DISPOSAL CELL CONSTRUCTION PLAN FOR THE SEQUOYAH FUELS CORPORATION FACILITY

Prepared for:

SEQUOYAH FUELS CORPORATION

I-40 & Highway 10
Gore, Oklahoma 74435

Prepared by:

MFG, INC.
consulting scientists and engineers

3801 Automation Way Suite 100
Fort Collins, CO 80525
(970) 223-9600
Fax: (970) 223-7171

MFG Project No. 180735

NOVEMBER 2007

TABLE OF CONTENTS

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 Purpose of Report

This report presents the construction plan for the on-site disposal cell at the Sequoyah Fuels Corporation (SFC) facility near Gore (Sequoyah County), Oklahoma. This report has been prepared for SFC by MFG, Inc. to address comments and provide additional detail for U.S. Nuclear Regulatory Commission (NRC) review and licensing of the reclamation plan for the SFC facility. This report is organized as Attachment E of the Reclamation Plan compiled by SFC.

1.2 Background

The conceptual design for the on-site disposal cell was documented in Morrison Knudson (MK, 1996b), ESCI (1996) and ESCI (1998). The on-site disposal cell location was selected in the process area, based on siting studies documented in Appendix H of the Reclamation Plan (MK, 1996a). The preliminary design of the disposal cell was described in MFG (2002b). The 2002 preliminary design was based on (1) additional site characterization data (including SFC, 1998 and MFG, 2002a), (2) modifications in disposal cell construction strategy by SFC, and (3) a disposal cell cover design incorporating a store-and-deplete infiltration control strategy with a vegetated surface. This report presents an update of the preliminary design in Appendix C of the Reclamation Plan (MFG, 2002b), and outlines the sequence for phased construction and filling of the disposal cell.

The disposal cell has been designed to meet the performance criteria for 11e.(2) byproduct material reclamation outlined in Appendix A of 10 CFR 40 and administered by the U.S. Nuclear Regulatory Commission (NRC). The technical analysis of the design has followed procedures outlined in NRC (1990) for long-term stability of 11e.(2) byproduct material sites. This report has been structured to present the updated disposal cell design and supporting technical analyses in a format and level of detail consistent with technical guidelines in NRC (1990), as well as reclamation plan review guidelines in NRC (2002).

1.3 Scope of Report

This report presents an update of the preliminary cell design in MFG (2002b), with design modifications as listed below.

1. The disposal cell construction plan is based on a perimeter embankment of compacted soils and granular materials from on-site cleanup operations. Stormwater and the remaining disposed materials will be managed within this perimeter embankment. The inside slopes of the perimeter embankment will be synthetically lined.

2. The cell base will be constructed across the disposal cell footprint, consisting of a multilayered synthetic and clay liner system. This liner system includes a provision for

leachate collection above the liner system and leak detection within the liner system. The outside perimeter of the liner system includes a synthetically lined clay berm.

3. The disposal cell base will be constructed in phases, with corresponding disposed material placement in phases of the cell.

4. The raffinate sludge has been treated with pressure filtration. If the raffinate sludge is disposed on site, the filtercake will be placed within the disposal cell with an additional liner and cover system.

Specific aspects of the disposal cell design are presented in additional documents that are organized as attachments of the Reclamation Plan. The specifications for construction of the disposal cell base and cover systems are outlined in the Technical Specifications for Cell Construction (Attachment A of the Reclamation Plan). The procedures for demolition of facility structures are outlined in the Demolition Plan (Attachment F of the Reclamation Plan). The sequencing of disposal cell base construction and material filling is presented in this report (Attachment E of the Reclamation Plan). The construction, filling, and covering of the disposal cell are illustrated in the Drawings (Attachment A of the Reclamation Plan).

2.0 SITE CONDITIONS

Site conditions pertinent to the disposal cell design are summarized in MFG (2002b). Site conditions pertinent to waste materials and site hydrogeology are described in MFG (2002a), SFC (1998), SFC (1997), and RSA (1991). These general conditions are not reproduced in this report. However, an update of the construction materials and materials to be disposed are summarized in the following subsections.

2.1 Liner System

A multi-layered liner system is proposed within the footprint of the disposal cell. This liner system consists of (from bottom to top): (1) a compacted three-foot thick clay layer, (2) a bedding layer of sand containing a leak detection system, (3) a synthetic liner, and (4) a cover layer of sand containing a leachate collection system. The soil used for the compacted clay layer will be obtained from the soil borrow area at the south end of the site (shown on the Drawings). The bedding layer and cover layer sands will be obtained from offsite sources (such as nearby aggregate production operations).

2.2 Cover System

A multi-layered cover system is proposed. This cover system will consist of (from bottom to top): (1) a compacted two-foot thick clay layer, (2) a textured synthetic liner, (3) a cover layer of sand, (4) a subsoil zone, and (5) a topsoil layer. The cover on the side slopes will have a layer of rock mulch placed at the base of the topsoil layer. Construction materials for the disposal cell cover system include soils and weathered sedimentary rock from on-site sources, and rock from off-site sources. These materials are discussed in MFG (2002b) and are summarized below.

2.3 Liner and Cover Construction Material

Clay Liner Material. The soil used for the compacted clay layer in the liner system and cover system will be a silty clay obtained from the soil borrow area at the south end of the site (shown on the Drawings). From radionuclide analysis of samples from this borrow area, these soils are of acceptable quality for use as cover material.

