Department of Energy
Washington, DC 20585

February 12, 2019

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Deputy Director
Mail Stop T8-F5
Washington, DC 20555-0001

Subject: Restoration Report for the Disposal Cell Cover Study at the Bluewater, New Mexico, Disposal Site (Docket No. 40-8902)

To Whom It May Concern:

Enclosed is the report, *Effects of Soil-Forming Processes on Cover Engineering Properties, Study Restoration Report, Bluewater, New Mexico, Disposal Site,* for the joint U.S. Nuclear Regulatory Commission (NRC) /U.S. Department of Energy Office of Legacy Management cover study at the Bluewater, New Mexico, Disposal Site. This report satisfies an August 17, 2015, request from NRC to document the restoration of test pits on disposal cell cover.

Please contact me at (970) 248-6018 or Mark.Kautsky@lm.doe.gov, if you have any questions. Please address any correspondence to:

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Sincerely,

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UMTRCA Program Manager

Enclosure

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File: BLU 0530.02 (records)
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Effects of Soil-Forming Processes on Cover Engineering Properties, Study Restoration Report, Bluewater, New Mexico, Disposal Site

January 2019

U.S. DEPARTMENT OF ENERGY | Legacy Management

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Abbreviations

AC	activated carbon
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
lb/ft^3	pounds per cubic foot
LM	Office of Legacy Management
LMS	Legacy Management Support
LTS&M	long-term surveillance and maintenance
NRC	U.S. Nuclear Regulatory Commission
pCi/m^2s	picocuries per square meter per second
UMTRCA	Uranium Mill Tailings Radiation Control Act
yd^2	square yards

Executive Summary

The U.S. Department of Energy Office of Legacy Management (LM) is responsible for the long-term surveillance and maintenance of disposal cells for uranium mill tailings throughout the United States. The long-term protectiveness of disposal cells relies on engineered covers to limit radon flux, rainwater percolation, and erosion.

In 2016, LM, the U.S. Nuclear Regulatory Commission, and others collaborated on a field study of the engineered cover system at the Bluewater, New Mexico, Disposal Site. The cover system consists of a low-permeability clay radon barrier and a riprap layer. This report documents the restoration and follow-up inspections of test pits excavated on and off the cover during the study. The field activities were performed in accordance with a site-specific Field Work Plan that included design criteria and specifications for restoration of the test pit excavations.

During the field study, test pits were excavated at 10 locations on the top slope of the disposal cell cover. A total of less than 0.5 cubic yard of radon barrier material was removed from the cover during the study. This material was replaced with clayey soil obtained from the same borrow source used for the original radon barrier construction. Two additional off-cell analogue test pits were excavated and sampled in undisturbed areas.

The radon barrier layer of the cover system was restored using excavated radon barrier and additional borrow source soil as needed to replace materials removed during the study. Cover layers were replaced in moisture-conditioned, loose lifts (layers) up to 12 inches thick. Verification testing confirmed that recompaction of the radon barrier in most cases satisfied the 95% of maximum dry density requirement determined according to ASTM International Standard D698. Lift moisture contents were adequate to achieve compaction. Post-restoration radon flux values on top of the restored radon barrier surface averaged less than pre-excavation values, an order of magnitude less than as-built conditions and about 2 orders of magnitude less than the Uranium Mill Tailings Radiation Control Act standard of 20 picocuries per square meter per second. Surficial rock riprap, which was stockpiled during excavation of test pits, was placed back in each test location, re-contoured and consolidated with a track-mounted mini-excavator.

The acceptability of test pit restoration with respect to meeting the original engineering design specifications was confirmed by measurements of lift thicknesses, soil moisture contents, compaction densities, and radon fluxes before and after restoration as described in the Field Work Plan. The condition of the test pit restoration is being monitored during annual inspections, and inspections have found no indications of settlement or erosion.

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1.0 Study and Restoration

1.1 Introduction

The U.S. Department of Energy (DOE) Office of Legacy Management (LM) is responsible for the long-term surveillance and maintenance (LTS&M) of disposal cells for uranium mill tailings throughout the United States. The long-term protectiveness of disposal cells relies on engineered covers to limit radon flux, rainwater percolation, and erosion.

Natural ecological and soil-forming processes may be slowly changing the as-built engineering properties of disposal cell covers in ways that could potentially influence remedy protectiveness.

LM is conducting a suite of studies to evaluate the effects of these natural processes on cover performance (DOE 2015). This study, *Effects of Soil-Forming Processes on Cover Engineering Properties, Study Restoration Report, Bluewater, New Mexico, Disposal Site* is evaluating the effects of changes in soil morphology on soil hydraulic properties, radon diffusion, and radon flux in engineered covers. Results from these studies will provide LM managers with information that may lead to improvements in the LTS&M of disposal cells.

The study is a collaboration between LM, the U.S. Nuclear Regulatory Commission (NRC), the Desert Research Institute, Navarro Research and Engineering, Inc. (Navarro), the University of Wisconsin, the University of California–Berkeley, and the University of Virginia. The technical task plan for the study contains a literature review regarding natural changes in the engineering properties of disposal cell covers and discussions of the relevance and objectives of the project (DOE 2015).

The objectives of the study are:

1. Characterize the morphology of disposal cell cover soils to understand the natural processes that are changing engineering properties and the degree of change over decades and millennia.
2. Measure effects of soil-forming processes on gas diffusivity and soil hydraulic properties.
3. Determine how changes in engineering properties vary with depth in cover profiles.
4. Measure and model how these changes influence radon flux rates and rainwater percolation.

Uranium Mill Tailings Radiation Control Act (UMTRCA) Title I and II sites that represented a range of cover types, climates, site conditions, and vulnerabilities to change were considered for study. A screening and ranking process evaluated all UMTRCA sites managed by LM.

On the basis of this process, collaborators selected the Title II Bluewater, New Mexico, Disposal Site as one of the 2016 test sites. Figure 1 presents the location of the site.

