SEQUOYAH FUELS
A GENERAL ATOMICS COMPANY

February 23, 1994 RE: 9420-E

AIRBORNE EXPRESS

Mr. Mike Hebert (6H-CX)
RCRA Enforcement Branch
U. S. Environmental Protection Agency
1445 Ross Avenue, Suite 1200
Dallas, TX. 75202-2733

RE: Sequoyah Fuels Corporation
Preliminary Report
RCRA U3008(h) Administrative Order on Consent
U. S. EPA Docket No. VI-005-(h)93-H
EPA I. D. No. OKD051961183

Dear Mr. Hebert:

Enclosed are three (3) copies of the final Preliminary Report: Description of Current Conditions and Investigations (CCI) which incorporates SFC's response to your comments received in a letter of January 24, 1994. Attached to this letter is a summary of our response to each of your comments. SFC is submitting the fourth copy of our required submittal under the AOC directly to the NRC to fulfill an SFC commitment to that agency.

Please be aware that SFC is not resubmitting copies of reports which accompanied the rough draft of the Preliminary Report submitted to your office on November 1, 1993. Those reports included the "Facility Environmental Investigation Findings Report," the "Addendum Facility Environmental Investigation Findings Report," and the "Preliminary Plan for Completion of Decommissioning". However, each of those reports is considered to be a part of the final Preliminary Report.

I have also provided a copy of the final CCI to Damon Wingfield of the Oklahoma Department of Environmental Quality. We look forward to receiving EPA approval of this document. Please let me know if there is any further clarification or changes which you would like to discuss prior to your approval.

Sincerely,

Tom Blachly
Project Coordinator

cc: Damon Wingfield, ODEQ

Attachment

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ATTACHMENT

SFC Response to EPA Comments

Preliminary Report: Current Conditions and Investigations

Section 1.1, Paragraph 2, Page 1-1

- In reference to the RCRA Administrative Order on Consent, please include a reference to the particular authority under which the Order was issued [i.e. U 3008(h)]. This reference should be included after the reference to RCRA.

Response: SFC agrees with this comment and has made the requested changes.

Section 1.5.2, Page 1-5

- The first sentence of this section indicates that corrective measures will be developed for contaminated soils and ground water following completion of the RFI. As stated in the Order, the intent of the RFI is to determine the nature and extent of all releases from the Facility (i.e. releases to all media). This section shall be revised to indicate that alternatives will be developed for all effected media.

  The second sentence of this section shall be revised to indicate "...alternatives for **known** contaminated areas...".

Response: SFC agrees with both comments and has made the requested changes.

Section 1.5.2.1, Page 1-5

- The term "Site" has been used in this section but has not been previously defined. SFC shall indicate the definition of this term or shall delete it from the text.

Response: A new section, Section 1.6, and figure, Figure 1-1, have been added which define terms used in the report when referring to land owned by SFC.

Section 1.5.2.1, Page 1-6

- Under the section entitled "excavate and isolate off-site", it is assumed that the word "disposal" has been inadvertently omitted between the words off-site and location.

Response: SFC agrees with the comment and has made the appropriate change.

Section 1.5.3, Page 1-8

- The term "Site" has been used in this section but has not been previously defined. SFC shall indicate the definition of this term or shall delete it from the text.

Response: See response to Section 1.5.2.1, Page 1-5, above.

- It is not clear how the "site criteria" listed relates to requirements of the Order regarding the formulation of corrective measures. SFC shall clarify this discrepancy by relating these criteria to those necessary to determine if corrective measures are needed.

Response: The listed "site criteria" were provided to fulfill requirements in Section C which requires an identification of site criteria that will influence the selection of corrective measure technologies. As is explained in Section 1.5.3 prior to the list, additional studies during the RFI may be necessary to further understand the specified criteria to allow for an informed and correct decision for remediating the facility media. The relationship of the list to requirements within the Order has been made clearer by addition of a title to that list which recognizes the criteria's role.

Section 2.1.1, Page 2-1

- The term "Site" has been used in this section but has not been previously defined. SFC shall indicate the definition of this term or shall delete it from the text.

Response: See response to Section 1.5.2.1, Page 1-5, above.

Section 2.1.2, Page 2-1

- This section describes the location of the SFC facility. Appendix B, Table B-1, indicates that Figure 1 of the Facility Environmental Investigation (FEI) Report depicts the required items listed in Task I.A.1.b. This figure does not clearly indicate the owners of all adjacent property. SFC shall revise this referenced figure to clearly indicate the owners of all adjacent property ~~owners~~. This revised figure shall be included within the CCI.

Response: SFC agrees with this comment and has produced a new figure, Figure 2-3, which is included in the CCI and indicates all adjacent property owners to SFC.

Section 2.1.3.1, Page 2-4

- This section indicates the Carlile House was situated initially on the SFC facility. SFC shall indicate the approximate initial location of the Carlile House on the SFC facility.

Response: The information about the Carlile House was found to be partially in error and has been corrected. The error was that the Carlile house is not a public attraction and did not serve as the way station but rather the Stage Coach Way Station served as such and is located as stated in the report. The way station is reported to have been located south of and near the southwest corner of Pond 2.

Section 2.1.3.2, Page 2-4

- This section should properly reference the Kerr-McGee Corporation.

Response: SFC has made the requested change.

Section 2.1.3.5, Page 2-11

- Under the section regarding EPA actions, SFC shall include within the text regarding the Administrative Order on Consent a reference to **RCRA U3008(h)**.

Response: SFC agrees with this comment and has made appropriate changes.

Section 4.3.1, Page 4-17

- This section states that the extent of the uranium contamination in the ground water within the shale/terrace and deep sandstone systems has fully been defined. Is this statement supported by an official regulatory decision regarding the above definition? If not, SFC shall revise this statement to accurately reflect the status of the contamination in question.

Response: SFC was reporting an opinion rather than quoting a regulatory decision. The language in the referenced section has been changed as follows to accommodate EPA's comment:

> The uranium was ~~fully defined~~ investigated in the shallow shale/terrace and deep sandstone/shale groundwater ~~at the Sequoyah Facility and~~ with no uranium ~~is known~~ found to have migrated ~~through the groundwater~~ beyond the site boundary.

Section 4.3.2, Page 4-19

- This section states that the extent of the uranium contamination in the soils at the facility has fully been defined. Is this statement supported by an official regulatory decision regarding the above definition? If not, SFC shall revise this statement to accurately reflect the status of the contamination in question.

Response: SFC was reporting an opinion rather than quoting a regulatory decision. The language is the referenced section has been changed as follows to accommodate EPA's comment and to report results of the investigation:

> The uranium was ~~fully defined~~ investigated with respect to area and depth. Soils impacted with uranium were generally those within a few feet (5 or less) of the surface with little, if any, found to have penetrated to deeper zones.

Section 4.3.5, Section f, Page 4-29

- SFC shall indicate the date that Pond 2 was taken out of service.

Response: The approximate date the Pond 2 was taken out of service was added to the "Present Status" section, as well as the date when the impoundment was "closed" or emptied until such time it is decommissioned under the NRC.

Appendix B, Table B-1, Page B-2

- Table B-1 indicates that Figure 3 of the FEI contains the items listed in Task I.A.1.c. Should this be "Drawing 3" instead of Figure 3? SFC shall correct this notation if necessary.

Response: Table B-1 should have indicated "Drawing 3" rather than "Figure 3" when referencing the FEI. The table has been corrected.

- Three subtasks (i.e. A.1.h, B.1.b, and B.1.d) do not reference any documents. As stated in the Appendix II, page 7, of the Order, SFC shall provide a written response or a reference to existing documentation which addresses the requested information. SFC shall provide the above information (i.e. response or reference) as it pertains to the three subtasks mentioned above.

Response: Subtask A.1.h requests a map showing land use surrounding the site. Since no such map existed at the writing of the Preliminary Report SFC provided a narrative description of land use in a 10-mile radius surrounding the site in Section 3.6.2. The section does contain a table (Table 3-9) which summarizes local land use. In response to EPA's comment a map showing land use immediately surrounding the site has been produced and is designated as Figure 3-8 in the CCI. Table B-1 has been changed to reflect the inclusion of this table within the CCI.

Subtasks B.1.b and B.1.d are preceded with language that indicates EPA was requesting that "existing" information be included in the CCI. SFC had not compiled such information at the time the Preliminary Report was written and therefore no information was submitted, which was shown as a blank in Table B-1. Table B-1 has been changed to reflect the information does not exist. [Note: This information was later compiled and included with the RFI Workplan.]

<u>Other Changes by SFC to Correct or Improve Draft CCI</u>

1. A list of of figures and tables were added to the Table of Contents.

2. The figure numbers in Section 3 have been corrected so the first figure is designated Figure 3-1 rather than Figure 3-5.

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1.0 Introduction

1.1 Background

In February 1993, Sequoyah Fuels Corporation (SFC) notified the Nuclear Regulatory Commission (NRC) of its decision to terminate activities authorized by its source materials license and requested termination of that license. At the same time, SFC submitted a preliminary plan for completion of decommissioning (PPCD) of the SFC Facility (Ref. 1). The PPCD included a commitment to develop a plan to characterize the extent and concentration of contamination at the SFC Facility.

On August 3, 1993, the Environmental Protection Agency issued a Resource Conservation and Recovery Act (RCRA) Administrative Order on Consent (AOC) under its authority authorized in Section 3008(h) of the RCRA to SFC (Ref. 2). The AOC included a requirement for SFC to perform a RCRA Facility Investigation (RFI). "The purpose of [the RFI] is to determine the nature and extent of releases of hazardous waste or constituents ... at the Facility and to gather all necessary data to support [corrective measures]" (Ref. 2).

1.2 Purpose

An early step in completion of the decommissioning effort at SFC is to gain a comprehensive understanding of the existing extent and concentration of radiological and non-radiological contamination. This effort is best accomplished through the development and implementation of a site characterization plan. The site characterization will provide information required to develop a decommissioning and remediation strategy which incorporates remediation of constituent releases as necessary to meet objective regulatory criteria. Implementation of this strategy will allow completion of the AOC requirements and termination of the NRC license.

1.3 Objectives

The objectives of SFC's site characterization are consistent with those stated by the NRC in its draft branch technical position regarding site characterization (Ref. 3) and the EPA in the Corrective Action Plan portion of its AOC issued to SFC (Ref. 2). In summary, the main objectives of SFC's site characterization effort are:

1. To quantify the physical and chemical characteristics of contamination and the extent of contaminant distribution, including the rate(s) and direction(s) of migration.

2. To quantify environmental parameters that significantly affect residual environmental risks following final stabilization, decontamination and remediation activity.

3. To provide that information necessary to support evaluation of alternative decommissioning and remediation actions and to allow detailed planning of the preferred approach(es) for decommissioning and remediation.

1.4 Scope

This report provides existing background information pertinent to the SFC Facility. Regional location, boundaries, physical features (e.g., topography, geology, climate, ...), and historical use of the facility with respect to production and waste handling are summarized. Existing information on the nature and extent of contamination is also included.

Throughout the course of operation of the SFC Facility, many reports have been developed that describe the environmental conditions at the facility. The more significant of these are listed in the Reference section of this report. The most recent and comprehensive of these is the Facility Environmental Investigation (FEI) implemented by SFC in the Fall of 1990 and concluded in the summer of 1991 (Ref. 4). The FEI was designed to identify and investigate locations at the SFC Facility where past or present[1] operations could have resulted in the release of licensed[2] and other chemical material to the environment.

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[1] "Present" refers to the time period during which the FEI was implemented.

[2] "Licensed material" refers to radiological material which SFC is authorized to possess under Source Material License SUB-1010, Docket No. 40-8027 issued by the Nuclear Regulatory Commission under the Atomic Energy Act.

SFC conducted additional investigations in 1991. The results were published as an addendum to the FEI (Addendum) in May 1992 (Ref. 5). The Addendum summarized the additional investigations and assessed the information in relationship to the findings of the original FEI. As applicable, information from the FEI and Addendum is summarized and/or referenced in this report.

Other information is also available regarding characterization of the SFC Facility. In responding to questions in relation to the NRC's environmental assessment of the SFC Facility in 1992, SFC obtained and analyzed a substantial amount of information regarding the hydrogeology, geology, meteorology, climatology, demography, and operation of the site (Ref. 6). As applicable, this information is also summarized in this report.

A subsequent report will describe SFC's strategy, rationale, methods, and schedule for completing a site characterization that satisfies the objectives described above in Section 1.3.

1.5 Pre-Investigation Evaluation of Corrective Measure Technologies

1.5.1 Site Criteria

A number of site criteria will influence decisions pertaining to corrective measures. Those site specific criteria have either already been determined in previous studies or will be determined during completion of the RCRA Facility Investigation. Site criteria deemed important in the decision-making process will be discussed in the RFI Workplan prior to its initiation. This will assure that all necessary site criteria have been determined upon completion of the investigation when corrective measure alternatives are evaluated.

1.5.2 Corrective Measures

Corrective measures alternatives will be developed for contaminated media following completion of the RFI. The preliminary assessment of those corrective measure alternatives for known contaminated areas at SFC includes the following:

1.5.2.1 Soils

Soils have been impacted with releases from processing areas and surface impoundments as discussed elsewhere in this Preliminary Report. Releases have resulted in elevated levels of certain radiological and non-radiological constituents in facility soils, as discussed elsewhere in this report. These constituents include those of concern to the NRC, and also those of concern to the EPA that may be related to management of hazardous wastes or hazardous waste constituents. As to the latter, releases of arsenic to soils have been identified as possible candidates for corrective action. Potential corrective measure technologies for arsenic and radiological materials are very similar for the most part. These include:

> stabilize in situ - the ability of soils within the industrial area to cause the contaminants to adsorb to soil particles and not be released to groundwater or surface water or to become airborne will be determined. Active stabilization may

require the addition of certain chemicals, (eg. lime) which would cause contaminants to become more stabilized than natural processes allow.

excavate and isolate on-site - those soils in locations containing unacceptable contaminant levels could be physically removed from their present location and placed into a more acceptable location on or near the SFC site. This may require construction of an engineered containment cell which is lined with clays and/or synthetic material.

excavate and isolate off-site - if a suitable location or design cannot be found on-site, those soils discussed above could be transported to an approved off-site disposal location.

ex situ treatment - contaminated soils can be excavated and washed by mixing with certain solutions, (eg. acids) which strip the contaminant from the soil and allow the soils to be placed back in their original or alternate location. This method would require the treatment and disposal of the stripping solution through an approved plan.

in situ treatment - for more porous soils the contaminant can sometimes be stripped without soil excavation, i.e, inject or percolate the solution and provide a means of solution recovery such as a recovery trench or well. As above, the stripping solution must be treated and disposed.

1.5.2.2 Groundwater

As discussed elsewhere in this report, certain groundwater areas of the site exhibit elevated levels of uranium and arsenic. In addition, a limited number of organic chemicals have been detected in a few groundwater monitoring wells at the site. A number of options that may be considered for remediation of contaminants in groundwater include:

<u>pump and treat</u> - the effectiveness of this remediation alternative will depend primarily on the hydrogeology and the geological interaction between the contaminant and site soils. If the site provides too low of a yield by pumping, because of low permeability in the saturated formation, the contamination removal could be restricted to a relative small area around the recovery well. The system may be enhanced by incorporating injection wells surrounding the recovery well to create a flow net which increases the recovery rate.

<u>in situ treatment</u> - this would involve injecting a solution into the saturated zone which would cause the contaminant to become less mobile through precipitation or adsorbtion.

intercept migration - construction of a recovery trench downgradient of contamination areas would allow the contamination to seep into the trench where it could be removed and disposed. Also, construction of an impermeable barrier downgradient of the contamination, such as a slurry trench, would prevent migration of the contaminant past the barrier structure.

groundwater monitoring - a monitoring program could be designed to determine that contamination does not threaten public water supplies, and allow remediation if unacceptable concentrations of constituents released from the site were determined to develop in SFC monitoring wells upgradient of the water supply.

1.5.3 Additional Studies

Each soil and groundwater corrective measure alternative utilizes specific site criteria to determine their effectiveness. Information obtained during the RFI and Site Characterization studies will develop an understanding of the following areas to assist in the evaluation of alternative corrective measures. Additional studies to understand the site criteria listed below, coupled with certain present and future land and groundwater usage will allow a determination whether corrective measures are required, and if so, which such measures are most suited to the remedial objectives for the Site.

Site Criteria Influencing Selection of Corrective Measures Technologies

A. Physical Processes

1) Geology

2) Hydrology

3) Climate and Weather

4) Surface Activity

B. Chemical Processes

1) Chemical Identification

2) Chemical Species Identification

3) Adsorption Potential

4) Mobility Potential

1.6 Site Terms

The Administrative Order on Consent (AOC) under Section 3008(h) of RCRA was issued to Sequoyah Fuels Corporation (SFC) by EPA under Section 3008(h) of RCRA. The AOC identifies SFC as the owner/operator of the Sequoyah Fuels Corporation facility, Highway 10, Gore, Oklahoma, and defines this facility for purposes of the AOC as the "Facility."

As used in this Preliminary Report, the term "Site" is synonymous with the term "Facility" as used in the AOC. Both terms refer to the approximately 688 contiguous acres of land owned by SFC located adjacent to Highway 10 in Gore, Oklahoma.[3] SFC conducted uranium processing operations on a portion of these 688 acres. These processing operations took place in an 85-acre portion of the property. In addition to this 85-acre process area, SFC has managed stormwater and by-product materials on additional portions of its 688 acres of land. These additional management areas and the 85 acre process area are referred to collectively in this report and other documents as the "industrial area." The industrial area, which is the area to be decommissioned in accordance with NRC requirements, encompasses approximately 200 acres of the 688 acre Site. Figure 1-1 shows the various areas defined above.

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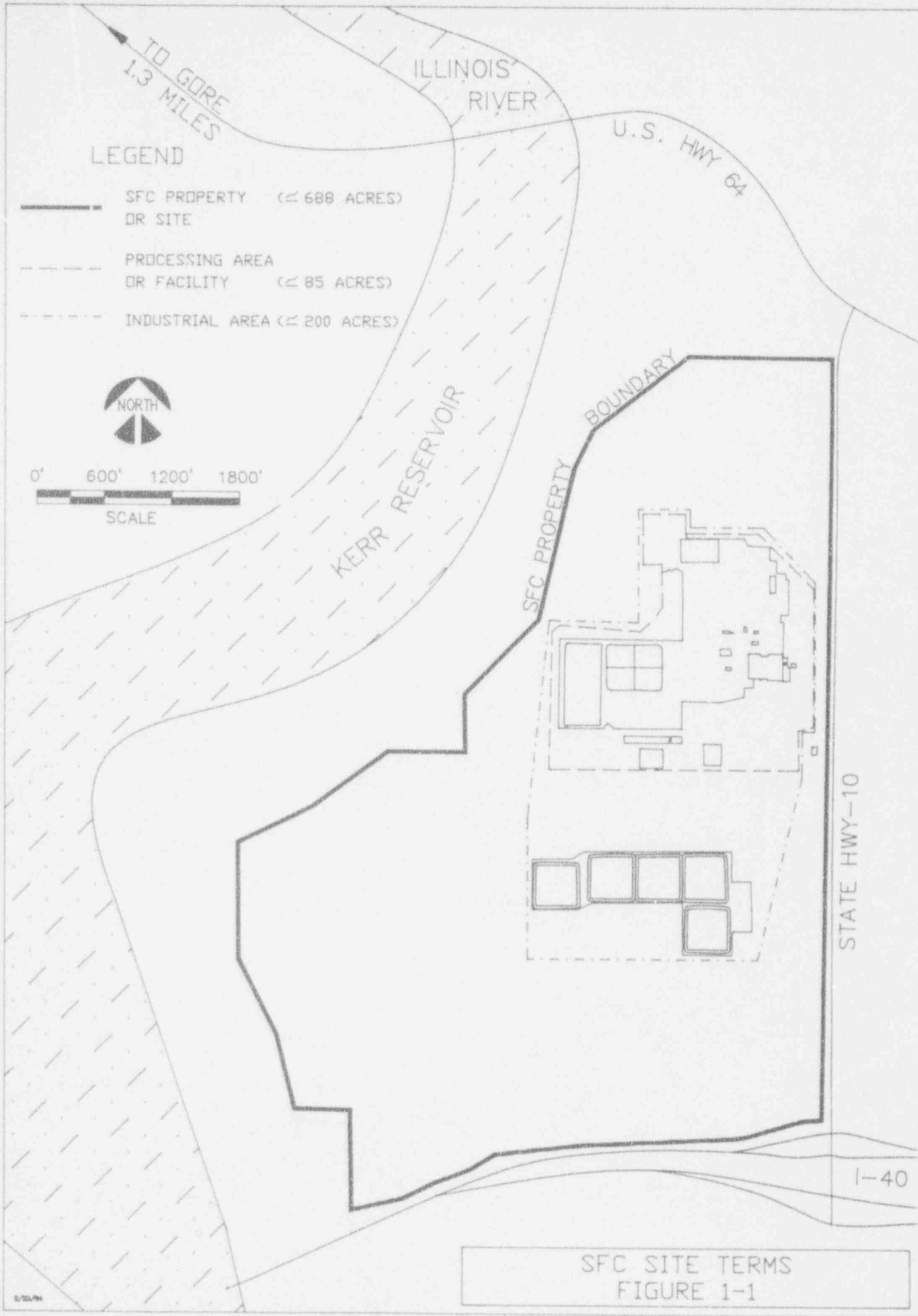
[3] These terms may be used differently in documents submitted to the U.S. Nuclear Regulatory Commission.



SFC SITE TERMS
FIGURE 1-1

2.0 General Information

2.1 Site Background

2.1.1 Site Ownership

Sequoyah Fuels Corporation (SFC) is a wholly-owned subsidiary of Sequoyah Fuels International Corporation, which is a wholly-owned subsidiary of Sequoyah Holding - owned subsidiary of General Atomic Technologies Corporation. SFC is incorporated in the state of Delaware (Ref. 7). SFC owns the Gore, Oklahoma facility and site.

2.1.2 Site Location

The SFC Facility is located in Sequoyah County in mideastern Oklahoma at 95° 5' west longitude and 35° 30' north latitude, about 150 miles east of Oklahoma City, Oklahoma, 40 miles west of Fort Smith, Arkansas, 25 miles southeast of Muskogee, Oklahoma, and 2.5 miles southeast of Gore, Oklahoma. The Facility is located in Section 21 of Township 12 North, Range 21 East, and consists of a total of 85 acres bounded on the north by private property and on the south by the State of Oklahoma Transportation Department Interstate 40 (I-40) and on the west by U.S. Government-owned land managed by the U.S. Army Corps of Engineers along the Illinois and Arkansas River tributaries of the Robert S. Kerr Reservoir. The eastern boundary of the Facility is Oklahoma State Highway 10. Access to the Facility is via State Highway 10, adjacent to the east site fence. The Facility is on gently rolling terrain at approximate elevation 570 feet M.S.L. The SFC Site is comprised of about 250 acres surrounding the Facility. The

SFC Site is bordered on the north, east, and south by land owned by Sequoyah Fuels International Corporation (Ref. 7).

The principal office of SFC is located at the Sequoyah Facility, I-40 and Highway 10 (Post Office Box 610), Gore, Oklahoma 74435. Figure 2-1 shows the general location of the SFC Facility with respect to major points of reference. A recent aerial photograph of the SFC Facility may be found in Reference 8. Figure 2-2 depicts the layout of the SFC Facility.

Prior to ceasing production operations, SFC conducted processing activities in an 85 acre portion of its property. The conversion of uranium ore concentrate into uranium hexafluoride (UF_6) was conducted in the Main Process Building, the Miscellaneous Digestion Building, and the Solvent Extraction Building. The reduction of depleted uranium hexafluoride to depleted uranium tetrafluoride (UF_4) was conducted in the UF_6 Reduction Plant. Feed material for the UF_6 Conversion Plant was stored on the yellowcake storage pad southwest of the Main Process Building. Liquid byproduct processing was conducted primarily in the clarifiers, settling basins, and the raffinate treatment area west of the yellowcake storage pad. Feed material for the UF_6 Reduction Plant is stored on a pad south and west of that facility. UF_6 cylinders are stored on the cylinder storage pad north of the Main Process Building, and UF_4 product is stored on the storage pad west of and inside of the UF_6 Reduction Plant. Solid waste processing (sorting and compacting clean and contaminated trash) during the active production period at the Facility was conducted primarily in the Solid Waste Building northwest of the Main Process Building. Analytical work to support process control and developmental activities was conducted in the Process Laboratory, which is part of the Main Process Building (Ref. 7).

As noted earlier, production operations ceased earlier this year. While materials used in or produced by the process are being removed from the Site by sale or transfer to others, certain materials are still stored at the SFC Facility pending suitable arrangements for disposition. Feed material for the former UF_6 Reduction Plant is stored on a pad south and west of the plant building. UF_6 cylinders containing small quantities of UF_6 are stored on the cylinder storage pad north of the Main Process Building, and UF_4 product is stored on the storage pad west of and inside the UF_6 Reduction Plant. Liquid byproduct materials, raffinate and raffinate sludge remain in the clarifiers located west of the former production buildings. Solid waste processing associated with the decommissioning process is conducted primarily in the Solid Waste Building northwest of the Main Processing Building.

2.1.3 Site History

2.1.3.1 Historic Significance

The National Register of Historic Places (Federal Register 48(41): 8626-8679, March 1, 1983, and prior annual listings) lists a number of historic places in Sequoyah County and in nearby Haskell and Muskogee Counties. The Tamaha Jail and Ferry

Landing in Haskell County are within about 10 miles of the SFC Facility. The historic places in Sequoyah County are Sequoyah's Cabin, about 25 miles east of the plant site; Dwight Mission, about 17 miles northeast of the plant site; and Parris Mound in Sallisaw, about 17 miles east-southeast of the site. The National Registry of Natural Landmarks has no listings for Haskell, Muskogee, or Sequoyah Counties (Federal Register 48 (41): 8682-8704, March 1, 1983).

The State of Oklahoma Historical Society lists Talonteeskee, the western capital of the Cherokee Nation which was located in the area from 1829 to 1839, as a location of interest. Dwight Mission was established in the area in 1821, and served the Cherokees until after the Civil War. A stagecoach way station, initially on the facility site, served stagecoaches running between Fort Smith, Arkansas and Fort Gibson, Oklahoma. The way station has been moved to a location on U.S. Route 64, near State Route 10, where it is preserved as a public attraction (Ref. 14).

2.1.3.2 NRC License History

License SUB-1010, Docket No. 40-8027 was originally issued to Kerr-McGee Corporation on October 14, 1969, for storage only of uranium ore concentrate. The license was amended on February 20, 1970, authorizing Kerr-McGee Corporation to operate a Uranium Hexafluoride (UF_6) Conversion Plant. The license was amended on February 25, 1987, to authorize operation of the UF_6 Reduction Plant. The license was last renewed on September 20, 1985, and would have expired on September 30, 1990.

The license has remained in effect, pursuant to 10 CFR 40.43, based on timely submittal of a renewal application dated August 29, 1990, and revised September 30, 1992. On February 16, 1993, and July 7, 1993, pursuant to 10 CFR 40.42, SFC notified the NRC of its intent to terminate licensed activities at the SFC Facility and requested termination of License SUB-1010.

2.1.3.3 Other Licenses and Permits

SFC currently maintains the following additional environmental-related licenses and permits:

a. U. S. Environmental Protection Agency, National Pollutant Discharge Elimination System Permit No. OK0000191.

b. U. S. Nuclear Regulatory Commission, Byproduct Materials License No. 35-12636-03.

c. Oklahoma Department of Environmental Quality, Air Quality Permits No. 78-012-0 (UF_6 Conversion Plant) and No. 86-015-0 (UF_6 Reduction Plant).

d. Oklahoma Department of Environmental Quality, Waste Disposal Permit No. WD-75-074.

e. U. S. Environmental Protection Agency, Hazardous Waste Generator I. D. No. OKD051961183.

2.1.3.4 Environmental Studies/Events

This section provides a summary of studies that have been performed to evaluate the impacts of SFC operations on the terrestrial and aquatic life surrounding the Site.

Several reports have been published containing information about the effect of SFC operations. While not all of the reports were specifically directed toward terrestrial and aquatic life, the conclusion drawn from them, individually and collectively, is that SFC operations have had little, if any, effect on terrestrial or aquatic life at the Site. The relevant reports are listed here:

a. Dorris, T. C. and G. L. Russell. 1980. Benthic macroinvertebrate fauna of the Illinois River below Tenkiller Reservoir adjacent to the effluent outfall of the Sequoyah Facility, Kerr-McGee Corporation, Gore, Oklahoma, October, 1978 to December, 1979, Oklahoma State University.

b. Russell, Geoff. 1982. Benthic macroinvertebrate fauna of the Robert S. Kerr Reservoir below Lake Tenkiller adjacent to the effluent outfall of the Sequoyah UF_6 facility, Kerr-McGee Corporation, Gore, Oklahoma, October, 1980 to December, 1981, Oklahoma State University.

c. Russell, Geoff. 1983. Benthic macroinvertebrate monitoring program for 1982 in the Illinois River adjacent to the effluent outfall of the Sequoyah facility.

d. Nuclear Regulatory Commission. 1985. Environmental Assessment for renewal of Special [sic] Nuclear Material License No. SUB-1010: Sequoyah Fuels Corporation. NUREG-1157.

e. Tucker, B. B. 1988. Sequoyah Fuels Corporation fertilizer development program, 1973-1986. Publication No. A-88-5. Oklahoma State University.

f. Sequoyah Fuels Corporation. 1992. Applicant's Environmental Report, Revision 1, for Sequoyah Fuels Corporation. Docket No. 40-8027. Source Material License No. SUB-1010.

g. Nuclear Regulatory Commission. 1986. Assessment of the public health impact from the accidental release of UF_6 at the Sequoyah Fuels Corporation facility at Gore, Oklahoma. NUREG-1189, Vol. 1.

The following subsections summarize the results of the aforementioned studies.

Surface Water Fauna

Benthic invertebrates were studied in the Illinois River for three years (Russell, 1980, 1982, 1983). The study reported that the benthic community in the Robert S. Kerr Reservoir at the point where SFC's effluent enters the water body has as many or more species, a higher diversity index and fewer number of individuals than either upstream or downstream locations. The study concluded that the Sequoyah Fuels discharge of effluent has no detrimental effect on the benthic community.

1986 UF_6 Release

In an NRC report concerning the health effects of the 1986 UF_6 release (NUREG-1189), some consideration was given to environmental effects. The report concludes that the radiation exposure from this incident was so small that no acute health effects were expected and the risk of chronic effects to a maximally exposed individual were imperceptible. It was also concluded that uranium concentrations added to offsite soil as a result of the incident are insignificant compared to background.

Effects of chemicals released during the 1986 incident are also small. Although no acute effects on foraging animals from increased fluoride in vegetation were observed, the NRC predicted that such an affect could have occurred. However, since fluoride is not accumulated in plants from the soil to any great extent, there would be no chronic effects.

Order for Information

On October 7, 1988, the EPA issued an Order for Information requiring biomonitoring testing of Outfall 001 (Combination Stream) under NPDES Permit No. OK0000191. The order was effective April 10, 1989. The order required four biomonitoring tests to determine discharge toxicity on a monthly basis over 12 consecutive months.

- Chronic static renewal 7-day (1) survival and (2) reproduction test using *Ceriodaphnia dubia* (Method 1002.0).

- Chronic static renewal 7-day (3) survival and (4) growth test using fathead minnow *(Pimephales promelas)* (Method 1000.0).

SFC responded to the order by initiating a biomonitoring study using specific EPA guidelines and an independent laboratory to perform the tests. Testing was performed monthly at five effluent concentrations: 100 percent, 87 percent, 77 percent, 30 percent, 1 percent, and 0 percent, with 87 percent being one-half low-flow dilution (twice critical dilution) and 77 percent being low-flow dilution (critical dilution). Samples of effluent were flow-weighted, 24-hour composite samples.

For the purpose of this biomonitoring requirement, chronic toxicity was defined as a statistically significant difference (at the 95 percent confidence level) between the test organisms exposed to the control and to a 77 percent effluent concentration. At this concentration of effluent, results were statistically identical to the control group, with no observable effects, indicating organisms survived, had normal growth rates, and reproduced normally at 100 percent effluent concentration (except for *Ceriodaphnia dubia* for the August biomonitoring test which exhibited an 80% survival at 100% effluent at 7th day).

EPA's conclusion was that each of the four tests showed no acute or chronic toxicity to test organisms exposed to the critical and twice critical dilutions of the effluent discharges from the SFC facility. At these dilutions, there were no observed effects on the test organisms.

Fertilizer Program

The fertilizer program has been extensively monitored and reported (See Tucker Report, 1988) in several studies carried out over a 14-year period. Over the course of these studies, data were obtained for loading rates and accumulation of trace elements and radionuclides from 204 study plots, 26 monitoring wells, and 12 retention reservoirs. Soil samples were collected from each plot at least twice per year, forage samples were collected from each forage harvest (average 3 per year), and tissue samples were collected from cattle raised on the forage in 1979 for trace element and radionuclide analysis, histopathology, and toxicology.

The fertilizer solution (SFC-N) used in the program had lower concentrations of trace elements than commercially available nitrogen fertilizer, with the exception of copper, nickel and molybdenum. The contributions of trace elements from SFC-N to the soil and forage were small in relation to inputs from other necessary fertilizers and soil amendments.

The Tucker Report concluded that cattle raised on forage treated with SFC-N showed greater weight gain than control animals and no difference in toxic response, histopathology, or trace metal content than control animals. No increases in concentration of trace metals or radionuclides over background soils, surface waters, or groundwaters could be attributed to the use of SFC-N fertilizer.

2.1.3.5 Enforcement Actions

This section provides a summary of recent regulatory enforcement actions brought against SFC. Only those enforcement actions involving major incidents or pertaining to assessment of environmental contamination are included.

U.S. Environmental Protection Agency (EPA)

On August 3, 1993 the EPA issued an Administrative Order on Consent (AOC) to SFC under authority authorized in § 3008(h) of the Resource Conservation and Recovery Act (RCRA) (Ref. 2). The order stemmed from alleged violations of hazardous waste accumulation time limits in the federal RCRA regulations (adopted by reference by Oklahoma). The order reflects EPA's concern of possible environmental contamination due to SFC's generation of hazardous waste. The mutual objectives of this order are to ensure that corrective action activities will be designed and implemented by SFC in order to protect human health and the environment. In meeting these objectives SFC will perform (1) Interim Measures at the facility to mitigate potential threats to human health or the environment, (2) RCRA facility investigation to determine fully the nature and extent of any release of hazardous waste or hazardous constituents, (3) Corrective Measure Study to identify and evaluate alternatives for corrective action necessary to prevent or control any type of hazardous material and any other information that would support the selection of corrective measures, (4) Corrective Measure Implementation implementing the corrective measure or measures selected, if any, by EPA for the facility. SFC consented to the order and is in the process of fulfilling its respective requirements.

In April, 1989 the EPA issued an order for SFC to perform sampling and analysis programs in support of SFC's NPDES permit. The results of the sampling are described above in the section titled "Studies."

<u>Oklahoma State Department of Health (OSDH)</u>

On May 15 and 16, 1991, the OSDH performed a compliance evaluation inspection of SFC to determine compliance with the Oklahoma Controlled Industrial Waste Disposal Act and the Rules and Regulations for Industrial Waste Management. A notice of violation was issued as a result of several areas of non-compliance. The five (5) violations cited were for incorrect source generation quantity, improper classification of hazardous wastes, improper labeling of hazardous wastes, exceeding time allowed for on-site storage of hazardous wastes, and drums containing hazardous waste left with open vents. SFC corrected the conditions that led to the violations.

U.S. Nuclear Regulatory Commission (NRC)

The NRC issued an Order Modifying License (OML) on September 19, 1990, requiring SFC to obtain information and develop characterization investigations regarding the uranium-bearing liquid which was present under the Main Process Building (MPB). The OML contained six specific actions, five of which required investigation and prevention of further releases of licensed material from the MPB. The sixth action required SFC to develop a Facility Environmental Investigation (FEI) Work Plan to identify and characterize other locations on SFC property where past or present operations could have resulted in releases of licensed material to the environment. A written FEI Work Plan proposed comprehensive environmental investigation activities. The findings of all six specific activities are included in reports issued in 1991 (Refs. 5 and 4).

The NRC issued an Order Modifying License and Demand for Information (OML/DFI) on October 3, 1991. The OML/DFI included the stipulation that SFC should not operate the Sequoyah Facility to produce Uranium Hexafluoride (UF_6) or Depleted Uranium Tetrafluoride (DUF_4) following its upcoming shutdown (scheduled to begin on September 23, 1991) until SFC submitted and obtained NRC approval or the plan and schedule to review the adequacy of the Health & Safety and Environmental Programs, and the qualifications of the individuals from outside SFC performing the review. The purpose of the review was to assure that the procedures provided clear instructions, were current, and were technically adequate, such that the intent of the procedure would be met.

