Addendum E

Final Remedial Action Plan
DOE-EM/GJ1547
April 2024

Remedial Action Inspection Plan (RAIP)

Number	Title
E1	Remedial Action inspection Plan (RAIP)**
E2	Computer Aided Earthmoving System (CAES) for Landfills

Note: ** RAIP (E1) modified the RAIP submitted with the Final Remedial Action Plan, Addendum E, July 2008.

DOE-EM/GJ1547-E

Remedial Action Plan and Site Design for Stabilization of Moab Title I Uranium Mill Residual Radioactive Material at the Crescent Junction, Utah, Disposal Site

Addendum E
Remedial Action Inspection Plan

Revision 8

April 2024

Office of Environmental Management

Prepared by the Remedial Action Contractor under contract number 89303322DEM000073 for the U.S. Department of Energy Office of Environmental Management, Grand Junction, Colorado.

DOE-EM/GJ1547-E

Moab UMTRA Project Remedial Action Plan Addendum E Remedial Action Inspection Plan

Revision 8

Review and Approval

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Acronyms and Abbreviations

ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
CFR	Code of Federal Regulations
CID	Construction Interface Document
CM	configuration management
CQA	Construction Quality Assurance
cy	cubic yard(s)
D_{50}	median stone diameter
DOE	U.S. Department of Energy
ft	foot (feet)
GNSS	Global Navigation Satellite System
in.	inch(es)
MDD	maximum dry density
min.	minimum
NA	not applicable
NQA	Nuclear Quality Assurance
PLS	pure live seed
QA	Quality Assurance
QAP	Quality Assurance Plan
QC	Quality Control
RAC	Remedial Action Contractor
RRM	residual radioactive material
UMTRA	Uranium Mill Tailings Remedial Action

1.0 Statement of Policy

This Remedial Action Inspection Plan, herein referred to as the Inspection Plan, identifies the means by which the remedial action activities associated with the U.S. Department of Energy (DOE) Uranium Mill Tailings Remedial Action (UMTRA) Project disposal cell at Crescent Junction, Utah, are controlled, verified, and documented.

This Inspection Plan has been developed within the scope of the *Moab UMTRA Project Quality Assurance Plan (QAP) for the Remedial Action Contractor* (DOE-EM/GJRAC1766). It complies with the applicable parts of American Society of Mechanical Engineers (ASME) Nuclear Quality Assurance (NQA)-1-2008, and addenda through 2009, "Quality Assurance Program for Nuclear Facilities"; Title 10 Code of Federal Regulations, Part 830 Subpart A (10 CFR 830A), "Quality Assurance"; and DOE Order 414.1D, "Quality Assurance."

2.0 Personnel Interactions Involved with Inspection and the Quality Process with Referenced Documents

2.1 Quality Assurance Plan (QAP)

Quality assurance (QA) during the construction activities shall be implemented in accordance with the QAP. The QAP has been developed specifically by the Remedial Action Contractor (RAC) for the DOE UMTRA Project in Moab, Utah.

2.2 Configuration Management Plan

The *Moab UMTRA Project Configuration Management Plan for Design and Construction* (DOE-EM/GJRAC3079), referred to as the Configuration Management (CM) Plan, addresses CM requirements to ensure changes that may affect the approved design configuration are recognized, processed, communicated, and documented. The CM Plan will be updated when necessitated by changes in the site CM policies, practices, and/or implementation schedules. This remedial action project is in a continuous construction phase until completed and is not an "operating facility." The Moab UMTRA project CM Plan scope applies to Change Control management activities to be utilized for the engineering design and engineering support during construction.

2.3 Design Change Controls

Any design changes that take place during the construction of the Project shall follow the approved *Moab UMTRA Project Design Change Control* (DOE-EM/GLRAC3080) process. This work instruction ensures that design change is controlled and communicated in a consistent manner, enabling project cost, budget, schedule, and quality to be achieved. This will be achieved by documentation, coordination, and agreement of all design changes on the project, irrespective of their source.

2.4 Construction Personnel Interfaces

It is important that personnel involved in this Project interface through formally approved channels. The *Moab UMTRA Project Construction Interface Document* (DOE-EM/GJRAC3081) summarizes the process for Moab UMTRA project personnel to formally communicate questions or requests for proposed modifications to the Design Authority. A Construction Interface Document (CID) Form (QA-F-023) is initiated by site construction personnel in order to ask a question or submit a request to the Operations Manager, who will screen and transmit the CID to the project's Design Authority for clarification and/or disposition. CIDs that necessitate the need for a design change will be processed by the Design Authority in accordance with *Moab UMTRA Project Design Change Control*. The use of the CID process and form is intended to provide quick and formal means of documenting responses to questions and disposition of proposed design changes.

3.0 Testing and Inspection

The testing and inspection activities discussed in this Inspection Plan are performed in accordance with the applicable sections of the QAP.

4.0 Purpose

The purpose of this Inspection Plan is to describe the methods by which the construction activities will be tested and inspected to assure that the project is constructed in conformance with the most recently approved Technical Specifications and Drawings, as well as applicable regulatory requirements and permit conditions.

5.0 Scope

This Inspection Plan defines the testing and inspection of remedial action construction activities at the Crescent Junction site. Types of tests, test frequencies and acceptability, and documentation and reporting requirements are provided in this Inspection Plan. Procedures for performing the individual tests shall be in accordance with the applicable ASTM International (ASTM) standards, the referenced or other approved methods, and the design specifications.

This Inspection Plan is also intended to: (1) establish guidelines for the flow of information and project communication; (2) establish protocols for project documentation; and (3) establish specific quality procedures for the major components of the project.

6.0 Project Construction Elements

The project has multiple distinct work elements. They include excavation of the disposal cell; construction of the earthen embankment around the perimeter of the disposal cell; construction of the embankment north of the disposal cell intended to divert surface water from the Book Cliffs around the disposal cell; placement and compaction of the residual radioactive material (RRM) transported from the Moab site to the disposal cell; placement and compaction of debris in the disposal cell; and, construction of the final cover system. The final cover system is discussed in Section 7.0.

6.1 Computer-based Compaction System

A computer-based compaction system may be used in lieu of or in conjunction with standard testing methods outlined in Sections 6.2 through 6.5, provided that the following are satisfied:

- A demonstration test pad was constructed with the applicable soil and built with the intended final construction method;

- All measured density and moisture requirements were satisfied using standard testing methods outlined in Sections 6.2 through 6.5; and
- The computer-based compaction system is approved separately for each project construction element by the Design Authority.

The Global Navigation Satellite System (GNSS), comprised of both the U.S. Global Positioning System and the Russian Global Orbiting Navigation Satellite System, and computer terrain modeling technology are combined to provide a method for compacting soil.