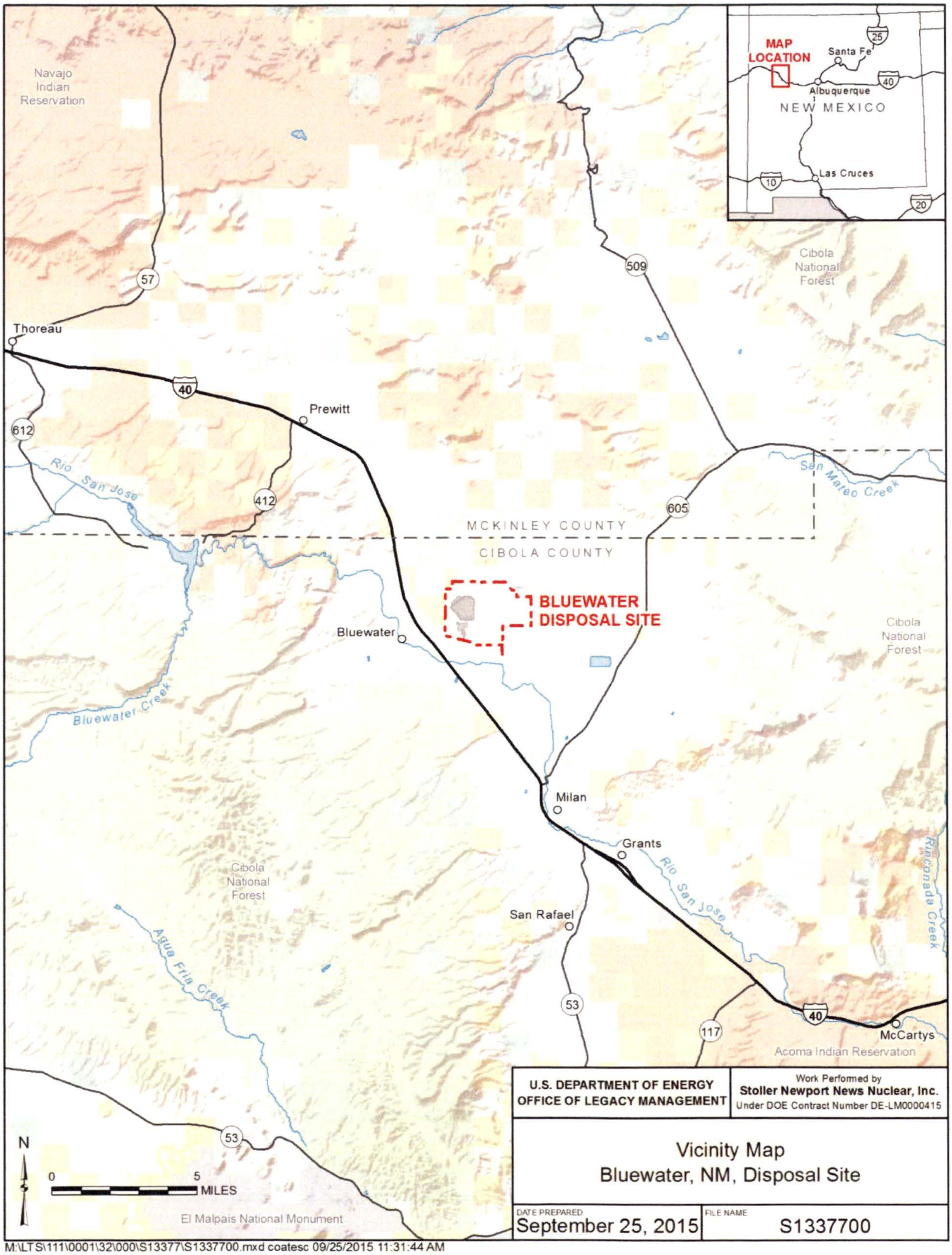


Figure 1. Vicinity Map of Bluewater, New Mexico, Disposal Site

1.2 Purpose and Scope

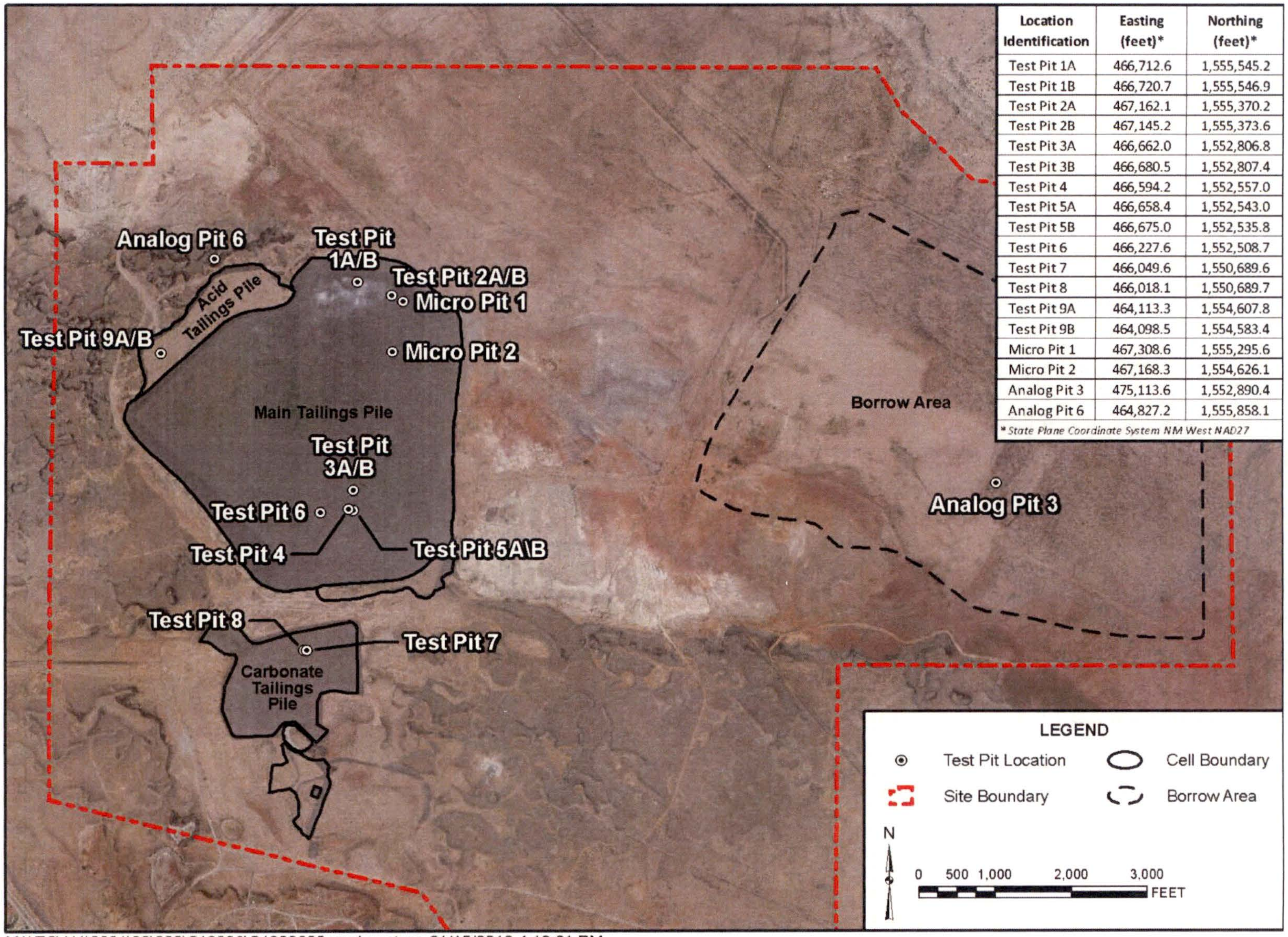
This report documents the methods, results, and follow-up inspections related to the restoration of test pits at the site, as requested by NRC.

All field activities were performed in accordance with the site-specific *Effects of Soil-Forming Processes on Cover Engineering Properties, Field Work Plan, Bluewater Disposal Site, New Mexico* (DOE 2016) (Field Work Plan). With NRC concurrence, the activities were not considered significant construction, action, or repairs, primarily due to the scale of disturbance, and therefore were exempt from Title 10 *Code of Federal Regulations* Sections 19–21 (10 CFR 19–21) in accordance with 10 CFR 40.28(c)(5). The cover system restoration process was outlined in the Field Work Plan Sections 1.2.10–1.2.12 with reference to the original cover design and construction criteria. Appendix A of this document includes photos (PL-1 through PL-26 referenced throughout the text) documenting the test pit excavations, restorations, and results of annual site inspections following the study. The acceptability of test pit restoration with respect to meeting the original engineering design specifications was confirmed by measurements of lifts, depths, soil moisture contents, compaction densities, and radon flux before, during, and after restoration described in the Field Work Plan.

All fieldwork, including restoration, was conducted between June 20 and June 29, 2016. A limited excavation through the radon barrier was performed for sampling and morphological investigation as discussed in the Field Work Plan. Intrusive activities into the radon barrier were performed at 10 locations on the disposal cell covers. Total radon barrier sample volume removed from the entire cover was less than 0.5 cubic yard. This material was replaced with a similar clayey soil obtained from the same borrow source that was also used during the original construction of the cover. These excavations through the radon barrier were open long enough to measure radon flux at the contact with contaminated materials and the cover, and characterize soil morphology. After radon flux was measured at the bottom of the radon barrier, a thin layer of radon barrier soil was added to the test pit to cover any exposed contaminated material. Test pits remained partially open less than 1 week before they were fully restored.

2.0 Test Pit Excavations

The Bluewater site is composed of three tailings disposal cells, the main tailings disposal cell, the carbonate tailings disposal cell, and the acid tailings disposal cell. Seven test pits and one micro pit were excavated on the top slope of the main tailings disposal cell, two test pits were excavated on the top slope of the carbonate tailings disposal cell, and one test pit was excavated on the top slope of the acid tailings disposal cell (Figure 2). Test pit excavation followed steps 1.2.3–1.2.9 in the Field Work Plan and was performed with a track-mounted mini-excavator. Disposal cell cover design specifications and as-built information from the *Completion Report for Reclamation of the Bluewater Mill Site* (Atlantic Richfield Company 1996) (Completion Report) were used to select the test pit locations, to guide study excavations, and as the basis for the test pit restoration and evaluation. The schematics presented in Figure 3 depict the as-built layered cover system with sequential excavation, sampling, and restoration. Prior to excavation, a 2-inch-diameter boring was made through the radon barrier at each location with a small hand auger, and cuttings were examined to determine the materials and layer contact depths at each test location (PL-1).



Location Identification	Easting (feet)*	Northing (feet)*
Test Pit 1A	466,712.6	1,555,545.2
Test Pit 1B	466,720.7	1,555,546.9
Test Pit 2A	467,162.1	1,555,370.2
Test Pit 2B	467,145.2	1,555,373.6
Test Pit 3A	466,662.0	1,552,806.8
Test Pit 3B	466,680.5	1,552,807.4
Test Pit 4	466,594.2	1,552,557.0
Test Pit 5A	466,658.4	1,552,543.0
Test Pit 5B	466,675.0	1,552,535.8
Test Pit 6	466,227.6	1,552,508.7
Test Pit 7	466,049.6	1,550,689.6
Test Pit 8	466,018.1	1,550,689.7
Test Pit 9A	464,113.3	1,554,607.8
Test Pit 9B	464,098.5	1,554,583.4
Micro Pit 1	467,308.6	1,555,295.6
Micro Pit 2	467,168.3	1,554,626.1
Analog Pit 3	475,113.6	1,552,890.4
Analog Pit 6	464,827.2	1,555,858.1

*State Plane Coordinate System NM West NAD27

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Figure 2. Final Test Pit and Restoration Locations
(a subset of potential test locations identified in the Field Work Plan was excavated and sampled)

