standard. Therefore, molybdenum might accumulate in the forage at concentrations that exceed recommended dietary standards. The EPA recommends a maximum soil concentration of 5 mg/L for molybdenum, which is estimated to limit plant concentration to less than 10 mg/L.

Forage analyses from 1993 showed several pastures with molybdenum levels above the acceptable 10 mg/L. The highest concentration of 24.0 mg/L was found in the Agland application area on the west side of the SFC site. However, when these pastures were re-sampled in 1995, the results did not confirm the high concentrations of molybdenum. A review of the data indicates that molybdenum could be a problem but no conclusive evidence could be found to demonstrate a buildup of molybdenum in the soil or forage crops. (Tucker, 1995)

G.3.10 Summary of Fertilizer Program

Since 1973, the SFC produced ammonium nitrate solution from waste nitric acid used in the uranium purification process. The nitric acid was treated with anhydrous ammonia and barium nitrate to raise its pH and precipitate out trace element impurities. The result was SFC-N that was applied, as nitrogen fertilizer, to lands used to produce forage crops.

While the NRC never licensed the spreading of the SFC-N, nor did they have any regulatory interest in the land used for the fertilizer program (Hickey, 1998), the NRC, Oklahoma State University, and the EPA monitored the program and reviewed the results of chemical and radiological analyses of the fertilizer, soil, ground water, surface water, forage crops, and grazing livestock. While a few of the individual test reports showed unusually high concentrations of certain heavy metals, re-sampling of the same area did not reproduce similar concentration levels, and the high readings were considered a sampling error or sample contamination. The vast majority of the studies show no adverse impact from the SFC-N. In fact, chemical analysis of the SFC-N showed it to contain fewer impurities than commercial ammonium nitrate.

The overall conclusion of the studies and reports found no adverse environmental impact from the use of SFC-N when compared to commercial ammonium nitrate fertilizer. Chemical and radiological analysis of soils, waters, plants, and animals from the treated areas showed material levels that were statistically identical to similar samples from untreated areas (OSDH, 1985).

G.3.11 References

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10. SUPPLEMENTARY NOTES

11. ABSTRACT *(200 words or less)*

Sequoyah Fuels Corporation (SFC) is proposing to conduct reclamation activities at its 243-hectare (600-acre) former uranium conversion site in Gore, Oklahoma. SFC proposes to consolidate contaminated sludges and soils, demolish existing site structures, and construct an engineered, above-grade, on-site disposal cell for the permanent disposal of all site contaminated materials. SFC also has submitted to the NRC a groundwater corrective action plan for the purposes of recovering and treating site groundwater contaminated by prior site operations, with the goal of reducing concentrations of identified hazardous constituents to the NRC-approved concentration limits for each constituent.

This Draft Environmental Impact Statement (DEIS) was prepared in compliance with the National Environmental Policy Act (NEPA) of 1969 and NRC regulations for implementing the Act found at Title 10, "Energy," of the U.S. Code of Federal Regulations (CFR), Part 51 (10 CFR Part 51). This DEIS evaluates the potential environmental impacts of the proposed action and its reasonable alternatives. This DEIS also describes the environment potentially affected by SFC's proposed site reclamation activities, presents and compares the potential environmental impacts resulting from the proposed action and its alternatives, and describes SFC's environmental monitoring program and mitigation measures.

12. KEY WORDS/DESCRIPTORS *(List words or phrases that will assist researchers in locating the report.)*

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