Liner bedding and cover material. Sand for the liner bedding and cover material in the liner system and cover system will be screened sands obtained from offsite sources (such as nearby aggregate production operations).

Subsoil layer. Subsoil layer material will be obtained from on-site terrace deposit soils and weathered Atoka Formation shale and sandstone. From material balance calculations in MFG (2002b), there is significantly more material available for subsoil cover material than required volume of material. These locations are shown on the Drawings.

Topsoil. Topsoil for the surface of the disposal cell cover and surrounding areas to be vegetated will be obtained from the Agland area on the west side of the site (shown on the Drawings). As discussed in Appendix H, there is sufficient topsoil of acceptable quality available in the Agland area for the disposal cell cover system and surrounding areas.

Rock mulch and perimeter apron rock. As described in subsequent sections, a layer of rock mulch is planned as an erosion protection zone on the side slopes of the disposal cell. A layer of rock is planned as an erosion protection zone along the perimeter of the cell. Rock of acceptable size and durability for both applications is available from nearby commercial sources of limestone (Appendix H).

2.4 Disposed Materials

The materials to be placed in the disposal cell consist of process waste materials, structural debris, and underlying liner materials and subsoils from planned site cleanup and reclamation activities. The disposal cell is a "dry" cell, where all of the materials to be placed in the cell are solid materials ranging in moisture content from dry to nearly saturated conditions. No process liquids will be disposed in the cell.

The results of previous characterization of the chemical, radiological and physical properties of these materials are presented in RSA (1991) and SFC (1997), with the most current information compiled in Appendix D of the Reclamation Plan (SFC, 1998). The characterization data in (SFC, 1998) is presented in terms of site characterization units (SCUs), representing specific processing areas or facilities on site. The locations of the SCUs are shown on the Drawings, and pertinent data for each SCU are summarized in Appendix A of this report.

In the preliminary disposal cell design, SFC has grouped similar materials from individual SCUs together for disposal sequencing. Due to the planned placement of these materials in layers in the cell, these groups are referred to as Material Types A through D. The relationships between the SCU numbers and layer numbers are presented in Appendix A of this report, along with estimated volumes of these materials. The material types are described below.

Type A. Type A materials consist of five components: (1) raffinate sludge, (2) Pond 2 residual materials, (3) Emergency Basin sediment, (4) North Ditch sediment, and (5) Sanitary Lagoon sediment. The locations of these materials are shown on the Drawings. The raffinate sludge, Emergency Basin sediment, North Ditch sediment, and Sanitary Lagoon sediment are currently being "dewatered" by pressure filtration for planned disposal at an approved offsite location. If it is not economically possible to dispose of these materials offsite, these materials, along with Pond 2 residual materials, will be disposed in a specifically designed area of the disposal cell.

The resulting physical properties of the filtered raffinate sludge (filtercake) are presented in Appendix B of this report. The filtercake is placed in polypropylene bags (supersacks) for temporary storage on the yellowcake storage pad at the site. The sacks of filtercake will either be shipped off site or placed in the disposal cell. The filtercake disposal cell will have a separate liner and cover system within the disposal cell liner and cover system (as shown on the Drawings).

The other major component of the Type A materials is the Pond 2 residual materials. The materials will be solidified by mixing with cement or fly ash. The mixed, solidified material for the cell capacity calculations is conservatively estimated to be 20 percent larger than the volume currently in Pond 2.

In terms of estimated volume placed in the disposal cell, Pond 2 residual materials comprise most of Type A materials (65.5 percent), followed by filtered raffinate sludge (30.5 percent), and the remaining sediments (totaling 4 percent).

Type B. Type B materials consist of soil liner and subsoil materials beneath the clarifier, the calcium fluoride basin, Pond 3E, the Emergency Basin, the North Ditch and the Sanitary Lagoon, as well as Pond 1 spoils pile material. The Type B materials (primarily contaminated soils) are listed second in the order, since they will be excavated after removal of Type A materials and placed directly on top of Type A materials in the disposal cell profile. In terms of estimated volume, the Pond 1 spoils pile (35 percent), clarifier liners (26 percent), and Emergency Basin soils (13 percent) comprise approximately 74 percent of the Type B materials.

Type C. Type C materials consist of structural materials, concrete and asphalt, calcium fluoride basin materials, calcium fluoride sediments, and on-site buried materials. These materials will be placed with or above the Type B materials, and placed with or covered with contaminated soils (Type D materials). In terms of estimated volume, the calcium fluoride sediments (44 percent), structural materials (38 percent) and concrete and asphalt (15 percent) comprise approximately 97 percent of the Type C materials.

Type D. Type D materials consist of contaminated soils and sedimentary rock that require cleanup. The approximate area of contaminated soil cleanup is shown on the Drawings.

The total layer material volumes from the estimates of disposed volumes in Appendix A are summarized in Table 2.1 below.