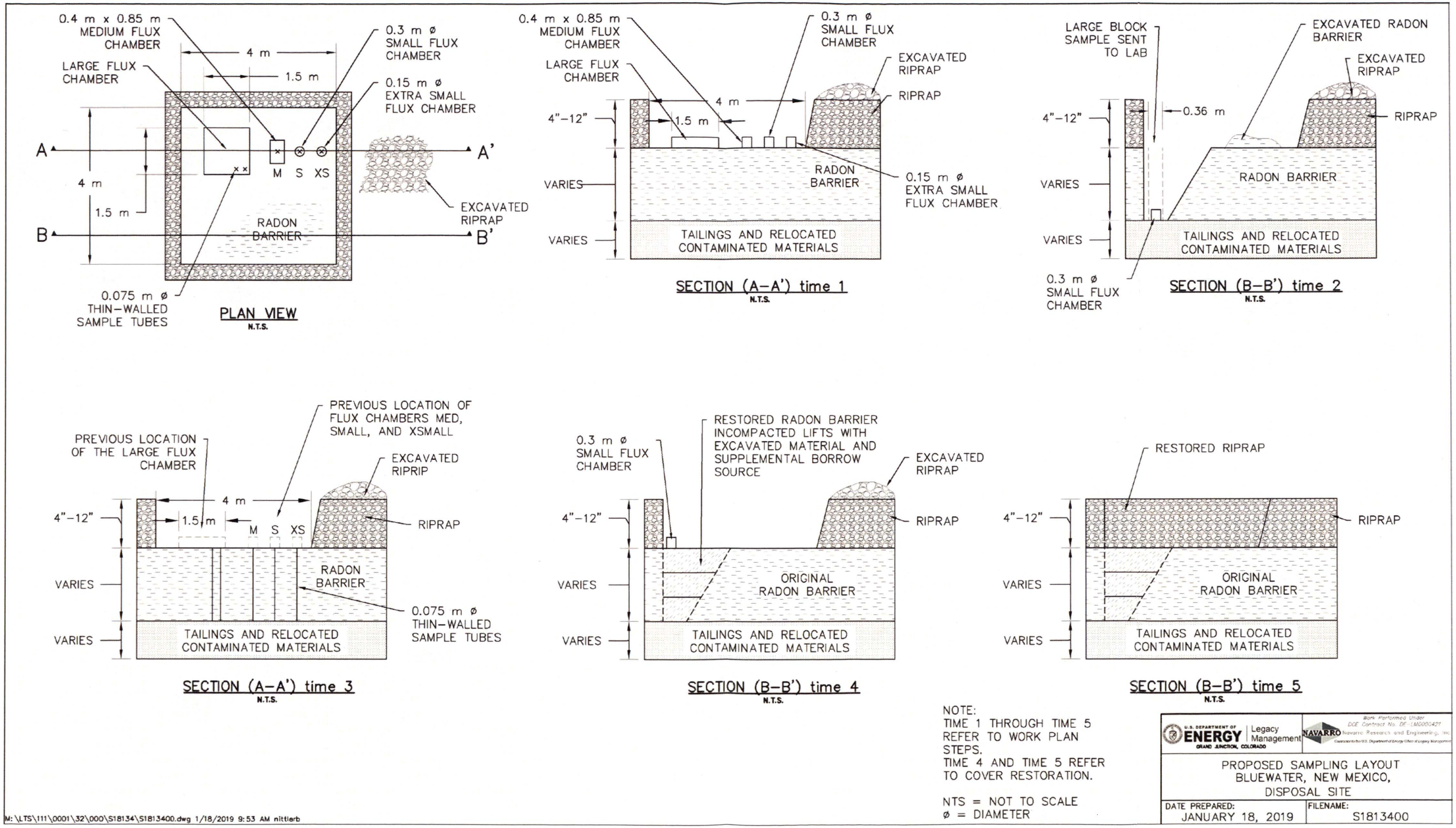

Figure 3. Proposed Sampling Layout, Bluewater, New Mexico, Disposal Site

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Excavations of the seven main tailings disposal cell test pits (Test Pit 1A/B, Test Pit 2A/B, Test Pit 3A/B, Test Pit 4, Test Pit 5A/B, Test Pit 6, and Micro Pit 2) disturbed an average of 16 square yards (yd^2) of surface cover (riprap) and less than 2 yd^2 of radon barrier. At test pits 7 and 8 on the carbonate tailings disposal cell, the depth of excavation required a larger disturbance. At Test Pit 7, the area of riprap disturbed was approximately 50 yd^2 and the area of radon barrier disturbed was approximately 18 yd^2. At Test Pit 8, the area of riprap disturbance was approximately 10 yd^2 and the area of radon barrier excavated was about 6 yd^2. The acid tailings disposal cell had topsoil instead of riprap and the test pit here (9A/9B) impacted less than a square yard of topsoil and radon barrier. The total area of the cells is 1,960,000 yd^2; therefore, the activities disturbed approximately 0.008% of the total cell surface cover and 0.002% of the radon barrier.

The designation of A/B in the test pit names is in reference primarily to duplicate radon flux measurements on the surface of the radon barrier. In some cases, based on study objectives, a second small excavation into the radon barrier was performed to compare morphology under the locations of paired flux measurements.

2.1 Excavations on the Main Tailings Disposal Cell

Excavations of the seven test pits (Test Pit 1A/B, Test Pit 2A/B, Test Pit 3A/B, Test Pit 4, Test Pit 5A/B, Test Pit 6, and Micro Pit 2) on the top slope of the main tailings disposal cell included the phased removal and stockpiling of the distinct cover layers (Figure 3). The rock riprap (ranging in thickness from 4–12 inches thick and 16 yd^2 in area) was removed first, exposing the top of the radon barrier (PL-2). The surface area of exposed radon barrier varied at each test pit, but was less than 20 yd^2 at all locations. Radon flux measurements were taken on the top surface of the radon barrier, following procedures in Benson et al. (2017), and are summarized in Section 4.1 (PL-3).

A smaller footprint of the radon barrier, generally less than 2 yd^2, was then excavated to a depth of 21–29 inches to expose the top of contaminated materials and create a clean pit face to the base of the radon barrier for soil morphology characterization (PL-4, PL-6, PL-7, and PL-8). Multiple lines of evidence were used to confirm the interface with buried contaminated materials including as-built thicknesses, auger cuttings, gamma radiation survey results, soil characteristics (e.g., color, grain size), and geomorphic features. Radon flux was also measured on the surface of the contaminated materials (Benson et al. 2017) (PL-5).

As a precaution, a thin layer of radon barrier soil was replaced on top of the contaminated materials to provide a clean surface for scientists to stand on and characterize the morphology of the pit face.

2.2 Excavations on the Acid Tailings Disposal Cell

One test pit (Test Pit 9A/B) was excavated on the top slope of the acid tailings disposal cell using methods described in Section 2.1 (Figure 3) with some exceptions discussed below.

The top slope of the acid tailings disposal cell is vegetated, it has no rock riprap, and the cover is 16 inches thick. Based on the Completion Report, this cover was approximately 6 inches of radon barrier and approximately 8 inches of topsoil. As with the other two cells, multiple lines of

evidence were used to confirm the interface with buried contaminated materials. Excavations on the acid tailings cell were dug by hand with a shovel and hammer drill and were approximately 2 feet in diameter (PL-9). No material or sample was removed from the acid tailings disposal cell radon barrier.

2.3 Excavations at the Analogue Locations

Two test pits were excavated and sampled at analogue locations (undisturbed off-cover locations) within the site boundary. One pit was excavated adjacent to the former borrow area. This pit, Analogue Pit 3, shown in Figure 2, was excavated to a depth of about 6 feet and had an area of about 25 yd^2 (PL-10). This pit was also the source of borrow material for the restoration of the radon barrier (about 0.5 cubic yard total). The other test pit was on a small hillside adjacent to the road leading to the main tailings disposal cell. This test pit, Analogue Pit 6, also shown in Figure 2, was excavated to a depth of about 3 feet in an area of about 4 yd^2 (PL-11).

3.0 Test Pit Restoration Methods

Test pit restoration began on June 23, 2016, and was completed on June 29, 2016. Restoration was performed according to steps 1.2.10 through 1.2.12 presented in the Field Work Plan (DOE 2016). Restoration methods for the analogue and borrow test pits are described in Section 3.3.

3.1 Materials

3.1.1 Radon Barrier Backfill Material

Backfill material used to restore the radon barrier primarily consisted of stockpiled material excavated from test pits. Small volumes of material from the original borrow source was added to the top lift to replace soil volumes removed during sampling. The small volume of borrow material was characterized in the field as similar to the excavated radon barrier. All material used for restoration was moisture-conditioned as necessary.

3.1.2 Protective Layers Overlying the Radon Barrier

The protective layer at the main tailings disposal cell and the carbonate tailings disposal cell (Test Pits 1–8 and Micro Pit 2) was rock riprap. Stockpiled rock riprap that had been removed during excavation of the test pits was used to restore this layer. Test Pit 9A/B on the acid tailings disposal cell had an approximately 8-inch thick vegetated topsoil layer overlying the radon barrier. Stockpiled topsoil that had been removed during excavation was used to restore this layer.

3.2 Restoration and Testing Methods

Activities focused on restoring the cover to its original design specifications. The radon barrier was reconstructed using excavated material in addition to some soil from the original borrow area. The design compaction requirement for the radon barrier was 95% of maximum dry density based on ASTM International (ASTM) Standard D698 (ASTM 2012b).

Moisture and density of the restored layers of radon barrier were measured with a nuclear moisture density gauge following ASTM Standard D6938 (ASTM 2017) and tests were conducted using an 8-inch probe depth. These results were compared to standard proctor tests performed on these materials, following ASTM Standard D698, to calculate percent of maximum dry density. These data are presented in Section 4.2 and can also be found in Appendix B.

3.2.1 Radon Barrier

The radon barrier was restored by placement of the material in 12-inch loose moisture-conditioned lifts. Compaction of the radon barrier layer was achieved using a hand-operated large rammer delivering 2900–3600 pounds per blow with three or more passes over all backfilled areas on each lift (PL-12). In all cases, the restored radon barrier was level with the surrounding undisturbed barrier.

The excavation footprint through the radon barrier was less than a square yard at eight of the ten test pit locations. Test Pits 7 and 8 required a larger footprint (approximately 18 yd^2 and 6 yd^2, respectively) but did not extend through the radon barrier, which was greater than 8 feet thick. Excavated materials were generally replaced in the reverse order in which they were removed.

Bulk density and moisture contents were measured at the surface of half of the restored compacted lifts. In all cases, the height of the restored radon barrier was level with the surrounding undisturbed barrier.

