DOE-EM/GJRAC2040-M

Moab UMTRA Project
Crescent Junction Disposal Cell Interim Completion Report Addendum - M

Revision 0

December 2023

U.S. Department of Energy

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.

Moab UMTRA Project
Crescent Junction Disposal Cell Interim Completion Report
Addendum M

Revision 0

Review and Approval

12/6/2023

X Kathy Turvy

Kathy Turvy
RAC Quality Assurance Manager
Signed by: KATHRYN TURVY (Affiliate)

12/5/2023

X Greg D. Church

Greg D. Church
RAC Program Manager
Signed by: GREGORY CHURCH (Affiliate)

Revision History

Revision	Date	Description
0	December 2023	Initial issue.

Contents

Figures

Figures *(continued)*

Tables

Appendices

Attachments

Acronyms and Abbreviations

ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials International
CAT	Caterpillar
CBCS	Computer Based Compaction System
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DOE O	DOE Order
ft	foot/feet
GPS	Global Positioning System
NQA	Nuclear Quality Assurance
QA	quality assurance
Ra-226	radium-226
RAC	Remedial Action Contract or Contractor
RAIP	Remedial Action Inspection Plan
RAP	Remedial Action Plan
RRM	residual radioactive material
TAC	Technical Assistance Contractor
UMTRA	Uranium Mill Tailings Remedial Action
yd^3	cubic yard(s)

Executive Summary

This Interim Completion Report, Addendum M, documents the construction of a portion of the disposal cell near Crescent Junction, Utah. The disposal cell is being constructed under the U.S. Department of Energy (DOE) Moab Uranium Mill Tailings Remedial Action (UMTRA) Project. The purpose of the disposal cell is to isolate and stabilize uranium mill tailings and other contaminated materials, known as residual radioactive material (RRM), removed from the former millsite in Moab, Utah. The disposal cell is designed to be effective for 1,000 years to the extent reasonably achievable, with a minimum performance period of 200 years.

The Crescent Junction disposal cell will require many years to construct. Multiple Interim Completion Reports will be prepared to compile and document data collected during the ongoing construction process. These Interim Completion Reports will be written in the format of sequential addenda referenced in a Final Completion Report that will be prepared to address the entire cell construction.

This Addendum addresses activities performed by North Wind Portage, the DOE Remedial Action Contractor (RAC) for the Moab Project, from October 1, 2022, through September 30, 2023. This Report includes placement of 652,094 yd^3 of RRM, 39,390 yd^3 of Spoils Wedge, and 395,913 yd^3 of final cover materials.

This Addendum also demonstrates that the referenced portion of the disposal cell was constructed in accordance with the *Moab UMTRA Project Final Remedial Action Plan and Site Design for Stabilization of Moab Title I Uranium Mill Tailings at the Crescent Junction, Utah, Disposal Site* (RAP) (DOE-EM/GJ1547). The RAP received conditional concurrence from the U.S. Nuclear Regulatory Commission. Included in this Report are a critical review, design assessment, and remedial action assessment of activities performed during this Report period. Also provided are associated data tables, photographs, laboratory results, and other supporting documentation.

The Moab Project follows the American Society of Mechanical Engineers (ASME) Nuclear Quality Assurance-1 (NQA-1) requirements for quality assurance (QA), including conducting audits and surveillances during the design and construction of the cell.

1.0 Introduction

The scope of the Moab Project is to relocate residual radioactive material (RRM) from the former uranium ore-processing facility and from off-site properties known as vicinity properties in Moab, Utah, to an engineered disposal cell constructed near Crescent Junction, Utah. Most of the processing buildings at the Moab site were demolished and placed in the southern corner of the tailings pile. An interim cover was placed over the tailings pile as part of decommissioning activities between 1988 and 1995. The estimated volume of the tailings pile before relocation began was 12 million yd^3 (16 million tons). The RRM is being transported to Crescent Junction primarily by rail.

The Moab site is located about 3 miles northwest of the city of Moab in Grand County. The Crescent Junction site is located northeast of the junction of Interstate 70 and U.S. Highway 191, approximately 30 miles north of the Moab site, also in Grand County (see Figure 1). The completed disposal cell will generally be rectangular and will encompass approximately 230 acres. Figure 2 shows general features of the Crescent Junction site.

