Office of Environmental Management – Grand Junction

UMTRA Project

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

Revision 0

December 2012

U.S. Department of Energy

Office of Environmental Management

Prepared by the Remedial Action Contractor Contractor under contract number DE-DT0002936
for the U.S. Department of Energy Office of Environmental Management, Grand Junction, Colorado.

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Revision 0

Review and Approval

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12/14/2012
Date

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December 14, 2012
Date

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In concurrence:

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12-17-2012
Date

Revision History

Revision No.	Date	Reason/Basis for Revision
0	December 2012	Initial issue.

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Acronyms and Abbreviations

CAES	Computer Aided Earthmoving System
DOE	U.S. Department of Energy
DOE O	DOE Order
NQA	Nuclear Quality Assurance
NRC	U.S. Nuclear Regulatory Commission
QA	Quality Assurance
RAC	Remedial Action Contract or Contractor
RAIP	Remedial Action Inspection Plan
RAP	Remedial Action Plan
RRM	residual radioactive material
TAC	Technical Assistance Contract or Contractor
UMTRA	Uranium Mill Tailings Remedial Action
yd^3	cubic yards

Executive Summary

This Interim Completion Report Addendum B documents the construction of a portion of a 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 that are referenced in a Final Completion Report that will be prepared to address the entire cell construction.

This Interim Completion Report Addendum B addresses activities performed by Portage, Inc., the DOE Remedial Action Contractor (RAC) for the Moab Project, from April 30, 2012, through September 30, 2012, and includes placement of 0.2 million cubic yards (yd^3) of RRM.

This Interim Completion Report Addendum B 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* (DOE-EM/GJ1547). The *Remedial Action Plan* (RAP) received conditional concurrence from the U.S. Nuclear Regulatory Commission (NRC). 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 Nuclear Quality Assurance-1 (NQA-1) requirements for quality assurance, 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 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 southeastern 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 is 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 be generally rectangular and will encompass approximately 230 acres. Figure 2 shows general features of the Crescent Junction site.

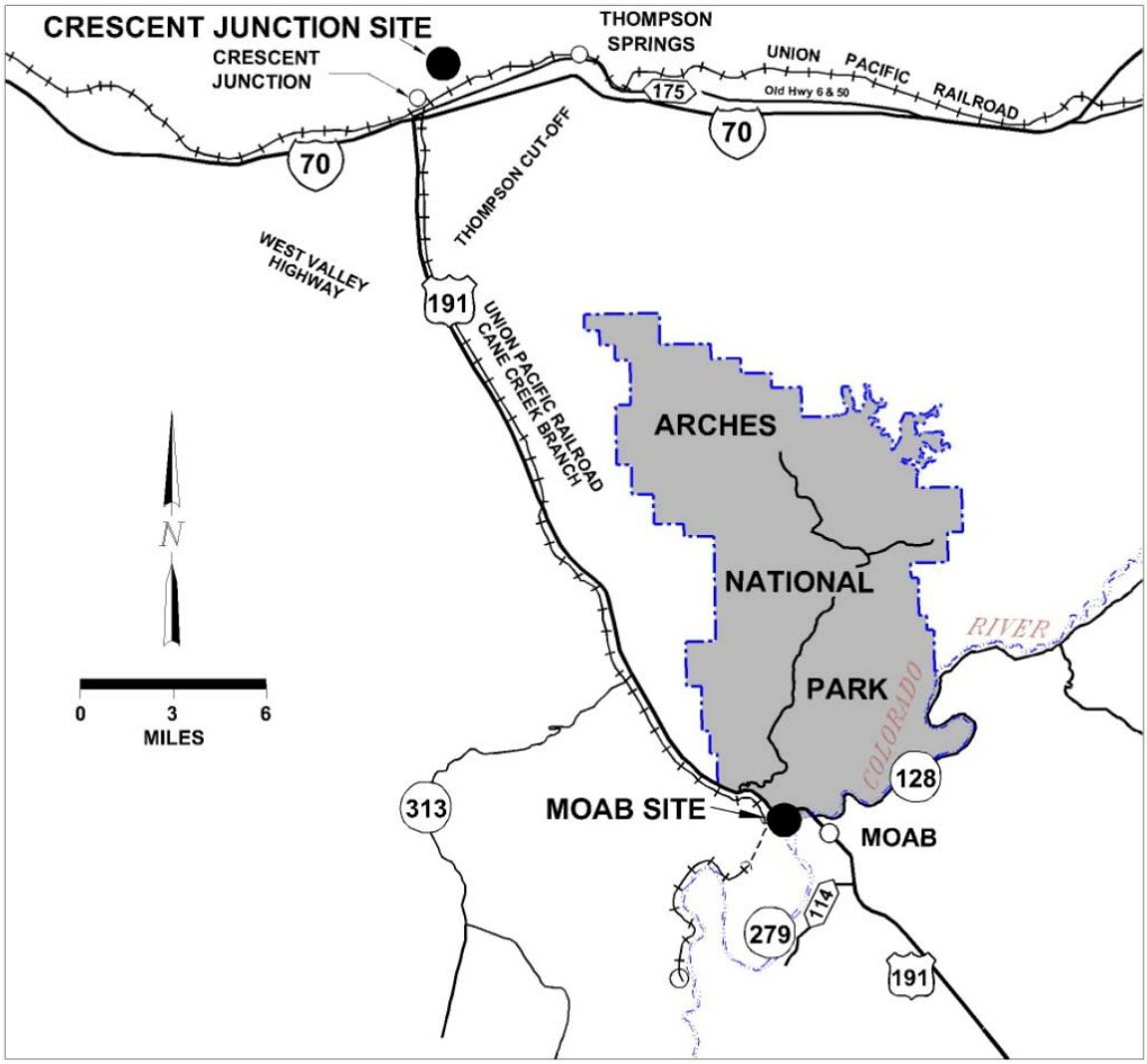


Figure 1. Location of Moab and Crescent Junction Sites

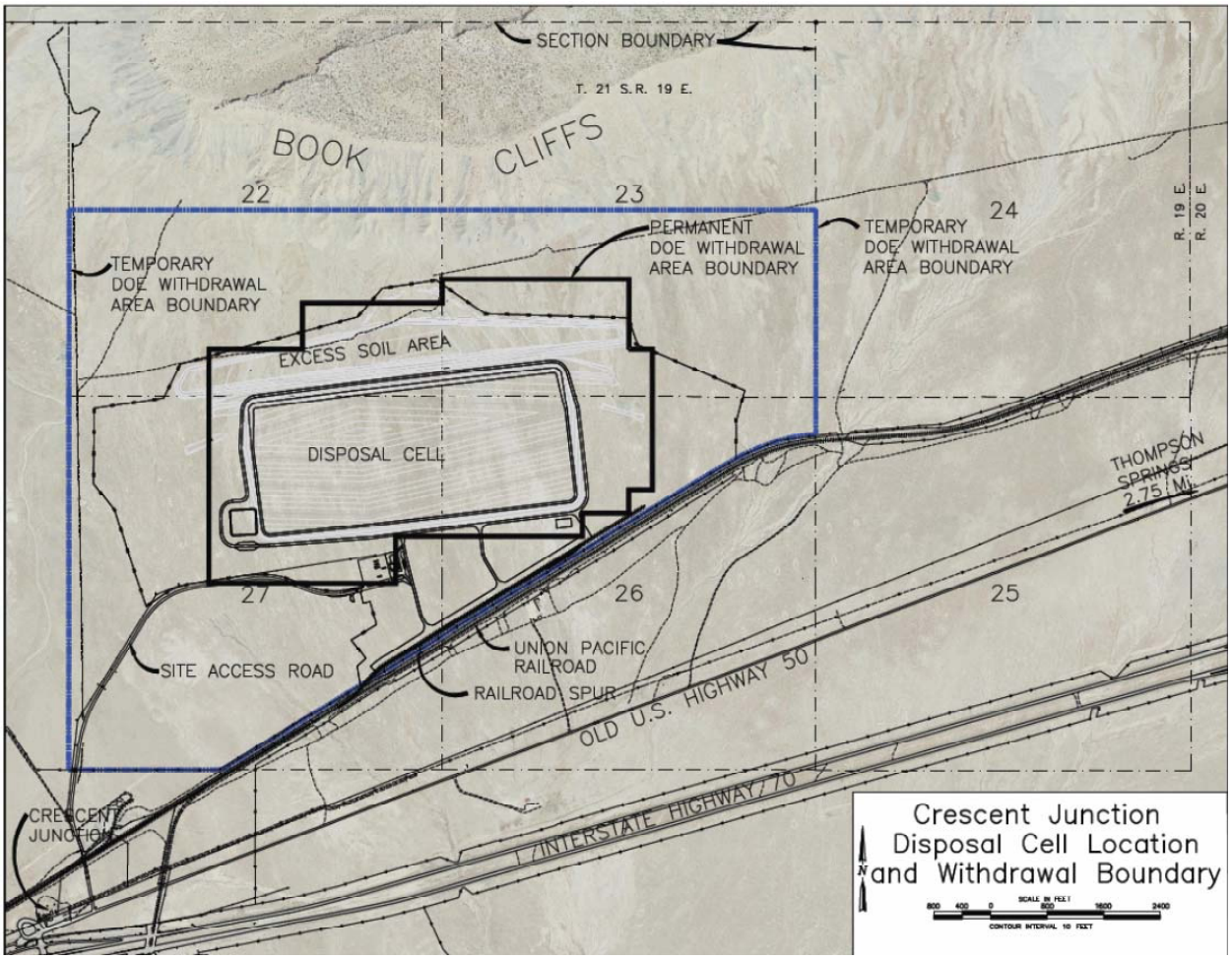


Figure 2. Crescent Junction Site Features

Addendum B of this Interim Completion Report also documents activities performed by the RAC for the Project from April 30, 2012, through September 30, 2012.

Addendum B 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 to the design requirements in the RAP.
- Section 4.0 provides verification that the excavation of the cell and placement of RRM were 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 RRM placement.

2.0 Critical Review

The Critical Review provides the reader with key technical information about the disposal cell construction. This section contains tables summarizing inspections or tests for cell excavation, embankment construction, RRM placement, and cover placement as appropriate for the report period. The tables reference the criteria and material testing procedures used to verify that the cell excavation and placement of each type of material was performed in accordance with design specifications or drawings and with the Remedial Action Inspection Plan (RAIP), which is Addendum E to the RAP. The distribution survey associated with each material type is also included in this section, as appropriate.

Information regarding total lifts of compacted material, tests performed, and geotechnical data is outlined in Table 1. Additional geotechnical data are located in Appendix A.

Table 1. Lifts/Testing Totals

	Total Volume Placed (yd^3)	Total Number of Lifts Approved	Lifts Approved Using CAES	Lifts Approved Not Using CAES	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 CAES Passes that Meet Compaction Criteria (%)	Total Number of Soil Classifications	Total Number of Durability Tests	Total Number of Gradation Tests
Cell Perimeter Embankment	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
RRM	199,698	117	117	0	42	1	91.7	97.6	NA	NA	NA
Interim Cover	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Radon Barrier	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Infiltration and Biointrusion Barrier	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Frost Protection Layer	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-in. Cap Rock	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

% = percent; CAES = Computer Aided Earthmoving System; in. = inch; NA = not applicable

2.1 Cell Excavation

No cell excavation activities were conducted during this period.

2.2 Perimeter Embankment

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

2.3 RRM

2.3.1 Computer Aided Earthmoving System Performance Verification Testing

The Project utilized machines equipped with a Computer Aided Earthmoving System (CAES) to compact RRM to meet verification requirements of in-place density tests in compliance with Section 6.4.3 of the RAIP. Additional information about the CAES verification testing is provided in Section 4.3 of this addendum. The RAIP also requires periodic verification of the CAES compaction by comparing the results to in-place density test results. Table 2 shows the results of the comparison test performed during this report period.

Table 2. CAES Performance Verification Testing

Lift ID Number	Test Performance Date	In-Place Density Compaction (%)	Lift Area Meeting CAES Compaction Criteria (%)
UW1A17120504-00	05/04/12	91.7	97.6

2.3.2 RRM Placement

The inspection and testing for RRM can be found in Table 3. The standard Proctor test results summary, lift approval summaries, and one lift approval package, for the RRM are provided in Appendix A2.

2.4 Interim Cover

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

2.5 Radon Barrier

2.5.1 Radon Barrier Placement

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

2.5.2 Verification Measurements for Radon Flux

No radon flux measurements were conducted during this period

Table 3. 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	At a minimum, scarify the top 1 in. of subsoil or preceding RRM lift, using a footed roller or a dozer, before placement of subsequent RRM layers. Fill material is placed in continuous and planar lifts. The method of dumping and spreading RRM shall result in loose lifts. Average thickness of fill area is not to exceed 12 in. Dozers shall have a minimum ground pressure of 1,650 lb/ft^2. Compaction equipment shall be footed rollers or dozers. Footed rollers shall have a minimum weight of 45,000 lb and at least one tamping foot 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 the RRM layers shall be repaired and grades reestablished. If freezing or desiccation occurs, the affected soil shall be reconditioned, as directed.	Specification 31-00-20 Sections 1.3.2, 3.2.1, and 3.2.4	6.4.2	Documented on 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, as applicable: ASTM D698 and D2216.	Specification 31-00-20 Section 3.1.1	6.4.3	42 tests were performed to determine compaction characteristics.
Sand Cone and Moisture Correlation Test	Companion sand cone tests and moisture tests must be performed with nuclear tests until a sufficient number have been performed to demonstrate a clear correlation. Perform in accordance with the following, as applicable: ASTM D1556, D2216, and D4643.	Specification 31-00-20 Section 3.4.1	6.4.3	Sand cone and moisture tests performed for correlation.
Moisture Test	Fill material is properly moisture conditioned. Optimum moisture content is ± 3%. Perform in accordance with the following, as applicable: ASTM D4643, D4944, and D4959.	Specification 31-00-20 Section 3.4.2	6.4.3	Moisture tests performed daily and documented in lift approval packages.