After restoration of the radon barrier, radon flux was measured on the surface of the restored radon barrier using a small flux chamber with an activated carbon (AC) canister following methods in Benson et al. (2017), and results are presented in Section 4.1.

3.2.2 Riprap

Placement of stockpiled rock riprap over the reconstructed radon barrier was performed using a track-mounted mini-excavator and satisfied the minimum thickness requirement. The top surface of the repaired riprap was then smoothed with a track-mounted mini-excavator to complete restoration of test pits.

3.2.3 Topsoil

Topsoil that was stockpiled from the excavation on the acid tailings disposal cell, was re-placed on top of the restored radon barrier and was consolidated with the rammer compactor.

3.3 Analogue Test Pit Restoration

The two off-cover test pits (Analogue Pit 3 and Analogue Pit 6) were not subject to engineering-specific restoration requirements. Both pits were backfilled in the reverse order in which material was removed and compacted in lifts using a track-mounted mini-excavator.

4.0 Restoration Monitoring Results

4.1 Radon Flux Verification

Prior to excavation through the radon barrier, radon flux was measured on top of the radon barrier using AC canisters, RAD7 real time monitors, and flux chambers of different sizes. Radon flux was measured again after the radon barrier was restored using only AC canisters and small diameter (0.3-meter) or extra small diameter (0.15-meter) flux chambers sealed to the ground surface with bentonite (PL-13 and PL-14). The AC canisters were deployed and processed according to procedures presented in Benson et al. (2017).

As-built (post-construction) radon flux sampling used AC canisters and small chambers and results are found in the Completion Report. Because the test pits in this study were not in the exact locations as the as-built flux measurements, the four to nine closest as-built flux measurement locations were used to calculate the average as-built flux for the test pit area. The pre-excavation radon flux values are derived from AC radon concentrations taken on the surface of the freshly exposed radon barrier. The post-restoration AC radon concentrations were used to calculate flux rates that were compared to as-built radon flux values. Table 1 presents the average as-built radon flux, the pre-excavation radon flux, and the post-restoration radon flux in units of picocuries per square meter per second (pCi/m^{2}s).

Table 1. Radon Flux Data

Test Pit	As-Built Radon Flux (pCi/m^{2}s)[a]	Pre-excavation Radon Flux (pCi/m^{2}s)	Post-restoration Radon Flux (pCi/m^{2}s)
1A/B	3.11	0.018	0.045
2A/2B	1.29	0.176	0.292
3A/B	6.05	0.383	0.094
Micro Pit 2	6.05	NM[b]	0.296
4	6.03	0.647	0.108
5A/B	6.03	2.361	3.992
6	5.92	NM[b]	1.242
7	0.43	0.005	0.034
8	0.43	NM[b]	0.139
9A/B	14.73	1.996	0.103

Notes:
[a] Average of flux values for the four to nine as-built radon flux locations closest to the test pit.
[b] Radon flux not measured.

The UMTRCA radon flux standard is 20 pCi/m^{2}s, averaged for the entire cell over time and space. The pre-excavation and post-restoration radon flux values were below the UMTRCA standard at all test pit locations. The pre-excavation and post-restoration radon flux values were also lower than the average as-built flux values at all test pit locations. There was no requirement for pre-excavation radon flux measurements and they were taken only to meet study objectives. Micro Pit 2 and Test Pit 8 were used for morphological characterization and Test Pit 6 was at the

site of an ant mound, and there was no way to seal a flux chamber to the ground surface, so no pre-excavation flux was measured at these locations.

4.2 Compaction Verification

Undisturbed (pre-excavation) radon barrier moisture and density were measured during the study at select test pit locations with the nuclear moisture density gauge following ASTM standard D6938 and sand-cone and moisture content tests following ASTM standards D1556 and D4944 (ASTM 2015; ASTM 2018) to document existing conditions (PL-15 and PL-16). The sand-cone test confirmed the accuracy of nuclear moisture density gauge measurements. As a result, nuclear moisture density gauge measurements were used as the sole method for verifying compaction. Table 2 presents the pre-excavation moisture and compaction measurements obtained from the top of the radon barrier at a subset of the test pits. These results represent the in situ pre-excavation conditions of the upper radon barrier at the time of the study.

A local geotechnical firm (Western Technologies Inc.) was subcontracted to perform proctor tests following ASTM standards D698 and D1557 (ASTM 2012a) of radon barrier soils collected from Micro Pit 1. Micro Pit 1 was the source of a small proctor test sample and the site of a saturated hydraulic conductivity test, not an excavated test pit, and therefore was not subject to restoration. That is why it is not included in Table 1 or Table 3 results. Relevant details include:

- The geotechnical lab's proctor test results for the radon barrier at test pit Micro Pit 1 show a maximum dry density of 199.9 pounds per cubic feet (lb/ft^3), with an optimum moisture content of 10%.
- The design compaction requirements for the radon barrier were 95% of maximum dry density and a moisture content of ±3% of optimum.

Table 2. Undisturbed Moisture and Compaction Data

Test Pit	Lift ID	Moisture (%)	Dry Density (lb/ft^3)	% of Maximum Dry Density
1A/B	Top of radon barrier	10.1	122.4	102
Micro Pit 1	Top of radon barrier	8.0	114.8	96
2A/B	Top of radon barrier	5.5	113.2	94
7	Top of radon barrier	8.6	119.5	100
8	Top of radon barrier	10.3	120.4	100
9A/B	Top of radon barrier	8.7	118.1	98

A geotechnical technician was onsite during the restoration process to test compaction and moisture of the radon barrier lifts with a nuclear moisture density gauge. During radon barrier restoration, all measured lifts were verified by the geotechnical field technician as meeting the requirements for 95% of maximum dry density and 10% ± 3% moisture. However, when the final geotechnical report (Appendix B) was issued and compared to the field data sheets, it was noted that field calculations were made using a maximum dry density of 119 lb/ft^3 instead of the 119.9 lb/ft^3 laboratory proctor result. With this error, five of the 22 compaction results were calculated to be slightly below the required criteria at 94%. Considering the expected

variability of the radon barrier soils across the covers, Navarro engineers concluded that these five compaction values were acceptable with the understanding that if these areas exhibit any signs of settlement, Legacy Management Support (LMS) contractors would rectify the problem. These locations will be monitored by the annual site inspection team for any observable settlement.

Table 3 contains the moisture and density data obtained using a nuclear moisture density gauge.

All geotechnical data including proctor curves, densities, and moisture contents are contained in Appendix B. It should also be noted that there was a nomenclature mix-up in the field. What is referred to in this report as Micro Pit 2 is called Micro Pit 3 in Appendix B.

Table 3. Restoration Moisture and Compaction Data

Test Pit	Lift ID	Moisture (%)[a,b]	Dry Density (lb/ft^3)[b]	% of Maximum Dry Density[c]
1A/B	Radon Barrier Lift 1	9.1	112.8	**94**
1A/B	Radon Barrier Lift Top	10.3	122.2	102
2A/B	Radon Barrier Lift 1	10.0	113.5	95
2A/B	Radon Barrier Lift 3	9.1	114.9	96
3A/B	Radon Barrier Lift 1	8.9	112.8	**94**
3A/B	Radon Barrier Lift 2	9.9	113.1	**94**
4	Radon Barrier Lift 1	12.6	113.4	**94**
4	Radon Barrier Lift 2	9.6	113.7	95
5A/B	Radon Barrier Lift 1	9.1	114.2	95
5A/B	Radon Barrier Lift 2	8.6	113.0	**94**
6	Radon Barrier Lift 1	11.6	114.6	96
6	Radon Barrier Lift 2	11.0	114.8	96
7	Radon Barrier Lift 1	9.8	119.6	100
7	Radon Barrier Lift 4	8.5	117.3	98
7	Radon Barrier Lift 7	12.3	115.0	96
7	Radon Barrier Lift Top	8.6	119.5	100
8	Radon Barrier Lift 1	10.4	115.0	96
8	Radon Barrier Lift 3	11.0	114.6	96
8	Radon Barrier Lift Top	10.3	120.4	100
9A/B	Radon Barrier Lift 1	11.0	114.8	96
Micro Pit 2	Radon Barrier Lift 1	12.8	114.8	96
Micro Pit 2	Radon Barrier Lift 2	12.7	114.9	96

Notes:
Values in **bold** are out of specified range.
[a] Volumetric moisture content.
[b] ASTM Standard D6938.
[c] ASTM Standard D698 Method A.

5.0 Post-restoration Inspections

Annual site inspections as required by long-term surveillance plans will document the long-term condition of restored test pits in the annual inspection reports. Annual site inspections were conducted on August 24, 2016, and September 13, 2017, approximately 2 and 14 months after the restoration was complete (PL-17 through PL-26). The 2017 inspection report (DOE 2017) stated that "No indications of settlement or erosion were visible, as was also noted during the 2016 annual inspection; therefore, annual inspections of the reclaimed test pits will be discontinued."

6.0 References

ASTM (ASTM International), 2012a. Standard D1557, "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort," West Conshohocken, Pennsylvania.

ASTM (ASTM International), 2012b. Standard D698, "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort," West Conshohocken, Pennsylvania.

ASTM (ASTM International), 2015. Standard D1556, "Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method," West Conshohocken, Pennsylvania.

ASTM (ASTM International), 2017. Standard D6938, "Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)," West Conshohocken, Pennsylvania.