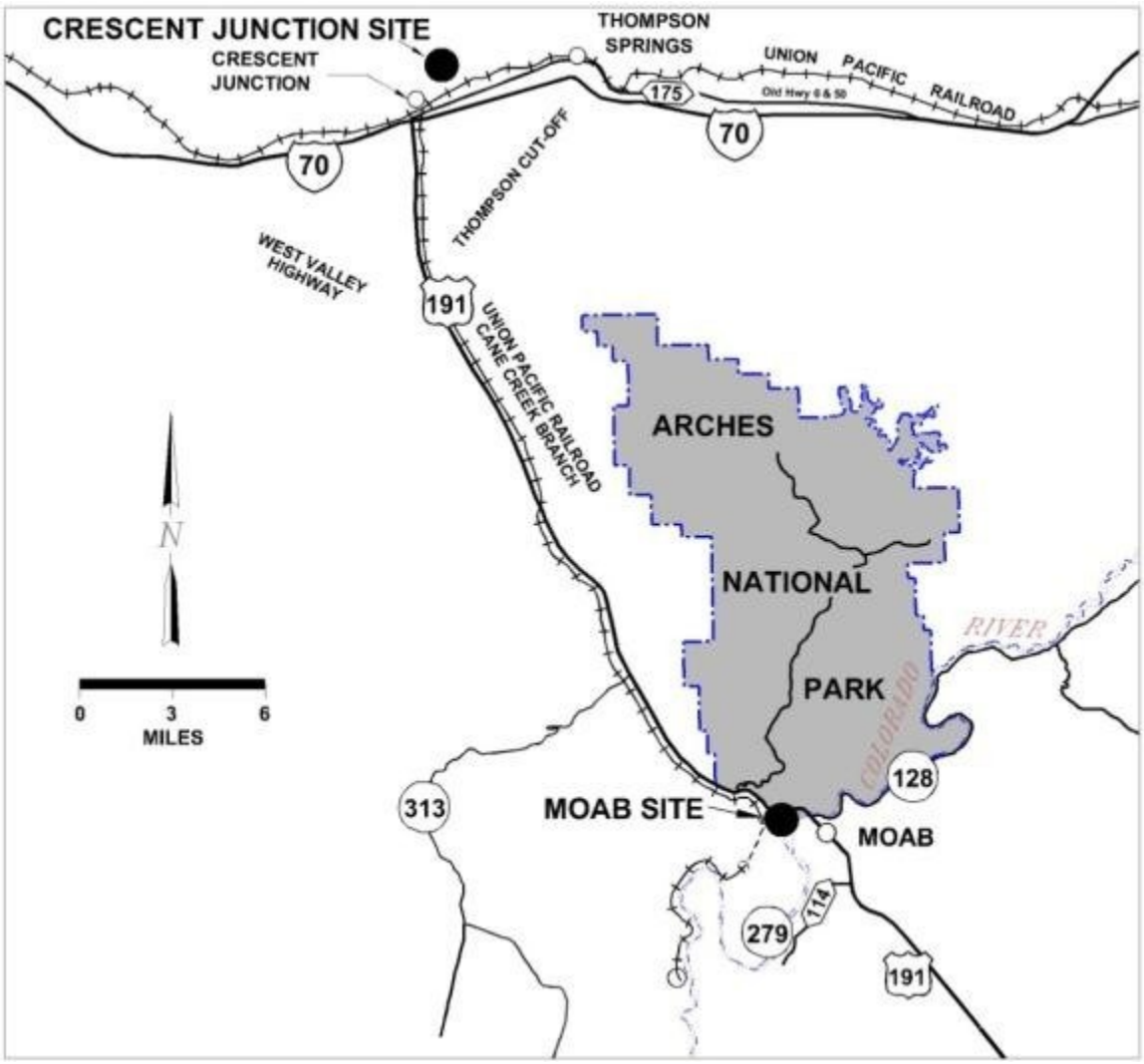

Figure 1. Location of Moab and Crescent Junction Sites

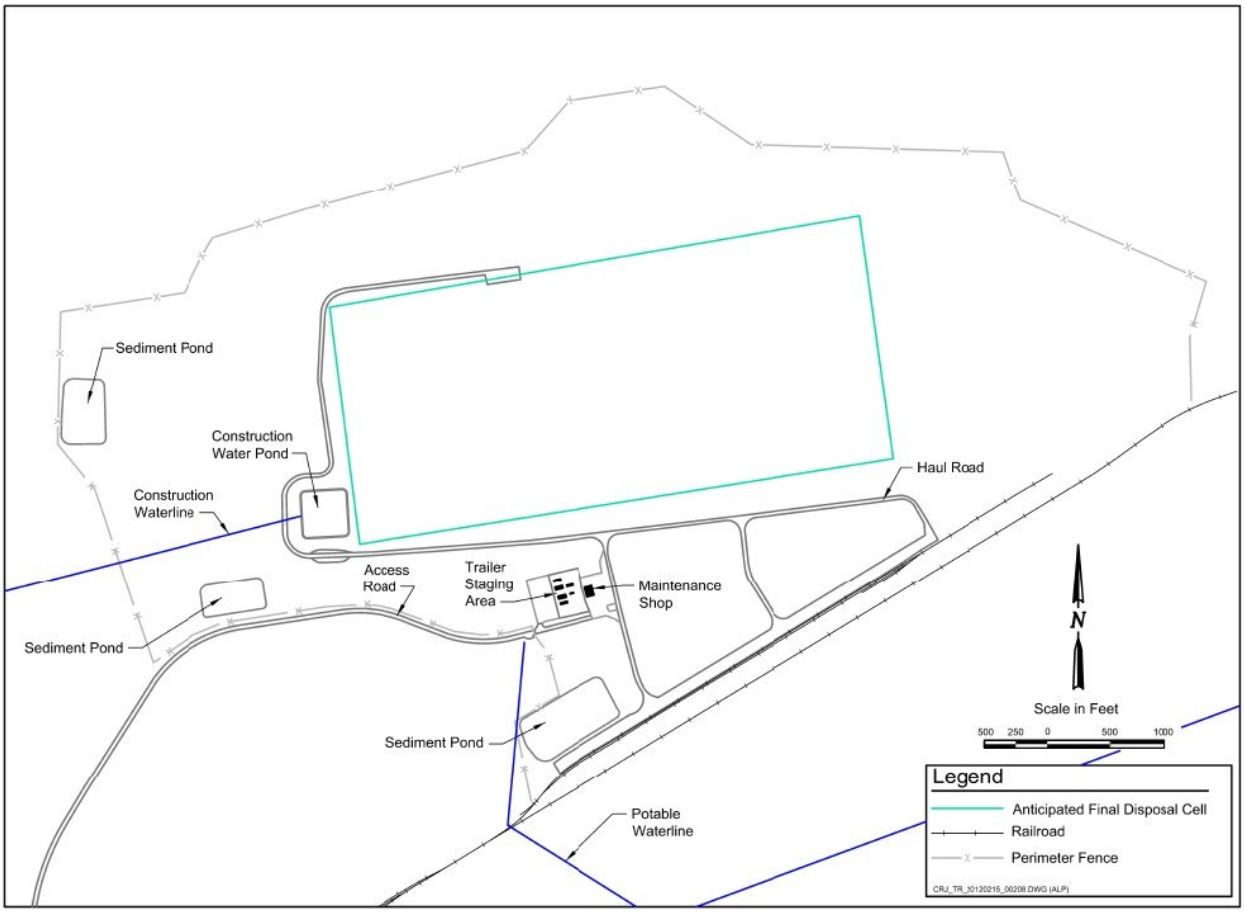

Figure 2. Crescent Junction Site Features

This Addendum documents activities performed by the remedial action contractor (RAC) for the Project from October 1, 2022, through September 30, 2023.

Addendum M sections are outlined below.

- Section 2.0 summarizes the results of critical aspects of the disposal cell construction and provides tables and figures summarizing data found in Appendix A.
- Section 3.0 describes any differences in the completed design from design requirements in the RAP.
- Section 4.0 provides verification that placement of RRM and interim cover was conducted according to RAP requirements.
- Section 5.0 is a list of references for this document.
- Appendix A includes test results to demonstrate compliance with compaction requirements.
- Appendix B contains photographs of the various stages of cell construction.
- Attachment 1 contains a revised procedure associated with constructing the cell.
- Attachment 2 contains the Geologic Verification of Phase 4 Cell Excavation.

2.0 Critical Review

The Critical Review provides key technical information about the disposal cell construction.

This section contains tables summarizing inspections or tests for cell excavation, embankment construction, RRM placement, and cell cover material placement as appropriate for this report period. The table's reference criteria and material testing procedures used to verify cell excavation and placement of each type of material, performed in accordance with design specifications or drawings and with Addendum E of the *Remedial Action Plan* (RAP), the *Remedial Action Inspection Plan* (RAIP). The distribution survey associated with each material type is also included in this section, as appropriate. Figure 3 shows the general extent of cell cover layers as of the end of this Addendum period.

Information regarding total lifts of compacted material, tests performed, and geotechnical data are summarized in Table 1. Additional geotechnical data, including proctor test result summaries, lift approval summaries, and lift approval packages, as appropriate, are located in Appendix A.

A lift approval package consists of documentation of tests conducted to demonstrate that the lift met requirements. A package could include lift approval forms and associated figures, slope elevation surveys, and field density tests.

Table 1. Lifts/Testing Totals

Area/ Material	Total Volume Placed (yd^3)	Total Number of Lifts Approved	Lifts Approved Using CBCS	Lifts Approved Not Using CBCS	Total Number of Standard Proctor Tests	Total Number of In-place Density/Moisture Tests	Total Average for All In-place Density Tests Performed (%)	Total Average CBCS Passes that Meet Compaction Criteria (%)	Total Number of Soil Classifications	Total Number of Durability Tests	Total Number of Gradation Tests
Cell Perimeter Embankment	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
RRM	652,094	203	191	12	36	60	94.5	99.7	N/A	N/A	N/A
Interim Cover	19,179	3	0	3	10	10	93.2	N/A	N/A	N/A	N/A
Radon Barrier	376,735	8	0	8	207	216	97.4	N/A	N/A	N/A	N/A
Infiltration and Bio-intrusion Barrier	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Frost Protection Layer	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2-in. Cap Rock	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

