Memorandum

To:	Roy Blickwedel General Electric	From:	Toby Leeson, PG Stantec, Steamboat Springs, Colorado
File:	St. Anthony Mine, 233001076	Date:	September 4, 2018

Reference: Summary of Supplemental Materials Characterization, St. Anthony Mine

INTRODUCTION

This memorandum summarizes the results of the Supplemental Materials Characterization of mine waste at the St. Anthony Mine (the site). The work was conducted in accordance with the *Supplemental Investigations Work Plan*, dated February 20, 2018. The Site is located 40 miles west of Albuquerque, New Mexico, approximately 4.6 miles southeast of Seboyeta, New Mexico on the Cebolleta Land Grant. The mine was an open pit and underground shaft uranium mine that includes one sealed shaft, one surface-sealed vent shaft, two open pits, five inactive ponds, seven piles of non-economical mine materials (partially revegetated), three topsoil piles, and several small piles of non-economical mine materials. The mine permit boundary area covers approximately 430 acres that includes these mine features along with roads and other disturbed areas. A site layout map is included on Figure 1.

A Materials Characterization was conducted in 2007 to characterize radiological contamination in surface and subsurface soils within the mine site features, such as the waste piles (MWH, 2007). The Mining and Minerals Division (MMD) noted that soils within the areas between the mine site features were not characterized and an outer boundary for the radiological contamination was not determined, as stated in their letter dated November 24, 2015. Therefore, the Supplemental Radiological Characterization was conducted to characterize the areas within the permit boundary that were excluded from the 2007 Materials Characterization and to estimate the location of the outer boundary (lateral extent) of the mine waste. The results of the Materials Characterization (2007 and 2018) were used to estimate the location and volume of mine waste at the site and will be used in the development of the *Closeout Plan*.

The investigation field work was conducted by AVM Environmental Services, Inc. (AVM) with oversight from Stantec. AVM prepared a *Supplemental Radiologic Characterization Report* that is included as Attachment A to this memorandum. Their report describes the field investigation methods and results of the investigation, and includes gamma survey measurements, subsurface sampling and analytical results, a correlation between gamma radiation and Ra-226 concentrations, and radiologic instrument calibration and function check records.

METHODS

The field investigation included static gamma radiologic survey measurements, Global Positioning System (GPS) based scan surveys, ex-situ and in-situ gamma radiation soil screening, soil sampling and laboratory analysis. Instrumentation for direct gamma radiation level measurements included 2x2 NaI scintillation detectors (Eberline SPA-3 and Ludlum 44-10), paired with a Ludlum 2221 or 2241 scale/rate meter. The scale/rate meters were connected to a Differential Global Positioning system (DGPS) of sub-meter accuracy that has data logging and surveying software capabilities.

The site was divided into 26 zones and surveys were taken along geo-projected transects spaced 30 feet apart, with the detector held one foot above the ground surface. A scan rate of around three feet per second was used and data were collected at a one to two second interval. Transects were created within the survey areas. The survey data were then mapped onto a site map, using different colors delineating the gamma level ranges. In addition to survey areas identified in the work plan, Stantec collected gamma survey data in step-out areas (e.g., areas outside the permit boundary) where gamma measurements exceeded the investigation levels (IL) for Ra-226. The IL for Ra-226 that was used for this investigation was 6.1 pCi/g (5.0 pCi/g above mean background level). The mean background level for Ra-226 was 1.6 pCi/g (MWH, 2007).

Based on the results of the gamma scan, Stantec targeted areas with the highest Ra-226 levels and selected 24 locations for subsurface sampling and analysis from test pits (Figure 3 of Attachment A). Stantec conducted subsurface soil sampling for on-site ex-situ gamma soil screening from April 16 to April 19, 2018. Subsurface samples were taken at one-foot depth intervals from the test pits, with sampling continuing until the gamma readings were below the IL (6.6 pCi/L).

Field personnel conducted ex-situ gamma radiation soil screening from the test pits by measuring the 609 KeV region gamma radiations of Bi-214, a decay product of Ra-226. This was done by using a Ludlum 2221 paired with a Ludlum 44-20 3x3 NaI scintillation detector. As soil sample was collected and then placed in a heavily shielded counting chamber, around a plastic lined detector.

A total of 57 subsurface samples were collected from test pits and 44 soil samples were sent to the laboratory for analysis (ALS Inc., Fort Collins CO). Field QA/QC duplicates, taken at 10 percent frequency (five samples), were split in the field and included in the batch sent to the laboratory. These soil samples were analyzed for Ra-226 using EPA Method 901.1 modified.

AVM developed a site-specific correlation using regression analysis for the collimated and bare 2x2 NaI detectors to convert the detector gamma radiation levels (in cpm) to surface soil Ra-226 concentration (in pCi/g). Correlation locations were determined after investigation confirmed that elevated levels of Ra-226 in the chosen locations were limited to the surface soil and that sources of lateral gamma radiation shine were minimal. Fourteen correlation samples were sent to the laboratory for Ra-226 analysis using EPA Method 901.1 modified. Eight additional samples with some particles greater than 0.25 inches were submitted the laboratory for analysis that included all particle sizes to evaluate if there was a difference compared to the initial samples which were sieved to remove particles greater than 0.25 inches. The results of the correlation are included in Appendix C of Attachment A.

RESULTS

Gamma radiation surveys began March 19, 2018 and were completed on May 12, 2018. The gamma radiation measurements in counts per minute (cpm) were converted to Ra-226 concentrations (activity) in pCi/g using the site-specific correlation. The 2007 Materials Characterization was conducted using exposure rate measurements, which were also converted to Ra-226 concentrations using the site-specific correlation.

The results of the gamma radiation survey in cpm are shown on Figures 1 and 2 of Attachment A, and in equivalent Ra-226 concentrations in pCi/g on Figures 5 and 6 of Attachment A.

The results of the 2007 Material Characterization are also shown on Figure 5 of Attachment A. The 2007 gamma survey results showed that Waste Piles 3, 4, 6, and 7, the Crusher/Stockpile, Pit 1, and the smaller piles at the West Shaft and Ore Storage 1 and 2 areas all had gamma radiation levels above 10 pCi/g. Pile 4 had some readings of 10.1 to 25.0 pCi/g; however, the majority ranged from <1.6 pCi/g to 10 pCi/g. Soils within the other mine features surveyed in 2017 were below the IL of 6.6 pCi/g.

The lateral extent of surface soils with Ra-226 concentrations greater than the IL is generally within the permit boundary, as shown on Figure 5 of Attachment A, except for the access road and some other small areas. The access road extends to the north of the permit boundary and had consistently high gamma measurements (generally between 10.1 and 100.0 pCi/g), as shown on Figure 6 of Attachment A. Other areas where IL exceedances were measured slightly outside the permit boundary included the following:

- South of Shale Pile 1
- South of Pit 1
- Around the West Shaft Area
- North of Pit 1

The highest Ra-226 concentrations within the Site were measured in the central portion of the Site adjacent to the west side of Pile 6, within the Crusher/Stockpile, and within Pile 7. There are numerous small waste piles in the area adjacent to Pile 6 where gamma radiation was measured above 100 pCi/g. The gamma radiation levels tended to decrease with increased distance from the piles and towards the permit boundaries. Ponds 1 through 4 in the West Shaft Area had similarly elevated readings that were generally contained within the pond boundaries. Additionally, the arroyo had readings of approximately 10 to 100 pCi/g in the deepest parts of the channel and readings of 6.6 to 10 pCi/g on the banks and adjacent areas.

Laboratory testing and ex-situ soil screening results are included in Appendix B of Attachment A. These results were generally consistent with the gamma measurements converted to Ra-226 levels. The on-site ex-situ soil screening results, laboratory analytical results, and observations made in the test pits, were used to estimate the depth of IL exceedances. These depth estimates were then used to interpolate the depth of IL exceedances for the remainder of the site. The lateral extent and depths of IL exceedances (excavation limits) are shown on Figure 2 and Figure 3. Maximum depths of IL exceedances were 5.0 to greater than 6.5 feet bgs in the following areas:

- 6.5 feet bgs (or greater) between Pile 3 and Pit 2 at Test Pit 24
- 6 feet bgs near Borrow Area South at Test Pit 23
- 5 ft bgs west of the Crusher/Stockpile Area at Test Pits 4 and 5
- 5 to 6 feet bgs between Pit 1 and Pile 6 at Test Pits 11 and 13

The ground surface elevations, the lateral extent (outer boundary) of Ra-226 above the IL, the depths of IL exceedances (including the mine features that were characterized in 2007) and the interpolated depths in other areas of the site, were used to estimate the volume of mine waste with Ra-226 concentrations above the IL (6.6 pCi/g). The volume was estimated to be 8.1 million cubic yards.

CONCLUSION

The overall goal to characterize the materials between site features and estimate the lateral and vertical extent of mine waste with Ra-226 greater than the IL of 6.1 pCi/g was completed. The IL exceedances are generally contained within the permit boundary, except for the access road and small areas south of Shale Pile 1, south of Pit 1, around the West Shaft Area, and north of Pit 1. The depth of impacts throughout the site was characterized from 24 test pits and was measured from 0.5 feet to approximately 6.5 feet bgs. This information along with the results of the 2007 Materials Characterization were used to estimate the volume of mine waste at 8.1 million cubic yards.

ATTACHMENTS

Figure 1 – Site Layout
Figure 2 – Excavation Limits
Figure 3 – Excavation Limits (no contours)
Attachment A – Supplemental Radiologic Characterization, St. Anthony Mine Site

REFERENCES

MWH, 2007. *Materials Characterization Report: Saint Anthony Mine Site.* MWH. October 26.

Stantec, 2018. *St. Anthony Supplemental Investigations Work Plan.* Stantec. February 23.