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Appendix A

Log and Photos

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Photograph Log

Photograph Location Number	Photograph Description
PL-1	Pre-excavation Soil Boring Through Cover
PL-2	Pulling Back Rock Riprap
PL-3	Top of Radon Barrier Radon Flux Monitoring
PL-4	Excavation through the Radon Barrier
PL-5	Measuring Radon flux at the bottom of the Radon Barrier
PL-6	Excavation through the radon barrier at Micro Pit 2
PL-7	Excavation through the radon barrier at Test Pit 5
PL-8	Continuous Face Exposed for Soil Morphology Logging
PL-9	Test Pit 9A/B Excavation of Radon Barrier
PL-10	Off-Cover Analogue Pit 3 and Borrow Source Excavation
PL-11	Excavation of Analogue Pit 6
PL-12	Restoration Compaction at Test Pit 7
PL-13	Restored Condition of Test Pit 7 with Post-restoration Radon Flux Measurement at Test Pit 8 in the Background
PL-14	Post-restoration Radon Flux Measurement at Test Pit 8 with Restored Test Pit 7 in the Background
PL-15	Nuclear Density and Moisture Testing
PL-16	Sand Cone Density and Moisture Testing
PL-17	Post-restoration Condition at Test Pit 1A/B on Main Tailings Disposal Cell, September 2017
PL-18	Post-restoration Condition at Test Pit 2A/B Under Ponded Area on Main Tailings Disposal Cell, September 2017
PL-19	Post-restoration Condition at Test Pit 3A/B on Main Tailings Disposal Cell, September 2017
PL-20	Post-restoration Condition at Test Pit 4 on Main Tailings Disposal Cell, September 2017
PL-21	Post-restoration Condition at Test Pit 5A/B on Main Tailings Disposal Cell, September 2017
PL-22	Post-restoration Condition at Test Pit 6 on Main Tailings Disposal Cell, September 2017
PL-23	Post-restoration Condition at Test Pit 7 on Carbonate Tailings Disposal Cell, September 2017
PL-24	Post-restoration Condition at Test Pit 8 on Carbonate Tailings Disposal Cell, September 2017
PL-25	Post-restoration Condition at Test Pit 9A/B on Acid Tailings Disposal Cell, June 2016
PL-26	Post-restoration condition at Micro Pit 2 on Main Tailings Disposal Cell, September 2017

PL-1. Pre-excavation Soil Boring Through Cover

PL-2. Pulling Back Rock Riprap

PL-3. Top of Radon Barrier Radon Flux Monitoring

PL-4. Excavation through the Radon Barrier

PL-5. Measuring Radon Flux at the Bottom of the Radon Barrier

PL-6. Excavation Through the Radon Barrier at Micro Pit 2

PL-7. Excavation Through the Radon Barrier at Test Pit 5A/B

PL-8. Continuous Face Exposed for Soil Morphology Logging

PL-9. Test Pit 9A/B Excavation of Radon Barrier

PL-10. Off-Cover Analogue Pit 3 and Borrow Source Excavation

PL-11. Excavation of Analogue Pit 6

PL-12. Restoration Compaction at Test Pit 7

PL-13. Restored Condition of Test Pit 7 with Post-restoration Radon Flux Measurement at Test Pit 8 in the Background

PL-14. Post-restoration Radon Flux Measurement at Test Pit 8 with Restored Test Pit 7 in the Background

PL-15. Nuclear Density and Moisture Testing

PL-16. Sand Cone Density and Moisture Testing

PL-17. Post-restoration Condition at Test Pit 1A/B on Main Tailings Disposal Cell, September 2017

PL-18. Post-restoration Condition at Test Pit 2A/B Under Ponded Area on Main Tailings Disposal Cell, September 2017

PL-19. Post-restoration Condition at Test Pit 3A/B on Main Tailings Disposal Cell, September 2017

PL-20. Post-restoration Condition at Test Pit 4 on Main Tailings Disposal Cell, September 2017

PL-21. Post-restoration Condition at Test Pit 5A/B on Main Tailings Disposal Cell, September 2017

PL-22. Post-restoration Condition at Test Pit 6 on Main Tailings Disposal Cell, September 2017

PL-23. Post-restoration Condition at Test Pit 7 on Carbonate Tailings Disposal Cell, September 2017

PL-24. Post-restoration Condition at Test Pit 8 on Carbonate Tailings Disposal Cell, September 2017

PL-25. Post-restoration Condition at Test Pit 9A/B on Acid Tailings Disposal Cell, June 2016

PL-26. Post-restoration Condition at Micro Pit 2 on Main Tailings Disposal Cell, September 2017

Appendix B

Compaction Testing Results

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PHYSICAL PROPERTIES OF SOILS & AGGREGATES

Date of Report 06-22-16
Job No. 3246JA167
Event / Invoice No. 6L348-2 — Lab No. 6L348-2
Authorized by DAVID DANDER — Date 06-20-16
Sampled by DAVID DANDER — Date 06-20-16
Submitted by BILL STAVAREK — Date 06-20-16
Source / Location Designated by CLIENT — Date 06-20-16

Client NAVARRO RESEARCH & ENGINEERING
669 EMORY VALLEY ROAD
OAK RIDGE, TN 87830

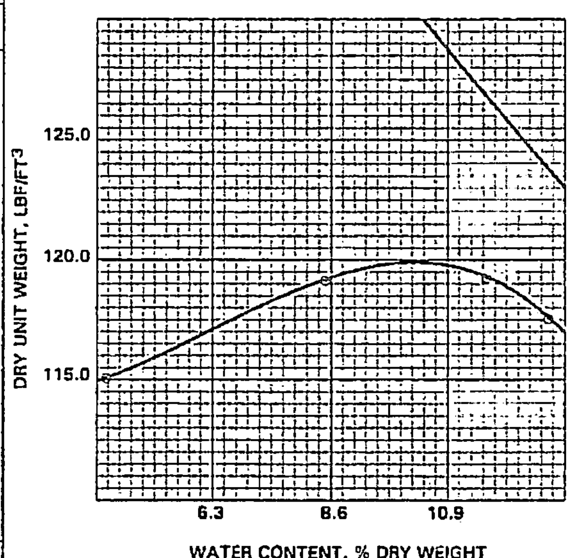
Project	BLUEWATER DISPOSAL SITE
Location	CIBOLA COUNTY
Type / Use of Material	RBT (CAPPING MATERIAL)
Supplier / Source	N/A
Sample Source / Location	MICRO PIT #1
Special Instructions	ASTM D698

TEST RESULTS

SIEVE ANALYSIS :
FINER THAN NO. 200 :

SIEVE	ACCUMULATIVE % PASSING	SPECIFICATION

LABORATORY COMPACTION CHARACTERISTICS : ASTM D698 METHOD A



SAMPLE PREPARATION: [X] WET [ ] DRY
RAMMER USED:
[X] 2 IN. CIRCULAR FACE [ ] OTHER
[ ] MECHANICAL [X] MANUAL

PROJECT PROCTOR ID: 1
MAXIMUM DRY UNIT WEIGHT, LBF/FT^3 → 119.9
OPTIMUM WATER CONTENT, % → 10.0

OVERSIZE AGGREGATE
ASSUMED BULK SPECIFIC GRAVITY : 2.65
ASSUMED ABSORPTION, % : 1.0
% OVERSIZE IN LAB SAMPLE : 0

ASSUMED SPECIFIC GRAVITY IN ZERO AIR VOID CURVE : 2.65

TEST PROCEDURE	RESULT	SPECS
LIQUID & PLASTIC PROPERTIES :		
LIQUID LIMIT →		
ESTIMATED % RETAINED ON NO. 40 — PLASTIC LIMIT →		
SAMPLE AIR DRIED [ ] YES [ ] NO — PLASTICITY INDEX →		
MOISTURE CONTENT : PORTION TESTED — % DRY WEIGHT →		
EXPANSION / COMPRESSION PROPERTIES OF COHESIVE SOIL : [ ] EXPANSION [ ] COMPRESSION, % →		
SURCHARGE, PSF — MAXIMUM SWELL PRESSURE, KSF →		
INITIAL WATER CONTENT, % — DRY UNIT WEIGHT LBF/FT^3		
EXPANSION INDEX OF SOIL : INITIAL WATER CONTENT, % ; INITIAL DRY UNIT WEIGHT LBF/FT^3 ; INITIAL DEGREE OF SATURATION ; FINAL WATER CONTENT, % — EI →		

TEST PROCEDURE	RESULT	SPECS
RESISTANCE TO DEGRADATION OF SMALL-SIZE COARSE AGGREGATES BY ABRASION :		
GRADING — 100 REV, % LOSS →		
GRADING — 500 REV, % LOSS →		
SPECIFIC GRAVITY : MAX. PARTICLE SIZE, IN — SPECIFIC GRAVITY @ 20°C →		
pH DETERMINATION : pH →		
SOLUBLE SALTS : PPM →		
MINIMUM RESISTIVITY : OHM-CM →		
SOIL CLASSIFICATION : GROUP SYMBOL: NAME:		

Comments :

Copies to : CLIENT (1)

THE SERVICES REFERRED TO HEREIN WERE PERFORMED IN ACCORDANCE WITH THE STANDARD OF CARE PRACTICED LOCALLY FOR THE REFERENCED METHOD(S) AND RELATE ONLY TO THE CONDITION(S) OR SAMPLE(S) TESTED AS STATED HEREIN. WESTERN TECHNOLOGIES INC MAKES NO OTHER WARRANTY OR REPRESENTATION, EXPRESSED OR IMPLIED, AND HAS NOT CONFIRMED INFORMATION INCLUDING SOURCE OF MATERIALS SUBMITTED BY OTHERS.