Table 2.1 Disposed Material Summary

Type	Description	Estimated In-Cell Volume (cu ft)	Fraction of Total Volume (%)	Natural Uranium (pCi/g)	Radium-226 (pCi/g)	Thorium-230 (pCi/g)
A	Sludge and sediment	1,081,890	21	357-12100	6-332	211-16300
B	Liner soils and subsoils	1,174,441	23	5-95	0.5-2.1	47-70
C	Calcium fluoride sediments, debris	2,049,840	40	168-520	0.2-0.8	2.1-4.8
D	Contaminated site soils	811,685	16	250	--	--
Totals		5,117,856	100	--	--	--

From the materials listed in Table 2.1, the contaminated site soils, subsoils, and selected demolition debris (concrete and asphalt) will comprise the materials to be used as the stormwater retention berm material for the disposal cell. These materials are primarily Type D materials, with minor amounts of Type B and C materials.

3.0 DESIGN STRATEGY

3.1 Design Criteria

The SFC site is planned for reclamation as an 11e.(2) byproduct material site under performance standards administered by the NRC. All of the waste materials disposed in the cell will be from on-site cleanup and reclamation. Upon successful demonstration to NRC of meeting these performance standards, the site will be transferred to the U.S. Department of Energy for long-term care and maintenance. The proposed boundary of the area to be transferred to the Department of Energy is the institutional control boundary shown on the Drawings.

The key design criteria for the disposal cell are to: (1) meet the performance standards for reclamation outlined in Appendix A of 10 CFR 40, (2) have a facility profile and shape that blends in with the surrounding area (from a visual, hydrologic and vegetative standpoint), (3) have a negligible effect on underlying groundwater, and (4) facilitate site cleanup and reclamation activity. These criteria are outlined below.

Performance standards. The performance standards in Appendix A of 10 CFR 40 include: (1) isolating the 11e.(2) material, (2) reducing the rate of radon emanation from the cover to an average of 20 picocuries per square meter per second, (3) providing effective protection over the design period (200 to 1,000 years), and (4) minimizing reliance on active maintenance.

Surrounding area impact. The top surface of the cell will be limited to an elevation of approximately 590 feet to minimize the visual impact of the disposal cell from surrounding areas. In addition, the side slopes of the cell will be at 5:1 (horizontal:vertical) or less, with the corners of the cell rounded to create a topographic feature that is visually similar to the surrounding area. The surface of the completed cell will be vegetated with natural grass and forb species similar to surrounding areas.

Effect on groundwater. The disposal cell cover design strategy includes minimizing infiltration of meteoric water. This is consistent with Appendix A of 10 CFR 40 as well as the conceptual design (MK, 1996a and ESCI, 1996). The cover design includes a compacted clay and synthetic liner system for initial infiltration control and a subsoil zone (five feet thick) for long-term infiltration control that promotes evapotranspiration from vegetation.

Facilitation of site cleanup. The siting and layout of the cell has been designed to accommodate stormwater management and construction activity during site cleanup without double-handling of materials, as described in subsequent sections of this report.

3.2 Capacity

The disposal cell has been designed to have sufficient capacity for the on-site materials described in Section 2.4. The estimated volumes listed in Table 2.1 total approximately 8.0 million cubic feet. The disposal cell layout shown on the Drawings has been sized for a capacity (beneath the cover system) for this volume.

The actual capacity required for the disposal cell depends on the volume of material excavated during site soil cleanup and the density of the material after placement in the cell. From the material volume estimates in Table 2.1, the materials with the largest potential variability are the contaminated soils (Type D). Due to this variability, the preliminary disposal cell design in MFG (2002b) incorporated a range of volumes (from 5 million to 12 million cubic feet). The geometric limits on the disposal cell are: (1) a maximum top surface elevation of approximately 590 feet (to minimize visual impact); (2) a minimum elevation of synthetic liner in the cell base five feet above groundwater and (3) the fixed location of the north, east, and west sides of the cell. The variability in disposed material volume is accommodated by reducing or extending the location of the south side of the cell, or reducing the elevation of the cell cover.

3.3 Site Selection

The disposal cell site was selected based on an evaluation of four potential sites identified on SFC property. The disposal cell site selected by SFC was in the process area. This site was chosen based on a ranking process outlined in Appendix H of the Reclamation Plan, and included hydrologic and erosional stability factors as well as cost and potential for expansion.

The location of the disposal cell within the process area was chosen to (1) provide the required capacity for disposed materials (Section 3.2), with the provision for additional contaminated soils; (2) be out of the way of major building demolition and subsurface excavations; (3) be located away from natural drainages, and (4) facilitate phased construction.

3.4 Cell Layout

The disposal cell layout consists of a four-sided, domed structure. The final surfaces are designed to meet NRC performance criteria for slope and erosional stability, with analyses presented in MFG (2002b). The disposal cell is designed for containment of the disposed materials under construction and long-term conditions. The cover system is designed for attenuation of radon-222 from the disposed materials under conservative, long-term emanation and radionuclide ingrowth conditions (described in MFG, 2002b).

3.5 Containment System

The cell is designed to contain the disposed materials and associated pore fluids with a multilayered liner system at the base of the cell, a perimeter embankment system, and a multilayered cover system over the disposed materials. This containment system includes soil and synthetic liner components, as described in Section 4 and shown on the Drawings.

3.6 Water Management

The design strategy for water management is outlined below.

1. Prior to disposal cell construction, stormwater and residual process liquids are handled under current SFC permit procedures and license requirements.

2. During cell construction and disposal operations, precipitation falling on the disposal cell footprint will be contained within the cell behind stormwater retention embankments. The embankments are designed with sufficient freeboard to contain precipitation from the Probable Maximum Precipitation (PMP) event.

