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Moab Site Project Completion Report Appendix Package

Highway 191 Phase 2

Work Performed by S.M. Stoller Corporation under DOE Contract No. DE–AC01–02GJ79491
for the U.S. Department of Energy Office of Environmental Management,
Grand Junction, Colorado

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1.0 Introduction and Background

The Moab Uranium Mill Tailings Remedial Action (UMTRA) Project Site (site) is a former uranium ore processing facility located about 3 miles northwest of the city of Moab in Grand County, Utah. It is located on the west bank of the Colorado River at the confluence with Moab Wash. The site encompasses approximately 400 acres, of which approximately 130 acres are covered by a mill tailings pile.

In 2001 the Floyd D. Spence National Defense Authorization Act (Act) was passed which required that the property title and the responsibility for cleanup be transferred from the Moab Mill Reclamation Trust to the U.S. Department of Energy (DOE). The Act mandated remediation of the site in accordance with Title I of the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978. The site is managed by the DOE Office of Environmental Management.

After all areas of the site have been remediated, a final Moab Millsite completion report will be prepared to summarize all remedial action land verification activities at the site.

This Appendix to the final completion report summarizes the results of the remediation and radiological survey data of a portion of the site known as Utah State Highway 191 (Hwy191) phase 2. The location is shown in Figure 1.

2.0 Basis for Remedial Action

Remedial action for the site has been conducted in accordance with UMTRCA; applicable provisions of the *Code of Federal Regulations* (40 CFR Part 192.12, Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings; and 40 CFR 192.22, Supplemental Standards); *Radiation Protection of the Public and the Environment* (DOE Order 5400.5); *Environment, Safety, and Health Program for Department of Energy Operations* (DOE Order 5480.1B); the National Environmental Policy Act (42 *United States Code* 4321); and all other applicable environmental regulations with an emphasis on maintaining all health and safety risks as low as reasonably achievable.

3.0 Cleanup Standards

3.1 Regulatory Standards

The cleanup standards, based on compliance with 40 CFR 192.12, are summarized in Table 1. This standard requires that the concentration of radium-226 (Ra-226) for the 0- to 15-centimeter (cm) soil layer must be 5 picocuries per gram (pCi/g) above background or less. Since the Ra-226 background for the site is 0.8 pCi/g (see section 3.2), the cleanup standard is 5.8 pCi/g for surface soil. For soil layers deeper than 15 cm the requirement is that Ra-226 must be 15 pCi/g above background or less. Therefore, the cleanup standard is 15.8 pCi/g for subsurface soil layers.