The system works as follows:

- A digital terrain model of the site receiving fill material is loaded into an on-site computer and onboard heavy equipment computer (CB-460). The on-site computer is linked to the CB-460 in the cab of the compaction equipment utilizing Trimble WorksOS. A GNSS receiver is also linked to the CB-460. When the machine moves across the site, the GNSS equipment provides an accurate position (to within 0.1 foot) and elevation of the equipment at all times.
- Soil is dumped and spread into a layer of fill. As the equipment spreads and compacts the layer of soil, the position of the machine is compared to the terrain model to determine the location and thickness of the fill layer being placed and/or compacted. The CB-460 provides real-time cut/fill information to the equipment operator so that the operator may place the material in a layer with uniform specified thickness.
- After a layer has been placed with uniform thickness, the compactor makes multiple passes over the fill to compact the fill material in place. The number of passes required to achieve the specified relative compaction is determined using an assessment test where pass count is correlated to nuclear density gage readings. Assessment tests are conducted of each material/soil type to determine the pass count/relative density correlation, or whenever a new material type is encountered. Each pass of the compactor is tracked using the computer-based compaction system. The compacted surface elevation is also tracked with the pass count and position information.
- As the compactor or dozer traverses the soil to compact it, the computer-based compaction system records the position data, comparison to previous lift/or terrain model, and pass count allowing the QA/quality control (QC) personnel to generate reports and verification that the lift met the specified number of machine passes for compaction and thickness requirements.

Visual inspection, correct placement and compaction techniques, and good moisture control are required to ensure that fill is properly placed and compacted. The computer-based compaction system method has the following potential advantages over traditional field density testing:

- Lift thicknesses are computer-controlled and are often more uniform than when layers are installed based on visual estimates by the equipment operators.
- Additionally, the computer tracks compaction over the entire surface of every layer, whereas the in-place test methods check only a few points on each layer.

Soil density verification tests and independent land surveys shall be performed to demonstrate the effectiveness of the computer-based compaction system.

6.2 Disposal Cell Excavation

Part of the proposed disposal cell is to be constructed below the ground surface via excavation, whereas part of it will be above grade. The excavation will be constructed in phases. The overall cell floor and side slopes are described below. Table 1 provides a QA summary for the disposal cell.

6.2.1 Floor and Side Slopes
The cell floor slopes 2.3 percent from northwest to southeast. There are cut slopes on the northern, western, and southern sides of the cell slope at either 2:1 or 3:1, as depicted in the Drawings.

6.2.2 Final Floor and Embankment Elevations
The cell floor coordinates and elevations are shown in the Drawings. When each section of the cell is excavated to the elevations indicated on the Drawings, a verification survey shall be performed to confirm that the excavation meets proposed lines and grades. The verification survey shall be signed and submitted to the RAC Crescent Junction Operations/Site Manager.

6.2.3 Cell Floor in Weathered Mancos Shale
The cell floor elevation has been set based on test pit and soil boring data and is at least 2 feet below the top of the Mancos Shale formation at each data point. The cell floor shall be visually inspected to confirm that it is in the Mancos Shale formation. If an area is observed where the overburden soil extends below the cell floor, the area will be undercut, backfilled with prepared Mancos Shale, and compacted.

6.2.4 Inspection and Testing
The QC Representative shall visually inspect the material, ground preparation, and verify the cell floor is constructed in accordance with the most recently approved Drawings and Specifications by checking and confirming:

- Cell floor and side slopes meet the design shown in the Drawings.
- Final cell floor and side slopes survey match the coordinates and elevations in the Drawings.
- Cell floor is weathered Mancos Shale across its entire footprint, or isolated areas undercut to a minimum depth to the top of the Mancos Shale formation, backfilled with prepared Mancos Shale, and compacted.

Table 1. Disposal Cell QA Summary

Soil Texture	Side Slope	Bottom Slope	Depth below Natural Grade	Density	Standard
Mancos Shale (in situ)	2:1 or 3:1 per Drawings	2.3% northwest to southeast per Drawings	2-ft, min.	NA	NA
Mancos Shale (prepared for low spots)	2:1 or 3:1 per Drawings	2.3% northwest to southeast per Drawings	2-ft, min.	95% of MDD, min.	ASTM D698

ASTM = American Society for Testing and Materials
MDD = maximum dry density
NA = not applicable

6.3 Perimeter Embankment Construction

Part of the proposed disposal cell will be below the existing ground surface in an excavation, and part will be above the existing ground surface within a constructed earthen perimeter embankment. The proposed embankment will have 3:1 or 2:1 interior slopes, 5:1 exterior slopes, and a minimum 30-foot-wide, level top. Excavated material from the cell excavation will be used to construct the cell perimeter embankment.

6.3.1 Material
Excavated material from the cell excavation shall be segregated into four types of soil: topsoil (upper foot of overburden), weathered Mancos Shale, common fill (overburden or alluvium), and

unsuitable material. Materials shall be separately stockpiled. The perimeter and spoils embankments will be constructed of common fill. The fill shall be tested to determine its maximum dry density in accordance with ASTM D698, and the moisture content shall be modified to bring the fill near its optimum moisture for compaction.

6.3.2 Subgrade Preparation

The soil beneath the proposed perimeter embankments, referred to as the subgrade, shall be prepared by stripping vegetation and loose soil from the site, scarifying and compacting the top 12 inches of soil. Compaction shall be performed to a minimum of 95% of the MDD per ASTM D698.

6.3.3 Lift Placement and Thickness

The perimeter embankment shall be constructed of fill materials placed in continuous and approximately horizontal lifts. The method of dumping and spreading fill shall result in loose lifts of nearly uniform thickness, not to exceed 12 inches. At the RAC's option, the compactor may be equipped with a computer-based compaction system and soil placement, and compaction shall be controlled by the computer-based compaction system. The contractor may use the computer-based compaction system to determine and document compaction or perform soil density tests is in accordance with the Inspection and Testing section below.

6.3.4 Inspection and Testing of Cell Perimeter Embankment

QC shall visually inspect the material preparation, ground preparation, and fill placement operations. QC shall perform in-place density tests with companion moisture tests to verify a minimum of 90 percent (Specification Section 31 00 00) of the laboratory maximum dry density in accordance with ASTM D698.

QC shall verify the perimeter embankment is constructed in accordance with Drawings and Specifications by checking and confirming:

- Interior slopes are 3:1 or 2:1 per the Drawings, and exterior slopes are 5:1 with a minimum 30-foot-wide, level top verified once at the end of excavation.
- Fill material is properly moisture conditioned near optimum moisture.
- Fill material is placed in continuous and approximately horizontal lifts. The method of dumping and spreading material shall result in loose lifts of nearly uniform thickness, not to exceed 12 inches.
- Embankment construction soil is common fill and/or Mancos Shale.
- Embankment fill shall be compacted with a minimum 45,000-pound static weight compactor. The compactor shall be a rubber-tired equipment with weight or a footed roller type, capable of kneading compaction, with feet a minimum of 6 inches in length.
- In-place density verification tests shall be performed on initial layers of each soil texture placed and on any unique material for which the computer-based compaction system is used.