Table 3. RRM Inspection and Testing (continued)

Inspection or Test Type	Criteria and Method Number	RAP Specification Section or Drawing Number	RAIP Section Number	Verification Results
In-place Density/ Moisture Test	Must meet 90% of maximum dry density standard Proctor. Optimum moisture content is ± 3%. Perform in accordance with the following, as applicable: ASTM D1556, D2216, D4643, and D6938.	Specification 31-00-20 Section 3.2.2	6.4.3	117 lifts were approved; 0 lifts were approved using in-place density/moisture testing; 1 test was performed with average in-place density of 91.7%, the laboratory-determined maximum dry density.
Compaction by CAES	QC shall monitor CAES 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	117 lifts were approved; 117 lifts were approved using CAES.
High-accuracy GPS	The top surface of the RRM shall be no greater than 2 in. above the lines and grades shown on the drawings, and verified by survey or the use of the CAES. No minus tolerance is permitted.	Specification 31-00-20 Section 3.3	6.4.5	Completed using high-accuracy GPS. See Appendix A2 for top-of-waste surveys.
Visual Observation	Each container of demolition debris shall be spread in a single layer (not stacked) and placed in a manner that results in a minimum of voids around the debris. Wood, concrete, and masonry: cut or break up to a maximum size of 3 ft measured in any dimension. Structural steel member, pipes, ducts, and other long items: cut into maximum lengths of 10 ft Concrete, clay tile, and other pipes: crush concrete and clay tile pipes. Crush other pipes and ducts that are 6 in. or greater in diameter or, if crushing is impractical, cut pipes and ducts in half longitudinally. Do not crush asbestos-cement pipe. Rubber tires excavated at the site: cut into two halves around the circumference. Geo-membranes and other sheet material: cut into strips with a maximum of 4 ft wide by 4 ft long. Tree limbs with a diameter of 4 in. and larger: cut into lengths of 8 ft or less.	Specification 31-00-20 Section 3.2.5	6.4.4	Debris inspections performed during debris placement. Inspections documented in lift approval packages.

% = percent; ASTM = ASTM International; ft = feet; GPS = global positioning system; in. = inches; in^2 = square inches; lb = pounds; lb/ft^2 = pounds per square feet; QC = Quality Control
ASTM Standard titles are included in the References section.

2.6 Infiltration and Biointrusion 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. This section discusses design criteria changes, changes to the design of the disposal cell and associated erosion control features, fulfillment of Quality Assurance (QA) requirements, and compliance with permit requirements.

3.1 Design Criteria Changes

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

3.2 Design Changes

No changes to the design were made during the period represented by this Addendum. Future Design Changes Notices will be included in Table 12.

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), which complies with the following:

- American Society of Mechanical Engineers NQA)1 2004 and addenda through 2007 consensus standard, "Quality Assurance Requirements for Nuclear Facility Applications (QA)."
- Appendix A of DOE O 226.1B, "Implementation of Department of Energy Oversight Policy."
- Title 10 Code of Federal Regulations Part 830 (10 CFR 830), "Nuclear Safety Management," Subpart A, "Quality Assurance."
- DOE O 414.1D, "Quality Assurance."

3.4 Permits and Agreements

The Project is in compliance with permits and agreements applicable to the Crescent Junction site. These are summarized in Table 4.

Table 4. Crescent Junction Site Permits and Agreements

Agreement Number	Document Name or Description	Issuing Agency	Purpose
Resolution 2006-2741	Grand County Council Resolution	Grand County	Approves Conditional Use Permit for the Project.
DE-RO01-05GJ68003	Access Agreement	DOE EMCBC	For installation and maintenance of air monitoring equipment and collection of air quality data for monitoring station MPS-0306.
DE-RO01-05GJ68004	Access Agreement	DOE EMCBC	For installation and maintenance of air monitoring equipment and collection of air quality data for monitoring station MPS-0307.
Public Land Order 7697	Permanent Land Transfer	BLM	Order permanently transferred 500 acres of BLM public domain land to DOE for disposal cell.
Public Land Order 7734	Public Land Withdrawal	BLM	Order withdrew 936 acres of public land for activities to support disposal of mill tailings at the Crescent Junction disposal site. The withdrawal is for 20 years to support Public Land Order 7697.
Not assigned	Water Use Agreement	Thompson Special Service District	Water use agreement between 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.
UTU-83353	ROW	BLM, Moab Field Office	ROW for 3-in. service culinary waterline and a 2-in. delivery culinary waterline to the disposal site.
UTU-83450	ROW	BLM, Moab Field Office	ROW for power line to the disposal site.
Case # 11-0028	Memorandum of Agreement	BLM, Utah State Preservation Office	Between DOE, BLM, and Utah State Historic Preservation Office regarding cultural resource issues related to development of disposal site.
Not assigned	Memorandum of Agreement	BLM, Moab Field Office	Between BLM and DOE for management of existing uses on lands withdrawn in conjunction with the Project.
UTR359187	Storm Water Permit	Utah Division of Water Quality	For the disposal site.

Table 4. Crescent Junction Site Permits and Agreements (continued)

Agreement Number	Document Name or Description	Issuing Agency	Purpose
UTU-83396	ROW	BLM, Moab Field Office	For buried telephone line at the disposal site.
Folder # 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 1-1/4 in. conduit at mile post 0.25, Cane Creek Subdivision, Thompson Springs, for the disposal site.
Folder # 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 1-1/2 in. conduit across Union Pacific Railroad's property at mile post 533.2, Green River Subdivision.
U.S. DOT-SP 14283	Special Permit Authorization	U.S. DOT	Permit to transport mill tailings from Moab site to the disposal site.
U.S. DOT # 011309550013QR	U.S. DOT Hazardous Materials Certificate of Registration	U.S. DOT	For shippers of hazardous materials for 2008 – 2010.
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.
REECBCDOE-6-08-0302	Waterline Easement	Grand County	Easement within CR-175 or old Highway 6 & 50 and Hastings Lane ROWs to construct waterline within 60-ft ROW and operate within 20-ft ROW.
REECBCDOE-6-08-0304	Waterline Easement	Private Owner	Easement across private land near the Green River to construct waterline within 60-ft ROW and operate within 20-ft ROW and pump station.
REECBCDOE-6-08-0301-1	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.
REECBCDOE-6-08-0309	Waterline Easement	City of Green River	Easement to construct waterline within 60 ft of CR-175 or old Highway 6 & 50 ROWs within Green River city limits and operate within 20-ft ROWs.
REECBCDOE-6-08-0308, SITLA # 1345	Waterline Easement	SITLA	Easement to construct waterline within 60-ft ROW and operate within 20-ft ROW on three parcels on SITLA land near Green River and Crescent Junction.
ESMT 463	Waterline Easement	SITLA	Easement across state land for potable waterline.
400 00177	Waterline Easement	Utah Division of Forestry, Fire, and State Lands	ROW easement to construct and operate waterline in the Green River.
Statewide Utility License Agreement # 8439	UDOT Utility License	Permits Officer	License with State of Utah to construct waterline across UDOT property.
Property # 70-4;189A: AEQ	UDOT Easement	Permits Officer	Easement for waterline across UDOT property near Floy Wash that allows 60-ft construction ROW and 20-ft permanent ROW.

Table 4. Crescent Junction Site Permits and Agreements (continued)

Agreement Number	Document Name or Description	Issuing Agency	Purpose
4P-082341-1	UDOT Encroachment Permit	UDOT	To construct waterline within UDOT 60-ft ROW and operate within 20-ft ROW near Floy Wash.
4P-082364-0	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.
SPK-2007-632	US Army Corps of Engineers 404 Permit	US Army Corps of Engineers	To construct pump station on the Green River.
08-92-01SA	Stream Channel Alteration Permit	Utah Division of Water Rights	To construct pump station on the Green River.
Folder # 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 mile post 533.21, Green River Subdivision line.
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.
DAQC-1110-2006	Fugitive Dust Control Plan (08/07/06) UAC R307-309-6 "Fugitive Emissions and Fugitive Dust-Fugitive Dust Control Plan-Uranium Mill Tailings Repository (UMTRA) Project near Crescent Junction, Grand County"	Utah Division of Air Quality	Approval letter from the State of Utah for the Fugitive Dust Control Plan for the Crescent Junction disposal cell.

= number; BLM + Bureau of Land Management; CR = County Road; EMCBC = Environmental Management Consolidated Business Center; ft = feet; in. = inches; ROW = right-of-way; SITLA = School and Institutional Trust Lands Administration; UAC = Utah Administrative Code; UDOT = Utah Department of Transportation; U.S. DOT = U.S. Department of Transportation

4.0 Remedial Action Assessment

A description of the pre-excavation site conditions, construction activities, and verification performed at the Crescent Junction disposal site is provided in this section.

4.1 Pre-excavation Site Conditions

Pre-excavation site conditions were discussed in the *Moab UMTRA Project Crescent Junction Disposal Cell Interim Completion Report, Addendum A.*

4.2 Cell Construction

There only cell construction activity during this period was placement of RRM.

The *Moab UMTRA Project Lift Approval Procedure* (DOE-EM/GJRAC1803) was used to ensure the material placed met the compaction criteria. Descriptions of compaction equipment used during RRM placement are provided in Table 5.

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 5. Descriptions of Compaction Equipment Used during Cell Construction

Compaction Equipment	Machine Weight (lbs)	Equipped with CAES	Material Layer Equipment Used On							
			RRM	Interim Cover	Radon Barrier	Infiltration and Biointrusion Barrier	Frost Protection	Rock Armor	Spoils Embankment	Perimeter Embankment
CAT 825H Soils Compactor	69,000	X	X							
CAT D-8 Bulldozer	84,850		X							
Komatsu 275X Bulldozer	112,466	X	X							

CAT = Caterpillar, Inc., lb = pounds

4.2.1 Excavation

There were no excavaction activities during this period.

4.2.2 Perimeter Embankment Construction

There were no perimeter embankment construction activities during this period.

4.2.3 RRM Placement

Placement of RRM began in April 2009 in the southwestern corner of the cell and progressed to the north and east. Containers were emptied from the platform discussed in Section 4.2.1. The dumped material was loaded into dump trucks and driven to the disposal area, where it was spread for compaction using a bulldozer. A sheepsfoot roller was then used to compact the RRM in place. In a letter dated October 26, 2009, DOE notified NRC that polypropylene liners were being used in the RRM containers to facilitate complete dumping of the material. Use of the liners did not result in voids in the waste mass.

NRC accepted the liner use in its response letter dated November 23, 2009. Copies of this correspondence between DOE and NRC regarding liners and the size variance are included in Attachment 4 of the *Moab UMTRA Project Crescent Junction Disposal Cell Interim Completion Report Addendum A* (DOE-EM/GJRAC2040-A).

4.2.4 Cover and Rock Armoring Placement

There were no cover and 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 northern side of the cell and the Book Cliffs mountain range. The spoils embankment helps control drainage of storm water around the cell perimeter. The topographic surface of the spoils embankment is shown on Figure 12.

There were no spoils embankment construction activities during this period.

4.3 Soil Compaction and Testing

Initial CAES compaction set-up and verification is documented in the *Crescent Junction Disposal Cell Interim Completion Report Addendum A.* The CAES compaction is periodically verified by performing in-place tests using a nuclear density gauge manufactured by Troxler Electronic Laboratories, Inc., following ASTM International methods. The individual nuclear density tests verified that the compaction achieved with the CAES was greater than the required 90 percent. The CAES compaction result compared to the nuclear density gauge are provided in Section 2.3.1.

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. The procedure was modified during this Addendum B period, and the revised version is provided in Attachment 1. An example lift approval package for RRM is provided in Appendix A2.

4.5 Geotechnical Testing

The RAIP describes the methods and frequencies for performing tests to verify that the material placed in the cell meet the requirements. Geotechnical tests performed fell within two general categories: soils testing and aggregate testing. The following subsections contain descriptions of these categories.

4.5.1 Soils Testing

Laboratory and/or field soils geotechnical tests were conducted on every lift of RRM placed to support demonstration that specified compaction requirements were met. Test requirements varied depending on whether or not the CAES was used for demonstrating compaction. Because the soils in the RRM can vary in composition, multiple compaction curves were prepared to determine the optimum moisture content for that material to achieve compaction.

Results of the tests conducted are shown in the standard Proctor test results summary table included in Appendix A2. When multiple standard Proctor tests, or "sets," were performed, the test selected to represent that soil type appears in red in the table. The table in Appendix A2 also summarizes the tests performed to determine soil type and geotechnical properties.

Moisture content testing was performed daily for RRM placed to verify that the moisture content met the requirements before the approval of RRM placed that day. The thickness of each lift was surveyed and verified using high-accuracy global positioning system, when practical; otherwise, manual measurements were taken.

4.5.2 Aggregate Testing

There were no aggregate testing activities during this period.

4.6 Radiological Verification

There were no radiological verification activities during this period for radium-226 measurements in RRM in the upper 7 ft or for radon flux measurements to verify the integrity of the radon barrier.

4.7 QA Requirements

QA activities were conducted in accordance with documents identified in Section 3.3. All personnel who performed work addressed in Addendum B were qualified in accordance with the requirements of the *Quality Assurance Plan for the Remedial Action Contractor*.
RRM placement activities, audits, and surveillances were performed by the RAC-to verify and provide assurance that these activities were performed in accordance with established plans, drawings, instructions, procedures, specifications, and other applicable documents. In addition, DOE and the Technical Assistance Contractor (TAC) performed audits, surveillances, and an assessment of these activities.

During the Addendum B period, one audit, one assessment, and three surveillances were performed of RRM placement (see Table 6). Any issues identified during these audits, surveillances, and assessment have been addressed.

Table 6. Results of Monitoring for the Presence of Fluids in Standpipe

Date Monitored	**Presence or Level of Fluids** (ft)
07/19/12	Dry

Dry = no fluids present; ft = feet

4.8 Monitoring for Presence of Free Liquids

To monitor for the presence of free liquids in the disposal cell, four standpipes are specified in Section 7.2.4 of the RAP *Remedial Action Selection Report* to be completed so that the screens are at the base of the placed RRM. The location of the first standpipe is shown in Figure 3. The result of periodic monitoring conducted during this report for the presence of fluids is shown in Table 7. No additional standpipes were installed during this period.

Table 7. Audit, Surveillances, and Assessments Conducted During Construction

Date	Conducted By	Type	Assessment #	Scope
05/14/12	RAC/TAC	Surveillance	DOE-12-S-013	S/CI – Review the ratchet type tie-down straps procured and used on site and verify the absence of S/CI equipment.
05/14/12	RAC/TAC	Surveillance	DOE-12-S-014	Review the corrective action plan to verify completion of the actions associated with December 2010 EM-PA-10-08.
05/21/12 - 05/24/12	DOE EMCBC	Audit	EM-PA-12-08	Verify QA Program implementation by DOE and contractors. This review was also intended as a follow-up to EM-PA-12-08, including an evaluation of the closure of the issues.
06/04/12 - 06/13/12	RAC	Surveillance	MB-12-S-008	Verify if Moab UMTRA Project Site Security Operations (DOE-EM/GJRAC1955) was being implemented with regard to work steps, guidelines, and instructions during activities associated with security operations at the Crescent Junction site.
09/10/12 - 09/14/12	DOE HQ	Assessment	TCAP	Verify compliance with applicable regulations, policies, and DOE orders in nine areas of P&T. The performance objectives also included identification of opportunities for improvements, and sharing of best practices and lessons learned.