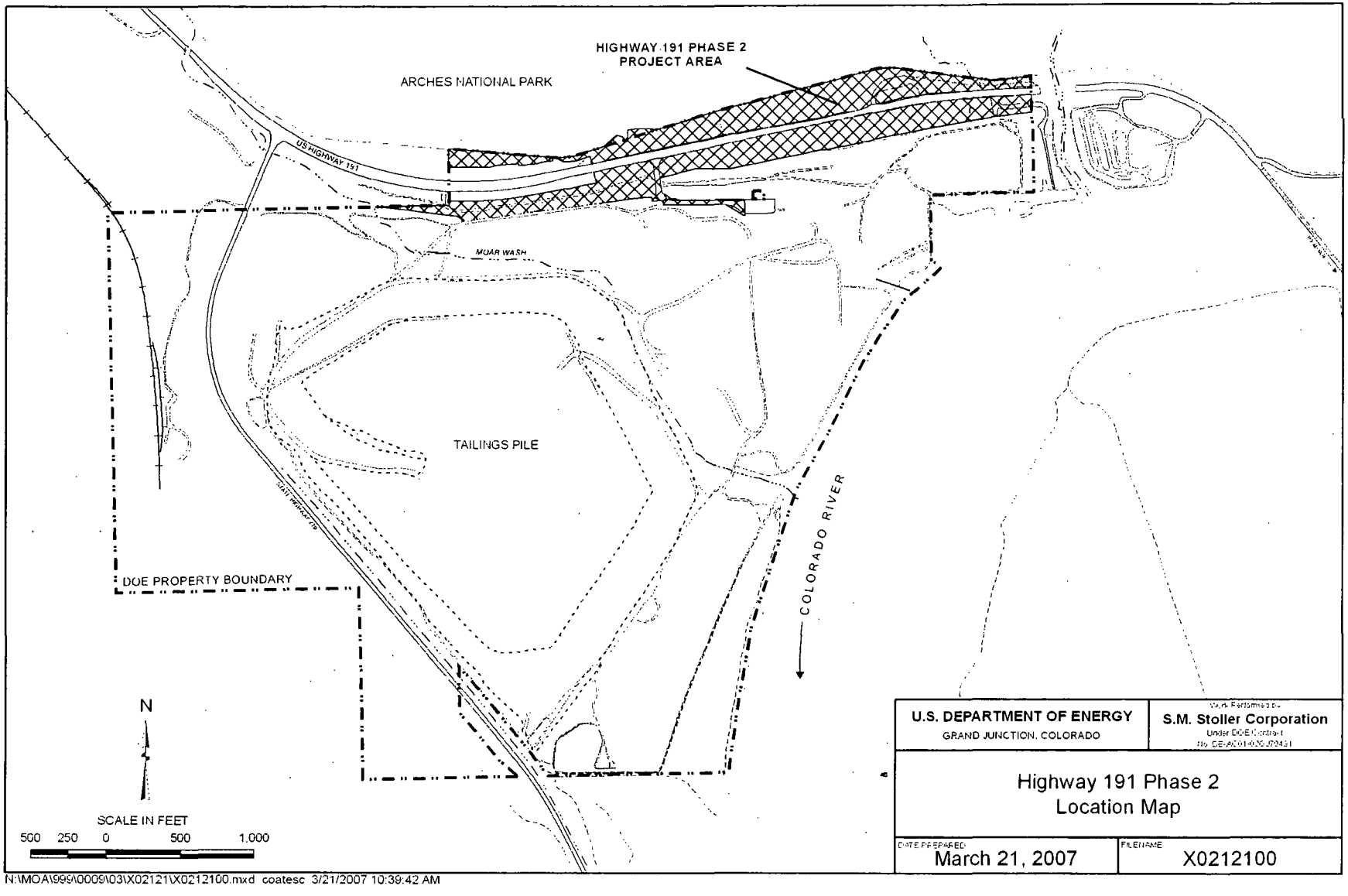

Figure 1. Site Location Map Showing the Highway 191 Phase 2 Project Area

Because thorium-230 (Th-230) decays to Ra-226, the Th-230 goals are based on a level of Th-230 that will ensure the site meets the Ra-226 standard over a 1,000-year performance period. The amount of Th-230 that can be left in place is dependent upon the amount of Ra-226 that is also left, as shown in Table 1. The Th-230 concentrations measured during assessment of this area ranged from 2.1 to 68.1 pCi/g. The average ratio of Th-230 to Ra-226 was 1.41. Uranium concentrations found during assessment ranged from 2.48 to 64.21 pCi/g. The average ratio of total uranium to Ra-226 averaged 1.13. This indicates that remediation activities to meet the Ra-226 standard will also reduce the Th-230 and uranium to levels that will ensure the site will not exceed the Ra-226 standard over the 1,000-year performance period specified in the standard.

Table 1. Cleanup Standards

Remediation Goals				
	Surface (including background)		Subsurface (including background)	
Ra-226	5.8 pCi/g		15.8 pCi/g	
Th-230	Ra-226 (pCi/g)	Th-230 (pCi/g)	Ra-226 (pCi/g)	Th-230 (pCi/g)
	1.0	14.6	1.0	43.2
	2.0	12.7	2.0	41.2
	3.0	10.9	3.0	39.5
	4.0	9.0	4.0	37.6
	5.0	7.2	5.0	35.7
	5.8	5.8	6.0	33.9
			7.0	32.0
			8.0	30.2
			9.0	28.3
			10.0	26.5
			11.0	24.6
			12.0	22.8
			13.0	20.9
			14.0	19.1
			15.0	17.2
			15.8	15.8
Total Uranium (pCi/g)	Not applicable in this remediation area		Not applicable in this remediation area	

3.2 Background Soil Radionuclide Concentrations

Soil radionuclide-concentration background values are summarized in Table 2. Background soil values for the site were determined from laboratory analysis of eight samples collected from four offsite background locations in November 2001.

Table 2. Background Soil Radionuclide Concentrations

Criterion	Background Value
Radium-226 Concentration in Soil	0.8 pCi/g
Thorium-230 Concentration in Soil	0.5 pCi/g
Total Uranium Concentration in Soil	1.2 pCi/g

4.0 Description of Area of Remediation

The Hwy191 phase 2 project area includes approximately 117,608 square meters (m^2) (29 acres). The project area includes the right-of-way adjacent to Hwy191 and the northern edge of the millsite (Figure 1). Residual radioactive material (RRM) consisted of uranium mill tailings and uranium ore contaminated soils. Crossing Hwy191 phase 2 are three features that will be addressed in separate supplemental standards applications. The first supplemental standards area is north of Hwy191 and is a bike path that was built on top of an abandoned section of the highway. The second supplemental standards area is a strip along the north and south edges of Hwy191 where a 1:1 slope containing RRM was left in place to ensure the stability and safety of the highway. The third supplemental standards area is south of Hwy191 and consists of a utility corridor containing fiber optic and electrical lines and three underground high-pressure gas lines. After remediation was completed, a portion of the electrical line in this area was rerouted and the old line was abandoned. The abandoned portion will be remediated at a later date.

The original property characterization is reported in the *Radiological Assessment for the Non-Pile Areas of the Moab Project Site* (DOE 2005a). The areas and depths of contamination that were assessed for Hwy191 phase 2 are shown in Plate 1.

5.0 Work Performed

5.1 Instrumentation

Gamma scintillometers were used to identify areas where elevated gamma levels indicate possible Ra-226 contamination. The types of scintillometers used included handheld Mount Sopris SC-132s, and Ludlum 44-10 sodium-iodide detectors mounted on an All-Terrain Vehicle (ATV) or in a backpack unit. Both types of scintillometers can be shielded (collimated) with lead around the sides of the detector. Collimated instruments were used to minimize elevated gamma (shine) caused by adjacent areas that were not yet remediated. Uncollimated instruments were used to maximize sensitivity for locating gamma anomalies. The ATV and backpack scintillometers were linked with a global positioning system (GPS) for mapping the location of the gamma measurements. These systems are referred to as gamma-scanning GPS (GS/GPS). The accuracy of the GPS for the ATV-mounted units is approximately plus or minus 4.6 m (15 ft.). The accuracy of the backpack-mounted units is approximately plus or minus 1 m (3 ft.)

Soil samples were analyzed on-site using a sodium-iodide-based Opposed Crystal System (OCS) for Ra-226. Verification to the 40 CRF 192 soil standards was based upon the OCS data. In accordance with quality control procedures, a minimum of 5 percent of the OCS verification samples were submitted to an independent analytical laboratory.

Soil samples were also analyzed on-site for uranium using an Ortec Gamma Gauge© high-purity germanium (HPGe) detector. The HPGe is used for screening and is considered a semi-quantitative method.

Instrument procedures are included in *Field Services Procedures Manual* (STO 203). All instruments had daily operation checks performed in accordance with the *Field Services Procedures Manual* (STO 203).

5.2 Characterization Survey Prior to Remediation

In order to determine which areas of the millsite required remediation to meet the cleanup standards, the millsite was characterized by S.M. Stoller between November 2001 and February 2005. A map of the areas and depths of assessed contamination within the Hwy191 phase 2 are shown in Plate 1 and discussed in the *Radiological Assessment for Non-Pile Areas of the Moab Project Site* (DOE 2005a). That report also provides a description of the methods used to characterize the site. It was approved by the DOE and was submitted to the Nuclear Regulatory Commission (NRC) for review. Review comments received from the NRC were resolved prior to the start of remediation.

5.3 Remediation

Remediation began in July 2006 and was completed in November 2006. Surveys of the remediated areas were performed in accordance with the *Field Services Procedure Manual* (STO 203). After excavation to the assessed depth of contamination, the excavations were 100 percent gamma scanned with handheld gamma scintillometers to locate any areas above the background gamma range that required further removal. Where required, excavation control soil samples were collected to further delineate areas for removal.

The asphalt-paved turnoff for Hwy191 (Verification Grid MJ and MK) was remediated by power washing the windblown contamination from the surface and cracks in the asphalt until background gamma exposure rates were obtained.