Relating to the Environmental Program, the scope of the review included:

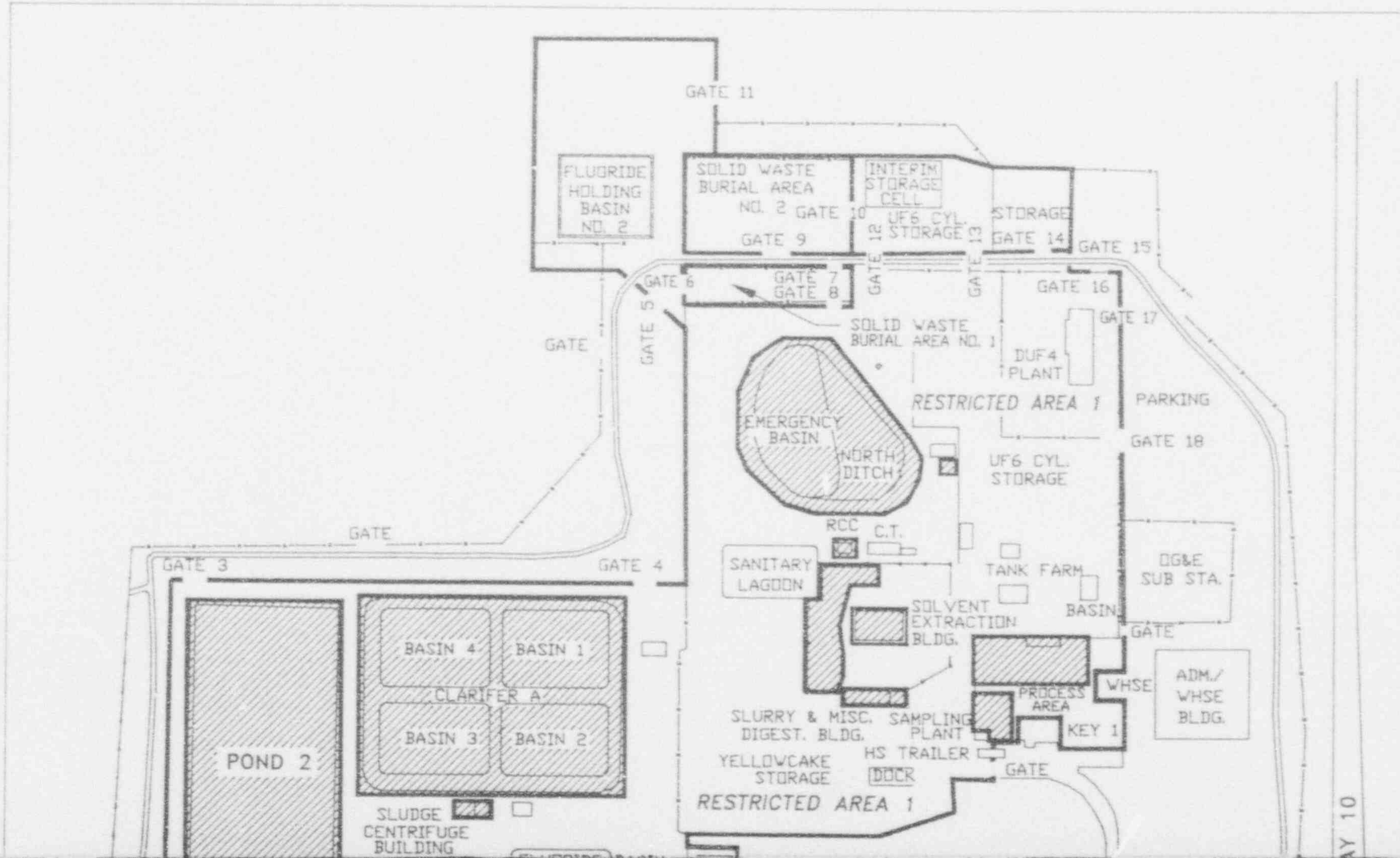
- Measures to maintain releases of licensed material to the restricted and unrestricted area As-Low-As-Reasonably-Achievable.

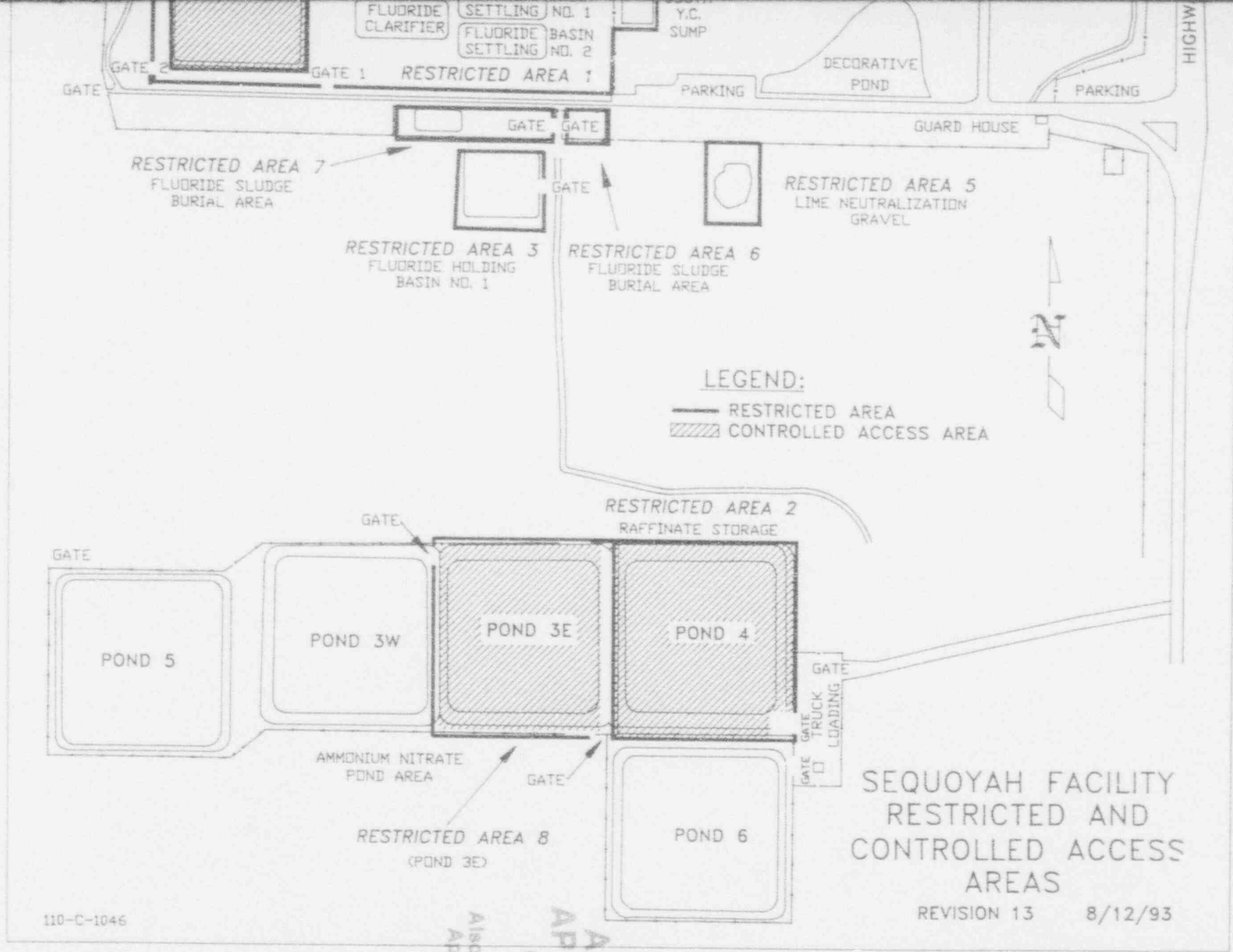
- Measures for sampling of groundwater monitor wells, analysis of samples, and evaluating the adequacy of the groundwater monitoring program.


Red Bird
Gibson
Okay
Porter
Clarksville
Tullahassee
Haskell
Wybark
Hyde Pa
Muskogee
Jamesville
Taft
Beland
Brushy Mtn
Summit
Boynton
Eram
MUSKOGE
Wainwright
Keefeton
McLain
Oktaha
Council Hill
3RD STANDARD PARALLEL
Hitchita
Rentiesville
Warner
Checotah
Dunigan Mtn
Onapa
Stidham
Fame
Texanna Mtn
Texanna
Porum
INTOSH
Vivian
Briartow
Eufaula
Hoyt
Raiford
EUFAULA
Mellette
Enterprise
LAKE
Canadian
HA
Russellville
Lewisville
Quinton
Crowder
Featherston
Tucker Knob
Blocker
Shoe Mtn

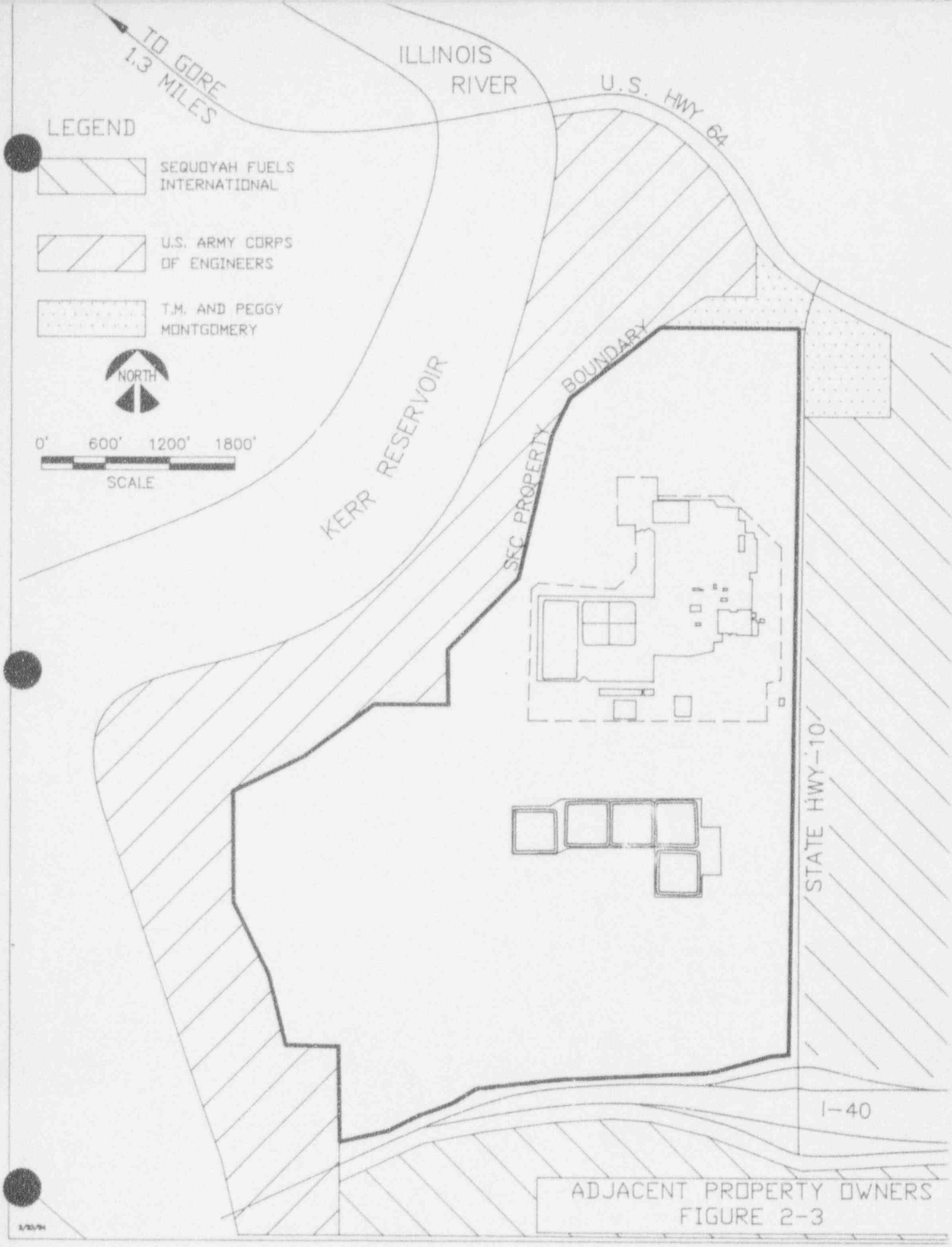
SEQUOYAH FUELS CORPORATION
CURRENT CONDITIONS REPORT
FIGURE 2-1
SEQUOYAH FACILITY
GENERAL LOCATION

9403110053-01


GATE 11
FLUORIDE HOLDING BASIN NO. 2
SOLID WASTE BURIAL AREA NO. 2
INTERIM STORAGE CELL
GATE 10
UF6 CYL. STORAGE
STORAGE
GATE 9
GATE 12
GATE 13
GATE 14
GATE 15
GATE 6
GATE 7
GATE 8
GATE 16
GATE 17
GATE 5
GATE
SOLID WASTE BURIAL AREA NO. 1
DUF4 PLANT
RESTRICTED AREA 1
PARKING
EMERGENCY BASIN
NORTH DITCH
GATE 18
UF6 CYL. STORAGE
GATE
RCC
C.T.
GATE 3
GATE 4
SANITARY LAGOON
TANK FARM
OG&E SUB STA.
SOLVENT EXTRACTION BLDG.
BASIN
GATE
BASIN 4
BASIN 1
CLARIFER A
BASIN 3
BASIN 2
WHSE
ADM./ WHSE BLDG.
PROCESS AREA
POND 2
SLURRY & MISC. DIGEST. BLDG.
SAMPLING PLANT
KEY 1
HS TRAILER
YELLOWCAKE STORAGE
DOCK
GATE
RESTRICTED AREA 1
SLUDGE CENTRIFUGE BUILDING



SEQUOYAH FUELS CORPORATION
CURRENT CONDITIONS REPORT
FIGURE 2-2
SEQUOYAH FACILITY
GENERAL LAYOUT



ADJACENT PROPERTY OWNERS
FIGURE 2-3

3.0 Physical Characteristics of the Site

3.1 Surface Features

The SFC Site is situated on gently rolling to level land, most of which is open field. Elevations on or near the Site range from 460 feet AMSL for the normal pool elevation of the Robert S. Kerr Reservoir to 700 feet on top of a hill southeast of the site. Slopes over most of the upland areas of the Site are less than 7%. Steeper slopes in creek ravines and on hillsides average roughly 28%. Most of the land surrounding the Site is used for forage production in conjunction with the SFC fertilizer application program (Ref. 4).

Major surface features of the Facility and surrounding areas are depicted in Figure 5 of the FEI (Ref. 4).

3.2 Climatology and Meteorology

3.2.1 Climatology

Sequoyah County has a warm, temperate, continental climate. Storms bring ample precipitation when moisture-laden air from the Gulf of Mexico meets cooler, drier air from the western and northern regions. The most variable weather occurs in the spring, when local storms can be severe and bring large amounts of precipitation. The mean annual temperature is 61.5° F. The monthly average ranges from 40° F in January to 82° F in July. The average daily range in temperature is 24° F. The lowest temperature on record was -19° F in January, 1930, and the highest was 115° F in August, 1936. The mean annual precipitation ranges from 42.9 inches in the town of Sallisaw, to approximately 44.1 inches in the northeastern part of Sequoyah County. The seasonal distribution of rainfall is fairly even, with 31% in Spring, 26% in summer, 23% in fall and 20% in winter. The average amount of snowfall from November through April is about 5.2 inches (Ref. 13). Lake evaporation averages about 47.5 inches annually. Of this, 72% occurs from May through October. Based on the precipitation and lake evaporation values, there is a net annual evaporation rate of about four inches in the area of the SFC Facility (Ref. 4).

3.2.2 Winds, Tornadoes, and Storms

The most severe storms occur in the Spring, although thunderstorms are also frequent during the summer months. Strong winds, heavy precipitation, and intense lightning may be associated with these storms. Severe hailstorms are rare and only five damaging hailstorms were recorded in a 42-year period in Sequoyah County. Tornadoes touch down in Sequoyah County on the average of once every six years. During a 92-year period, 25 tornadoes were recorded in the county, with roughly 80% of them occurring from April through June. The probability of any particular point in Sequoyah county being hit by a tornado is 1.66 x 10-3 (the equivalent of once every 600 years) (Ref. 9).

3.2.3 Meteorology

There is no national weather station in the immediate vicinity. Meteorological data may be obtained from the national weather station at Tulsa, Oklahoma, about 70 miles northwest and at Fort Smith, Arkansas, about 40 miles east. Fort Smith, Arkansas is the closest first-order data station having similar topographic and climatological characteristics as the facility site (Ref. 9).

Five-year composite STAR data sets were generated from data collected at Tulsa, Oklahoma, from January 1986 through December 1990 and from Fort Smith, Arkansas, from January 1984 through December 1988 (Ref. 6). The five-year STAR data for Tulsa and Fort Smith are shown in Tables 3-1 and 3-2. The Tulsa data shows a predominant north-south wind flow pattern. The wind blows generally from the south approximately 50 percent of the time. Northerly winds are observed nearly 27 percent of the time. The Fort Smith data shows a predominant east-west wind pattern. The wind blows from the east more than 47 percent of the time and from the west approximately 23 percent of the time.

The 90-degree difference in wind flow patterns appear to be due primarily to terrain influences. Surface wind flow patterns generally tend to follow the topography of a region. Tulsa is located in a relatively flat region between the Arkansas and Verdigris Rivers. Both rivers flow in a general north to south direction in the vicinity of Tulsa. The nearest terrain feature to the Tulsa airport, which is 650 feet above mean sea level (msl), is a mountain located approximately 6.5 miles to the northwest and rising approximately 885 feet above msl and is aligned in a north-south direction. Therefore, the surface winds are generally north and south.

Fort Smith is located in the Ozark Mountains region along the Arkansas River. There are a number of mountains and ridges in the vicinity of Fort Smith. These terrain features are all aligned in a general east-west pattern. Backbone Mountain is a long ridge-shaped feature located about 7 miles south of the airport with a maximum elevation of approximately 885 feet above msl. The Arkansas River also influences the region. In the vicinity of Fort Smith the river flows in a meandering west-to-east direction. Therefore, the surface winds are generally east and west.

The Sequoyah Facility is located near the confluence of the Illinois and Arkansas Rivers at the western edge of the Ozark Mountains region. The land to the west of the facility is flat, however there are numerous terrain features in the other directions. There are several small mountains to the south and southwest of the facility and the terrain rises and falls sharply in the vicinity of the Sequoyah National Wildlife Refuge which is just to the southeast of Sequoyah Fuels. The Arkansas River flows in a northwest to southeast direction in this region. A limited amount of meteorological data has been collected at the Sequoyah Facility. This data, which has not undergone the rigorous quality assurance/quality control required for dispersion modeling purposes, indicates that the wind at the site is primarily from the southeast. However, during the winter, cold fronts may bring winds from the north or northwest.

Based on the terrain influences, the meteorological data from Fort Smith would be more appropriate for use in modeling the Sequoyah Fuels facility. In addition, Fort Smith is closer to the facility than is Tulsa.

Finally, a review of the STAR data sets shows that the Fort Smith data has a higher percentage of stable atmospheric conditions than the Tulsa data. Stable atmospheric conditions usually result in higher modeled concentration, and therefore, provide a more conservative estimate of impacts of airborne emissions from the facility.

Table 3-1							
Ft. Smith STAR Data							
DIRECTION	ATMOSPHERIC STABILITY CLASS	WIND SPEED (M/S)					
		1 - 2	2 - 3	3 - 5	5 - 8	8 - 10	> 10
N	A	0.00021	0.00046	0.00000	0.00000	0.00000	0.00000
NNE	A	0.00009	0.00018	0.00000	0.00000	0.00000	0.00000
NE	A	0.00031	0.00043	0.00000	0.00000	0.00000	0.00000
ENE	A	0.00027	0.00073	0.00000	0.00000	0.00000	0.00000
E	A	0.00053	0.00107	0.00000	0.00000	0.00000	0.00000
ESE	A	0.00026	0.00089	0.00000	0.00000	0.00000	0.00000
SE	A	0.00025	0.00041	0.00000	0.00000	0.00000	0.00000
SSE	A	0.00019	0.00046	0.00000	0.00000	0.00000	0.00000
S	A	0.00025	0.00059	0.00000	0.00000	0.00000	0.00000
SSW	A	0.00021	0.00059	0.00000	0.00000	0.00000	0.00000
SW	A	0.00026	0.00041	0.00000	0.00000	0.00000	0.00000
WSW	A	0.00030	0.00055	0.00000	0.00000	0.00000	0.00000
W	A	0.00032	0.00059	0.00000	0.00000	0.00000	0.00000
WNW	A	0.00020	0.00039	0.00000	0.00000	0.00000	0.00000
NW	A	0.00015	0.00025	0.00000	0.00000	0.00000	0.00000
NNW	A	0.00009	0.00023	0.00000	0.00000	0.00000	0.00000
N	B	0.00082	0.00171	0.00089	0.00000	0.00000	0.00000
NNE	B	0.00063	0.00114	0.00082	0.00000	0.00000	0.00000
NE	B	0.00113	0.00201	0.00107	0.00000	0.00000	0.00000
ENE	B	0.00179	0.00415	0.00224	0.00000	0.00000	0.00000
E	B	0.00290	0.00664	0.00499	0.00000	0.00000	0.00000
ESE	B	0.00161	0.00333	0.00183	0.00000	0.00000	0.00000
SE	B	0.00081	0.00151	0.00148	0.00000	0.00000	0.00000
SSE	B	0.00097	0.00130	0.00094	0.00000	0.00000	0.00000
S	B	0.00111	0.00214	0.00196	0.00000	0.00000	0.00000
SSW	B	0.00078	0.00210	0.00192	0.00000	0.00000	0.00000
SW	B	0.00062	0.00183	0.00212	0.00000	0.00000	0.00000
WSW	B	0.00095	0.00203	0.00183	0.00000	0.00000	0.00000
W	B	0.00085	0.00260	0.00242	0.00000	0.00000	0.00000
WNW	B	0.00060	0.00139	0.00114	0.00000	0.00000	0.00000
NW	B	0.00050	0.00135	0.00078	0.00000	0.00000	0.00000
NNW	B	0.00037	0.00066	0.00050	0.00000	0.00000	0.00000
N	C	0.00013	0.00128	0.00310	0.00100	0.00005	0.00000
NNE	C	0.00024	0.00098	0.00098	0.00009	0.00000	0.00000
NE	C	0.00033	0.00203	0.00224	0.00018	0.00000	0.00000

Table 3-1							
Ft. Smith STAR Data							
DIRECTION	ATMOSPHERIC STABILITY CLASS	WIND SPEED (M/S)					
		1 - 2	2 - 3	3 - 5	5 - 8	8 - 10	> 10
ENE	C	0.00090	0.00727	0.00725	0.00064	0.00000	0.00000
E	C	0.00122	0.00894	0.01505	0.00155	0.00002	0.00000
ESE	C	0.00046	0.00306	0.00550	0.00062	0.00000	0.00000
SE	C	0.00034	0.00164	0.00212	0.00025	0.00000	0.00000
SSE	C	0.00020	0.00107	0.00228	0.00039	0.00000	0.00000
S	C	0.00026	0.00178	0.00367	0.00128	0.00002	0.00000
SSW	C	0.00024	0.00128	0.00461	0.00141	0.00002	0.00000
SW	C	0.00027	0.00160	0.00518	0.00221	0.00002	0.00002
WSW	C	0.00036	0.00201	0.00461	0.00123	0.00005	0.00002
W	C	0.00044	0.00290	0.00675	0.00141	0.00005	0.00000
WNW	C	0.00023	0.00128	0.00386	0.00078	0.00007	0.00000
NW	C	0.00022	0.00110	0.00255	0.00064	0.00009	0.00000
NNW	C	0.00017	0.00064	0.00169	0.00030	0.00000	0.00000
N	D	0.00100	0.00367	0.01020	0.01464	0.00153	0.00014
NNE	D	0.00078	0.00276	0.00502	0.00379	0.00046	0.00007
NE	D	0.00146	0.00490	0.00547	0.00189	0.00014	0.00000
ENE	D	0.00247	0.01102	0.01357	0.00417	0.00007	0.00002
E	D	0.00388	0.01759	0.04092	0.02182	0.00103	0.00005
ESE	D	0.00169	0.00680	0.01163	0.00657	0.00027	0.00005
SE	D	0.00094	0.00388	0.00504	0.00265	0.00005	0.00000
SSE	D	0.00080	0.00260	0.00354	0.00201	0.00009	0.00000
S	D	0.00130	0.00376	0.00648	0.00486	0.00021	0.00000
SSW	D	0.00068	0.00203	0.00481	0.00607	0.00041	0.00005
SW	D	0.00057	0.00226	0.00486	0.00994	0.00153	0.00018
WSW	D	0.00085	0.00331	0.00566	0.00591	0.00075	0.00021
W	D	0.00092	0.00470	0.01134	0.01286	0.00173	0.00071
WNW	D	0.00058	0.00267	0.00851	0.01355	0.00283	0.00043
NW	D	0.00039	0.00194	0.00650	0.01111	0.00144	0.00018
NNW	D	0.00036	0.00148	0.00527	0.00734	0.00078	0.00016
N	E	0.00000	0.00212	0.00568	0.00000	0.00000	0.00000
NNE	E	0.00000	0.00221	0.00205	0.00000	0.00000	0.00000
NE	E	0.00000	0.00490	0.00116	0.00000	0.00000	0.00000
ENE	E	0.00000	0.01291	0.00411	0.00000	0.00000	0.00000
E	E	0.00000	0.01667	0.01006	0.00000	0.00000	0.00000
ESE	E	0.00000	0.00609	0.00160	0.00000	0.00000	0.00000

Table 3-1							
Ft. Smith STAR Data							
DIRECTION	ATMOSPHERIC STABILITY CLASS	WIND SPEED (M/S)					
		1 - 2	2 - 3	3 - 5	5 - 8	8 - 10	> 10
SE	E	0.00000	0.00365	0.00082	0.00000	0.00000	0.00000
SSE	E	0.00000	0.00169	0.00062	0.00000	0.00000	0.00000
S	E	0.00000	0.00317	0.00169	0.00000	0.00000	0.00000
SSW	E	0.00000	0.00185	0.00160	0.00000	0.00000	0.00000
SW	E	0.00000	0.00224	0.00210	0.00000	0.00000	0.00000
WSW	E	0.00000	0.00292	0.00260	0.00000	0.00000	0.00000
W	E	0.00000	0.00372	0.00967	0.00000	0.00000	0.00000
WNW	E	0.00000	0.00144	0.00541	0.00000	0.00000	0.00000
NW	E	0.00000	0.00084	0.00379	0.00000	0.00000	0.00000
NNW	E	0.00000	0.00080	0.00274	0.00000	0.00000	0.00000
N	F	0.00322	0.00360	0.00000	0.00000	0.00000	0.00000
NNE	F	0.00443	0.00417	0.00000	0.00000	0.00000	0.00000
NE	F	0.01360	0.01197	0.00000	0.00000	0.00000	0.00000
ENE	F	0.02845	0.03166	0.00000	0.00000	0.00000	0.00000
E	F	0.02872	0.03031	0.00000	0.00000	0.00000	0.00000
ESE	F	0.01126	0.00718	0.00000	0.00000	0.00000	0.00000
SE	F	0.00540	0.00369	0.00000	0.00000	0.00000	0.00000
SSE	F	0.00418	0.00308	0.00000	0.00000	0.00000	0.00000
S	F	0.00601	0.00532	0.00000	0.00000	0.00000	0.00000
SSW	F	0.00393	0.00383	0.00000	0.00000	0.00000	0.00000
SW	F	0.00528	0.00438	0.00000	0.00000	0.00000	0.00000
WSW	F	0.00684	0.00776	0.00000	0.00000	0.00000	0.00000
W	F	0.00805	0.01083	0.00000	0.00000	0.00000	0.00000
WNW	F	0.00215	0.00267	0.00000	0.00000	0.00000	0.00000
NW	F	0.00142	0.00171	0.00000	0.00000	0.00000	0.00000
NNW	F	0.00112	0.00119	0.00000	0.00000	0.00000	0.00000

Table 3-2							
Tulsa STAR Data							
DIRECTION	ATMOSPHERIC STABILITY CLASS	WIND SPEED (M/S)					
		1 - 2	2 - 3	3 - 5	5 - 8	8 - 10	> 10
N	A	0.00038	0.00032	0.00000	0.00000	0.00000	0.00000
NNE	A	0.00012	0.00014	0.00000	0.00000	0.00000	0.00000
NE	A	0.00019	0.00016	0.00000	0.00000	0.00000	0.00000
ENE	A	0.00017	0.00009	0.00000	0.00000	0.00000	0.00000
E	A	0.00040	0.00030	0.00000	0.00000	0.00000	0.00000
ESE	A	0.00031	0.00025	0.00000	0.00000	0.00000	0.00000
SE	A	0.00050	0.00041	0.00000	0.00000	0.00000	0.00000
SSE	A	0.00033	0.00032	0.00000	0.00000	0.00000	0.00000
S	A	0.00043	0.00048	0.00000	0.00000	0.00000	0.00000
SSW	A	0.00023	0.00021	0.00000	0.00000	0.00000	0.00000
SW	A	0.00031	0.00025	0.00000	0.00000	0.00000	0.00000
WSW	A	0.00012	0.00014	0.00000	0.00000	0.00000	0.00000
W	A	0.00036	0.00025	0.00000	0.00000	0.00000	0.00000
WNW	A	0.00025	0.00023	0.00000	0.00000	0.00000	0.00000
NW	A	0.00019	0.00007	0.00000	0.00000	0.00000	0.00000
NNW	A	0.00017	0.00009	0.00000	0.00000	0.00000	0.00000
N	B	0.00154	0.00217	0.00135	0.00000	0.00000	0.00000
NNE	B	0.00068	0.00082	0.00055	0.00000	0.00000	0.00000
NE	B	0.00056	0.00128	0.00046	0.00000	0.00000	0.00000
ENE	B	0.00078	0.00100	0.00066	0.00000	0.00000	0.00000
E	B	0.00103	0.00162	0.00080	0.00000	0.00000	0.00000
ESE	B	0.00052	0.00071	0.00053	0.00000	0.00000	0.00000
SE	B	0.00079	0.00144	0.00098	0.00000	0.00000	0.00000
SSE	B	0.00085	0.00183	0.00148	0.00000	0.00000	0.00000
S	B	0.00152	0.00322	0.00313	0.00000	0.00000	0.00000
SSW	B	0.00091	0.00132	0.00110	0.00000	0.00000	0.00000
SW	B	0.00080	0.00121	0.00098	0.00000	0.00000	0.00000
WSW	B	0.00044	0.00084	0.00039	0.00000	0.00000	0.00000
W	B	0.00071	0.00082	0.00030	0.00000	0.00000	0.00000
WNW	B	0.00037	0.00055	0.00037	0.00000	0.00000	0.00000
NW	B	0.00078	0.00087	0.00055	0.00000	0.00000	0.00000
NNW	B	0.00049	0.00110	0.00071	0.00000	0.00000	0.00000
N	C	0.00047	0.00274	0.00546	0.00144	0.00007	0.00000
NNE	C	0.00020	0.00110	0.00288	0.00080	0.00007	0.00000
NE	C	0.00024	0.00121	0.00151	0.00046	0.00005	0.00000

Table 3-2							
Tulsa STAR Data							
DIRECTION	ATMOSPHERIC STABILITY CLASS	WIND SPEED (M/S)					
		1 - 2	2 - 3	3 - 5	5 - 8	8 - 10	> 10
ENE	C	0.00016	0.00073	0.00144	0.00018	0.00000	0.00000
E	C	0.00028	0.00135	0.00231	0.00032	0.00000	0.00000
ESE	C	0.00028	0.00107	0.00212	0.00032	0.00000	0.00000
SE	C	0.00023	0.00171	0.00338	0.00059	0.00005	0.00000
SSE	C	0.00041	0.00244	0.00744	0.00242	0.00041	0.00005
S	C	0.00072	0.00372	0.01313	0.00632	0.00164	0.00037
SSW	C	0.00024	0.00162	0.00493	0.00242	0.00048	0.00002
SW	C	0.00030	0.00123	0.00340	0.00142	0.00014	0.00000
WSW	C	0.00016	0.00096	0.00201	0.00053	0.00000	0.00005
W	C	0.00029	0.00137	0.00158	0.00034	0.00000	0.00000
WNW	C	0.00024	0.00119	0.00215	0.00046	0.00002	0.00000
NW	C	0.00030	0.00192	0.00201	0.00041	0.00002	0.00000
NNW	C	0.00038	0.00194	0.00336	0.00068	0.00007	0.00000
N	D	0.00197	0.00840	0.02374	0.03176	0.00701	0.00062
NNE	D	0.00064	0.00231	0.00842	0.01219	0.00203	0.00027
NE	D	0.00053	0.00242	0.00571	0.00390	0.00071	0.00016
ENE	D	0.00054	0.00267	0.00306	0.00128	0.00011	0.00002
E	D	0.00128	0.00479	0.00514	0.00189	0.00016	0.00002
ESE	D	0.00055	0.00297	0.00591	0.00269	0.00023	0.00000
SE	D	0.00076	0.00338	0.01244	0.01288	0.00194	0.00009
SSE	D	0.00085	0.00443	0.02333	0.03630	0.00801	0.00089
S	D	0.00124	0.00564	0.03025	0.07541	0.02557	0.00482
SSW	D	0.00030	0.00128	0.00543	0.01240	0.00388	0.00121
SW	D	0.00024	0.00144	0.00279	0.00459	0.00068	0.00021
WSW	D	0.00054	0.00155	0.00267	0.00283	0.00041	0.00016
W	D	0.00100	0.00263	0.00349	0.00374	0.00075	0.00007
WNW	D	0.00073	0.00258	0.00358	0.00406	0.00068	0.00005
NW	D	0.00111	0.00507	0.00616	0.00662	0.00064	0.00002
NNW	D	0.00125	0.00566	0.01023	0.01199	0.00160	0.00002
N	E	0.00000	0.00479	0.00740	0.00000	0.00000	0.00000
NNE	E	0.00000	0.00103	0.00240	0.00000	0.00000	0.00000
NE	E	0.00000	0.00171	0.00174	0.00000	0.00000	0.00000
ENE	E	0.00000	0.00176	0.00100	0.00000	0.00000	0.00000
E	E	0.00000	0.00317	0.00137	0.00000	0.00000	0.00000
ESE	E	0.00000	0.00290	0.00194	0.00000	0.00000	0.00000

Table 3-2

Tulsa STAR Data

DIRECTION	ATMOSPHERIC STABILITY CLASS	WIND SPEED (M/S)					
		1 - 2	2 - 3	3 - 5	5 - 8	8 - 10	> 10
SE	E	0.00000	0.00329	0.00854	0.00000	0.00000	0.00000
SSE	E	0.00000	0.00484	0.02112	0.00000	0.00000	0.00000
S	E	0.00000	0.00610	0.03872	0.00000	0.00000	0.00000
SSW	E	0.00000	0.00126	0.00502	0.00000	0.00000	0.00000
SW	E	0.00000	0.00084	0.00180	0.00000	0.00000	0.00000
WSW	E	0.00000	0.00100	0.00107	0.00000	0.00000	0.00000
W	E	0.00000	0.00176	0.00205	0.00000	0.00000	0.00000
WNW	E	0.00000	0.00153	0.00189	0.00000	0.00000	0.00000
NW	E	0.00000	0.00228	0.00279	0.00000	0.00000	0.00000
NNW	E	0.00000	0.00384	0.00345	0.00000	0.00000	0.00000
N	F	0.00654	0.01075	0.00000	0.00000	0.00000	0.00000
NNE	F	0.00123	0.00192	0.00000	0.00000	0.00000	0.00000
NE	F	0.00145	0.00201	0.00000	0.00000	0.00000	0.00000
ENE	F	0.00190	0.00260	0.00000	0.00000	0.00000	0.00000
E	F	0.00398	0.00603	0.00000	0.00000	0.00000	0.00000
ESE	F	0.00309	0.00377	0.00000	0.00000	0.00000	0.00000
SE	F	0.00348	0.00575	0.00000	0.00000	0.00000	0.00000
SSE	F	0.00652	0.01370	0.00000	0.00000	0.00000	0.00000
S	F	0.01082	0.02144	0.00000	0.00000	0.00000	0.00000
SSW	F	0.00191	0.00297	0.00000	0.00000	0.00000	0.00000
SW	F	0.00194	0.00297	0.00000	0.00000	0.00000	0.00000
WSW	F	0.00302	0.00393	0.00000	0.00000	0.00000	0.00000
W	F	0.00532	0.00626	0.00000	0.00000	0.00000	0.00000
WNW	F	0.00435	0.00578	0.00000	0.00000	0.00000	0.00000
NW	F	0.00679	0.00858	0.00000	0.00000	0.00000	0.00000
NNW	F	0.00620	0.00893	0.00000	0.00000	0.00000	0.00000

3.2.4 Air Quality

Oklahoma has adopted air quality standards that are very similar to the National Ambient Air Quality Standards.

The air quality in the counties surrounding the SFC Facility are classified as "better than national standards" for Total Suspended Particulates and SO2. For CO, NOx and Ozone, the air quality cannot be classified. Generally, this means that there are insufficient data to establish a classification under Environmental Protection Agency (EPA) regulations. (Ref. 9).

The information presented in Tables 3-3 and 3-4 represents SFC's significant non-radiological point source emissions, defined by the reporting requirements associated with the annual Oklahoma State Department of Health's (OSDH) Air Quality Service Point Source Emissions Inventory Report, for calendar years 1987 through 1991 (Ref. 6). Tables 3-3 and 3-4 represent operating conditions at the Facility as opposed to the current shutdown condition. The point source emissions are presented by source as an annual mass emission rate, and an annual average mass emission over the five reported years in units of tons per year (TPY). The corresponding stack exhaust gas temperatures, flow rates and physical parameters for each stack are presented in Table 3-3.

The information presented in Table 3-1 summarizes SFC's radiological air emissions. Semi-annual effluent reports are submitted to the Nuclear Regulatory Commission in accordance with the requirements of 10 CFR 40.65, "Effluent Monitoring Reporting Requirements." A summary of airborne effluent results submitted for the past 10 years (1983 - 1992) is provided in Table 3-5. Airborne effluents include releases from monitored stacks and vents at the facility. The activity of uranium-natural and volume of air released is indicated for each year. Airborne releases remained fairly constant during the period of monitoring summarized with some minor fluctuations from year to year.

Prior to November 1992, SFC operated the UF_6 Plant under OSDH Permit Number 78-012-0 which provides an opacity limitation along with the standard conditions for operating an air emissions source. SFC also operated the DUF_4 Plant under OSDH Permit Number 86-015-0 which provides monitoring requirements and permit limits for the Dust Collector and Molecular Sieve stacks.

The Main Plant Stack received emissions from four individual processes. These processes included the #1 and #2 Boilers, the HF Off-Gas Scrubber and the Reduction Off-Gas Burner. The flow rates are listed as individual source contributions during plant operation.

Table 3-3
Source Stack Physical Parameters
Sequoyah Fuels Corporation

Source	Associated Process	Temperature (°F)	Diameter (ft)	Height (ft)	Flow Rate (acfm)
Sampling Plant Dust Collector	Sampling Plant	Ambient	2.7	72	13,000
HF Off-Gas Scrubber	Fluorination/ Cold Traps/Cell Rooms/ Hydrofluorination	250	3.3	150	5,920
DUF_4 Plant Dust Collector	DUF_4 Plant	Ambient	2.0	71	7,600
Boiler #1	Utilities	250	3.3	150	10,660
Boiler #2	Utilities	250	3.3	150	10,660
Reduction Off-Gas Burner	Reduction	250	3.3	150	940
NOx Scrubber	Digestion/Boildown/ Denitration	90	1.5	70	3,000
Solvent Extraction Hexane Vents	Solvent Extraction	Information Not Available			
Main Plant Dust Collector	UF_6 Plant	Ambient	2.7	66	25,000
Cell Rework Dip Tank	Cell Rework	Ambient	2.5	43	15,900
Cell Rooms	Cell Rooms	Ambient	2.6	17	9,000

Note: HF Off-Gas Scrubber, Reduction Off-Gas Burner, Boiler #1 and Boiler #2 discharge to the Main Plant Stack; their individual flow contributions to the total flow is reflected.