EMCBC = Environmental Management Consolidated Business Center; IWP = Integrated Work Plan; P&T = packaging and transportation; TCAP = Transportation Compliance Assurance Program

4.9 Monitoring for Presence of Ground Water

Four of the characterization boreholes were previously monitored for the presence of ground water outside of the disposal cell footprint (see Figure 3). Results of monitoring for the presence of ground water in the wells are shown in Table 8.

Table 8. Results of Monitoring for Presence of Ground Water

Date Monitored	Monitor Well Number			
	202	203	205	210
7/19/12	Dry	Dry	Dry	Dry

Dry = no fluids present

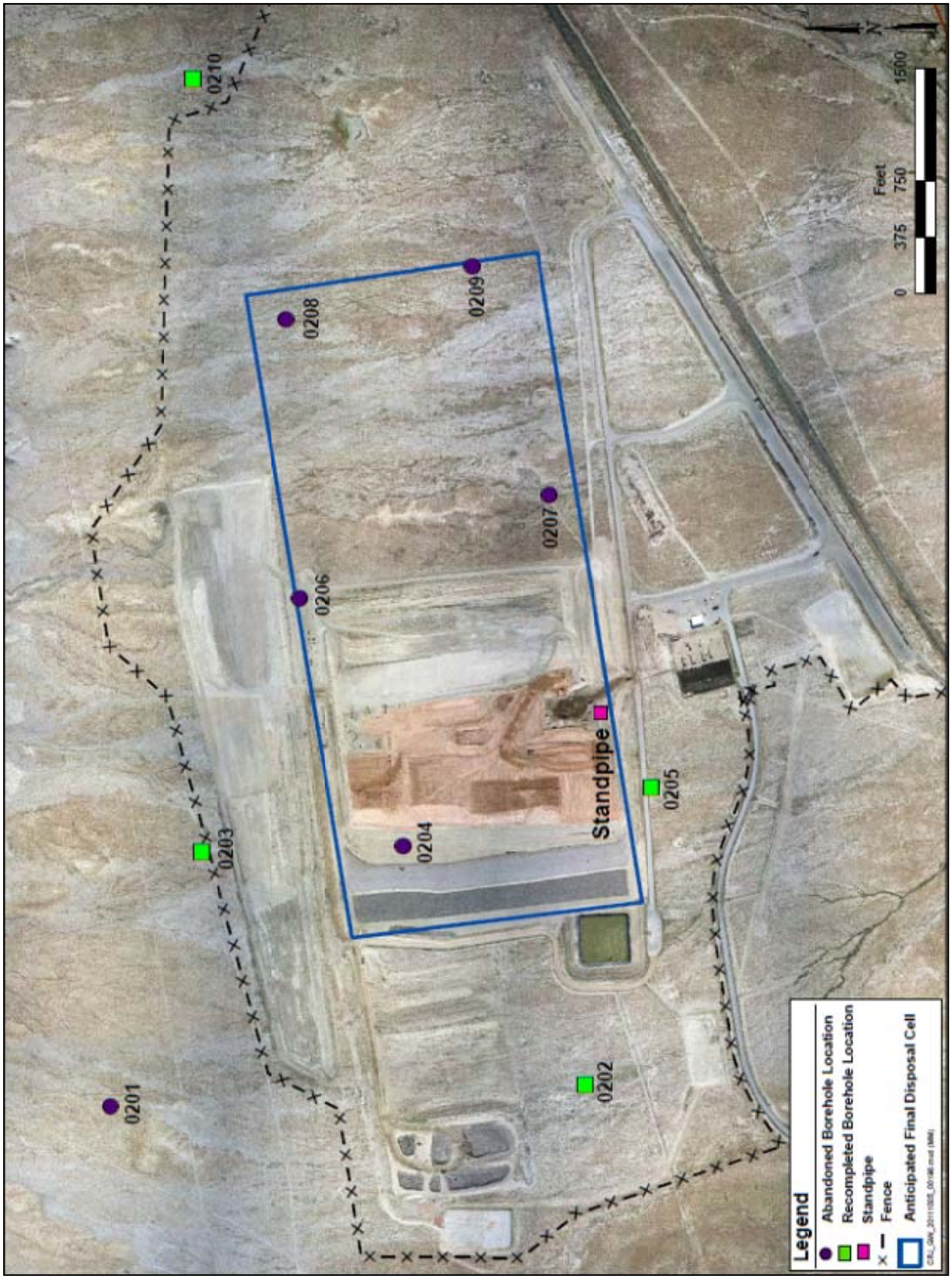


Figure 3. Locations Abandoned and Recompleted Boreholes and Standpipe

5.0 References

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

American Society for Testing and Materials (ASTM) Standard D698, "Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort."

American Society for Testing and Materials (ASTM) Standard D1556, "Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method."

American Society for Testing and Materials (ASTM) Standard D2216, "Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass."

American Society for Testing and Materials (ASTM) Standard D4643, "Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Heating."

American Society for Testing and Materials (ASTM) Standard D4944, "Standard Test Method for Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester."

American Society for Testing and Materials (ASTM) Standard D4959, "Standard Test Method for Determination of Water (Moisture) Content of Soil by Direct Heating Method."

American Society for Testing and Materials (ASTM) Standard D6938, "Standard Test Method for In-Place Density and Water content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)."

American Society of Mechanical Engineers (ASME), Nuclear Quality Assurance (NQA)-1 2004 and addenda through 2007 consensus standard, "Quality Assurance Requirements for Nuclear Facility Applications (QA)."

DOE (U.S. Department of Energy), *Moab UMTRA Project Crescent Junction Disposal Cell Interim Completion Report, Addendum A* (DOE-EM/GJRAC2040-A), December 2012.

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* (DOE-EM/GJ1547), July 2008 (updated December 2012).

DOE (U.S. Department of Energy), *Moab UMTRA Project Lift Approval Procedure* (DOE-EM/GJRAC1803), August 2012.

DOE (U.S. Department of Energy), *Moab UMTRA Project Quality Assurance Plan for the Remedial Action Contractor* (DOE-EM/GJRAC1766), September 2012.

DOE (U.S. Department of Energy), Order 226.1B, "Implementation of Department of Energy Oversight Policy," Appendix A.

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

Appendix A.
Construction Verification Data

Appendix A. Construction Verification Data

Contents

Appendices A1 and A3 through A8 are not included as they are not relevant to the Addendum B time period.

Appendix A2.
RRM

Standard Proctor Test Results Summary
Lift Approval Summaries
Lift Approval Package

Appendix A2. RRM
Standard Proctor Test Results Summary

Set	Proctor ID	Date Sampled	Date Approved	Max Dry Density	Optimum Moisture	Proctor Description
Set # 102	RRM # 310	5/3/2012	5/31/2012	116.1	12.3	Reddish brown (5YR5/4) very fine to medium, well graded, subround sand.
	RRM # 311	5/3/2012	5/31/2012	116.0	10.7	Reddish brown (5YR5/4) very fine to medium, well graded, subround sand.
	RRM # 312	5/3/2012	5/31/2012	115.6	12.3	Reddish brown (5YR5/4) very fine to medium, well graded, subround sand.
Set # 103	RRM # 313	5/21/2012	6/11/2012	111.4	15.3	Light brown (7.5YR6/3) very fine to fine, poorly graded, sub round, sand w/silt
	RRM # 314	5/21/2012	6/11/2012	111.9	16.0	Light brown (7.5YR6/3) very fine to fine, poorly graded, sub round, sand w/silt
	RRM # 315	5/21/2012	6/11/2012	111.3	15.1	Light brown (7.5YR6/3) very fine to fine, poorly graded, sub round, sand w/silt
Set # 104	RRM # 316	5/31/2012	6/27/2012	112.5	14.3	Light brown (7.5YR6/3) very fine to fine, poorlygraded, sub round, sand with silt
	RRM # 317	5/31/2012	6/27/2012	111.5	15.1	Light brown (7.5YR6/3) very fine to fine, poorlygraded, sub round, sand with silt
	RRM # 318	5/31/2012	6/27/2012	114.8	14.1	Light brown (7.5YR6/3) very fine to fine, poorlygraded, sub round, sand with silt
Set # 105	RRM # 319	Protor set rejected due to proctor curves				
	RRM # 320					
	RRM # 321					

Appendix A2. RRM (continued)
Standard Proctor Test Results Summary

Set	Proctor ID	Date Sampled	Date Approved	Max Dry Density	Optimum Moisture	Proctor Description
Set # 106	RRM # 322	6/18/2012	7/10/2012	113.6	15.1	Light brown very fine to fine, poorly graded sub round, sand w/clay
	RRM # 323	6/18/2012	7/10/2012	113.3	15.3	Light brown very fine to fine, poorly graded sub round, sand w/clay
	RRM # 324	6/18/2012	7/10/2012	112.4	15.3	Light brown very fine to fine, poorly graded sub round, sand w/clay
Set # 107	RRM # 325	7/9/2012	9/10/2012	117.0	13.7	Light brown (7.5YR6/3) very fine to fine, moderately graded, subround sand with clay
	RRM # 326	7/9/2012	9/10/2012	115.6	13.8	Light brown (7.5YR6/3) very fine to fine, moderately graded, subround sand with clay
	RRM # 327	7/9/2012	9/10/2012	116.0	14.1	Light brown (7.5YR6/3) very fine to fine, moderately graded, subround sand with clay
Set 108	RRM # 328	7/16/2012	8/2/2012	115.5	13.9	Light brown (7.5YR6/3) very fine to fine, moderately graded, subround sand with clay
	RRM # 329	7/16/2012	8/14/2012	114.8	13.9	Light brown (7.5YR6/3) very fine to fine, moderately graded, subround sand with clay
	RRM # 330	7/16/2012	8/2/2012	114.2	14.1	Light brown (7.5YR6/3) very fine to fine, moderately graded, subround sand with clay

Appendix A2. RRM (continued)
Standard Proctor Test Results Summary

Set	Proctor ID	Date Sampled	Date Approved	Max Dry Density	Optimum Moisture	Proctor Description
Set # 109	RRM # 331	7/25/2012	8/14/2012	114.1	15.1	Light reddish brown (5YR6/34) very fine to fine, poorly graded, sub round, sand w/silt
	RRM # 332	7/25/2012	8/14/2012	115.6	14.0	Light reddish brown (5YR6/34) very fine to fine, poorly graded, sub round, sand w/silt
	RRM # 333	7/25/2012	8/14/2012	114.8	14.5	Light reddish brown (5YR6/34) very fine to fine, poorly graded, sub round, sand w/silt
Set # 110	RRM # 334	8/2/2012	8/20/2012	115.7	14.8	Light brown (7.5YR6/3) very fine to fine, moderately graded, sub round, sand w/clay
	RRM # 335	8/2/2012	8/20/2012	116.1	14.2	Light brown (7.5YR6/3) very fine to fine, moderately graded, sub round, sand w/clay
	RRM # 336	8/2/2012	8/20/2012	116.3	14.2	Light brown (7.5YR6/3) very fine to fine, moderately graded, sub round, sand w/clay

Appendix A2. RRM (continued)
Standard Proctor Test Results Summary

Set	Proctor ID	Date Sampled	Date Approved	Max Dry Density	Optimum Moisture	Proctor Description
Set # 111	RRM # 337	8/8/2012	10/3/2012	115.7	13.2	Reddish brown (5YR5/4) very fine to fine, moderately graded, subround sand
	RRM # 338	8/8/2012	10/3/2012	113.2	12.3	Reddish brown (5YR5/4) very fine to fine, moderately graded, subround sand
	RRM # 339	8/8/2012	10/3/2012	116.3	12.3	Reddish brown (5YR5/4) very fine to fine, moderately graded, subround sand
Set # 112	RRM # 340	8/15/2012	9/10/2012	113.9	15.6	Brown (7.5YR5/3) very fine to fine, moderately graded, subround sand with clay.
	RRM # 341	8/15/2012	9/10/2012	113.3	15.2	Brown (7.5YR5/3) very fine to fine, moderately graded, subround sand with clay.
	RRM # 342	8/15/2012	9/10/2012	114.8	14.6	Brown (7.5YR5/3) very fine to fine, moderately graded, subround sand with clay.
Set # 113	RRM # 343	8/22/2012	9/10/2012	113.1	15.8	Light brown (7.5YR6/3) very fine to fine, moderately graded, subround sand with abundant clay.
	RRM # 344	8/22/2012	9/10/2012	113.2	15.9	Light brown (7.5YR6/3) very fine to fine, moderately graded, subround sand with abundant clay.
	RRM # 345	8/22/2012	9/10/2012	113.3	15.0	Light brown (7.5YR6/3) very fine to fine, moderately graded, subround sand with abundant clay.