RRM that were removed from the Hwy191 phase 2 area consisted of uranium mill tailings and uranium ore contaminated soils. Depths of removal ranged from 15 cm (6 inches) for surficial contamination to 3.05 m (10 feet) on the west end of the project area where a storm drain culvert went under Hwy191and drained to the south. The contaminated material was stockpiled on-site in the tailing pile area. After completion of the disposal cell at Crescent Junction, Utah, the material will be transported there for disposal.

5.4 Verification

Verification was based on meeting the 40 CFR 192 standards for Ra-226 concentrations in soil. Gamma scanning and soil sampling were used to verify that the cleanup standards were achieved. Areas of Hwy191 phase 2 that are designated on Plates 1 and 2 as "backfilled" were verified to the subsurface radium-in-soil standard of 15.8 pCi/g. All other areas were verified to meet the surface standard of 5.8 pCi/g.

5.4.1 Reference Grids

After excavation was complete, a predetermined grid measuring 210 m × 180 m was overlain on the verification area. The verification grid areas are identified by a "V" for verification plus two letters (e.g., grid V-ML). Each grid area was subdivided into 378 smaller verification blocks measuring 10 m × 10 m (100 m^2). Blocks are uniquely identified by the alphabetic identifier and

location number within the larger grid (e.g., V-ML-370). Composite verification soil samples were collected from the verification blocks shown in Plates 1 and 2.

5.4.2 Gamma Scan Measurements

The accessible excavated surface was 100 percent scanned for gamma using the handheld scintillometers. To minimize the amount of soil sampling required, field personnel determined a range of gamma reading that were representative of the background in the excavated area. The background ranges are shown in Table 3.

Table 3. Verification Background Gamma Levels

Type of Measurement	Background Value
Collimated Surface 0 to 15 cm Excavation	4 to 8 µR/hr*
Collimated Subsurface >15 cm Excavation	4 to 8 µR/hr
Uncollimated Surface 0 to 15 cm Excavation	12 to 20 µR/hr
Uncollimated Subsurface >15 cm Excavation	12 to 20 µR/hr

*µR/hr microroentgens per hour

To determine the background ranges, the GS/GPS data were used to calculate the average gamma for verification blocks where soil sampling showed the block met the cleanup standard. The paired average gamma and Ra-226 soil results for the gamma data are shown in Table 4, and graphically presented in Figures 2 through 5. The block locations are shown in Plates 1 and 2.

The results of the GS/GPS scans prior to backfilling and final grading are shown in Plate 2. No GS/GPS data were collected for block V-LH-205 and the blocks to the south because they were verified by 100 percent soil sampling. Block V-ML-194 was also verified by soil sampling. The other areas on Plate 2 which do not show gamma measurements are due to imprecision in the GPS locations.

After removal of contaminated material, the excavated area north of Hwy191 in verification grids V-MK and V-ML was gamma scanned using uncollimated instruments. Uncollimated instruments were used because the excavation was too deep for the ATV-mounted scanner, and a backpack unit with a collimated sodium-iodide detector was not available until later in the project.

A line of elevated gamma readings between blocks V-MK-106 and V-MK-89 is due to remediation of that area in two stages. The elevated gamma readings were detected along the boundary of the area that was remediated first, and were caused by contaminated material in the area that was removed later. The same effect shows up west of block V-ML-066. Elevated gamma readings adjacent to the supplemental standards areas were investigated during remedial action and are due to shine from contamination in the sides of the excavation and in the supplemental standards area.

Future completion report appendix packages will demonstrate the reduction of gamma levels after remediation of the remaining adjacent areas. At a future date an application for the use of supplemental standards for the utility corridors will be submitted, because the risks and excessive cost associated with excavation of the area are expected to outweigh the benefits of remediation.

5.4.3 Soil Measurements

After remediation, the level of Ra-226 in soil was verified by collecting composite soil samples from selected 100-m^2 verification blocks. Composite samples were taken by dividing a block into approximately nine equal sub-blocks and then collecting an aliquot at the center of each sub-block. Soil samples were analyzed for Ra-226 using the OCS method. The blocks were randomly selected by verification personnel to give a representative coverage of the remediated area. Some areas were sampled at a greater frequency while the background gamma range (Section 5.4.2) was being developed; or to verify that elevated gamma levels along the edges of excavations were due to shine from adjacent, unremediated areas.

The results of the OCS analyses for Ra-226 are provided in Table 4. There were 124 OCS soil samples collected, and 11 were submitted to an independent laboratory for confirmatory analysis. This meets the quality control guidance in the *Field Services Procedures Manual* (STO 203) that requires 5 percent of the samples be submitted to an outside laboratory.

One of the confirmatory samples, V-MK-201, had a Ra-226 value of 6.01 pCi/g based on laboratory testing. This exceeds the surface cleanup standard of 5.8 pCi/g. However, the verification of the property is based on the OCS result which was 3.70 pCi/g. The cleanup standard is within the uncertainty of the laboratory measurement for this sample which is ±0.754 pCi/g.

The independent laboratories that performed the quality control analyses were Severn Trent Laboratories St. Louis (STL) and Paragon Analytics Laboratories. STL analyzed Ra-226 by method EML GA-01-R MOD, Th-230 by method EML A-01-R MOD, and uranium by method EPA 6020. Paragon analyzed Ra-226 by method SOP713R8, Th-230 by SOP714R10, and uranium by method EPA 6020. All methods are approved by DOE.

As indicated in Table 4, the laboratory analytical results validated the use of OCS for soil verification. The 11 verification samples measured by both the OCS and the independent laboratory averaged 2.8 pCi/g according to the OCS method and 3.14 pCi/g in the laboratory. Therefore, OCS results collected in the field can be considered conservative and are a valid verification measurement.