Table 3-4
Point Source Non-Radiological Emissions
Sequoyah Fuels Corporation
1987 through 1991
(Tons/Year)

Inventory Year	1987	1988	1989	1990	1991(1)	Avg.
Total Particulate Matter, TPM						
Sampling Plant Dust Collector	0.002	0.003	0.006	0.010	0.003	0.005
HF Off-Gas Scrubber	0.040	0.040	0.053	0.060	0.070	0.053
DUF_4 Plant Dust Collector	--	0.001	0.001	0.009	0.001	0.003
Boiler #1	0.600	0.620	0.190	0.200	0.160	0.354
Boiler #2	0.620	0.620	0.190	0.180	0.180	0.358
Sulfur Dioxide, SO2						
Boiler #1	0.030	0.040	0.040	0.040	0.030	0.036
Boiler #2	0.030	0.040	0.040	0.040	0.040	0.038
Reduction Off-Gas Burner	25.0	30.6	22.1	22.7	17.5	23.6
Oxides of Nitrogen, NOx						
Boiler #1	3.75	3.69	2.18	9.40	7.62	5.33
Boiler #2	3.72	3.69	2.18	8.63	8.54	5.35
NOx Scrubber	1.70	1.96	1.96	3.45	2.75	2.36
Volatile Organic Compounds, VOC						
Boiler #1	0.120	0.190	0.340	0.190	0.150	0.198
Boiler #2	0.187	0.190	0.340	0.170	0.170	0.211
Carbon Monoxide, CO						
Boiler #1	1.07	1.05	1.28	2.35	1.90	1.53
Boiler #2	1.06	1.05	1.28	2.16	2.14	1.54
Hydrogen Fluoride, HF						
HF Off-Gas Scrubber	0.119	2.38	0.181	0.183	0.138	0.600
Fluoride, F(2)						
DUF_4 Plant Dust Collector	--	--	--	--	0.03	0.03
Main Plant Dust Collector	--	--	--	--	1.90	1.90
Cell Rework Dip Tank	--	--	--	--	0.90	0.90
Cell Rooms	--	--	--	--	0.07	0.07
Hexane(2)(3)						
Solvent Extraction Hexane Vents (4)	--	--	--	--	86.30	86.30

Note: (1) Values for 1991 reflect the period of reduced operations.
(2) Values were not reported on the annual point source emissions inventory reports for 1987-1990.
(3) Mass balance calculations were performed to estimate the hexane emissions. This estimate includes both stack and fugitive emissions.

TABLE 3-5
Summary of Radiological Air Emissions
1983-1992

Airborne Effluents		
Year	U-Nat Released (Ci)	Volume Released (liters)
1983	0.053	5.38E+12
1984	0.058	4.77E+12
1985	0.080	6.38E+12
1986	0.034	4.40E+12
1987	0.047	6.65E+12
1988	0.055	1.73E+13
1989	0.054	6.10E+12
1990	0.057	6.22E+12
1991	0.059	8.05E+12
1992	0.033	7.59E+12

3.3 Surface Water Hydrology

The Sequoyah Facility is located on the east bank of the headwaters of the Illinois River tributary of the Robert S. Kerr Reservoir approximately 2.5 miles south-southeast of Gore, Oklahoma. The Illinois River tributary flows in a southwesterly direction about 1 mile to join the Arkansas River tributary of the Robert S. Kerr Reservoir approximately 2 miles downstream from Webbers Falls, Oklahoma. The Illinois River in the vicinity of the Sequoyah site is part of the reservoir. The river flow is regulated by releases from Tenkiller Ferry Reservoir, which is located on the Illinois River approximately 7 miles upstream of the site. The average flow of the Illinois River near the site is 1600 ft^3/s (Ref. 9).

Because of the rugged nature of the watershed and the spring-fed streams in the area, the Illinois River carries less sediment than other major rivers entering the Arkansas River in Oklahoma. The Illinois River in the vicinity of the Sequoyah site has an average specific conductance of 170 microsiemen per centimeter (μS/cm) and a turbidity of 3 Jackson Turbidity Units (JTU). Downstream at the Robert S. Kerr Dam, the average values for these parameters are 600 μS/cm and 15 JTU. Water quality parameters of the Illinois River in the vicinity of the Site are shown in Table 3-6 (Ref. 9).

Table 3-6

Water Quality Parameters in the Illinois River in the Vicinity of the Site (Ref. 10).

	Illinois River [a,b]	Oklahoma Standards [c]
Flow (m^3/s)	20 - 145	Not Applicable
Temperature (° C)	6 - 19	Not Applicable
Total Suspended Solids	20	Not Applicable
Fluoride	0.1 - 0.3	1.6
Nitrate (as N)	0.2 - 3.9	10
pH (no units)	7.4 - 8.1	6.5 - 9.0
Alkalinity (CaCO3)	63 - 76	Not Applicable
Hardness (CaCO3)	7.3 - 10	88

* Units are mg/l unless otherwise noted.

[a] U.S. Geological Survey, Water Resources Data of Oklahoma, Vol. 1, Arkansas River Basin, U.S. Geological Survey Water Data Report OK-76-1.

[b] STORET, Water Quality Database, Environmental Protection Agency, 1980, 1981, 1982.

[c] Oklahoma's Water Quality Standards, 1988, Oklahoma Water Resources Board, Oklahoma City, OK.

In the vicinity of the Sequoyah Site, the Illinois River drains an area of 1620 square miles. The entire Facility drains to the headwaters of the Robert S. Kerr Reservoir (Illinois River tributary). The principal site drainage consists of the facility effluent, identified as the Combination Stream (Figure 2-2), and stormwater, which flows west in an unnamed tributary to the Robert S. Kerr Reservoir (Ref. 9).

Liquid effluent releases have decreased significantly, with the 1992 activity released being approximately one order of magnitude less than the activity released in 1983. The volume of liquids released have also decreased a by a factor of approximately 2.

3.4 Geology

3.4.1 Regional Geology

The SFC site is located on the southwest flank of the Ozark Uplift, a major tectonic feature extending from east-central Missouri to northwest Arkansas and northeast Oklahoma. The Arkoma Basin lies immediately to the south and southeast, while the Ouachita Mountains are about 50 miles south of the facility. The geology in the region consists of Quaternary-age alluvial and terrace deposits along and adjacent to the major rivers in the region. Bedrock formations present in the region consist of Pennsylvanian, Mississippian, Devonian, Silurian, and Ordovician-age shale, limestone, siltstone, and sandstone formations. The geologic formations regionally dip to the southwest at 2 to 3 degrees toward the Arkoma Basin. The bedrock formation present in the Sequoyah Facility area is the Pennsylvanian-age. A regional geological map showing the Sequoyah

Facility, an explanation for this map, and a regional stratigraphic column is presented in Figures 44, 45, and 46 of the FEI (Ref. 4). More specific information on regional geology of the SFC Facility may be found in Section 7.0 of the FEI (Ref. 4).

3.4.2 Site Specific Geology

The Sequoyah Facility is built upon a thin layer of Quaternary-age terrace deposits which are underlain by approximately 390 feet of the Pennsylvanian-age Atoka Formation. The Atoka Formation is underlain by the Pennsylvanian-age Wapanoka Limestone Formation. The regional dip in the site area is 2-3 degrees southwest into the Arkoma Basin.

The Atoka Formation is characterized by very irregularly bedded discontinuous units of sandstone, siltstone, and shale, with thin limestones in the lower part. Beneath the facility, the Atoka bedrock surface slopes toward the northwest, west, and south-southwest from its high point located in the Main Process Building (MPB) area. An area stratigraphic column is also shown for bedrock units present in the Arkoma Basin and adjacent areas as presented in Figure HYD 5-1 of Appendix A of this report. The following subsections summarize the site specific geology at the SFC Facility. A more thorough description of the site specific geology at the SFC Facility is presented in Section 7.0 of the FEI (Ref. 4).

3.4.2.1 Fill Material

Small amounts of fill are present in select areas at the SFC Facility. Most of the fill materials occur in the MPB and SX Building areas immediately adjacent to buried utility lines and as subbase to concrete floors, concrete and asphalt roads, and concrete storage pad areas. The fill material in the buried utility line trenches immediately surrounding the utility lines consists mostly of silty sand and silty gravel. The fill materials in the utility trenches area, adjacent to but not immediately surrounding the utility line, consist mostly of silty sand, sandy gravel, silty clays, and weathered shale. The fill materials beneath the concrete floors, concrete storage pads, and roadways consist mostly of silty sand and sandy clay that reach a maximum thickness of about 1.5 feet. A silty clay and/or weathered shale fill material typically overlies the coarser sands and gravels in the utility line trenches. The fill material in the buried utility line trenches occurs from depths of about 0 to 20 feet but averages 5 to 7 feet in thickness and depth (Ref. 11).

3.4.2.2 Terrace Deposits

The terrace deposits are remnants of extensive terrace deposits laid down during historical high water stages of the local river systems. Downcutting by these rivers has left these deposits high above the present-day river valley. The terrace deposits consist primarily of silts, sandy clays, gravelly clays, and clays that overlie shale and sandstone units of the Atoka Formation. From their maximum thickness on the hilltops in the area (including the MPB and Solvent Extraction (SX) Building areas), the terrace deposits thin rapidly in all directions. The terrace deposits at the Sequoyah Facility range in thickness from zero to approximately 16.4 feet (average about 6.7 feet). The thickest deposits are located near the southwest corner of the MPB and thin in all directions away from this area.

3.4.2.3 Shale Unit

The top of the Atoka Formation present in the Sequoyah Facility area consists of an upper shale unit which underlies the MPB and SX Building areas, the UF_6 storage pad, the Yellowcake Storage Pad, the Emergency Basin, Sanitary Lagoon, the North Ditch, the DUF_4 Building, and portions of the Fluoride Clarifier and Fluoride Sludge Basins.

The thickness of this uppermost shale ranges from zero to 20.1 feet. The thickest areas of the shale are found in the Yellowcake Storage Pad area, the SX Building a ea, the MPB area, and the area north of the MPB. The shale thins to zero feet thickness to the west, north and south of the MPB area. This shale unit is typically dark grayish brown, fissile, silty and sandy near the contacts with adjacent sandstone units. This unit is laterally continuous beneath the Sequoyah Facility until it is no longer present in the stratigraphic sequence due to erosion.

3.4.2.4 Sandstone Unit

Located beneath the uppermost shale is a highly cemented, very fine to medium-grained, pale brown to dark gray, sandstone. This sandstone is laterally continuous across most areas of the Sequoyah Facility. This sandstone is essentially impermeable (except for joints or fractures) due to its highly cemented nature. The formation ranges in thickness from zero to 12.5 feet and occurs at depths anywhere from 2 to 27.5 feet. The sandstone is thickest near the southeast and northeast corners of the MPB and generally thins toward the west where it is eventually removed from the section through erosion.

Beneath the uppermost sandstone (in the MPB and SX Building area) is an alternating sequence of laterally continuous sandstone and shale units with lenses of sandstone and shale irregularly scattered throughout the formation. These individual units have been characterized to a depth of about 45 feet in the 85-acre Sequoyah Facility.

3.4.3 Structural Geology

The rocks underlying the SFC property are, for the most part, nearly flat lying. Jointing and fracturing are present but not prominent in most of the Atoka rocks in the area. The silty shales and shaley siltstones are much less conspicuously jointed than the purer clay shale, and the observable joints are wavy, irregular, and short. Most of the sandstone beds also lack prominent jointing; where observed, they are short and irregular.

The area of East Central Oklahoma, where the Sequoyah Facility is located, lies in a quiet seismic region of the United States. Although distant earthquakes may produce shocks strong enough to be felt in this area, the region is considered to be one of minor seismic risk.

The most recent documented subsurface movement to have occurred within the SFC area occurred along the Meers Fault system an estimated 2,000 years ago. This system is located in south central Oklahoma. Other tectonic movements have occurred along the El Reno-Nemaha Ridge, which extends from central Oklahoma through Kansas and into Nebraska. Both of these systems are considered seismically dormant. The most recent significant regional tectonic movement occurred in the New Madrid area of Missouri. The probability of significant damage to the Sequoyah Facility from earthquakes is remote.

The Carlile School fault (approximately 2800 feet southeast of MPB) is the most prominent structural feature in the immediate area. The plane of the fault is not exposed, but its presence is revealed by vertical beds of sandstone which form hummocky parallel ridges south of the Carlile School. The ridges stretch for a couple of hundred meters across a pasture. They are about 150 feet apart, and are the surface indication of sandstone beds at 1 to 2 feet thick. Data collected during the drilling program in the MPB area did not indicate the definite presence of any faults or lithological offsets. However, some difficulty was encountered in correlation of lithological data south of the Decorative Pond, which could indicate a small fault or most probably a lithological facies change (Ref. 4).

Minerals in the area consist of coal, limestone/sandstone, and sand/gravel from the Arkansas River floodplain, and clay and shale. The nearest coal production is approximately nine miles west of the Sequoyah Facility. Coal is being mined from a depth of 1400 feet at Stigler in Haskell County, 18 miles south of the Sequoyah Facility. There are no known oil or gas fields in the area.

3.4.4 Soils

The formation of the soils is a function of the parent material, the surface slopes, climate, biological activity, and time. In the site vicinity, the predominant Pennsylvanian and Quaternary subsurface materials yield loamy and clayey soils. Area soils generally are associated with moderate to poor drainage and permeabilities. Soils with high drainage capabilities are often found on slopes of topographic highs because runoff tends to remove the less permeable (finer grained) soil particles. The degree of permeability in the lower elevations is mainly influenced by the characteristics of the parent material, which can include fine- to medium-grained colluvium, alluvium, or fine- to medium-grained weathered sandstone and shale (Ref. 4).

More specific information on site soils may be found in Section 7.0 of the FEI (Ref. 4).

3.5 Hydrogeology

3.5.1 Regional Hydrogeology

Regional flow of groundwater in the Sequoyah Facility area is west and south toward the Arkansas and Illinois Rivers. Shallow groundwater beneath the Sequoyah Facility may discharge through springs, evapotranspiration, or recharge to other strata. The Atoka formations and terrace deposits of the area are likely recharged from precipitation falling over their outcrop areas, and to a lesser degree from recharge from underlying formations.

The Sequoyah Facility is located near the edge of a major alluvial and terrace aquifer deposited along the Arkansas and Illinois Rivers. Usable groundwater in the region occurs principally in the thicker alluvial and terrace deposits of the Arkansas, Illinois, and Canadian Rivers. Groundwater also occurs to minor degrees in the Pennsylvanian-age bedrock formations. A major bedrock aquifer (the Keokuk and Reed Springs formations of Mississippian-age) occurs approximately 10 miles northeast of the Sequoyah Facility. This aquifer is capable of yielding between 3 to 50 gallons per minute of good quality water. Site specific data indicate that only a thin veneer of terrace deposits exist at the Sequoyah Facility and these are not capable of yielding usable or sustainable quantities of groundwater due to their limited saturated thickness and areal extent. The terrace deposits in the Sequoyah Facility area yield very little to no groundwater and much of the terrace deposits in the MPB, SX Building, and overall

Sequoyah Facility area are unsaturated and therefore are not capable of yielding groundwater.

A USGS map showing the availability of groundwater in the area shows that the Sequoyah Facility is located over geological units which are considered least favorable for development of groundwater supplies. The Sequoyah Facility is also located in an area where the chemical quality of groundwater contained in underlying lithological units is described as poor to fair.

The only significant fresh water aquifer in the immediate SFC Facility area is the alluvium of the Arkansas River Valley. The lower part of the alluvium consists of up to 15 feet of coarse sand with a productivity of as much as 900 gpm. The water is classified as "hard to very hard" (greater than 180 mg/L total hardness) but is suitable for irrigation and watering stock.

3.5.2 Site Specific Hydrogeology

The hydrologic conditions in the immediate area of the Sequoyah Facility are typical of those described for the Atoka formation discussed below. This formation is considered to be a very poor aquifer because the soil cover is thin and has poor permeability thus limiting recharge, and the underlying sandstone and shale beds require fracturing to provide storage capacity. Water quality is poor and yields average only 0.5 gpm. It is estimated that because of the very low permeability of the Atoka rocks, a high percentage of the rainfall is lost by surface runoff. The Sequoyah Facility does not use groundwater resources but obtains water from the Tenkiller Reservoir located about 7 miles to the north.

Groundwater at the Sequoyah Facility occurs in limited quantities in the terrace deposits and within the deeper interbedded sandstones and shales in the Atoka Formation. The FEI identified two zones that support groundwater flow systems with limited interconnection. The following subsections summarize the site specific hydrogeology at the SFC Facility. A more thorough description of the site specific hydrogeology is presented in Section 7.0 of the FEI (Ref. 4).

3.5.2.1 Shallow Shale/Terrace System

The uppermost system is a shallow fractured weathered shale that is in hydraulic communication with groundwater contained in overlying terrace deposits. This system is referred to as the shallow shale/terrace system. The average groundwater flow velocity in the shallow shale/terrace system was determined to be 0.016 feet/day (i.e., 5.8 feet/year) (Ref. 4). The groundwater potentiometric surface map for this unit is found in Appendix B of Reference 11.

3.5.2.2 Deep Sandstone/Shale System

Beneath this upper groundwater system, but separated by a dense, nearly impermeable, highly cemented, non-porous sandstone, is an interbedded shale and sandstone sequence referred to as the deep sandstone/shale system. The deep sandstone has a very low vertical permeability, and separates the overlying shallow shale/terrace groundwater from deeper bedrock groundwater systems. There appears to be no major communication with the groundwater contained within the overlying shale or terrace deposits. In fact, the uppermost sandstone unit may act in some areas as an impermeable barrier on which groundwater contained within the overlying shale and terrace deposits is perched. This sandstone is very highly cemented, very fine grained, and has very little primary porosity through which groundwater can move. The average groundwater flow velocity in the deep sandstone/shale system was determined to be 0.073 feet/day or about 27 feet/year.

3.6 Demography and Land Use

3.6.1 Demography

The SFC site is located in rural Sequoyah County, which had a 1990 population of 33,838. The four adjacent counties of Muskogee, Haskell, McIntosh and Cherokee had a combined 1990 population of about 129,846. The major population center is the city of Muskogee (37,708), about 25 miles to the northwest. Nearby towns include Gore (population 690), Webbers Falls (722), Warner (1,479), Vian (1,414), Checotah (3,290) and Sallisaw (7,122), all of which are located along Interstate 40 or old U.S. Route 64. The total population within 5 miles of the site is about 3,103 (Ref. 6).

A sector-segment grid was constructed originating at the latitude-longitude coordinates of the Sequoyah Fuels Facility with 16 sectors centered on the compass points and radii of 1, 2, 3, 4, 5, 10, 20, 30, 40, and 50 miles as shown in figures 3-1 and 3-2. Figure 3-1 shows the detailed 5-mile sector-segment grid, and Figure 3-2 expands the view to 50 miles. Figure 3-3 provides a more detailed display of the grid over selected highways, roads, and communities in Sequoyah County. A solid bell symbol marks the location of the facility (Ref. 6).

Table 3-7 shows the 1990 populations by sector-segments. The cumulative totals are listed in Table 3-7. Table 3-8 lists the total populations for all counties included in whole or in part in the 50-mile grid. Note that only small portions of some of those counties are within the grid and may not contain significant fractions of the total population (Ref. 6).

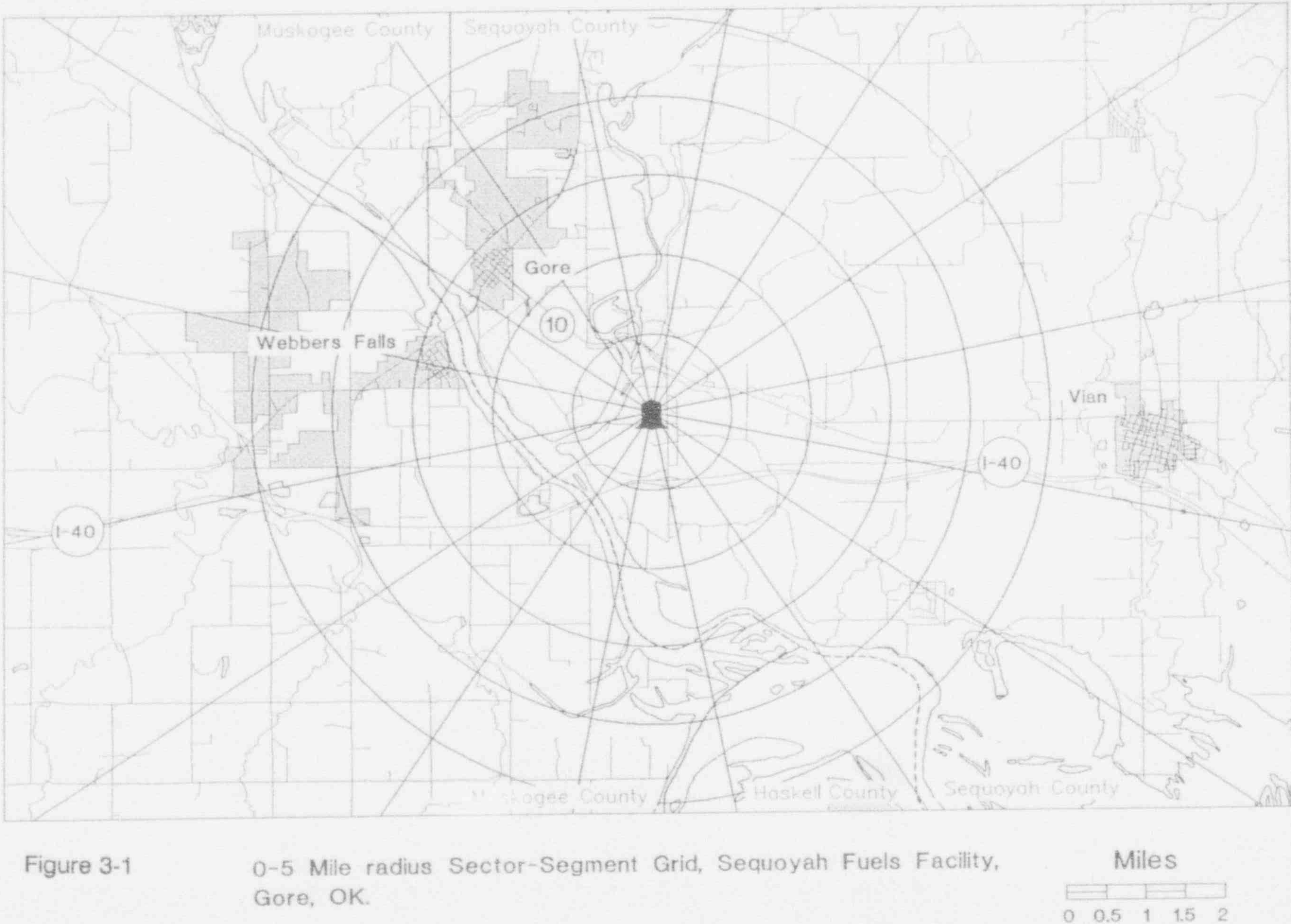


Figure 3-1 0-5 Mile radius Sector-Segment Grid, Sequoyah Fuels Facility, Gore, OK.

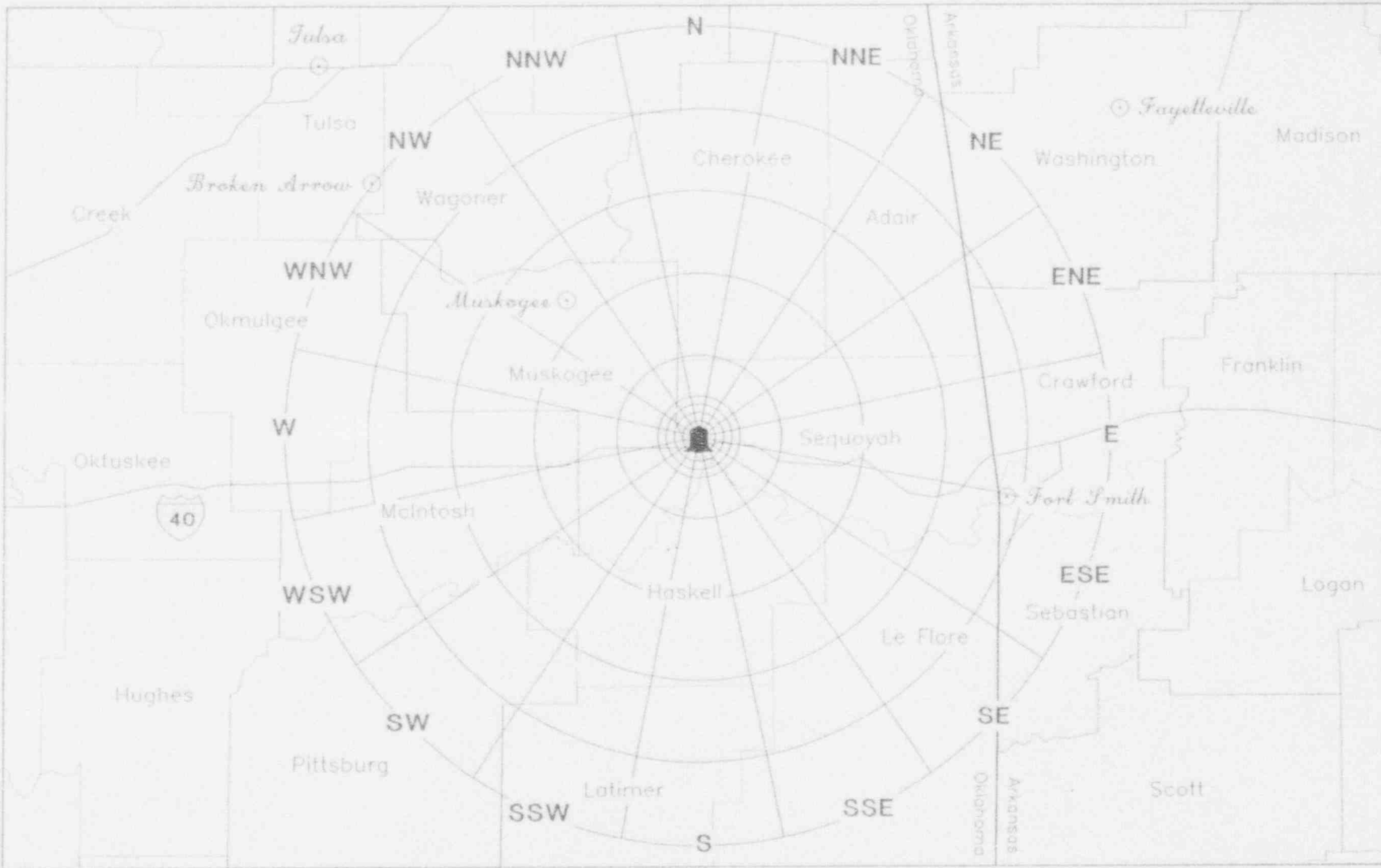


Figure 3-2 50-Mile Grid with Counties and Cities with a Population Greater than 25,000.

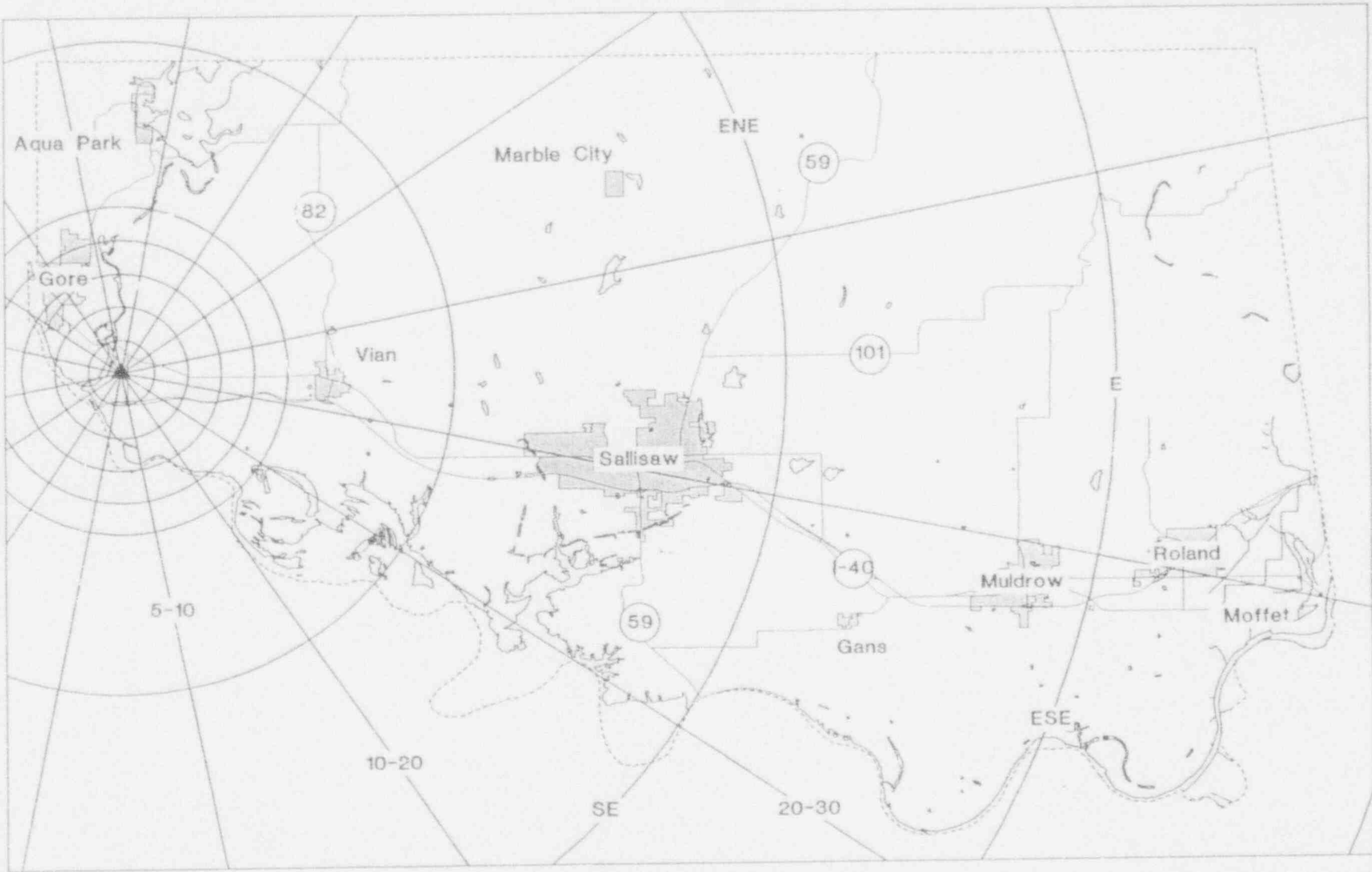


Figure 3-3 Sequoyah County with Sector Segments.

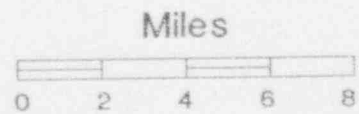


Table 3-7. Sequoyah Fuels Facility Population Distribution for 1990

1990 POPULATIONS BY SECTOR-SEGMENT										
DIRECTION	DISTANCE (MILES)									
	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
N	5	9	20	36	102	744	213	6,030	4,523	6,406
NNE	3	10	17	40	54	376	1,801	13,162	5,243	2,969
NE	2	10	17	24	30	558	593	2,345	7,870	8,127
ENE	1	9	17	41	54	314	1,145	1,704	1,820	1,729
E	1	24	31	53	68	1,857	6,826	3,418	21,616	36,092
ESE	0	11	18	23	29	244	3,432	5,668	38,063	39,265
SE	0	12	12	18	12	156	341	2,741	11,023	7,471
SSE	0	12	8	2	2	111	1,303	1,220	841	4,580
S	0	6	3	11	18	73	3,789	718	1,417	1,485
SSW	0	2	1	3	25	195	836	1,152	1,603	6,121
SW	0	1	2	2	16	278	1,884	2,163	1,853	2,238
WSW	0	1	7	4	21	140	769	2,831	4,983	1,408
W	0	1	282	138	17	283	2,812	5,243	2,090	13,214
WNW	0	1	219	43	39	225	1,600	1,973	3,796	2,440
NW	0	1	358	211	92	270	2,789	41,585	3,820	14,018
NNW	0	12	77	177	120	356	1,679	7,608	11,816	5,604

Table 3-8. County Populations

1990 POPULATION TOTALS BY COUNTY	
STATE OF OKLAHOMA	
COUNTY	
Adair	18,421
Cherokee	34,049
Delaware	28,070
Haskell	10,940
LeFiore	43,270
Latimer	10,333
Mayes	33,366
McIntosh	16,779
Muskogee	68,078
Okmulgee	36,490
Pittsburgh	40,581
Rogers	55,170
Sequoyah	33,828
Tulsa	503,341
Wagoner	47,883
STATE OF ARKANSAS	
COUNTY	
Crawford	42,493
Sebastian	99,590
Washington	113,409

3.6.2 Land Use

Prior to the advent of railroads in the area, the land was primarily cattle range. With availability of railroads, corn and cotton became the main agricultural products. In the last 40 years, however, the trend has been away from cultivation of these crops and back to cattle grazing and production of other food crops. Areas remaining in cultivation are primarily in the bottom lands along the Arkansas River. In 1970, about 30% of the acreage of Sequoyah County was used for range and about 40% was forested. The range is usually grazed year round, but the forage is supplemented with protein cubes, prepared pasture, and hay consisting of tame grasses and small grain. High-quality trees have been largely eliminated from the forested areas by heavy cutting, fires, and uncontrolled grazing. Most woodland in the county is used for grazing (Ref. 9).

Sequoyah Fuels Corporation's development and growth intensified land use demand in areas around Vian, Gore and Webbers Falls. New housing additions were developed in each of these towns. Also the development and completion of the Robert S. Kerr Reservoir and the Kerr-McClellan Waterway in the late 1970's and early 1980's has attributed to the change in the land use patterns. The land now covered by these waters once was fertile bottom land used for agricultural purposes. With the increase of the recreational activities these waters provide, additional housing has been developed in these areas on once unused rough terrain. Industrial and commercial growth has remained constant (Ref. 6).

An estimate based on topographic data from USGS Stigler NE, OK, Quadrangle, 1963, photo revised 1979; USGS Vian, photo revised 1982; USGS Holt Mountain, photo revised 1979 and Blackgum Quadrangle, photo revised 1979 and previously published land use information, the following land uses have been estimated for a 10-mile radius around the SFC facility (Ref. 6):

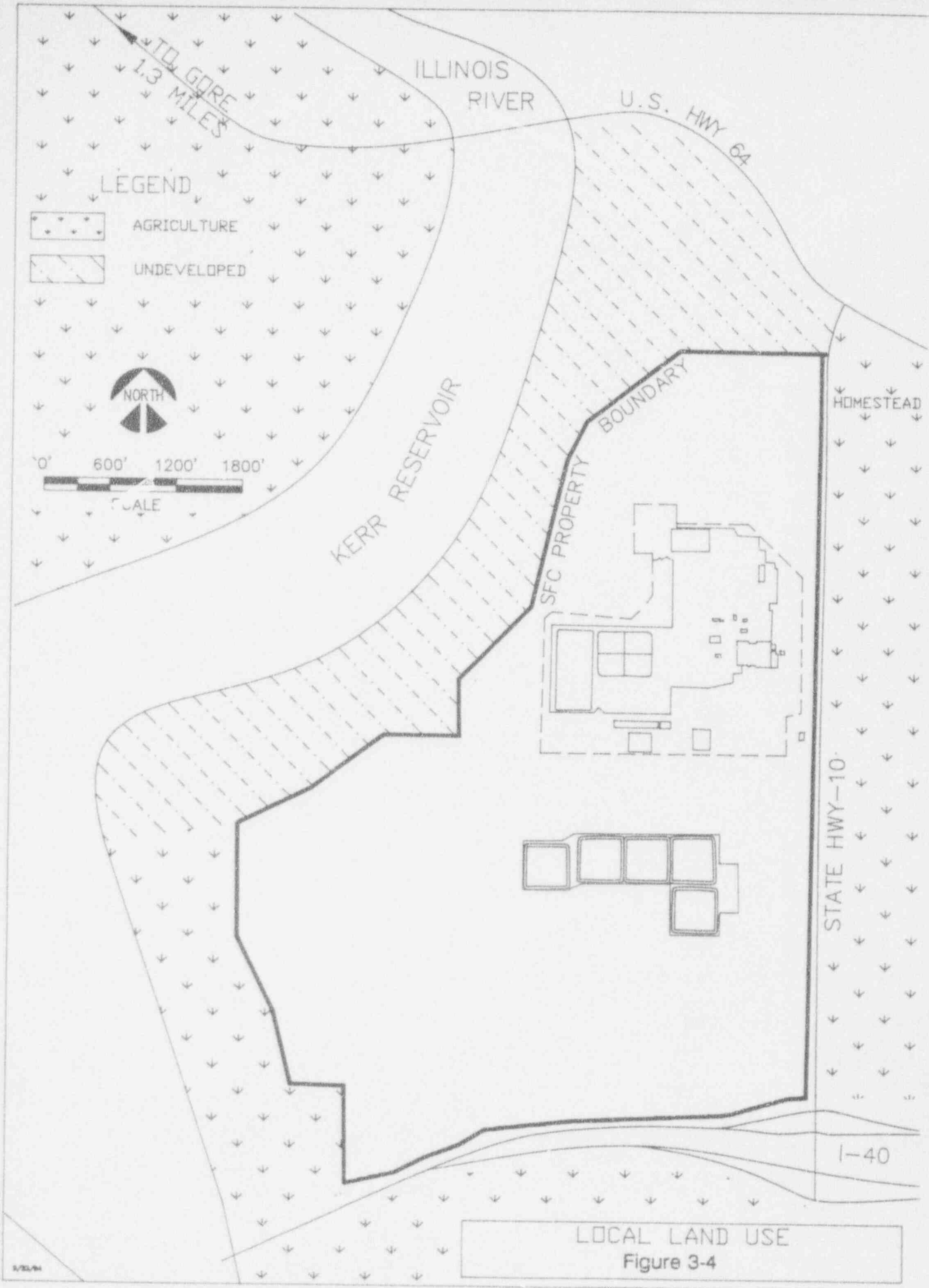
Table 3-9
Land Use Around Sequoyah Facility
Sequoyah Fuels Corporation

Land Use	Percent[a]
Agricultural (much farming)	20%
Recreational	40%
Residential	25%
Commercial & Industrial	15%
Unused Rough Terrain	20%

[a] Due to multiple use of some areas, the total exceeds 100%.