Appendix A2. RRM (continued)
Standard Proctor Test Results Summary

Set	Proctor ID	Date Sampled	Date Approved	Max Dry Density	Optimum Moisture	Proctor Description
Set # 114	RRM # 346	8/29/2012	10/25/2012	114.6	15.5	Light reddish brown (5YR6/34) very fine to fone moderately graded, sub round, sand w/abundant clay.
	RRM # 347	8/29/2012	10/25/2012	116.1	14.6	Light reddish brown (5YR6/34) very fine to fone moderately graded, sub round, sand w/abundant clay.
	RRM # 348	8/29/2012	10/25/2012	115.6	15.0	Light reddish brown (5YR6/34) very fine to fone moderately graded, sub round, sand w/abundant clay.
Set # 115	RRM # 349	9/10/2012	10/25/2012	114.7	14.9	Light brown (7.5YR6/3) very fine to fine, poorly graded, sub round, sand w/clay
	RRM # 350	9/10/2012	10/25/2012	114.8	14.6	Light brown (7.5YR6/3) very fine to fine, poorly graded, sub round, sand w/clay
	RRM # 351	9/10/2012	10/25/2012	115.4	15.2	Light brown (7.5YR6/3) very fine to fine, poorly graded, sub round, sand w/clay

Appendix A2. RRM (continued)
Standard Proctor Test Results Summary

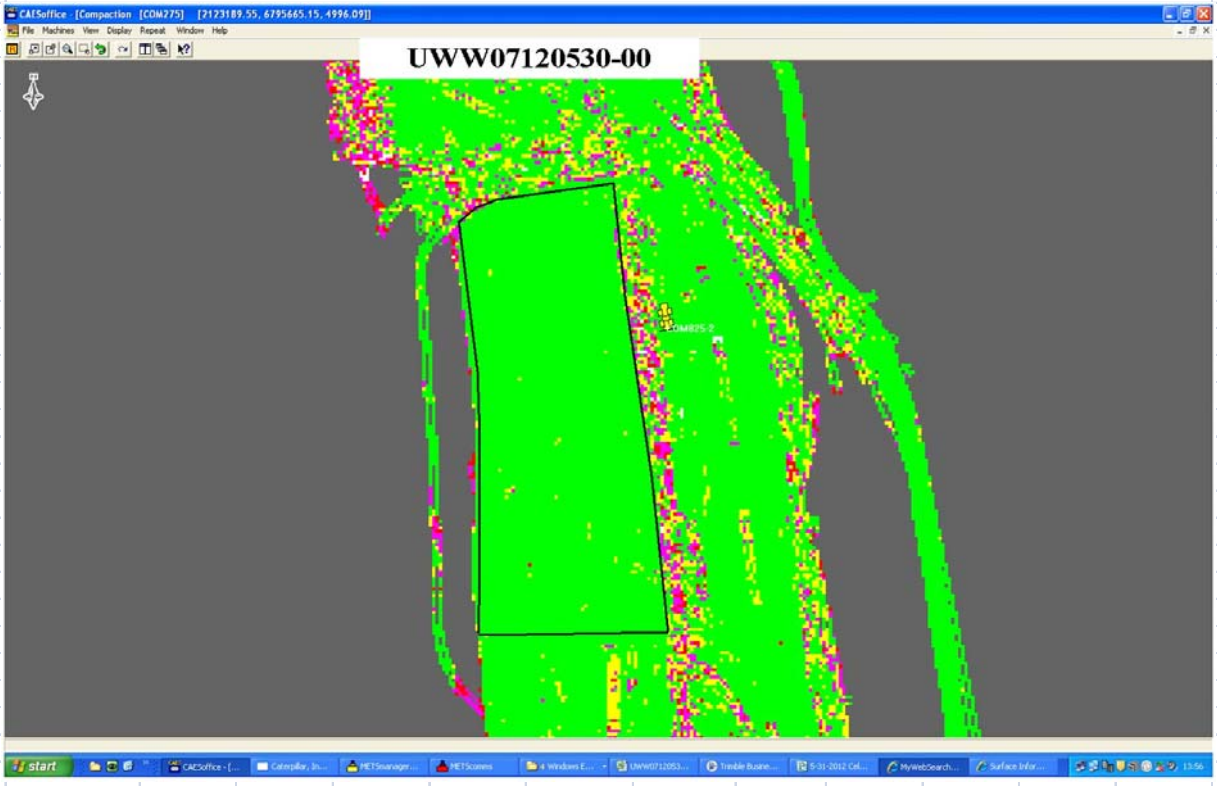
Set	Proctor ID	Date Sampled	Date Approved	Max Dry Density	Optimum Moisture	Proctor Description
Set # 116	RRM # 352	9/20/2012	10/25/2012	117.8	14.1	Reddish brown (5YR5/4) very fine to medium, moderately graded, sub round, sand w/clay
	RRM # 353	9/20/2012	10/25/2012	116.2	14.8	Reddish brown (5YR5/4) very fine to medium, moderately graded, sub round, sand w/clay
	RRM # 354	9/20/2012	10/25/2012	117.7	14.1	Reddish brown (5YR5/4) very fine to medium, moderately graded, sub round, sand w/clay

Appendix A2. RRM (continued)
Lift Approval Summaries

May 2012										
Date	Lift ID #	# of Passing Moisture Tests	Quantity Approved (yd³)	Commutative Quantity Approved (yd³)	CAES Screen Passing Pixels (%)	Average Lift Thickness (ft)	Proctor ID #	# Troxler Density Verification	# Sandcone Verification	Verified Compaction (%)
5/3/2012	UWW07120427-00	1	2490	2490	99.5%	0.9	RRM # 296			
5/4/2012	UWT01120503-00	1	2507	4997	98.4%	0.9	RRM # 300			
5/4/2012	UW1A17120504-00	2	1522	6519	97.6%	0.9	RRM # 294	1	1	91.7%
5/8/2012	UW1A17120504-00			6519						
5/9/2012	UWW07120508-00	1	2766	9285	97.3%	1.0	RRM # 294			
5/10/2012	UWT01120509-00	1	2979	12264	97.2%	1.0	RRM # 294			
5/10/2012	UWX15120508-00	1	1843	14107	98.8%	1.0	RRM # 294			
5/11/2012	UWZ06120511-00	1	1640	15747	97.0%	0.7	RRM # 296			
5/11/2012	UW1A17120510-00	0	1320	17067	97.1%	0.9	N/A			
5/15/2012	No lifts Approved			17067						
5/16/2012	No lifts Approved			17067						
5/17/2012	UWX15120515-00	1	1579	18646	99.0%	0.9	RRM # 307			
5/18/2012	UWT01120516-00	1	2970	21616	96.1%	1.0	RRM # 307			
5/21/2012	No lifts Approved			21616						
5/22/2012	UWW07120515-00	1	2742	24358	96.8%	1.0	RRM # 307			
5/23/2012	UW1A17120517-00	0	1235	25593	96.8%	0.8	N/A			
5/23/2012	UWX15120522-00	1	1754	27347	96.2%	1.0	RRM # 305			
5/24/2012	UWW07120523-00	1	2742	30089	97.3%	1.0	RRM # 307			
5/24/2012	UWZ06120518-00	1	1586	31675	96.2%	0.7	RRM # 300			
5/24/2012	UWX15120524-00	1	1666	33341	99.3%	1.0	RRM # 305			
5/29/2012	UWW07120524-00	0	2355	35696	98.6%	0.9	N/A			
5/30/2012	UWX15120529-00	1	1333	37029	97.0%	0.8	RRM # 307			
5/31/2012	UWW07120530-00	1	2355	39384	98.3%	0.9	RRM # 307			
					Average CAES Screen Passing Pixels =	97.6%				
					Total Quantity Approved (yd³) =	39384				
					Total # of passing Moisture Tests =	17				
					Total Quantity Approved Per Moisture test Taken Test Taken =	2317				
					Average of Average Lift Thickness =	0.9				

Appendix A2. RRM (continued)
Lift Approval Summaries

CAES compaction screen example from May 2012. There are compaction screens for each lift approved on record. The number of passing pixels reported refers to the percentage of the lift which has green pixels. A green pixel verifies that the minimum of six wheel passes with the compactor has been recorded.

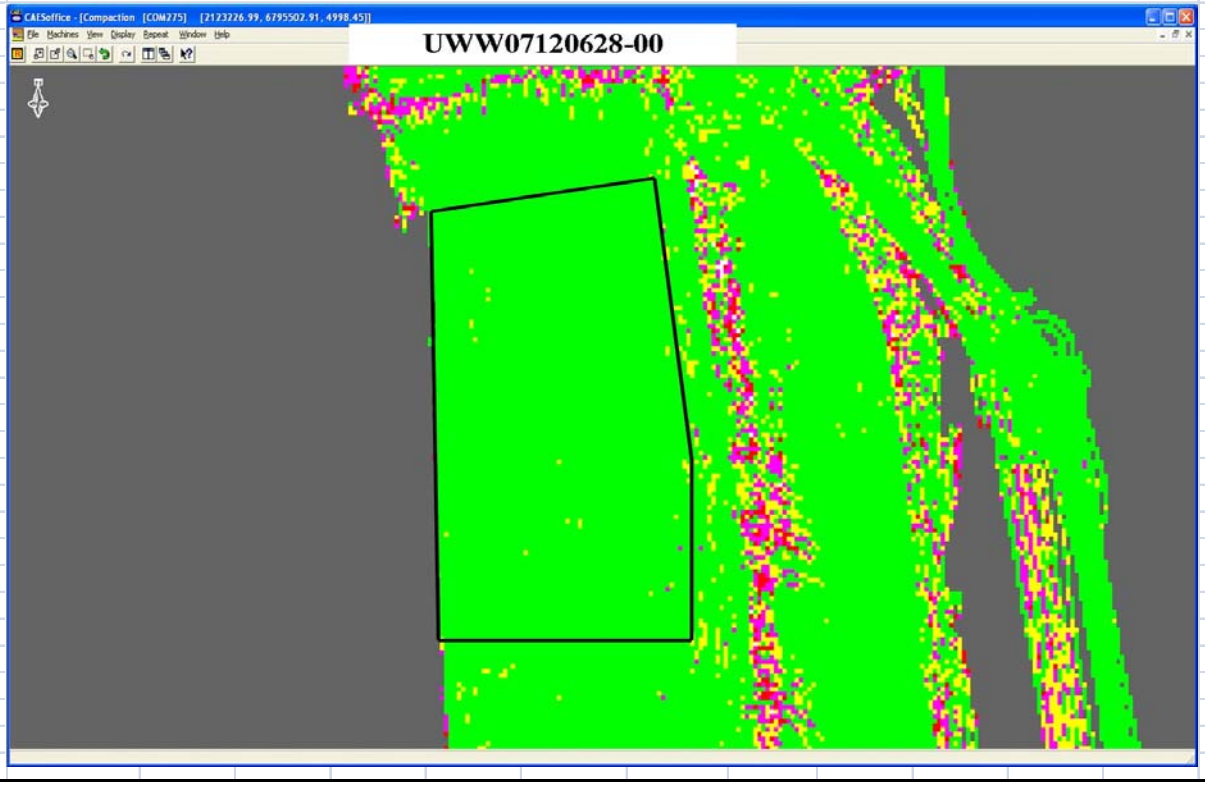


Appendix A2. RRM (continued)
Lift Approval Summaries

June 2012										
Date	Lift ID #	# of Passing Moisture Tests	Quantity Approved (yd^3)	Commutative Quantity Approved (yd^3)	CAES Screen Passing Pixels	Average Lift Thickness (ft)	Proctor ID #	# Troxler Density Verification	# Sandcone Verification	Verified Compaction (%)
6/4/2012	UW1A17120531-00	1	1095	1095	99.2%	0.8	RRM # 305			
6/5/2012	UWZ06120604-00	1	1834	2929	99.2%	0.9	RRM # 307			
6/5/2012	UWX15120604-00	1	1500	4429	96.1%	0.9	RRM # 305			
6/6/2012	UWW07120605-00	1	2617	7046	95.6%	1.0	RRM # 307			
6/7/2012	UWX15120606-00	0	1666	8712	94.5%	1.0	N/A			
6/11/2012	UWW07120607-00	1	2355	11067	93.3%	0.9	RRM # 300			
6/12/2012	UWT01120523-00	2	2329	13396	96.1%	0.9	RRM # 305			
6/13/2012	UWX15120612-00	0	1652	15048	98.9%	0.8	N/A			
6/14/2012	UWT01120613-00	1	2131	17179	98.1%	0.8	RRM # 310			
6/14/2012	UWW07120612-00	1	1782	18961	98.9%	0.9	RRM # 305			
6/18/2012	UWX15120614-00	1	2065	21026	98.9%	1.0	RRM # 313			
6/19/2012	UWW07120618-00	1	1782	22808	99.1%	0.9	RRM # 313			
6/19/2012	UWZ06120619-00	0	320	23128	97.7%	0.8	N/A			
6/20/2012	UWT01120619-00	0	1865	24993	97.7%	0.7	N/A			
6/20/2012	UWZ06120620-00	0	359	25352	94.7%	0.9	N/A			
6/21/2012	UWT01120620-00	1	1377	26729	98.1%	0.6	RRM # 307			
6/25/2012	UWW07120621-00	2	1997	28726	99.3%	0.9	RRM # 313			
6/26/2012	UWX15120625-00	0	1855	30581	97.6%	0.9	N/A			
6/27/2012	UWW07120626-00	0	1815	32396	99.5%	0.9	N/A			
6/27/2012	UWT01120625-00	2	1721	34117	99.2%	0.9	RRM#307 and RRM #313			
6/28/2012	UWX15120627-00	0	1649	35766	94.9%	0.8	N/A			
			Average CAES Screen Passing Pixels =	97.5%						
			Total Quantity Approved (yd^3) =	35766						
			Total # of passing Moisture Tests =	16						
			Total Quantity Approved Per Moisture test Taken Test Taken =	2235						
			Average of Average Lift Thickness =	0.9						

Appendix A2. RRM (continued)
Lift Approval Summaries

CAES compaction screen example from June 2012. There are compaction screens for each lift approved on record. The number of passing pixels reported refers to the percentage of the lift which has green pixels. A green pixel verifies that the minimum of six wheel passes with the compactor has been recorded.