CBCS = Computer Based Compaction System; in. = inch

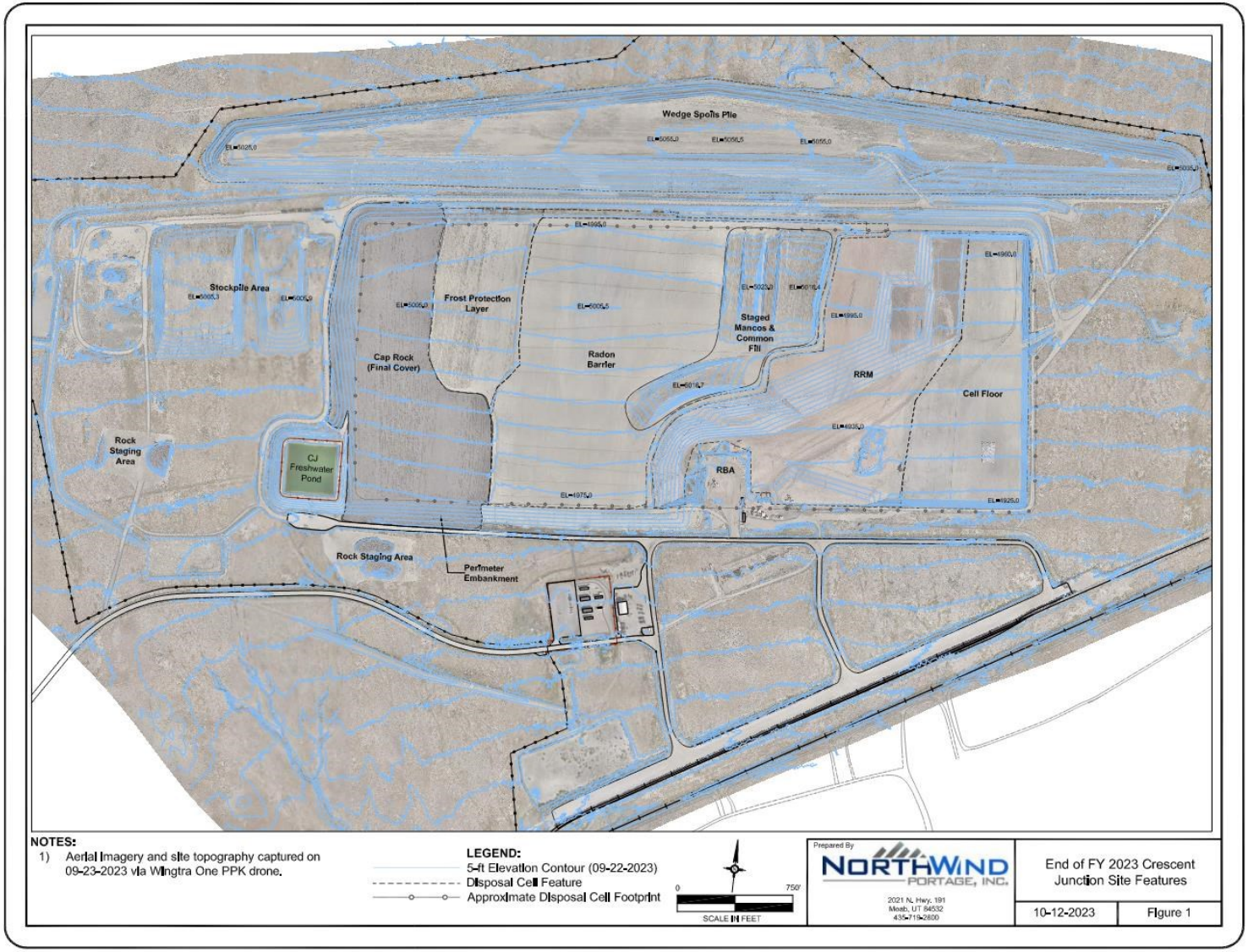

Figure 3. General Extent of Cover Layers and Cell Floor Excavation

2.1 Cell Excavation

Phase 4 cell excavation was completed during this report period. The area of cell excavation involved approximately 783,259 yd^3, performed from November 7, 2022, to June 4, 2023. The excavated material was used to extend the spoils embankment to the east and utilized for radon barrier and interim cover.

The Phase 4 buyoff survey is included as Attachment 2. The inspection and testing summary for cell excavation can be found in Table 2.

Table 2. Cell Excavation Inspection and Testing

Inspection or Test Type	Criteria and Method #	RAP Specification Section or Drawing #	RAIP Section #	Verification Results
Visual Observation	The disposal cell floor is weathered Mancos Shale or low spots have been compacted with processed Mancos Shale.	N/A	6.2.3	All locations observed met criteria for Phase 4.
High-Accuracy GPS Survey	Floor and side slopes are per design plans. The final floor and side slopes survey match the coordinates and elevations in the design. The cell floor slopes 2.3% from northeast to southwest. The cut slopes on the north, west, and south sides of the cell slope at 2:1 or 3:1.	Drawing E-02-C-102	6.2.1	Cell floor and side slopes were checked for grade.

% = percent; GPS = global positioning system; N/A = not applicable

2.2 Perimeter Embankment

No activities associated with the perimeter embankment were conducted during this period.

2.3 RRM

2.3.1 Computer Based Compaction System Performance Verification Testing

The Project used machines equipped with a Computer Based Compaction System (CBCS) to meet RRM compaction requirements as specified in Section 6.4.3 of the RAIP. Additional information about the computer-based compaction system verification testing is provided in Section 4.3 of this Addendum.

The RAIP also requires periodic verification of the CBCS compaction by comparing the results to in-place, nuclear density gauge test results. Table 3 shows the results of the comparison tests performed during this Report period.

Table 3. CBCS Performance Verification Testing

Lift ID Number	Test Performance Date	In-place Density Compaction (%)	Lift Area Meeting CBCS Compaction Criteria (%)
UW2P05230613-00	6/14/23	95.2	99.9
UW2R6N230614-00	6/15/23	93.2	99.9
UW2P05230619-00	06/21/23	94.6	100.0
UW2Q7N230703-01	07/04/23	95.0	99.4
UW2Q7N230711-00	07/12/23	93.1	99.9
UW2M01230802-00	08/03/23	93.6	99.9
UW2R1230920-00	09/25/23	95.5	99.8

2.3.2 RRM Placement

RRM inspections and tests are shown in Table 4. The distribution of survey points is shown in Figure 4. The standard proctor test results summary, lift approval summaries, one lift approval package for RRM, and top-of-waste buyoff survey are provided in Appendix A2.

Table 4. RRM Inspection and Testing

Inspection or Test Type	Criteria and Method Number	RAP Specification Section or Drawing Number	RAIP Section Number	Verification Results
Visual Observation	Scarify, at a minimum, the top 1 in. of subsoil or preceding RRM lift 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 average thickness not to exceed 24 in. Compaction equipment shall consist of footed rollers,. Footed rollers shall have a minimum weight of 45,000 lb, and at least one tamping foot shall be provided for each 110 in^2 of drum surface. The length of each tamping foot from the outside surface of the drum shall be at least 6 in. After lift placement, moisture content shall be maintained until the next lift is placed. Erosion that occurs in RRM layers shall be repaired and grades re-established. If freezing or desiccation occurs, the affected soil shall be reconditioned.	Specification 31-00-20 Sections 1.3.2, 3.2.1, 3.2.4, 3.5.1, and 3.5.2	6.4.2, 6.4.3	Visually verified throughout material preparation, ground preparation, and RRM placement. Documented in lift approval packages.
Laboratory Compaction Characteristics	Assessment tests shall be performed on RRM to ensure compliance with specified requirements and to develop compaction requirements for placement. Perform tests (standard proctor) in accordance with the following standards, as applicable: *ASTM D698 and D2216.	Specification 31-00-20 Section 3.1.1 And 3.4.1	6.4.3	Eight tests were performed to determine compaction characteristics.

Table 4. RRM Inspection and Testing (continued)

Inspection or Test Type	Criteria and Method Number	RAP Specification Section or Drawing Number	RAIP Section Number	Verification Results
Visual Observation	RRM shall be placed and compacted within the moisture content range needed to achieve 90% of the laboratory determined maximum dry density of each type of material. The range in moisture content shall be maintained uniform throughout each lift as necessary to achieve 90% compaction and dust control. The moisture content shall be maintained uniform throughout each lift.	Specification 31-00-20 Section 3.2.2	6.4.3	Daily observations were performed during placement.
In-place Density/ Moisture Test	Density tests must meet at least 90% of the material's maximum dry density in accordance with *ASTM D698. Perform in accordance with the following standards, as applicable: *ASTM D1556, D2216, D4643, and D6938.	Specification 31-00-20 Sections 3.2.2, 3.2.3	6.4.3	Thirty-six tests were performed with average in-place density of 94.5 % of the laboratory-determined maximum dry density.
Compaction by CBCS	QC shall monitor CBCS compaction by visually inspecting the process and reviewing the computer records for each layer of soil placed.	Specification 31-00-20 Section 3.4.1	6.4.3	191 lifts were approved using the CBCS.
Visual Observation	Each container of demolition debris shall be placed in the cell along with RRM. Debris shall not contain free liquids. Debris shall be sized to minimize voids. Pipes and ducts that are 6 in. or greater in diameter shall be crushed, filled, or cut.	Specification 31-00-20 Section 3.2.5	6.4.4	Debris inspections performed during debris placement. Inspections documented in lift approval packages.
Visual Inspection	Debris may be placed as a sacrificial lift at the bottom of the disposal cell in a 2-ft 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-ft lift profile. Sacrificial debris lifts are not subject to moisture and compaction criteria.	Specification 31-00-20 Section 3.2.5	6.4.4	Debris inspections performed during debris placement. Inspections documented in lift approval packages.

ASTM = ASTM International; in. = inches; in^2 = square inches; lb = pounds; lb/ft^2 = pounds per square foot; QC = quality control.
*ASTM Standard titles are included in the References (see Section 5.0).