Recreational development is primarily represented by the large unoccupied acreage of the Robert S. Kerr Reservoir, federally-owned land and water areas along the Arkansas and Illinois Rivers. This includes the 21,000 acre Sequoyah National Wildlife Refuge south of Interstate Highway 40 where large numbers of migrating waterfowl are found in the spring, fall and winter (Ref. 6).

Figure 3-4 shows the current land use immediately surrounding the site.



LOCAL LAND USE

Figure 3-4

3.7 Threatened and Endangered Species

A review of SFC's 1992 Environmental Report, Revision 1, the 1985 NRC Environmental Assessment (Ref. 14), and the Oklahoma Natural Heritage Inventory database for the region covered by the USGS maps Keefton, Warner, Webbers Falls, Holt Mountain, Stigler NE, and Gore identified several special category species (endangered, threatened, or category 2) that occur in the vicinity of the Sequoyah Fuels facility.

Endangered species that might be found in the vicinity included the least tern, bald eagle, grey bat, Indiana bat, Ozark big-eared bat, and peregrine falcon. The neosho madtom, a threatened species, and *Carex fissa*, a sedge listed as a category 2 species, may also be found in the area.

Because of specific habitat requirements and general patterns of occurrence, it is unlikely that any of these species, with the exception of the bald eagle, would be found on the Sequoyah Fuels facility. Bald eagles winter at Robert S. Kerr Reservoir and there are at least a few resident breeding pairs. It is likely that some individuals will visit the Sequoyah Fuels site.

3.8 Biota

3.8.1 Terrestrial Biota

The site is located in the oak-hickory savannah region, which is characterized by various degrees of dominance of woodland and grassland. The region is within the transition area or ecotone between the eastern deciduous forest and the central prairies. The ecology of the area has been modified by grazing, by the clearing of forest for cultivation and pasture, and by the construction of reservoirs that destroyed bottomland forests (Ref. 9).

The site itself is primarily an upland area. The woodlands are dominated by several species of oaks and hickories. Forests along streams and in river bottomlands are dominated by species such as cottonwood, sycamore, sweetgum, red oak, and water oak. Numerous dirt roads or trails have been cleared through most of the woodlands on the site to allow the passage of the fertilizer spraying equipment. Pastures and fields on the site are dominated by Bermuda grass, rye, and fescue (Ref. 9).

The fauna of the site is dominated by both woodland and grassland species. Some 120 bird species breed in the region and a few hundred other species migrate through or overwinter in the area. Woodlands, brushlands, and wetlands usually support a larger number of bird species than do fields and pastures. About 65 species of mammals and 70 species of amphibians and reptiles occur in the region. Important game species that occur on the site include the bobwhite, white-tailed deer, red and gray squirrel, and eastern cottontail. The Sequoyah National Wildlife Refuge is located to the south and west of the SFC site and is used by large numbers of waterfowl and wading birds during the spring and fall migratory periods (Ref. 9).

3.8.2 Aquatic Biota

The Sequoyah facility is located on the Illinois River embayment of the Robert S. Kerr Reservoir. The Illinois River, which is spring-fed, traverses a rugged, relatively undeveloped portion of Oklahoma. Consequently, the water is of relatively good quality and carries a low-sediment load. The reservoir provides habitat for a number of game-fish species including black bass, channel catfish, crappie, and walleye. Nongame fish species are found in the shallow, weedy, brushy flats of the river, and a "put-and-take" rainbow trout fishery exists in the Illinois River below Tenkiller Dam, upstream of the site. (Ref. 9).

A study of the macrobenthic fauna of the Illinois River in the vicinity of the discharge of the combination (or effluent) stream was conducted for the applicant by Doris and Russell during 1978-1979 and by Russell during 1980-1981 (Ref. 9).

Results of these studies showed that the benthic fauna in the river is dominated on a seasonal basis by aquatic worms and chironomid larvae, but the damsel fly nymph, Argia sp., was dominant in the combination stream. The combination stream was found to have a more stable, less fluctuating environment than the Illinois River in the vicinity of the plant (Ref. 9).

3.9 Floodplains and Wetlands

Floodplains at the SFC site are associated primarily with the Illinois and Arkansas Rivers. A very narrow floodplain is located along the small stream at the northern border of the site. The Illinois and Arkansas Rivers in the immediate vicinity of the site are considered to be part of the Robert S. Kerr Reservoir. The normal pool elevation of the reservoir is 460 feet, which is about 10 feet above the original water level of the rivers at the SFC site prior to construction of the dam. Based on maintenance of a normal pool elevation of 460 feet at the Robert S. Kerr Lock and Dam, the maximum historical flood (1943) would cause the water level in the reservoir to raise to 479 feet at the site, while a 50-year flood would raise water levels at the site to only about 474 feet. Thus only a small part of the forage production area near the confluence of the rivers could be impacted by the maximum floods. No large marshes or swamps occur on the site (Ref. 9).

3.10 Water Usage

The principal source of drinking water in the area are the reservoirs created by impounded surface water. Eufaula Reservoir, located approximately 25 miles southwest of the SFC Facility, supplies the City of Warner and adjacent rural areas (Ref. 4).

The source of water supply for the immediate area east of the Arkansas River is Lake Tenkiller, located about 7 miles north (upstream) of the SFC Facility (Ref. 4). The communities of Gore, Webbers Falls, and Vian utilize Lake Tenkiller, as does the local rural water district and the SFC Facility.

The Oklahoma Water Resources Board files indicate that there are no water wells recorded within two miles of the SFC Facility. As part of the FEI, however, a more detailed historical record search and door-to-door survey was conducted to identify water wells near the SFC Facility. In 1991, a total of 22 water wells were identified. The survey documented no impacts to groundwater from Sequoyah Facility operations have occurred on water wells in the general area. Most of the water wells identified in the off-site well survey are not in current use. The locations of these wells are depicted on Figure 42 of the FEI (Ref. 4). There are no groundwater users downgradient of the Sequoyah Facility (Ref. 4).

Crop irrigation and livestock watering occur in the area using either man-made ponds, surface water diversions, or water wells (Ref. 6).

4.0 Extent and Concentration of Contamination

4.1 Analysis and Review of Source and Contamination Characterization

In the Fall of 1990, SFC implemented a comprehensive facility environmental investigation (FEI) (Ref. 4). The FEI was designed to identify and investigate locations on SFC property where past or then ongoing (now discontinued) operations could have resulted in the release of licensed material to the environment. The FEI was performed over approximately a nine month period and included six major tasks. These tasks are described below.

Task 1, facility-wide surface water investigation, developed a detailed understanding of surface water flow paths on SFC property. This task identified potential pathways for release of licensed material offsite via surface water.

Task 2, facility process flow and process stream characterization investigation, provided a more complete understanding of the overall Sequoyah Facility unit operations and processes. It serves as reference for identifying and assessing potential sources of licensed or non-licensed material that may be released offsite.

Task 3, past and present operations, historical information investigation, identified 28 operational units at the Sequoyah Facility for which a historical review was conducted, including building areas, ponds, surface water, burial sites, etc (See Figure 4-1). The review determined the scope of operations which had been performed at each unit. Other pertinent data collected included dates of operation, aerial photographs, characterization of material managed at each unit, release and/or migration data, employee interviews, and data from associated environmental monitoring.

Task 4, facility-wide underground utility investigation, characterized the quantity and location of licensed material in the subsurface fill soils in all SFC Facility utility trenches with potential for transporting licensed material from the Sequoyah Facility. The utility investigation also identified and verified all potential pathways that could contribute to the migration of licensed material to and from past and present operational units.

Task 5, past and present operations, material characterization, and Task 6, groundwater (saturated zone) and unsaturated zone soil investigation, provided a detailed investigation of groundwater and soils in all areas of the Sequoyah Facility. Data was collected predominantly from soil borings, monitor well installations, and sampling of unsaturated zone soils.

In the summer of 1991, SFC conducted additional investigations of soil, groundwater, surface drainage water and sediment, and performed further investigation of the primary water effluent discharge. The results were published as an addendum to the FEI (Ref. 5). The addendum summarized the findings of these additional investigations and assessed the findings in relationship to the findings of the original FEI.

4.1.1 Past Operations and Activities

Hazardous chemical storage systems at the SFC Facility were designed and constructed with secondary and tertiary spill containment to prevent release to the environment in the event of a spill. SFC does not have information regarding spills at the Facility for the period of facility operation by Kerr-McGee (or its subsidiaries or divisions) prior to 1987. A review of the available records revealed that no spills subject to the reporting requirements of CERCLA, SARA, RCRA, or State regulations have occurred during the period from 1987 through 1992. NRC release reporting requirements under 10 CFR Parts 20 and 40 began to be revised in the late 1980s and revisions were promulgated in late 1990 and 1991. In response to these proposed and final regulatory changes, SFC began in 1990 reporting more spills to NRC. Significant NRC reportable events that occurred prior to 1990 are captured in Section 2.0 of the FEI (Ref. 4).

Several NRC reportable events occurred during 1991 and 1992. These events are fully described in SFC's decommissioning files. Except for the two instances mentioned below, the events reported in 1991 and 1992 were minor in nature. They generally can be categorized as minor on-site contaminations which were subsequently cleaned up, equipment failures, or discovery of existing contamination.

In late 1991, SFC adopted new, more stringent limits for beta-gamma surface contamination levels for unrestricted areas at the Sequoyah Facility. Subsequently, areas were identified as radiologically contaminated that had previously been considered uncontaminated. In February 1992, a written plan was prepared providing specific guidance regarding organization, procedure, and documentation for a comprehensive radiological survey of the unrestricted area at SFC; the plan was last revised in July 1992 (Ref. 12). The field survey effort was completed in November 1992. Contaminated items or areas were either decontaminated, relocated to the restricted area, or marked to identify the potential presence of contamination. The results of the survey are included in SFC's Decommissioning File.

On November 17, 1992, a Site Area Emergency was declared due to nitrogen oxide (NOx) fumes being emitted from the digestion area and traveling offsite. Environmental sample results taken from the site boundary, in the plume pathway, did not indicate any radioactivity above background levels.

4.2 Source Characterization

The FEI activities and findings have been presented in detail in findings reports issued in 1990 and 1991 (Refs. 5 and 14). Other sources of information have also been summarized (Refs. 13 and 6). This section provides a summary of the principal FEI findings reported and other available information regarding identification and characterization of sources of contamination.

4.2.1 Past and Present Operations, Historical Information Review

The FEI identified 28 past or present operational units at the Sequoyah Facility for investigation. Except for the ammonium nitrate lined ponds (Unit 24), these units are all located on an approximate 85-acre parcel of land, well within the SFC property boundaries. The units include process areas and buildings; the surface water management system; impacted soils, materials, and discarded equipment storage areas; active and inactive impoundments; impacted drainage areas; equipment and sludge burial areas; and underground utilities. These units have the potential for releasing licensed material and other process-related substances to the environment at the Sequoyah Facility. None of these units are "regulated units" as that term is defined under RCRA and its regulations. SFC has no hazardous waste treatment storage or disposal units permitted either under 40 CFR Parts 264 or 265. The locations of all 28 units are shown in Figure 4-1. The historical information obtained from file searches and interviews includes the following topics:

- each unit's location and defined boundaries;
- dates of operation, if known;
- any available characterization of material managed at the unit;
- any existing data found on unit environmental sample characterization; and
- any data on release information and associated migrations or remediations.

The specific information for each unit may be found in Section 2.0 of the FEI (Ref. 4).

4.2.2 Facility Process Flow and Process Stream Characterization

As part of the FEI, a detailed Sequoyah Facility process flow and process stream evaluation was completed to provide a reference for assessing identified releases and for identifying potential release sources and constituents.

A complete process flow diagram was developed and verified for the Sequoyah Facility. From the process flow assessment, the following seven waste streams were identified:

1. Hydrogen fluoride scrubber wastewater treated in the fluoride treatment system and the resulting sludge solids,
2. Sludge solids produced in the fluorine production cells,
3. Overflow or excess cooling water,
4. Steam condensate,
5. Sedimentation basin and water softener blowdown from the potable water treatment system,
6. Sanitary wastewater, and
7. Laboratory wastewater.

A brief process description and SFC management practices for the above waste streams are provided in Section 3.0 of the FEI (Ref. 4).

Other constituents were identified to be present at the facility with potential for release to the environment. Most notable are the miscellaneous constituents present in the uranium ore concentrate processed at the Sequoyah Facility.

On February 18, 1993, the Oklahoma State Department of Health (OSDH) requested information regarding the nature of materials managed by SFC in seven specific areas at the facility: ammonium nitrate ponds, fluoride holding basins, fluoride clarifier, fluoride settling basins, raffinate storage area, Pond 2, and lime neutralization gravel. Each area is identified on Figure 4-1.

All seven areas discussed in the request for information have been, or are currently, used to manage either of two process stream materials, known as raffinate and fluoride sludge. To fully understand the nature of these two process streams it is helpful to understand the production process from which they were derived.

a. Raffinate

Uranium ore concentrates were received by SFC in either a dry solid form (i.e., yellowcake) or as a wet slurry from solution mining. These feedstock materials consisted of uranium (30% to 80% by weight), various other metallic salts and chemical constituents found in the native ores. In the first step of SFC's process, the ore concentrates were dissolved in nitric acid (Digestion) to form an aqueous uranyl nitrate solution. Next, a 30% solvent solution of tributylphosphate, dissolved in n-hexane, was contacted with the digested ore concentrates to chemically extract uranium from the slurry (Solvent Extraction). The solvent formed complexes with uranium and uranyl salts and allowed the uranium to transfer across the phase boundary, leaving behind the nitric acid containing the "other" ore materials. This nitric acid solution is called raffinate. The uranium/solvent mixture proceeded on through various processes to form the facility's primary product, uranium hexafluoride or UF_6. The remaining process steps are not germane to understanding the nature of raffinate and therefore are not described here.

The raffinate was processed in several surface impoundments to precipitate the remaining uranium and metallic salts by the addition of ammonia. Barium chloride is added to precipitate Ra-226. This was done in a 4-cell synthetically-lined impoundment, known as Clarifier A. Solid and liquid phases formed due to gravity settling.

The solid phase material, raffinate sludge, contains elevated uranium levels which can exceed uranium concentrations in native ores. The solid phase also contains elevated levels of Th-230 which was present with the ore concentrates as a naturally occurring impurity. Other transformation products from the natural uranium series are also present in the sludge. Sludges are routinely pumped from the clarifiers either to a holding pond (Pond 4) or directly to a transport truck for delivery to a uranium mill for use as an alternate feed material.

The liquid phase material is an ammonium nitrate fertilizer solution containing from 1.5 to 2.5% nitrogen. The fertilizer is pumped from Clarifier A into holding ponds after it meets regulatory requirements. The resultant fertilizer is applied to ranch lands controlled by SFC.

b. <u>Fluoride Sludge</u>

Certain production processes at SFC produced gaseous effluents. Those gas streams containing hydrogen fluoride, hydrogen and/or fluoride gases were combined into a single stream and contacted with a water spray in scrubbing equipment. The resulting scrubber discharge (HF Scrubber Water) was piped to an above-ground tank for neutralization with calcium oxide (Lime Neutralization). The solution was then piped to one of several basins where the precipitated solids were allowed to settle out. The liquid was decanted from the settling basins to the Fluoride Clarifier which acts as a polishing unit. Additional settling of solids occurred in this unit and the clarified liquid was released into the facility Combination Stream for discharge to a tributary of the Robert S. Kerr Reservoir under federal (NPDES) and state (OWRB) wastewater discharge permits. The calcium fluoride solids (fluoride sludge) are presently being stored in the basins in which they are settled. These include fluoride settling basin numbers 1 and 2 and fluoride holding basin numbers 1 and 2. Prior to 1981, fluoride sludge was placed in earthen containment cells (fluoride sludge burial area; see Figure 4-1).

4.2.3 Facility-Wide Surface Water Investigation

The surface water management system was identified as a specific operational unit for investigation in the FEI (Unit 4). The surface water exits the Sequoyah Facility at a well-defined outfall which is monitored by SFC. Surface water routed to the Combination Stream Drain, and subsequently discharged through permitted Outfall 001, was investigated separately in the FEI.

For purposes of the FEI, a comprehensive network of 20 monitoring stations was defined to characterize the surface water at the Sequoyah Facility. These monitoring sites included all pertinent outfalls plus additional sites selected at key transitional drainage locations based on a detailed areal topographic survey and site map developed in the FEI.

Two sampling events were performed during separate rainfall events to characterize the surface water. These events occurred on January 15, 1991 (Event No. 1) and March 1, 1991 (Event No. 2).

A third surface water runoff sampling event was conducted on October 24, 1991 during a rainfall event of 4.5 inches in a 24 hour period. Samples were taken at the same 20 monitoring sites monitored in Events No. 1 and No. 2, as well as one additional site, SW-21. As a result of previous analyses, an earthen stormwater diversion dike was constructed downgradient of Unit 10. The additional surface water monitoring location (SW-21) was added to determine the effectiveness of the dike to decrease uranium concentrations in stormwater from the area.

This investigation effort is more completely described in Section 4.0 of the FEI (Ref. 4) and Section 3.0 of the FEI Addendum (Ref. 5).

4.2.4 Facility-Wide Underground Utility Investigation

The Facility-Wide Underground Utility Investigation characterized the quantity and location of licensed materials in the subsurface fill soils in the SFC underground utility trenches. Utility trenches backfilled with more porous material provide a potential pathway for migration of licensed and non-licensed materials.

From this FEI effort, a complete set of utility drawings, which locate past and present utilities at the Sequoyah Facility, was generated. This effort also included review of facility construction drawings relative to site geology and documented that no construction foundations or piers penetrate the underlying upper shale unit. Twenty-seven utility trench excavations were performed to investigate migration potential. Eighteen hydraulic barriers and 23 trench monitors were installed.

This investigation effort is more completely described in Section 5.0 of the FEI (Ref. 4).

4.2.5 Combination Stream Drain Investigation

The investigation of the Combination Stream Drain (CD) was not one of the original principal FEI Work Plan Tasks but emerged during the FEI as a major component of the Facility-Wide Underground Utility Investigation. Two extensive investigations were performed during the FEI, one internal and one external.

The internal investigation identified all contributing waste streams to the CD and clarified the operational dynamics of the CD. Two flow and sampling events were completed to characterize the CD. The CD characterization investigation determined that the major uranium loading is from the cooling tower equalization basin. Along the CD, the potential sources of inflow with the greatest uranium concentration include the sanitary sump and cooling water hot side basin sump. The internal investigation also determined no measurable infiltration or exfiltration was occurring into or out of the CD, respectively.

The external investigation of the CD trench backfill material has included the installation of three trench backfill monitoring wells and two porewater recovery wells. The trench backfill monitoring program has defined the levels of uranium along the CD trench backfill. The external investigation identified the SX Building area as the probable major contributor of uranium to the CD trench. A porewater recovery well was installed where the CD exits the restricted area boundary. There appears to be no major infiltration or exfiltration of fluids into or out of the CD pipeline. The porewater levels in the CD trench are below the invert of the pipeline from the cooling tower area to the middle of the yellowcake pad. Therefore, there cannot be any infiltration of fluids into the CD pipeline across this area.

This investigation effort is more completely described in Section 6.0 of the FEI (Ref. 4 and Section 9.0 of the FEI Addendum (Ref. 5).

4.2.6 Unit and Groundwater Investigations

SFC initiated a detailed groundwater and soil investigation to determine the quantity and extent of licensed material and other constituents in SFC groundwater and soils. The other constituents were identified by conducting broad spectrum chemical analysis of select wells located in areas most likely to be impacted by process operations or materials handling. Metals were identified utilizing a list of 20 that are present in yellowcake while organic chemicals were identified with Methods 624 and 625 of SW-846 (which identify approximately 65 semi-volatiles and 38 volatiles). The list of metals and organics included those identified as being present in materials utilized at the SFC Facility plus many others which were not known to have ever been used at the Facility. As of July 15, 1991, SFC had installed 79 shallow shale/terrace groundwater monitoring wells, 78 deep sandstone/shale wells, one groundwater recovery well, two CD recovery wells, and three CD trench monitoring wells. In addition, approximately 100 lithological characterization borings and approximately 210 soil chemical characterization borings were drilled for the purpose of defining the extent and quantity of licensed material and associated constituents in soils at the facility. Also, sediment samples were collected from present and historical surface water drainage pathways.

After July 1991, SFC conducted additional investigations of soil and groundwater. Thirteen additional boring locations were drilled during the Phase III drilling program. Three shallow shale/terrace monitor wells and 13 deep sandstone/shale monitor wells were installed to aid in evaluating the subsurface stratigraphy/hydrogeology and to delineate possible impacts to soils/groundwater. In addition, the wells aid in bounding areas of impact on groundwater.

SFC conducted additional soil characterization investigations at two areas; the north cylinder storage pad and the Unit 10 subarea. These units were investigated because previous analytical data and/or operational history indicated there was a possibility that licensed materials and associated constituents might be present in the soils.

Between October 21 and 27, 1991, groundwater from all shallow shale/terrace and deep sandstone/shale wells was sampled. The groundwater was sampled for the purpose of characterizing the chemical quality of the uppermost and next deeper groundwater systems upgradient and downgradient from the MPB and SX Building areas as well as other FEI units.

In September 1991, additional sampling was performed of the sediments present in historical drainage pathways. The latest groundwater sampling occurred in April and May of 1993.

These investigation efforts are more completely described in Sections 4.0, 5.0, 6.0, and 7.0 of the FEI (Ref. 4) and Sections 4.4 and 8.0 of the FEI Addendum (Ref. 5). The groundwater monitoring program is summarized and updated in Section 4.0 of the draft Groundwater Monitoring Interim Measures Workplan (Ref. 11).

4.2.6.1 Groundwater Transport Model

SFC calculated the approximate nitrate, arsenic, and uranium plume boundaries in the groundwater for 3, 5, and 10 year intervals using the MYGRT (Version 2.0) groundwater model (Ref. 6). The modelling effort and results are more completely described in Appendix A of this report.

4.2.6.2 Geochemical Modelling of Sequoyah Facility Groundwater and Utility Trench Porewater

As part of the FEI, an investigation was performed to determine the relative mobility and species of uranium contained in groundwater, soils, and utility trench porewater at the Sequoyah Facility. The objectives included: 1) characterization of dissolved uranium concentrations in trench backfill porewater, shallow shale/terrace groundwater, and deep sandstone/shale groundwater; 2) define the migration potential of uranium; and 3) evaluate uranium geochemistry along the groundwater-flow path.

The geochemical modelling study indicated that uranium in groundwater exists mainly as uranyl carbonate and uranyl phosphate complexes. These anionic complexes are soluble in the facility groundwater. The results of the saturation index calculations indicate that groundwater should be unsaturated with respect to uraninite, amorphous UO_2, U_4O_9, U_3O_8, coffinite, UF_4, $UF_4 \bullet 2 \bullet 5H_2O$, $U(HPO_4)_2$, ningyoite, UO_3, gummite, B-$UO_2(OH)_2$, schoepite, rutherfordine, H-autunite, uranophane, and bassetite. These minerals are generally expected not to precipitate from solution. However, there were several areas where uranium is predicted to be oversaturated with respect to U_3O_8, U_4O_9, B-$UO_2(OH)_2$, schoepite, rutherfordine, uraninite, and $USiO_4$. These wells are mostly in the MPB, SX Building, and Combination Stream Drain trench areas. Uranium is likely being removed from solution through a precipitation process in these areas. Partial removal of uranium from solution through adsorption with ferric oxyhydroxide, a strong adsorbent for uranium, is also predicted to occur naturally at the Sequoyah Facility. The results of the geochemical modelling are more completely described in Section 7.4.4 of the FEI (Ref. 4).

4.3 Contamination Characteristics

Radiologically and non-radiologically contaminated areas at the Facility include the Main Process Building (MPB) area, Solvent Extraction (SX) Building area, Sanitary Lagoon, North Ditch, areas around the Emergency Basin, Incinerator area, Contaminated Equipment Burial areas #1 and #2, an area adjacent to the Solid Waste Building, Pond #2, Pond #1 Spoils Pile, and the Combination Stream Drain.

4.3.1 Groundwater Contamination

Groundwater investigations at the SFC Facility include historical monitoring, the FEI and Addendum, and more recent routine monitoring. These investigations have indicated that areas of groundwater at the Sequoyah Facility were impacted, with respect to uranium, and the impacts were generally in the MPB and SX Building areas. The uranium was investigated in the shallow shale/terrace and deep sandstone/shale groundwater with no uranium found to have migrated beyond the site boundary. The extent of nitrate, fluoride, and arsenic in the two groundwater systems was also evaluated.

Metal analyses of the facility groundwater indicated that the only metals that were significantly higher than EPA primary drinking water standards were arsenic and barium. Organic analyses of groundwater indicated that 1,1,1-trichloroethane, tributylphosphate, and trichlorofluoromethane were found in the groundwater at the facility. These organics were detected at slightly elevated levels. The 1,1,1-trichloroethane is thought to be limited in areal extent.

The groundwater impacted by facility operations can be characterized as being very low yield and not capable of providing sufficient quantity for domestic purposes. There are no domestic users of groundwater within one mile of the facility, and none downgradient of the contamination. In addition, the groundwater moves very slowly (5-25 ft/yr) towards the west where it is believed to outcrop prior to reaching surface waters. Therefore, contamination contained in the groundwater is not believed to pose a threat to human health or the environment.

The groundwater sampling results are more completely described in Section 4.0 of the draft Groundwater Monitoring Interim Measures Workplan (Ref. 11).

4.3.2 Soil Contamination

The levels of nitrate, fluoride, and uranium in soils have been investigated extensively at the SFC Facility. Specifically, these investigations include historical monitoring, and the FEI and Addendum. These investigations have indicated that limited areas of soils at the SFC Facility were impacted and that the impacts were generally in the MPB and SX Building areas. The uranium was investigated with respect to area and depth. The extent of nitrate and fluorides impacts were not as completely defined.

Analyses for soil gases indicated a presence of hydrocarbons in only a few locations, (near the Main Process Building and the SX Building) at low levels, and generally near the surface.

The results of the soil and sediment sampling are more completely described in Section 7.0 of the FEI (Ref. 4) and Section 4.0 of the FEI Addendum (Ref. 5).

4.3.3 Surface Water and Sediment Contamination

With respect to the surface water sampling events described in Section 4.2.3, the concentrations of fluoride measured for all monitoring sites were below the discharge limitations established in permits issued to SFC by the EPA and the OWRB. The data indicate fluoride does not pose an environmental concern for the Sequoyah Facility surface water system.

Nitrate concentrations did not exceed the permit limit for the surface water outfall (008) in Event No. 1 and only slightly exceeded the permit limit in Event No. 2. All other Sequoyah Facility exit points (SW4, SW6, and SW8) for surface water were below the SFC environmental action level[3] (EAL) (20 mg/L) for nitrate in both events. During Event No. 3, the nitrate concentrations showed a decrease from the concentrations measured during Event No. 2 at 14 of the monitoring sites. For each event, nitrate concentrations exceeded the SFC EAL in drainage areas generally around Unit 18, Unit 25, and Unit 8.

Uranium concentrations for all monitoring sites were below the allowable 10 CFR 20 discharge limit for each event. The Event No. 1 and Event No. 3 uranium concentrations for all four Sequoyah Facility exit point monitoring sites were well below the Sequoyah Facility EAL (225 μg/L). The Event No. 2 uranium concentrations for two Sequoyah Facility exit point monitoring sites were below the SFC EAL and slightly above the SFC EAL at the other two exit point monitoring sites. Uranium concentrations exceeded the SFC EAL in the Unit 10 and Unit 11 drainage areas during Event No. 2. Uranium concentrations also exceeded the SFC action limits in other FEI defined drainage areas during Events No. 1, No. 2, and No. 3.

The results of each sampling event are more completely described in Section 3.0 and 8.0 of the FEI (Ref. 4) and Section 3.0 of the FEI Addendum (Ref. 5).

The sediment samples collected from drainage pathways were analyzed for total uranium, radium-226, and thorium-230. The sample results indicated the present drainage

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[3] The EAL is a level established by SFC in order to trigger evaluation or corrective action prior to exceedance of a regulatory limit.

pathway to be uncontaminated but historical drainage pathways to be intermittently impacted with low concentrations of uranium and thorium-230.

The results of the sediment sampling are more completed described in Section 7.0 of the FEI (Ref. 4) and Section 4.0 of the FEI Addendum (Ref. 5).

4.3.4 Structures and Equipment Contamination

The interior of structures within the restricted area are contaminated with fixed and removable radioactive material. Depending on the structure, the average levels range from 1 to 4,200 disintegrations per minute per 100 cm^2 (dpm/100 cm^2) removable alpha, 4 to 20,000 dpm/100 cm^2 removable beta/gamma, 21 to 21,000 dpm/100 cm^2 fixed alpha, 2,000 to 34,000 dpm/100 cm^2 fixed beta/gamma, 0.2 to 54 mrem/h contact beta/gamma dose rate, and 0.2 to 7 mrem/h general area dose rate. Detailed surveys of equipment are not available but results similar to the structure interior results would be expected on the exterior of this equipment. The interior of process equipment is expected to have higher levels of contamination. Except for the UF_6 Reduction Facility, a more complete summary of contamination survey results for structures and grounds is contained in Appendix A of SFC's Preliminary Plan for Completion of Decommissioning (Ref. 1). A more complete summary of contamination survey results for the UF_6 Reduction Facility may be found in Table 4-1 and Figures 4-2 and 4-3.

TABLE 4-1

SEQUOYAH FUELS CORPORATION
UF6 REDUCTION FACILITY RADIATION AND CONTAMINATION SURVEY
BASED ON SURVEYS PERFORMED IN JULY 1993

AVERAGE RESULTS

	Surface Contamination (dpm/100 cm^2)				Dose Rate (mrem/hr)			
	Removable		Fixed		Contact		General Area	
	Alpha	Beta/Gamma	Alpha	Beta/Gamma	Gamma	Beta/Gamma	Gamma	Beta/Gamma
1st Level North	310	4700	1300	N/R	<.2	<.2	<.2	<.2
1st Level South	270	3200	210	N/R	<.2	<.2	<.2	<.2
2nd Level	210	2400	4200	N/R	<.2	<.2	<.2	<.2
3rd Level	280	4200	6100	N/R	0.3	<.2	0.3	<.2
4th Level	260	2900	1900	N/R	0.2	<.2	0.2	<.2
5th Level	290	3700	3600	N/R	0.4	<.2	0.3	<.2

MAXIMUM RESULTS

	Surface Contamination (dpm/100 cm^2)				Dose Rate (mrem/hr)			
	Removable		Fixed		Contact		General Area	
	Alpha	Beta/Gamma	Alpha	Beta/Gamma	Gamma	Beta/Gamma	Gamma	Beta/Gamma
1st Level North	480	8500	12000	N/R	0.2	<.2	0.2	<.2
1st Level South	300	4300	2000	N/R	<.2	<.2	<.2	<.2
2nd Level	230	2800	10000	N/R	0.2	<.2	0.2	<.2
3rd Level	350	5400	24000	N/R	0.3	<.2	0.3	<.2
4th Level	280	4000	4000	N/R	0.5	<.2	0.5	<.2
5th Level	400	5300	12000	N/R	2.5	<.2	2	<.2

4.3.5 Impoundments

The following information addresses the age, historical use, present status and nature of materials found in specific areas at SFC. Each area is identified on Figure 4-1.

a. **Fertilizer Pond Area - Ponds #3 East, #3 West, #4, #5, and #6**

Description: The Ammonium Nitrate Pond Area consists of five impoundments located south of the main processing area. Each measures approximately 400 feet by 400 feet by 25 feet deep. The ponds are clay and hypalon-lined with a leak detection system located between the two liners. The volumes and dates of construction are as follows:

Pond 3E: 2,166,000 cubic feet, September 1978

Pond 3W: 2,213,000 cubic feet, September 1978

Pond 4: 2,235,000 cubic feet, February 1980

Pond 5: 2,178,000 cubic feet, December 1984

Pond 6: 2,142,000 cubic feet, April 1985

Present Status: All five ponds are currently in use. Four of the ponds (Ponds 3E, 3W, 5, and 6) are used for storage of ammonium nitrate fertilizer transferred from Clarifier A. The fifth pond (Pond 4), is used for storing raffinate sludge. It receives the sludge from Clarifier A after liquid-solid phase separation. Liquids overlying the raffinate sludge in Pond 4 are occasionally pumped to Clarifier A to precipitate additional uranium into the solid phase and to return nitrate-containing liquids to the fertilizer ponds.

Historical Use: All five ponds have historically been used for the same purpose as they are today. The only deviation is Pond 4 which also received the raffinate sludge from Pond 2 before Pond 2 was closed and taken out of service.

Chemical Quality:

(1) Ammonium Nitrate Fertilizer - extensive analysis exists on the chemical quality of the fertilizer as a result of license requirements from the NRC. Recent representative analysis of the total RCRA metals is provided in Table 4-2.

(2) Raffinate Sludge - Representative composite samples from Pond 4 were recently analyzed for both total and leachable RCRA metals; results are provided in Table 4-2.

b. **Fluoride Holding Basins #1 and #2**

Description: Fluoride Holding Basin No. 1 (aka Fluoride Sludge Pond) was constructed in June 1981 to hold sludge collected from the fluoride settling basins. Basin No. 1 is clay lined and measures 190 feet wide by 130 feet long by 16 feet deep, with an estimated capacity of 186,000 cubic feet.

Fluoride Holding Basin No. 2 is a clay-lined basin which was constructed in 1985. The basin's estimated capacity is 201,000 cubic feet, and it measures 220 feet wide, 150 feet long, and 9 feet deep.

Present Status: Both fluoride holding basins are currently holding fluoride sludge and receive minor quantities of materials from the Process Laboratory.

Historical Use: Fluoride Holding Basin No. 1 has been used only to store fluoride sludge since its construction. Fluoride Holding Basin No. 2 was initially constructed with a synthetic liner and received raw raffinate for a short period of time after completion. The basin was subsequently drained, the liner removed, and its use dedicated to Fluoride Sludge.

Chemical Quality: Representative composite samples were recently taken of the sludges from both basins and analyzed for total RCRA metals. The results are provided in Table 4-2.

c. **Fluoride Clarifier**

Description: The Fluoride Clarifier Basin, directly west of the fluoride settling basins, is managed in conjunction with the settling basins. This impoundment is clay-lined and measures 220 feet long by 85 feet wide and 14 feet deep, with an estimated capacity of 102,100 cubic feet.

Present Status: The clarifier is currently in use to polish (settle) any remaining solids from the liquid phase prior to discharge of the liquid to the Combination Stream.

Historical Use: The impoundment has always served in its present capacity and has not received any other materials.

Chemical Quality: A representative composite sample was recently taken of the fluoride clarifier sludges and analyzed for total RCRA metals; the results are provided in Table 4-2.

d. **Fluoride Settling Basins No. 1 and No. 2**

Description: The Fluoride Settling Basins (Unit 14), are located south the Clarifier A, and east of Pond 2 within the restricted area boundary. The unit consists of two separate basins, each measuring 190 feet long by 75 feet wide and 14 feet deep. The estimated capacities are 46,800 cubic feet for each settling basin. The basins were built in 1971 and receive neutralized HF Scrubber Water.

Present Status: The settling basins are currently in use and hold Fluoride Sludge.

Historical Use: The basins have both been used to hold fluoride sludge which results from neutralization of the HF Scrubber Water and small amounts of Process Laboratory materials with similar chemical characteristics.

Chemical Quality: Each basin was sampled recently and analyzed from composite samples for total RCRA metals. The results of each analysis are provided in Table 4-2. In addition, a TCLP analysis for leachable RCRA metals was performed on a composite sample produced from each impoundment's discreet composite sample. The results of this analysis is provided in Table 4-2.

e. **Raffinate Storage Area - Basins No. 1, No. 2, No. 3, and No. 4**

Description: Clarifier A consists of four basins commonly referred to as Clarifiers 1A, 2A, 3A, and 4A. The clarifier was built in 1980 and each basin is lined with clay and hypalon with a leak detection system between the two liners. Each basin measures 250 feet wide, 200 feet long and 13 feet deep. The clarifier is located directly north of the fluoride settling basins within the restricted area boundary.

Present Status: All four basins are currently in use. Until recently the clarifiers received raffinate from the Solvent Extraction process. Currently they are being used to precipitate uranium and radium from various sources including liquids pumped from Pond 4, laundry effluent, low volumes of water pumped from uranium recovery wells, hold sludge for future disposition, and other minor processing area flows.

Historical Use: Clarifier A was constructed for the current method of management of raffinate, i.e, four clarifier basins operated in series or parallel, from a single settling basin which was originally constructed in 1970, known as Pond 1. When Pond 1 was converted to Clarifier A in 1980, the accumulated sludges were transferred to Pond 2 and residual sludges removed and stored on site in an area known as the "Pond 1 Spoils Pile"; see Figure 4-1. The Pond 1 Spoils Pile lies directly north of the Clarifier A and west of the Emergency Basin. Clarifier A served to manage raffinate and other minor volumes of industrial sources which contained recoverable levels of uranium. These other sources included those listed above in "Present Status" and other smaller sources which are not documented.

Because of the high ratio of raffinate volume to volumes from these other sources, the contents of the clarifiers can be described chemically as raffinate.

Chemical Quality: A representative composite sample of clarifier 4A sludge was analyzed recently for total and leachable RCRA metals. The 4A basin was chosen because, in the clarifiers management scheme, it was the basin most likely to contain the highest levels of metals since it was first in the series where the majority of metal precipitated out. The results are provided in Table 4-2.

f. **Raffinate Storage Area No. 2 - Pond 2**

Description: Construction of Pond 2 was completed in June 1971 and first used in October 1971. It was constructed without a synthetic liner and utilized for the management of raffinate and raffinate sludge. The pond measures 300 feet wide by 700 feet long by 18 feet deep, with an estimated total capacity of 2,963,000 cubic feet. The pond lies directly west of Clarifier A and the fluoride settling basins, spanning the length of both units.