3. Meteoric water collected within the disposal cell during construction and disposal operations will be drawn from the cell as necessary and pumped to cleaned ponds on site for treatment and permitted discharge.

4. As cell construction is completed, the outside slopes of the cell will be covered with clean soils where possible to allow discharge of stormwater runoff.

5. After cover construction, stormwater runoff will be diverted away from the cell and discharged without treatment. The cover surfaces have been designed to withstand the peak runoff from the PMP event.

4.0 DISPOSAL CELL DESCRIPTION

This section describes the general layout of the disposal cell.

4.1 General Layout

The four-sided cell will cover approximately 16 acres. Approximately half of the cover surface area consists of side slopes, and the remainder is the top surface. The top surface of the cell drains to the southeast (the corner with the highest ground surface elevation) at a one-percent slope. The direction of top surface drainage was chosen to be toward the highest ground elevation and away from the west side of the cell. The side slopes of the cell are at 5:1 (20 percent), the maximum slope under NRC reclamation criteria.

The estimated volume of disposed materials in Table 2.1 is approximately 8 million cubic feet. Due to the variability in disposed material density, the amount of stabilizing additives that may be added to some materials, and the volume of soils that may actually be excavated, the disposal cell location and layout has been planned to accommodate a range of disposed material volumes. The disposal cell layout shown on the Drawings is based on a disposed material capacity of 8 million cubic feet. For a larger volume of disposed materials, the cell footprint would be extended to the south. For a smaller volume of disposed materials, the final elevation of the cell would be lowered, or the south side of the cell would be moved to the north.

The disposal cell layout has a similar shape and area to the design in MK (1996) and ESCI (1996), but with the following modifications.

1. The layout incorporates rounded corners to facilitate earthmoving construction techniques as well as produce a feature that blends in with surrounding topography.
2. The facility was moved to the north to utilize the topography of the emergency basin area for leachate collection and leak detection.
3. The facility was moved to the east, with the west side angled to reduce the length of slope and area draining into the gully west of the emergency basin.
4. The layout was adjusted to tie into natural ground or anticipated post-reclamation contours to provide drainage away from the toe of the slopes along the perimeter of the cell.
5. The top surface slope of the cell was modified to drain to the southeast with a top elevation of approximately 590 feet. This allows runoff to flow over the side slope on the sides with the shortest slope lengths.

4.2 Disposal Cell Base

The base of the disposal cell will contain a multi-layered liner system, with an upper and lower liner, separated by a leak detection system layer. The liner system is designed to contain leachate from disposed materials above the upper liner as well as provide a leak detection system for the upper (synthetic) liner. The components of the cell base and liner system are outlined below (from bottom to top).

Subsurface fill. The foundation of the cell will include concrete pad surfaces, excavated soil or weathered sedimentary rock surfaces, or undisturbed soil surfaces, based on the extent of subsurface contamination and material cleanup. Subgrade fill will be placed over the excavated foundation surface (where required). Subgrade fill will be placed and compacted to provide a firm base for the liner system and fill in areas to create desired gradients for leak detection system flow. Subgrade fill will also raise the elevation of the cell base such that the elevation of synthetic liner is at least five feet above groundwater levels. This subgrade fill will consist of clean fill from on-site or off-site sources.

Clay layer. A compacted clay layer (36 inches thick) will be placed on the subsurface fill or foundation surface to form the secondary or lower liner for the liner system. As mentioned in Section 2, the soil for the clay layer will be excavated from on-site sources. At the perimeter of the cell, the clay layer forms the perimeter berm for leachate retention.

Bedding layer. A bedding layer of sand (6 inches thick) will be placed on the top surface of the clay layer to form a free-draining bedding layer for the synthetic liner as well as a leak detection zone above the clay layer (if leakage through the upper liner would occur). The leak detection system will consist of a series of 4-inch diameter perforated pipes installed in the bedding layer, as shown on the Drawings. As mentioned in Section 2, the sand for the bedding layer will be obtained from off-site sources.

Synthetic liner. A synthetic liner will be installed on top of the bedding layer surface to form the primary or upper liner for the liner system. The synthetic liner will be smooth, 60-mil thick, high-density polyethylene (HDPE) or similar approved material of appropriate low permeability, puncture resistance, and resistance to oxidation. The synthetic liner will extend over the clay berm along the perimeter of the cell, as shown on the Drawings.

Cover layer. A cover layer of sand (18 inches thick) will be placed on the synthetic liner surface to form a protective layer for the synthetic liner as well as a leachate collection zone above the synthetic liner. As mentioned in Section 2, the sand for the cover layer will be obtained from off-site sources. The leachate collection system will consist of a series of 6-inch diameter perforated pipes installed in the cover layer, as shown on the Drawings.

Collection system discharge. The leak detection and leachate collection system pipe layouts are designed to flow by gravity to the lowest corner of each phase of the disposal cell. Each pipeline system transitions into a single solid pipe that conveys liquid by gravity to an external sump (as shown on the Drawings). These pipeline systems are independent, so for the three phases of the disposal cell there are three separate leak detection systems and sumps as well as three separate leachate collection systems and sumps. This allows independent subsurface water management for each phase of disposal cell construction.