Table 4. Summary of Soil Data and Gamma Data After Remedial Excavation

Verification Block ID	Sample Ticket No.	Sample Date	Sample Depth (cm)	OCS Ra-226 (pCi/g)	HPGe U (pCi/g)	Lab Ra-226 (pCi/g)	Lab Th-230 (pCi/g)	Lab U (pCi/g)	Average Collimated Gamma (µR/hr)	Average Uncol. Gamma (µR/hr)
V-LF-019	NEN 279	08/07/06	0 to 15	1.60					4.36	
V-LF-038	NEN 280	08/07/06	0 to 15	1.60					3.80	
V-LF-042	NEN 281	08/07/06	0 to 15	1.17					3.84	
V-LF-238	NEN 478	09/18/06	0 to 15	2.79					5.20	
V-LF-244	NEN 479	09/18/06	0 to 15	1.54					6.31	
V-LF-293	NEN 488	09/24/06	0 to 15	2.17		0.80	0.72	2.62	6.80	
V-LG-004	NEN 308	08/07/06	0 to 15	1.40					4.34	
V-LG-029	NEN 309	08/07/06	0 to 15	1.80					4.95	
V-LG-033	NEN 310	08/07/06	0 to 15	0.78					5.16	
V-LG-044	NEN 282	08/07/06	0 to 15	1.89					3.73	
V-LG-168	NEN 475	09/18/06	0 to 15	0.24					4.82	
V-LG-210	PAA 297	04/16/07	0 to 15	2.66					7.98	
V-LG-247	NEN 485	09/24/06	0 to 15	1.37					6.09	

Table 4. Summary of Soil Data and Gamma Data After Remedial Excavation (continued)

Verification Block ID	Sample Ticket No.	Sample Date	Sample Depth (cm)	OCS Ra-226 (pCi/g)	HPGe U (pCi/g)	Lab Ra-226 (pCi/g)	Lab Th-230 (pCi/g)	Lab U (pCi/g)	Average Collimated Gamma (µR/hr)	Average Uncol. Gamma (µR/hr)
V-LG-259	NEM 487	09/24/06	0 to 15	1.45					7.50	
V-LH-006	NEN 408	08/21/06	>15	6.90					6.30	
V-LH-037	NEN 489	09/26/06	>15	0.46					5.44	
V-LH-039	NEN 471	09/18/06	>15	0.95					6.40	
V-LH-055	NEN 465	09/18/06	0 to 15	0.91					4.95	
V-LH-071	NEN 472	09/18/06	0 to 15	0.41					4.75	
V-LH-082	NEN 467	09/18/06	0 to 15	1.38		1.70	1.24	5.24	5.40	
V-LH-098	NEN 476	09/18/06	0 to 15	2.74					4.67	
V-LH-101	NEN 490	09/24/06	>15	2.91					7.60	
V-LH-110	NEN 492	09/18/06	0 to 15	1.16					6.63	
V-LH-115	NEN 477	09/18/06	0 to 15	0.71					5.02	
V-LH-160	NEN 482	09/26/06	0 to 15	1.20					6.22	
V-LH-161	PAA 298	04/16/07	0 to 15	1.68					6.56	
V-LH-162	PAA 301	04/16/07	0 to 15	3.49					7.54	
V-LH-163	NEN 491	09/25/06	>15	4.41					6.44	
V-LH-169	PAA 299	04/16/07	0 to 15	3.52					7.37	
V-LH-170	PAA 300	04/16/07	0 to 15	3.25					7.66	
V-LH-171	NEN 483	09/26/06	0 to 15	1.30					7.18	
V-LH-172	PAA 290	04/11/07	0 to 15	1.18					6.93	
V-LH-173	PAA 291	04/11/07	0 to 15	2.06					7.75	
V-LH-175	PAA 292	04/11/07	0 to 15	1.20					5.42	
V-LH-176	PAA 293	04/11/07	0 to 15	0.64					5.47	
V-LH-177	PAA 294	04/11/07	0 to 15	2.20					5.63	
V-LH-178	PAA 302	04/16/07	0 to 15	0.25					5.67	
V-LH-194	PAA 286	04/11/07	0 to 15	2.10					8.95	
V-LH-195	NEN 484	09/26/06	0 to 15	1.00					6.26	
V-LH-196	PAA 287	04/11/07	0 to 15	0.76					6.36	
V-LH-197	PAA 288	04/11/07	0 to 15	1.09					8.96	
V-LH-198	PAA 289	04/11/07	0 to 15	0.97					11.73	
V-LH-199	PAA 009	10/03/06	0 to 15	2.95					8.32	
V-LH-201	PAA 010	10/03/06	0 to 15	2.99		2.32	0.38	3.45	7.33	
V-LH-204	PAA 014	10/03/06	0 to 15	4.03					6.01	
V-LH-205	PAA 011	10/03/06	>15	2.52					7.50	
V-LH-226	PAA 012	10/03/06	>15	1.83					7.97	
V-LH-229	PAA 006	10/02/06	>15	1.23					4.36	
V-LH-247	NEM 325	05/09/05	>15	2.80					7.04	
V-LH-247A	PAA 013	10/03/06	>15	3.75						
V-LH-268	NEM 333	05/09/05	>15	1.81						
V-LH-289	NEM 339	05/09/05	>15	1.80						
V-LI-001	NEN 470	09/18/06	0 to 15	1.20					4.69	
V-LI-018	NEN 466	09/18/06	0 to 15	1.44					4.41	
V-LI-031	NEN 473	09/18/06	0 to 15	2.64		3.15	2.12	3.58	4.91	
V-LI-034	NEN 474	09/18/06	0 to 15	1.32					4.56	
V-LI-046	NEN 468	09/18/06	0 to 15	1.16					4.35	
V-LI-215	PAA 008	10/02/06	>15	0.74					4.66	
V-LI-223	PAA 021	10/23/06	>15	1.31					4.78	
V-LI-243	PAA 007	10/02/06	>15	1.58					4.26	
V-MH-287	NEM 523	07/31/06	0 to 15	3.80					4.75	
V-MH-323	NEM 524	07/31/06	0 to 15	2.30					4.53	
V-MH-334	NEN 411	08/21/06	0 to 15	3.30					5.00	
V-MH-351	NEN 409	08/21/06	0 to 15	0.80					4.81	
V-MH-368	NEN 410	08/21/06	0 to 15	2.40	1.09	1.30	1.35	3.38	4.81	
V-MI-162	NEM 525	07/31/06	0 to 15	3.68					5.80	16.6
V-MI-189	NEN 305	08/07/06	0 to 15	1.00					4.29	15.7
V-MI-197	NEM 526	07/31/06	0 to 15	1.55					5.09	16.8
V-MI-208	NEN 304	08/07/06	0 to 15	4.30					4.63	18.5
V-MI-227	NEN 395	08/14/06	0 to 15	1.32					4.42	17.5
V-MI-230	NEN 389	08/14/06	0 to 15	1.03					4.40	21.1