Testing and verification frequencies for lifts constructed without the computer-based compaction system shall be in accordance with the following requirements.

6.3.5 Testing Cell Perimeter Embankment Frequency

Material compacted by other than hand-operated machines:

The frequency for testing of material placed to construct the perimeter embankment shall consist of a minimum of one test per 50,000 square feet or 1,850 cubic yards of material placed (or fraction thereof), a minimum of one test for each lift of fill or backfill, and a minimum of two tests per day that fill is compacted in accordance with ASTM D6938.

Material compacted by hand-operated machines:
In areas where hand-operated machines are used for compaction, the minimum testing frequency is one test per 500 square feet (or fraction thereof) of each lift of fill or backfill areas.

6.3.6 Testing Cell Perimeter Embankment Test Standards

In-place density and moisture content tests shall be performed in accordance with at least one of the following standards:

- ASTM D1556
- ASTM D2216
- ASTM D4643
- ASTM D6938

Check Tests on In-Place Densities
If ASTM D6938 is used, in-place densities will be checked by ASTM D1556 as follows:

- One check test for each 20 tests of fill or backfill compacted by other than hand-operated machines (per ASTM D6938).
- One check test for each 10 tests of fill or backfill compacted by hand-operated machines (per ASTM D6938).

Optimum Moisture and Laboratory Maximum Density
Laboratory density and moisture content tests (ASTM D698 and ASTM D2216) will be performed for each type of fill material to determine the optimum moisture and laboratory maximum density values. One representative density test will be performed per material type and every 20,000 cubic yards thereafter or when any change in material occurs that may affect the optimum moisture content or laboratory maximum dry density.

One correlation test for moisture contents every 10 tests per ASTM D6938 will be performed in accordance with ASTM D4643 or D2216. In the stockpile, excavations, or borrow areas, moisture tests will be performed to control the moisture content of material being placed as fill.

Control of moisture content of fill shall be performed by conducting routine testing of moisture content by at least one of the following tests:

- ASTM D2216
- ASTM D4643
- ASTM D4944
- ASTM D4959

During unstable weather, tests will be performed as dictated by local conditions and approved by the Crescent Junction Operations/Site Manager.

6.4 Disposal Cell Spoils Embankment (Wedge)

The spoils embankment is a fill embankment to be constructed north of the cell. The embankment will divert storm water from the Book Cliffs around the cell and shall be constructed of surplus excavated material (spoils material) from the cell excavation.

Before placement, spoils material shall be tested to determine its maximum dry density and optimum moisture content in accordance with ASTM D698.

6.4.1 Constructing the Spoils Embankment

- Prepare the ground beneath the proposed perimeter embankment by stripping vegetation and loose soil from the site.

- Dump and spread fill in loose lifts of nearly uniform thickness, not to exceed 12 inches.
- Compact material with rollers, equipment tracks, or successive passes of scrapers. Fill shall be compacted to a density of 90 percent of the laboratory-determined maximum density in accordance with ASTM D698.

6.4.2 Quality Control

QC shall verify that the spoils embankment is constructed in accordance with the most recently approved Drawings and Specifications by checking and confirming:

- Exterior slopes are 3:1.
- Fill material is properly moisture conditioned near optimum moisture.
- Fill material is placed in continuous and approximately horizontal lifts.
- The method of dumping and spreading material shall result in loose lifts of nearly uniform thickness, not to exceed 12 inches.
- Embankment construction soil is surplus excavated material.
- Compaction is properly performed.
- Embankment fill shall be compacted with rollers, equipment tracks, or successive passes of scrapers at a minimum 45,000-pound static weight.
- In-place density and moisture content compaction verification tests are performed on compacted fill material in accordance with the In-Place Density Testing sections below.
- In-place density verification tests shall be performed on initial layers of soil placed and on any specific type of material for which the computer-based compaction system is approved.

6.4.3 Spoils Embankment Testing Frequency

Testing and verification frequencies for lifts constructed without the computer-based compaction system shall be in accordance with the following tests:

- One test per 100,000 square feet or 3,700 cubic yards of material placed for material compacted by other than hand-operated machines.
- One test per 500 square feet (or fraction thereof) of each lift of fill or backfill areas for material compacted by hand-operated machines.

6.4.4 Optimum Moisture and Laboratory Maximum Density (Proctor Test)

Laboratory density and moisture content tests (ASTM D698 and D2216) will be performed for each type of applicable fill material to determine the optimum moisture and laboratory maximum density values. One representative density test will be performed per material type and every 20,000 cubic yards thereafter or when any change in material occurs that may affect the optimum moisture content or laboratory maximum dry density. One correlation test for moisture every 10 tests per ASTM D6938 will be performed in accordance with ASTM D4643 or D2216. In the stockpile, excavations, or borrow areas, moisture tests will be performed to control the moisture content of material being placed as fill. Control of moisture content of fill shall be performed by conducting routine testing of moisture content by one of the following tests:

- ASTM D2216
- ASTM D4643
- ASTM D4944
- ASTM D4959

6.4.5 Spoils Embankment Testing Standards

In-place density and/or moisture content tests shall be performed in accordance with the following methods:

- ASTM D1556

- ASTM D2216
- ASTM D6938
- ASTM D4643

6.4.6 Check Tests on In-Place Densities

If ASTM D6938 is used, in-place densities will be checked with ASTM D1556 as follows:

- One check test for each 20 tests of fill or backfill compacted by other than hand-operated machines (per ASTM D6938).
- One check test for each 10 tests of fill or backfill compacted by hand-operated machines (per ASTM D6938).

During unstable weather, tests will be performed as dictated by local conditions and approved by the Crescent Junction Operations/Site Manager.

6.5 Residual Radioactive Material

The objective is to place and compact the RRM in the waste cell to create a stable waste mass. QC shall visually inspect the material preparation, ground preparation, and RRM placement operations, and shall perform in-place density tests with companion moisture tests for the computer-based compaction system to verify that RRM compaction meets the compaction requirements.

QC shall verify that RRM placement is performed in accordance with Drawings and Specifications and that the top of the placed waste matches the final grades identified in Section 6.4.5. RRM shall not be placed when frozen or over frozen subgrade. If rainwater ponding has occurred or RRM is near saturation, placement of RRM shall be performed only after the area is dewatered, and approval of the Crescent Junction Operations/Site Manager and QC to place has been obtained.

6.5.1 Moisture Modification

RRM material should be shipped from the Moab site dried to a moisture content necessary to meet required compaction specifications. Some RRM may require minor moisture modification when received at Crescent Junction site.

6.5.2 Residual Radioactive Material Placement

At a minimum the top inch of subsoil or preceding RRM lift shall be scarified using a footed roller or a dozer before placing subsequent RRM layers. Fill materials shall be placed in continuous and planar lifts. The method of dumping and spreading RRM shall result in loose lifts of nearly uniform thickness, with thickness not to exceed 24 inches. Compaction equipment shall consist of rubber-tired equipment with weight, footed rollers or dozers. Footed rollers shall have a minimum weight of 45,000 pounds and at least one tamping foot shall be provided for each 110 square inches of drum surface.