4.3 Disposal Cell Construction

The strategy for disposal cell construction is to place the materials with the higher shear strength around the perimeter of the cell as a compacted embankment or berm (the stormwater retention berm), then place lower shear-strength materials and demolition debris inside of the stormwater retention berm. As mentioned in Section 2.3, the materials to be placed in the disposal cell are solid materials, with no process liquid discharge. The only water to be handled during disposal cell construction will be meteoric water from precipitation directly on the cell.

As outlined in Section 3.6, meteoric water collected within the cell will be temporarily stored within the cell. The crest of the stormwater retention berms around the cell will be maintained with a minimum of five feet above the elevation of the interior materials. This freeboard is conservatively chosen to provide capacity for meteoric water from the PMP event (26 inches). At the initial stage of disposal for each phase, the initial berm will have a height of 8 feet. Subsequently, the minimum freeboard requirement will be maintained at 5 feet to account for the sloping cell base surface. In addition, the catchment area of Phase II will be initially limited to 100,000 square feet by the construction of diversion ditches along the upper portion of the Phase II area.

As the level of the interior of the cell rises with material disposal, the elevation of the stormwater retention berm will be raised as necessary to maintain this stormwater storage requirement. The stormwater retention berm will be raised in an upstream manner, with the centerline of the retention berm inside the centerline of the previous berm. The inside face of each raise of the stormwater retention berm will be covered with a synthetic liner to prevent moisture migration through the berm.

The stormwater retention berms will be constructed by placing material in lifts and compacting. The material in the interior of the cell will be placed in lifts and compacted or filled with disposed materials to minimize void spaces. The final surface of the disposed materials will be graded and compacted to minimize void spaces and reduce the potential for future differential settlement of the cover.

4.4 Cell Cover System

The cover system over the disposal cell consists of a 10-foot thick soil cover on both the top surface and side slopes of the cell. The components of the cover system are shown on the Drawings and are described below (from top to bottom).

Erosion protection zone. The upper 18 inches of the cover system consists of an erosion protection and vegetation zone. On the top surface, the upper 18 inches of the cover thickness consists of a topsoil layer. On the side slopes, the upper 18 inches consists of a 9-inch thick topsoil layer above a 9-inch thick rock mulch layer. The cover surface will be vegetated, with the long-term vegetation being a native grasses and forbs.

Subsoil zone. A five-foot thick subsoil zone of the cover system will consist of on-site soils to provide a root zone and moisture retention zone for infiltrating meteoric water.

Liner cover material. Underlying the subsoil zone will be 18 inches of sand. The liner cover provides a lateral drain for infiltrating meteoric water (that has passed through the subsoil zone), and provides a protective cover for the underlying synthetic liner.

Synthetic liner. A synthetic liner will be installed at the bottom of the cover system on both the top surface and side slopes. The synthetic liner will be anchored with the synthetic liner at the base of the cell (along the perimeter of the cell) to provide the containment as described in Section 3.5. The synthetic liner will be a textured, 60-mil thick HDPE (or similar approved material).

Compacted clay liner. The base of the cover will be a two-foot thick compacted clay layer.

Cell perimeter apron. The disposal cell will have a perimeter apron designed to transition into the surrounding reclaimed site topography. The perimeter apron is designed for energy dissipation of runoff from the cell side slopes and to direct drainage away from the cell. The perimeter apron will consist of a zone of rock two feet thick and 20 feet wide. One the east side of the cell, the perimeter apron will be extended to the east into a broad channel to direct runoff around the northeast and southeast corners of the cell (and away from State Highway 10).

The cover system and underlying disposed materials have been evaluated for durability, erosional stability, slope stability, radon emanation, infiltration and settlement. The evaluation results are presented as Appendices C through H of this document, and show acceptable results relative to NRC design and performance criteria.

5.0 CELL CONSTRUCTION SEQUENCE

A phased cell construction plan has been prepared to demonstrate that the cell can be constructed in the process area while minimizing double-handling of materials. This plan is illustrated on the Drawings and outlined in the following subsections.

5.1 Phased Components

The disposal cell will be constructed using the perimeter embankment strategy outlined in Section 4.3, with disposed materials placed within the stormwater retention berms. The disposal cell will be constructed in three phases to allow one area of the cell base to be prepared for receipt of materials excavated from another area of the cell. After all three base areas of the cell have been constructed, materials from outside the disposal cell footprint can be placed throughout the cell.

Perimeter and internal berms. A key factor in the phased disposal cell construction is the stormwater, sediment, and leachate retention along perimeter of each phase of the cell. As shown on the Drawings, the cell base includes a three-foot high perimeter berm on the outside edges of the cell. The perimeter berm is designed with a 3:1 inside slope and 5:1 outside slope to tie into the synthetic liner and outside slope of the cover. The cell base includes a three-foot high internal berm on the inside edges of the cell. The internal berm is designed for the cell base liner system to tie into the adjoining phase of cell base. The perimeter and internal berms are designed to aid in leachate collection within each cell.

Stormwater retention berms. Stormwater management is accommodated by water retention with berms or embankments constructed primarily with contaminated site soils, other soils to be disposed in the cell, and minor amounts of broken concrete. As outlined in Section 3.6, the elevation of the retention berms will be maintained at a minimum of five feet above the top surface elevation of the interior materials, with an initial berm height of 8 feet. The berms will be placed in lifts and compacted to aid with moisture retention. As shown on the Drawings, the berms will be raised in an upstream manner (with additional berms constructed with the berm centerline inside of the previous berm). Synthetic liner will be installed on the inside slopes of the retention berms to enhance water retention.