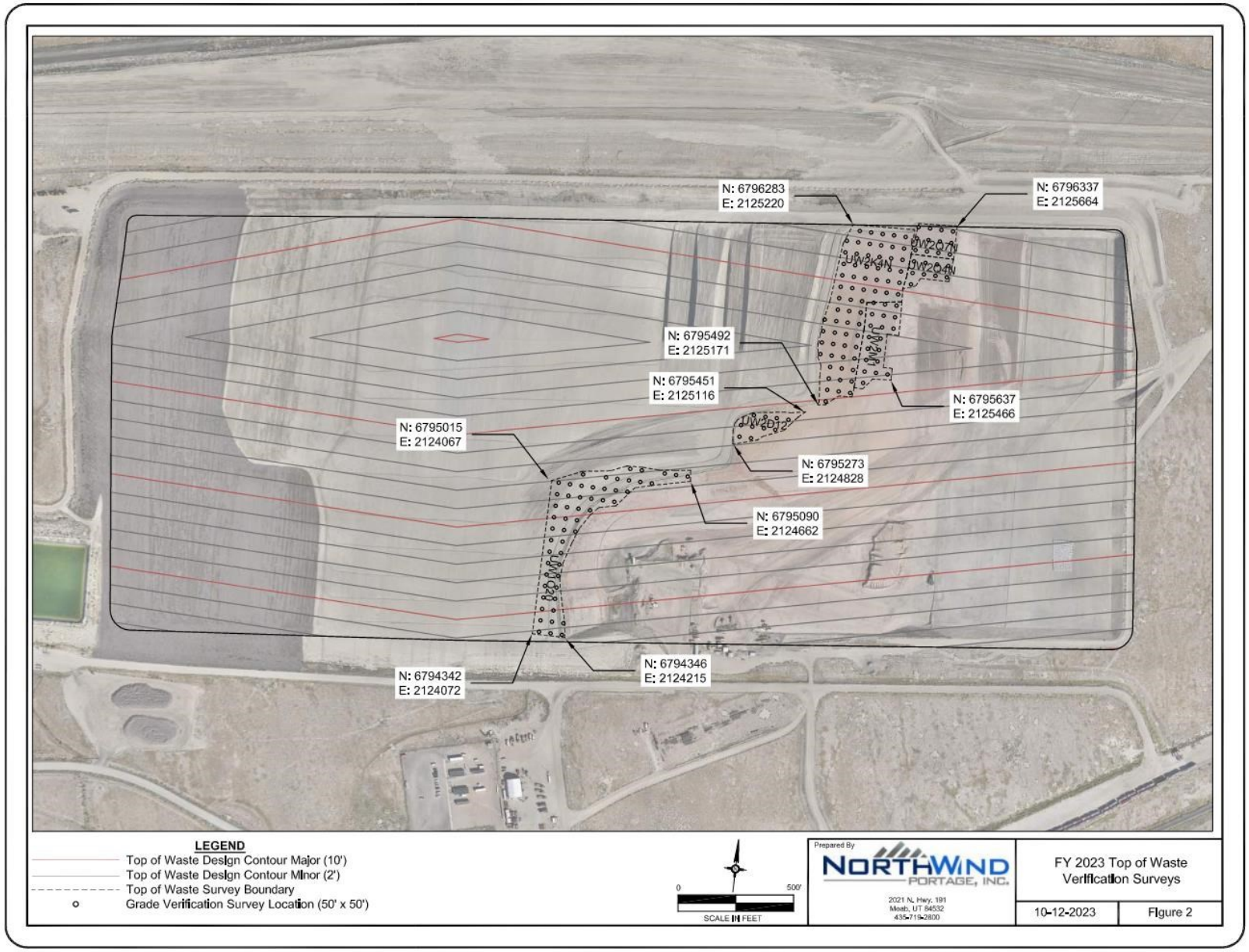

Figure 4. Distribution of Survey Points to Verify Compliance with RRM Specifications

2.4 Interim Cover

The inspection and testing for the interim cover can be found in Table 5. The distribution of survey points is shown in Figure 5. The standard proctor test results summary, lift approval summaries, one lift approval package, and buyoff surveys for the interim cover are provided in Appendix A3.

Table 5. Interim Cover Inspection and Testing

Inspection or Test Type	Criteria and Method Number	RAP Specification Section or Drawing Number	RAIP Section Number	Verification Results
Visual Observation	Common fill (1 ft clean compacted): loose lifts with an average thickness not to exceed 14 in. Interim cover is placed in continuous and approximately horizontal lifts. Soil shall be free of roots, debris, and organic or frozen material. After lift placement, moisture content shall be maintained until the next lift is placed. Erosion that occurs in the RRM layers shall be repaired and grades re-established. Freezing and desiccation of the RRM shall be prevented. If freezing or desiccation occurs, the affected soil shall be reconditioned, as directed.	Specification 31-00-20 Section 3.2.1	6.5.4	Visually verified throughout material preparation, ground preparation, and interim cover placement. Documented on lift approvals.
Visual Observation	Visual inspection of the process and review of computer records.	Specification 31-00-20 Section 3.4.1	6.5	Lift approvals document the approval process.
High-Accuracy GPS Survey	The top surface of the interim cover shall be no greater than 2 in. above the lines and grades shown on the drawings. No minus tolerance will be permitted.	Specification 31-00-20 Section 3.3	6.5.5	Completed using high-accuracy GPS.
In-Place Density/ Moisture Test	Compaction and moisture content tests shall be performed in accordance with the following as applicable: ASTM D1556, D2216, D4643, and D6938.	Specification 31-00-20 Section 3.4.1	6.5.4	Three approved lifts; using in-place density/moisture testing. Ten in-place tests were performed with average density 93.2% of laboratory-determined maximum dry density.
Laboratory Compaction Characteristics	Common fill. Perform in accordance with the following as applicable: ASTM D698 and D2216.	Specification 31-00-20 Section 3.1.1	6.5.4	Three tests performed to determine compaction characteristics.

Table 5. Interim Cover Inspection and Testing (continued)

Inspection or Test Type	Criteria and Method Number	RAP Specification Section or Drawing Number	RAIP Section Number	Verification Results
Visual Observation	A smooth, non-vibratory steel-wheeled roller shall be used to produce a smooth compacted surface on the top of the completed interim cover layer, such that direct rainfall causes minimal erosion. Steel-wheeled rollers shall weigh a minimum of 20,000 lb. The final lift shall be rolled smooth with at least 3 passes of the smooth steel-wheeled roller to provide a smooth surface or proof rolled with rubber-tired construction equipment, such as a loaded dump truck or loaded scraper, with a minimum weight of 45,000 lb to produce a smooth compacted surface on the top of the completed interim cover layers, such that direct rainfall causes minimal erosion.	Specification 31-00-20 Section 1.3.2, 1.3.3 and 3.2.4	6.5.5	Visually verified cover compaction using rubber-tired construction equipment performed on the final lift of the interim cover.

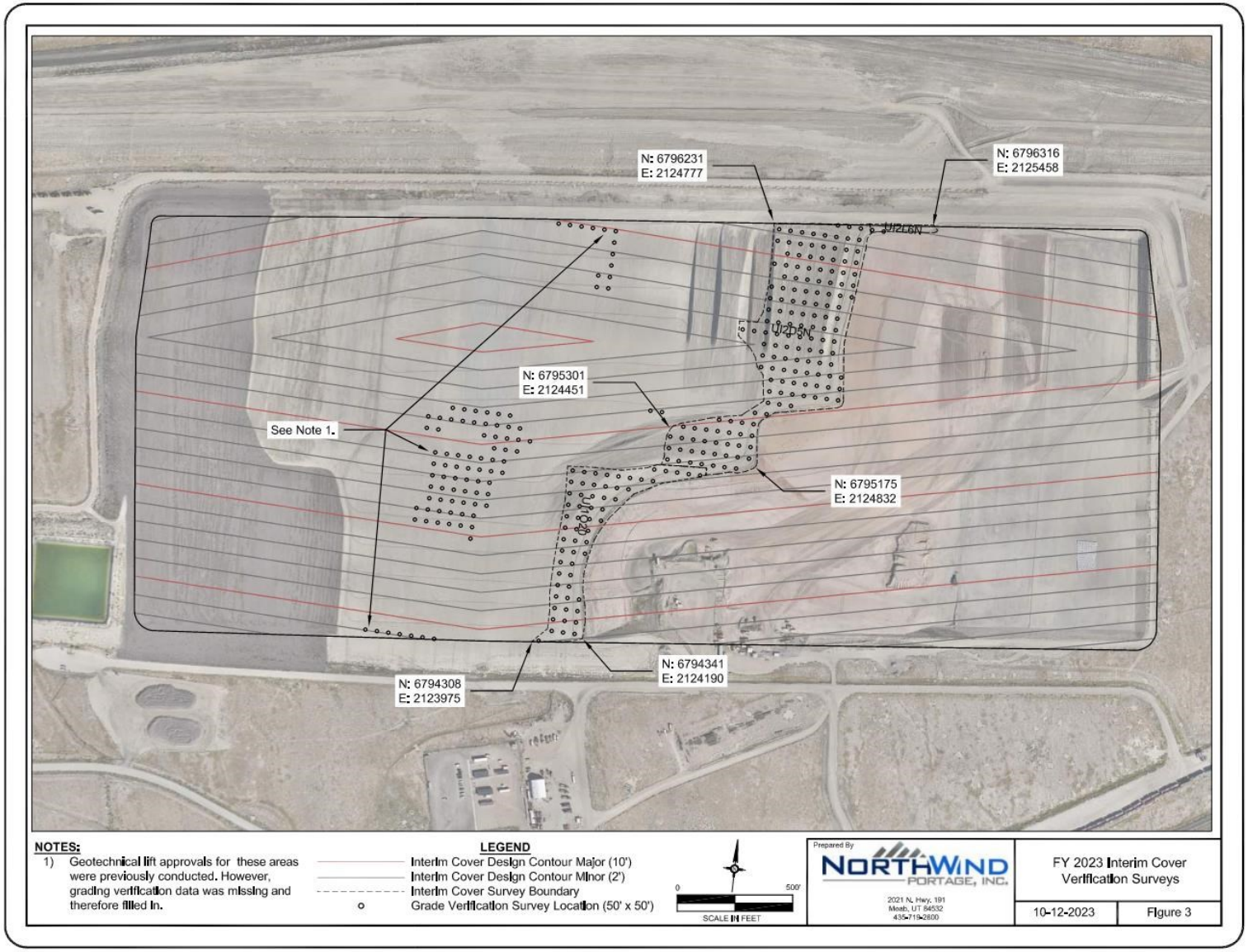

Figure 5. Distribution of Survey Points to Verify Compliance with Interim Cover Specifications