The length of each tamping foot from the outside surface of the drum shall be at least 6 inches. During compaction operations, the spaces between the tamping feet shall be maintained clear of materials that would impair the effectiveness of the tamping foot rollers. Dozers shall have a minimum ground pressure of 1,650 pounds per feet. The computer-based compaction system may be used to direct fill placement, monitor compaction, and record the location and thickness of each soil layer being placed.

6.5.3 Inspection and Testing

QC shall visually inspect the ground preparation and fill placement operations. RRM shall be compacted to meet a minimum of 90 percent of the laboratory-determined maximum dry density in accordance with ASTM D698. QC shall verify the RRM placement is constructed in accordance with design plans and specifications by checking and confirming:

- Assessment tests shall be performed on RRM to ensure compliance with specified requirements and to develop compaction requirements for placement. A minimum of three tests for maximum dry density (ASTM D698) and optimum moisture content (ASTM D2216) shall be performed for each type of RRM soil observed.
- Fill material is properly moisture conditioned; one moisture content quick test will be performed each day material is placed in accordance with ASTM D4643, D4944, or D4959 until a sufficient number have been performed to demonstrate a clear correlation allowing a reduction in testing.
- Fill material is placed in continuous and planar lifts. The method of dumping and spreading RRM shall result in loose lifts of nearly uniform thickness, with thickness of fill area not to exceed 24 inches.
- Compaction meets specifications.
- Compaction by computer-based system shall be monitored by QC by visually inspecting the process and reviewing the computer records for each layer of soil placed.
- In-place density verification tests shall be performed on the initial layer of RRM and on any layers in which the computer-based compaction system indicates problems occurred obtaining compaction.

***NOTE*:** Companion sand cone and moisture tests must be performed along with nuclear tests until enough have been performed to demonstrate a clear correlation.

Testing Requirements when Computer-Based Compaction System Is Not Used

If the computer-based compaction system is not used, the following testing requirements shall be followed.

In-place density and moisture content compaction verification tests will be performed on compacted fill material in accordance with the following requirements:

- A verification representative sample from each principal type or combination of blended RRM materials shall be tested to establish compaction curves using ASTM D698.
- A minimum of one set of compaction curves shall be developed per 10,000 cubic yards of RRM material or until a compaction curve has been developed for each principal type or combination of blended RRM material, after which time the compaction value from the appropriate compaction curve may be used in lieu of sampling and testing using ASTM D698.
- In-place density and moisture content tests are performed on a soil layer; a minimum of two tests shall be performed per 5,000 cubic yards or 135,000 square feet of fill material placed.

Compaction and moisture content tests shall be performed in accordance with at least one of the following methods:

- ASTM D1556
- ASTM D2216
- ASTM D6938
- ASTM D4643

6.5.4 Other Inspection Requirements for Placement of RRM

1. Erosion that occurs in the RRM layers shall be repaired and grades re-established before proceeding.
2. Freezing and desiccation of the RRM soil shall be prevented. If freezing or desiccation occurs, the affected soil shall be reconditioned.

3. Areas that have been repaired shall be retested. Repairs to the RRM layers shall be documented, including location and volume of soil affected, corrective action taken, and results of retests.

6.5.5 Placement of Demolition Debris within RRM

Demolition debris may be placed in the cell along with RRM. Debris shall not contain free liquids. Debris shall be sized and placed to minimize voids. Pipes and ducts 6 inches or greater in diameter shall be crushed, longitudinally cut in half, or cut small enough to allow them to be filled with soil or other approved material. Rubber tires shall be cut and placed to minimize void space. Debris shall be spread and/or oriented in a manner that results in a minimum of voids.

Debris may be placed as a sacrificial lift at the bottom of the disposal cell in a maximum 2-foot lift. Debris in sacrificial lifts shall contain no free liquids and shall be oriented in a manner that minimizes voids, and contained within the 2-foot lift profile. Sacrificial debris lifts are not subject to moisture and compaction criteria; however, soils contained in the sacrificial lifts shall be compacted to meet soil density and moisture intent of the adjacent soils.

6.5.6 Final RRM Geometry

The top surface of the RRM shall adhere to the grades and elevations shown in the Drawings. The tolerance shall be +0.17-ft, -0. These grades and elevations shall be verified by survey.

7.0 Final Cover System (Evapotranspiration Cover)

The proposed final cover system is an evapotranspiration cover. It is composed of four layers from bottom to top: (a) interim cover, (b) radon barrier, (c) frost protection layer; and (d) surface admixture layer.

The multi-layered cover system will be placed over the prepared RRM. The material specifications, layer configurations, layer thicknesses, borrow sources, placement methods, and compaction requirements are described in the Technical Specifications. Inspection of the final construction system shall monitor placement, moisture conditioning, and compaction of the backfill material as it is placed. Figure 1 shows the cover profile.