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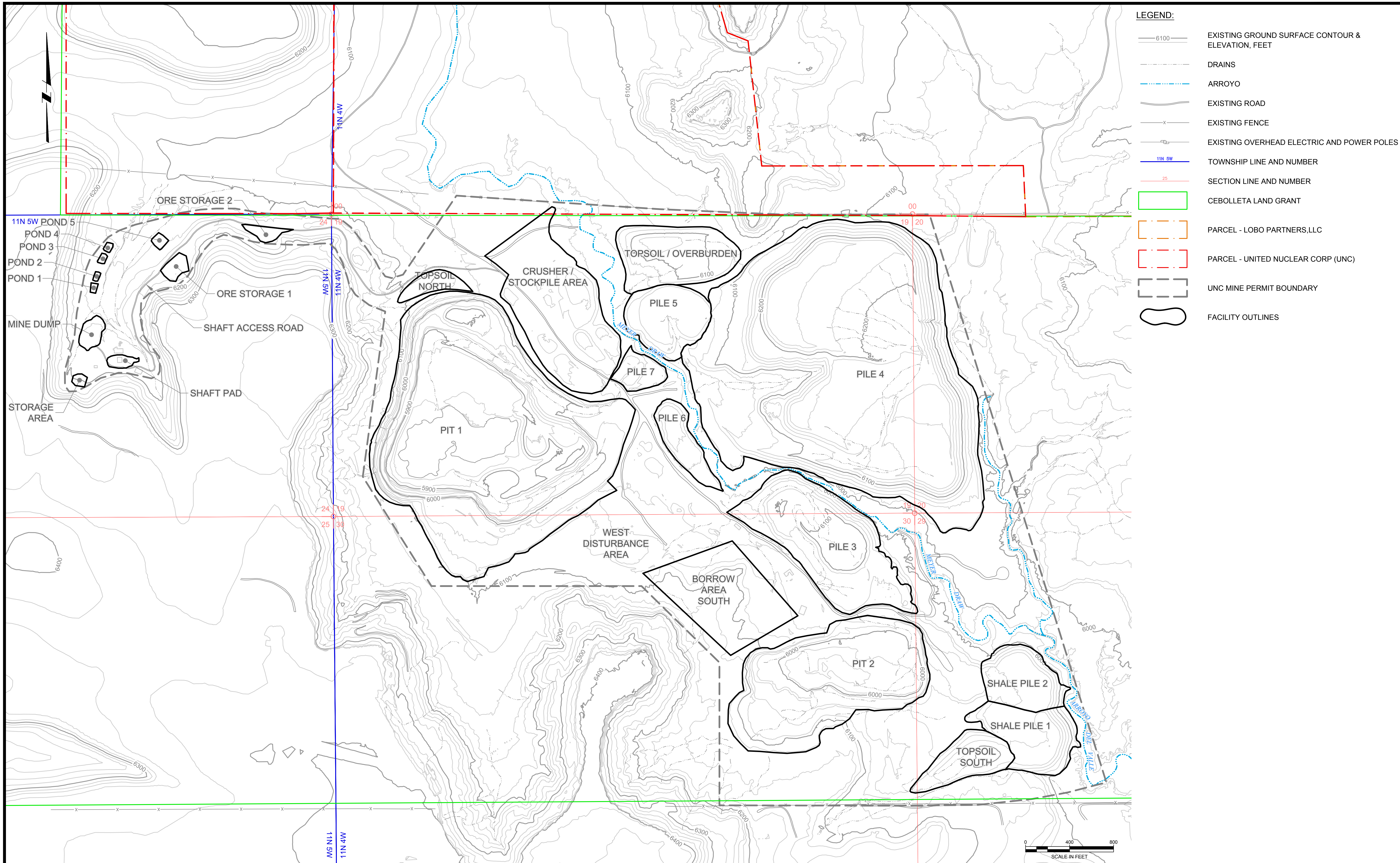
ATTACHMENTS

FIGURES



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Stantec

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CIBOLA COUNTY, NEW MEXICO

SITE LAYOUT

FIGURE

1

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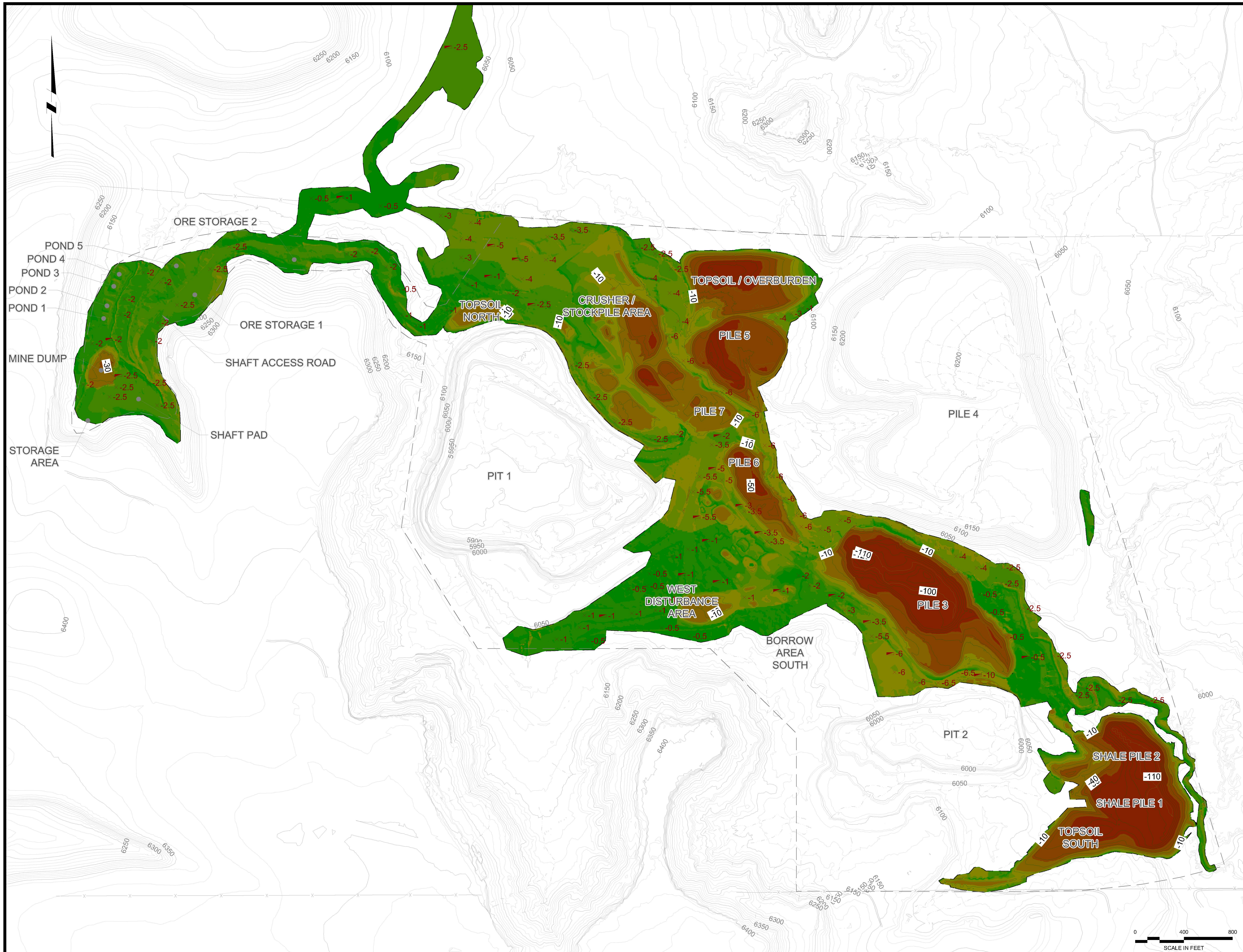

LEGEND:

6100	EXISTING GROUND SURFACE CONTOUR & ELEVATION, FEET
	DRAINS
	ARROYO
	EXISTING ROAD
	EXISTING FENCE
	EXISTING OVERHEAD ELECTRIC AND POWER POLES
	UNC MINE PERMIT BOUNDARY
-1.5	TEST PIT AND EXCAVATION DEPTH (STANTEC, 2018)

Excavation Depths

NUMBER	COLOR	MINIMUM DEPTH (FT)	MAXIMUM DEPTH (FT)
1		-138.9	-52.8
2		-52.8	-27.3
3		-27.3	-12.0
4		-12.0	-5.8
5		-5.8	-3.1
6		-3.1	-1.9
7		-1.9	-0.5
8		-0.5	34653465.0

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EXCAVATION LIMITS

FIGURE
2
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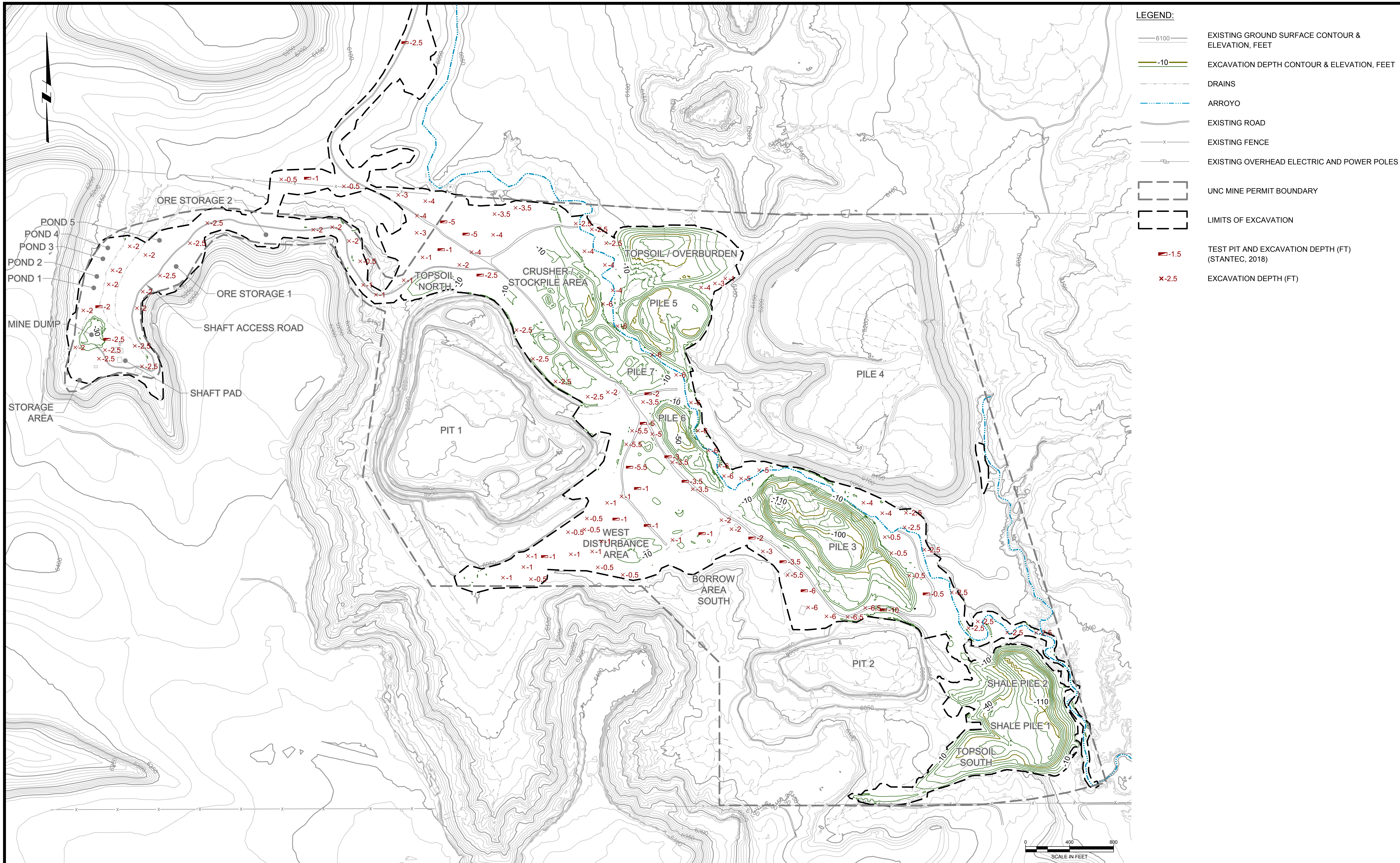