2.5 Radon Barrier

2.5.1 Radon Barrier Placement

The inspection and testing for the radon barrier can be found in Table 6. The CBCS was not used for the compaction of radon barrier lifts; therefore, inspections and associated criteria for the CBCS are not included in the table. The distribution of survey points is shown in Figure 6. The standard proctor test-results summary, lift-approval summaries, one lift-approval package, and buyoff surveys for the radon barrier are provided in Appendix A4.

Table 6. Radon Barrier Inspection and Testing

Inspection or Test Type	Criteria and Method #	RAP Specification Section or Drawing #	RAIP Section #	Verification Results
Visual Observation	Processed Mancos Shale. Loose lifts not to exceed 12 in. Compacted with rubber-tired or footed roller compaction equipment. Maximum particle size in the fill material shall be 4 in. No locations where rock type particles accumulate in a concentrated location. Scarification shall be performed on all areas of the upper surface of each underlying soil layer, prior to placement of the next lift. The final lift shall not be scarified. It shall be smooth-rolled with a minimum of 3 passes of an approved steel smooth-drum roller.	Specification 31-00-30 Sections 2.1, 3.2.2, and 3.2.4	6.7.4	Radon barrier processing, ground preparation, and placement were visually verified, surveyed, and documented on lift approval packages.
Visual Observation	Processed Mancos Shale.	Specification 31-00-30 Section 3.2.1	6.7.4	Lift approval packages document the approval process.
Laboratory Compaction Characteristics	Processed Mancos Shale. Perform in accordance with the following as applicable: ASTM D698 and D2216.	Specification 31-00-30 Section 3.2.1	6.7.4	Thirty-four tests performed to determine compaction characteristics.
In-Place Density/ Moisture Test	Processed Mancos Shale. 95%. Optimum ± 3%. Perform in accordance with the following as applicable: ASTM D1556, D2216, D4643, and D6938.	Specification 31-00-30 Sections 3.2.1 and 3.2.3	6.7.4	207 in-place density/moisture tests performed with average density of 97.2% of the laboratory-determined maximum dry density.
Soil Classification	Processed Mancos Shale. Perform in accordance with the following as applicable: ASTM D422, D698, D1140, D2216, D4318, or D4643.	Specification 31-00-30 Section 3.2.1, Table 1	6.7.1	Thirty-four soil classification tests performed.
Moisture Test	Processed Mancos Shale. Optimum ± 3%. Perform in accordance with the following as applicable: ASTM D4643 and D4944 or D4959.	Specification 31-00-30 Section 3.2.3	6.7.4	Tests performed to ensure moisture is within acceptable range.
High-Accuracy GPS Survey	Processed Mancos Shale. Confirm the total fill thickness of the radon barrier is in accordance with plans and specifications.	Specification 31-00-30 Section 3.5.2	6.7.5	Completed using high-accuracy GPS.
Sand Cone and Moisture Correlation Test	Processed Mancos Shale. With nuclear tests. Perform in accordance with the following as applicable: ASTM D1556, D2216, and D4643.	Specification 31-00-30 Section 3.6.1	6.7.4	Sand cone and moisture correlation tests performed.

= number; % = percent; ASTM = American Society of Testing and Materials; GPS = global positioning system; in. = inches; QC = Quality Control.

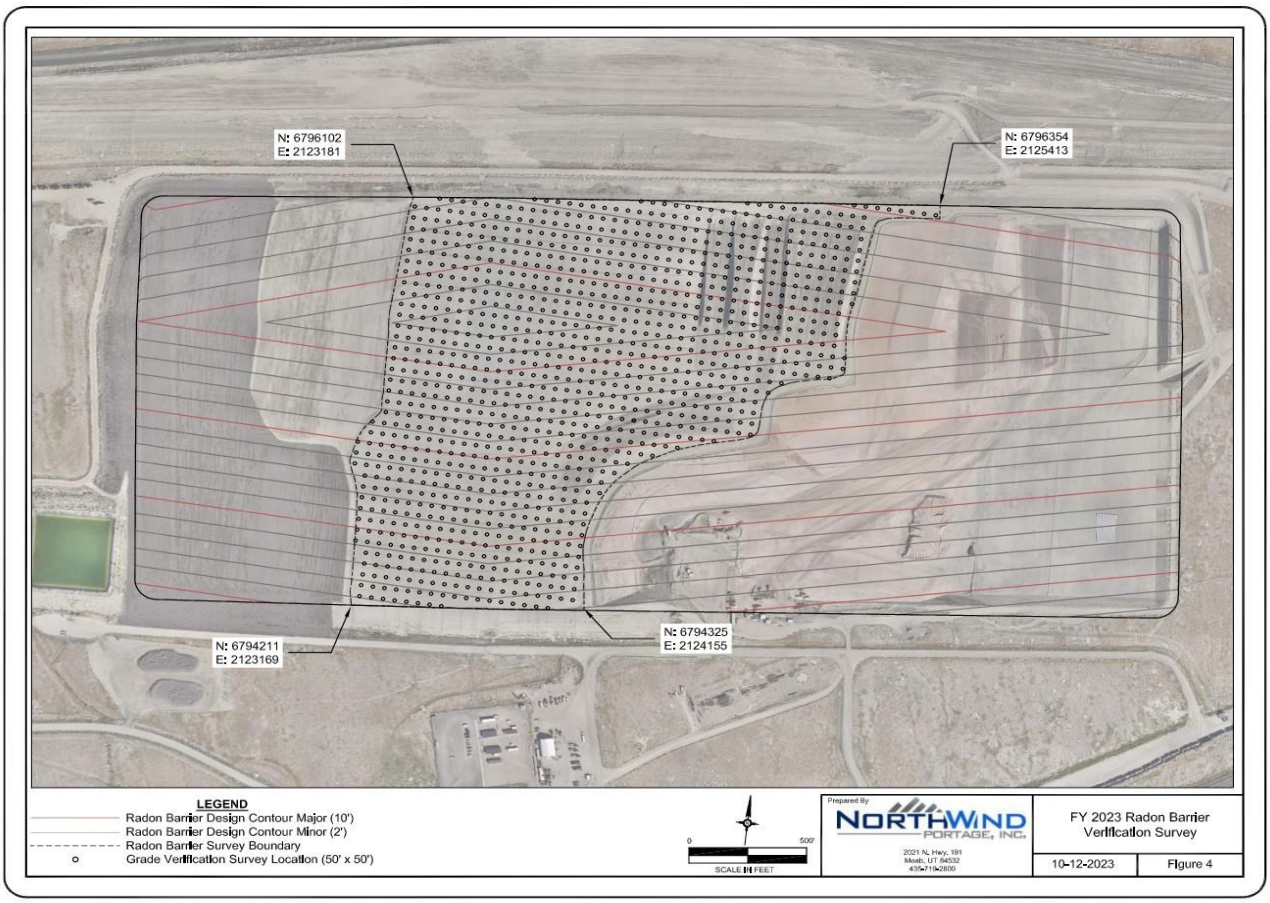

Figure 6 – Distribution of Survey Points to Verify Compliance with Radon Barrier

2.6 Infiltration and Bio-intrusion Barrier

No activities associated with this material layer were conducted during this period.

2.7 Frost Protection Layer

No activities associated with this material layer were conducted during this period.