Present Status: Pond 2 was taken out of service in the early 1980's and put back in service temporarily in 1989 due to excessive rainfall. A remediation plan was then developed, the sludge was removed and transferred to

Pond 4. In 1991 a synthetic cover was installed over the entire impoundment to prevent storm water from leaching contaminants from the impacted clays at the bottom of the pond. The southwest corner of the berm was breached to allow rainfall to drain from the cover.

Historical Use: Pond 2 was not in service while modifications to the dikes were made in August 1973, but its use as an active component of raffinate management continued thereafter until Clarifier A was built in 1980. A leakage problem from Pond 2 was identified as early as 1974. In an effort to minimize the seepage, SFC spread 25 tons of quicklime in the south end and one ton of bentonite clay in the southeast quadrant of the pond in 1974. This treatment was not successful.

The materials that had been placed in Pond 2 were removed in 1991. The vast majority of this material was raffinate sludge which was transferred to Pond 4 or shipped to a uranium mill for uranium recovery. Other solid materials (carbon anode blades, miscellaneous metal parts, rocks, etc.) removed from Pond 2 were packaged in 55-gallon drums and stored on site.

Chemical Quality: All sludges and liquids have been removed from Pond 2. Following the sludge transfer, an extensive characterization was performed on the natural clays at the bottom of the pond. In closing of Pond 2 a maximum radiological level from U-238 of 2000 pCi/gm, based on discreet samples, was allowed to remain in the natural clays.

g. **Lime Neutralization Gravel (limestone used to neutralize hydrogen fluoride scrubber wash waters)**

Description: The Lime Neutralization Area is located southwest of the Decorative Pond, approximately 150 feet south of the SFC entrance road. A limestone pile functioned as the initial neutralization facility for SFC's HF Scrubber Water. The scrubber water was discharged to the lime pile from 1969, the Sequoyah Facility's start-up year, until construction of the fluoride settling basins and clarifier was completed in 1971. Upon completion, the scrubber water was re-routed for processing through these settling basins, and use of the Lime Neutralization Area was discontinued. At that time the limestone pile was leveled and abandoned.

An investigation of the area was performed as part of the Facility Environmental Investigation in 1990-91. The depth from surface to sandstone was found to range from one to four feet. Soil samples taken from the middle of the Lime Neutralization Area in October 1990 indicated uranium concentrations ranging from <5.0 to 636 μg/g. Fluoride concentrations ranged from 648 μg/g to 65,100 μg/g. A sludge/slurry sample contained 90.0 mg/L uranium, while water samples taken downgradient of the unit from a rainwater runoff depression area contained uranium concentrations of 7.6 to 109.0 µg/L and fluoride concentrations of 0.4 to 2.9 mg/l.

The potential for release of licensed material (uranium) at the Lime Neutralization Area was identified by SFC personnel in the early stages of the FEI. In 1990, SFC excavated and exposed an old abandoned line, which historically routed HF Scrubber Water to the limestone pile, at two upgradient locations. Also, at that time, SFC installed a cut-off trench with a trench monitor at both locations. A detailed investigation of the area was also conducted by SFC and its consultant in October 1990 to determine the extent of licensed material at this area and to assess groundwater quality.

Originally the area was believed to consist of approximately 175 tons of crushed limestone covering an 80 feet by 20 feet area. In 1992, SFC started removing the impacted material and found less than 50 tons of crushed stone. The impacted gravel has been removed and is being stored in a temporary soil storage cell on-site. The area is maintained as a restricted area due to elevated levels of uranium in the soil.

TABLE 4-2. CHEMICAL ANALYSIS RESULTS

AMMONIUM NITRATE FERTILIZER 1992 Season Average (2)									
ANALYSIS	As	Ba	Cd	Cr	Pb	Hg	Se	Ag	U
Total Metals, mg/l Pond 6	0.72	0.34	<0.01	<0.02	<0.10	<0.0002	<0.01	NA (1)	<0.006

RAFFINATE SLUDGE March, 1993									
ANALYSIS	As	Ba	Cd	Cr	Pb	Hg	Se	Ag	U
Total Metals, mg/kg Pond 4	350.0	5450.0	<5.0	70.0	120.0	0.15	27.1	8.0	4200
Leachable Metals, mg/l Pond 4	0.16	0.57	0.037	<0.05	<0.1	0.0004	0.09	<0.05	NA
Total Metals, mg/kg Clarifier 4A	154.2	NA	<0.3	40.0	41.4	NA	3.0	1.0	16000
Leachable Metals, mg/l Clarifier 4A	<0.001	<0.01	<0.005	<0.01	<0.02	0.0025	<0.002	<0.01	NA

FLUORIDE SLUDGE March, 1993									
ANALYSIS	As	Ba	Cd	Cr	Pb	Hg	Se	Ag	U
Total Metals, mg/kg Fluoride Holding Basin 1	141.0	14.0	<0.3	22.8	2.8	NA	<3.0	1.9	NA
Total Metals, mg/kg Fluoride Holding Basin 2	2.5	13.6	<0.3	16.4	2.0	NA	<3.0	1.8	NA
Total Metals, mg/kg Fluoride Settling Basin 1	67.1	23.3	<0.3	18.3	4.4	NA	<3.0	2.0	NA
Total Metals, mg/kg Fluoride Settling Basin 2	17.2	20.5	<0.3	13.9	3.1	NA	<3.0	5.3	NA
Total Metals, mg/kg Fluoride Clarifier	3.5	14.4	<0.3	11.1	2.5	NA	<3.0	<0.3	NA
Leachable Metals, mg/l Composite Sample (3)	0.018	0.30	<0.025	<0.05	<0.01	<0.0002	<0.01	<0.05	NA
Total Metals, mg/kg Composite Sample (2)	NA	NA	NA	NA	NA	NA	NA	NA	1245

NOTES:

(1) In the tables the term "NA" means "not available".

(2) Only a partial list of parameters are included here.

(3) A composite sample from each impoundment which stores the sludge was combined into a single composite sample and analyzed.

(4) The term "leachable" as used herein means the sample was extracted utilizing methodology associated with the RCRA TCLP procedure.

4.3.6 Interim Storage of Contaminated Soils

In the Fall of 1991, SFC identified several soil areas at the Facility that were contaminated with low concentrations of uranium. SFC determined it desirable to consolidate, stabilize, and store these soils on site on an interim basis pending future treatment or disposal. SFC developed an interim storage plan providing greater assurance that subject soils will be stored in a manner that more adequately protects the environment (Ref. 8). The chosen interim storage method was an above-ground cell.

Description of Soils

Three primary units of uranium-contaminated soils were initially identified to be placed into the interim storage cell. They were the soil (sod) contaminated by the 1986 cylinder rupture; limestone gravel associated with a former hydrofluoric acid neutralization area; and soils from various excavation activities around the solvent extraction building temporarily stored on the yellowcake storage pad. The volume and uranium concentration of each of these units of contaminated soils are provided in Table 4-3. The former storage location of each of these units and the location of the interim storage cell are shown in Figure 4-1.

Table 4-3. Soils To Be Stored In An Above-Ground Cell *

	Approximate Volume (ft^3)	Natural Uranium Concentration Average (ug/g)	Natural Uranium Range (ug/g)
Soil from 1986 accident	12,000	223	145 - 388
Gravel and soil from hydrofluoric acid neutralization pile	66,000	20	6 - 636
Soil excavated from around solvent extraction building	45,000	1800	<400 - 6030
Total Volume	123,000		

* Currently, some additional soils from other areas have also been placed in the cell. The respective volumes and concentrations, however, are small compared to the three primary units described in this table.

As additional soils are identified, SFC evaluates their suitability for storage in the cell on a case by case basis. Currently, some additional soils from other areas have also been placed in the cell. The respective volumes and concentrations, however, are small compared to the three primary units described above. There is no uranium concentration limit on soils being placed into the cell.

Description of Storage Cell

The interim storage cell has been constructed on an existing concrete pad at the north end of the Facility (Figure 4-1). The wall structure of the cell is formed from concrete inverted-tee sections.

The overall outer dimensions of the storage cell are approximately 100 feet in width and 160 feet in length. The height of the cell will be about twelve feet in the middle, sloping to a height equal to the height of the top of the storage cell wall (four feet).

A liner has been placed on the bottom of the storage cell. The liner is a 38 mil thick reinforced polymeric alloy. A geotextile fabric of 10 ounces per square yard has been placed beneath and above the liner for added strength and physical protection of the liner. Both layers of the geotextile fabric and the liner are physically secured to the storage cell wall.

A cover is placed over the soils as the cell is filled. Upon completion, a cover will be placed over the soils in the storage cell. The cover will be a composite laminate of co-extruded polyolefin film. The cover will be secured around the outer edges of the storage cell wall.

Environmental Monitoring

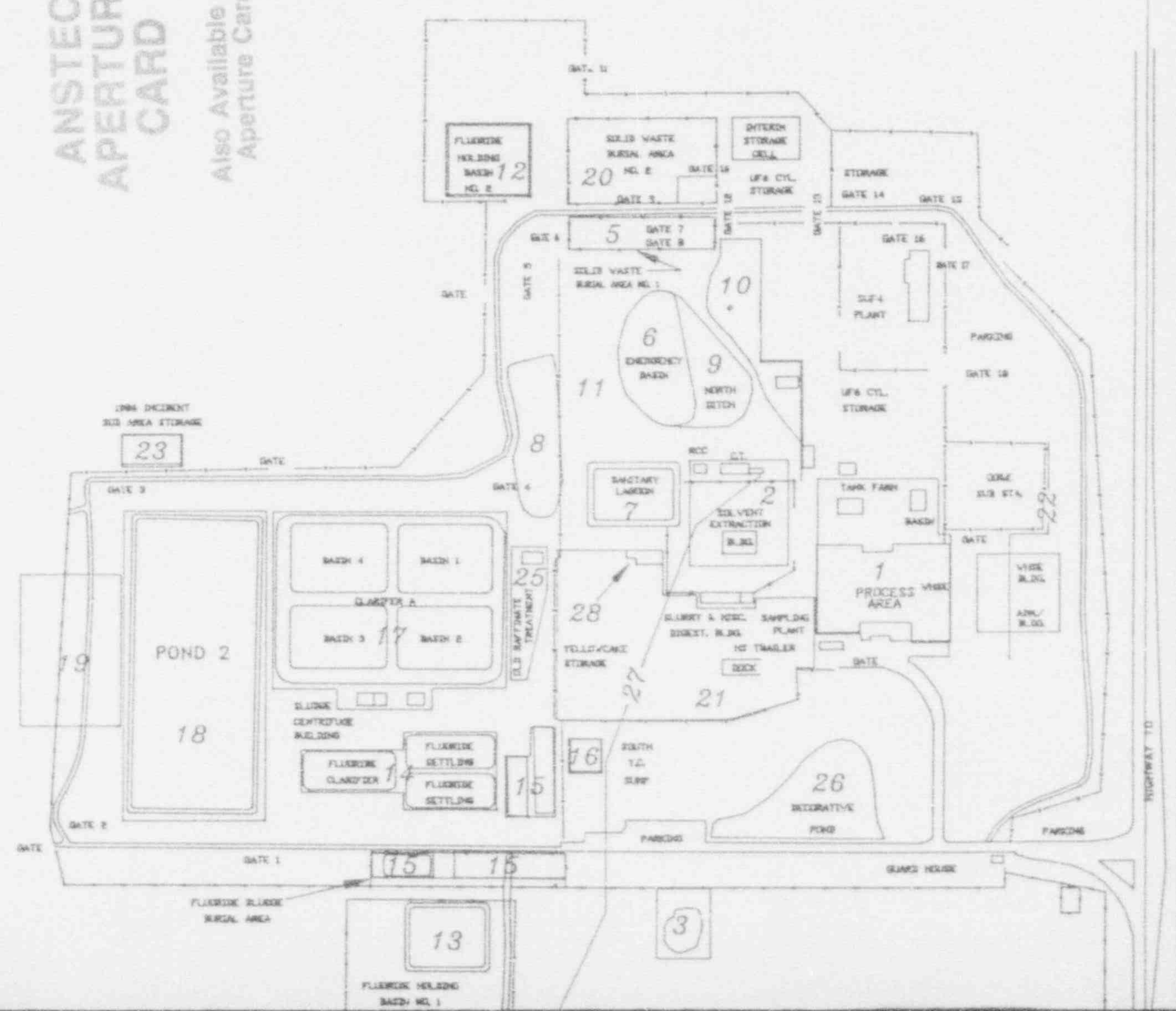
Two sumps have been placed in the soil storage cell, one each at the east and west ends on the north side of the cell. The sumps will be used to collect rainfall runoff during filling. Also, the cell has been constructed such that any liquids that collect between the liner and the upper geotextile fabric will be transferred to one of the sumps.

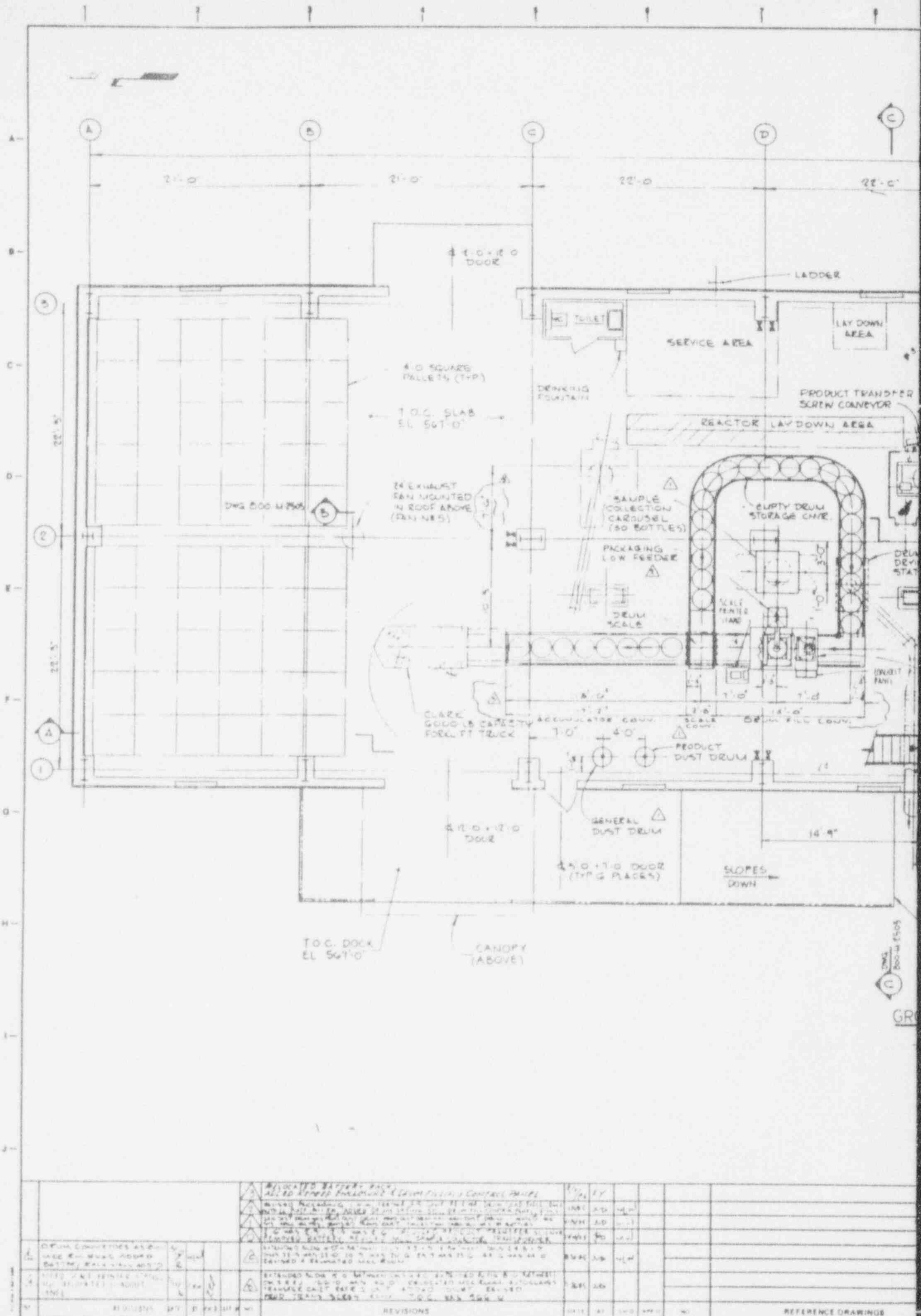
SEQUOYAH FUELS CORPORATION
CURRENT CONDITIONS REPORT
FIGURE 4-1
SEQUOYAH FACILITY
LAYOUT WITH 28 FEI UNITS

9403110053-03

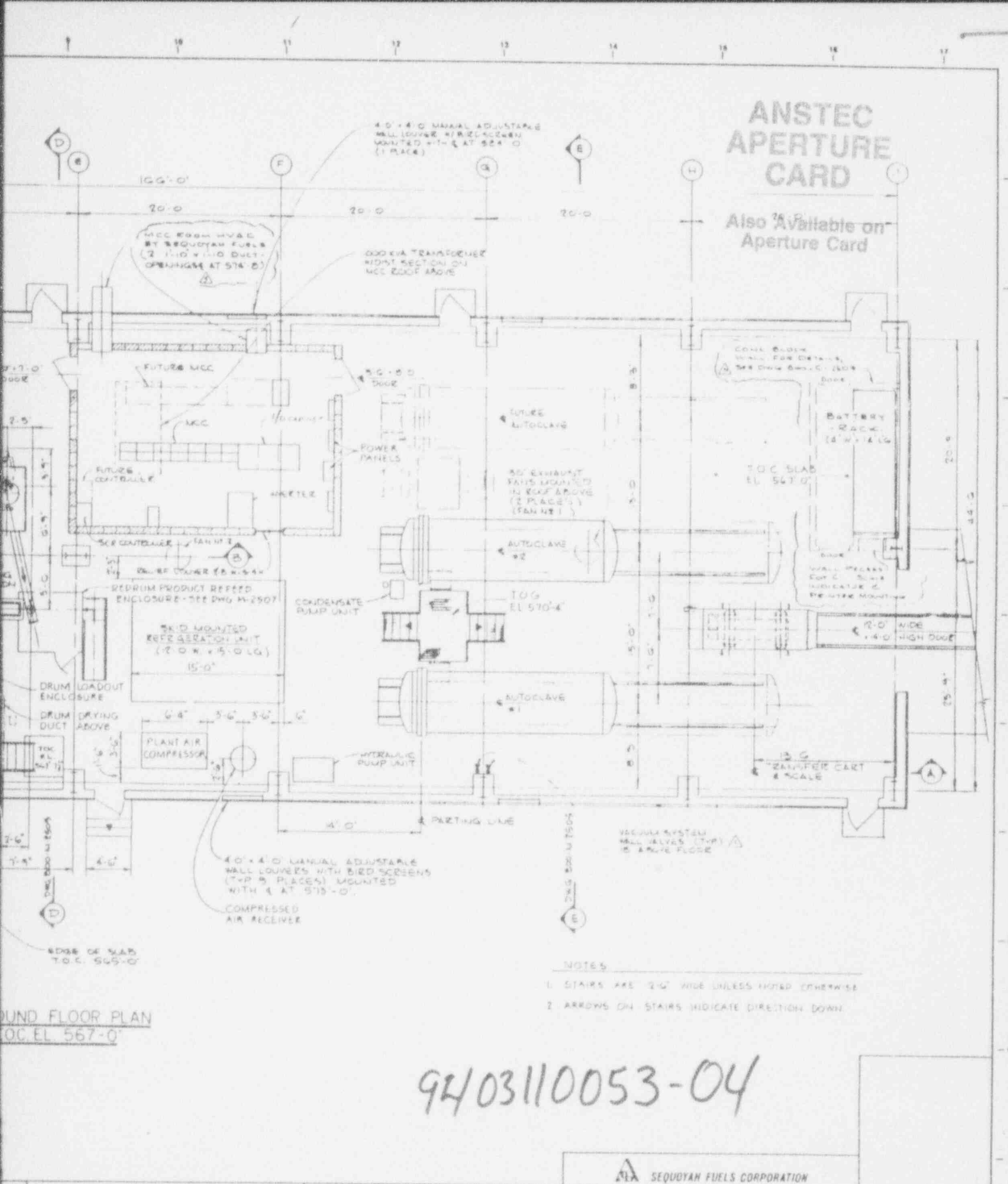
PAST AND PRESENT OPERATION UNITS

1 MAIN PROCESS BUILDING AREA
2 SOLVENT EXTRACTION AREAS
3 INITIAL LIME NEUTRALIZATION AREA (1970)
4 SURFACE WATER, ENTIRE FACILITY
5 CONSTRUCTION EQUIPMENT BURIAL AREA
6 EMERGENCY BASIN
7 SANITARY LAGOON
8 POND 1 SPOILS PILE
9 NORTH DITCH
10 ASH RECEIVERS, CONTAMINATED EQUIPMENT AREA
11 DRAINAGE AREAS AROUND EMERGENCY BASINS, SANITARY LAGOON INCINERATOR AND OLD RAFFINATE LINES
12 FLUORIDE SLUDGE BASIN #2
13 FLUORIDE SLUDGE STORAGE POND
14 FLUORIDE SETTLING BASINS
15 FLUORIDE SLUDGE BURIAL AREA
16 YELLOWCAKE SUMP AREA
17 CLARIFIER POND AREA
18 POND 2
19 DITCH, WEST OF POND 2
20 CONTAMINATED EQUIPMENT STORAGE
21 YELLOWCAKE STORAGE PAD
22 DITCH FROM UF_6 CYLINDER COOL DOWN AREA
23 CONTAMINATED SOIL FROM 1986 RELEASE
24 AMMONIUM NITRATE LINED PONDS
25 AREAS OF OPERATIONAL SPILLS
26 DECORATIVE POND
27 COMBINATION STREAM DRAIN
28 PRESENT LIME NEUTRALIZATION AREA

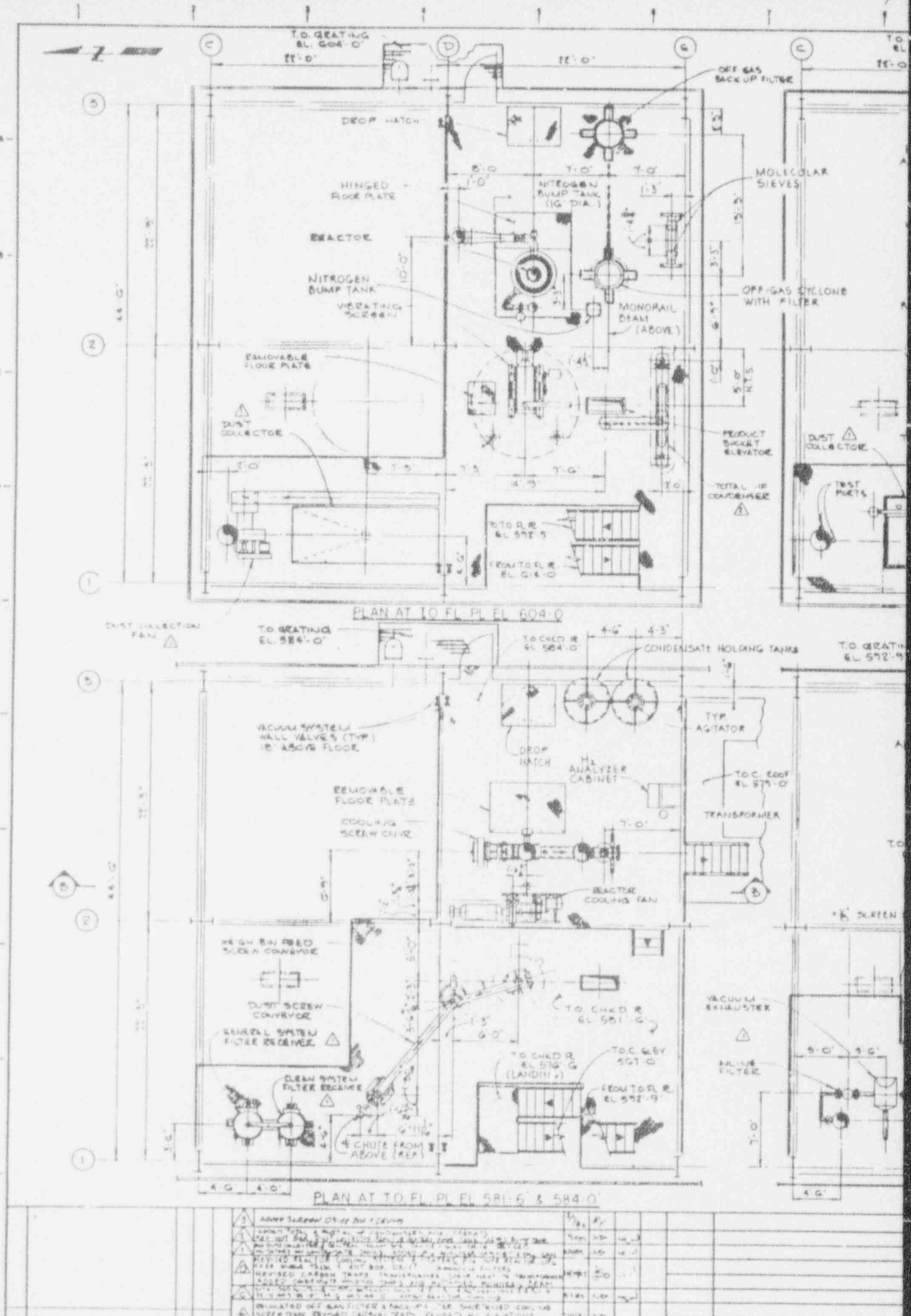




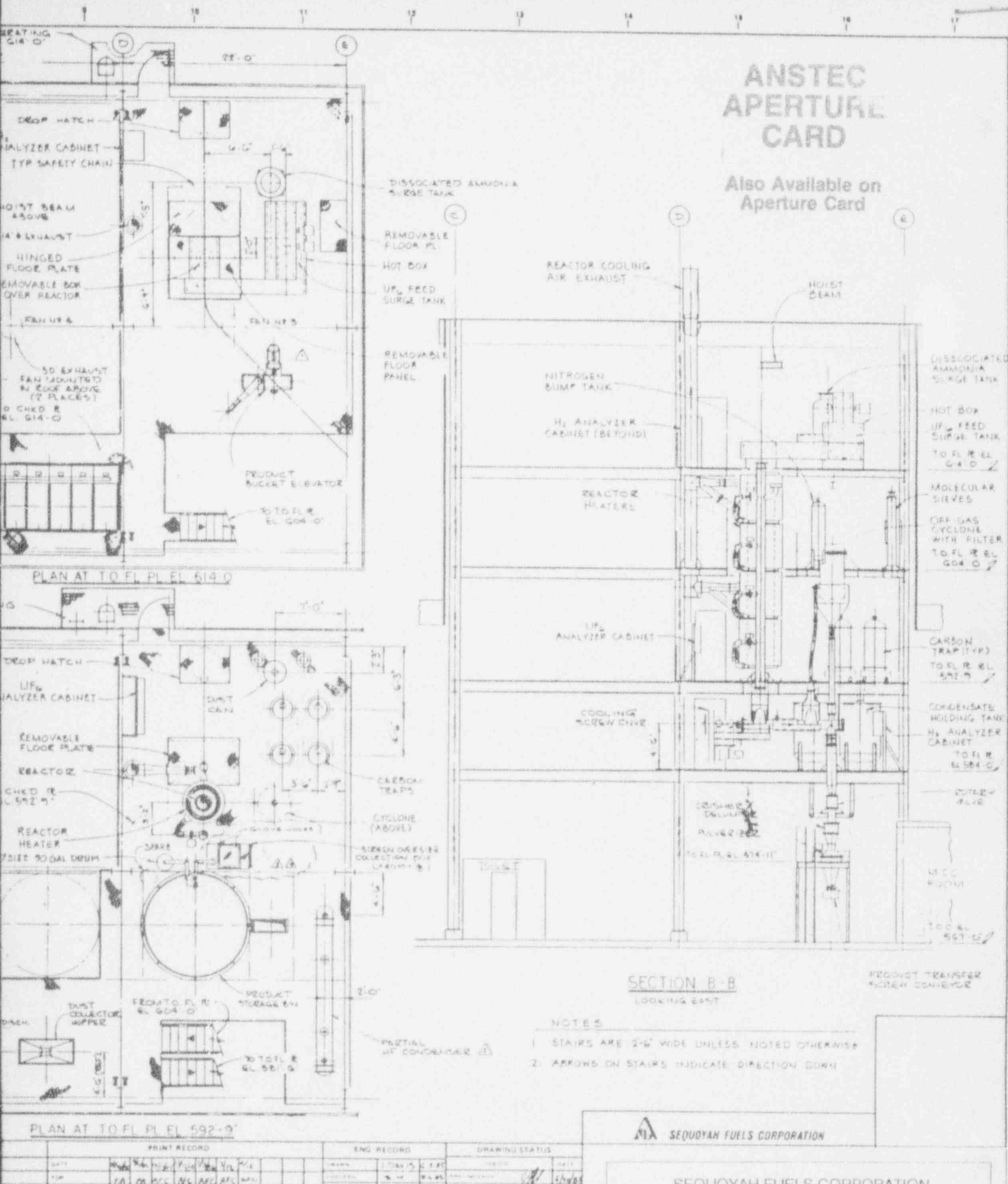
21'-0"
21'-0"
22'-0"
22'-0"
4'-0 SQUARE PALLETS (TYP)
T.O.C. SLAB EL 567'-0"
¢ 12'-0 × 12'-0 DOOR
LADDER
TOILET
SERVICE AREA
LAY DOWN AREA
DRINKING FOUNTAIN
PRODUCT TRANSFER SCREW CONVEYOR
REACTOR LAYDOWN AREA
24" EXHAUST FAN MOUNTED IN ROOF ABOVE (FAN N85)
DWG 800 M 2505
SAMPLE COLLECTION CAROUSEL (30 BOTTLES)
EMPTY DRUM STORAGE CONV.
PACKAGING LOW FEEDER
DRUM SCALE
CLARK 6000 LB CAPACITY FORKLIFT TRUCK
ACCUMULATOR CONV.
SCALE CONV.
DRUM FILL CONV.
PRODUCT DUST DRUM
GENERAL DUST DRUM
¢ 12'-0 × 12'-0 DOOR
¢ 5'-0 × 7'-0 DOOR (TYP 6 PLACES)
SLOPES DOWN
14'-9"
T.O.C. DOCK EL 567'-0"
CANOPY (ABOVE)
REVISIONS
REFERENCE DRAWINGS



SEQUOYAH FUELS CORPORATION
CURRENT CONDITIONS REPORT
FIGURE 4-2
UF6 REDUCTION FACILITY
GENERAL ARRANGEMENT OF GROUND FLOOR



T.O. GRATING EL. 604'-0"
OFF-GAS BACK UP FILTER
DROP HATCH
HINGED FLOOR PLATE
NITROGEN BUMP TANK (16' DIA.)
MOLECULAR SIEVES
REACTOR
NITROGEN BUMP TANK
VIBRATING SCREEN
OFF-GAS CYCLONE WITH FILTER
MONORAIL BEAM (ABOVE)
REMOVABLE FLOOR PLATE
DUST COLLECTOR
PRODUCT BUCKET ELEVATOR
TOTAL OF CONDENSER
TEST PORTS
T.O. FL. R. EL 592'-9"
FROM T.O. FL. R. EL 616'-0"
PLAN AT T.O. FL. PL. EL 604'-0"
DUST COLLECTION FAN
T.O. GRATING EL. 584'-0"
T.O. CHKD. R. EL. 584'-0"
CONDENSATE HOLDING TANKS
VACUUM SYSTEM WALL VALVES (TYP.) 18" ABOVE FLOOR
TYP. AGITATOR
DROP HATCH
H_2 ANALYZER CABINET
T.O.C. ROOF EL 575'-0"
REMOVABLE FLOOR PLATE
COOLING SCREW CONV.
TRANSFORMER
REACTOR COOLING FAN
WEIGH BIN FEED SCREW CONVEYOR
DUST SCREW CONVEYOR
GENERAL SYSTEM FILTER RECEIVER
T.O. CHKD. R. EL. 581'-6"
VACUUM EXHAUSTER
T.O. CHKD. R. EL. 576'-6" (LANDING)
T.O.C. ELEV. 561'-0"
FROM T.O. FL. R. EL. 592'-9"
CLEAN SYSTEM FILTER RECEIVER
CHUTE FROM ABOVE (REF.)
INLINE FILTER
PLAN AT T.O. FL. PL. EL 581'-6" & 584'-0"
REVISIONS
REFERENCE DRAWINGS



NOTES

1. STAIRS ARE 2'-6" WIDE UNLESS NOTED OTHERWISE
2. ARROWS ON STAIRS INDICATE DIRECTION DOWN

SEQUOYAH FUELS CORPORATION

SEQUOYAH FUELS CORPORATION
CURRENT CONDITIONS REPORT
FIGURE 4-3
UF6 REDUCTION FACILITY
GENERAL ARRANGEMENT OF PLATFORMS

9403110053-05

Appendix A

GROUNDWATER MODELLING

This appendix is a copy of information previously developed for the Nuclear Regulatory Commission. It is a response to one of several questions from NRC to SFC designed to obtain information necessary to support an Environmental Assessment (EA) of SFC's facility and process (Ref. 6). The EA was being developed in association with SFC's application to renew its NRC license. Commitments addressed within this appendix are not germane to this Preliminary Report.

Hydrology: Question 5

Provide a concise projection and interpretation of concentrations and extent of nitrate, arsenic, and uranium plumes in the groundwater for 3-, 5-, and -10 year intervals. The bases of the calculations and projections should also be provided. If the concentration level of any component in the groundwater at the river bank exceeds appropriate regulatory limits for the river, provide a local scale analysis to predict contaminant levels in the river.

Response

A response to this question requires a brief review of the current understanding of subsurface conditions at the SFC Facility. The groundwater hydrology at the Facility has been investigated extensively by SFC and its consultants. The results of these investigations are described in the Facility Environmental Investigation Findings Report (SFC 1991) and its Addendum (SFC 1992).

Conceptual Model of Groundwater System

The conceptual model describes previous findings and principal assumptions regarding the groundwater flow system that are important for evaluating a specific issue. In terms of constituent movement away from the SFC Facility, the conceptual model includes the following key points:

- The subsurface profile at the SFC Facility includes a thin layer of terrace deposits that are 0 to 16 feet thick, with an average thickness of 7 feet. The terrace deposits are composed of silt, clay, sand and gravel, but are generally fine-grained. They are underlain by a thick sequence (nearly 400 feet) of the Atoka Formation, a sequence of irregularly bedded, discontinuous layers of sandstone, siltstone, and shale, with thin limestone layers in the lower part. Individual layers of sandstone and shale in the upper part of the Atoka Formation at the Facility appear to be nearly flat-lying and variable in thickness, each ranging from 0 to 20 feet in thickness. Fill material has been placed at various locations at the SFC Facility, although fill generally lies above the water table.

- The SFC Facility is located near the edge of a slope east of the Illinois River Branch of the Robert S. Kerr Reservoir. The terrace deposits and the upper portion of the Atoka Formation have been eroded over time by historical river systems. In this area, the land surface on the steep slopes of the Illinois River valley are covered with a thin layer of unconsolidated sediments. Depending on elevation, the various sandstone/shale layers of the Atoka Formation subcrop beneath the sediments on the steep slope leading down to the Robert S. Kerr Reservoir. This situation is depicted in Figure HYD 5-1.

- Both the terrace deposits and the various sandstone and shale layers may be saturated in specific intervals. The depth to groundwater measured in monitoring wells is generally 5 to 15 feet at the Facility.

- The groundwater system at the Facility consists of several layered horizontal flow systems with limited natural vertical interconnection. Where saturated, the terrace deposits and uppermost shale unit at the site comprise the shallow shale/terrace unconfined groundwater flow system. This is underlain by the deep sandstone/shale confined groundwater flow system. It is expected that even deeper confined flow systems occur below those investigated at the Facility, but their great depth below the active portions of the site and limited interconnection with shallower groundwater flow systems indicate a low potential for groundwater movement between shallow flow systems and deeper flow systems.

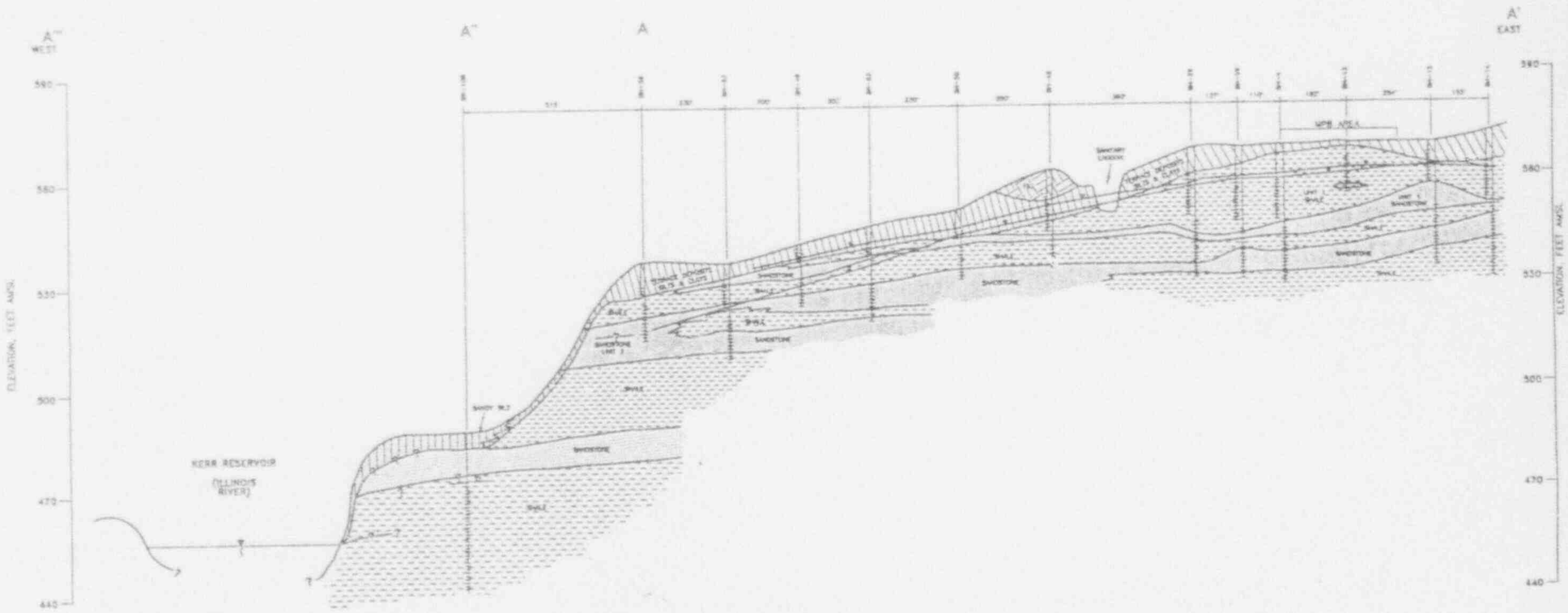
- In general, the shale layers are slightly more permeable than sandstone layers because the shale layers exhibit platy fracturing along bedding planes, while the sandstone layers are fine grained and highly cemented with silica. Within a particular flow system, the sandstone tends to form a confining layer and the shale generally transmits groundwater. The geometric mean of hydraulic conductivity for the two uppermost subsurface flow systems estimated from slug tests at the facility are:

  - 2×10^{-5} centimeters per second (cm/sec) for the shallow shale/terrace deposits

  - 7×10^{-5} cm/sec for the deep sandstone/shale

- Groundwater movement in the layered horizontal flow systems generally radiates westward, northwestward, and southwestward from the topographically high area occupied by the Main Process Building. The shallow shale/terrace and deep sandstone/shale groundwater flow systems discharge into the root zone of the soil on the steep slopes above the Illinois River Branch of the Robert S. Kerr Reservoir.