Table 4. Summary of Soil Data and Gamma Data After Remedial Excavation (continued)

Verification Block ID	Sample Ticket No.	Sample Date	Sample Depth (cm)	OCS Ra-226 (pCi/g)	HPGe U (pCi/g)	Lab Ra-226 (pCi/g)	Lab Th-230 (pCi/g)	Lab U (pCi/g)	Average Collimated Gamma (µR/hr)	Average Uncol. Gamma (µR/hr)
V-MI-240	NEN 414	08/21/06	0 to 15	1.60					5.37	
V-MI-244	NEN 400	08/14/06	0 to 15	2.80					4.52	17.8
V-MI-259	NEN 415	08/21/06	>15	5.60					5.12	
V-MI-264	NEN 399	08/14/06	0 to 15	1.83					4.80	21.1
V-MI-278	NEN 416	08/21/06	>15	6.08					5.36	
V-MI-295	NEN 413	08/21/06	0 to 15	1.56		2.55	1.91	3.45	5.02	
V-MI-297	NEN 412	08/21/06	0 to 15	2.90					4.98	
V-MI-333	NEN 463	09/18/06	0 to 15	1.09					4.51	
V-MI-349	NEN 464	09/18/06	0 to 15	1.98					8.23	
V-MI-364	NEN 469	09/18/06	0 to 15	1.58					5.71	
V-MJ-019	NEM 528	07/31/06	0 to 15	3.10					4.19	12.0
V-MJ-072	NEM 529	07/31/06	0 to 15	3.60					5.26	15.5
V-MJ-089	NEM 527	07/31/06	0 to 15	3.89					5.25	15.3
V-MJ-115	NEN 301	08/07/06	0 to 15	1.07					4.32	15.1
V-MJ-118	NEN 302	08/07/06	0 to 15	0.19					3.87	13.5
V-MJ-121	NEN 303	08/07/06	0 to 15	2.35					4.29	14.2
V-MJ-147	NEN 382	08/14/06	>15	2.02					4.64	15.9
V-MJ-150	NEN 306	08/07/06	0 to 15	1.20					4.36	15.7
V-MJ-153	NEN 307	08/07/06	0 to 15	1.10					4.53	16.2
V-MJ-162	NEN 383	08/14/06	0 to 15	2.10					4.22	
V-MJ-177	NEN 386	08/14/06	0 to 15	1.40					4.22	17.5
V-MJ-181	NEN 384	08/14/06	0 to 15	0.94		2.03	1.76	5.10	4.71	
V-MJ-193	NEN 387	08/14/06	0 to 15	4.70					4.96	22.0
V-MJ-196	NEN 385	08/14/06	0 to 15	0.80					4.38	
V-MJ-211	NEN 388	08/14/06	0 to 15	1.60					4.53	17.9
V-MJ-250	NEN 438	09/11/06	0 to 15	0.98					4.29	
V-MJ-262	NEN 447	09/11/06	0 to 15	1.20					4.64	
V-MJ-265	NEN 448	09/11/06	0 to 15	3.10					4.60	
V-MJ-268	NEN 449	09/11/06	0 to 15	2.40					5.37	
V-MJ-273	NEN 446	09/11/06	0 to 15	4.00					5.24	
V-MJ-295	NEN 453	09/18/06	0 to 15	1.43					4.80	
V-MJ-298	NEN 462	09/18/06	0 to 15	3.32					5.32	
V-MJ-301	NEN 450	09/11/06	0 to 15	2.49					5.63	
V-MJ-304	NEN 452	09/11/06	0 to 15	1.81					5.32	
V-MJ-309	NEN 451	09/11/06	0 to 15	2.01					4.64	
V-MK-043	NEM 531	07/31/06	0 to 15	3.02	1.89	2.21	3.27		4.80	13.4
V-MK-048	NEM 530	07/31/06	>15	1.56					4.39	12.3
V-MK-082	NEM 463	07/24/06	>15	4.12					5.70	14.6
V-MK-084	NEM 464	07/24/06	>15	4.05	2.23	4.42	3.36	3.17	5.89	15.4
V-MK-089	NEM 465	07/24/06	>15	3.47					5.22	15.0
V-MK-094	NEM 518	07/24/06	>15	4.55					6.07	15.8
V-MK-100	NEM 519	07/24/06	>15	4.60					5.73	14.6
V-MK-106	NEM 520	07/24/06	>15	1.50					5.12	14.1
V-MK-111	NEN 381	08/14/06	>15	4.00					5.55	18.7
V-MK-192	NEN 432	09/11/06	0 to 15	1.00					4.39	
V-MK-196	NEN 433	09/11/06	0 to 15	3.40					4.76	
V-MK-201	NEN 434	09/11/06	0 to 15	3.70		6.01	4.67	4.13	5.58	
V-MK-220	NEN 435	09/11/06	0 to 15	2.00					4.48	
V-MK-235	NEN 436	09/11/06	0 to 15	1.59					4.38	
V-MK-238	NEN 437	09/11/06	0 to 15	1.66					4.51	
V-ML-066	NEM 521	07/24/06	>15	6.80	9.14	8.05	6.90	6.27	6.87	18.6
V-ML-070	NEM 522	07/24/06	>15	2.60					6.40	16.6
V-ML-194	NEN 481	09/26/06	>15	1.50						

Note: Blank cells indicate no measurement for that analyte or by that method were taken.
* Average gamma is based on multiple collimated GS/GPS readings for the verification block.