2.8 Cap Rock and Armoring

No activities associated with this material layer were conducted during this period.

3.0 Design Assessment

The disposal cell design incorporates established design criteria, drawings and specifications, and calculations, all of which are included in the RAP and in Interim Completion Report addenda.

This section discusses design criteria changes, changes to the design of the disposal cell, associated erosion control features, fulfillment of QA requirements, and compliance with permit requirements.

3.1 Design Criteria Changes

No changes to the design criteria were made during this period.

3.2 Design Changes

No changes to the design were made during the period.

3.3 QA Requirements

There were no QA requirements for design changes during this period.

QA activities were conducted in accordance with the *Moab UMTRA Project Quality Assurance Plan for the Remedial Action Contractor* (DOE-EM/GJRAC1766), and compliant with:

- ASME NQA-1 2008 and addenda through 2009 consensus standard, "Quality Assurance Requirements for Nuclear Facility Applications."
- DOE Order (O) 226.1B, "Implementation of Department of Energy Oversight Policy."
- Title 10 Code of Federal Regulations Part 830 (10 CFR 830) Subpart A, "Nuclear Safety Management, Quality Assurance Requirements."
- DOE Office of Environmental Management EM-QA-001, "EM Quality Assurance Program."
- DOE O 414.1D, Admin Chg. 2, "Quality Assurance."

3.4 Permits and Agreements

The Project is in compliance with permits and agreements applicable to the Crescent Junction site. The permits and agreements are summarized in Table 7.

Table 7. Crescent Junction Site Permits and Agreements

Agreement Number	Document Name or Description	Issuing Agency	Purpose
400-00177	Easement for Green River Pump Station	Utah Division of Forestry, Fire, and State Lands	ROW easement to construct and operate water pipeline in the Green River.
4P-082341-1	UDOT Encroachment Permit	UDOT	To construct waterline within UDOT 60-ft ROW and operate within 20-ft ROW for State Route 19 near City of Green River.
6-UT-06-F-014	Biological Opinion	U.S. Fish and Wildlife Service	U.S. Fish and Wildlife Service issued Biological Opinion for Green River Pump Station.
1-92-677	Green River Water Right	State Water Engineer	Gives DOE right to divert 323 acre-feet or ~200 gallons per minute from Green River for Crescent Junction disposal site.
DE-RO01-06GJ68009	Access Roadway Contract and Grant of Easement	Private Owner	Perpetual easement and ROW for construction of an access roadway and related utilities at the disposal site.

Table 7. Crescent Junction Site Permits and Agreements (continued)

Agreement Number	Document Name or Description	Issuing Agency	Purpose
Folder No. 02392-96	Pipeline Crossing Agreement	Union Pacific Railroad	Agreement grants right to construct, maintain, and operate one underground waterline and access for phone line and 1.5-in. conduit across Union Pacific Railroad's property at milepost 533.2, Green River Subdivision.
Folder No. 02399-44	Pipeline Crossing Agreement	Union Pacific Railroad	Agreement grants right to construct, maintain, and operate one underground waterline and access for phone line and 1.25-in. conduit at milepost 0.25, Cane Creek Subdivision, Thompson Springs, for the disposal site.
Folder No. 2537-02	Industrial Track Contract	Union Pacific Railroad	Covers construction, maintenance, and operation of 5,209-ft Track A, 3,524-ft Track B, and 617-ft Track C at milepost 533.21, Green River Subdivision line.
Property No. 70-4; 189A: AEQ	Easement	UDOT	Easement for waterline across UDOT property near Floy Wash that allows 60-ft construction ROW and 20-ft permanent ROW.
Public Land Order 7697	Permanent Land Transfer	BLM	Order permanently transferred 500 acres of BLM public domain land to DOE for disposal cell.
REEMCBCDOE-3-15-0702	Real Estate License	Rocky Mountain Power	Power line extension to dump ramp.
REEMCBCDOE-6-08-0304	Waterline Easement	Grand County	Easement within County Road 175 or old Highway 6 and 50 and Hastings Lane ROWs to construct waterline within 60-ft ROW and operate within 20-ft ROW.
REEMCBCDOE-6-08-0308 SITLA No. 1345	Waterline Easement	SITLA	Easement to construct waterline within 60-ft ROW and operate within 20-ft ROW on three parcels of SITLA land near Green River and Crescent Junction.
REEMCBCDOE-6-08-0309	Waterline Easement	City of Green River	Easement to construct waterline within 60 ft of County Road 175 or old Highway 6 and 50 ROWs within Green River city limits and operate within 20-ft ROWs.
REEMCBCDOE-6-12-0302	Waterline Easement	Private Owner	Permanent easement across private land near Crescent Junction to construct waterline within 60-ft ROW and operate within 20-ft ROW.
REEMCBCDOE-7-15-0104	Access Agreement	Private Owner	For installation and maintenance of air monitoring equipment and collection of air quality data for monitoring station MPS-0306.

Table 7. Crescent Junction Site Permits and Agreements (continued)

Agreement Number	Document Name or Description	Issuing Agency	Purpose
REEMCBCDOE-7-15-0106	Access Agreement	Private Owner	For installation and maintenance of air monitoring equipment and collection of air quality data for monitoring station MPS-0307.
Resolution 2006-2741	Grand County Council Resolution	Grand County	Approves conditional use permit for the Project.
Statewide Utility License Agreement No. 8439	Utility License	UDOT	License with state of Utah to construct waterline across UDOT property.
U.S. DOT-SP 14283	Special Permit	U.S. DOT	Permit to transport mill tailings from Moab site to the disposal site.
UTR359187	Storm Water Permit	Utah Division of Water Quality	To limit the discharge of pollutants from disposal cell construction activities.
UT-SES-GR-17001	MOU	Utah Dept. of Natural Resources and BLM	MOU outlines terms and conditions for helicopter use of pond for wildland fire fighting.
UTU-83354	Waterline ROW	BLM Moab Field Office	For construction of 14.5 miles of waterline on BLM land from Green River to disposal site.
UTU-83396	Utility ROW	BLM Moab Field Office	For buried telephone line at the disposal site.
UTU-83450	Utility ROW	BLM Moab Field Office	ROW for power line to the disposal site.
Not assigned	Memorandum of Agreement	BLM Moab Field Office	Between DOE and BLM for management of existing uses on lands withdrawn in conjunction with the Project.
Not assigned	Water Use Agreement	Thompson Special Service District	Water use agreement among Thompson Special Service District in Grand County, Crescent Junction Properties, Inc., and DOE to install potable waterline from Thompson Springs, Utah, to the disposal site.

BLM = U.S. Bureau of Land Management; ft = feet; in. = inches; MOU = Memorandum of Understanding; ROW = right-of-way; SITLA = School and Institutional Trust Lands Administration; UDOT = Utah Department of Transportation; U.S. DOT = U.S. Department of Transportation.

4.0 Remedial Action Assessment

This section describes pre-excavation site conditions, construction activities, and verifications performed at the Crescent Junction disposal site.

4.1 Pre-excavation Site Conditions

Pre-excavation site conditions were discussed in Addendum A of the *Moab UMTRA Project Crescent Junction Disposal Cell Interim Completion Report* (DOE-EM/GJRAC2040-A).

4.2 Cell Construction

Cell construction during this period included five major activities:

- Excavation of soils to the design depth to ensure a competent surface for placement of RRM.
- Placement of RRM to the design thickness and assuring that the radium-226 (Ra-226) activity in the upper 7 feet (ft.) of placed material does not exceed design criteria.
- Placement of Interim Cover to the design thickness.
- Placement of Radon Barrier to the design thickness.
- Construction of the spoils embankment.

The *Moab UMTRA Project Lift Approval Procedure* (DOE-EM/GJRAC1803) was used to ensure that the material placed met the compaction criteria. Descriptions of compaction equipment used during the above cell construction activities are provided in Table 8.

Each activity performed as part of this Addendum is further described in the following subsections. Photographs representative of the cell construction activities are included in Appendix B.

Table 8. Compaction Equipment Used during Cell Construction

Compaction Equipment	Machine Weight (lb)	Equipped with CBCS	Material Layer						
			RRM	Interim Cover	Radon Barrier	Infiltration and Bio-intrusion Barrier	Frost Protection	Perimeter Embankment	Spoils Embankment
CAT 825H Soils Compactor	69,000	X	X						
CAT D8 Bulldozer	84,850			X	X				
Komatsu 275AX Bulldozer	112,466	X	X						
CAT D6 Bulldozer	34,361	X	X						
CAT D10 Bulldozer	171,674			X	X				X
CAT 631G Scraper	102,460			X	X				X
CAT D10 Bulldozer	171,674			X	X				X

CAT = Caterpillar; lb = pounds

4.2.1 Excavation

The disposal cell is being excavated in phases. Excavation of Phase 4 was completed in June 2023. Approximately 783,259 cubic yards (yd3) were excavated; excavated material was used to construct the Spoils Wedge.