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Tuesday, September 04, 2018 10:47:20 AM KWREED C:\PWWORKDIR\D0492656\STA-EXCAVATION_LIMITS.DWG Layout:Figure (2)

SUPPLEMENTAL RADIOLOGIC CHARACTERIZATION
AVM ENVIRONMENTAL SERVICES, INC.

Supplemental Radiologic Characterization
St. Anthony Mine Site
Seboyeta, New Mexico

Prepared by:

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August 13, 2018

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Appendices

1.0 Introduction and Background

This report provides the framework and results of the Supplemental Radiologic Characterization that was conducted at the St. Anthony Mine Site (Site) near Seboyeta, New Mexico. The methods and procedures used were consistent with Section 4 of the February 23, 2018 Supplemental Investigation Work Plan (Work Plan) and the applicable survey methods described in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM, EPA 2000a). The purpose of this Supplemental Radiological Characterization was to delineate the radiologic contamination boundary based upon an appropriate Investigation Level (IL), and to characterize the Site by performing radiological surveys and collecting soil samples in the areas between the mine features, as shown in Figure 4 of the Work Plan. Site features were characterized in 2007, as described in the *Materials Characterization Report, Saint Anthony Mine Site* (MWH, 2007b). The following sections describe the strategy, methods and procedures that were used and the results of the Supplemental Radiological Characterization of the Site.

The Site was an open pit and underground shaft uranium mine located on the Cebolleta Land Grant located in Cibola County, approximately 4.6 miles southeast of Seboyeta, New Mexico. The Site is in a remote, sparsely populated area with limited access. The location of the Site is shown in Figure 1. United Nuclear Corporation (UNC) operated the Site from 1975 to 1981, pursuant to a mineral lease with the Cebolleta Land Grant, the current owner of the surface and mineral rights. The original lease covered approximately 2,560 acres. This lease was obtained on February 10, 1964 and surrendered by a Release of Mineral Lease dated October 24, 1988.

The Site includes underground workings consisting of one shaft, approximately eight vent shafts that are sealed at the surface, two open pits (one containing a pond), seven large piles of non-economical mine materials with some revegetation, numerous smaller piles of non-economical mine materials, and three topsoil piles. No perennial streams occur within the Site, but an ephemeral stream or arroyo (Meyer Gulch) passes through the Site. The layout of the Site is shown in Figure 4 of the Work Plan and shows the site features and the UNC mine permit boundary (permit boundary). The actively mined area encompasses approximately 430 acres and includes site roads and the other disturbed areas along with the features previously characterized.

2.0 Previous Characterization

As discussed above, only the site features were radiologically characterized during the 2007 Materials Characterization. The features defined in the 2007 Materials Characterization included the Background Area, Borrow Sources, Top Soil Stockpiles, Non-Economic Materials Storage Piles, and Western Shaft Area. Gamma exposure rate surveys and soil sampling were conducted during the 2007 Material Characterization. The gamma exposure rate surveys included exposure rate measurements performed at one meter above the ground surface. The areas between the site features were not radiologically characterized during the 2007 Material Characterization. Additionally, the lateral extent of radiologic contamination at the Site was not identified in the 2007 Materials Characterization. A Ra-226 background level of 1.6 pCi/g for the Site was established during the 2007 Materials Characterization.

3.0 Objective of the Supplemental Characterization

The Site is a former uranium mine therefore the surface and subsurface soil is expected to be impacted by radionuclides associated with the uranium decay series, with Ra-226 being the primary Constituent of Concern (COC). Current and anticipated land use surrounding the Site is grazing and wildlife habitat, which is the designated post-mining land use supported by the land owner. Even though an IL based on risk-based cleanup criteria for a ranching scenario would be appropriate for the site characterization, Radiation Cleanup Criteria specified in the March 2016 *Joint Guidance for the Cleanup and Reclamation of Existing Uranium Mining Operations in New Mexico* (NMMMD, 2016) by the State of New Mexico Mining and Mineral Division (NMMMD) and New Mexico Environment Department (NMED) was used for the IL as a conservative measure. The Ra-226 cleanup criteria of 5.0 pCi/g above the background level in land averaged over 100 square meters in surface soil (top six inches) specified in the Joint Guidance are taken from the UMTRCA (40 CFR 192), which are based on an unrestricted land use exposure scenario. A 6.6 pCi/g Ra-226 IL (5.0 pCi/g plus 1.6 pCi/g background level) is used for the Site Characterization.

The objective of this Supplemental Radiological Characterization was to delineate the radiologic contamination boundary corresponding to the Ra-226 IL and radiologic characterization of the areas between the site features to estimate surface and subsurface Ra-226 soil concentrations. The objective included a site-specific correlation to convert the results of the supplemental characterization gamma radiation scan surveys in counts per minute (cpm) to Ra-226 soil concentration (pCi/g). An additional objective was to perform a cross-calibration and correlation of exposure rate survey equipment to convert and normalize the 2007 Material Characterization exposure rate measurements to direct gamma radiation levels to cpm and equivalent of Ra-226 surface soil concentrations to normalize the data consistent with the supplemental characterization data and the Ra-226 soil concentration IL.

4.0 Field Investigation

Field investigations for the Supplemental Radiologic Characterization were conducted consistent with the Work Plan during the period March 19, 2018 to May 12, 2018. The supplemental characterization areas and the site features previously characterized are shown in Figure 4 of the Work Plan. The field investigation included, both static gamma radiologic survey measurements and Global Positioning System (GPS) based gamma scan surveys, along with ex-situ and in-situ soil screening, and soil sampling and analysis. The geo-located gamma scans were conducted to provide Ra-226 concentration level estimates in surface soil and to determine the radiologic contamination boundary relative to the IL. Ex-situ gamma radiation soil screening and in-situ gamma radiation level measurements were performed to provide real-time information to estimate subsurface contamination depth. Subsurface soil sampling and analysis was performed to confirm subsurface contamination depth estimated by field ex-situ gamma radiation soil screening. Additionally, gamma radiation static surveys (cpm), exposure rate (µR/hr) measurements, and surface soil samples and analysis were performed at selected locations for the site-specific correlation.

4.1 Investigation Level

The 6.6 pCi/g Ra-226 IL for the Supplemental Radiological Characterization specified in the Work Plan is presented in terms of Ra-226 mass activity concentration and is expressed in units of activity per unit mass of soil, pCi/g. The direct gamma radiation surveys using a NaI scintillation detector provide radiation levels in counts per unit time, generally obtained as cpm. A gamma radiation level cpm equivalent to the IL from a site-specific correlation is useful to guide the field gamma scan activities and estimate the survey boundary relative to the lateral extent of contamination. As discussed in the Work Plan, a site-specific correlation was not available during the field activities for making decisions. As specified in the Work Plan, a correlation between direct gamma radiation levels in cpm and Ra-226 soil concentrations in pCi/g at a similar uranium mine site was used to determine the cpm of approximately 25,000 equating to 6.6 pCi/g Ra-226 in surface soil. However, a 22,500 cpm gamma radiation level was used for a conservative measure and to provide a safety margin for a real time estimate of lateral extent of surface soil contamination during the field gamma scan activities. As discussed in section 4.3 below, a site-specific correlation was developed to convert the gamma scan survey results in cpm to surface soil Ra-226 concentration.

4.2 Gamma Radiation Survey

Direct gamma radiation surveys, gamma exposure rate surveys, ex-situ and in-situ gamma radiation soil screening, and soil sampling and analysis were used for the supplemental radiologic characterization of the Site as described in the Work Plan. The instrumentation configuration for direct gamma radiation level measurements during this characterization consisted of 2x2 NaI scintillation detectors (Eberline SPA-3 and Ludlum 44-10) for detection of gamma radiation, coupled to a scaler/rate meter (Ludlum 2221 or Ludlum 2241). This instrument configuration is used widely for this type of survey and is recommended by the MARSSIM. The scaler/rate meters were interfaced with a sub-meter accurate Differential Global Positioning System (DGPS) with surveying software and a data logger controller for electronically recording the gamma radiation levels to the corresponding location coordinates. The coordinate system that was used for this work was the State Plane Coordinate System (NAD83, New Mexico West, US Feet). The direct gamma radiation surveys using a NaI scintillation detector provide radiation levels in counts per unit time, generally obtained as cpm. A Ludlum Model 19 μR Meter was used for gamma exposure rate (μR/hr) measurements.