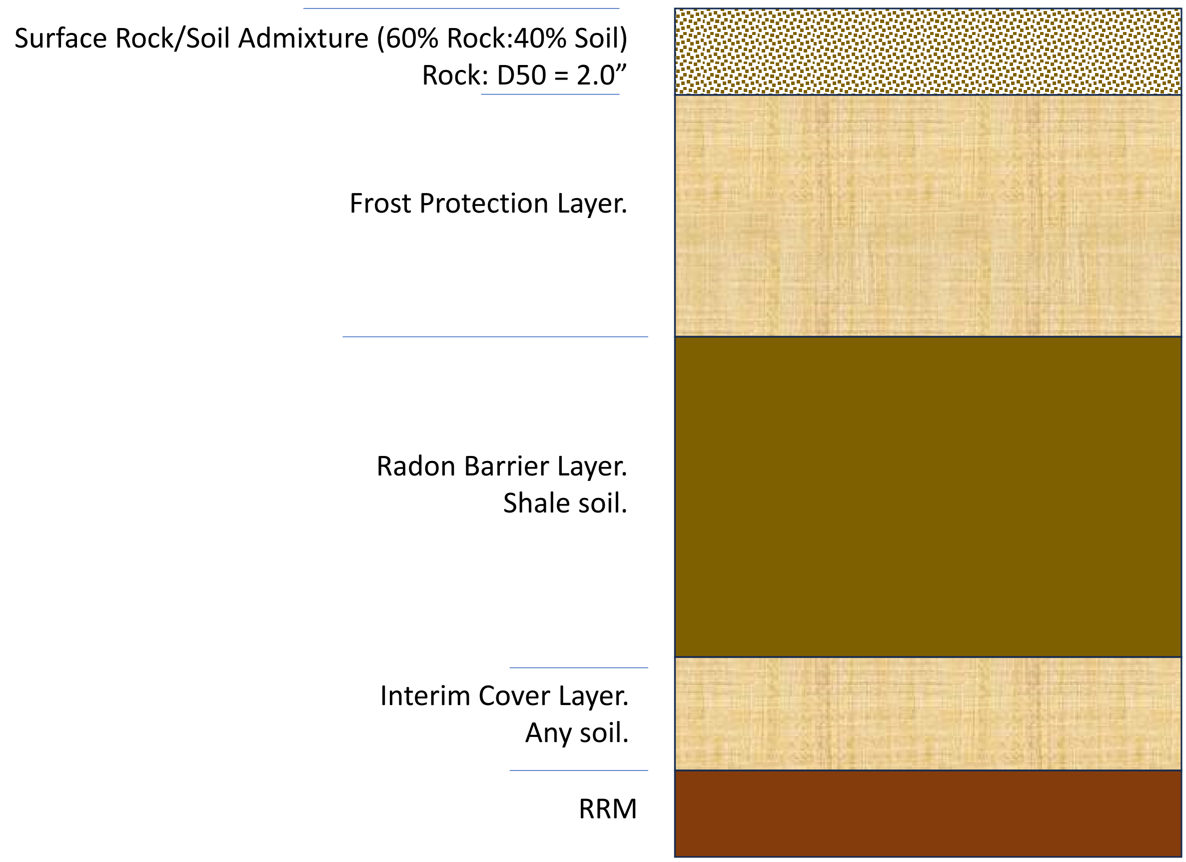

Figure 1. Evapotranspiration Cover Profile with Surface Admixture Depth Options

The bottom foot of the cover system will be the interim cover as described in the Technical Specifications. This soil can be either alluvium/overburden or Mancos Shale soil excavated from the approved on-site borrow sources. The next layer of the cover system (Radon Barrier Layer) shall be composed of Mancos Shale soil. The next soil layer is the frost protection layer. Similar to the interim cover, this soil can be either alluvium/overburden or Mancos Shale soil excavated from the approved on-site borrow sources. The top layer is the surface rock/soil admixture to be composed of alluvium/overburden cover soil excavated from the approved on-site borrow source uniformly mixed with rock from the approved stockpile.

For construction of the ET Cover system, refer to Specification Section 31 00 01 COVER RELATED EARTHWORK. All admixture layer mixing methods must be approved prior to commencement of this activity described in Specification Section 31 00 50 METHOD SPECIFICATION FOR MATERIAL MIXING AND SURFACE ADMIXTURE PLACEMENT. For the rock to be included in the admixture layer, refer to Specification Section 32 11 22 FINAL COVER SYSTEM RIPRAP AND ADXMITURE ROCK

Uniformity of final soil composition for all soil layers is critical. Quality Assurance of the cover soil shall accomplish these objectives:

- Ensure layer material quality meets specifications;
- Ensure rock/soil admixture and soil texture combination soil layers are uniformly mixed; and
- Ensure each layer material is properly placed.

Uniformity of compaction for all soil layers is critical. During cover placement, it is crucial that each lift be bonded to the previous lift. This mitigates potential inter-lift passageways (cracks) for the water to travel along as it passes from an overlying lift to a lower one. To minimize the creation of inter-lift passageways, if a smooth-rolled compactor is used, each lift shall be scarified to a depth of 1 to 2 in. prior to the placement of the next lift, thus establishing continuity between the lifts.

7.1 Material Conformance Monitoring and Testing

QC will oversee monitoring and verification testing to ensure that the fill materials meet the gradation and classifications specifications. The QC representative shall also monitor earthmoving operations to ensure that the fill material is taken from the proper borrow sources.

Prior to the placement of the next layer of the cover, the inspector shall inspect the completed layer and document any of the following:

- Erosion of the layer surface;
- Cracking or desiccation of the surface;
- Fill areas that may contain excessive organics or other debris;
- Depressions, or settlement of the layer;
- Irregularities in the layer surface (e.g., grading errors); and
- Any other significant issue not described here.

Any documented items that constitute non-conformance with the Drawings and Technical Specifications shall be corrected prior to placement of the subsequent layer of the cover.

7.2 Cover Soils

The cover soils shall be obtained from the approved borrow sources and shall meet the gradation and placement requirements outlined in the Technical Specifications. Soil shall be free of roots, debris, and/or frozen material. Overburden/alluvium and weathered Mancos Shale shall each be excavated, pulverized, wetted, and mixed separately to produce a uniform soil texture.

7.2.1 Interim Cover Soil Layer

The bottom layer or interim cover soil layer shall be composed of overburden/alluvium or Mancos Shale soil from the on-site approved borrow source. This layer shall be 1 ft thick after compaction. Refer to Table 4 for depth tolerances.

7.2.2 Radon Barrier Cover Soil Layer

The radon barrier layer shall be a minimum of 4 ft after compaction. This cover soil shall be processed Mancos Shale from the on-site approved borrow source. Refer to Table 4 for depth tolerances.

7.2.3 Frost Protection Cover Soil Layer

The frost protection soil layer shall be composed of overburden/alluvium or Mancos Shale soil from the on-site approved borrow source. This layer shall be 28.5-in thick after compaction. Refer to Table 4 for depth tolerances.

7.2.4 Surface Rock/Soil Admixture

The surface layer or rock/soil admixture layer shall consist of overburden/alluvium soil from the on-site approved borrow source with rock uniformly mixed into it and compacted to a total depth of 10-in. Refer to Table 4 for depth tolerances.

The rock portion of the admixture will consist of rock from approved borrow sources. Rock shall meet approved size (D_{50} = 2.0 in.) and durability requirements (score of 80 or better). If the rock does not meet durability requirements, submit testing results to the Design Authority for potential oversizing and resulting design implications oversizing may dictate. The surface admixture material shall be free from roots, branches, rubbish, and debris. Submittal of rock size and durability shall be approved prior to shipment.

The mixtures of rock to soil shall be 60% rock (D_{50} = 2.0 in.) to 40% soil by volume. The rock/soil admixture surface layer shall be placed and inspected per Specification Section 31 00 50 METHOD SPECIFICATION FOR MATERIAL MIXING AND SURAFCE ADMIXTURE PLACEMENT.

The gradation specifications for the rock used for the admixture material shall be confirmed by gradation testing prior to mixing with the soil, to determine the particle sizes.

7.2.5 Material Placement

The inspector shall observe the surface condition prior to fill placement. If the compacted surface of any layer of fill is too smooth to bond properly with the layer of material to be placed thereon, it will be reworked with a harrow, scarifier, or other suitable equipment to a 1- to 2-in. depth to provide a satisfactory bonding surface before the next succeeding layer of fill is placed.

If the compacted surface of any layer of fill in-place is too wet (e.g., due to precipitation), it will be reworked with harrow, scarifier, or other suitable equipment to reduce the moisture content to an acceptable level. It will then be recompacted to the fill requirements.