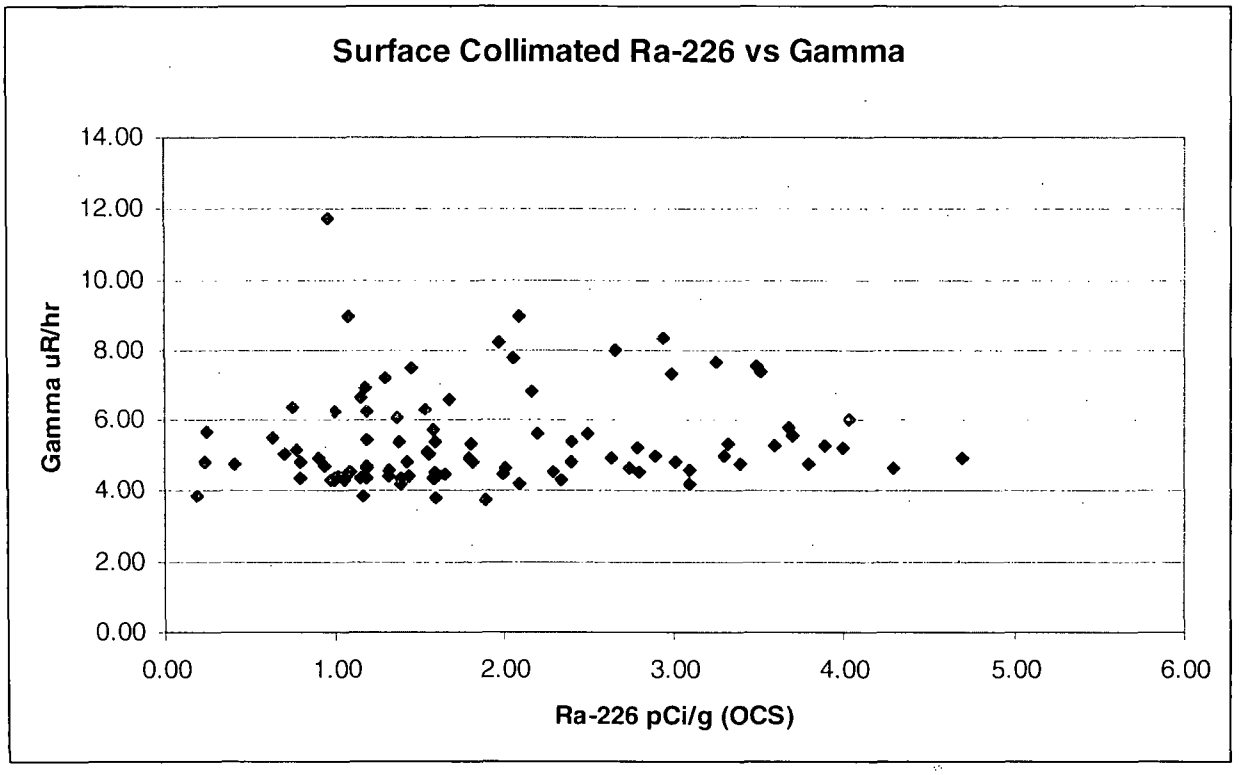

Figure 2. Collimated Data for Areas Verified to the Surface Standard

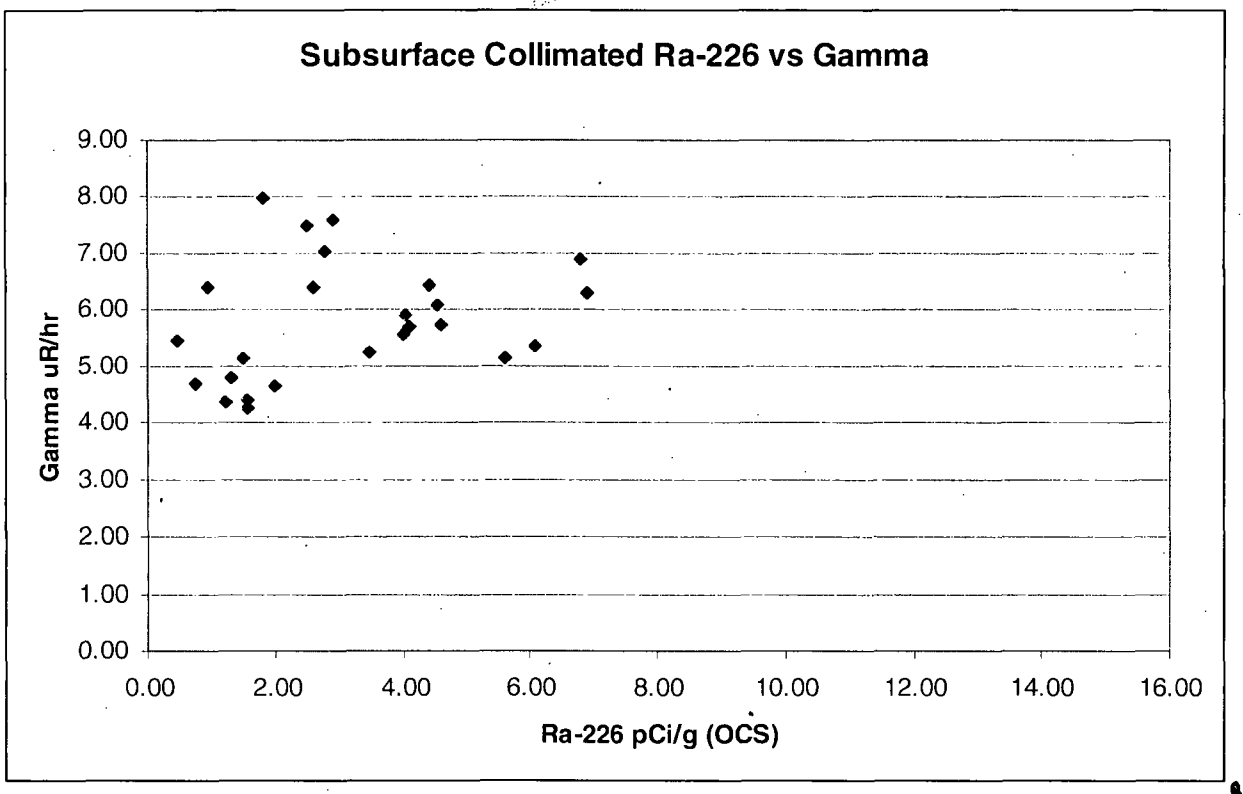

Figure 3. Collimated Data for Areas Verified to the Subsurface Standard

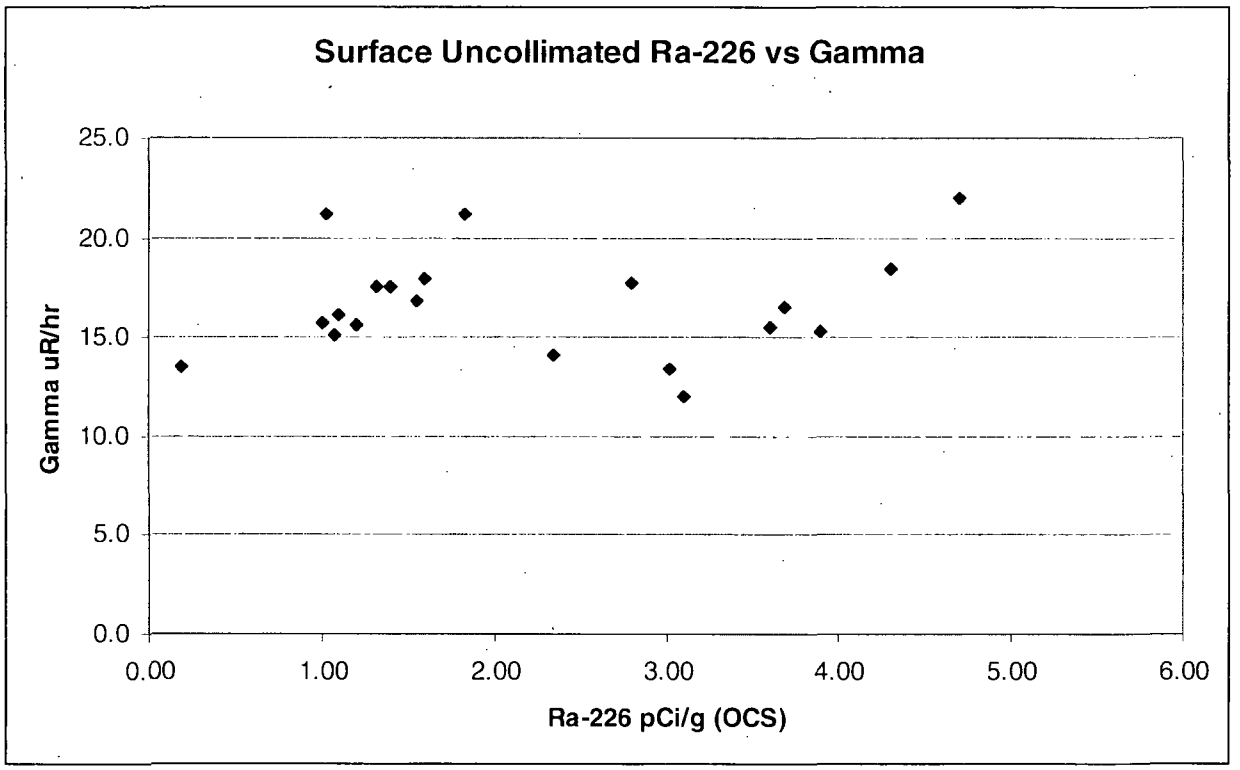

Figure 4. Uncollimated Data for Areas Verified to the Surface Standard

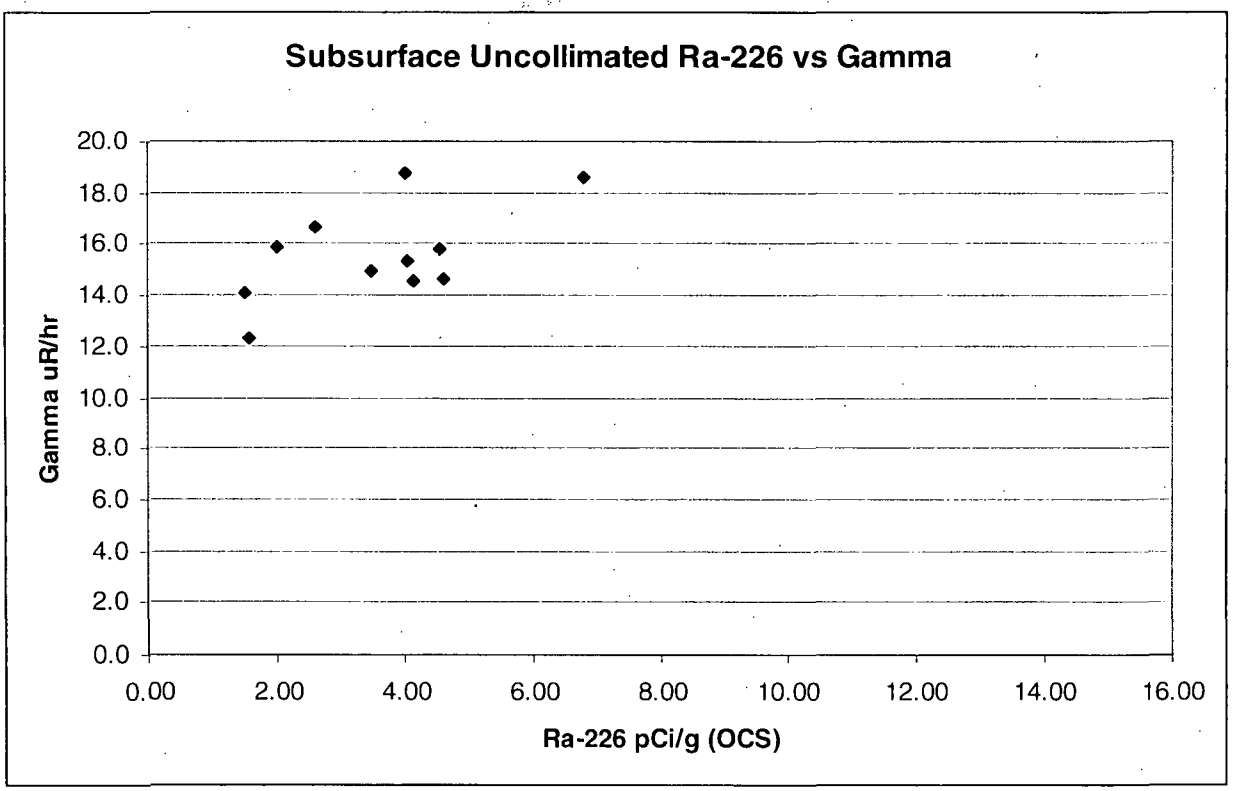

Figure 5. Uncollimated Data for Areas Verified to the Subsurface Standard

6.0 Final Condition

A summary of radiological results after remediation is provided in Table 5. Because of limitations of current technology and procedures for identifying and remediating RRM, unknown deposits of contamination may exist below the levels excavated during this remediation. After remediation the area was contoured and planted with native vegetation.