DGPS based systematic gamma radiation scan surveys using bare detectors were performed at the Site to determine the lateral extent of Ra-226 in surface soil during this Supplemental Radiological Characterization. The field gamma scan activities began on March 19, 2018. Although bare detectors do not avoid any lateral gamma radiation shine, the bare detectors have a significantly larger field of view and provide a larger scan coverage for an efficient lateral extent of contamination assessment for larger areas. Since the Site encompasses a large area with varying types of terrain, the Site scan area was divided into 26 zones for management and organization of the field gamma scan activities. The gamma scan surveys were performed consistent with AVM SOP-3, included in the Work Plan, to provide a 20 percent coverage of the ground surfaces. Based on a conservative field of view (FOV) of at least six feet diameter for a bare detector for Ra-226 gamma radiations, a 20% coverage would require a scanning transect spacing of 30 feet. The 30-feet spaced geo-projected transects for each area were digitally created using mapping software and loaded on the field data logger/controller. The gamma scan survey was performed by scanning along these transects with a bare detector at 12 inches above the ground surface at a scan rate of about three feet per second, with a data collection time interval of one and two seconds, depending upon the scaler/ratemeter used. Technicians walked along these transects with the gamma scan survey instruments for the gamma scans in accordance with AVM SOP-3.

The gamma scan survey was conducted by first scanning the areas between site features within the permit boundary, as shown in Figure 4 of the Work Plan, to determine if the radiologic contamination boundary based on the IL cpm is contained within the permit boundary, or if any contamination has migrated beyond the permit boundary. The geo-located gamma scan data includes the gamma scan point ID, date and time, location coordinates, and gamma cpm. The scan data was exported from the data logger, mapped using a mapping software, arranged in color coded ranges, and then reviewed to determine the areas that exceeded the IL cpm. The color-coded range was structured to include the cpm equivalent to the Ra-226 6.6 pCi/g screening level, as discussed previously.

Based on the review of the scan data, additional step-out gamma scans were conducted within and outside the permit boundary identified during field investigation, such as North Wash Area, Arroyo bed and the Access Road, until gamma radiation levels below the IL were detected. The field gamma scan activities were completed on May 12, 2018. The supplemental characterization gamma scan survey included approximately 154,000 gamma scan data points within a total of approximately 370 acres at the Site. The gamma scan data were exported from the scan system data logger into Excel files. The detector cpm were converted into equivalent estimated surface soil Ra-226 concentration in pCi/g using the site-specific correlation for the bare detector as discussed in Section 4.5. A typical gamma scan data export from the scan system data logger is shown in Table 1. Gamma scan data for all the gamma scan surveys during this supplemental characterization are provided in spreadsheet files on a compact disc included in Appendix A. Figure 1 and Figure 2 show the extent of gamma scan at the Site and results in cpm from a 2x2 NaI detector. As shown in Figure 1, the gamma scan surveys included the areas of potential surface contamination that were discussed in UNC's June 15, 2018 response to the NMMMDs April 17, 2018 comments on the Work Plan.

4.3 Test Pits and Ex-Situ Gamma Radiation Soil Screening

Test pit trench excavations and on-site ex-situ gamma radiation soil screening were performed from April 16 through April 19, 2018. These methods were used to define the vertical extent of subsurface contamination at the Site. The ex-situ gamma radiation soil screening was conducted in accordance with the AVM SOP-4 included in the Work Plan and provides a real-time estimate of Ra-226 concentrations in soil samples. This method is more reliable than the in-situ direct gamma surveys for real-time Ra-226 assessment in soils. The on-site ex-situ soil screening method consists of selectively measuring the 609 KeV region gamma radiations of Bi-214, a decay product of Ra-226 as discussed in AVM SOP-4 included in the Work Plan. A single channel analyzer (Ludlum L2221) integrated with a Ludlum 44-20 3x3 NaI scintillation detector was used to measure the 609 keV energy peak region of Bi-214. The soil sample was placed around the plastic lined detector in a heavily shielded counting chamber. The heavily shielded counting chamber lowers the system background counts, thus improving the system's minimum detectable concentration (MDC). A reference soil with the same concentration as the IL of 6.6 pCi/g was prepared as described in Appendix B and was used for soil screening at the Site.

An estimated Ra-226 soil concentration was created using a correlation from a similar uranium mine site to show the ranges of Ra-226 concentrations by mapping the geo-located gamma scan data using a color ramp, as shown in Figure 3. Also shown in Figure 3, a total of 24 locations were selected for subsurface assessment in areas with an estimated Ra-226 concentration level above 10 pCi/g at the surface, and where Ra-226 contamination was considered likely to be deeper than one foot below ground surface (bgs). No locations were selected in periphery areas where Ra-226 contamination was low and considered likely to be only in surface soils.

A track excavator was used to excavate trenches at each test pit location for subsurface soil sample collection. The trench was excavated at approximately one-foot depth intervals. At each interval, a subsurface soil sample was collected from the base of the excavation for ex-situ soil screening. The excavation continued until the on-site ex-situ soil screening indicated that Ra-226 concentrations of the soils samples were below the 6.6 pCi/g IL. The test pit excavation geotechnical logs along with the field soil screening forms are included in Appendix B. The test pit subsurface soil screening data is summarized in Table 2. The subsurface soil samples above or below the 6.6 pCi/g IL are shown in Table 2 based on the field soil screening results.

Although the primary objective of the ex-situ gamma radiation soil screening was to determine the Ra-226 concentrations above or below the 6.6 pCi/g IL, Ra-226 concentrations were estimated in all test pit excavation subsurface soil samples screened. During the set up of the soil screening system prior to mobilizing in the field, a calibration/correlation of the ex-situ soil screening system was performed using the 6.6 pCi/g reference soil sample, a 100 pCi/g reference soil sample and a background soil sample. This correlation is included in Appendix B. The estimated Ra-226 concentration in the borehole samples determined using this correlation are included in Table 2.

For the test pit subsurface soil investigation, 44 samples out of a total of 57 borehole subsurface soil samples screened onsite were sent to the off-site vendor laboratory, ALS, Inc. in Fort Collins, CO (ALS). These soil samples were analyzed for Ra-226 using EPA Method 901.1 (modified for soil matrix) for confirmation of the onsite soil screening results. The 44 samples sent to the laboratory included at least one sample from each test pit excavation that screened at a Ra-226 concentration below the IL. Also, 10% (5 samples) of the samples sent to the lab were split in the field and sent to the lab for QA/QC duplicates. The laboratory results reports are included in Appendix B and are summarized in Table 2. As shown in Table 2, the estimated Ra-226 levels by on-site ex-situ soil screening are consistent with the laboratory Ra-226 results, specifically in regard to determining the depth of Ra-226 levels above or below the IL, except for two samples. The first sample, SB-TP04-05, taken at a depth of five feet, from Test Pit 04, had an estimated Ra-226 concentration of 7.3 pCi/g, while the laboratory reported concentration was 4.9 pCi/g. In sample SB-TP04-06, which was collected at a depth of six feet, both the ex-situ field soil screening and laboratory results were below the IL. As a result, for a conservative measure, a six-foot Ra-226 contamination level depth will be used at this location for subsurface contamination assessment. The second sample, SB-TP12-04, taken at a depth of four feet from Test Pit 12, had an estimated Ra-226 concentration at 2.9 pCi/g, while the laboratory reported concentration was 16.0 pCi/g. Sample SB-TP12-03, which was taken at a shallower depth of three feet, had an estimated Ra-226 concentration of 6.2 pCi/g, while the laboratory reported concentration was 2.3 pCi/g, a lower concentration than SB-TP12-04. Generally, the contamination level decreased with depth, not increased. Therefore, Ra-226 contamination at or above the IL at this location is likely extend to three feet bgs. Based on the field soil screening and the laboratory sample results, the depth of Ra-226 concentrations above the 6.6 pCi/g IL at each test pit location is summarized in Table 3 and shown in Figure 3.

4.4 Site-Specific Gamma Radiation Level to Surface Soil Ra-226 Correlation

A site-specific correlation was developed for both collimated and bare 2x2 NaI detectors, consistent with AVM SOP-2 that was included in the Work Plan. The correlation was developed to convert gamma radiation levels in cpm for the detector to surface soil Ra-226 concentration in pCi/g. Although a collimated detector was not used for gamma surveys during this supplemental characterization, the data were collected and a correlation was developed for a 0.5-inch thick collimated detector for future use at the Site. Correlation locations were identified and investigated to ensure that the Ra-226 contamination distribution was limited to the surface soil, and that there was not a source of significant lateral gamma radiation shine. Prior to collecting the correlation surface soil samples at each location, one-minute static gamma measurements using detectors at 12 inches above the ground surface and a gamma exposure rate (μR/hr) measurement from 1 meter above ground surface using a calibrated μR meter were taken. The μR measurements were taken at each location to convert the 2007 Materials Characterization gamma exposure rate survey results to a Ra-226 concentration. The 14 correlation sample locations are shown in Figure 4. The correlation field gamma radiation level survey field forms and soil sampling logs are included in Appendix C.

The correlation soil samples were sent to ALS for Ra-226 analysis using EPA Method 901.1 (modified for soil matrix). Initially, ALS sieved out the +0.25-inch (rocks and pebbles) fraction from the samples during sample preparation and took an aliquot for gamma spectroscopy analysis, rather than processing the entire sample (i.e., all particles). Eight samples with noticeable rocks and pebbles greater than 0.25 inches were re-submitted to ALS for sample preparation and analysis including all of the sample material. The laboratory results report is included in Appendix C. The correlation data, gamma radiation levels, exposure rate measurements and laboratory Ra-226 analytical results of the soil samples are summarized in Table 4. Three linear regressions between the co-located soil sample Ra-226 and gamma radiation levels were performed for the correlations: 1) Bare 2x2 NaI detector cpm at 12 inches above the ground surface, 2) 0.5-inch thick lead collimated 2x2 NaI detector cpm at 12 inches above the ground surface, and 3) Ludlum 19 exposure rate μR/hr measurements at one meter above the ground surface. Data from location SA-COR-011 was not included in the correlation regression because it was determined to be an outlier due to a significantly elevated gamma radiation level and potential lateral gamma shine interference from scattered waste ore rocks and berms around this location. All three correlations with regression analysis summaries are included in Appendix C, and the regression equations are summarized as follow:

- **2x2 NaI Bare Detector:**

  Ra-226 pCi/g = (cpm x 0.0005 pCi/g/cpm, slope) - 5.51, intercept or constant, with an R^2 = 0.98 , and results into approximately 24,200 cpm equivalent to the 6.6 pCi/g surface soil Ra-226 IL.