- Because of low hydraulic conductivities, the groundwater discharge through the flow systems at the SFC Facility is low. The rate of groundwater discharge along the steep slopes above the Robert S. Kerr Reservoir is too low to form visible springs or seeps on the ground surface. Discharged groundwater appears to either evaporate or be transpired by the heavy vegetative growth on the slopes.



NOTES:
1. GEOLOGIC CROSS SECTION A'''-A''-A-A' ADAPTED FROM SEQUOYAH FUELS CORPORATION ADDENDUM TO THE FACILITY ENVIRONMENTAL FINDINGS REPORT (SFC 1993)

LEGEND

- GROUNDWATER POTENTIOMETRIC SURFACE, DEEP SANDSTONE/SHALE, OCTOBER 21-22, 1991
- GROUNDWATER POTENTIOMETRIC SURFACE, SHALLOW SHALE/TERRACE, OCTOBER 21-22, 1991
- ILLINOIS RIVER STAGE, GORE, OK. QUADRANGLE (USGS 1974)
- MONITOR WELL SCREEN INTERVAL

SANDSTONE

TERRACE SILT AND CLAY

SHALE

SANDY SILT

SCALE: VERTICAL 1"=30'
HORIZONTAL 1"=300'
VERTICAL EXAGGERATION x10

Figure HYD 5-1
WEST TO EAST
GEOLOGIC CROSS SECTION A'''-A''-A-A'
SEQUOYAH FUELS CORPORATION

On the basis of this conceptual model, no direct groundwater flow path is believed to exist from either the shallow shale/terrace or deep sandstone/shale groundwater flow systems to the Illinois River Branch of the Robert S. Kerr Reservoir. The groundwater quality data from monitoring wells completed in deeper water bearing zones, such as MW-95A, -97A, and -98A, suggest that the groundwater quality effects of site operations are restricted to the uppermost groundwater flow systems at the Facility.

Groundwater Flow Path and Plume Evaluation

Because of the absence of a confirmed groundwater flow path between the shallow groundwater flow systems and the Illinois River Branch, SFC has evaluated the groundwater quality along specific flow paths from the identified constituent source areas to the discharge points on the steep slopes above the Illinois River Branch. Figure HYD 5-2 is a map showing the identified groundwater flow paths. The heads of the arrows on Figure HYD 5-2 correspond generally with the locations of the discharge point for the flow path, and the tails of the arrows generally correspond to the assumed location of the source areas. The paths are numbered and listed in Table HYD 5-1, along with a description of the path.

Table HYD 5-1
Groundwater Flow Paths Evaluated for Plume Movement

Path	Zone	Constituents Evaluated
1	Deep Sandstone/Shale	Uranium
2	Deep Sandstone/Shale	Uranium
3	Deep Sandstone/Shale	Arsenic
4	Deep Sandstone/Shale	Arsenic
5	Deep Sandstone/Shale	Arsenic and nitrate
6	Deep Sandstone/Shale	Nitrate
7	Deep Sandstone/Shale	Nitrate
8	Shallow Shale/Terrace	Uranium
9	Shallow Shale/Terrace	Arsenic and nitrate

Note: Flow paths are depicted on Figure HYD 5-2.

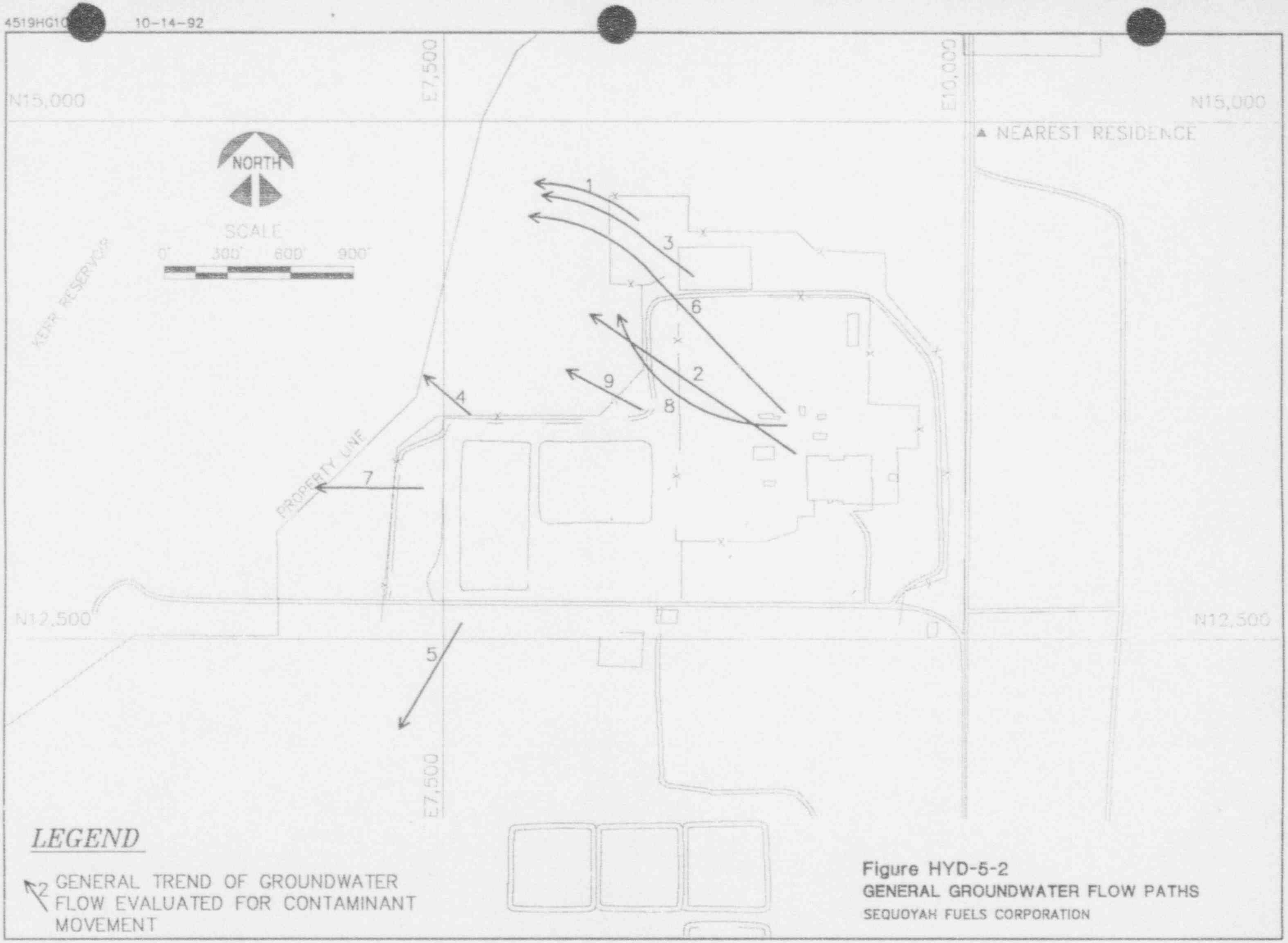


Figure HYD-5-2
GENERAL GROUNDWATER FLOW PATHS
SEQUOYAH FUELS CORPORATION

Flow paths were delineated by reviewing constituent isopleth maps for the site (SFC 1991 and SFC 1992), identifying areas of elevated constituent concentrations at the SFC Facility, and using recent potentiometric surface maps for the Facility to determine potential groundwater flow directions downgradient of the source areas and the Facility. Emphasis was placed on those flow paths that were directed generally westward in the direction of the Illinois River branch, because in most cases this represents the shortest flow path between onsite zones of impact and offsite discharge points.

The fertilizer ponds area was not included as a source area in this analysis and no paths were identified in this area because of the lack of potentiometric surface data at the time these questions were received. Evaluation of this area is continuing and will be submitted upon completion.

Predictions of Future Constituent Concentrations

Method Discussion and Input Data

Version 2.0 of the MYGRT code (EPRI 1989) was used to predict future concentrations along the identified flow paths. MYGRT is a quasi-analytical model based on the advection-dispersion retardation-decay equation. It can account for these processes in either one or two dimensions. The derivation for the solution to the partial differential equation for these four processes was derived by Cleary and Ungs (1978) and Javendel, et al. (1984).

The major assumptions of MYGRT version 2.0 are:

- The groundwater velocity is constant over the distance being simulated

- Longitudinal and transverse dispersion is represented by Ficks Law, and is a functicn of the scale of the problem (i.e., the length being simulated)

- Sorption/desorption is fast relative to the rate of groundwater flow and is represented as a linear, equilibrium partitioning between aqueous and solid phases.

- Sorption, represented by a retardation factor (the ratio of groundwater velocity to constituent velocity), is assumed to be constant over the distance being simulated

- Interference and competition for sorption sites is considered to be negligible

- The constituent in the source area is evenly distributed throughout the thickness of the aquifer

- The constituent source is linear and oriented perpendicular to the hydraulic gradient

The input data and basis for variables necessary to run MYGRT are:

- Groundwater velocity: based on hydraulic gradients interpreted from potentiometric surface maps of the site (SFC 1992); permeability estimates from slug test data (SFC 1991); and effective porosity estimates (SFC 1991)

- Dispersion coefficients (longitudinal and transverse): based on computed groundwater velocity, groundwater flow path length, and plots of dispersion coefficients (EPRI 1989)

- Retardation factor: assumed to be one (1) for nitrate (no retardation) based on Freeze and Cherry (1979); a calibrated factor ranging from 1 to 100 for uranium and arsenic, based on the observed distribution of arsenic and uranium

- Source width: estimated from the size of the area of impact, based on isopleth maps for the facility (SFC 1991 and SFC 1992)

- Source concentration: assumed to be equivalent to the maximum observed concentration in the source area, based on the most recently available isopleth maps for the facility (SFC 1992)

- Background concentration: assumed to be negligible relative to the concentrations measured at the source areas

- Time of simulation: based on the length of time since the assumed source areas have been operating, estimated from available historical information on changes in site operation (SFC 1991).

MYGRT input data are presented in Table HYD 5-2. Four simulation times are listed in Table HYD 5-2. The first time listed represents current conditions, and is equivalent to the approximate length of time that has elapsed since the structure or facility was constructed and potentially may have acted as the source for the observed concentrations. The implicit assumption is that constituents were released to the groundwater soon after operation began, and that the rate of release has remained constant over time. The other three times listed represent predictions 3, 5, and 10 years, respectively, into the future. In addition, Table HYD 5-2 summarizes the predicted concentrations at the assumed groundwater flow system discharge points (based on projected locations of each layer's subcrop on the steep slope above the Illinois River branch of the Robert S. Kerr Reservoir).

Table HYD 5-1 Groundwater Flow Paths Evaluated for Plume Movement		
Path	**Zone**	**Constituents Evaluated**
1	Deep Sandstone/Shale	Uranium
2	Deep Sandstone/Shale	Uranium
3	Deep Sandstone/Shale	Arsenic
4	Deep Sandstone/Shale	Arsenic
5	Deep Sandstone/Shale	Arsenic and nitrate
6	Deep Sandstone/Shale	Nitrate
7	Deep Sandstone/Shale	Nitrate
8	Shallow Shale/Terrace	Uranium
9	Shallow Shale/Terrace	Arsenic and nitrate
Note: Flow paths are depicted on Figure HYD 5-2.		

Table HYD 5-2
Summary of MYGRT Input Data and Results

Zone[a]	Constituent	Flowpath[b] Number	Groundwater Flowpath Length[b] (ft)	Assumed Source Width (ft)	Groundwater Velocity (ft/yr)	Longitudinal Dispersion Coefficient (ft^2/yr)	Transverse Dispersion Coefficient (ft^2/yr)	Retardation Coefficient	Groundwater Concentration At Source (mg/L)	Predicted Concentration at Discharge Point (mg/L)	Simulation Time (years)	Simulation ID
DSS	Uranium	1	450	100	36.9	2,720	270	10	0.694	<0.005	20	DSS-U-A
		1	450	100	36.9	3,130	310	10	0.694	<0.005	23	DSS-U-A
		1	450	100	36.9	3,400	340	10	0.694	<0.005	25	DSS-U-A
		1	450	100	36.9	4,080	408	10	0.694	<0.005	30	DSS-U-A
		2	1,410	50	60	8,460	846	30	1.04	<0.005	20	DSS-U-B1
		2	1,410	50	60	8,460	846	30	1.04	<0.005	23	DSS-U-B1
		2	1,410	50	60	8,460	846	30	1.04	<0.005	25	DSS-U-B1
		2	1,410	50	60	8,460	846	30	1.04	<0.005	30	DSS-U-B1
		2	1,620	50	7.2	1,160	116	8	16.3	<0.005	20	DSS-U-B2
		2	1,620	50	10	1,620	162	8	16.3	<0.005	23	DSS-U-B2
		2	1,620	50	12	1,940	194	8	16.3	<0.005	25	DSS-U-B2
		2	1,620	50	17	2,750	275	8	16.3	<0.005	30	DSS-U-B2
	Arsenic	3	870	50	44.9	4,050	405	3	0.081	<0.005	20	DSS-A-A
		3	870	50	44.9	4,660	466	3	0.081	<0.005	23	DSS-A-A
		3	870	50	44.9	5,060	506	3	0.081	<0.005	35	DSS-A-A
		3	870	50	44.9	6,070	607	3	0.081	<0.005	30	DSS-A-A
		4	480	100	61.0	7,440	744	100	0.159	<0.005	20	DSS-A-B
		4	480	100	61.0	8,560	856	100	0.159	<0.005	23	DSS-A-B
		4	480	100	61.0	9,300	930	100	0.159	<0.005	25	DSS-A-B
		4	480	100	61.0	11,190	1,119	100	0.159	<0.005	30	DSS-A-B
		5	600	100	65.3	2,590	259	30	2.10	<0.005	20	DSS-A-C
		5	600	100	65.3	2,980	298	30	2.10	<0.005	23	DSS-A-C
		5	600	100	65.3	3,240	324	30	2.10	<0.005	25	DSS-A-C
		5	600	100	65.3	3,870	387	30	2.10	<0.005	30	DSS-A-C
	Nitrate	7	420	100	117	4,910	491	1	1560	920	20	DSS-N-C
		7	420	100	117	4,910	491	1	1560	920	23	DSS-N-C
		7	420	100	117	4,910	491	1	1560	920	25	DSS-N-C
		7	420	100	117	4,910	491	1	1560	920	30	DSS-N-C
		6	1,440	100	43.1	6,210	621	1	316	14	20	DSS-N-B
		6	1,440	100	68.2	9,820	982	1	316	45	23	DSS-N-B
		6	1,440	100	68.2	9,820	982	1	316	50	25	DSS-N-B
		6	1,440	100	68.2	9,820	982	1	316	60	30	DSS-N-B
		5	600	100	58.4	3,500	350	1	4,350	1,880	20	DSS-N-A
		5	600	100	58.4	3,500	350	1	4,350	1,930	23	DSS-N-A
		5	600	100	58.4	3,500	350	1	4,350	1,940	25	DSS-N-A
		5	600	100	58.4	3,500	350	1	4,350	1,960	30	DSS-N-A

Table HYD 5-2
Summary of MYGRT Input Data and Results

Zone[a]	Constituent	Flowpath Number[b]	Groundwater Flowpath Length[b] (ft)	Assumed Source Width (ft)	Groundwater Velocity (ft/yr)	Longitudinal Dispersion Coefficient (ft^2/yr)	Transverse Dispersion Coefficient (ft^2/yr)	Retardation Coefficient	Groundwater Concentration At Source (mg/L)	Predicted Concentration at Discharge Point (mg/L)	Simulation Time (years)	Simulation ID
SST	Uranium	8	1,020	100	7.0	840	84	1	1.230	<0.005	20	SST-U-A
		8	1,020	100	12.3	1,480	148	1	1.230	<0.005	23	SST-U-A
		8	1,020	100	12.3	1,480	148	1	1.230	<0.005	25	SST-U-A
		8	1,020	100	12.3	1,480	148	1	1.230	0.005	30	SST-U-A
	Arsenic	9	300	100	16.4	549	54.9	4	0.302	<0.005	10	SST-A-A
		9	300	100	16.4	549	54.9	4	0.302	<0.005	13	SST-A-A
		9	300	100	16.4	549	54.9	4	0.302	0.01	15	SST-A-A
		9	300	100	16.4	549	54.9	4	0.302	0.02	20	SST-A-A
	Nitrate	9	285	75	29.3	835	83	1	1,610	700	10	SST-N-A
		9	285	75	29.3	835	83	1	1,610	900	13	SST-N-A
		9	285	75	29.3	835	83	1	1,610	1,000	15	SST-N-A
		9	285	75	29.3	835	83	1	1,610	1,100	20	SST-N-A

Notes:

a) DSS = Deep sandstone/shale flow system
SST = Shallow shale/terrace flow system
b) Flowpaths are shown on Figure HYD 5-2.
c) The four times listed for each simulation represent, from top to bottom, predicted conditions in 1992, 1995, 1997, and 2002.
d) MYGRT output plots and summary input data are provided in Attachment HYD 5-1.
e) Two runs are listed for DSS-U-B because two source areas lie along this flow path.

Results of Predictions

Attachment HYD 5-1 contains results of the MYGRT simulations, in the form of predicted concentrations plotted against distance along the various flow paths. For the purposes of this analysis, the following discharge points were assumed, on the basis of Figure HYD 5-1 and Figure 7 in SFC (1992):

- The shallow shale/terrace groundwater flow system is assumed to discharge at the base of the Unit 1 Sandstone. The arrowheads for flow paths 8 and 9 in Figure HYD 5-2 generally correspond with the locations of the assumed discharge points.

- The deep sandstone/shale groundwater flow system is assumed to discharge at the top of the Unit 3 Sandstone. The arrowheads for flow paths 1 through 7 in Figure HYD 5-2 generally correspond with the locations of the assumed discharge points.

As shown in Table HYD 5-2, concentrations at the discharge points are predicted to be below the detection limits (0.005 mg/L for arsenic and uranium; 0.01 mg/L for nitrate) or near background concentrations for most of the flow paths analyzed. The exceptions are:

- Nitrate in the deep sandstone/shale unit along flow path 5 (southwest toward the storm water reservoir), where predicted concentrations are 1,930 mg/L in 1995, 1,940 mg/L in 1997, and 1960 mg/L in 2002.

- Nitrate in the deep sandstone/shale unit along flow path 6 (northwest from the main process building area toward the steep slope above the Illinois River), where predicted concentrations are 45 mg/L in 1995, 50 mg/L in 1997, and 60 mg/L in 2002.

- Nitrate in the deep sandstone/shale unit along flow path 7 (west from the Pond 2 area toward the steep slope above the Illinois River branch), where predicted concentrations are 920 mg/L in 1995, 1997, and 2002.

- Uranium in the shallow shale/terrace unit along flow path 8 (northwest from north of the main process building area toward the steep slope above the Illinois River branch), where predicted concentrations are below the detection limit of 0.005 mg/L in 1995 and 1997, and near the detection limit in 2002.

- Arsenic in the shallow shale/terrace unit along flow path 9 (northwest from north of the clarifier pond area toward the steep slope above the Illinois River Branch), where predicted concentrations are below the detection limit of 0.005 mg/L in 1995, and are 0.01 mg/L in 1997 and 0.02 mg/L in 2002.

- Nitrate in the shallow shale/terrace unit along flow path 9 (northwest from north of the clarifier pond area toward the steep slope above the Illinois River branch,) where predicted concentrations are 900 mg/L in 1995, 1,000 mg/L in 1997, and 1,100 mg/L in 2002.

The predicted locations of the plume fronts are shown in Figures HYD 5-3 through HYD 5-9. The plume fronts were defined as the facility action level for uranium (225 ug/L), the maximum contaminant level (MCL) for drinking water for arsenic (0.05 mg/L), and the MCL for nitrate (10 mg/L). For plumes that already appear to have reached the discharge point along the flow path evaluated, it was not possible to map the plume front.

On the basis of these estimates, it appears that arsenic and uranium concentrations will be near or below detectable concentrations at the groundwater flow system discharge points, which are uphill of the Illinois River branch of the Robert S. Kerr Reservoir. Nitrate is the only constituent evaluated where predicted concentrations at the discharge point are above the MCL of 10 mg/L. This is a result of three factors:

- Nitrate is mobile; it is expected to have little chemical interaction with the aquifer, and therefore has a low retardation factor

- Apparent sources of nitrate are located close to the facility boundary

- Observed nitrate concentrations are several orders of magnitude above the concentrations of either uranium or arsenic

Because of low permeabilities in the water bearing zones at the SFC Facility, the rate of groundwater discharge to the surface or the root zone of the slopes above the Illinois River branch is expected to be low. No direct discharge via the groundwater pathway is expected between existing plumes and the Illinois River branch of the Robert S. Kerr Reservoir. No local-scale analysis of mixing in the river, therefore, has been performed.

Evaluation of Results

The retardation factor was the principal variable used for fitting predicted results to observed concentrations during calibration. During calibration, it was determined that the model was sensitive to changes in groundwater flow velocity, source concentration, and the length of time for which the source was assumed to be active.

As listed in Table HY 5-2, the calibrated values for retardation factors varied from 1 to 10 for uranium, and from 3 to 100 for arsenic. It is reasonable to expect retardation factors for pH- and Eh-sensitive constituents to vary from location to location at the SFC Facility, because variability in both pH and Eh has been documented by previous site investigations at the Facility (SFC 1991).

LEGEND

↖ GENERAL TREND OF GROUNDWATER FLOW EVALUATED FOR URANIUM MOVEMENT, WITH PREDICTED LOCATIONS OF PLUME IN 1992,1995,1997, AND 2002 (DEFINED AS CONCENTRATIONS ABOVE THE FACILITY ACTION LEVEL OF 225ug/L)

Figure HYD-5-3
PREDICTED URANIUM CONCENTRATIONS IN DEEP SANDSTONE/SHALE ALONG FLOW PATH 1
SEQUOYAH FUELS CORPORATION

LEGEND

↖ GENERAL TREND OF GROUNDWATER FLOW EVALUATED FOR URANIUM MOVEMENT, WITH PREDICTED LOCATIONS OF PLUME IN 1992,1995,1997, AND 2002 (DEFINED AS CONCENTRATIONS ABOVE THE FACILITY ACTION LEVEL OF 0.225mg/L).

Figure HYD-5-4
PREDICTED URANIUM CONCENTRATIONS IN DEEP SANDSTONE/SHALE ALONG FLOW PATH 2
SEQUOYAH FUELS CORPORATION

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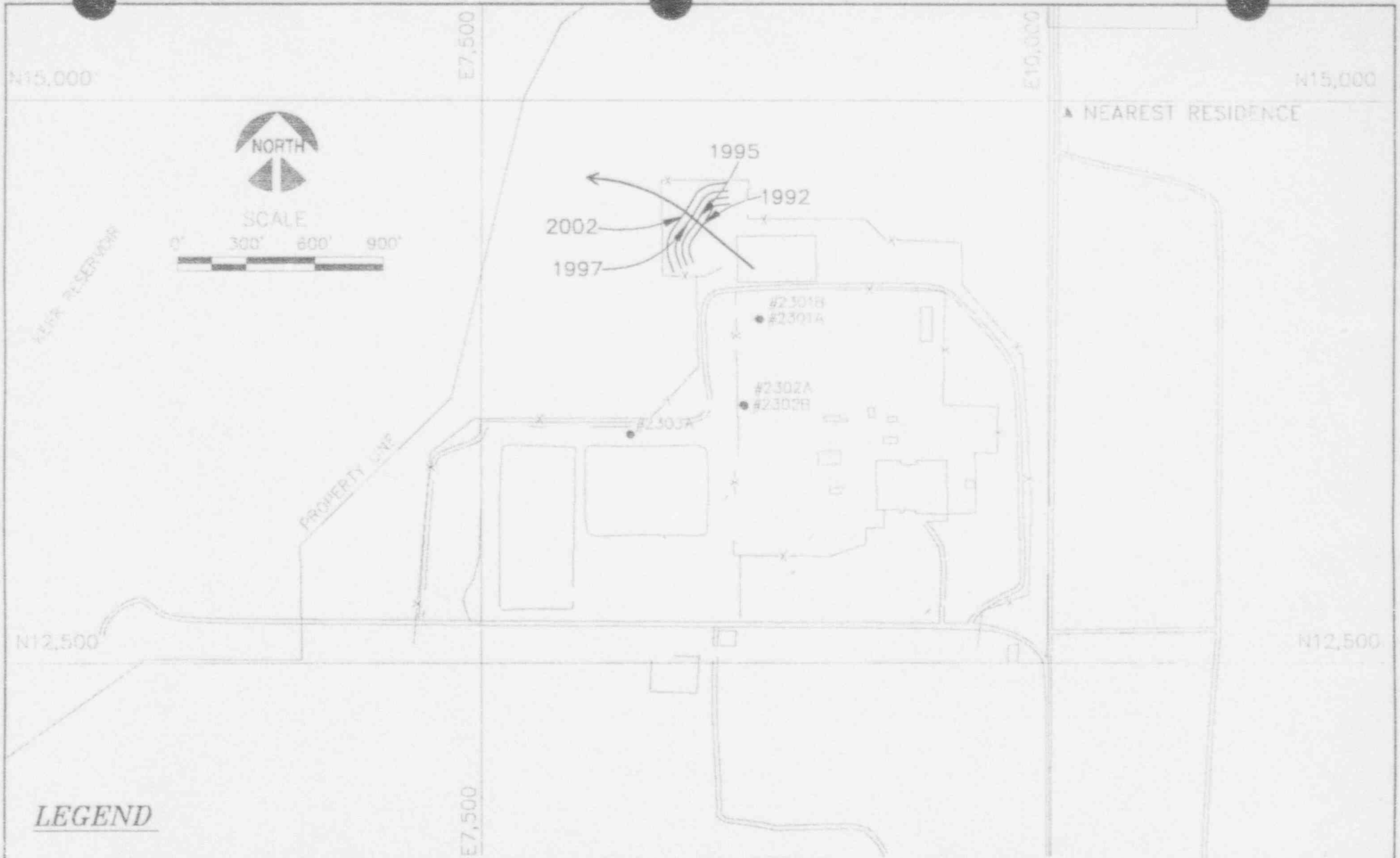

LEGEND

↖ GENERAL TREND OF GROUNDWATER FLOW EVALUATED FOR ARSENIC MOVEMENT, WITH PREDICTED LOCATIONS OF PLUME IN 1992,1995,1997, AND 2002 (DEFINED AS CONCENTRATIONS ABOVE THE MCL OF 0.05mg/L)

Figure HYD-5-5
PREDICTED ARSENIC CONCENTRATIONS IN DEEP SANDSTONE/SHALE ALONG FLOW PATH 3

SEQUOYAH FUELS CORPORATION

4519HG05 10-27-92

LEGEND

↖ GENERAL TREND OF GROUNDWATER FLOW EVALUATED FOR ARSENIC MOVEMENT, WITH PREDICTED LOCATIONS OF PLUME IN 1992,1995,1997, AND 2002 (DEFINED AS CONCENTRATIONS ABOVE THE MCL OF 0.05mg/L)

Figure HYD-5-6
PREDICTED ARSENIC CONCENTRATIONS IN DEEP SANDSTONE/SHALE ALONG FLOW PATH 4
SEQUOYAH FUELS CORPORATION

LEGEND

↖ GENERAL TREND OF GROUNDWATER FLOW
EVALUATED FOR ARSENIC MOVEMENT, WITH PREDICTED LOCATIONS OF PLUME IN 1992,1995,1997, AND 2002 (DEFINED AS CONCENTRATIONS ABOVE THE MCL OF 0.05mg/L)

Figure HYD-5-7
PREDICTED ARSENIC CONCENTRATIONS IN DEEP SANDSTONE/SHALE ALONG FLOW PATH 5
SEQUOYAH FUELS CORPORATION

LEGEND

↖ GENERAL TREND OF GROUNDWATER FLOW EVALUATED FOR URANIUM MOVEMENT, WITH PREDICTED LOCATIONS OF PLUME IN 1992,1995,1997, AND 2002 (DEFINED AS CONCENTRATIONS ABOVE THE FACILITY ACTICN LEVEL OF 225ug/L)

Figure HYD-5-8
PREDICTED URANIUM CONCENTRATIONS IN SHALLOW SHALE/TERRACE ALONG FLOW PATH 8
SEQUOYAH FUELS CORPORATION

4519HG0 10-27-92

LEGEND

↖ GENERAL TREND OF GROUNDWATER FLOW EVALUATED FOR ARSENIC MOVEMENT, WITH PREDICTED LOCATIONS OF PLUME IN 1992,1995,1997, AND 2002 (DEFINED AS CONCENTRATIONS ABOVE THE MCL OF 0.05mg/L)

Figure HYD-5-9
PREDICTED ARSENIC CONCENTRATIONS IN SHALLOW SHALE/TERRACE ALONG FLOW PATH 9

SEQUOYAH FUELS CORPORATION

The NRC (1984) cites a range in retardation factors for uranium (IV) and uranium (VI) of 840 to 7,200 for mixtures of sand and clay. Using distribution coefficients from Baes and Sharp (1983) for arsenic in soils, retardation factors ranging from 50 to 970 can be calculated for arsenic (III) and arsenic (V). The values of retardation factors obtained from model calibration were less than these literature values, suggesting that the predicted rates of plume movement provided by this analysis may be conservatively high. Many assumptions made for this analysis, such as the length of time over which a source has been active, are difficult to verify. For this reason, the results of this analysis are considered a preliminary effort to characterize the movement of uranium, arsenic, and nitrate at the SFC Facility.

References

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Javendel, I., C. Doughty, and C.F. Tsang. 1984. Groundwater Transport: Handbook of Mathematical Models. Water Resources Monograph 10, American Geophysical Union, Washington, D.C.

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Attachment HYD 5-1

MYGRT Model Input Data and Output Plots

Note: The MYGRT model input variables are presented for each run accompanied by plots of predicted concentrations. In addition to those variables defined in the tables themselves, the following variables are presented for each MYGRT run in the appropriate input table:

- Run# = model run number identification labels
  - Base is current (1992) conditions
  - A is 1995 conditions
  - B is 1997 conditions
  - C is 2002 conditions
- V = Groundwater flow velocity in meters per year
- D_x = Longitudinal dispersion (meter^2/year)
- D_y = Transverse dispersion (meter^2/year)
- Ton = The time the source became active
- Toff = The time the source became inactive
- Rd = Retardation factor

MYGRT variables are expressed in SI units. Conversion values are:

- Velocity in meters/year to feet per day: multiply by 0.009
- Dispersion coefficient in meters^2/year to feet^2/day: multiply by 0.03
- Source width in meters to feet: multiply by 3.3

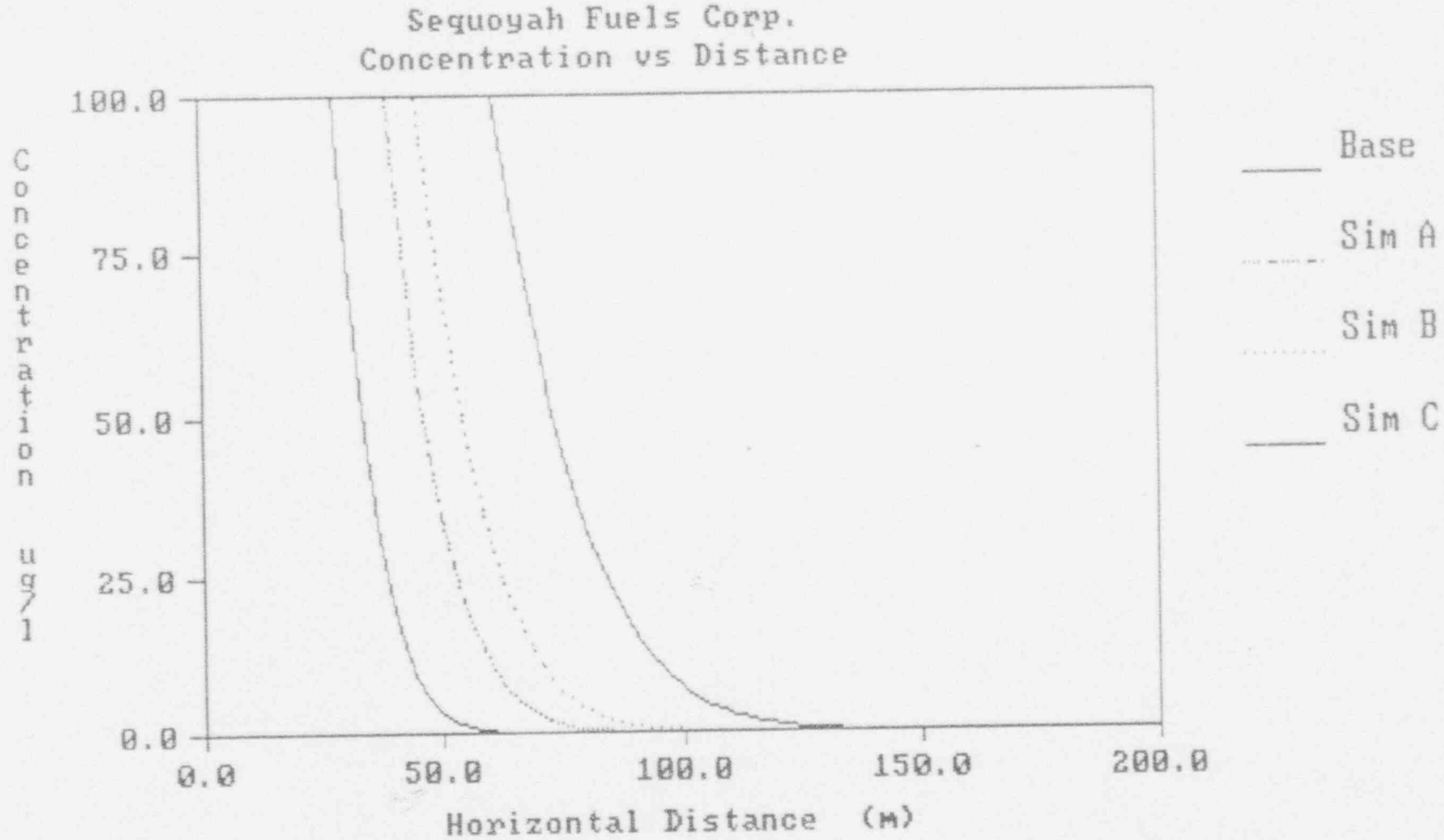
MYGRT Version 2.0

Simulation of DSS-U-A   at Sequoyah Fuels Corp.