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PHYSICAL PROPERTIES OF SOILS & AGGREGATES

Client NAVARRO RESEARCH & ENGINEERING
669 EMORY VALLEY ROAD
OAK RIDGE, TN 87830

Date of Report	06-22-16		
Job No.	3246JA167		
Event / Invoice No.	6L348-1	Lab No.	6L348-1
Authorized by	DAVID DANDER	Date	06-20-16
Sampled by	DAVID DANDER	Date	06-20-16
Submitted by	BILL STAVAREK	Date	06-20-16
Source / Location Designated by	CLIENT	Date	06-20-16

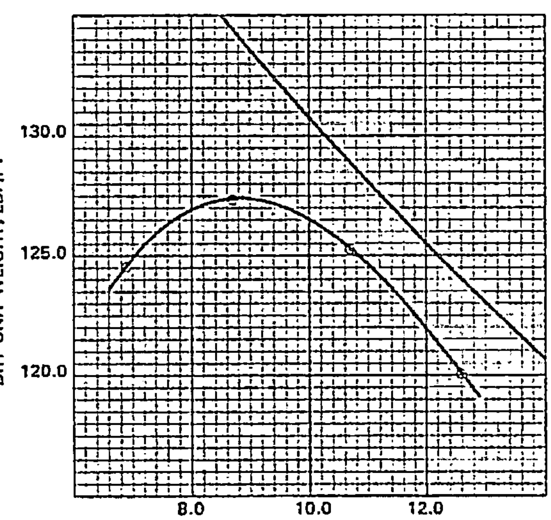
Project	BLUEWATER DISPOSAL SITE
Location	CIBOLA COUNTY
Type / Use of Material	RBT (CAPPING MATERIAL)
Supplier / Source	N/A
Sample Source / Location	MICRO PIT #1
Special Instructions	ASTM D1557

TEST RESULTS

SIEVE ANALYSIS :
FINER THAN NO. 200 :

SIEVE	ACCUMULATIVE % PASSING	SPECIFICATION

LABORATORY COMPACTION CHARACTERISTICS : ASTM D1557 METHOD A



SAMPLE PREPARATION: [X] WET [ ] DRY
RAMMER USED:
[X] 2 IN. CIRCULAR FACE [ ] OTHER
[ ] MECHANICAL [X] MANUAL

PROJECT PROCTOR ID: 2
MAXIMUM DRY UNIT WEIGHT, LBF/FT^3 → 127.4
OPTIMUM WATER CONTENT, % → 8.8

OVERSIZE AGGREGATE :
ASSUMED BULK SPECIFIC GRAVITY : 2.65
ASSUMED ABSORPTION, % : 1.0
% OVERSIZE IN LAB SAMPLE : 0

ASSUMED SPECIFIC GRAVITY IN ZERO AIR VOID CURVE : 2.65

TEST PROCEDURE	RESULT	SPECS
LIQUID & PLASTIC PROPERTIES : LIQUID LIMIT →		
ESTIMATED % RETAINED ON NO. 40 — PLASTIC LIMIT →		
SAMPLE AIR DRIED [ ] YES [ ] NO — PLASTICITY INDEX →		
MOISTURE CONTENT : PORTION TESTED — % DRY WEIGHT →		
EXPANSION / COMPRESSION PROPERTIES OF COHESIVE SOIL : [ ] EXPANSION [ ] COMPRESSION, % →		
MAXIMUM SWELL PRESSURE, KSF →		
SURCHARGE, PSF		
INITIAL WATER CONTENT, % — DRY UNIT WEIGHT LBF/FT^3		
EXPANSION INDEX OF SOIL : INITIAL WATER CONTENT, % : INITIAL DRY UNIT WEIGHT LBF/FT^3 : INITIAL DEGREE OF SATURATION : FINAL WATER CONTENT, % : — EI →		

TEST PROCEDURE	RESULT	SPECS
RESISTANCE TO DEGRADATION OF SMALL-SIZE COARSE AGGREGATES BY ABRASION : GRADING — 100 REV, % LOSS →		
GRADING — 500 REV, % LOSS →		
SPECIFIC GRAVITY : MAX. PARTICLE SIZE, IN — SPECIFIC GRAVITY @ 20°C →		
pH DETERMINATION : pH →		
SOLUBLE SALTS : PPM →		
MINIMUM RESISTIVITY : OHM CM →		
SOIL CLASSIFICATION : GROUP SYMBOL: NAME:		

Comments :

Copies to : CLIENT (1)

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SOIL / AGGREGATE FIELD UNIT WEIGHT TESTS (FIELD DENSITY)

Date of Report 06-22-16
Job No. 3246JA167 Page 1 of 1
Event/Invoice No. 6JA167-2N
Authorized By D.DANDER Date 06-20-16
Tested By B.STAVAERK Date 06-20-16

Client NAVARRO RESEARCH & ENGINEERING
669 EMORY VALLEY ROAD
OAK RIDGE, TN 87830

Client NAVARRO RESEARCH & ENGINEERING
Project BLUEWATER DISPOSAL SITE
Location CIBOLA COUNTY, GRANTS, NM
Test Locations Designated By CLIENT
Test Procedures In-Place Unit Weight : ASTM D6938 Moisture Content : ASTM D6938
Gauge : Make TROXLER Model 3411-B Serial No. 15927 Standard Count: Unit Weight 1713 H_2O 629

TEST NO.	IN-PLACE CHARACTERISTICS				LAB CHARACTERISTICS			COMPACTION	REQUIREMENTS		
	Hole Volume cu. ft	Moisture % of Dry Unit Weight	Dry Unit Weight lbf / cu. ft.	Oversize %	ID	Maximum Dry Unit Weight lbf / cu. ft.	Optimum Moisture %	% of Maximum Dry Unit Weight	Moisture %	Compaction %	CONFORMANCE INDICATED
1		8.0	114.8	0	1	119.9	10.0	96			
2		5.5	113.2	0	1	119.9	10.0	94			

TEST NO.	TEST LOCATION, HORIZONTAL	TEST LOCATION, VERTICAL Approximate Fill Depth, ft.	Elevation *	MATERIAL TESTED
1	MP #1 RBT INSITU	0.0	100.0	
2	TP #2 RBT INSITU	0.0	100.0	

LABORATORY DATA & COMPACTION CHARACTERISTICS

LAB ID.	EVENT/ INVOICE NO.	DESCRIPTION OF MATERIAL	SOURCE OF MATERIAL	OPTIMUM MOISTURE, %	MAXIMUM DRY UNIT WEIGHT, lbf / cu. ft.	TEST METHOD
1	6L348-2	RED SILTY SAND	MP#1	10.0	119.9	D698-A

Comments: * DATUM 100 = TOP OF FILL
This engagement does NOT include provision for WT opinions, conclusions nor directions in regard to this project.

Distribution : CLIENT (1)

TESTING WAS PERFORMED PER LOCAL INDUSTRY PRACTICES THAT MAY INCLUDE SLIGHT DEVIATIONS FROM THE STANDARDS

TESTS REPORTED HEREIN ARE INDICATIVE OF CONDITIONS FOUND AT THE EXACT LOCATION AND TIME OF TESTING ONLY. THE ABOVE SERVICES AND REPORT WERE PERFORMED PURSUANT TO THE TERMS AND CONDITIONS OF THE CONTRACT BETWEEN WT AND CLIENT. WT WARRANTS THAT THIS WAS PERFORMED UNDER THE STANDARD OF REASONABLE CARE APPLICABLE TO SUCH TESTING GENERALLY. NO OTHER WARRANTY GUARANTY OR REPRESENTATION, EXPRESSED OR IMPLIED, IS INCLUDED OR INTENDED

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SOIL / AGGREGATE FIELD UNIT WEIGHT TESTS (FIELD DENSITY)

Client NAVARRO RESEARCH & ENGINEERING
669 EMORY VALLEY ROAD
OAK RIDGE, TN 87830

Date of Report 06-22-16
Job No. 3246JA167

Event/Invoice No. 6JA167-2N
Authorized By D.DANDER Date 06-20-16
Tested By B.STAVAERK Date 06-20-16

Client NAVARRO RESEARCH & ENGINEERING
Project BLUEWATER DISPOSAL SITE
Location CIBOLA COUNTY, GRANTS, NM
Test Locations Designated By CLIENT
Test Procedures In-Place Unit Weight : ASTM D6938 Moisture Content : ASTM D6938
Gauge : Make TROXLER Model 3411-B Serial No. 15927 Standard Count: Unit Weight 1713 H_2O 629

TEST NO.	IN-PLACE CHARACTERISTICS: Hole Volume cu. ft.	Moisture % of Dry Unit Weight	Dry Unit Weight lbf / cu. ft.	Oversize %	LAB CHARACTERISTICS: ID	Maximum Dry Unit Weight lbf / cu. ft.	Optimum Moisture %	COMPACTION: % of Maximum Dry Unit Weight	REQUIREMENTS: Moisture %	Compaction %	CONFORMANCE INDICATED
1		8.0	114.8	0	2	127.4	8.8	90			
2		5.5	113.2	0	2	127.4	8.8	89			

TEST NO.	TEST LOCATION, HORIZONTAL	TEST LOCATION, VERTICAL: Approximate Fill Depth, ft.	Elevation *	MATERIAL TESTED
1	MP #1 RBT INSITU	0.0	100.0	
2	TP #2 RBT INSITU	0.0	100.0	

LABORATORY DATA & COMPACTION CHARACTERISTICS

LAB ID.	EVENT/ INVOICE NO.	DESCRIPTION OF MATERIAL	SOURCE OF MATERIAL	OPTIMUM MOISTURE, %	MAXIMUM DRY UNIT WEIGHT, lbf / cu. ft.	TEST METHOD
2	6L348-1	RED SILTY SAND	MP#1	8.8	127.4	D1557-A

Comments: * DATUM 100 = TOP OF FILL
This engagement does NOT include provision for WT opinions, conclusions nor directions in regard to this project.