- **0.5 inch thick lead collimated 2x2 NaI Detector:**

  Ra-226 pCi/g = (cpm x 0.0015 pCi/g/cpm, slope) - 5.21, intercept or constant, with an R^2 = 0.90 , and results into approximately 7,870 cpm equivalent to the 6.6 pCi/g surface soil Ra-226 IL.

- **Exposure Rate (µR/hr) Meter:**

  Ra-226 pCi/g = (µR/hr x 0.49 pCi/g/µR/hr, slope) - 5.10, intercept or constant, with an R^2 = 0.90, and results into approximately 24 µR/hr equivalent to the 6.6 pCi/g surface soil Ra-226 IL.

This site specific correlation for the bare detector is comparable to the correlation (pCi/g = cpm x 0.0005 - 6.14) from a similar uranium mine site that was used to guide the field gamma scan activities as discussed in Section 4.1 As discussed above, this correlation was developed to predict Ra-226 concentrations only in surface soil (0" to 6" depth). The correlation used a survey geometry consisting of a 2x2 NaI detector held at 12 inches above the ground surface and a scan rate of about three feet per second. This correlation may over estimate Ra-226 in surface soil in areas with Ra-226 contamination deeper than six inches, such as waste ore rock piles and backfill areas. Also, the correlation may over estimate Ra-226 levels in areas with significant lateral gamma radiation shine, such as areas near waste piles.

4.5 Ra-226 Investigation Level Contamination Boundary

The radiation level data in cpm collected during this Supplemental Radiological Characterization was converted to the equivalent estimated Ra-226 pCi/g concentration using the regression equation for bare 2x2 detectors, as described above and shown in Figure 5 and Figure 6. The data were structured in the maps into ranges of pCi/g and set to a color ramp. The 6.6 pCi/g Ra-226 IL contamination boundary was delineated using the color ramped ranges as a guide, as shown in Figure 5 for the Site and Figure 6 for the Site Access Road.

A total of 421 surface gamma exposure rate measurements in µR/hr at one meter above the ground surface were made during the 2007 Materials Characterization. The 2007 gamma exposure rate measurements are summarized in Table 3 and shown on Figure 3 of the *Materials Characterization Report*. These gamma exposure rates at one meter above the ground surface in µR/hr were converted to estimated surface soil Ra-226 in pCi/g using the site specific gamma exposure rate to surface soil Ra-226 correlation (pCi/g = µR/hr x 0.19 - 5.10) discussed in Section 4.4 above, and included in Appendix C. The 2007 Materials Characterization gamma survey measurements are shown on Figure 5 and Figure 6, and included in Appendix A.

As shown in Figure 5, the contamination boundary at the IL is contained within the permit boundary on the east side of the Site, south of the shale piles and Pit 2, and west of Pit 2 and Borrow Area South. There is a small area south of Shale Pile 1 just outside the permit boundary above the IL, which is a road leading to a monitoring well. The contamination level above the IL in the arroyo bed appears to cease at the southern permit boundary. The contamination boundary south of Pit 1 extends just outside the permit boundary. However, as indicated in the UNC's June 15, 2018 response to the State of New Mexico Energy, Mineral and Natural Resource Departments April 17, 2018 comments on the Work Plan, the area south of Pit 1 is not within the permit boundary because it was not mined or operated by UNC, and records indicate that an underground mine was operated in that area by another entity. Therefore, the contamination boundary south of Pit 1 is delineated at the permit boundary.

The IL contamination boundary near the West Shaft Area is mostly just inside or at the permit boundary with some small isolated areas just outside of the permit boundary east and southeast of Ore Storage 1, south of the Shaft Pad, east of the Mine Dump, Pond 1 area. The contamination boundary extends outside the permit boundary in areas northeast of the West Shaft Area and an area near the entrance gate. The contamination boundary north of the Crusher Stockpile area is contained inside the permit boundary. The contamination boundary north of the Topsoil/Overburden and Pile 4 areas is well inside the permit boundary. Overall, the IL contamination boundary at the Site is mostly within the permit boundary, but extends slightly outside permit boundary in a few locations, as discussed above. As shown in Figure 6, the Site Access Road contains Ra-226 levels in soil above the IL, and is likely to extend at a minimum to the road shoulders. Contamination above the IL appears to have migrated east of the Site Access Road near the entrance to the Site.

5.0 Soil Sampling and Analysis

Surface soil correlation samples and subsurface soil samples from the test pit excavations for onsite ex-situ gamma radiation soil screening were collected consistent with AVM-SOP-5, included in the Work Plan. Field QA/QC duplicate samples were split at a frequency of 10% of the total number of soil samples collected. A total of 71 surface and subsurface soil samples were collected during the supplemental characterization. Field sampling equipment used for soil sampling, which included: stainless steel scoops, bowls, spoons, and hand auger barrels, were decontaminated between sample locations. The soil sampling equipment decontamination was conducted by brushing off loose visible soil, washing the equipment with a detergent/water solution and rinsing with distilled water. Track excavator buckets were cleaned by removing any loose, visible soil. Any soils generated from the excavation of test pits created were put back into the excavations from which the soil came. All equipment decontamination water/rinsate was poured on top of excess soil from the test pits. Personal protection equipment (PPE), such as gloves, were brushed off and scanned for residual contamination and disposed of as solid waste.

Subsurface soil samples were analyzed by on-site ex-situ gamma radiation soil screening (AVM SOP-4) to estimate Ra-226 concentrations. A completed Chain-of-Custody (COC) along with the surface soil samples and confirmatory subsurface soil samples were placed in labeled Ziploc bags, and packaged in five gallon buckets with sealed lids and shipped to ALS for Ra-226 analysis. The soil samples were analyzed for Ra-226 with a reporting limit of 0.5 pCi/g, using EPA Method 901.1 (modified for soil matrix). The laboratory completed COCs are included with the analytical results reports in appropriate appendices to this report.

6. 0 Quality Assurance and Quality Control Measures

Quality Assurance/Quality Control (QA/QC) measures as specified in the Work Plan were implemented during the Supplemental Radiological Characterization to ensure that decisions are made based on data of acceptable quality. All radiologic survey instruments, including personnel and vehicle contamination friskers, have been calibrated annually, as specified in AVM SOP-1. Additionally, operational functions checks were performed on all radiologic instruments daily prior to use in accordance with AVM SOP-1. The calibration and function check documents are included in Appendix D. During this Supplemental Radiological Characterization, no instruments were found to be out of calibration or inoperable as indicated by the operational function checks. The instrument background measurements for bare 2x2 NaI detectors during daily operational function checks were less than 10,000 cpm as shown in Appendix D. The bare detector field of view (FOV) at 12 inches above the ground surface is conservatively assumed at an area of six feet diameter. The 2x2 NaI detector response factor is determined to be 0.0006 pCi/g/cpm from the linear regression for the site-specific correlation included in Appendix C. Based on the above detector parameters, the Ra-226 minimum detectable concentrations (MDCs) for scan survey at scan speed of three feet per second calculated MARSSIM guidance as shown in AVM SOP-1 were less than 1.0 pCi/g, significantly less than 50% of the 6.6 pCi/g IL. The ex-situ soil gamma radiation screening system was calibrated prior to mobilization in the field and daily operational function checks were performed prior to use. The calibration and function check documentation are included in Appendix D. Based on the highest system background (blank) measurements from daily operational function checks and efficiency (pCi/g/cpm), the highest Ra-226 MDC for the screening system calculated, as shown in AVM SOP-4, was less than 0.8 pCi/g, significantly less than the 6.6 pCi/g IL. The MDCs during the supplemental characterization met the QA objective.

The QA/QC measures also included field QA/QC duplicate soil sampling at a frequency of 10% of the soil samples collected for laboratory analysis. As discussed above, field QA/QC duplicate soil samples were collected and sent to the laboratory for analysis, and the QA/QC duplicate results are included in appropriate summary tables.