5.2 Water Management

Water management during disposal cell construction will be based on containing water within the cell that is affected by disposed materials, and discharge of stormwater that is unaffected by disposed materials. This includes the elements outlined below.

1. Diversion of stormwater runoff from clean work areas away from areas where material excavation will take place and from the disposal cell footprint.

2. Preparation of the clarifier ponds for stormwater retention, by removal of raffinate sludge and cleaning or re-lining the pond surfaces. The clarifier ponds have an operating capacity of approximately 10 million gallons or 1.37 million cubic feet. The PMP event (26 inches in 6 hours) over the disposal cell footprint prior to cover placement is slightly less than this volume.

3. Collection of stormwater runoff from work areas affected by disposed materials and within the disposal cell perimeter. This water will be pumped or routed to the clarifier ponds for treatment and permitted discharge or use for disposed material compaction or dust control.

4. Operation of the disposal cell with stormwater retention berms surrounding the interior disposed materials. The elevation of the stormwater retention berm crest will be a minimum of five feet above the level of the disposed materials within the cell, or (during initial cell filling) with additional freeboard to provide sufficient capacity for stormwater storage capacity.

5. Removal of collected stormwater within the cell by pumping to the clarifier ponds. This water will be drawn from the cell using a floating intake and piped to the clarifier ponds with high-capacity pumps maintained by SFC on site.

6. Placement of clean fill on the outside slopes of the cell where possible to allow clean stormwater discharge.

5.3 Phases of Construction

The materials to be placed in the disposal cell are listed in the tables in Appendix A by their current location relative to the cell and the phase of the cell where they will be disposed. From the volumes of soils identified for berm material and remaining internal materials, the ratio of berm material volume to internal material volume is: 2.46, 1.49, and 1.33 for phases I through III, respectively. The higher ratio for phase I is designed for the additional material required around the perimeter of the first phase of cell. Lower ratios are required for subsequent phases of cell construction. The tables also outline the schedule of cell construction by: (1) initial work, (2) phase I, (3) phase II, (4) phase III, and (5) post-cell construction. This schedule is summarized in the following paragraphs.

Initial work. Initial work consists of preparatory work prior to construction of the phase I cell base. This includes: (1) pressure filtration of sludges and sediments requiring dewatering, (2) emptying and cleaning of the clarifier ponds (for stormwater storage), (3) moving of UF6 cylinders from the phase I cell area, and (4) initiation of building demolition in the phase I cell area (incinerator building, solid waste building, and Bechtel building). The DUF4 building is just east of the phase I cell perimeter and can be demolished later.

The northeast corner of the disposal cell footprint is primarily concrete or asphalt that is unaffected by facility operations. The soil sampling and analysis program conducted by SFC in this area has verified that soils in this area meet cleanup criteria. The northeast portion of the cell would comprise the first phase of the cell construction sequence.

Phase I of the disposal cell would be constructed on top of the concrete or asphalt pads, with the liner system and perimeter berms forming the cell base. Following base construction, excavation of materials from the phase II area of the disposal cell would be placed in the phase I area. The stormwater retention berm would be raised as soils are available and as needed for freeboard requirements.

Phase II. After the phase II area foundation is cleaned up and the cell base is constructed, excavation of materials and building demolition debris from the phase III area would be placed in the phase II area of the cell. The stormwater retention berm would be raised as soils are available and as needed for freeboard requirements. Phase I and II areas may be joined into one working area.

If the filtered raffinate sludge is disposed on site, the disposal cell for the supersacks of filtercake would be disposed in the phase II area of the cell (as shown on the Drawings). The raffinate sludge disposal area would have an additional synthetic liner installed over the cover layer. This synthetic liner would be extended over the top of the supersacks of filtercake, to completely enclose the raffinate sludge within the disposal cell.

Phase III. After the phase III area foundation is cleaned up and the cell base is constructed, excavation of materials and building demolition debris from outside the cell footprint would be placed in the phase III area of the cell. The stormwater retention berm would be raised as soils are available and as needed for freeboard requirements. Phase I through III areas may be joined into one working area (as shown on the Drawings).

Calcium fluoride sludge placement. Calcium fluoride sludge will be solidified by mixing with cement or fly ash. The mixed, solidified sludge will be placed in the bottom of the interior of the cell (immediately above the synthetic liner cover layer) in all three phases of the disposal cell.

Work prior to cover construction. Work at the end of disposal operations and prior to cover construction includes: (1) ensuring that materials to be disposed in the cell have been identified and placed in the cell; (2) ensuring that all contaminated site soils outside of the cell footprint have been identified, excavated, and placed in the cell; (3) grading and compacting the top surface of the disposed materials to required bottom-of-cover slopes and grades; and (4) smoothing the final bottom-of-cover surface for synthetic liner installation.

6.0 COVER CONSTRUCTION

The cover system is described in Section 4.4, and analysis of the cover performance with respect to NRC criteria is presented in MFG (2002b).

6.1 Construction Sequence

The construction sequence for the disposal cell cover is outlined below.