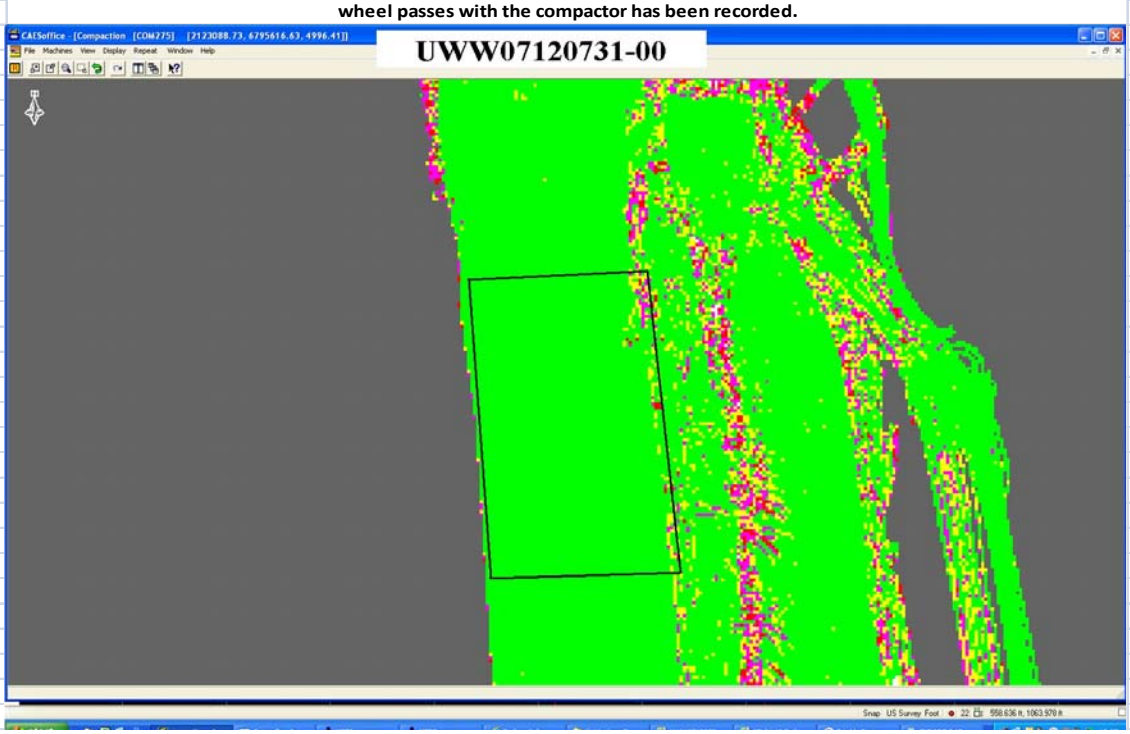


Appendix A2. RRM (continued)
Lift Approval Summaries

July 2012										
Date	Lift ID #	# of Passing Moisture Tests	Quantity Approved (yd^3)	Commutative Quantity Approved (yd^3)	CAES Screen Passing Pixels (%)	Average Lift Thickness (ft)	Proctor ID #	# Troxler Density Verification	# Sandcone Verification	Verified Compaction (%)
7/9/2012	UWW07120628-00	1	2348	2348	98.9%	1.0	RRM # 313			
7/9/2012	UWT01120709-00	0	1912	4260	98.6%	1.0	N/A			
7/10/2012	UWX15120709-00	1	2061	6321	97.1%	1.0	RRM # 307			
7/11/2012	UWW07120710-00	1	2114	8435	99.4%	0.9	RRM # 313			
7/11/2012	UWT01120711-00	1	1530	9965	98.2%	0.8	RRM # 313			
7/12/2012	UWX15120711-00	0	1546	11511	96.7%	0.7	N/A			
7/16/2012	No Lifts Approved Today			11511						
7/17/2012	UWW07120712-00	1	2348	13859	98.5%	1.0	RRM # 313			
7/17/2012	UWT01120717-00	1	1091	14950	98.6%	0.7	RRM # 305			
7/17/2012	UWX15120716-00	1	2061	17011	98.6%	1.0	RRM # 313			
7/18/2012	UWW07120717-00	0	2038	19049	99.4%	1.0	N/A			
7/19/2012	UWX15120718-00	2	2061	21110	96.7%	1.0	RRM # 305			
7/23/2012	UWT01120723-00	0	1091	22201	98.7%	0.7	N/A			
7/23/2012	UWZ06120723-00	0	253	22454	91.1%	0.7	N/A			
7/23/2012	UWW07120719-00	0	1869	24323	99.1%	0.9	N/A			
7/23/2012	UWT01120723-01	1	935	25258	98.0%	0.6	RRM # 313			
7/24/2012	UWX15120724-00	1	1649	26907	97.1%	0.8	RRM # 313			
7/25/2012	UWW07120724-00	1	1869	28776	98.2%	0.9	RRM # 313			
7/25/2012	UWT01120725-00	0	717	29493	96.9%	0.7	N/A			
7/26/2012	UWX15120725-00	0	1855	31348	96.1%	0.9	N/A			
7/30/2012	UWW07120726-00	1	2030	33378	97.9%	1.0	RRM # 305			
7/30/2012	UWT01120730-00	0	614	33992	97.3%	0.6	N/A			
7/31/2012	UWX15120730-00	1	2061	36053	94.7%	1.0	RRM # 313			
7/31/2012	UWW07120731-00	0	2077	38130	96.3%	1.0	N/A			
7/31/2012	UWT01120731-00	0	410	38540	93.5%	0.4	N/A			
				Average CAES Screen Passing Pixels =	97.3%					
				Total Quantity Approved (yd^3) =	38540					
				Total # of passing Moisture Tests =	14					
				Total Quantity Approved Per Moisture test Taken Test Taken =	2753					
				Average of Average Lift Thickness =	0.8					

Appendix A2. RRM (continued)
Lift Approval Summaries

CAES compaction screen example from July 2012. There are compaction screens for each lift approved on record. The number of passing pixels reported refers to the percentage of the lift which has green pixels. A green pixel verifies that the minimum of six wheel passes with the compactor has been recorded.

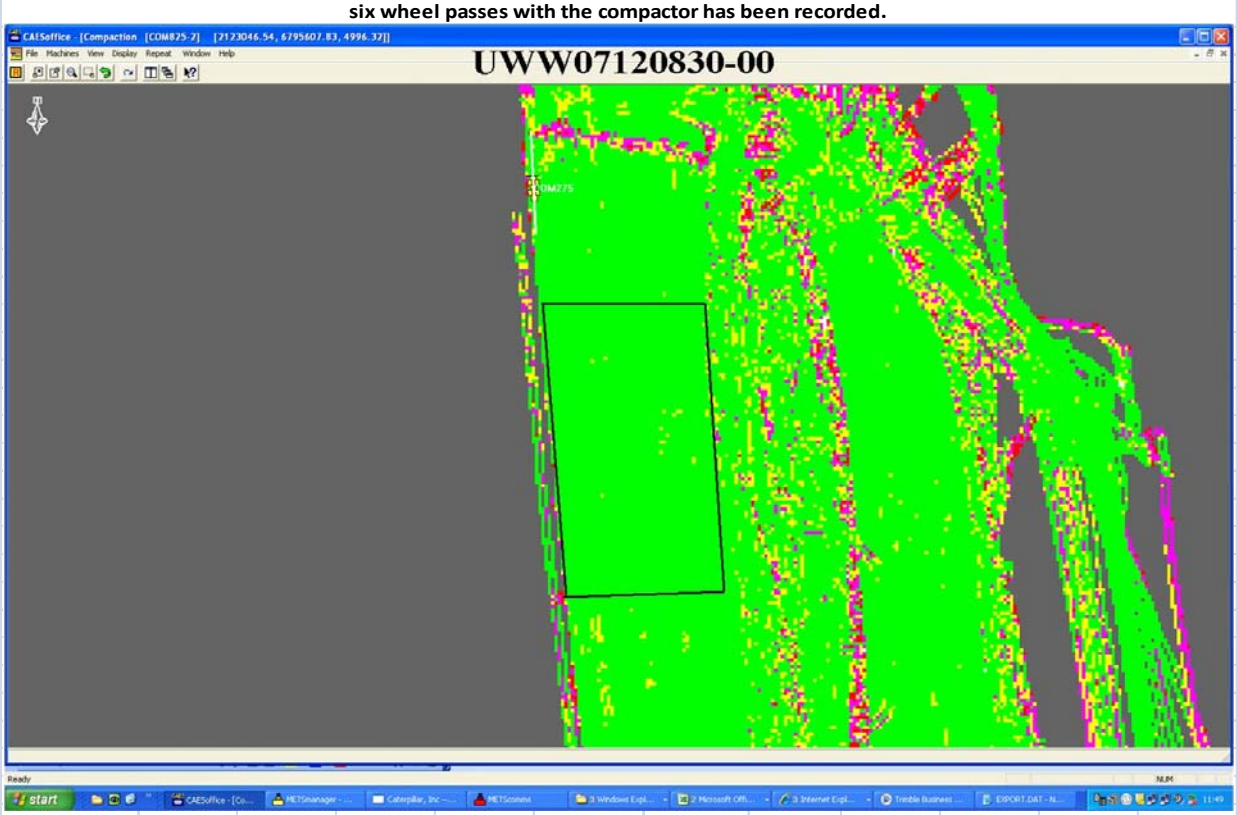


Appendix A2. RRM (continued)
Lift Approval Summaries

August 2012										
Date	Lift ID #	# of Passing Moisture Tests	Quantity Approved (yd^3)	Commutative Quantity Approved (yd^3)	CAES Screen Passing Pixels (%)	Average Lift Thickness (ft)	Proctor ID #	# Troxler Density Verification	# Sandcone Verification	Verified Compaction (%)
8/1/2012	UWX15120731-00	1	1855	1855	91.6%	0.9	RRM # 313			
8/2/2012	UWW07120801-00	2	2151	4006	99.5%	0.9	RRM # 307, 313			
8/6/2012	UWW07120806-00	1	1922	5928	96.5%	0.8	RRM # 307			
8/6/2012	UWX15120802-00	0	1556	7484	98.9%	0.9	N/A			
8/7/2012	UWX15120807-00	0	310	7794	96.4%	0.6	N/A			
8/7/2012	UWW07120807-00	1	1785	9579	97.6%	0.9	RRM # 307			
8/7/2012	UWX15120806-00	0	1040	10619	98.1%	0.6	N/A			
8/8/2012	UWW07120808-00	0	1389	12008	97.0%	0.7	N/A			
8/8/2012	UWW07120808-01	0	381	12389	93.1%	0.4	N/A			
8/9/2012	UWX15120808-00	1	1734	14123	97.8%	1.0	RRM # 313			
8/13/2012	UWW07120809-00	1	1785	15908	97.6%	0.9	RRM # 313			
8/14/2012	UWT01120813-00	1	2419	18327	98.3%	0.8	RRM # 313			
8/14/2012	UWX15120814-00	1	1387	19714	97.5%	0.8	RRM # 307			
8/15/2012	UWW07120814-00	0	1785	21499	95.9%	0.9	N/A			
8/16/2012	UWT01120815-00	1	2117	23616	97.4%	0.7	RRM # 307			
8/20/2012	UWX15120816-00	1	2167	25783	96.1%	1.0	RRM # 313			
8/20/2012	UWW07120816-0	0	1372	27155	100.0%	0.8	N/A			
8/21/2012	UWT01120820-00	1	3000	30155	99.7%	1.0	RRM # 307			
8/22/2012	UWX15120821-00	1	1734	31889	93.4%	0.8	RRM # 307			
8/22/2012	UWW07120821-00	0	1382	33271	98.9%	0.8	N/A			
8/23/2012	UWT01120822-00	2	2700	35971	99.2%	0.9	RRM # 313			
8/27/2012	UWX15120827-00	1	2167	38138	93.4%	1.0	RRM # 170			
8/28/2012	UWW07120827-00	0	1715	39853	99.4%	1.0	N/A			
8/29/2012	UWT01120828-00	1	3000	42853	98.8%	1.0	RRM # 313			
8/30/2012	UW1A17120823-00	1	2727	45580	97.6%	0.9	RRM # 313			
8/30/2012	UWX15120829-00	0	1510	47090	98.5%	0.9	N/A			
				Average CAES Screen Passing Pixels =	97.2%					
				Total Quantity Approved (yd^3) =	47090					
				Total # of passing Moisture Tests =	18					
				Approved Per Moisture test Taken Test Taken =	2616					
				Average of Average Lift Thickness =	0.8					

Appendix A2. RRM (continued)
Lift Approval Summaries

CAES compaction screen example from August 2012. There are compaction screens for each lift approved on record. The number of passing pixels reported refers to the percentage of the lift which has green pixels. A green pixel verifies that the minimum of six wheel passes with the compactor has been recorded.