Tables

Table 1
Typical Gamma Scan Data Exported From the Scan System Data Logger

ID	Time	Northing[1] (feet)	Easting[1] (feet)	MSL Elevation (feet)	CPM 2x2 NaI Detector	Ra-226 pCi/g	Zone_ID
1	3/29/2018 9:40:21	1514268	2881680	6051.796	17401	3.19	Pit_1
2	3/29/2018 9:40:23	1514265	2881675	6051.789	17141	3.06	Pit_1
3	3/29/2018 9:40:25	1514261	2881669	6051.904	18457	3.72	Pit_1
4	3/29/2018 9:40:27	1514257	2881663	6052.176	17774	3.38	Pit_1
5	3/29/2018 9:40:29	1514252	2881657	6052.058	17937	3.46	Pit_1
6	3/29/2018 9:40:31	1514246	2881652	6052.019	18383	3.68	Pit_1
7	3/29/2018 9:40:33	1514241	2881647	6051.927	18223	3.60	Pit_1
8	3/29/2018 9:40:35	1514237	2881640	6051.986	18429	3.70	Pit_1
9	3/29/2018 9:40:37	1514232	2881634	6052.166	17831	3.41	Pit_1
10	3/29/2018 9:40:39	1514227	2881628	6051.953	18942	3.96	Pit_1
11	3/29/2018 9:40:41	1514222	2881621	6052.009	18395	3.69	Pit_1
12	3/29/2018 9:40:43	1514216	2881615	6052.035	18316	3.65	Pit_1
13	3/29/2018 9:40:45	1514211	2881609	6052.127	19453	4.22	Pit_1
14	3/29/2018 9:40:47	1514207	2881602	6052.029	19185	4.08	Pit_1
15	3/29/2018 9:40:49	1514202	2881595	6051.878	19125	4.05	Pit_1
16	3/29/2018 9:40:51	1514197	2881589	6052.038	18106	3.54	Pit_1
17	3/29/2018 9:40:53	1514194	2881583	6051.845	18761	3.87	Pit_1
18	3/29/2018 9:40:55	1514192	2881580	6051.769	18926	3.95	Pit_1
19	3/29/2018 9:41:06	1514188	2881575	6051.819	17473	3.23	Pit_1
20	3/29/2018 9:41:08	1514184	2881569	6052.068	17936	3.46	Pit_1
21	3/29/2018 9:41:10	1514179	2881562	6051.842	17904	3.44	Pit_1
22	3/29/2018 9:41:12	1514174	2881555	6051.888	17817	3.40	Pit_1
23	3/29/2018 9:41:14	1514168	2881549	6051.956	18075	3.53	Pit_1
24	3/29/2018 9:41:16	1514163	2881543	6051.812	18881	3.93	Pit_1
25	3/29/2018 9:41:18	1514157	2881537	6051.848	19111	4.05	Pit_1
26	3/29/2018 9:41:20	1514152	2881531	6051.694	19098	4.04	Pit_1
27	3/29/2018 9:41:22	1514146	2881525	6051.779	18165	3.57	Pit_1
28	3/29/2018 9:41:24	1514141	2881520	6051.678	17647	3.31	Pit_1
29	3/29/2018 9:41:26	1514135	2881514	6051.704	16679	2.83	Pit_1
30	3/29/2018 9:41:28	1514130	2881507	6051.723	17441	3.21	Pit_1
31	3/29/2018 9:41:30	1514126	2881501	6051.553	17220	3.10	Pit_1
32	3/29/2018 9:41:32	1514121	2881494	6051.543	17687	3.33	Pit_1
33	3/29/2018 9:41:34	1514117	2881487	6051.796	18375	3.68	Pit_1
34	3/29/2018 9:41:36	1514112	2881479	6051.746	18552	3.77	Pit_1
35	3/29/2018 9:41:38	1514108	2881473	6051.779	18808	3.89	Pit_1
36	3/29/2018 9:41:40	1514103	2881466	6051.609	17910	3.45	Pit_1
37	3/29/2018 9:41:42	1514099	2881459	6051.618	18145	3.56	Pit_1
38	3/29/2018 9:41:44	1514095	2881452	6051.366	18277	3.63	Pit_1
39	3/29/2018 9:41:46	1514090	2881445	6051.353	18827	3.90	Pit_1
40	3/29/2018 9:41:48	1514085	2881438	6051.714	17861	3.42	Pit_1

(1) Projection: NAD 1983, New Mexico West, Feet.

Table 2
St. Anthony Mine Site Test Pits Subsurface Soil Sample Field Gamma Radiation Screening Summary

Sample Data					Field Soil Screening Data				Laboratory Data			
Test Pit ID	Soil Sample ID	Northing(1) (feet)	Easting(1) (feet)	Date	6.6 pCi/g SSL Reference Soil CPM	Soil Sample CPM	Comments	Estimated Ra-226 pCi/g	Sample Sent to Lab	Ra-226 pCi/g	Error Estimate pCi/g	MDC pCi/g
01	SB-TP01-01 (@ 1.1 ft)	1,519,977.7	2,879,801.1	4/19/2018	628	734	**>SSL**	**7.2**	Y	9.20	1.20	0.50
	SB-TP01-02 (@ 2.5 ft)			4/19/2018		286	**<SSL**	**1.7**	Y	1.26	0.30	0.50
02	SB-TP02-01 (@ 1.1 ft)	1,518,527.1	2,880,209.9	4/19/2018	628	2325	**>SSL**	**26.8**	Y	35.40	4.20	0.60
	SB-TP02-02 (@ 2.5 ft)			4/19/2018		383	**<SSL**	**2.9**	Y	1.38	0.32	0.51
03	SB-TP03-01 (@ 1.0 ft)	1,517,294.7	2,879,324.8	4/16/2018	667	243	**<SSL**	**1.2**	Y	1.61	0.35	0.48
04	SB-TP04-03 (@ 3.0 ft)	1,516,898.8	2,880,561.8	4/16/2018	667	3587	**>SSL**	**42.3**	N	-	-	-
	SB-TP04-05 (@ 5.0 ft)			4/16/2018		741	**>SSL**	**7.3**	Y	4.87	0.69	0.44
	SB-TP04-06 (@ 6.0 ft)			4/16/2018		457	**<SSL**	**3.8**	Y	2.79	0.39	0.33
05	SB-TP05-01 (@ 1.0 ft)	1,516,786.8	2,880,764.9	4/16/2018	667	1864	**>SSL**	**21.1**	N	-	-	-
	SB-TP05-02 (@ 2.0 ft)			4/16/2018		2286	**>SSL**	**26.3**	N	-	-	-
	SB-TP05-03 (@ 3.0 ft)			4/16/2018		2574	**>SSL**	**29.8**	N	-	-	-
	SB-TP05-04 (@ 4.0 ft)			4/16/2018		2750	**>SSL**	**32.0**	N	-	-	-
	SB-TP05-05 (@ 5.0 ft)			4/16/2018		496	**<SSL**	**4.3**	Y	0.65	0.19	0.34
06	SB-TP06-01 (@ 1.0 ft)	1,516,646.2	2,880,538.3	4/16/2018	667	402	**<SSL**	**3.1**	Y	4.79	0.71	0.67
07	SB-TP07-01 (@ 1.0 ft)	1,516,414.4	2,880,892.5	4/16/2018	667	2295	**>SSL**	**26.4**	y	29.30	3.50	0.90
	SB-TP07-201 Field QA/QC Dup of SB-TP07-01								Y	27.80	3.40	1.10
	SB-TP07-02 (@ 2.5 ft)			4/16/2018		244	**<SSL**	**1.2**	Y	0.69	0.18	0.31

(1) Projection: NAD 1983, New Mexico West, Feet.

Table 2 (Continued)
St. Anthony Mine Site Test Pits Subsurface Soil Sample Field Gamma Radiation Screening Summary

Sample Data					Field Soil Screening Data				Laboratory Data			
Test Pit ID	Soil Sample ID	Northing(1) (feet)	Easting(1) (feet)	Date	6.6 pCi/g SSL Reference Soil CPM	Soil Sample CPM	Comments	Estimated Ra-226 pCi/g	Sample Sent to Lab	Ra-226 pCi/g	Error Estimate pCi/g	MDC pCi/g
08	SB-TP08-01 (@ 1.0 ft)	1,516,128.0	2,877,428.9	4/16/2018	667	733	**>SSL**	**7.2**	Y	15.30	1.90	0.70
	SB-TP08-02 (@ 2.1 ft)			4/16/2018		210	**<SSL**	**0.8**	Y	0.92	0.25	0.40
	SB-TP08-03 (@ 3.0 ft)			4/16/2018		211	**<SSL**	**0.8**	N	-	-	-
09	SB-TP09-01 (@ 1.0 ft)	1,515,831.1	2,877,501.9	4/16/2018	667	2108	**>SSL**	**24.1**	N	-	-	-
	SB-TP09-02 (@ 2.5 ft)			4/16/2018		267	**<SSL**	**1.5**	Y	1.54	0.32	0.47
	SB-TP09-03 (@ 3.5 ft)			4/16/2018		266	**<SSL**	**1.4**	Y	-	-	-
10	SB-TP10-01 (@ 1.0 ft)	1,515,336.8	2,882,418.7	4/18/2018	628	974	**>SSL**	**10.2**	Y	15.10	1.80	0.50
	SB-TP10-201, Field QA/QC Dup of SB-TP10-01								Y	8.10	1.10	0.60
	SB-TP10-02 (@ 2.0 ft)			4/18/2018		450	**<SSL**	**3.7**	Y	5.03	0.70	0.58
11	SB-TP11-01 (@ 1.0 ft)	1,515,067.3	2,882,375.8	4/18/2018	628	533	**<SSL**	**4.7**	N	-	-	-
	SB-TP11-02 (@ 2.1 ft)			4/18/2018		2674	**>SSL**	**31.1**	N	-	-	-
	SB-TP11-03 (@ 3.0 ft)			4/18/2018		1879	**>SSL**	**21.3**	N	-	-	-
	SB-TP11-04 (@ 4.0 ft)			4/18/2018		2284	**>SSL**	**26.3**	Y	21.70	2.70	0.90
	SB-TP11-05 (@ 5.0 ft)			4/18/2018		599	**<SSL**	**5.5**	Y	4.30	0.61	0.44
12	SB-TP12-02 (@ 2.0 ft)	1,514,764.1	2,882,599.4	4/18/2018	628	1197	**>SSL**	**12.9**	N	-	-	-
	SB-TP12-03 (@ 3.0 ft)			4/18/2018		653	**≈SSL**	**6.2**	Y	2.25	0.42	0.52
	SB-TP12-04 (@ 4.0 ft)			4/18/2018		387	**<SSL**	**2.9**	Y	16.00	2.00	0.60
13	SB-TP13-04 (@ 4.0 ft)	1,514,669.1	2,882,250.3	4/18/2018	628	3255	**>SSL**	**38.2**	N	-	-	-
	SB-TP13-05 (@ 5.0 ft)			4/18/2018		1605	**>SSL**	**17.9**	Y	12.60	1.60	0.80
	SB-TP13-06 (@ 5.5 ft)			4/18/2018		792	**>SSL**	**7.9**	Y	6.93	0.95	0.58
14	SB-TP14-02 (@ 2.0 ft)	1,514,540.5	2,882,755.6	4/18/2018	628	1452	**>SSL**	**16.0**	Y	16.40	2.00	0.50
	SB-TP14-202, Field QA/QC Dup of SB-TP14-02								Y	14.40	1.80	0.80
	SB-TP14-03 (@ 3.5 ft)			4/18/2018		393	**<SSL**	**3.0**	Y	2.08	0.39	0.46

(1) Projection: NAD 1983, New Mexico West, Feet.