Testing of oversized material will be controlled through selective excavation of stockpiled material, observation of placement by QC Technicians with authority to stop work and reject material being placed, and by removing oversized material from the fill. Successive loads of material will be placed on the fill so as to produce the best practical distribution of material.

The inspector shall monitor the weather and temperature conditions. No material will be placed when the fill material or the underlying material is frozen or when ambient temperatures do not permit the placement or compaction of the materials to the specified density without developing frost lenses in the fill.

The inspector shall monitor and document the lift thicknesses frequently to ensure that the specifications are met. The required layer and lift thicknesses are listed in Table 2.

Table 2. Summary of Cover Components Layer and Lift Thicknesses

Cover Component	Material Type	Layer Thickness	Placement Lift Thickness
Interim Cover	Alluvium or Mancos Shale from approved on-site borrow	12 in. compacted	Place in 1 lift
Radon Barrier	Mancos Shale from approved on-site borrow	4 ft compacted	Place in approximate 1-ft thick lifts
Frost Protection Layer	Alluvium or Mancos Shale from approved on-site borrow	28.5 in. compacted	Place in 2 approximately equal lifts
Surface Admixture (soil and rock mixture)	Alluvium mixed with rock from approved borrow	10 in. compacted	Place per Specification Section 31 00 50

7.2.6 Moisture and Density Control

The inspector shall monitor placement, moisture conditioning, and compaction of each soil texture as it is placed. Prior to the start of field compaction operations, appropriate laboratory compaction curves/proctors shall be obtained for the range of materials to be placed (ASTM D698). Laboratory compaction curves based on complete Proctor tests will be conducted at the appropriate frequencies, depending on the variability of materials being placed.

Each layer of the cover soil shall be conditioned so that the moisture content is relatively uniform throughout the layer prior to and during compaction. Each lift will be compacted by a sufficient number of machine passes or other compaction equipment to achieve the required density. Material that is too wet or does not meet the required density will be rejected and will be reworked until the moisture content and density are within the specified limits. Reworking may include removal, re-harrowing, reconditioning, re-rolling, or combinations of these procedures.

The required testing frequencies are included in Tables 3 through 5. Field density testing may be conducted with the sand cone test (ASTM D1556); a nuclear density gauge (ASTM D6938); or other method approved by the Design Engineer. An alternative method for determining soil field densities must be approved by the Design Engineer prior to commencement of cover construction. If applicable, correlation of nuclear density gauge results shall be by comparison with results from sand cone test(s) and laboratory testing for water content(s) using ASTM D2216 or ASTM D4643 on similar material.

Field density tests shall be compared with Standard Proctor tests (ASTM D698 Method A or C) on the same material. Rock corrections (ASTM D4718) for oversize particles may be required for the rock/soil admixture (or other materials) depending on the gradation of the rock material selected.

The actual frequency of testing may be increased by the QA Manager or Design Engineer if variability of materials is noted at the site, during adverse conditions, or to isolate failing areas of the construction.

7.2.7 Surface Slopes and Grades

Each layer of the cover profile shall have the slope as designated in the Drawings and Technical Specifications. The slopes shall be free from abrupt changes in grade or areas of runoff concentration.

7.3 Tolerances

The layer thicknesses shall meet the required thicknesses with tolerances as specified in the Technical Specifications and Tables 3 to 5.

7.4 Nonconformance, Corrective Action and Stop Work

A problem is defined as material or workmanship that does not meet the requirements of the Drawings, Technical Specifications, or Inspection Plan for the project of any obvious defect in material or workmanship (even if there is conformance with plans, Technical Specifications, and the Inspection Plan). The QA Manager and inspector(s) will have the authority to reject material that is brought to the Site or material that has been placed.

For a failed field moisture/density test, the inspector shall determine the extent and depth of the affected area and require re-work of the material as described above. If persistent failed tests occur, indicating inadequate compaction methods, the QA Manager or inspector will have the authority to stop the work until the underlying cause is determined and the Contractor can demonstrate that the moisture/density specifications can be met. The Design Engineer shall be involved in determination of nonconformance. The QA Manager shall be involved in determining the extent and depth of affected area.

At a minimum, problem identification and corrective measures reports shall contain the following information:

- Location of the problem;
- Description of the problem (in sufficient detail and with supporting sketches or photographic information where appropriate) to adequately describe the problem;
- Probable cause for the problem;
- How and when the problem was identified (reference to inspection data sheet or daily summary report by inspector);
- Where relevant, estimation of how long the problem existed;
- Any disagreement noted by the inspector between him/herself and contractor about whether or not a problem existed or the cause of the problem;
- Suggested corrective measure(s);
- Documentation of correction, if corrective action was taken and completed prior to finalization of the problem, and completed corrective measures report (reference to inspection data sheet, where applicable);
- Where applicable, outline of suggested methods to prevent similar problems in the future; and
- Signature of the inspector and review signature of QA Manager.

7.5 Documentation

All field and laboratory test results, observations of fill placement, and field compaction test results will be recorded. Tables 3 through 5 include a summary of the required materials testing and frequencies for the cover components.

7.5.1 Hold Points

There will be four hold points for placement of the cover profile: (1) after completion of the interim cover soil layer; (2) after completion of the Radon Barrier soil layer; (3) after completion of the frost protection soil layer; and (4) after completion of the surface rock/soil admixture layer.

After mixing (for appropriate layer), placement, and compaction of each cover layer, the final condition of the material shall be inspected for concurrence. The QA Manager shall document compliance.

Table 3. Testing and Performance Criteria for Borrow Source Areas
(tested & approved at borrow sources prior to placement)

Component	Parameter	Test Method	Minimum Frequency	Performance Criteria Objective	Performance Criteria Tolerance	Response to Nonconformance
Surface Rock/Soil Admixture Layer	Soil texture: borrow source -- alluvium / overburden	Visual confirmation soil comes from approved borrow source	Constant	No stone or clod larger than nominally 4-in. diameter, no large roots, frozen material or foreign objects.	No large roots, frozen material, or foreign objects.	Reject if rock not uniformly distributed through layer. Remove large objects, roots.
	Rock	Durability testing per Technical Specifications	1 per borrow source prior to delivery of rock to site	D_{50} 2.0-in. dia.	Rock to be relatively uniform in size. No large roots, frozen material, or foreign objects.	Reject if rock does not meet Technical Specifications requirements. If oversizing is required, Design Engineer to approve. Remove large objects, roots.
Frost Protection Layer	Soil texture: borrow source -- alluvium / overburden or Mancos Shale soil	ASTM D698 ASTM D2216	A minimum of three tests for maximum dry density (ASTM D698); optimum moisture content tests (ASTM D2216) shall be performed for each type of soil observed to establish the optimum moisture material placement. QA Manager or Design Engineer can request additional tests depending on consistency of soil.	No stone or clod larger than 4-in. diameter, no large roots, frozen material, or foreign objects.	No large roots, frozen material, or foreign objects.	Remove large objects, roots.