4.2.2 Perimeter Embankment Construction

There were no perimeter embankment construction activities during this period.

4.2.3 RRM Placement

Placement of RRM in the disposal cell continued east from where it ended, as shown in Addendum L of the *Moab UMTRA Project Crescent Junction Disposal Cell Interim Completion Report* (DOE-EM/GJ2040-L). The RRM was loaded into dump trucks and driven to the placement area, where it was spread for compaction using a bulldozer. A Caterpillar (CAT) 825H soils compactor, CAT D6 bulldozer, and Komatsu 275AX bulldozer were used to compact the RRM in place.

4.2.4 Cover and Rock Armoring Placement

There were no cover or rock armoring activities during this period.

4.2.5 Spoils Embankment Construction

Material excavated to construct the disposal cell was used to create a spoils embankment, or wedge, between the north side of the cell and the Book Cliffs Mountain range. The spoils embankment helps control drainage of storm water around the cell perimeter. The inspection and testing for the spoils embankment can be found in Table 9. The standard Proctor test results summary, lift approval summary, and one lift approval package for the spoils embankment are provided in Appendix A8.

Table 9. Spoils Embankment Inspection and Testing

Inspection or Test Type	Criteria and Method #	RAP Specification Section or Drawing #	RAIP Section #	Verification Results
Visual Observation	Common fill: 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 in. Compaction: embankment fill shall be compacted with rollers, equipment tracks, or successive passes of scrapers with a minimum 45,000-lb static weight. Fill material shall be properly moisture conditioned near optimum moisture content levels.	Specification 31-00-00 Section 3.11.1.3	6.3.5	Visual inspection performed throughout placement to verify compaction and lift thickness. Compaction performed using CAT 631G Scraper and CAT D8 Bulldozer. Thickness was visually verified. Each lift is documented.
High-Accuracy GPS Survey	Exterior slopes are 3:1.	Drawing C-02-C-501	6.3.5	Survey performed. See drawings C-02-C-102 and C-02-C-501.
Laboratory Compaction Characteristics	Common fill: spoils material shall be tested to determine maximum dry density and the moisture content shall be modified to bring fill to near optimum for compaction. Perform in accordance with the following as applicable: ASTM D 698.	Specification 31-00-00 Section 3.11.1.3	6.3.5	16 tests performed to determine compaction characteristics.

Table 9. Spoils Embankment Inspection and Testing (continued)

Inspection or Test Type	Criteria and Method #	RAP Specification Section or Drawing #	RAIP Section #	Verification Results
In-place Density/ Moisture Test	Initial layers of soil placed, and on any specific type of material in which the CAES is used. (Follow non-CAES frequency.) One test per 100,000 ft^2 or 3,700 yd^3 of material placed for material compacted by other than hand-operated machines. One test per 500 ft^2, or fraction thereof, of each lift of fill or backfill areas for material compacted by hand-operated machines. Perform in accordance with the following as applicable: ASTM D1556, D2216, D4643, and D6938	Specification 31-00-00 Section 3.14.1.2	6.3.5	70 in-place density/moisture tests performed with an average density of >90% of the laboratory-determined maximum dry density.
Sand Cone Correlation	One check test for every 20 tests per ASTM D6938, of fill or backfill compacted by other than hand-operated machines. One check test for every 20 tests per ASTM D6938, of fill or backfill compacted by hand-operated machines. Perform in accordance with the following as applicable: ASTM D1556.	Specification 31-00-00 Section 3.14.2	6.3.5	None - Sand cone correlation performed.
Moisture Correlation Test	One correlation test for moistures every 10 tests per ASTM D6938 will be performed in accordance to ASTM D4643 or D2216.	Specification 31-00-00 Section 3.14.2	6.3.5	None - Moisture correlation tests performed.
Laboratory Compaction Characteristics	Perform laboratory density and moisture content tests for each type of fill material to determine the optimum moisture (optimum moisture content ±5%) and laboratory maximum density values. One representative density test per material type and every 20,000 yds^3, thereafter, or when any change in material occurs, which may affect the optimum moisture content or laboratory maximum dry density. Perform in accordance with the following as applicable: ASTM D698 and D2216.	Specification 31-00-00 Section 3.14.3	6.3.5	16 tests were performed to determine compaction characteristics.

= number; % = percent; ft^2 = square feet, ASTM = American Society of Testing and Materials; CAT = Caterpillar, Inc., GPS = global positioning system; in. = inches; lb = pounds, yd^3 = cubic yards

4.3 Soil Compaction and Testing

Initial CBCS compaction setup and verification is documented in Crescent Junction *Interim Completion Report* Addendum H. The CBCS compaction is periodically verified by performing in-place tests using a nuclear density gauge manufactured by Troxler Electronic Laboratories, Inc., following ASTM methods and in compliance with the RAIP. The individual nuclear density tests verify that the compaction achieved with the CBCS is greater than or equal to the required 90 percent. The CBCS compaction results are compared to the nuclear density gauge results in Table 3.

4.4 Lift Approval

The *Lift Approval Procedure* and Addenda B and E of the RAP were followed to verify that each lift met established criteria. Results of lifts are documented in lift approval packages. A sample lift approval for RRM placed during this Report period is provided in Appendix A.

4.5 Geotechnical Testing

The RAIP describes methods and frequencies for performing tests to verify that material placed in the cell meets the requirements. Geotechnical tests fall within two general categories: soils testing and aggregate testing. The *Moab UMTRA Project Moisture/Density Testing Procedure* (DOE-EM/GJRAC1783) provides requirements and methods for the proper moisture/density testing of soils placed in the cell. Only soils testing was used during this Addendum period, as described below.

4.5.1 Soils Testing

Laboratory and/or field soils geotechnical tests were conducted on every lift of each material layer placed to support verification that specified compaction requirements were met. Test requirements varied depending on whether the CBCS was used for demonstrating compaction.

Because the soils in the RRM can vary in composition, compaction curves were developed to determine the maximum dry density and optimum moisture content for that material to achieve compaction.

Results of tests conducted are shown in the standard proctor test results summary tables included in Appendix A. Over time, the RRM was found to have a consistent soil type, so the need for sets of standard proctor tests was eliminated, and standard proctors were completed in the frequency required by the RAIP. The tables also summarize the tests performed to determine soil type and geotechnical properties.

Material is compacted to meet 90 percent of the laboratory-determined maximum dry density in accordance with ASTM D698. When practical, thickness of each lift was surveyed and verified using a high-accuracy GPS; otherwise, manual measurements were taken.

4.5.2 Aggregate Testing

There were no aggregate testing activities during this period.

4.6 Radiological Verification

Section 5 of the Remedial Action Selection Report of the RAP, *Radon Attenuation*, identifies two primary verification criteria associated with construction of the disposal cell: radium-226 (Ra-226) measurements in RRM placed in the upper 7 ft and radon flux measurements to verify the integrity of the radon barrier. Addendum A of this Report provides an explanation of this verification process.

During this Addendum period, 252 samples of RRM were taken in 9 lifts in the upper 7 ft of the disposal cell. The Ra-226 activity of the material ranged from 198 to 690 picocuries per gram(pCi/g). Table 7 shows the average results for material placed in each lift tested.

Table 10. Results of Ra-226 Activity in Upper 7 Feet of Placed RRM

Lift Identification No.	Samples Taken	Lift Average (pCi/g)	Lift Area (m^2)
UW1O20	28	446	10086
UW2L6N	28	461	1944
UW2D12	28	308	2525
UW2K4N	28	491	3915
UW2N5N	28	488	3693
UW2J02	28	368	5819
UW2Q7N	28	544	2047
UW2M01	28	412	5091
UW2Q4N	28	533	2534

4.7 QA Requirements

QA activities were conducted in accordance with documents identified in Section 3.3. During construction activities, surveillances and assessments were performed by the RAC to verify and ensure that these activities were performed in accordance with established plans, drawings, instructions, procedures, specifications, and other applicable documents.

In addition, the Technical Assistance Contractor (TAC) supports the DOE in the assessment of the RAC.

During the period of this Addendum, multiple oversight inspections, two management assessments, and one assessment were performed (see Table 11). Corrective actions were developed to address any deficiencies identified during the assessments.