1. Compaction of the top surface and side slopes of material forming the base of the cover.
2. Construction of the cover on the side slopes of the disposal cell. The cover material could be placed in horizontal lifts or in lifts parallel to the outside 5:1 slopes. The rock mulch and topsoil would be placed as cover areas are completed to final slopes and grades.
3. Construction of the cover over the top surface of the cell, after the volume of contaminated soils has been established. The elevation of the top surface of the cell will be reduced if the final volume of material is less than 8 million cubic feet (due to higher compacted densities of disposed materials or lower actual volumes of materials).
4. Construction of the perimeter apron of the disposal cell to promote runoff away from the disposal cell and transition with surrounding reclaimed topography.
5. Establishment of vegetation on the disposal cell surface, consistent with the overall plan for revegetation.
6. Establishment and marking of settlement monuments, wells, sumps, and other monitoring features on the cell surface and perimeter.

6.2 Institutional Control

As described above, the disposal cell design is based on the site being transferred to the U.S. Department of Energy for long-term care and maintenance. As with other 11e.(2) byproduct material sites, the U.S. Department of Energy will exercise institutional control of the site. This means that the site will be fenced to limit unauthorized access. Activities within the institutional control boundary are only those authorized by the U.S. Department of Energy or its contractors, such as monitoring or maintenance. The proposed institutional control boundary for the SFC facility after reclamation is shown on the Drawings.

7.0 PERFORMANCE MONITORING AND VERIFICATION

The performance monitoring and verification tasks for the disposal cell are consistent with plans for overall site reclamation and review guidelines in NRC (2002). Key tasks are outlined in the following subsections, and address the period of time from site reclamation until property transfer to the U.S. Department of Energy.

7.1 Settlement

Since the soil-like disposal materials will be placed in lifts and compacted to minimize void spaces (as described above) and sludges will be pressure filtered or solidified, differential settlement will not be as critical an issue as for slurried uranium tailings impoundments. Disposal cell cover settlement has been evaluated and is documented in Appendix G. However, settlement will be monitored with survey monuments installed on a grid system on the completed cover surface. The monuments will be surveyed on a quarterly basis until four quarters of stable conditions (less than 0.1 foot of settlement) are measured.

7.2 Vegetative Cover

A revegetation plan has been prepared for the disposal cell surface outlining the species desired for the cell and the schedule and methods planned for achieving mature vegetation (such as institution of weed control). This revegetation plan is presented in the Technical Specifications. After establishment of the initial vegetation on the cover surface, the condition of the initial vegetation will be monitored for comparison with the revegetation plan. SFC will monitor the vegetation performance until that responsibility is changed with property transfer to the U.S. Department of Energy.

7.3 Erosional Stability

The erosional stability of the cover surface will be monitored on a semi-annual basis, most likely at the same time as vegetation monitoring. Elements of the erosional stability monitoring are degree of vegetation cover (in terms of surface coverage), identification of settled or ponded areas (such as on the top surface), and identification of rills, gullys, or other areas of runoff concentration. Areas that are identified will be monitored to determine if corrective action is necessary. Corrective action would include fill placement with topsoil or placement of erosion-resistant materials on the surface, such as rock mulch.

7.4 Groundwater Protection

The elements associated with groundwater protection for the disposal cell are described below.

Design components. The primary groundwater protection mechanism is the use of a liner that is "designed, constructed and installed to prevent any migration of wastes out of the impoundment to the adjacent subsurface soil, groundwater or surface water at any time during the active life (including the closure period) of the impoundment (10 CFR 40 Appendix A 5A[1])." The migration of wastes out of the impoundment is impeded by the following three design components.

1. The cover system is designed to minimize meteoric water from infiltrating into the cell, by using both a moisture retention and evapotranspiration zone and low permeability layer at the base of the cover.

2. Leachate from infiltrating meteoric water or drain down from disposed material within the cell will be collected in the leachate collection system and removed from the cell.

3. A composite liner system, consisting of compacted clay and a synthetic liner will be in place as an additional barrier at the base of the cell.

Leak detection. In addition to the design components listed above, treated calcium fluoride sludge will be placed in the bottom of the cell as the initial layer of disposed material. Sulfate in the treated sludge will provide an indicator of leakage in the liner system (if it should occur), as described below.

As requested by NRC, SRC has evaluated unique and conservative parameters that could be used in a conventional way for prompt detection of leakage from the disposal cell. Sulfate has been selected as an appropriate non-hazardous constituent that can be used for prompt detection of seepage from the lined disposal cell. Sulfate is typically used as an indicator parameter, as a conservative constituent in groundwater flow (since it is transported with essentially no retardation). Because the hazardous constituents on site have some retardation, sulfate would be the first indicator of seepage.

Sulfate concentrations in groundwater at the site are relatively low, and the materials to be placed in the disposal cell do not contain elevated levels of sulfate. Although limited data exists for sulfate concentrations in groundwater at the site, two samples from the terrace/shale 1 layer (wells MW-025 and MW-075) were taken in 2001 and analyzed for sulfate. These data indicate that the background sulfate concentrations in the terrace/shale 1 layer are relatively low (6.7 and 278 mg/l).

Fly ash will be added to the calcium fluoride sludge to stabilize that material before it is placed in the cell (using approximately 1 part fly ash to 2 parts calcium fluoride sludge). Treated fly ash mixture will be placed in the bottom of the disposal cell, comprising a layer approximately two feet thick. Water leaching through the cell would flow through this material before it encounters the liner system.