Table 5. Summary of Radiological Release Survey Results

Certification Criteria	Number of Observations	Cleanup Standard	Cleanup Standard Including Background	Results pCi/g
Ra-226 (pCi/g) Surface	95	Shall not exceed 5 pCi/g above background in the surface to 15-cm layer, averaged over 100 m^2	5.8	OCS Analysis Sample mean = 1.93 Maximum = 4.70 Std. dev = 1.04 $z_{95\%}$ = 1.65 $\mu_{95\%}$ = 2.11
Th-230 (pCi/g) Surface	9	Shall not exceed 5 pCi/g above background in the surface to 15-cm layer based averaged over 100 m^2	5.8	Laboratory Analysis Sample mean = 1.94 Maximum = 4.67
Ra-226 (pCi/g) Subsurface	29	Shall not exceed 15 pCi/g above background in any 15-cm-thick soil layer more than 15 cm below the surface, averaged over 100 m^2	15.8	OCS Analysis Sample mean = 3.02 Maximum = 6.90 Std. dev = 1.82 $z_{95\%}$ = 1.65 $\mu_{95\%}$ = 3.57
Th-230 (pCi/g) Subsurface	2	Shall not exceed 16 pCi/g above background in any 15-cm-thick soil layer more than 15 cm below the surface, averaged over 100 m^2	15.8	Laboratory Analysis Sample mean = 5.13 Maximum = 6.90
Uranium Surface	8	Not determined	Not determined	Laboratory Analysis Sample mean = 3.69 Maximum = 5.24
Uranium Subsurface	2	Not determined	Not determined	Laboratory Analysis Sample mean = 4.72 Maximum = 6.27

NA = not applicable
n = number of measurements
$z_{95\%}$ = z distribution statistic at 95% confidence (> 15 cm, n = 95 for 0 to 15 cm)
$\bar{x}$ = sample mean
S = Std. dev., the sample standard deviation
$\mu_{95\%}$ = upper limit of the true population mean at the 95 percent confidence level, using the following equation:

$$\mu_{95\%} = \bar{x} + z_{95\%} \frac{s}{\sqrt{n}}$$

6.1 Areas Verified to the Subsurface Standard (>15 cm)

The 40 CFR 192 standard for subsurface areas is 15.8 pCi/g Ra-226. For subsurface areas the maximum concentration was 6.90 pCi/g, which is below the cleanup standard (Table 5). The mean Ra-226 concentration was 3.02 pCi/g. The projected upper limit of the mean concentration, calculated at the 95 percent confidence level, was 3.57 pCi/g. These results indicate that the radionuclide concentrations do not exceed the cleanup standards; therefore, all cleanup criteria have been met for the areas verified to the subsurface standard.

All areas verified to the subsurface standard were backfilled with a minimum of 15 cm (6 inches) of material with an average Ra-226 concentration of 0.6 pCi/g. Backfill soil sample results are shown in Table 6.

Table 6. Backfill Data

Sample Identification	OCS Ra-226 (pCi/g)
LeGrande Pit #1	0.3
LeGrande Pit #2	0.4
LeGrande Pit #3	1.2

6.2 Areas Verified to the Surface Standard

For areas verified to the surface standard, the maximum concentration of Ra-226 was 4.70 pCi/g, which is below the cleanup standard of 5.8 pCi/g (Table 5). The mean concentration was 1.93 pCi/g. The projected upper limit of the mean concentration, calculated at the 95 percent confidence level, was 2.11 pCi/g. These results indicate that the radionuclide concentrations do not exceed the cleanup standards; therefore, all cleanup criteria have been met for the areas verified to the surface standard.

6.3 Areas That Did Not Require Remediation

The millsite characterization (Section 5.2) demonstrated that some areas of Hwy191 phase 2 were below the 40 CFR 192 cleanup standards and therefore did not require remediation. The data from these areas is shown in Table 7 and the locations are shown on Plates 1 and 2.

Table 7. Radium-226, Thorium-230, and Uranium Data in Areas that Were Not Remediated

Location	Sample Depth (cm)	OCS Ra-226 (pCi/g)	Borehole Ra-226 (pCi/g)	Lab Ra-226 (pCi/g)	Lab Th-230 (pCi/g)	Lab Uranium (pCi/g)
R0395	0 to 15	4.38				
R0396	0 to 15	3.43				
R0397	0 to 15	4.96				
R0398	0 to 15	2.06				
R0400	0 to 15		2.24			
R0401	0 to 15	0.98				
R0402	0 to 15	2.34				
R0403	0 to 15	3.60				
R0404	0 to 15	3.02				
R0569	0 to 15	1.10				
R0570	0 to 15	1.96				
R0572	0 to 15	0.87				
R0573	0 to 15	0.17				
R0574	0 to 15	0.80				
R0575	0 to 15	0.77				
R0592	0 to 15		2.76	1.82	2.7	4.7

Note: Blank cells indicate no measurement for that analyte or by that method were taken.

7.0 References

40 CFR 192.12. EPA (Environmental Protection Agency), Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, *Code of Federal Regulations,* March 2007.

40 CFR 192.22, EPA (Environmental Protection Agency), Supplemental Standards, *Code of Federal Regulations,* March 2007.

42 U.S.C. 4321. EPA (Environmental Protection Agency), National Environmental Policy Act, *United States Code*, January 2007.

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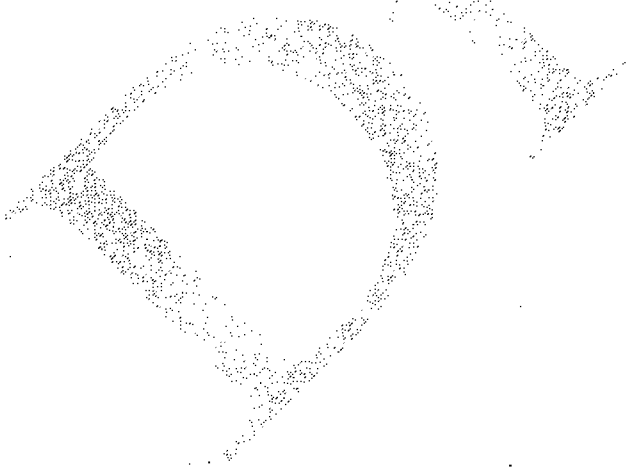

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