Horizontal, Areal   Inorganic Solute

Background Concentration of DSS-U-A : Cbk = 0.000000 (ug/l)
Aquifer Concentration of DSS-U-A : Co = 694.000000 (ug/l)
Source Width: W = 30.480000 (m)

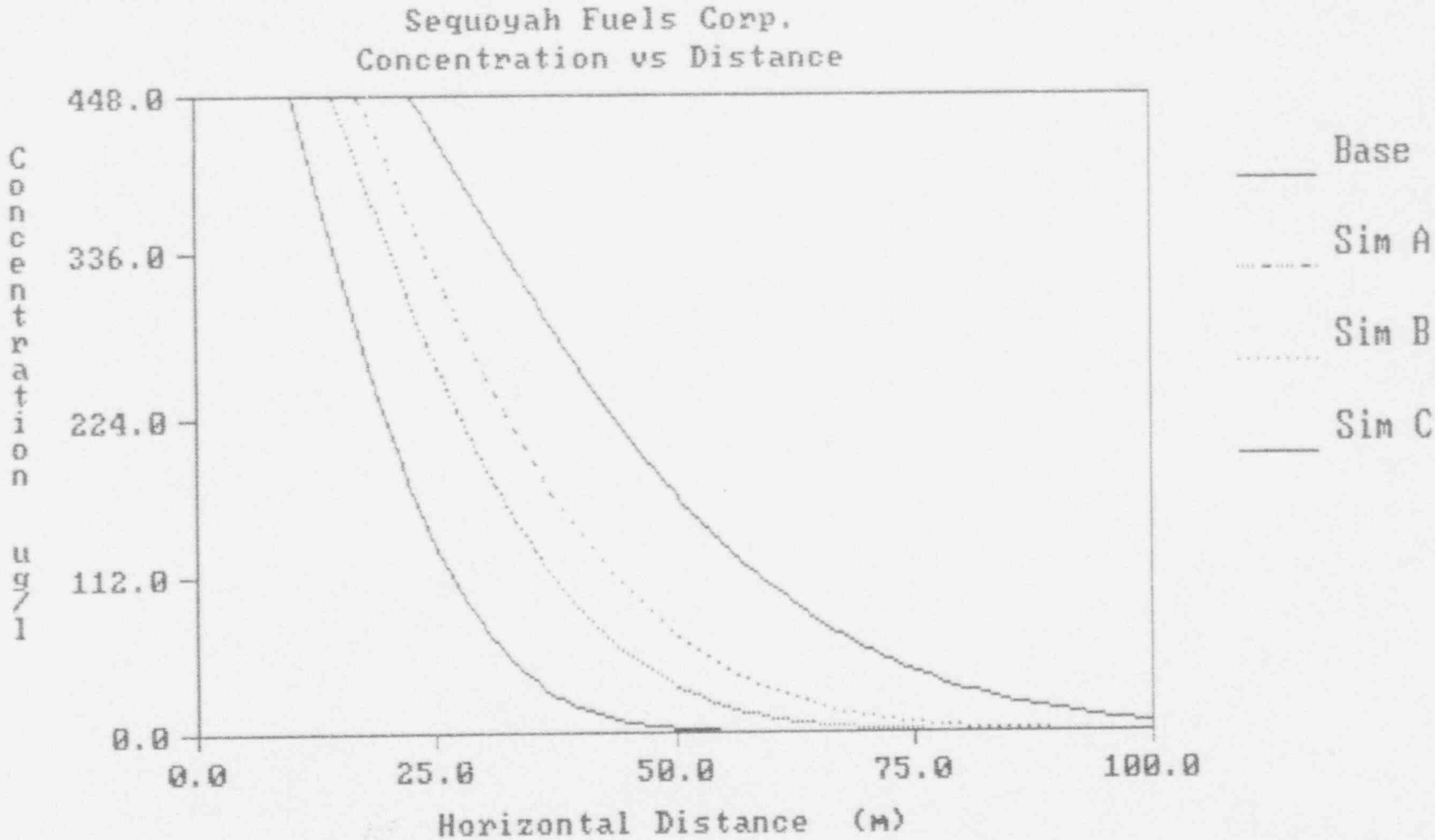
Run#	V	Dx	Dy	Ton	Toff	Rd
Base	11.2	253	25.3	10	15.0	10.00
A	11.2	291	29.1	7	15.0	10.00
B	11.2	316	31.6	5	15.0	10.00
C	11.2	379	37.9	0	15.0	10.00



Solute = DSS-U-A T = 15.0 (yr)

Y = 0.0 (m)

HYD 5-22



Solute = DSS-U-A

T = 15.0 (yr)
Y = 0.0 (m)

HYD 5-23

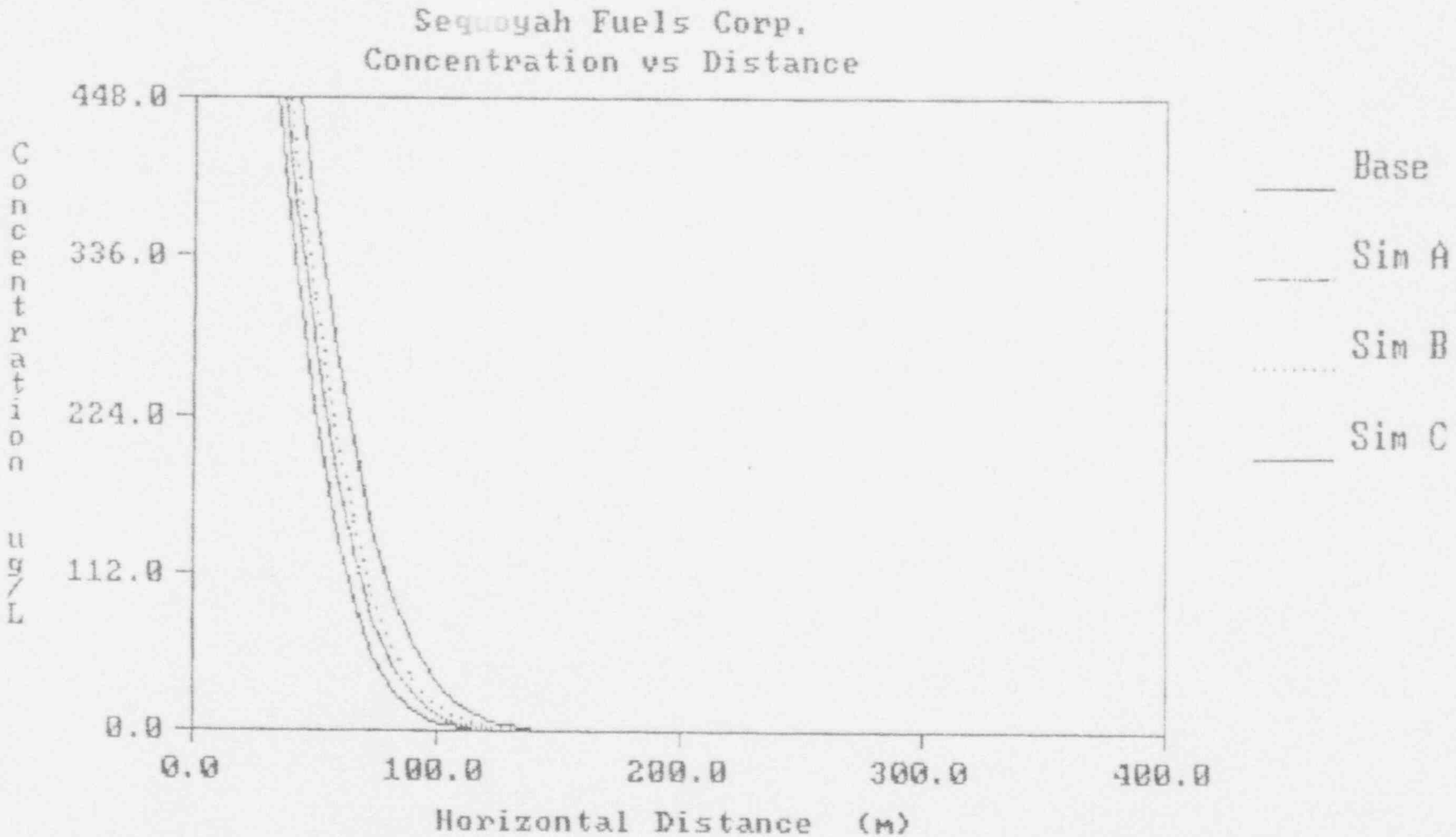
MYGRT Version 2.0

Simulation of DSS-U-B1 at Sequoyah Fuels Corp.

Horizontal, Areal Organic Solute

Background Concentration of DSS-U-B1 :	Cbk =	0.000000	(ug/L)
Aquifer Concentration of DSS-U-B1 :	Co =	1040.000000	(ug/L)
Source Width:	W =	50.000000	(m)

Run#	V	Dx	Dy	Ton	Toff	Rd
Base	18.3	786	78.6	10	30.0	30.00
A	18.3	786	78.6	7	30.0	30.00
B	18.3	786	78.6	5	30.0	30.00
C	18.3	786	78.6	0	30.0	30.00



Solute = DSS-U-B1 T = 30.0 (yr)
Y = 0.0 (m)

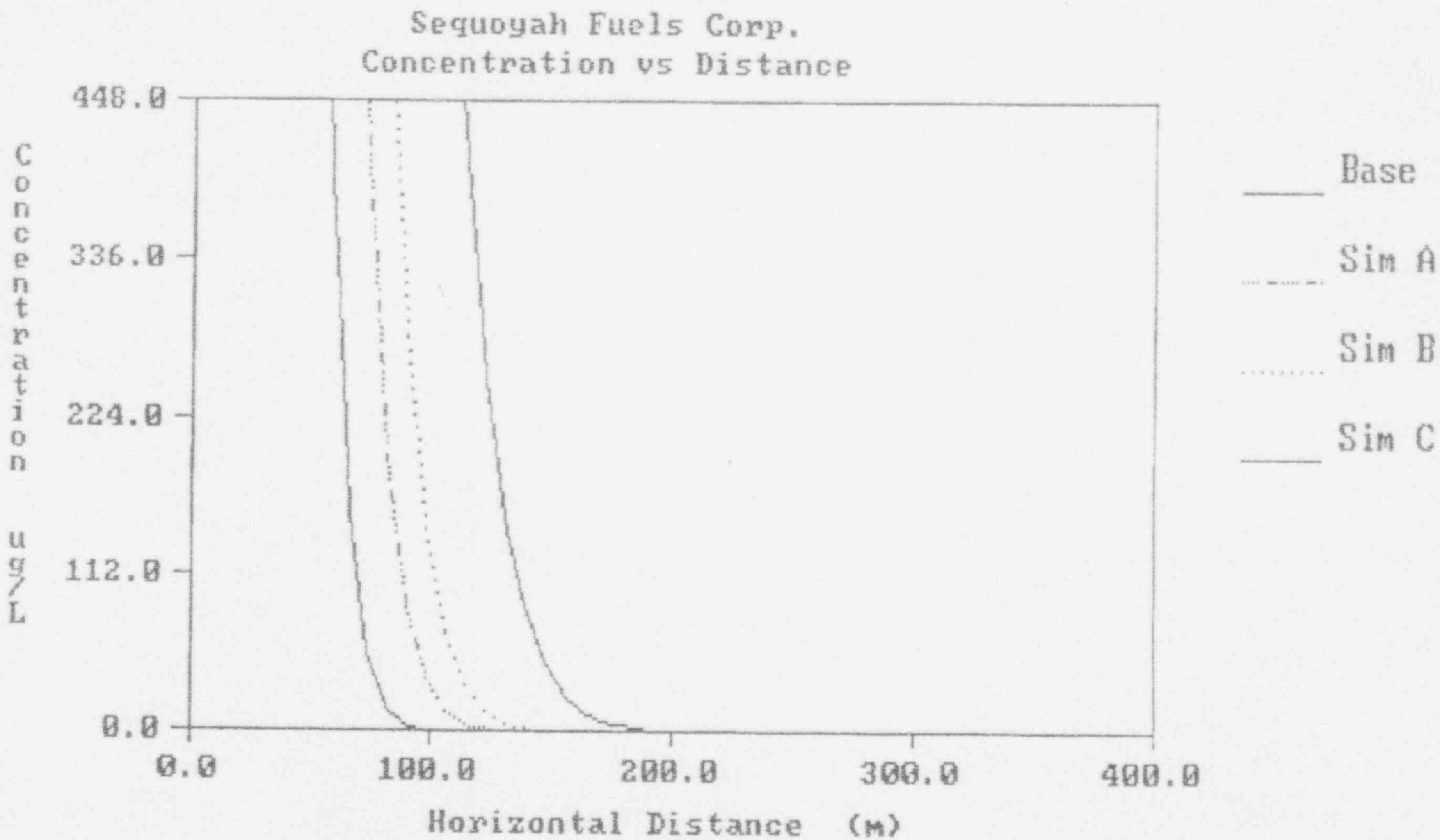
MYGRT Version 2.0

Simulation of DSS-U-B2 at Sequoyah Fuels Corp.

Horizontal, Areal Organic Solute

Background Concentration of DSS-U-B2 : Cbk = 0.000000 (ug/L)
Aquifer Concentration of DSS-U-B2 : Co = 16000.000000 (ug/L)
Source Width: W = 50.000000 (m)

Run#	V	Dx	Dy	Ton	Toff	Rd
Base	2.2	108	10.8	10	30.0	8.00
A	3.1	150	15.0	7	30.0	8.00
B	3.7	180	18.0	5	30.0	8.00
C	5.2	255	25.5	0	30.0	8.00



Solute = DSS-U-B2

T = 30.0 (yr)

Y = 0.0 (m)

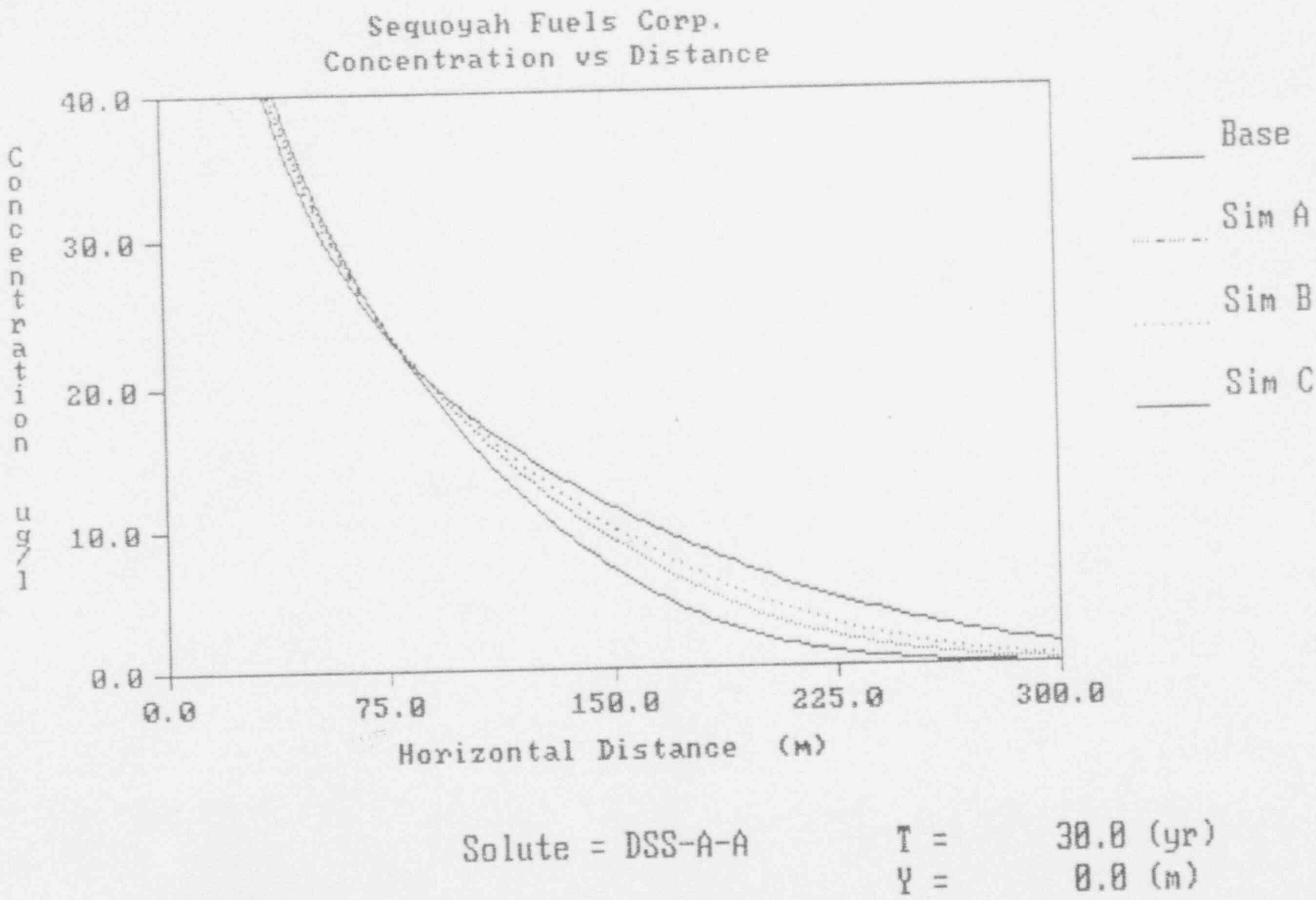
MYGRT Version 2.0

Simulation of DSS-A-A   at Sequoyah Fuels Corp.

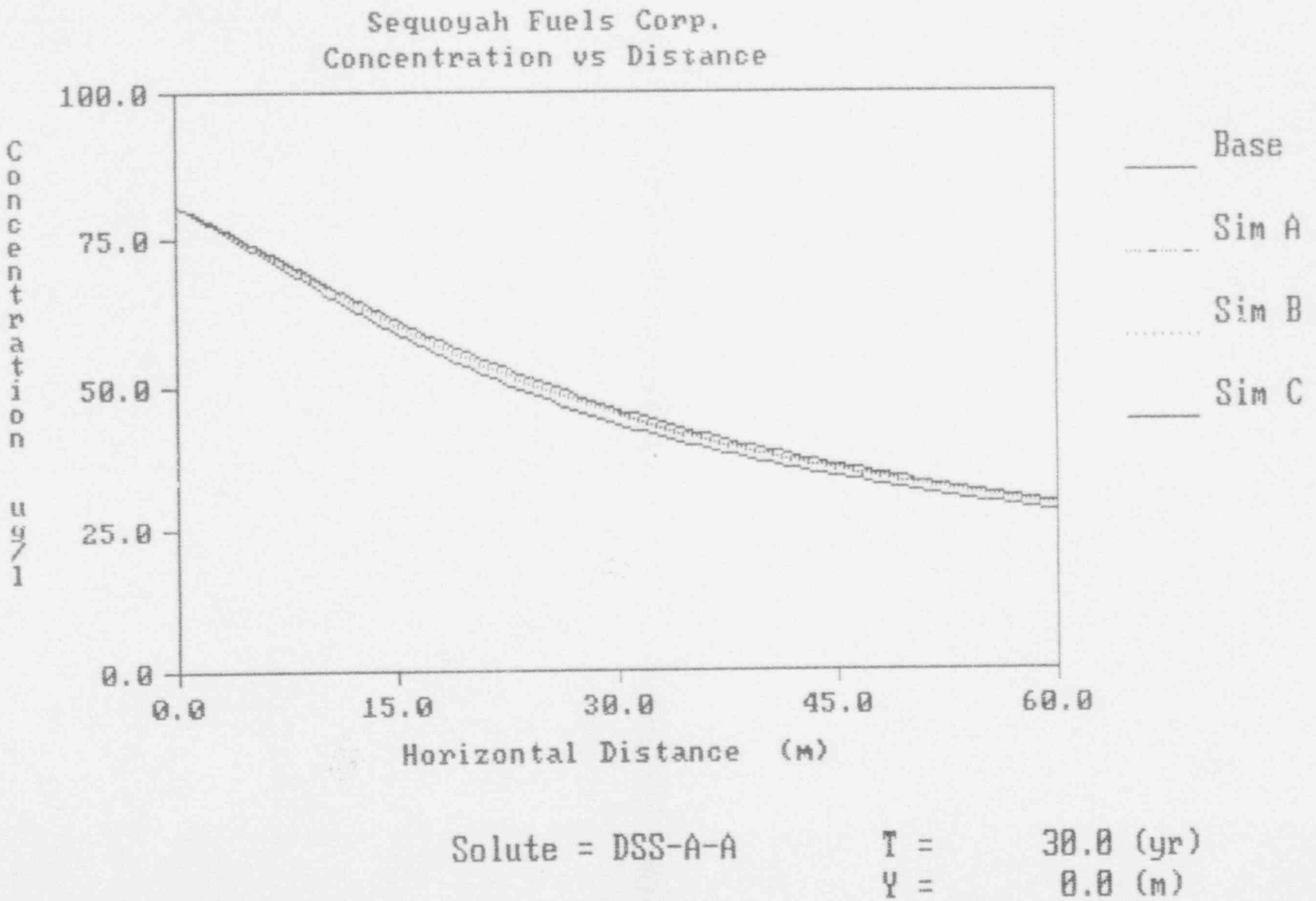
Horizontal, Areal   Inorganic Solute

Background Concentration of DSS-A-A : Cbk = 0.000000 (ug/l)
Aquifer Concentration of DSS-A-A : Co = 81.000000 (ug/l)
Source Width: W = 15.240000 (m)

Run#	V	Dx	Dy	Ton	Toff	Rd
Base	13.7	376	37.6	10	30.0	3.00
A	13.7	433	43.3	7	30.0	3.00
B	13.7	470	47.0	5	30.0	3.00
C	13.7	564	56.4	0	30.0	3.00


Sequoyah Fuels Corp.
Concentration vs Distance
Concentration ug/l
40.0
30.0
20.0
10.0
0.0
0.0
75.0
150.0
225.0
300.0
Horizontal Distance (m)
Base
Sim A
Sim B
Sim C
Solute = DSS-A-A
T = 30.0 (yr)
Y = 0.0 (m)

HYD 5-28



Sequoyah Fuels Corp.
Concentration vs Distance
100.0
75.0
50.0
25.0
0.0
Concentration ug/l
0.0
15.0
30.0
45.0
60.0
Horizontal Distance (m)
Base
Sim A
Sim B
Sim C
Solute = DSS-A-A
T = 30.0 (yr)
Y = 0.0 (m)

HYD 5-29

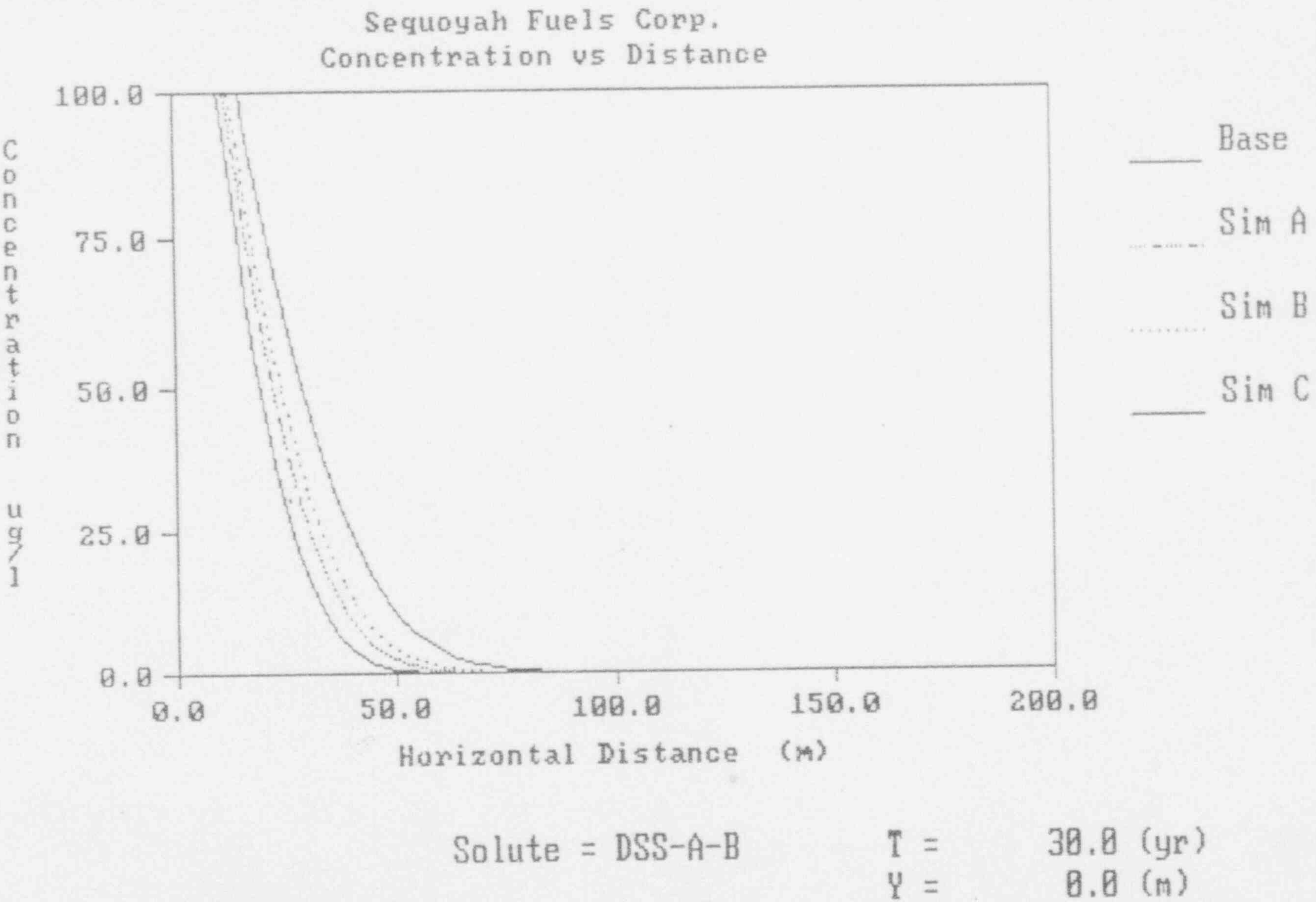
MYGRT Version 2.0

Simulation of DSS-A-B at Sequoyah Fuels Corp.

Horizontal, Areal Inorganic Solute

Background Concentration of DSS-A-B : Cbk = 0.000000 (ug/l)
Aquifer Concentration of DSS-A-B : Co = 159.000000 (ug/l)
Source Width: W = 30.480000 (m)

Run#	V	Dx	Dy	Ton	Toff	Rd
Base	18.6	691	69.1	10	30.0	100.00
A	18.6	795	79.5	7	30.0	100.00
B	18.6	864	86.4	5	30.0	100.00
C	18.6	1040	104.0	0	30.0	100.00


Sequoyah Fuels Corp.
Concentration vs Distance
100.0
75.0
50.0
25.0
0.0
Concentration ug/l
0.0
50.0
100.0
150.0
200.0
Horizontal Distance (m)
Base
Sim A
Sim B
Sim C
Solute = DSS-A-B
T = 30.0 (yr)
Y = 0.0 (m)

HYD 5-31

MYGRT Version 2.0

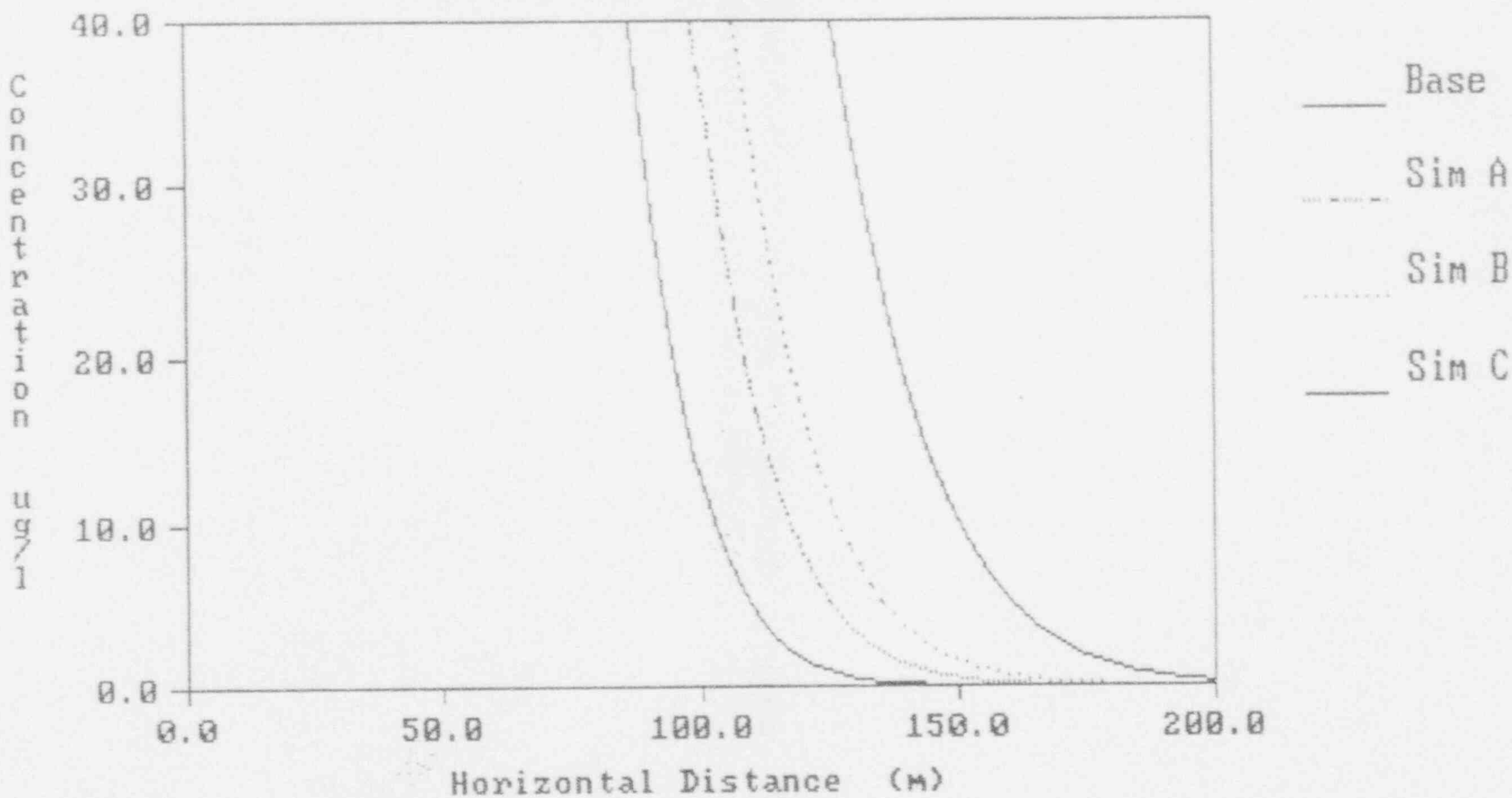
Simulation of DSS-A-C at Sequoyah Fuels Corp.

Horizontal, Areal Inorganic Solute

Background Concentration of DSS-A-C : Cbk = 0.000000 (ug/l)
Aquifer Concentration of DSS-A-C : Co = 2100.000000 (ug/l)
Source Width: W = 30.480000 (m)

Run#	V	Dx	Dy	Ton	Toff	Rd
Base	19.9	790	79.0	10	30.0	30.00
A	19.9	908	90.8	7	30.0	30.00
B	19.9	987	98.7	5	30.0	30.00
C	19.9	1180	118.0	0	30.0	30.00

Sequoyah Fuels Corp.
Concentration vs Distance

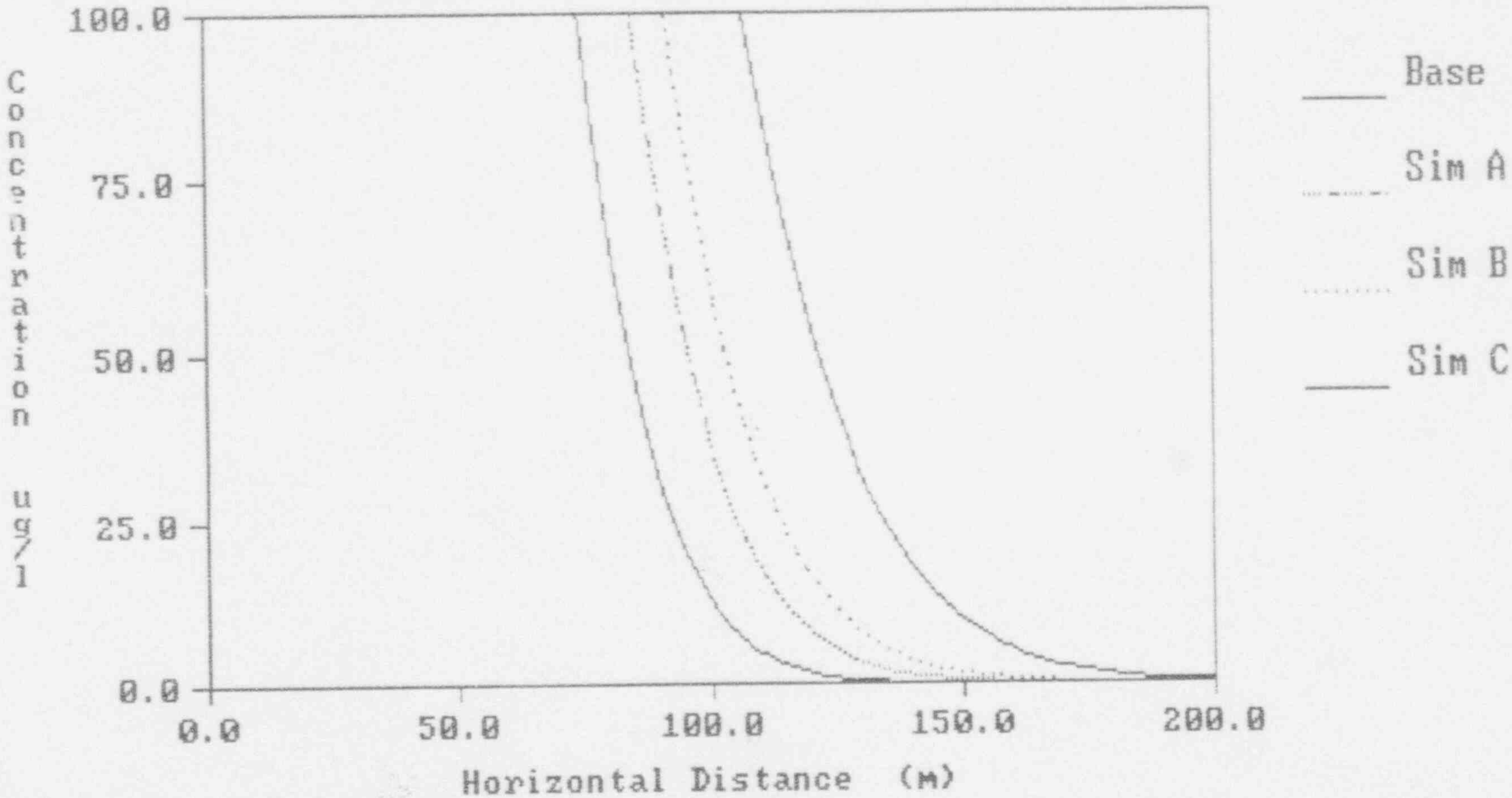


HYD 5-33

Solute = DSS-A-C

T = 30.0 (yr)
Y = 0.0 (m)

Sequoyah Fuels Corp.
Concentration vs Distance



HYD 5-34

Solute = DSS-A-C T = 30.0 (yr)

Y = 0.0 (m)

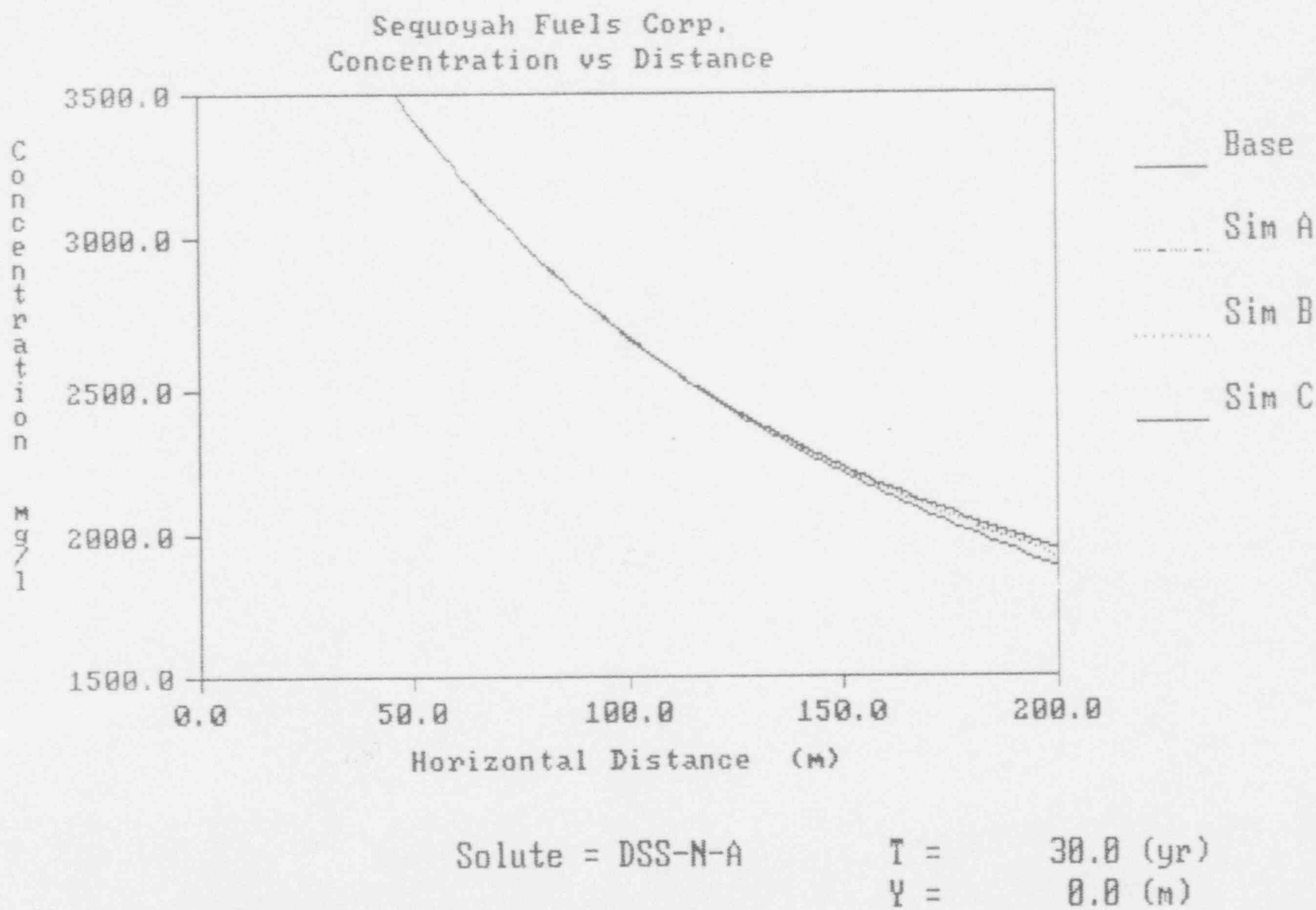
MYGRT Version 2.0

Simulation of DSS-N-A at Sequoyah Fuels Corp.