Table 3. Testing and Performance Criteria for Borrow Source Areas (tested & approved at borrow sources prior to placement)

Component	Parameter	Test Method	Minimum Frequency	Performance Criteria Objective	Performance Criteria Tolerance	Response to Nonconformance
Radon Barrier	Soil texture: borrow source -- Mancos Shale Particle Size Analysis (wet sieve)	ASTM D698 ASTM D2216 ASTM D422 ASTM D1140 ASTM D4318	A minimum of three tests for maximum dry density (ASTM D698); optimum moisture content tests (ASTM D2216) shall be performed for each type of soil observed to establish the optimum moisture for radon barrier material placement. 1 (ASTM D422, ASTM D1140, ASTM D4318) per 10,000 CY of soil. QA Manager or Design Engineer can request additional tests depending on consistency of soil.	Max. particle size = 4 in. Min. passing no. 4 sieve = 80% Min. passing No. 200 sieve = 50% Min. liquid limit = 30 Min. plasticity index = 10 Max. plasticity index = 40 No large roots or foreign objects.	No large roots, frozen material, or foreign objects.	Reject if criteria not met; Remove large objects, roots.
Interim Cover	Soil texture: borrow source alluvium/ overburden or Mancos Shale soil	ASTM D698 ASTM D2216	A minimum of three tests for maximum dry density (ASTM D698); optimum moisture content tests (ASTM D2216) shall be performed for each type of soil observed to establish the optimum moisture material placement. QA Manager or Design Engineer can request additional tests depending on consistency of soil.	No stone or clod larger than 4-in. diameter, no large roots, frozen material, or foreign objects.	No large roots, frozen material, or foreign objects.	Remove large objects, roots.

ASTM = American Society for Testing and Materials
NA = not applicable
TBD = to be determined

Table 4. Testing and Performance Criteria for Cover Soils

Component	Parameter	Test Method*	Minimum Frequency	Performance Criteria Objective	Performance Criteria Tolerance	Response to Nonconformance
Interim Cover	Density	ASTM D6938	1 test per 5000 CY	90% of the maximum dry density as determined by ASTM D698	Minimum 90% of maximum dry density	Rework
		ASTM D1556	1 per 25 ASTM D6938 readings for calibration purposes	90% of the maximum dry density as determined by ASTM D698	Minimum 90% of maximum dry density	Rework
	Moisture	ASTM D6938	1 test per 5000 CY	Moisture content as determined by ASTM D698	Moisture content as determined by ASTM D698	Rework
		ASTM D2216 or ASTM D4318	1 per 25 ASTM D6938 readings for calibration purposes	Moisture content as determined by ASTM D698	Moisture content as determined by ASTM D698	Rework
	Depth	Survey or Approved method	50 ft × 50 ft grid	Bottom layer of cover shall be 1 ft after compaction	1 ft; + 0.17 ft, - 0 ft	Add soil where depth is insufficient
Radon Barrier	Density	ASTM D6938	1 test per 5000 CY	90% of the maximum dry density as determined by ASTM D698	Minimum 90 maximum dry density	Rework
		ASTM D1556	1 per 25 ASTM D6938 readings for calibration purposes	90% of the maximum dry density as determined by ASTM D698	Minimum 90 maximum dry density	Rework
	Moisture	ASTM D6938	1 test per 5000 CY	Moisture content as determined by ASTM D698	Moisture content as determined by ASTM D698	Rework
		ASTM D2216 or ASTM D4318	1 per 25 ASTM D6938 readings for calibration purposes	Moisture content as determined by ASTM D698	Moisture content as determined by ASTM D698	Rework
	Depth	Survey or Approved method	50 ft × 50 ft grid	Middle layer of cover shall be a minimum of 4 ft after compaction	4 ft; +0.17 ft, -0 ft	Add soil where depth is insufficient
Frost Protection Layer	Density	ASTM D6938	1 test per 5000 CY	90% of the maximum dry density as determined by ASTM D698	Minimum 90 maximum dry density	Rework

Table 4. Testing and Performance Criteria for Cover Soils

Component	Parameter	Test Method*	Minimum Frequency	Performance Criteria Objective	Performance Criteria Tolerance	Response to Nonconformance
		ASTM D1556	1 per 25 ASTM D6938 readings for calibration purposes	90% of the maximum dry density as determined by ASTM D698	Minimum 90 maximum dry density	Rework
	Moisture	ASTM D6938	1 test per 5000 CY	Moisture content as determined by ASTM D698	Moisture content as determined by ASTM D698	Rework
		ASTM D2216 or ASTM D4318	1 per 25 ASTM D6938 readings for calibration purposes	Moisture content as determined by ASTM D698	Moisture content as determined by ASTM D698	Rework
	Depth	Survey or Approved method	50 ft × 50 ft grid	Middle layer of cover shall be a minimum of 28.5 in after compaction	Combination of frost protection layer ***and*** surface admixture layer ***total*** depth after compaction: 38.5 in; +0.17 ft, -0 ft	Add material as specified where depth is insufficient
Surface Rock/Soil Admixture Layer	Density	Refer to Specification Section 31 00 50	Refer to Specification Section 31 00 50	90% of the maximum dry density as determined by ASTM D698	Refer to Specification Section 31 00 50	Rework
		Refer to Specification Section 31 00 50	Refer to Specification Section 31 00 50	90% of the maximum dry density as determined by ASTM D698	Refer to Specification Section 31 00 50	Rework
	Moisture	Refer to Specification Section 31 00 50	Refer to Specification Section 31 00 50	Dry of optimum moisture content as determined by ASTM D698	Dry of optimum moisture content as determined by ASTM D698	Rework
		Refer to Specification Section 31 00 50	Refer to Specification Section 31 00 50	Dry of optimum moisture content as determined by ASTM D698	Dry of optimum moisture content as determined by ASTM D698	Rework
	Depth	Refer to Specification Section 31 00 50	Refer to Specification Section 31 00 50	10 in.	Refer to Specification Section 31 00 50	Add soil/gravel mixture as specified where depth is insufficient

*Alternative test methods to those listed must be approved by the Design Engineer prior to commencement of applicable activities.
ASTM = American Society for Testing and Materials
CY = cubic yards
min. = minimum