Table 2 (Continued)
St. Anthony Mine Site Test Pits Subsurface Soil Sample Field Gamma Radiation Screening Summary

Sample Data					Field Soil Screening Data				Laboratory Data			
Test Pit ID	**Soil Sample ID**	**Northing[1] (feet)**	**Easting[1] (feet)**	**Date**	**6.6 pCi/g SSL Reference Soil CPM**	**Soil Sample CPM**	**Comments**	**Estimated Ra-226 pCi/g**	**Sample Sent to Lab**	**Ra-226 pCi/g**	**Error Estimate pCi/g**	**MDC pCi/g**
15	SB-TP15-01 (@ 1.1 ft)	1,514,476.2	2,882,323.8	4/18/2018	628	247	**<SSL**	**1.2**	Y	1.04	0.24	0.36
	SB-TP15-02 (@ 2.0 ft)			4/18/2018		253	**<SSL**	**1.3**	Y	0.76	0.25	0.45
16	SB-TP16-01 (@ 1.0 ft)	1,514,197.5	2,882,127.8	4/18/2018	628	242	**<SSL**	**1.1**	Y	0.77	0.25	0.41
	SB-TP16-02 (@ 2.0 ft)			4/18/2018		247	**<SSL**	**1.2**	Y	0.87	0.24	0.43
17	SB-TP17-01 (@ 1.2 ft)	1,514,139.3	2,882,412.6	4/18/2018	628	275	**<SSL**	**1.6**	Y	1.42	0.24	0.35
	SB-TP17-02 (@ 2.1 ft)			4/18/2018		236	**<SSL**	**1.1**	Y	0.91	0.26	0.41
18	SB-TP18-01 (@ 1.0 ft)	1,514,065.8	2,882,908.7	4/18/2018	628	330	**<SSL**	**2.2**	Y	1.02	0.24	0.35
	SB-TP18-02 (@ 2.1 ft)			4/18/2018		276	**<SSL**	**1.6**	Y	0.94	0.27	0.50
19	SB-TP19-01 (@ 1.3 ft)	1,514,025.5	2,883,361.9	4/18/2018	628	1918	**>SSL**	**21.8**	Y	29.00	3.60	0.90
	SB-TP19-201, Field QA/QC Dup of SB-TP19-01								Y	26.80	3.30	0.70
	SB-TP19-02 (@ 2.3 ft)			4/18/2018		265	**<SSL**	**1.4**	Y	0.90	0.24	0.42
20	SB-TP20-01 (@ 1.0 ft)	1,513,518.0	2,884,947.0	4/19/2018	628	272	**<SSL**	**1.5**	Y	1.60	0.38	0.58
	SB-TP20-02 (@ 2.0 ft)			4/19/2018		268	**<SSL**	**1.5**	Y	1.32	0.32	0.50
	SB-TP10-202, Field QA/QC Dup of SB-TP20-02								Y	1.26	0.34	0.61
21	SB-TP21-01 (@ 1.0 ft)	1,513,857.6	2,881,478.5	4/18/2018	628	291	**<SSL**	**1.7**	Y	1.35	0.30	0.43
	SB-TP21-02 (@ 2.0 ft)			4/18/2018		254	**<SSL**	**1.3**	Y	0.78	0.22	0.37
22	SB-TP22-03 (@ 3.1 ft)	1,513,810.0	2,883,645.0	4/19/2018	628	683	**≈SSL**	**6.6**	Y	6.63	0.38	0.50
	SB-TP22-07 (@ 7.5 ft)			4/19/2018		296	**<SSL**	**1.8**	Y	1.97	0.35	0.42
23	SB-TP23-04 (@ 4.0 ft)	1,513,547.0	2,883,838.0	4/19/2018	628	2870	**>SSL**	**33.5**	Y	31.20	3.80	0.90
	SB-TP23-06 (@ 6.0 ft)			4/19/2018		486	**<SSL**	**4.1**	Y	2.26	0.40	0.48
24	SB-TP24-05 (@ 5.5 ft)	1,513,371.5	2,884,557.1	4/19/2018	628	3463	**>SSL**	**40.8**	Y	30.00	0.80	0.50
	SB-TP24-06 (@ 6.5 ft)			4/19/2018		2693	**>SSL**	**31.3**	Y	55.50	6.60	0.50

(1) Projection: NAD 1983, New Mexico West, Feet.

Table 3
St. Anthony Mine Site Test Pit Subsurface Ra-226 Contamination Depth Summary

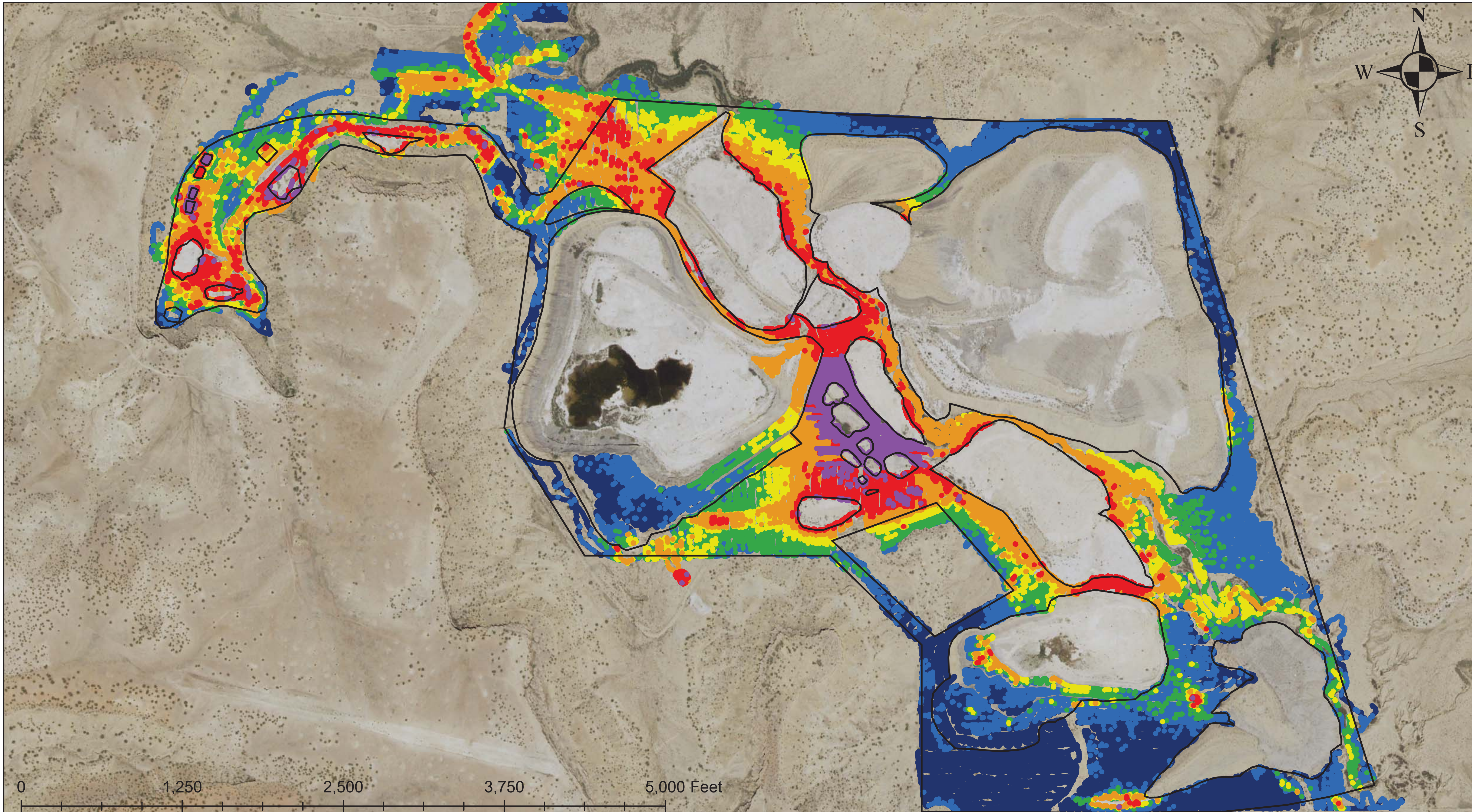
Test Pit ID	Test Pit Location Coordinates [1] (Feet)		Date	Depth of Subsurface Ra-226 Contamination >SSL (Feet)
	Northing	Easting		
1	1,519,977.7	2,879,801.1	4/19/2018	**2.5**
2	1,518,527.1	2,880,209.9	4/19/2018	**2.5**
3	1,517,294.7	2,879,324.8	4/16/2018	**1.0**
4	1,516,898.8	2,880,561.8	4/16/2018	**6.0**
5	1,516,786.8	2,880,764.9	4/16/2018	**5.0**
6	1,516,646.2	2,880,538.3	4/16/2018	**1.0**
7	1,516,414.4	2,880,892.5	4/16/2018	**2.5**
8	1,516,128.0	2,877,428.9	4/16/2018	**2.1**
9	1,515,831.1	2,877,501.9	4/16/2018	**2.5**
10	1,515,336.8	2,882,418.7	4/18/2018	**2.0**
11	1,515,067.3	2,882,375.8	4/18/2018	**5.0**
12	1,514,764.1	2,882,599.4	4/18/2018	**3.0**
13	1,514,669.1	2,882,250.3	4/18/2018	**6.0**
14	1,514,540.5	2,882,755.6	4/18/2018	**3.5**
15	1,514,476.2	2,882,323.8	4/18/2018	**1.1**
16	1,514,197.5	2,882,127.8	4/18/2018	**<1.0**
17	1,514,139.3	2,882,412.6	4/18/2018	**<1.0**
18	1,514,065.8	2,882,908.7	4/18/2018	**1.0**
19	1,514,025.5	2,883,361.9	4/18/2018	**2.3**
20	1,513,518.0	2,884,947.0	4/19/2018	**<1.0**
21	1,513,857.6	2,881,478.5	4/18/2018	**<1.0**
22	1,513,810.0	2,883,645.0	4/19/2018	**3.1**
23	1,513,547.0	2,883,838.0	4/19/2018	**6.0**
24	1,513,371.5	2,884,557.1	4/19/2018	**>6.5**

(1) Projection: NAD 1983, New Mexico West, U.S. Feet.