Distribution : CLIENT (1)

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SOIL / AGGREGATE FIELD UNIT WEIGHT TESTS (FIELD DENSITY)

Date of Report 06-22-16
Job No. 3246JA167 Page 1 of 1
Event/Invoice No. 6JA167-2
Authorized By D.DANDER Date 06-20-16
Tested By B.STAVAREK Date 06-20-16

Client NAVARRO RESEARCH & ENGINEERING
669 EMORY VALLEY ROAD
OAK RIDGE, TN 87830

Client NAVARRO RESEARCH & ENGINEERING
Project BLUEWATER DISPOSAL SITE
Location CIBOLA COUNTY, GRANTS, NM
Test Locations Designated By CLIENT
Test Procedures In-Place Unit Weight : ASTM D1556 Moisture Content : ASTM D4944
Apparatus ID A Calibrated Volume of Sand Cone Apparatus 0.0380 cu. ft. Bulk Unit Weight of Sand 96.1 lbf/cu. ft.

TEST NO.	IN-PLACE CHARACTERISTICS: Hole Volume cu. ft.	Moisture % of Dry Unit Weight	Dry Unit Weight lbf / cu. ft.	Oversize %	LAB CHARACTERISTICS: ID	Maximum Dry Unit Weight lbf / cu. ft.	Optimum Moisture %	COMPACTION: % of Maximum Dry Unit Weight	REQUIREMENTS: Moisture %	Compaction %	CONFORMANCE INDICATED
1	0.0952	7.6	115.6	0	2	127.4	8.8	91			
2	0.0894	5.5	111.2	0	2	127.4	8.8	87			

TEST NO.	TEST LOCATION, HORIZONTAL	TEST LOCATION, VERTICAL: Approximate Fill Depth, ft.	Elevation *	MATERIAL TESTED
1	MP1 RBT INSITU GAUGE CORRELATION	0.0	100.0	
2	TP2 RBT INSITU GAUGE CORRELATION	0.0	100.0	

LABORATORY DATA & COMPACTION CHARACTERISTICS

LAB ID.	EVENT/ INVOICE NO.	DESCRIPTION OF MATERIAL	SOURCE OF MATERIAL	OPTIMUM MOISTURE,%	MAXIMUM DRY UNIT WEIGHT, lbf / cu. ft.	TEST METHOD
2	6L348-1	RED SILTY SAND	MP#1	8.8	127.4	D1557-A

Comments: * DATUM 100 = TOP OF FILL
This engagement does NOT include provision for WT opinions, conclusions nor directions in regard to this project.

Distribution : CLIENT (1)

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SOIL / AGGREGATE FIELD UNIT WEIGHT TESTS (FIELD DENSITY)

Date of Report 06-22-16
Job No. 3246JA167
Event/Invoice No. 6JA167-2
Authorized By D.DANDER Date 06-20-16
Tested By B.STAVAREK Date 06-20-16

Client NAVARRO RESEARCH & ENGINEERING
669 EMORY VALLEY ROAD
OAK RIDGE, TN 87830

Client NAVARRO RESEARCH & ENGINEERING
Project BLUEWATER DISPOSAL SITE
Location CIBOLA COUNTY, GRANTS, NM
Test Locations Designated By CLIENT
Test Procedures In-Place Unit Weight : ASTM D1556 Moisture Content : ASTM D4944
Apparatus ID A Calibrated Volume of Sand Cone Apparatus 0.0380 cu. ft. Bulk Unit Weight of Sand 96.1 lbf/cu. ft.

TEST NO.	IN-PLACE CHARACTERISTICS				LAB CHARACTERISTICS			COMPACTION	REQUIREMENTS		
	Hole Volume cu. ft.	Moisture % of Dry Unit Weight	Dry Unit Weight lbf / cu. ft.	Oversize %	ID	Maximum Dry Unit Weight lbf / cu. ft.	Optimum Moisture %	% of Maximum Dry Unit Weight	Moisture %	Compaction %	CONFORMANCE INDICATED
1	0.0952	7.6	115.6	0	1	119.9	10.0	96			
2	0.0894	5.5	111.2	0	1	119.9	10.0	93			

TEST NO.	TEST LOCATION, HORIZONTAL	TEST LOCATION, VERTICAL		MATERIAL TESTED
		Approximate Fill Depth, ft.	Elevation *	
1	MP1 RBT INSITU GAUGE CORRELATION	0.0	100.0	
2	TP2 RBT INSITU GAUGE CORRELATION	0.0	100.0	

LABORATORY DATA & COMPACTION CHARACTERISTICS

LAB ID.	EVENT/ INVOICE NO.	DESCRIPTION OF MATERIAL	SOURCE OF MATERIAL	OPTIMUM MOISTURE, %	MAXIMUM DRY UNIT WEIGHT, lbf / cu. ft.	TEST METHOD
1	6L348-2	RED SILTY SAND	MP#1	10.0	119.9	D698-A

Comments: * DATUM 100 = TOP OF FILL
This engagement does NOT include provision for WT opinions, conclusions nor directions in regard to this project.

Distribution : CLIENT (1)

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SOIL / AGGREGATE FIELD UNIT WEIGHT TESTS (FIELD DENSITY)

Date of Report 06-28-16
Job No. 3246JA167 Page 1 of 1
Event/Invoice No. 6JA167-3S
Authorized By CLIENT Date 06-23-16
Tested By B.STAVAREK Date 06-23-16

Client NAVARRO RESEARCH & ENGINEERING
669 EMORY VALLEY ROAD
OAK RIDGE, TN 87830

Client NAVARRO RESEARCH & ENGINEERING
Project BLUEWATER DISPOSAL SITE
Location CIBOLA COUNTY, GRANTS, NM
Test Locations Designated By BILL STAVAREK
Test Procedures In-Place Unit Weight : ASTM D1556 Moisture Content : ASTM D4944
Apparatus ID A Calibrated Volume of Sand Cone Apparatus 0.0380 cu. ft. Bulk Unit Weight of Sand 95.4 lbf/cu. ft.

TEST NO.	IN-PLACE CHARACTERISTICS				LAB CHARACTERISTICS			COMPACTION	REQUIREMENTS		
	Hole Volume cu. ft.	Moisture % of Dry Unit Weight	Dry Unit Weight lbf / cu. ft.	Oversize %	ID	Maximum Dry Unit Weight lbf / cu. ft.	Optimum Moisture %	% of Maximum Dry Unit Weight	Moisture %	Compaction %	CONFORMANCE INDICATED
1A	0.0770	10.3	122.2	0	1	119.9	10.0	100+	7.0 TO 13.0	95	YES

TEST NO.	TEST LOCATION, HORIZONTAL	TEST LOCATION, VERTICAL: Approximate Fill Depth, ft.	TEST LOCATION, VERTICAL: Elevation *	MATERIAL TESTED
1A	TEST PIT RBT	0.0	100.0	TRENCH BACKFILL

LABORATORY DATA & COMPACTION CHARACTERISTICS

LAB ID.	EVENT/ INVOICE NO.	DESCRIPTION OF MATERIAL	SOURCE OF MATERIAL	OPTIMUM MOISTURE,%	MAXIMUM DRY UNIT WEIGHT, lbf / cu. ft.	TEST METHOD
1	6L348-2	RED SILTY SAND	MP#1	10.0	119.9	D698-A

Comments: * DATUM 100 = FINISHED BACKFILL

Distribution : CLIENT (1)

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SOIL / AGGREGATE FIELD UNIT WEIGHT TESTS (FIELD DENSITY)

Date of Report 06-28-16
Job No. 3246JA167
Page 1 of 1
Event/Invoice No. 6JA167-004
Authorized By CLIENT — Date 06-27-16
Tested By BILL S. — Date 06-27-16

Client NAVARRO RESEARCH & ENGINEERING
669 EMORY VALLEY ROAD
OAK RIDGE, TN 87830

Client NAVARRO RESEARCH & ENGINEERING
Project BLUEWATER DISPOSAL SITE
Location CIBOLA COUNTY, GRANTS, NM
Test Locations Designated By BILL S.
Test Procedures In-Place Unit Weight : ASTM D6938 Moisture Content : ASTM D6938
Gauge : Make TROXLER Model 3411-B Serial No. 15927 Standard Count: Unit Weight 1728 H_2O 631

TEST NO.	IN-PLACE CHARACTERISTICS				LAB CHARACTERISTICS			COMPACTION	REQUIREMENTS		
	Hole Volume cu. ft.	Moisture % of Dry Unit Weight	Dry Unit Weight lbf / cu. ft.	Oversize %	ID	Maximum Dry Unit Weight lbf / cu. ft.	Optimum Moisture %	% of Maximum Dry Unit Weight	Moisture %	Compaction %	CONFORMANCE INDICATED
1		10.4	115.0	0	1	119.9	10.0	96	7.0 TO 13.0	95	YES
2		9.1	112.8	0	1	119.9	10.0	94	7.0 TO 13.0	95	NO
3		10.0	113.5	0	1	119.9	10.0	95	7.0 TO 13.0	95	YES
4		12.6	113.4	0	1	119.9	10.0	95	7.0 TO 13.0	95	YES
5		9.1	114.2	0	1	119.9	10.0	95	7.0 TO 13.0	95	YES
6		9.6	113.7	0	1	119.9	10.0	95	7.0 TO 13.0	95	YES
7		8.9	112.8	0	1	119.9	10.0	94	7.0 TO 13.0	95	NO
8		9.9	113.1	0	1	119.9	10.0	94	7.0 TO 13.0	95	NO
9		8.6	113.0	0	1	119.9	10.0	94	7.0 TO 13.0	95	NO