Table 11. Inspections and Assessments Conducted during Construction

Date	Conducted By	Type	Assessment Number	Scope
2/13/23	RAC	Assessment	MB-23-A-007	The purpose was to evaluate and verify proper implementation of MB-IWP/JSA-034, Excavation of Disposal Cell.
6/20/23	RAC	Management Assessment	MA-23-017	The purpose of this assessment was to ensure the Riprap and rock deliveries to the CJ site could be performed to minimize incidents.
7/11/23	RAC	Management Assessment	MA-23-023	The purpose was to evaluate the QA Programs Inspection process by QA/QC and evaluate compliance with the requirements of the QAP.
9/18/23	RAC	Management Assessment	MA-23-020	The purpose of this management assessment is to evaluate the process of transporting the ACM Super Sacks from Moab to Crescent Junction disposal site.
Daily/ Weekly	DOE/TAC	Oversight	NA	Operational awareness oversight “boots-on-the-ground”: conducted to verify compliance to Project/contractual requirements including Remedial Action Plan specifications.

ISMS = Integrated Safety Management System.

4.8 Monitoring for Presence of Free Liquids

A second standpipe was installed on May 11, 2023. Table 12 provides the results of the standpipe (locations shown on Figure 7) monitoring for the presence of free liquids in the disposal cell. During this reporting period, no water was present in the standpipe.

Table 12. Results of Monitoring for Presence of Fluids in Standpipes 01 and 02

Date Monitored	Presence or Level of Fluids (ft)	
	Standpipe 01	Standpipe 02
12/05/22	Dry	NA
04/14/22	Dry	NA
09/28/22	Dry	Dry

Notes: Dry = no fluids present, NA = Not Applicable
(Standpipe 02 not installed until May 11, 2023)

4.9 Monitoring for Presence of Groundwater

In addition to monitoring the standpipe, monitoring wells 0202, 0203, 0205, and 0210 (Figure 6) were also checked for the presence of groundwater. These results are presented in Table 13. Groundwater has consistently been detected in wells 0202 and 0205 since June 2019 and June 2015, respectively. Wells 0203 and 0210 were dry throughout this Report period.

Table 13. Results of Monitoring for Presence of Groundwater

Date Monitored	Monitor Well Number			
	0202	0203	0205	0210
12/05/22	DTW = 49.73 TD = 60.84	DTW = Dry TD = 61.42	DTW = 45.98 TD = 69.66	DTW = Dry TD = 54.75
04/25/23	DTW = 48.00 TD = 60.88	DTW = Dry TD = 61.40	DTW = 43.65 TD = 69.71	DTW = Dry TD = 54.75
08/02/23	DTW = 46.98 TD = NM	DTW = Dry TD = 61.36	DTW = 43.41 TD = NM	DTW = Dry TD = 54.70

Notes: DTW = Depth to Water (ft below top of casing), Dry = no water present,
TD = Total Depth (ft below top of casing), NM = Not Measured

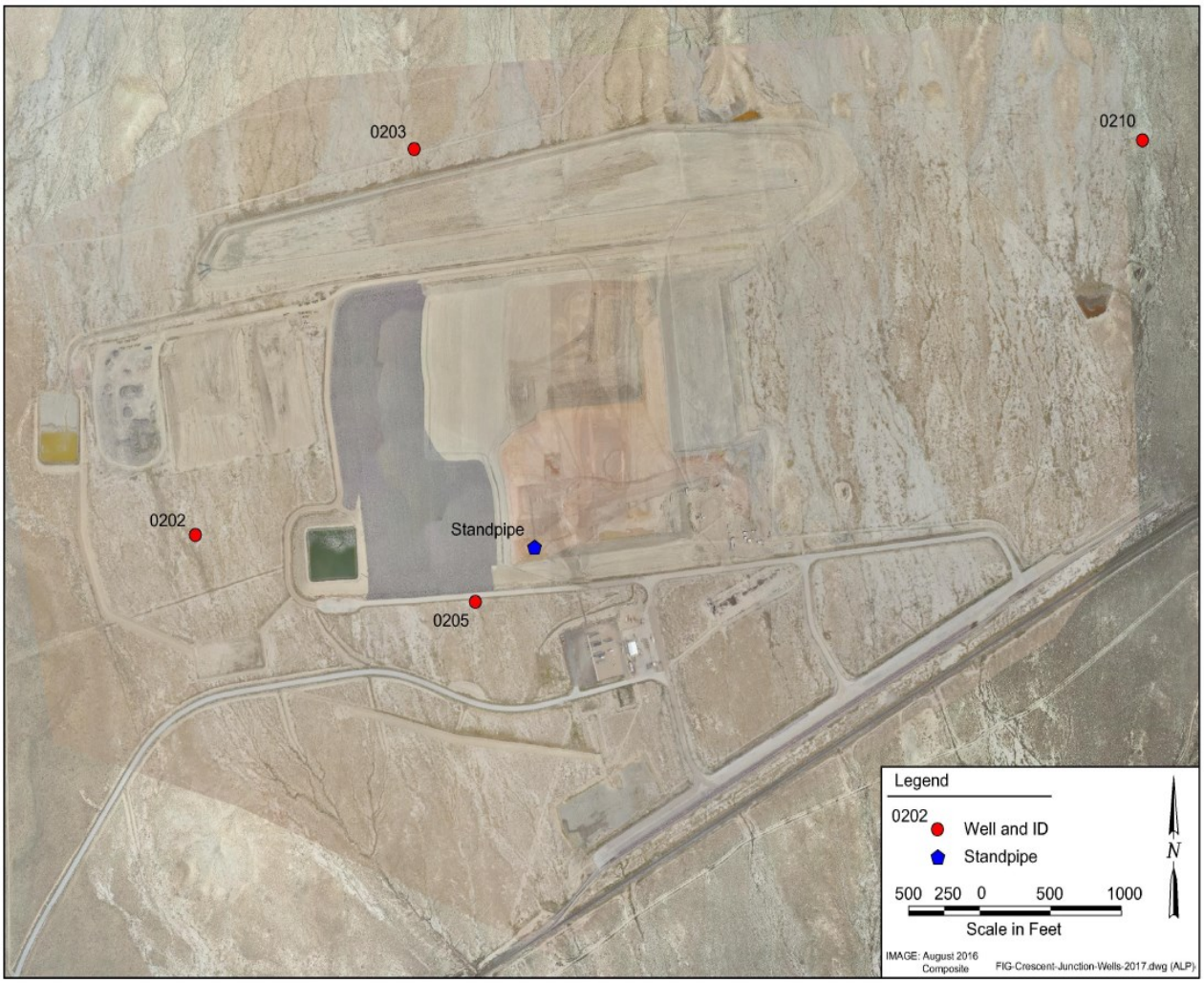

Figure 7. Locations of Monitoring Wells and Standpipe

Water level, precipitation, and recovery test data along with the analytical results continue to suggest that the groundwater source is surface runoff flowing off the cover.

5.0 References

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

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) Standard D698, "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort."

ASTM Standard D1556, "Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method."

ASTM Standard D2216, “Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.”

ASTM Standard D4643, “Standard Test Method for Determination of Water (Moisture) Content of Soil by Microwave Oven Heating.”

ASTM Standard D6938, “Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).”

DOE (U.S. Department of Energy), *Moab UMTRA Project Final Remedial Action Plan and Site Design for Stabilization of Moab Title I Uranium Mill Tailings at the Crescent Junction, Utah, Disposal Site,* Addendum E, *Remedial Action Inspection Plan* (DOE-EM/GJ1547).

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 Moisture/Density Testing Procedure* (DOE-EM/GJRAC1783).

DOE (U.S. Department of Energy), *Moab UMTRA Project Lift Approval Procedure* (DOE-EM/GJRAC1803).

DOE (U.S. Department of Energy), *Moab UMTRA Project Crescent Junction Disposal Cell Interim Completion Report*, Addendum A (DOE-EM/GJRAC2040-A).

DOE (U.S. Department of Energy), *Moab UMTRA Project Crescent Junction Disposal Cell Interim Completion Report*, Addendum L (DOE-EM/GJRAC2040-L).

DOE (U.S. Department of Energy), *Moab UMTRA Project CJ Cell Verification Survey Procedures (DOE-EM/GJRAC3048)*

DOE Office of Environmental Management, “EM Quality Assurance Program” (EM-QA-001).

DOE, Order 226.1B, “Implementation of Department of Energy Oversight Policy.”
DOE, Order 414.1D, Admin Chg 2, “Quality Assurance.”