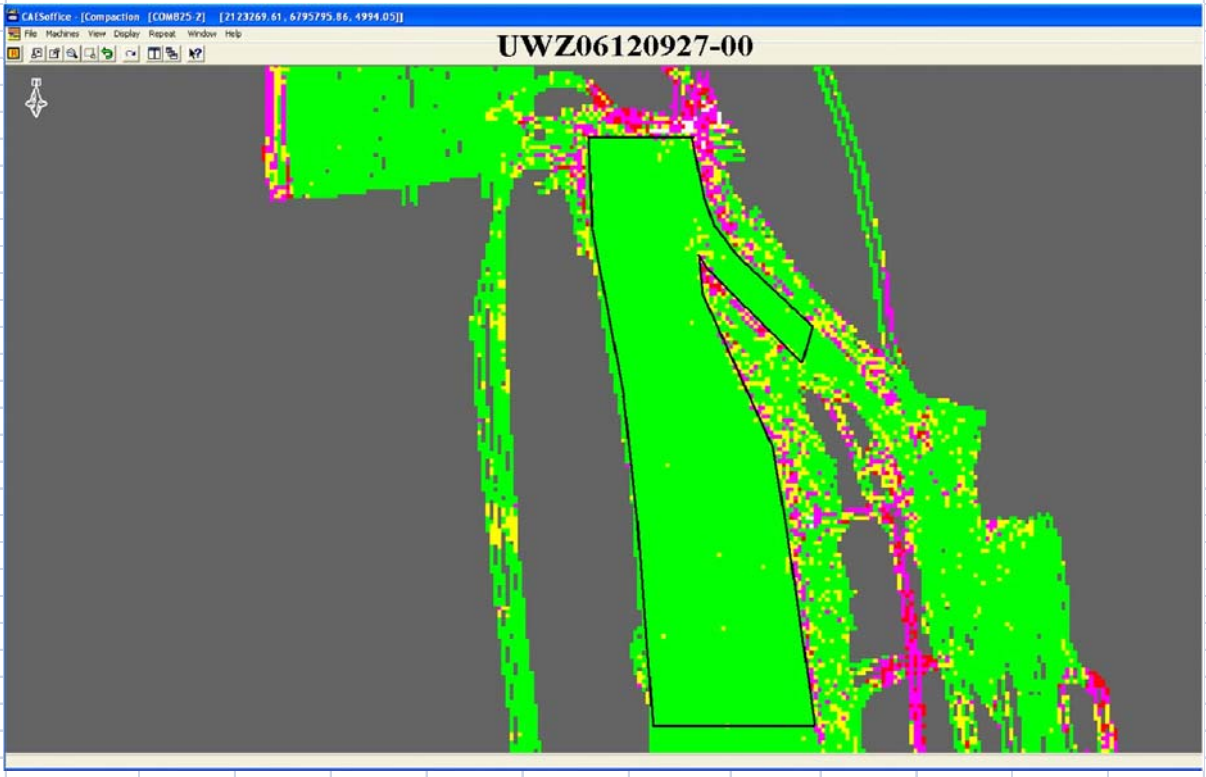


Appendix A2. RRM (continued)
Lift Approval Summaries

September 2012										
Date	Lift ID #	# of Passing Moisture Tests	Quantity Approved (yd^3)	Commutative Quantity Approved (yd^3)	CAES Screen Passing Pixels (%)	Average Lift Thickness (ft)	Proctor ID #	# Troxler Density Verification	# Sandcone Verification	Verified Compaction (%)
9/4/2012	UWW07120830-00	1	1705	1705	99.9%	1.0	RRM # 313			
9/5/2012	UWT01120829-00	1	2435	4140	99.2%	0.8	RRM # 313			
9/5/2012	UWX15120905-00	0	1510	5650	98.5%	0.9	N/A			
9/6/2012	UWW07120905-00	2	1535	7185	99.2%	0.9	RRM #313			
9/10/2012	UWT01120906-00	0	2740	9925	99.2%	0.9	N/A			
9/11/2012	UWT01120910-00	1	758	10683	98.4%	0.5	RRM # 313			
9/11/2012	UW1A12120910-00	0	1471	12154	99.2%	0.9	N/A			
9/12/2012	No Lifts Approved Today			12154						
9/13/2012	UWY05120911-00	1	1027	13181	98.6%	0.8	RRM # 305			
9/13/2012	UW1A12120911-00	4	1400	14581	99.2%	0.9	RRM # 313, 305			
9/13/2012	UWY05120913-00	0	1072	15653	99.1%	0.8	N/A			
9/17/2012	UW1A12120913-00	0	1555	17208	99.0%	1.0	N/A			
9/17/2012	UWY05120917-00	0	1206	18414	99.7%	0.9	N/A			
9/18/2012	UWY05120918-00	0	1398	19812	98.4%	0.9	N/A			
9/18/2012	UW1A12120917-00	1	1400	21212	96.7%	0.9	RRM # 307			
9/19/2012	UW1A12120918-00	1	1366	22578	99.8%	0.9	RRM # 170			
9/19/2012	UWY05120919-00	0	1398	23976	98.6%	0.9	N/A			
9/20/2012	UW1A12120919-00	1	1517	25493	99.8%	1.0	RRM # 313			
9/20/2012	UWZ06120920-00	0	217	25710	93.2%	0.6	N/A			
9/20/2012	UWY05120919-01	0	1553	27263	97.3%	1.0	N/A			
9/24/2012	UWZ06120924-00	0	1689	28952	96.1%	0.9	N/A			
9/24/2012	UW1A12120920-00	1	1214	30166	98.5%	0.8	RRM # 307			
9/25/2012	UW1A12120924-00	1	1365	31531	97.6%	0.9	RRM # 307			
9/25/2012	UWZ06120925-00	0	1519	33050	94.8%	0.8	N/A			
9/26/2012	UW1A12120925-00	3	1261	34311	98.6%	0.8	RRM # 307			
9/26/2012	UWZ06120926-00	0	1616	35927	98.6%	0.8	N/A			
9/27/2012	UW1A12120926-00	1	1577	37504	96.5%	1.0	RRM # 307			
9/27/2012	UWZ06120927-00	0	1414	38918	97.2%	0.7	N/A			
				Average CAES Screen Passing Pixels =		98.2%				
				Total Quantity Approved (yd^3) =		38918				
				Total # of passing Moisture Tests =		19				
				Total Quantity Approved Per Moisture test Taken Test Taken =		2048				
				Average of Average Lift Thickness =		0.9				

Appendix A2. RRM (continued)
Lift Approval Summaries

CAES compaction screen example from September 2012. There are compaction screens for each lift approved on record. The number of passing pixels reported refers to the percentage of the lift which has green pixels. A green pixel verifies that the minimum of six wheel passes with the compactor has been recorded.



Appendix A2. RRM (continued)
Lift Approval Package

LIFT APPROVAL FORM

PROJECT: Moab UMTRA **OTHER**

NW CORNER **DATE:** 7/18/2012

See attached for lift map

P 1			
EW:	X		=
NS:	X		=
P 2			
EW:	X		=
NS:	X		=
P 3	N		
EW:	X		=
NS:	X	A	=
P 4			
EW:	X		=
NS:	X		=
P 5			
EW:	X		=
NS:	X		=

Page 2 attached: Y N

IDENTIFY LOTS ABOVE

LIFT ID: UWX15120718-00 NW CORNER: 6795317 N. 2123106 E.

Uncompacted Thickness: 1.0 Compacted Thickness: N/A Debris Insp. By: N/A Date: N/A Time: N/A

NW CORNER of debris placement: N/A EW Dimension N/A NS Dimension N/A

Lift Area (ft²): 55,643 Lift Volume (yd³): 2,061

Comments: QC verified that the lift area was scarified prior to placement. The daily moisture tests for 7/18/2012 and 7/19/2012 was performed on this lift with satisfactory results.

Attached Forms: **Grid Slope** X **Compaction Macro** X **Print Screen** X **Moisture/ Density** X

KEYING IN NOTES: N E S [W] Satisfactory MOISTURE/ DENSITY TESTS ID # (S): 1, 2

LIFT APPROVED BY: Mitch Hogan/ DATE: 7/19/2012 TIME: 1340

QA/QC APPROVAL 7/23/12 DATE

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Appendix A2. RRM (continued)
Lift Approval Package

Slope Elevation Survey

Average lift thickness= 1.0	Bounding Box	Northing	Easting
Grid Size= 50'	Lower Left	N	
Lift ID: UWX15120718-00	Upper Right		A

Last Lift Elevations			Lift Approval Elevations			Lift Thickness	
Northing	Easting	Elevation	Northing	Easting	Elevation	Thickness	
6795137	2123132	4977.7	6795137	2123132	4978.1	0.4	OK
6795187	2123132	4977.5	6795187	2123132	4978.4	0.9	OK
6795237	2123132	4977.9	6795237	2123132	4979.0	1.1	OK
6795287	2123132	4979.3	6795287	2123132	4980.3	1.0	OK
6795087	2123182	4976.4	6795087	2123182	4977.1	0.7	OK
6795137	2123182	4976.4	6795137	2123182	4977.4	1.0	OK
6795187	2123182	4976.8	6795187	2123182	4977.9	1.1	OK
6795237	2123182	4977.4	6795237	2123182	4978.5	1.2	OK
6795287	2123182	4978.6	6795287	2123182	4979.7	1.1	OK
6795037	2123232	4974.2	6795037	2123232	4975.2	1.0	OK
6795087	2123232	4975.1	6795087	2123232	4976.2	1.1	OK
6795137	2123232	4975.8	6795137	2123232	4976.9	1.1	OK
6795187	2123232	4976.3	6795187	2123232	4977.3	1.0	OK
6795237	2123232	4976.8	6795237	2123232	4977.9	1.1	OK
6795287	2123232	4977.7	6795287	2123232	4978.9	1.2	OK
6795037	2123282	4973.0	6795037	2123282	4973.9	1.0	OK
6795087	2123282	4974.6	6795087	2123282	4975.8	1.2	OK
6795137	2123282	4975.3	6795137	2123282	4976.5	1.2	OK
6795187	2123282	4975.8	6795187	2123282	4976.9	1.1	OK
6795237	2123282	4976.5	6795237	2123282	4977.5	1.0	OK
6795287	2123282	4977.5	6795287	2123282	4978.7	1.2	OK
6795037	2123332	4971.9	6795037	2123332	4972.2	0.4	OK
						0.0	OK
						0.0	OK
						0.0	OK
						0.0	OK
						0.0	OK
						0.0	OK
						0.0	OK
						0.0	OK
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						0.0	OK
						0.0	OK

N/A

MK 1-19-12

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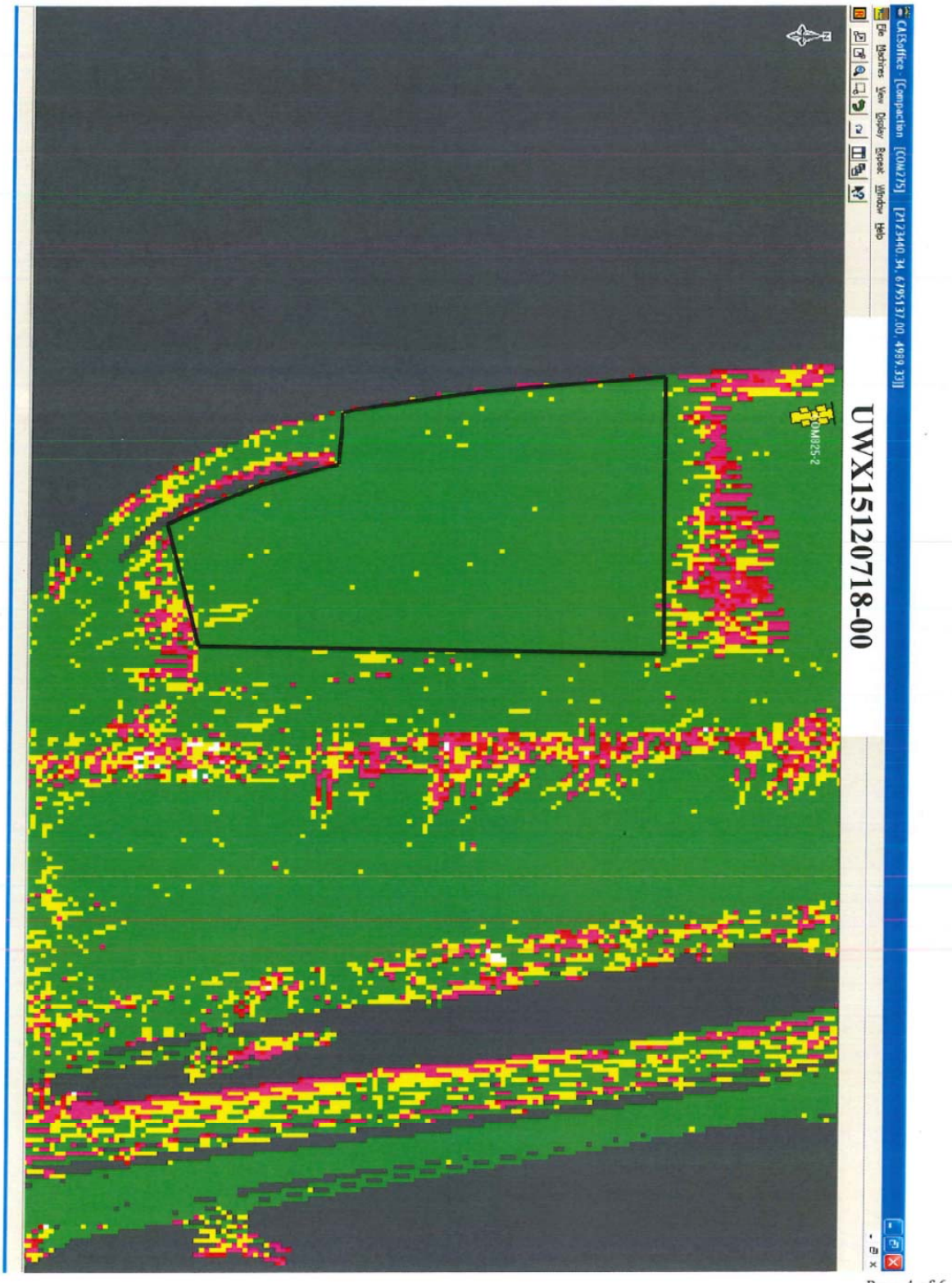
Appendix A2. RRM (continued)
Lift Approval Package



Appendix A2. RRM (continued)
Lift Approval Package

FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER** _____

LIFT IDENTIFICATION: UWX15120718-00 DATE: 7/18/2012

TEST ID NUMBER(S): # 1

TEST LOCATION: Lift Area TEST METHOD: N/A D1556 N/A D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model _____ Gauge Serial # _____

Last Calibration Date: N/A

Daily Standard Counts:

Density _____ Moisture _____

_____ Method A (Direct Transmission) or _____ Method B (Backscatter)

Depth Setting _____ (inches) Count Time _____ (minutes)

Moisture Count _____ Density Count _____

Wet Density (ρ_m) _____ (lbs/ft^3) Dry Density _____ (lbs/ft^3)

Moisture Density _____ (lbs/ft^3) Moisture Fraction _____ (%)

N A

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus _____ Calibrated Vol. (lbs/ft^3) _____

Bulk Density of sand (ρ_1) _____ g/cm^3 _____ lbs/ft^3

Mass of Sand to Fill Cone & Plate (M_2) _____ g

Mass of bottle & cone **before** filling cone, plate & hole		g
Mass of bottle & cone **after** filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_1)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

Test Hole Volume

$V = (M_1 - M_2) / \rho_1$ _____ cm^3

Dry Mass of soil

$M_4 = 100\ M_3 / (w + 100)$ _____ g

Wet Density

$\rho_m = (M_3 / V) \times 62.43$ _____ lbs/ft^3

Dry Density

$\rho_d = M_4 / V$ _____ g/cm^3

Dry Unit Weight

$\gamma_d = \rho_d \times 62.43$ _____ lbs/ft^3

MOISTURE DETERMINATION

ASTM D4643

Container ID D-7

Mass of container & wet specimen (M_{cms})	553.4	g
Mass of container & dry specimen (M_{cds})	502.3	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	51.1	g
Mass of container (M_c)	211.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	290.9	g
Moisture content (w) $w = (M_w / M_s) \times 100$	17.6	%

Dry Density (ρ_d) = $(100 \times \rho_m)/(100 + w)$

$\rho d = (\ 100\ \times$ ##### $)\ /\ (100 +$ 17.6 $) =$ 0.0 lbs/ft^3

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

N A

Percent Compaction = ρ_d / $\gamma_d max$ x 100

0.0 / 111.3 x 100 = 0.0 %

Soil Description: **Light reddish brown very fine to fine, well graded, poorly round sand w/silt**

Proctor ID: **RRM # 305**

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_d max$) 111.3 (lbs/ft^3)

Optimum Moisture (w_{opt}) 16.7 (%)

Required Moisture: 13.7 % to 19.7 %

Required Percent Compaction: 90.0 (%)

Comments:

Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 7/18/12

Failed Moisture

Failed Compaction Time: 1325

By: Beachem Bosh / _____

(print) (signature)

_____ 07.23.2012

QA/QC APPROVAL DATE

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Appendix A2. RRM (continued)
Lift Approval Package