One of the major constituents of the stabilized sludge is calcium sulfate (gypsum). Gypsum would be leached from the mixture if water were to contact the solidified sludge. Any leachate from the cell would have sulfate concentrations at approximately 1500 to 2000 mg/l which is the sulfate concentration controlled by gypsum solubility. This sulfate concentration would be significantly greater than the background sulfate concentrations, indicating sulfate would serve as an effective indicator parameter for leak detection.

Groundwater monitoring. Groundwater beneath and downgradient from the cell will be monitored in a two-step manner. First, the cell liner system has a leak detection component, as described in Section 4. The leak detection system will provide a timely indication should leakage from the cell occur. Second, five point-of-compliance (POC) wells downgradient and one upgradient, will be installed once the cell construction is complete. The wells will be completed in the clean fill that will replace excavated, contaminated soils. The wells will be completed in the clean fill material, above the underlying aquiclude (the Unit 1 Sandstone of the Atoka Formation) at the base of the well. Leakage from liner system would accumulate on the top of the Unit 1 Sandstone and be detected in these downgradient POC wells. The combination of the leak detection system and the wells placed in the clean fill comprise the groundwater monitoring for the cell that will "provide the earliest practical warning that the impoundment is releasing hazardous constituents to the groundwater."

The leak detection system will be visually monitored, with a water quality samples collected and analyzed, if leakage is present, for the parameters listed in Table 7.1. The POC wells will be monitored on a quarterly basis for the constituents listed in Table 7.1. These constituents are from the Groundwater Monitoring Plan (GWMP) and were incorporated into NRC License SUB-1010 as Condition 49.B. from Amendment 31 dated August 2005. The GWMP also includes a discussion of background groundwater quality, and well construction details. The GWMP will be revised to include the POC wells when they have been installed.

Table 7.1 Groundwater Monitoring Constituents

Antimony	Nickel
Arsenic	Nitrate (as N)
Barium	Selenium
Beryllium	Silver
Cadmium	Thallium
Chromium	Radium-226 and 228
Fluoride	Sulfate
Lead	Thorium-230
Mercury	Uranium (natural)
Molybdenum	

Borehole and well plugging. Every reasonable effort will be made to find and plug hydraulic conduits between the upper and lower aquifers during site reclamation and cell construction. Using the known coordinates of the old boreholes, efforts will be made to locate the old borings during soil cell excavation and cell construction. When excavations are completed to bedrock for soil clean up or cell construction in the areas where the boreholes were advanced, the bedrock surface will be cleaned of residual soils and loose excavation material and, using such methods as spray washing or sweeping, visual inspections will be performed to identify the borehole in the undisturbed shale or sandstone. Methods such as re-drilling or air jetting may be employed to evacuate materials from the old boreholes and the holes will be plugged in accordance with procedures outlined in the Ground Water Monitoring Plan (GWMP), and a bentonite seal will be placed over the stratigraphic interval of the uppermost sandstone unit, in order to preclude future vertical migration down the old boring.

8.0 REFERENCES

Earth Science Consultants, Inc. (ESCI), 1996. "Conceptual Design Report, Decommissioning, Excavation, and Stabilization/Solidification Program," prepared for Sequoyah Fuels Corporation.

Earth Science Consultants, Inc. (ESCI), 1998. "Calculation Brief, RADON Analysis, Case I and Case II Scenarios, Sequoyah Fuels Corporation, Gore, Oklahoma, Project No. 4881-04." Prepared for SFC, December 9.

Linsley, R.K., M.A. Kohler, and J.L.H. Paulhus, 1975. Hydrology for Engineers. Second Edition, McGraw-Hill.

MFG, Inc. (MFG), 2002a. "Hydrogeological and Geochemical Site Characterization Report," prepared for Sequoyah Fuels Corporation, October.

MFG, Inc. (MFG), 2002b. "Preliminary Design Report," prepared for Sequoyah Fuels Corporation, December.

Morrison Knudsen Corporation (MK), 1996a. "Disposal Cell Design Siting Study for On-Site Disposal Cell," report prepared for SFC, September.

Morrison Knudsen Corporation (MK), 1996b. "Conceptual Design and Cost Estimates for Disposal Cells in Process Area and Fertilizer Pond Area." Prepared for Sequoyah Fuels Corporation.

Reid, Miller, and Associates (RMA), 2003. "Assessment of Alternate Cell Location Costs." Memorandum prepared for SFC, November 12.

Roberts/Schornick and Associates, Inc. (RSA), 1991. "Facility Environmental Investigation, Findings Report," (four volumes), prepared for Sequoyah Fuels Corporation, July 31.

Sequoyah Fuels Corporation (SFC), 1997. "Final RCRA Facility Investigation of the Sequoyah Fuels Uranium Conversion Industrial Facility."

Sequoyah Fuels Corporation (SFC), 1998. "Site Characterization Report."

U.S. Nuclear Regulatory Commission (NRC), 1989. "Calculation of Radon Flux Attenuation by Earthen Uranium Mill Tailings Covers," NUREG 3.64.

U.S. Nuclear Regulatory Commission (NRC), 1990. "Final Staff Technical Position, Design of Erosion Protective Covers for Stabilization of Uranium Mill Tailings Sites." August.

U.S. Nuclear Regulatory Commission (NRC), 1999. "Design of Erosion Protection for Long-term Stabilization." NUREG-1623, Draft Report for Comment, February.

U.S. Nuclear Regulatory Commission (NRC), 2002. "Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act." NUREG-1620, Draft Report for Comment, January.