Table 5. Testing and Performance Criteria for Gravel Admixture

Component	Parameter	Test Method	Minimum Frequency	Performance Criteria/Objective	Performance Criteria Tolerance	Response to Nonconformance
Rock (approved vendor, or approved equal)	Size	Vendor certification	1 per rock borrow source	Vendor certification and submittal approved by Design Engineer	D_{50} of 2.0 in. diameter	Reject
	Durability	NUREG 1623, Table D-1	1 per rock borrow source	Vendor certification of durability and approval by Design Engineer	Durability of greater than or equal to rating of 80% per NUREG 1623, Table D-1	If less than 80%, submit to Design Engineer for approval and potential oversizing requirements.
Rock/Soil Admixture	Volumetric mixture	Refer to Specification Section 31 00 50 METHOD SPECIFICATION FOR MATERIAL MIXING AND SURAFCE ADMIXTURE PLACEMENT	Refer to Specification Section 31 00 50 METHOD SPECIFICATION FOR MATERIAL MIXING AND SURAFCE ADMIXTURE PLACEMENT	60% rock by volume to 40% by volume soil	Rock must be uniformly mixed with no clumping throughout layer. Refer to Specification Section 31 00 50	Reject
	Depth	Refer to Specification Section 31 00 50 METHOD SPECIFICATION FOR MATERIAL MIXING AND SURAFCE ADMIXTURE PLACEMENT	Refer to Specification Section 31 00 50 METHOD SPECIFICATION FOR MATERIAL MIXING AND SURAFCE ADMIXTURE PLACEMENT	10 in.	Refer to Specification Section 31 00 50	Add rock/soil admixture where depth is insufficient. Remove rock/soil admixture where depth is too deep

ASTM = American Society for Testing and Materials
CY = cubic yards
min. = minimum
D_{50} = mean size of rock

8.0 Seeding

Cover soil agronomic properties shall be assessed prior to placement. The cover soil shall be analyzed for potential organic and/or nutrient amendments. Any required organics and/or nutrient amendments shall be established prior to placement of the upper surface admixture cover soil. The mixing method shall be submitted and approved by the Design Engineer to establish mixing of organics and/or amendments (as required) as well as rock into the admixture layer.

8.1 Material

A certificate of analysis from a certified testing laboratory shall accompany seed. Certify the following individual seed tests:

- Purity and germination: Before seed is used, retest for germination all seed stored over 6 months from the date of the original acceptance test and resubmit the results for inspection.
- Prohibited noxious weed seed: Seed shall not contain any federal- or state-listed prohibited noxious weed seed as determined by a standard purity test.
- Weed seed: Seed shall contain no more than 1% by weight of weed seed of other crops and plant species as determined by standard purity tests.

8.2 Inspection and Testing

All seed shall be subject to inspection and concurrence by the QA Manager before the subcontractor is authorized to proceed with the seeding operation. Seed shall be tested according to the Association of Official Seed Analysts, International Seed Testing Association, and the Federal Seed Act standards.

Certification from a certified seed-testing laboratory for seed testing within 6 months of date of delivery includes the following:

- Name and address of laboratory;
- Date of test;
- Lot number of each seed type; and
- Results of tests, including name, percentage of purity and germination, percentages of weed content for each kind of seed furnished, hard seed content, and in case of seed mixtures, pure live seed (PLS) proportions of each kind of seed as specified.

The seed vendor on each standard sealed container label can provide information regarding the seed mixture. The labels shall include the following information:

- Seed mixture name;
- Lot number;
- Total net weight and PLS weight of each seed type;
- Percentages of purity and germination;
- Seed coverage (in acres) on a PLS basis; and
- Percentage of maximum weed seed content clearly marked for each seed type.

8.3 Placement

Seeding is to be performed by drill seeding unless otherwise approved by the Design Engineer. Equipment and methods are to be submitted prior to commencement of seeding. Equipment proposed for use and the methods of seeding shall be inspected for concurrence prior to the commencement of seeding operations. The equipment shall be checked for compliance to safety requirements (in the contractor's health and safety plan) prior to the commencement of seeding operations. Equipment calibration tests shall be conducted immediately prior to commencement of seeding operations and when the seed mix changes, or different equipment is used.

9.0 Records

All documentation created in the course of compliance with this Plan is considered a Project record and will be managed in accordance with the *Moab UMTRA Project Records Management Manual* (DOE-EM/GJ1545), which follows DOE orders, policies, and regulations for retention and maintenance of records.

Test and inspection records shall be reported and filed in a timely manner, consistent with the status of work performed. Inspection and test status shall be available at all times to prevent inadvertent by-passing of an inspection or test. Test and inspection records shall contain the following, at a minimum:

- Items tested or inspected;
- Date of test or inspection;
- Tester/inspector;
- Type of test or inspection;
- Results and acceptability, including the test or inspection acceptance criteria;
- Identification number of instrument used in performing the test or inspection;
- Action taken in connection with any deviations noted; and
- Person evaluating test results.

Test and inspection records shall be filed and maintained in accordance with the *Records Management Manual*. Surveillances shall be performed by QA of measurement and testing equipment used by QC. Daily Inspection Reports shall be generated, describing the adequacy, discrepancies, progress, dispositions, and details of each day's construction activities. Permanent QA/QC records shall be periodically evaluated through internal and external surveillances and audits.

QC reports shall be generated daily, summarizing the volume of placed materials and the number of lifts approved. A summary of this information shall be included in the RAC's weekly Project status report submitted to DOE.

10.0 References

10 CFR 830 (Code of Federal Regulations), "Nuclear Safety Management," Subpart A, "Quality Assurance."

ASME (American Society of Mechanical Engineers), Nuclear Quality Assurance (NQA)-1 2008 and addenda through 2009 consensus standard, "Quality Assurance Requirements for Nuclear Facility Applications (QA)."

ASTM (ASTM International) C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

ASTM (ASTM International) D1140 – Standard Test Method for Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve.

ASTM (ASTM International) D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

ASTM (ASTM International) D2216 – Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

ASTM (ASTM International) D422 – Standard Test Method for Particle-Size Analysis of Soils.

ASTM (ASTM International) D4318 – Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

ASTM (ASTM International) D4643 – Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Heating.

ASTM (ASTM International) D4718 – Standard Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles.

ASTM (ASTM International) D4944 – Standard Test Method for Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester.

ASTM (ASTM International) D4959 – Standard Test Method for Determination of Water (Moisture) Content of Soil by Direct Heating Method.

ASTM (ASTM International) D6938 – Standard Test Method for In-Place Density and Water content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

ASTM (ASTM International) D698 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.

DOE (U.S. Department of Energy) Order 414.1D, "Quality Assurance."

DOE (U.S. Department of Energy), Moab UMTRA Project *Construction Interface Document (CID) Form* (QA-F-023).

DOE (U.S. Department of Energy), *Moab UMTRA Project Records Management Manual* (DOE-EM/GJ1545).

DOE (U.S. Department of Energy), *Moab UMTRA Project Quality Assurance Plan for the Remedial Action Contractor* (DOE-EM/GJRAC1766).

DOE (U.S. Department of Energy), *Moab UMTRA Project Configuration Management Plan for Design and Construction* (DOE-EM/GJRAC3079).

DOE (U.S. Department of Energy), *Moab UMTRA Project Design Change Control* (DOE-EM/GJRAC3080).

DOE (U.S. Department of Energy), *Moab UMTRA Project Construction Interface Document* (DOE-EM/GJRAC3081).