FIELD DENSITY TEST

PROJECT: Moab UMTRA Project **OTHER** _____

LIFT IDENTIFICATION: UWX15120718-00 DATE: 7/19/2012

TEST ID NUMBER(S): # 2

TEST LOCATION: Lift Area TEST METHOD: N/A D1556 N/A D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model _____ Gauge Serial # _____

Last Calibration Date: N/A

Daily Standard Counts:

Density _____ Moisture _____

_____ Method A (Direct Transmission) or _____ Method B (Backscatter)

Depth Setting _____ (inches) Count Time _____ (minutes)

Moisture Count _____ Density Count _____

Wet Density (ρ_m) _____ (lbs/ft^3) Dry Density _____ (lbs/ft^3)

Moisture Density _____ (lbs/ft^3) Moisture Fraction _____ (%)

N A

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus _____ Calibrated Vol. (lbs/ft^3) _____

Bulk Density of sand (ρ_1) _____ g/cm^3 _____ lbs/ft^3

Mass of Sand to Fill Core & Plate (M_2) _____ g

Mass of bottle & cone **before** filling cone, plate & hole		g
Mass of bottle & cone **after** filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_1)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_3)		g

Test Hole Volume
$V = (M_1 - M_2) / \rho_1$ _____ cm^3

Dry Mass of soil
$M_4 = 100\ M_3 / (w + 100)$ _____ g

Wet Density
$\rho_m = (M_3 / V) \times 62.43$ _____ lbs/ft^3

Dry Density
$\rho_d = M_4 / V$ _____ g/cm^3

Dry Unit Weight
$\gamma_d = \rho_d \times 62.43$ _____ lbs/ft^3

N A

MOISTURE DETERMINATION

ASTM D4643

Container ID D-7

Mass of container & wet specimen (M_{cms})	473.7	g
Mass of container & dry specimen (M_{cds})	433.9	g
Mass of water (M_w) $M_w = M_{cms} - M_{cds}$	39.8	g
Mass of container (M_c)	211.4	g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$	222.5	g
Moisture content (w) $w = (M_w / M_s) \times 100$	17.9	%

Soil Description: Light reddish brown very fine to fine, well graded, poorly round sand w/silt

Proctor ID: RRM # 305

Standard Proctor (ASTM D698)

Maximum Dry Density ($\gamma_{d\,max}$) 111.3 (lbs/ft^3)

Optimum Moisture (w_{opt}) 16.7 (%)

Required Moisture: 13.7 % to 19.7 %

Required Percent Compaction: 90.0 (%)

Dry Density (ρ_d) = $(100 \times \rho_m)/(100 + w)$

$\rho d = (100 \times$ ##### $) / (100 +$ 17.9 $=$ 0.0 lbs/ft^3

Note: Wet Density from ASTM D 1556 (ρ_m) takes precedence over ASTM D 6938 (ρ_m)

N A

Percent Compaction = ρ_d / $\gamma_{d\,max} \times 100$

0.0 / 111.3 x 100 = 0.0 %

Comments:

Microwave oven power setting on HIGH. Initial time setting of 3 minutes and subsequent incremental drying periods of 1 minute until a change of 0.1 % or less of the initial wet mass of the soil.

TEST RESULTS:

X Pass Date: 7/19/12

_____ Failed Moisture

_____ Failed Compaction Time: 0947

By: Mitch Hogan / _____

(print) (signature)

QA/QC APPROVAL DATE 7/23/12

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Appendix B.
RRM Placement Photographs

Appendix B. RRM Placement Photographs

June 2012

June 2012

Appendix B. RRM Placement Photographs (continued)

June 2012

June 2012

Appendix B. RRM Placement Photographs (continued)

June 2012

August 2012

August 2012

August 2012

Appendix B. RRM Placement Photographs (continued)

August 2012

Appendix B. R Photographs (continued)

September 2012

September 2012

Attachment 1.
Moab UMTRA Project Lift Approval Procedure

Attachment 1. Moab UMTRA Project Lift Approval Procedure

DOE–EM/GJRAC1803

Office of Environmental Management – Grand Junction

MOAB UTAH UMTRA Project

Moab UMTRA Project
Lift Approval

Revision 5

August 2012

U.S. Department of Energy

Office of Environmental Management

Prepared by the Remedial Action Contractor under contract number DE-DT0002936
for the U.S. Department of Energy Office of Environmental Management, Grand Junction, Colorado.

Attachment 1. Moab UMTRA Project Lift Approval Procedure (continued)

DOE-EM/GJRAC1803

Moab UMTRA Project
Lift Approval Procedure

Revision 5

August 2012

Prepared by the Remedial Action Contractor under contract number DE-DT0002936
for the U.S. Department of Energy Office of Environmental Management, Grand Junction, Colorado.

Attachment 1. Moab UMTRA Project Lift Approval Procedure (continued)

DOE-EM/GJRAC1803

Moab UMTRA Project
Lift Approval Procedure

Revision 5

Review and Approval

8/09/2012
Date
Beachem Bosh
RAC Quality Assurance Representative

8/14/2012
Date
Kathy Turvy
RAC Quality Assurance Manager

FOR CRAIG NIEMEYER 08-09-2012
Date
Craig Niemeyer
RAC Crescent Junction Site Manager

Revision History

Revision No.	Date	Reason/Basis for Revision
0	April 16, 2009	Initial issue.
1	April 23, 2009	Revision update includes correction of lift approval percentage.
2	December 2009	Revision updates include machine parameter changes, compactor information, cold weather placement, and surveying methods.
3	November 2010	Revision updates include updated forms, reference to testing in accordance with DOE-EM/GJRAC1783, horizontal lift compaction requirements, and survey documentation requirements.
4	July 2011	Revision updates include new verbiage to section 3.2.4 Lift Survey.
5	August 2012	Revision updates include adding the correct machine weights and updated forms.

Attachment 1. Moab UMTRA Project Lift Approval Procedure (continued)

Table of Contents

Attachments

Attachment 1. Moab UMTRA Project Lift Approval Procedure (continued)

Acronyms and Abbreviations

ASTM	American Society for Testing of Materials
CAES	computer-aided earthmoving system
GPS	global positioning system
IWP	integrated work plan
lb	pound
QA	Quality Assurance
QC	Quality Control
RAIP	Moab UMTRA Project Remedial Action Inspection Plan
RRM	residual radioactive material
RWP	radiological work permit
UMTRA	Uranium Mill Tailings Remedial Action

Attachment 1. Moab UMTRA Project Lift Approval Procedure (continued)

1.0 Purpose and Scope

1.1 Purpose

The purpose of this procedure is to provide a consistent and practical method for compacting waste material on the Moab Uranium Mill Tailings Remedial Action (UMTRA) Project using a machine equipped with a computer-aided earthmoving system (CAES) and to provide methods for approving waste lifts.

1.2 Scope

This procedure applies to the disposal of waste using a machine equipped with a CAES and the approval of waste lifts.

2.0 General

2.1 Definitions

Computer-aided Earthmoving System (CAES) – Machine guidance system that delivers real-time productivity information to machine operators on an in-cab display using satellite navigation technology, machine-mounted components, a radio network, and office-management software.

Layer of Snow – Blanket of snow that covers working lift areas without any voids in the snow.

Lift Area – Area of the embankment identified for material placement.

Lift Identification – Discrete number that consists of the following:

- Embankment (i.e., U for UMTRA project cell)
- Work Element (i.e., W for residual radioactive material [RRM] placement, I for interim cover placement, R for radon barrier placement, B for biointrusion placement, F for frost protection placement, C for cap rock placement, E for embankment placement)
- Lift Area – (e.g., A1, B1, C1) year, month, and day (e.g., UWA1090117, UIA1090117, URA1090117, UBA1090117, UFA1090117, UCA1090117).

NOTE: The day the lift area is first tested will be the date used for lift identification.

Machine – Heavy equipment that is greater than or equal to 56,669 pounds (lbs) in weight.

Machine Pass – Movement of a machine across an area of the lift in any direction that meets compaction criteria calculated by an algorithm in the CAES. Movement of the machine from one side of the lift to the opposite side of the lift (which meets compaction criteria calculated by an algorithm in the CAES) constitutes one pass; the return trip from the opposite side of the lift (which also meets compaction criteria calculated by an algorithm in the compactor's system) constitutes a second pass.

Wheel Pass – Movement of the machine rear or front axle/wheels across an area of the lift that meets compaction criteria calculated by an algorithm in the compactor's system. The CAES reports one wheel pass for each end of the machine (i.e., two wheel passes equals one machine pass).

2.2 Source Documentation

- ASTM IInternatinal (ASTM) Standard D6938, "Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)"
- ASTM D1556, "Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method"
- ASTM D698, "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))"
- ASTM D2216, "Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass"
- ASTM D4643, "Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Heating"

2.3 Responsibilities

2.3.1 Quality Assurance Manager

The Quality Assurance (QA) Manager is responsible for:

- Implementing and directing Quality Control (QC) activities contained within this procedure.
- Identifying QC problems.
- Initiating, recommending, and/or providing QC solutions.

2.3.2 QA/QC Representative

The QA/QC Representative or designee is responsible for the proper implementation of this procedure and for approving lifts in accordance with this procedure.

2.3.3 Operations/Site Manager

The Operations/Site Manager or designee is responsible for issuing directives to equipment operators.

2.3.4 Equipment Operators

Equipment operators are responsible for compacting lifts with the compaction machine in accordance with this procedure.

2.3.5 All Personnel

When involved in compacting waste using the compaction machine, all employees are responsible for identifying any safety hazards and complying with the applicable Radiological Work Permits (RWPs) and Integrated Work Plans (IWPs).

2.4 Precautions and Limitations

2.4.1 Stop Work
Work shall be immediately terminated by any personnel who feel the activity in progress is unsafe and/or may create an unsafe condition. Work will be resumed when the condition is corrected.

2.4.2 Safety Protocols
All personnel shall remain clear of any operating equipment and maintain good communication with the equipment operator.

Personnel observing compaction using the compaction machine shall always be in visual view of the operator and shall be in front of the machine and never behind the machine working area while machine is in operation.

2.4.3 Training and Procedures
All personnel using the Troxler Nuclear Density Gauge shall attend 8 hours of Nuclear Moisture/Density Gauge training and shall perform all testing in accordance with project procedures.

2.5 Records

The compactor screen printout and the calculations of the exported terrain data shall be attached to the Lift Approval Form (QC-F-001) (see Attachment 1).

Following QA/QC approval of the QC documents, copies shall be made to be maintained on site as a reference file and the original documentation transmitted to Records Management in accordance with the *Moab UMTRA Project Records Management Manual* (DOE-EM/GJ1545).

3.0 Requirements and Guidance

3.1 Compliance

3.1.1 Lift Identification
Each lift shall be given a discrete lift identification number. The lift identification number shall be used to identify all documentation for that lift.

3.1.2 Waste Disposal
No waste material shall be disposed on a lift until the prior lift is approved, with the exception of management of stockpile material.

3.1.3 Lift Thickness
Lift thickness shall not exceed an average uncompacted thickness of 12 inches.

3.1.4 Debris

In accordance with this procedure, debris placement shall be in a single layer, shall be distributed across the lift, and shall comply with the debris size requirements found in Addendum E, *Remedial Action Inspection Plan* (RAIP), of the *Moab UMTRA Project Remedial Action Plan* (DOE-EM/GJ1547).

3.1.5 Machine Properties

The machine properties (see Attachments 2 and 3) under the machine parameters tab for the machines shall be:

- Number of levels (the number of machine passes) shall be set at three or four depending on machine weight. Four machine passes are required for machines weighing between 56,669 and 84,850 lbs. Three machine passes are required for 825H Caterpillar compactors and machines weighing greater than or equal to 84,850 lb.
- Lift height shall be set at 12 inches.
- Thick lift threshold shall be set at 2 feet.

3.2 Procedure

3.2.1 Moisture Testing

When performing moisture testing, the sample location shall be from material placed that day. The QC Technician (or qualified personnel) shall perform a moisture test in accordance with applicable ASTM standards for each day that material is placed. Test results shall be documented on the Field Density Test Form (QC-F-002) (see Attachment 4).

3.2.2 Debris Inspection

The QC Technician (or qualified personnel) shall inspect the debris once it is spread out across the lift. The debris shall be spread out uniformly across the lift in a manner to minimize void spaces and shall not exceed debris size requirements. The debris inspection shall be documented on the Lift Approval Form (QC-F-001) (see Attachment 1).

3.2.3 Visual Inspection

The QC Technician (or qualified personnel) shall visually inspect the lift areas for frozen material, frost, and snow prior to placement of RRM. No material that is frozen, has frost, or is under a layer of snow shall be approved or placed on. The inspection shall be documented on the Lift Approval Form (QC-F-001) (see Attachment 1) under the comment section.

3.2.4 Lift Surveys

Each lift shall be surveyed using a hand-held global positioning system (GPS) or CAES. When determining the lift thickness of a lift area less than 3,000 square feet, one survey point should be performed for every 15 feet. When determining the lift thickness of a lift area greater than or equal to 3,000 square feet, the survey for each lift shall have a minimum of 10 points. The lift thickness will be determined by comparing the current lift elevations to the previous lift elevations located on the same northing and easting locations. When calculating the loose lift thickness, no survey point shall be <1.3 feet6, as long as the average loose thickness is $\leq$ 1.0 feet. QC shall perform a visual inspection to ensure lift is placed uniformly thick. Surveys shall be documented on the appropriate form and attached to the Lift Approval Form (QC-F-001) (see Attachment 1).

3.2.5 CAES Terrain Data

Each lift shall be compacted by a minimum of three or four machine passes depending on weight and type of machine used. To ensure the lift area meets the three or four machine pass requirement, print the compaction screen and identify the lift, and export the terrain data for the lift using the CAES.

NOTE: See the CAES Office User Guide for more information on exporting terrain data.

The terrain data results shall be copied into a spreadsheet, and the percentage of pixels that have greater than or equal to three or four machine passes shall be calculated. A copy of the calculations and the compaction screen printout shall be attached to the Lift Approval Form (QC-F-001) (see Attachment 1).

3.2.6 Requirements for Lift Approval

Lifts that meet the following requirements shall be approved.

- Seventy percent of the pixels have greater than or equal to three or four machine passes depending on weight of machine (green pixels) when placing material on slopes.
- Eighty percent of the pixels have greater than or equal to three or four machine passes depending on weight of machine (green pixels) when placing material on approximately horizontal lifts.
- The average lift thickness is less than or equal to 12 inches with no white pixels on the compactor screen printout.
- The compactor screen print out shows uniform compaction over the entire lift area.