TEST NO.	TEST LOCATION, HORIZONTAL	TEST LOCATION, VERTICAL		MATERIAL TESTED
		Approximate Fill Depth, ft.	Elevation *	
1	TP8 RBL1	0.0		TRENCH BACKFILL
2	TP1 RBL3	0.0		TRENCH BACKFILL
3	TP2 RBL1D	0.0		TRENCH BACKFILL
4	TP4 RBL1	0.0		TRENCH BACKFILL
5	TP5 RBL1	0.0		TRENCH BACKFILL
6	TP4 RBL2	0.0		TRENCH BACKFILL
7	TP3 RBL1	0.0		TRENCH BACKFILL
8	TP3 RBL2	0.0		TRENCH BACKFILL
9	TP5 RBL2	0.0		TRENCH BACKFILL

LABORATORY DATA & COMPACTION CHARACTERISTICS

LAB ID.	EVENT/ INVOICE NO.	DESCRIPTION OF MATERIAL	SOURCE OF MATERIAL	OPTIMUM MOISTURE, %	MAXIMUM DRY UNIT WEIGHT, lbf / cu. ft.	TEST METHOD
1	6L348-2	RED SILTY SAND	MP#1	10.0	119.9	D698-A

Comments:

Distribution : CLIENT (1)

TESTING WAS PERFORMED PER LOCAL INDUSTRY PRACTICES THAT MAY INCLUDE SLIGHT DEVIATIONS FROM THE STANDARDS.

TESTS REPORTED HEREIN ARE INDICATIVE OF CONDITIONS FOUND AT THE EXACT LOCATION AND TIME OF TESTING ONLY. THE ABOVE SERVICES AND REPORT WERE PERFORMED PURSUANT TO THE TERMS AND CONDITIONS OF THE CONTRACT BETWEEN WT AND CLIENT. WT WARRANTS THAT THIS WAS PERFORMED UNDER THE STANDARD OF REASONABLE CARE APPLICABLE TO SUCH TESTING GENERALLY. NO OTHER WARRANTY, GUARANTY, OR REPRESENTATION, EXPRESSED OR IMPLIED, IS INCLUDED OR INTENDED.

REVIEWED BY JEFF BOYD
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Since 1955

8305 Washington Place, N.E.
Albuquerque, New Mexico 87113-1670
(505) 823-4488

SOIL / AGGREGATE FIELD UNIT WEIGHT TESTS (FIELD DENSITY)

Client NAVARRO RESEARCH & ENGINEERING
669 EMORY VALLEY ROAD
OAK RIDGE, TN 87830

Date of Report 06-30-16
Job No. 3246JA167 Page 1 of 1
Event/Invoice No. 6JA167-005
Authorized By CLIENT Date 06-28-16
Tested By B. STAVAREK Date 06-28-16

Client NAVARRO RESEARCH & ENGINEERING
Project BLUEWATER DISPOSAL SITE
Location CIBOLA COUNTY, GRANTS, NM
Test Locations Designated By B. STAVAREK
Test Procedures In-Place Unit Weight : ASTM D6938 Moisture Content : ASTM D6938
Gauge : Make TROXLER Model 3411-B Serial No. 15927 Standard Count: Unit Weight 1711 H_2O 629

TEST NO.	IN-PLACE CHARACTERISTICS				LAB CHARACTERISTICS			COMPACTION	REQUIREMENTS		
	Hole Volume cu. ft.	Moisture % of Dry Unit Weight	Dry Unit Weight lbf / cu. ft.	Oversize %	ID	Maximum Dry Unit Weight lbf / cu. ft.	Optimum Moisture %	% of Maximum Dry Unit Weight	Moisture %	Compaction %	CONFORMANCE INDICATED
1		11.6	114.6	0	1	119.9	10.0	96	7.0 TO 13.0	95	YES
2		12.8	114.8	0	1	119.9	10.0	96	7.0 TO 13.0	95	YES
3		9.1	114.9	0	1	119.9	10.0	96	7.0 TO 13.0	95	YES
4		11.0	114.8	0	1	119.9	10.0	96	7.0 TO 13.0	95	YES
5		12.7	114.9	0	1	119.9	10.0	96	7.0 TO 13.0	95	YES
6		9.8	119.6	0	1	119.9	10.0	100	7.0 TO 13.0	95	YES
7		8.5	117.3	0	1	119.9	10.0	98	7.0 TO 13.0	95	YES
8		12.3	115.0	0	1	119.9	10.0	96	7.0 TO 13.0	95	YES

TEST NO.	TEST LOCATION, HORIZONTAL	TEST LOCATION, VERTICAL		MATERIAL TESTED
		Approximate Fill Depth, ft.	Elevation *	
1	TP6 RBL1 LIFT 1	0.0		TRENCH BACKFILL
2	MP3 RBL1 LIFT 1	0.0		TRENCH BACKFILL
3	TP2 RBL3 LIFT 3	0.0		TRENCH BACKFILL
4	TP6 RBL2 LIFT 2	0.0		TRENCH BACKFILL
5	MP3 RBL2 LIFT 2	0.0		TRENCH BACKFILL
6	TP7 RBL1 LIFT 1	0.0		TRENCH BACKFILL
7	TP7 RBL4 LIFT 4	0.0		TRENCH BACKFILL
8	TP7 RBL7 LIFT 7	0.0		TRENCH BACKFILL

LABORATORY DATA & COMPACTION CHARACTERISTICS

LAB ID.	EVENT/ INVOICE NO.	DESCRIPTION OF MATERIAL	SOURCE OF MATERIAL	OPTIMUM MOISTURE, %	MAXIMUM DRY UNIT WEIGHT, lbf / cu. ft.	TEST METHOD
1	6L348-2	RED SILTY SAND	MP#1	10.0	119.9	D698-A

Comments:

Distribution : CLIENT (1)

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SOIL / AGGREGATE FIELD UNIT WEIGHT TESTS (FIELD DENSITY)

Client NAVARRO RESEARCH & ENGINEERING
669 EMORY VALLEY ROAD
OAK RIDGE, TN 87830

Date of Report 06-30-16
Job No. 3246JA167 Page 1 of 1
Event/Invoice No. 6JA167-6
Authorized By MIKE L Date 06-29-16
Tested By BILL S Date 06-29-16

Client NAVARRO RESEARCH & ENGINEERING
Project BLUEWATER DISPOSAL SITE
Location CIBOLA COUNTY, GRANTS, NM
Test Locations Designated By D DANDER
Test Procedures In-Place Unit Weight : ASTM D6938 Moisture Content : ASTM D6938
Gauge : Make TROXLER Model 3411B Serial No. 15927 Standard Count: Unit Weight 1718 H_2O 628

TEST NO.	IN-PLACE CHARACTERISTICS				LAB CHARACTERISTICS			COMPACTION	REQUIREMENTS		
	Hole Volume cu. ft.	Moisture % of Dry Unit Weight	Dry Unit Weight lbf / cu. ft.	Oversize %	ID	Maximum Dry Unit Weight lbf / cu. ft.	Optimum Moisture %	% of Maximum Dry Unit Weight	Moisture %	Compaction %	CONFORMANCE INDICATED
1		11.0	114.6	0	1	119.9	10.0	96	7.0 TO 13.0	95	YES
2		8.6	119.5	0	1	119.9	10.0	100	7.0 TO 13.0	95	YES
3		10.3	120.4	0	1	119.9	10.0	100	7.0 TO 13.0	95	YES
4		11.0	114.8	0	1	119.9	10.0	96	7.0 TO 13.0	95	YES
5		8.7	118.1	0	1	119.9	10.0	98		95	YES

TEST NO.	TEST LOCATION, HORIZONTAL	TEST LOCATION, VERTICAL		MATERIAL TESTED
		Approximate Fill Depth, ft.	Elevation *	
1	TEST PIT 8 RAYDON BARRIER LIFT 3	0.7		TRENCH BACKFILL
2	TEST PIT 7 INSITU RAYDON BARRIER TOP	0.0		TEST FOR INFO ONLY
3	TEST PIT 8 INSITU RAYDON BARRIER TOP	0.0		TEST FOR INFO ONLY
4	TEST PIT 9 RAYDON BARRIER LIFT 1	0.7		TRENCH BACKFILL
5	TEST PIT 9 RAYDON BARRIER INSITU	0.0		TEST FOR INFO ONLY

LABORATORY DATA & COMPACTION CHARACTERISTICS

LAB ID.	EVENT/ INVOICE NO.	DESCRIPTION OF MATERIAL	SOURCE OF MATERIAL	OPTIMUM MOISTURE, %	MAXIMUM DRY UNIT WEIGHT, lbf / cu. ft.	TEST METHOD
1	6L348-2	RED SILTY SAND	MP#1	10.0	119.9	D698-A

Comments: * DATUM 100 =

Distribution : CLIENT (1)

TESTING WAS PERFORMED PER LOCAL INDUSTRY PRACTICES THAT MAY INCLUDE SLIGHT DEVIATIONS FROM THE STANDARDS.

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