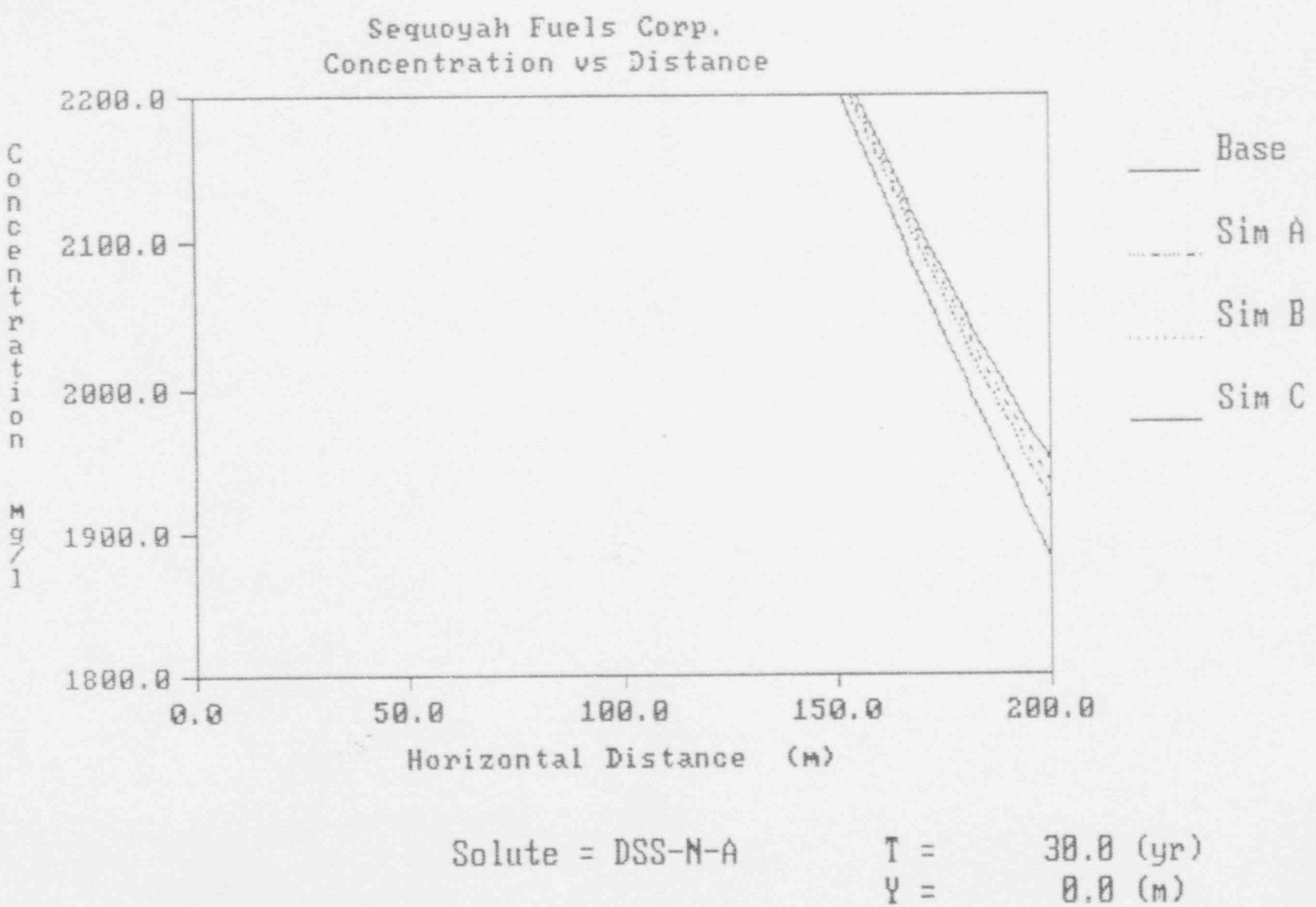
Horizontal, Areal Inorganic Solute

Background Concentration of DSS-N-A : Cbk = 0.000000 (mg/l)
Aquifer Concentration of DSS-N-A : Co = 4350.000000 (mg/l)
Source Width: W = 30.480000 (m)

Run#	V	Dx	Dy	Ton	Toff	Rd
Base	17.8	325	32.5	10	30.0	1.00
A	17.8	325	32.5	7	30.0	1.00
B	17.8	325	32.5	5	30.0	1.00
C	17.8	325	32.5	0	30.0	1.00


Sequoyah Fuels Corp.
Concentration vs Distance
3500.0
3000.0
2500.0
2000.0
1500.0
Concentration mg/l
0.0
50.0
100.0
150.0
200.0
Horizontal Distance (m)
Base
Sim A
Sim B
Sim C
Solute = DSS-N-A
T = 30.0 (yr)
Y = 0.0 (m)

HYD 5-36


Sequoyah Fuels Corp.
Concentration vs Distance
Concentration mg/l
2200.0
2100.0
2000.0
1900.0
1800.0
0.0
50.0
100.0
150.0
200.0
Horizontal Distance (m)
Base
Sim A
Sim B
Sim C
Solute = DSS-N-A
T = 30.0 (yr)
Y = 0.0 (m)

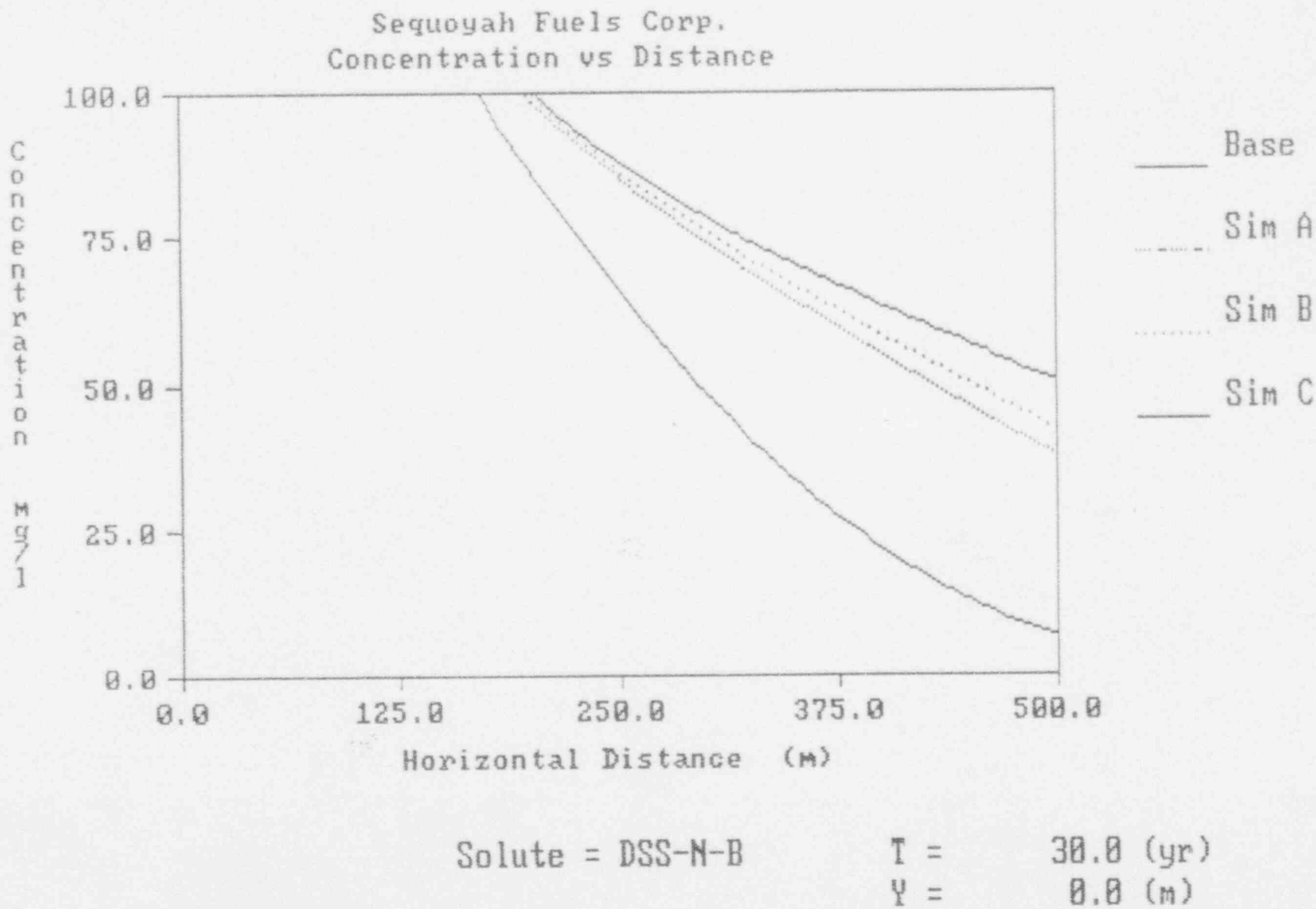
MYGRT Version 2.0

Simulation of DSS-N-B at Sequoyah Fuels Corp.

Horizontal, Areal Inorganic Solute

Background Concentration of DSS-N-B : Cbk = 0.000000 (mg/l)
Aquifer Concentration of DSS-N-B : Co = 316.000000 (mg/l)
Source Width: W = 30.480000 (m)

Run#	V	Dx	Dy	Ton	Toff	Rd
Base	13.2	577	57.7	10	30.0	1.00
A	20.8	912	91.2	7	30.0	1.00
B	20.8	912	91.2	5	30.0	1.00
C	20.8	912	91.2	0	30.0	1.00



Sequoyah Fuels Corp.
Concentration vs Distance
100.0
75.0
50.0
25.0
0.0
Concentration mg/l
0.0
125.0
250.0
375.0
500.0
Horizontal Distance (m)
Base
Sim A
Sim B
Sim C
Solute = DSS-N-B
T = 30.0 (yr)
Y = 0.0 (m)

HYD 5-39

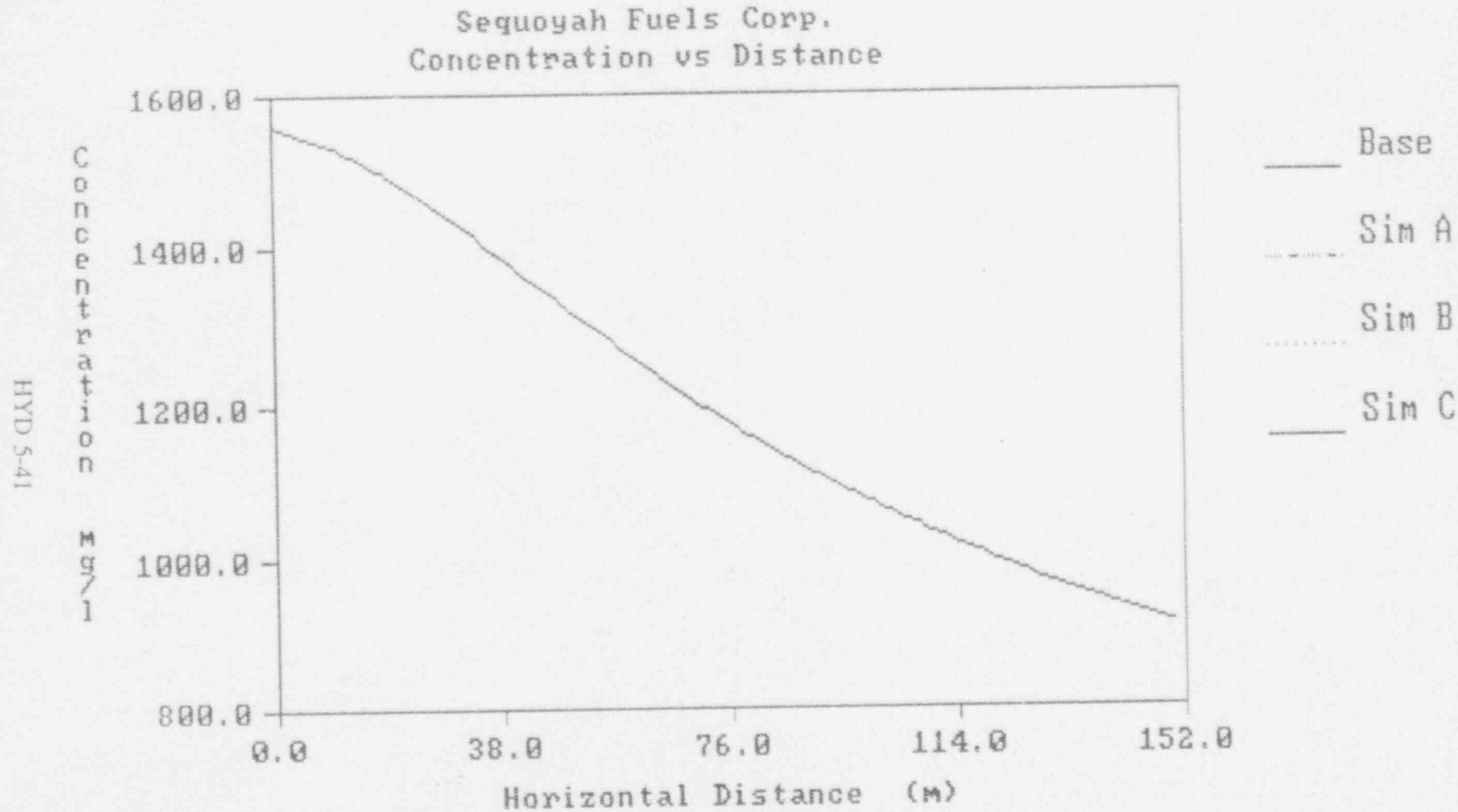
MYGRT Version 2.0

Simulation of DSS-N-C at Sequoyah Fuels Corp.

Horizontal, Areal Inorganic Solute

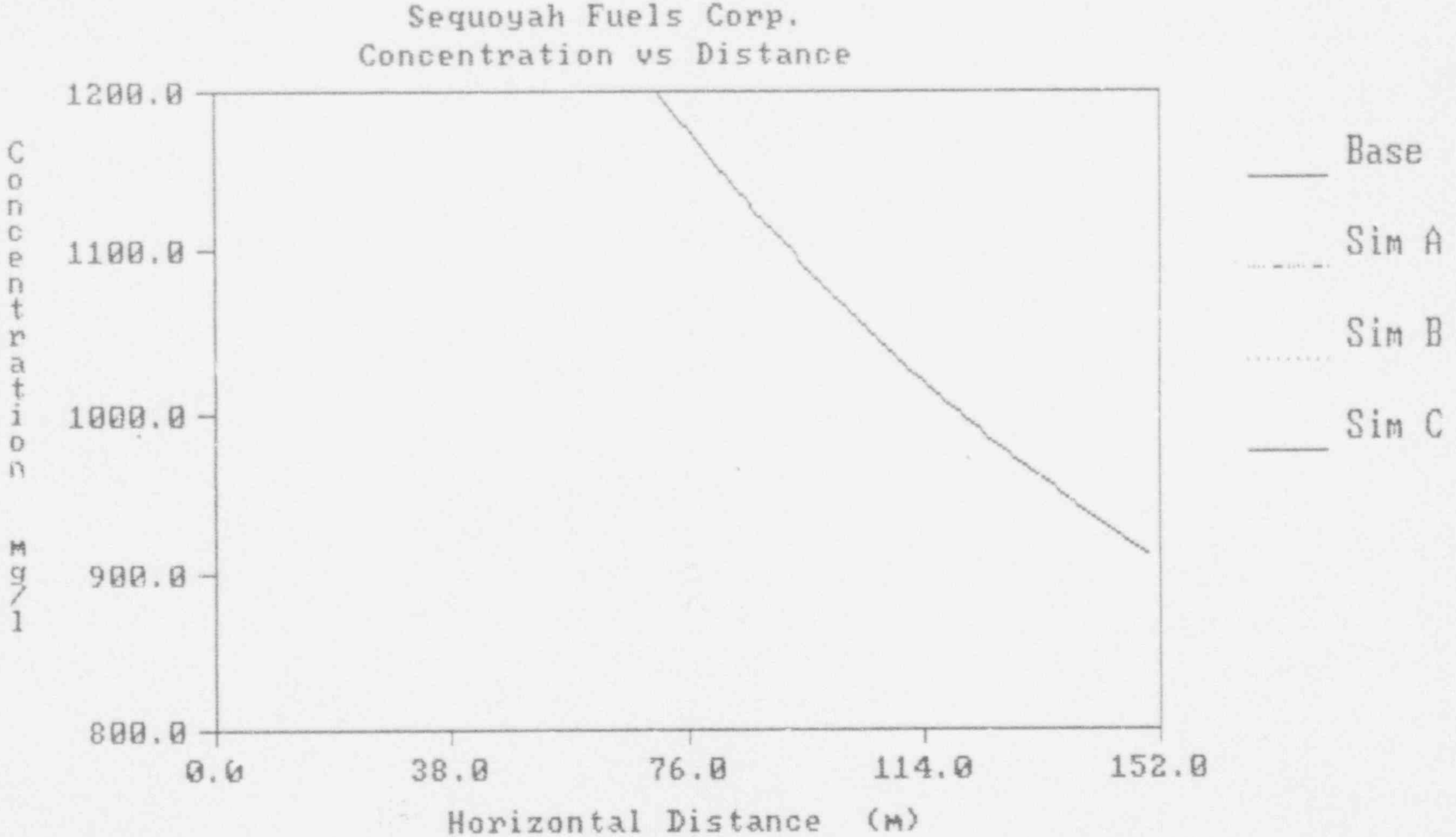
Background Concentration of DSS-N-C : Cbk = 0.000000 (mg/l)
Aquifer Concentration of DSS-N-C : Co = 1560.000000 (mg/l)
Source Width: W = 30.480000 (m)

Run#	V	Dx	Dy	Ton	Toff	Rd
Base	35.7	456	45.6	10	30.0	1.00
A	35.7	456	45.6	7	30.0	1.00
B	35.7	456	45.6	5	30.0	1.00
C	35.7	456	45.6	0	30.0	1.00



Solute = DSS-N-C

T = 30.0 (yr)
Y = 0.0 (m)



HYD 5-42

Solute = DSS-N-C T = 30.0 (yr)
Y = 0.0 (m)

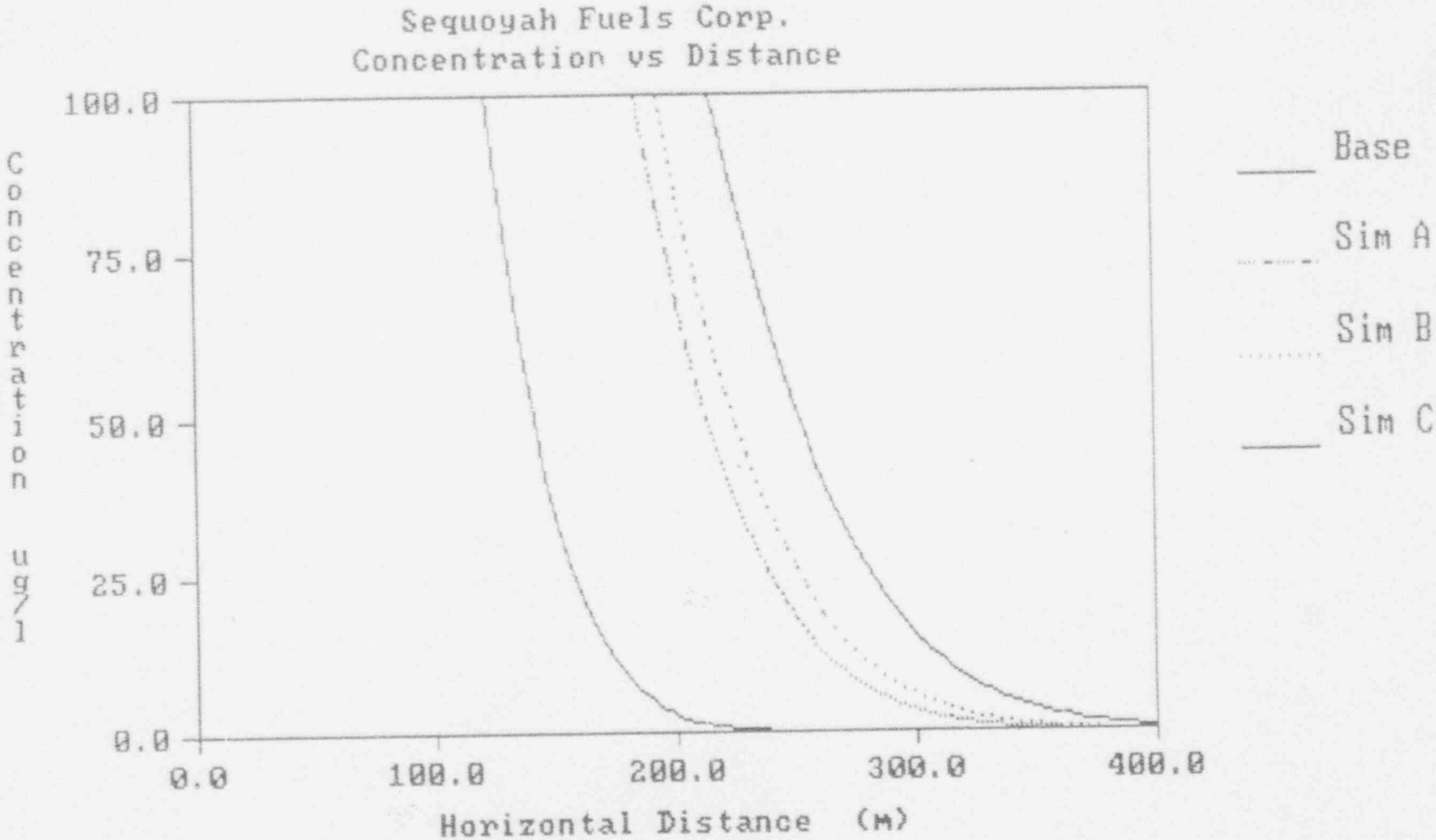
MYGRT Version 2.0

Simulation of SST-U-A at Sequoyah Fuels Corp.

Horizontal, Areal Inorganic Solute

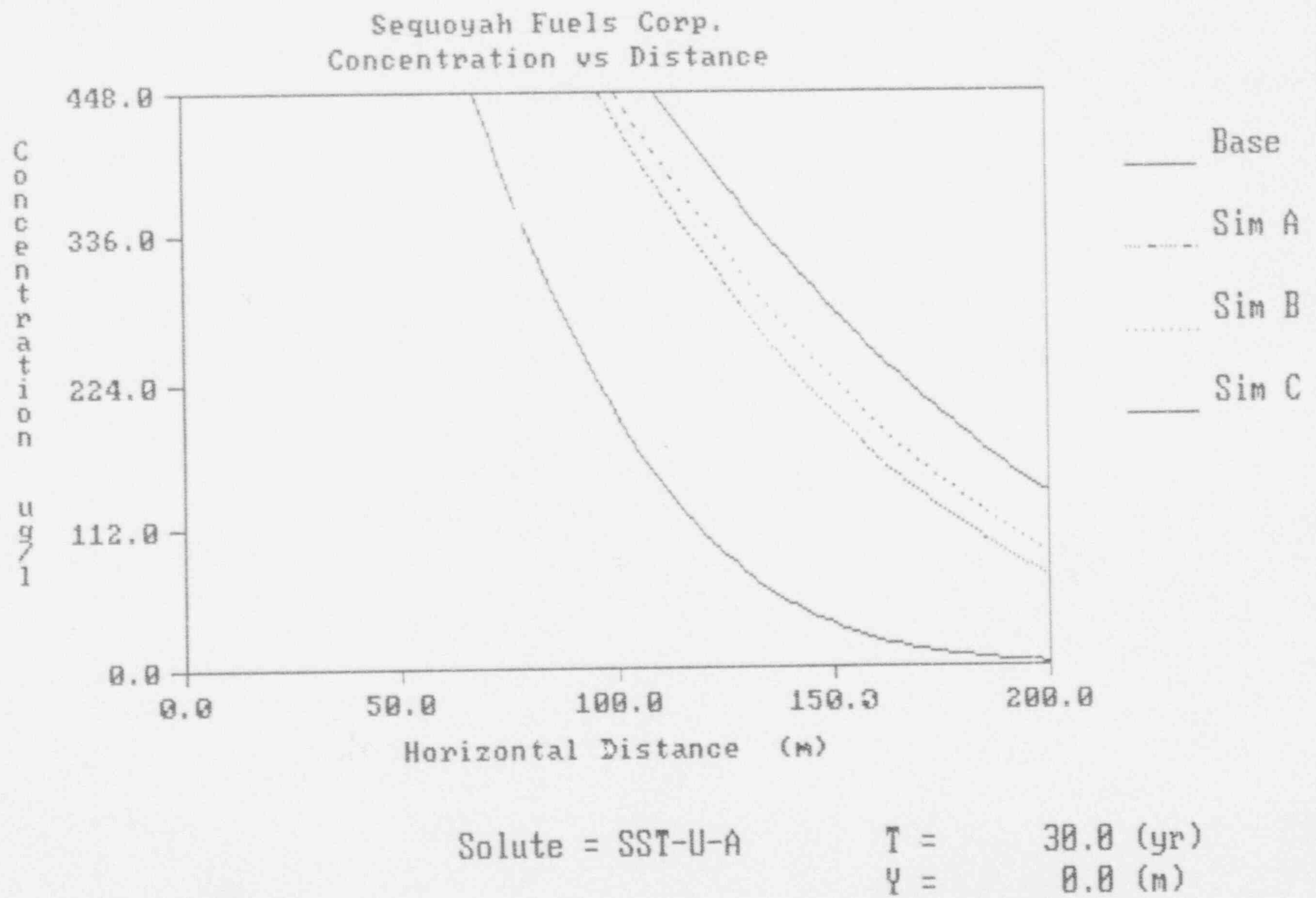
Background Concentration of SST-U-A : Cbk = 0.000000 (ug/l)
Aquifer Concentration of SST-U-A : Co = 1230.000000 (ug/l)
Source Width: W = 30.000000 (m)

Run#	V	Dx	Dy	Ton	Toff	Rd
Base	2.1	78	7.8	10	30.0	1.00
A	3.8	138	13.8	7	30.0	1.00
B	3.8	138	13.8	5	30.0	1.00
C	3.8	138	13.8	0	30.0	1.00



HYD 5-44

Solute = SST-U-A T = 30.0 (yr)
Y = 0.0 (m)


Sequoyah Fuels Corp.
Concentration vs Distance
448.0
336.0
224.0
112.0
0.0
Concentration ug/l
0.0
50.0
100.0
150.0
200.0
Horizontal Distance (m)
Base
Sim A
Sim B
Sim C
Solute = SST-U-A
T = 30.0 (yr)
Y = 0.0 (m)

HYD 5-45

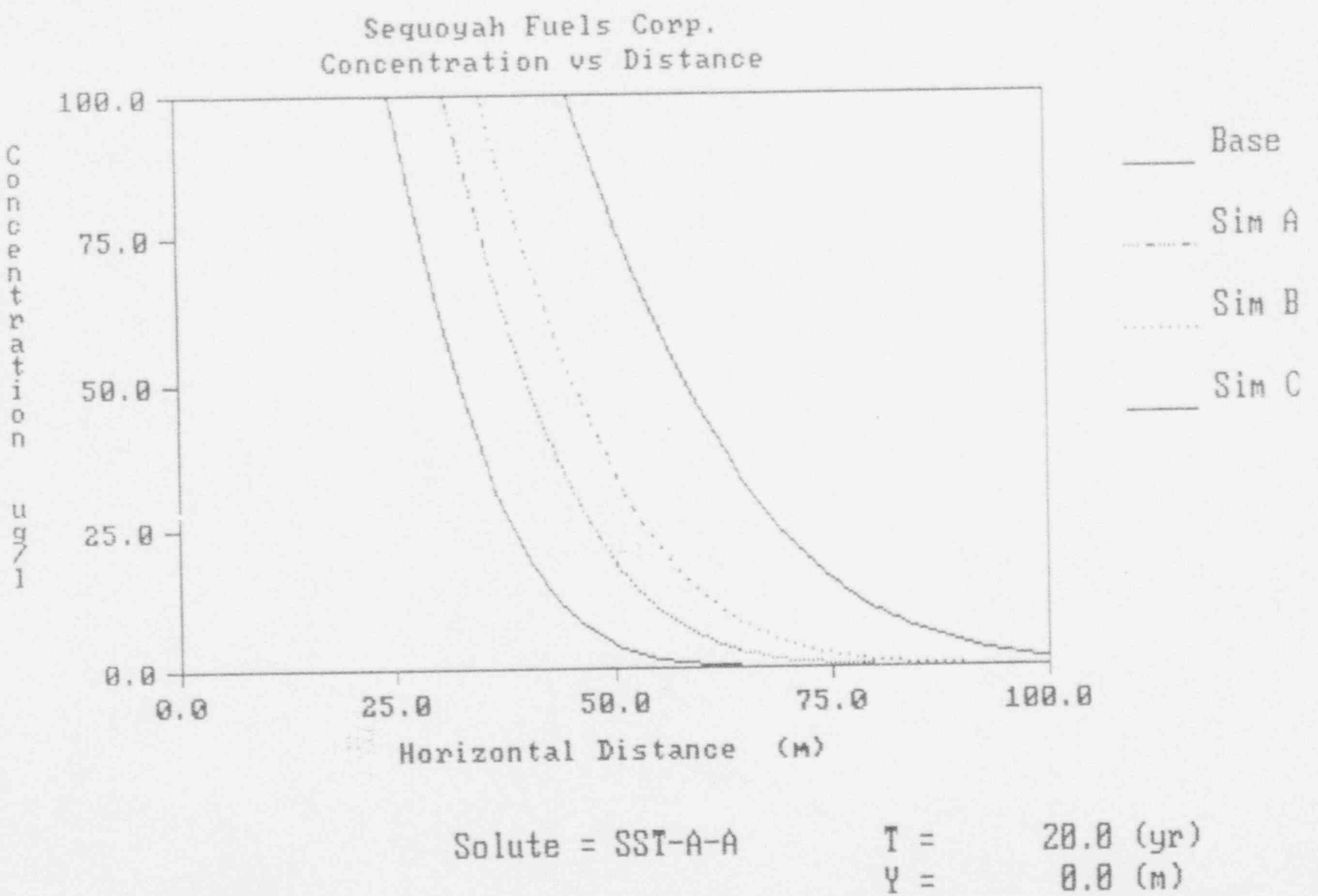
MYGRT Version 2.0

Simulation of SST-A-A at Sequoyah Fuels Corp.

Horizontal, Areal Inorganic Solute

Background Concentration of SST-A-A : Cbk = 0.000000 (ug/l)
Aquifer Concentration of SST-A-A : Co = 302.000000 (ug/l)
Source Width: W = 30.480000 (m)

Run#	V	Dx	Dy	Ton	Toff	Rd
Base	5.0	51	5.1	10	20.0	4.00
A	5.0	58	5.8	7	20.0	4.00
B	5.0	63	6.3	5	20.0	4.00
C	5.0	77	7.7	0	20.0	4.00


Sequoyah Fuels Corp.
Concentration vs Distance
100.0
75.0
50.0
25.0
0.0
Concentration ug/l
0.0
25.0
50.0
75.0
100.0
Horizontal Distance (m)
Base
Sim A
Sim B
Sim C
Solute = SST-A-A
T = 20.0 (yr)
Y = 0.0 (m)

HYD 5-47

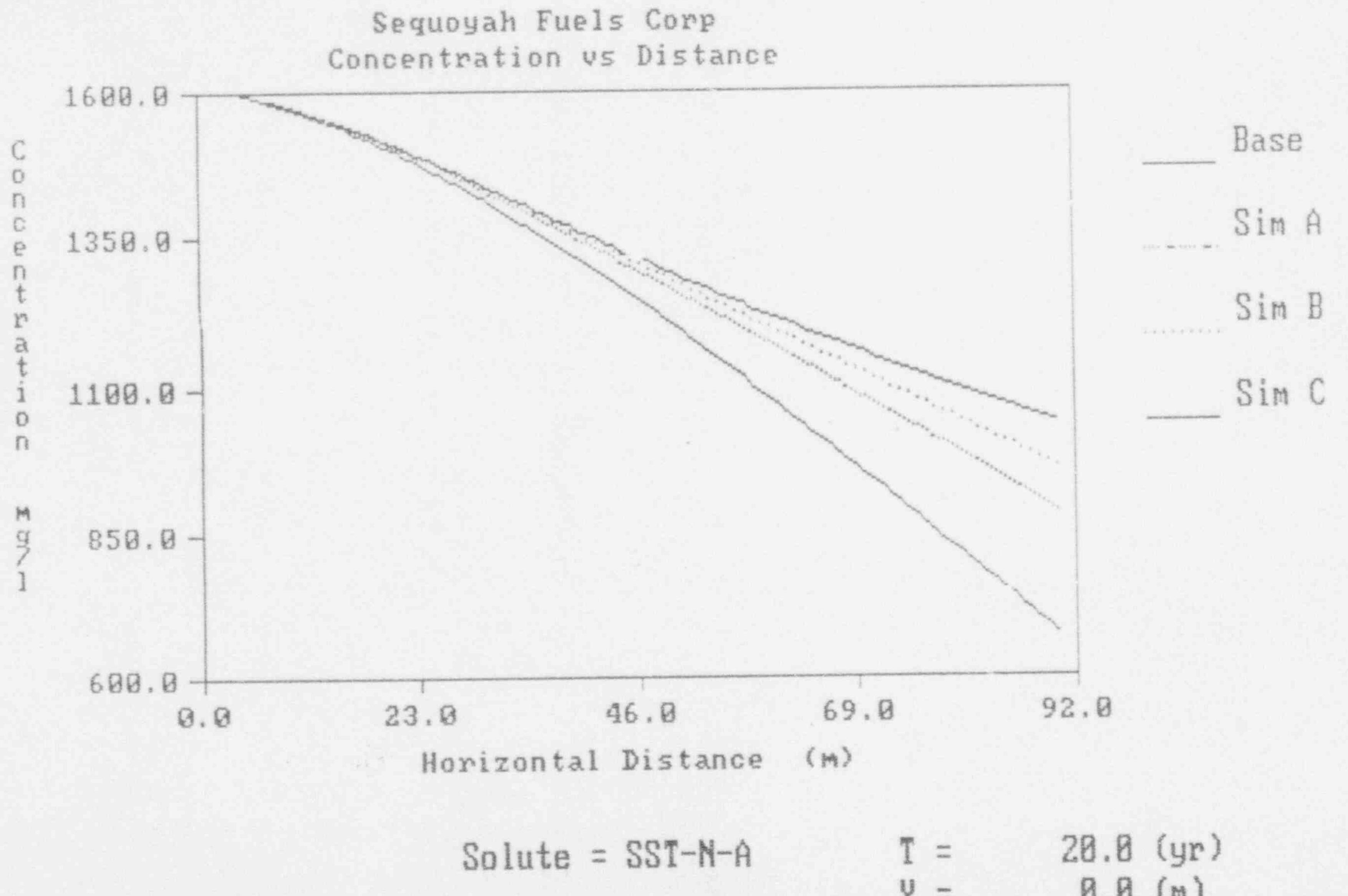
MYGRT Version 2.0

Simulation of SST-N-A at Sequoyah Fuels Corp

Horizontal, Areal Inorganic Solute

Background Concentration of SST-N-A : Cbk = 0.000000 (mg/l)
Aquifer Concentration of SST-N-A : Co = 1610.000000 (mg/l)
Source Width: W = 22.860000 (m)

Run#	V	Dx	Dy	Ton	Toff	Rd
Base	8.9	78	7.8	10	20.0	1.00
A	8.9	78	7.8	7	20.0	1.00
B	8.9	78	7.8	5	20.0	1.00
C	8.9	78	7.8	0	20.0	1.00



Sequoyah Fuels Corp
Concentration vs Distance
1600.0
1350.0
1100.0
850.0
600.0
Concentration mg/l
0.0
23.0
46.0
69.0
92.0
Horizontal Distance (m)
Base
Sim A
Sim B
Sim C
Solute = SST-N-A
T = 20.0 (yr)
Y = 0.0 (m)

HYD 5-49

Appendix B

CROSS-REFERENCE

Table B-1 provides a cross-reference between the requirements of Task I of the Resource Conservation and Recovery Act Administrative Order on Consent (Task I) (Ref. 2) and information in other documents produced by SFC that is relevant to the respective requirement. These other documents are: this report (draft Preliminary Report Description of Current Conditions and Investigations (CCI) for the Sequoyah Fuels Facility), Sequoyah Fuels Corporation Facility Environmental Investigation Findings Report (FEI) (Ref. 4), and Sequoyah Fuels Corporation draft Groundwater Monitoring Interim Measures Workplan (GMIM) (Ref. 11).

TABLE B-1. **Cross-Reference between Resource Conservation and Recovery Act Administrative Order on Consent - Corrective Action Plan (Task I) and information in this draft Current Conditions and Investigations Report (CCI), the Facility Environmental Investigation (FEI), and the draft Groundwater Monitoring Interim Measures Workplan (GMIM).**

CAP-TASK I	CCI	FEI	GMIM
A			
A.1.a	Figure 2-1	Figure 4	
A.1.b			
A.1.c		Drawing 3	
A.1.d	Figure 2-2	Figures 2 and 6	Appendix F
A.1.e		Figure 6	
A.1.f		Figure 6	
A.1.g		Drawing 4	
A.1.h	Figure 3-4		
A.1.i		Addendum Tables 1 and 2	Appendix F
A.2	Section 2.1		
A.3	Section 4.1.1	Section 2	
A.4	Section 2.1.3		
B			Section 4.0
B.1	Sections 4.1 and 4.2	Section 3	
B.1.a		Figure 6	Appendix F
B.1.b *			
B.1.c			Section 4.0
B.1.d *			
B.2			3.0, Appendices G-L
B.2.a	Section 4.3	Sections 4,5,6 and 7	Appendix L
B.2.b	Sections 3.1 - 3.5	Sections 2,3,4,5,6,7 Drawing 4	Appendix A
B.2.c	Sections 3.6 - 3.10 Appendix A		
C	Section 1.5		Section 4.0

* Information does not exist

References

1. Sequoyah Fuels Corporation, "Preliminary Plan for Completion of Decommissioning," February 16, 1993.

2. U. S. Environmental Protection Agency, Resource Conservation and Recovery Act § 3008(h) Administrative Order on Consent for Sequoyah Fuels Corporation, August 3, 1993.

3. U. S. Nuclear Regulatory Agency, Branch Technical Position "Site Characterization for Decommissioning Sites," draft July 1992.

4. Sequoyah Fuels Corporation, "Facility Environmental Investigation Findings Report," Vols. I-V, July 1991.

5. Sequoyah Fuels Corporation, "Addendum Facility Environmental Investigation Findings Report," May 21, 1992.

6. Sequoyah Fuels Corporation, License Renewal Application, "Questions for Clarification - SFC Environmental Assessment," September 4 and October 30, 1992.

7. Sequoyah Fuels Corporation, U. S. Nuclear Regulatory Commission, Materials License SUB-1010, Docket 40-8027.

8. Sequoyah Fuels Corporation, "Interim Storage of Contaminated Soils," November 22, 1991.

9. U. S. Nuclear Regulatory Commission, "Environmental Assessment for Renewal of License No. SUB-1010, Docket No. 40-8027, NUREG-1157," August, 1985.

10. Oak Ridge Associated University, "Raffinate Pond Sampling at the Sequoyah Fuels Corporation Site, Gore, Oklahoma," March 1988.

11. Sequoyah Fuels Corporation, "Draft Groundwater Monitoring Interim Measures Workplan", September 2, 1993.

12. Sequoyah Fuels Corporation, "Radiological Survey Plan - Unrestricted Areas," Revision 2, July 24, 1992.

13. Sequoyah Fuels Corporation, "Response to Request for Information," Oklahoma State Department of Health, April 23, 1993.

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1. Sequoyah Fuels Corporation, "Groundwater Monitoring Plan," License Amendment Application, March 31, 1992.

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