3.2.7 Reworking of Lifts

Lifts shall be reworked (e.g., adding additional compaction, cutting the lift, adding more moisture) that do not meet the requirements in Section 3.2.

3.2.8 Troxler Gauge Testing

The QC Technician (or qualified personnel) shall perform in-place density tests every 6 months in accordance with ASTM D6938 and ASTM D1556 to verify the CAES is working correctly.

If the CAES is not used to verify compaction and the lift thickness, then the lift shall be tested in accordance with *Moab UMTRA Project Moisture/Density Testing Procedure* (DOE-EM/GJRAC1783). The testing frequency, inspections, and required reporting shall comply with the RAIP and surveying shall be performed using a hand-held GPS or a level survey.

4.0 References

ASTM (American Society for Testing of Materials) Standard D6938, "Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)."

ASTM (American Society for Testing of Materials) Standard D1556, "Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method."

ASTM (American Society for Testing of Materials) Standard D698, "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))."

ASTM (American Society for Testing of Materials) Standard D2216, "Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass."

ASTM (American Society for Testing of Materials) Standard D4643, "Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Heating."

CAES Office User Guide.

DOE (U.S. Department of Energy) *Moab UMTRA Project Moisture/Density Testing Procedure* (DOE-EM/GJRAC1783), February 2009.

DOE (U.S. Department of Energy) *Moab UMTRA Project Records Management Manual* (DOE-EM/GJ1545), April 2008.

DOE (U.S. Department of Energy) *Moab UMTRA Project Remedial Action Plan* (DOE-EM/GJ1547), July 2008.

Attachment 1. Moab UMTRA Project Lift Approval Procedure (continued)

Attachment 1.
Lift Approval Form (QC-F-001)

Attachment 1. Moab UMTRA Project Lift Approval Procedure (continued)

Attachment 1. Lift Approval Form (QC-F-001)

LIFT APPROVAL FORM

PROJECT: _____ OTHER _____

NW CORNER DATE: _____

F 1			
EW:	X	=	
NS:	X	=	
F 2			
EW:	X	=	
NS:	X	=	
F 3			
EW:	X	=	
NS:	X	=	
F 4			
EW:	X	=	
NS:	X	=	
F 5			
EW:	X	=	
NS:	X	=	
Page 2 attached		Y	N

IDENTIFY LOTS ABOVE

LIFT ID: _____ NW CORNER: _____

Uncompacted Thickness: _____ Compacted Thickness: _____ Debris Insp By: _____ Date: _____ Time: _____

NW CORNER of debris placement: _____ EW Dimension _____ NS Dimension _____

Lift Area (ft²): _____ Lift Volume (yd³): _____

Comments:

KEYING IN NOTES: N E S W _____ MOISTURE DENSITY TESTS ID # (S): _____

LIFT APPROVED BY _____ DATE: _____ TIME: _____

_____ _____

QA/QC APPROVAL DATE

QC-F-001
Rev 1, November 2010

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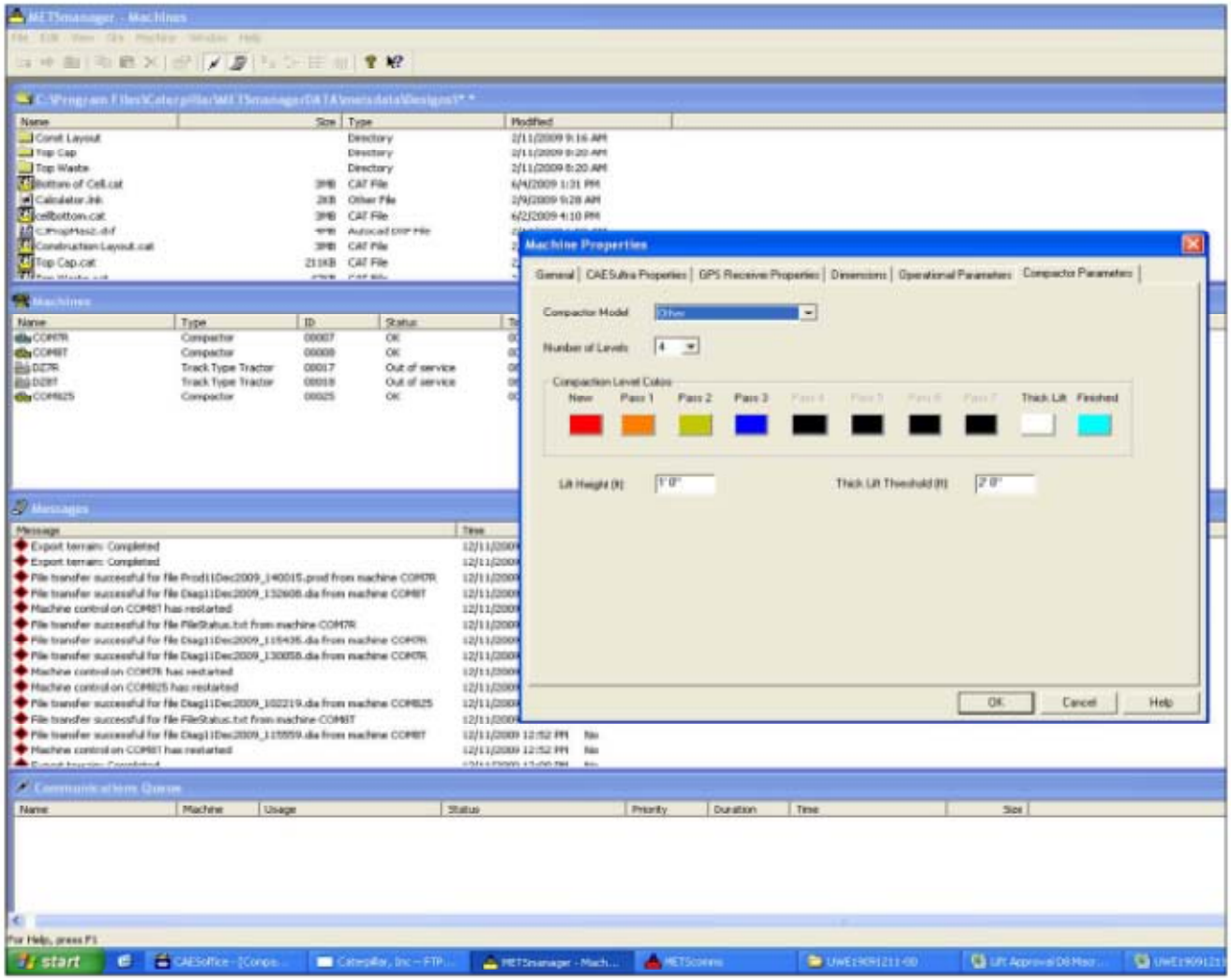
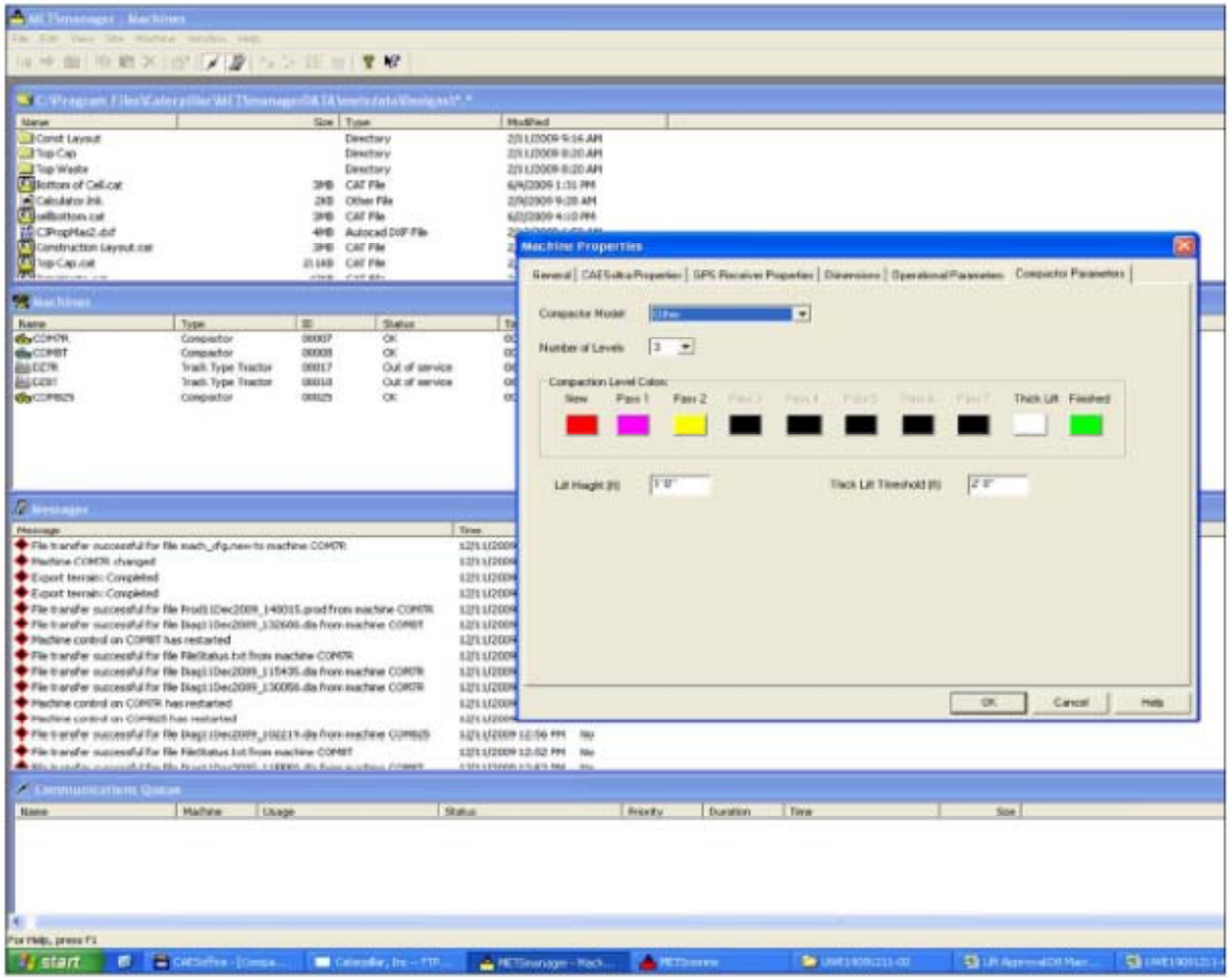
Attachment 2.
Machine Parameters for Machines Weighing 56,669 lb to 84,850 lb

Attachment 2. Machine Parameters for Machines Weighing 56,669 lb to 84,850 lb



Attachment 3.
Machine Parameters for CAT 825H Compactors and Machines Weighing Greater Than or Equal to 84,850 lb

Attachment 3. Machine Parameters for CAT 825H Compactors and Machines Weighing Greater Than or Equal to 84,850 lb



Attachment 4.
Field Density Test Form (QC-F-002)

Attachment 1. Moab UMTRA Project Lift Approval Procedure (continued)

Attachment 4. Field Density Test Form (QC-F-002)

Moab UMTRA Project

FIELD DENSITY TEST

PROJECT: _____ OTHER _____

LIFT IDENTIFICATION: _____ DATE: _____

TEST ID NUMBER(S): _____

TEST LOCATION: _____ ____ D1556 ____ D6938

ASTM D6938 (DENSITY DETERMINATION)

Make/Model _____ Gauge Serial # _____

Last Calibration Date: N/A

Daily Standard Counts:

Density _____ Moisture _____

____ *Method A (Direct Transmission)* or ____ *Method B (Backscatter)*

Depth Setting ____ *(inches)* Count Time ____ *(minutes)*

Moisture Count _____ Density Count _____

Wet Density (ρ_w) _____ *(lbs/ft³)* Dry Density _____ *(lbs/ft³)*

Moisture Density _____ *(lbs/ft³)* Moisture Fraction _____ *(%)*

MOISTURE DETERMINATION

____ ASTM D2216 @ 110° C or ____ ASTM D4643

Container ID _____

Mass of container & wet specimen (M_{cws})		g
Mass of container & dry specimen (M_{cds})		g
Mass of water (M_w) $M_w = M_{cws} - M_{cds}$		g
Mass of container (M_c)		g
Mass of dry specimen (M_s) $M_s = M_{cds} - M_c$		g
Moisture content (w) $w = (M_w / M_s) \times 100$		%

Dry Density $(\rho_d) = (100 \times \rho_w)/(100 + w)$

$\rho d = ($ 100 $\times$ _____ $) / (100 +$ _____ $) =$ _____ *lbs/ft³*

Note: Wet Density from ASTM D 2216 (ρ_w) value preference over ASTM D 6938 (ρ_w)

Percent Compaction = ρ_d / $\gamma_d max$ x 100

_____ / _____ x 100 = _____ %

Comments:

ASTM D1556 (DENSITY DETERMINATION)

Testing Apparatus ____ Calibrated Vol. *(lbs/ft³)* _____

Bulk Density of sand (ρ_s) _____ *g/cm³* _____ *lbs/ft³*

Mass of Sand to Fill Cone & Plate (M_3) _____ *g*

Mass of bottle & cone before filling cone, plate & hole		g
Mass of bottle & cone after filling cone, plate & hole		g
Mass of sand to fill cone, plate, & hole (M_1)		g
Mass of sand to fill hole		g
Mass of wet soil & container		g
Mass of container		g
Mass of wet soil (M_2)		g

Test Hole Volume
$V = (M_1 - M_3) / \rho_s$ _____ *cm³*

Dry Mass of soil
$M_4 = 100 M_2 / (w + 100)$ _____ *g*

Wet Density
$\rho_w = (M_2 / V) \times 62.43$ _____ *lbs/ft³*

Dry Density
$\rho_d = M_4 / V$ _____ *g/cm³*

Dry Unit Weight
$\gamma_d = \rho_d \times 62.43$ _____ *lbs/ft³*

Soil Description: _____

Proctor ID: _____

____ ASTM D698 or ____ ASTM D1557

Maximum Dry Density ($\gamma_d max$) _____ (lbs/ft³)

Optimum Moisture (w_{opt}) _____ (%)

Required Moisture: _____ % to _____ %

Required Percent Compaction: 90.0 (%)

TEST RESULTS:

_____ Pass Date: _____

_____ Failed Moisture

_____ Failed Compaction Time: _____

By: _____ / _____
(print) *(signature)*

_____ QA/QC APPROVAL

_____ DATE

QC-F-002
Rev 2, June 2011

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