Table 4
St. Anthony Mine Site Gamma Radiation Level to Ra-226 Correlation Data Summary

Surface Soil Sample ID	Exposure Rate µR/hr	2x2 NaI 0.5-Inch Lead Collimated Detector		2x2 NaI Bare Detector		Soil Sample Ra-226 Laboratory Analysis pCi/g (EPA Method 901.1 Modified)		
		CPM	Avg. CPM	CPM	Avg. CPM	Ra-226	Uncertainty	MDC
SA-COR-001	10	3324 3383 3381	3363	9937 10077 10013	10009	0.85	0.27	0.45
SA-COR-002	11	3165 3070 3238	3158	10406 10441 10425	10424	0.83	0.20	0.28
SA-COR-003	95	25600 25894 25731	25742	84039 83117 83689	83615	43.9	5.3	0.9
SA-COR-003 Field QA/QC Duplicate						41.1	4.9	0.8
SA-COR-004	70	22796 20739 22490	22008	68362 64884 65222	66156	25.3	3.1	0.9
SA-COR-004 Lab QA/QC Duplicate						34.7	4.1	0.6
SA-COR-005	20	7439 6924 7043	7135	19346 19412 19769	19509	6.36	0.86	0.55
SA-COR-006	12	3124 3328 3251	3234	11405 11685 11194	11428	0.75	0.22	0.40
SA-COR-006 Field QA/QC Duplicate						0.74	0.27	0.44
SA-COR-007	15	4991 5241 5096	5109	14131 14174 14372	14226	2.73	0.45	0.48
SA-COR-008	20	6881 6849 7065	6932	20219 20268 20155	20214	5.17	0.73	0.47
SA-COR-009	70	26362 26596 26725	26561	64037 64428 63871	64112	29.7	3.5	0.60
SA-COR-010	25	8515 8672 8635	8607	22943 23060 22997	23000	6.78	0.92	0.50
SA-COR-011	110	35912 36235 35798	35982	99965 96941 98212	98373	69.2	8.2	1.0
SA-COR-012	30	7748 8050 8126	7975	25242 25514 25390	25382	6.63	0.87	0.47
SA-COR-012 Lab QA/QC Duplicate						5.91	0.82	0.51
SA-COR-013	25	8293 8192 8199	8228	21581 21295 21891	21589	5.45	0.74	0.46
SA-COR-014	12	4358 4412 4496	4422	11945 11972 11970	11962	1.25	0.27	0.41

Figures

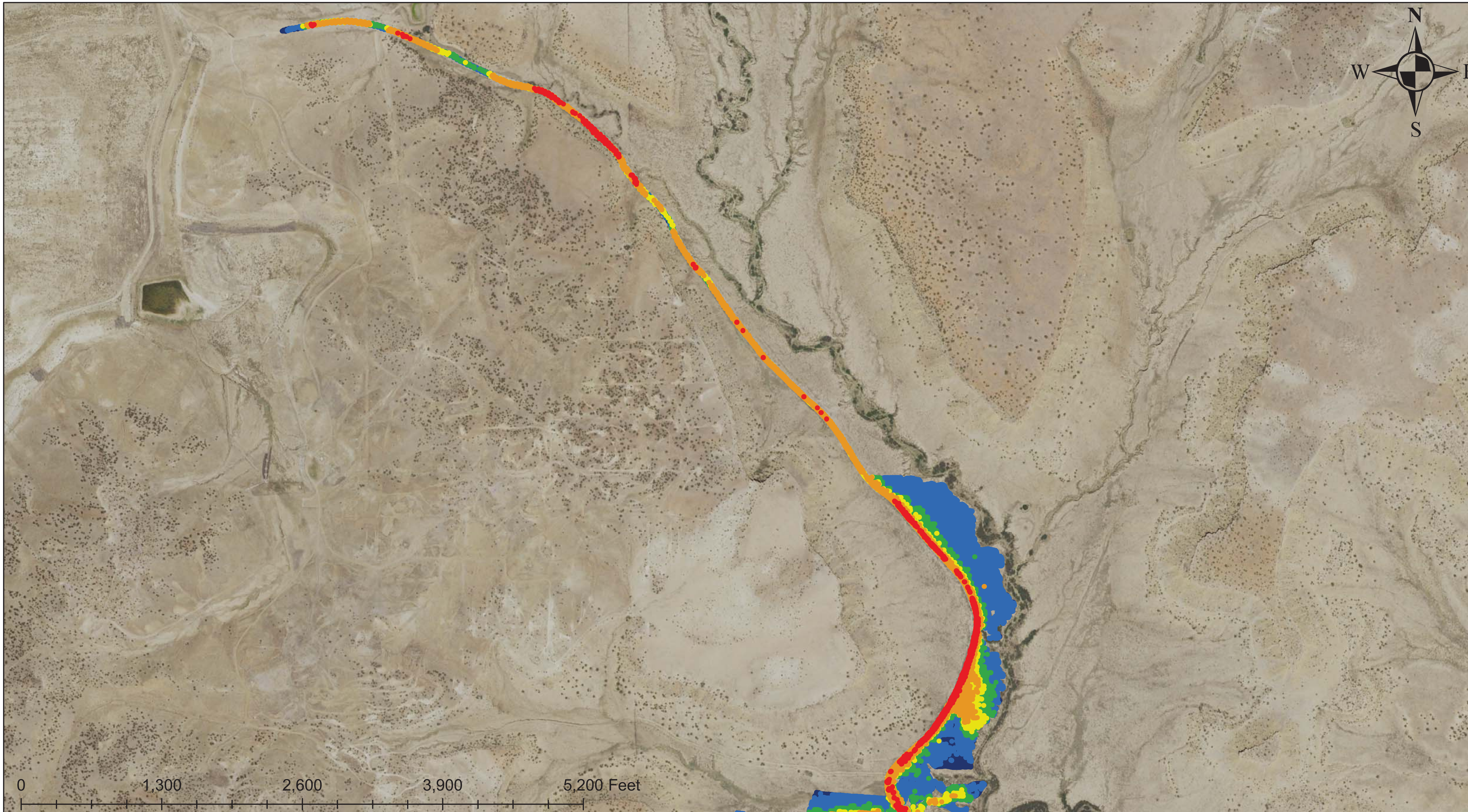


AVM Environmental Services, Inc.

Figure 1
St. Anthony Mine Site Supplemental Radiologic Characterization
Gamma Radiation Level Scan

Legend

- <15,000 cpm
- 15,001 - 20,000 cpm
- 20,001 - 25,000 cpm
- 25,001 - 32,000 cpm
- 32,001 - 62,000 cpm
- 62,001 - 212,000 cpm
- >212,000 cpm

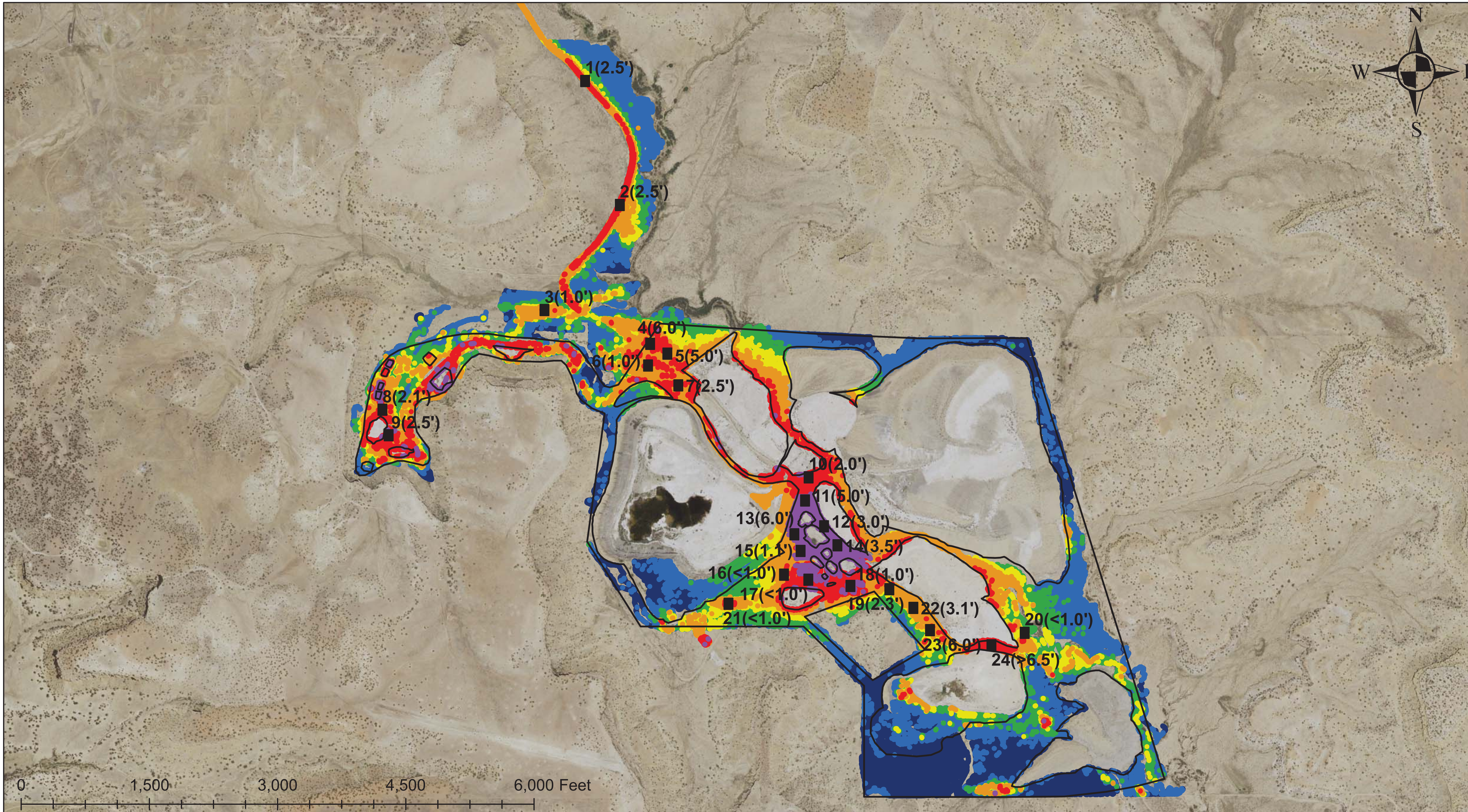


AVM Environmental Services, Inc.

Figure 2
St. Anthony Mine Site Access Road
Supplemental Radiologic Characterization
Gamma Radiation Level Scan

Legend

- <15,000 cpm
- 15,001 - 20,000 cpm
- 20,001 - 25,000 cpm
- 25,001 - 32,000 cpm
- 32,001 - 62,000 cpm
- 62,001 - 212,000 cpm
- >212,000 cpm

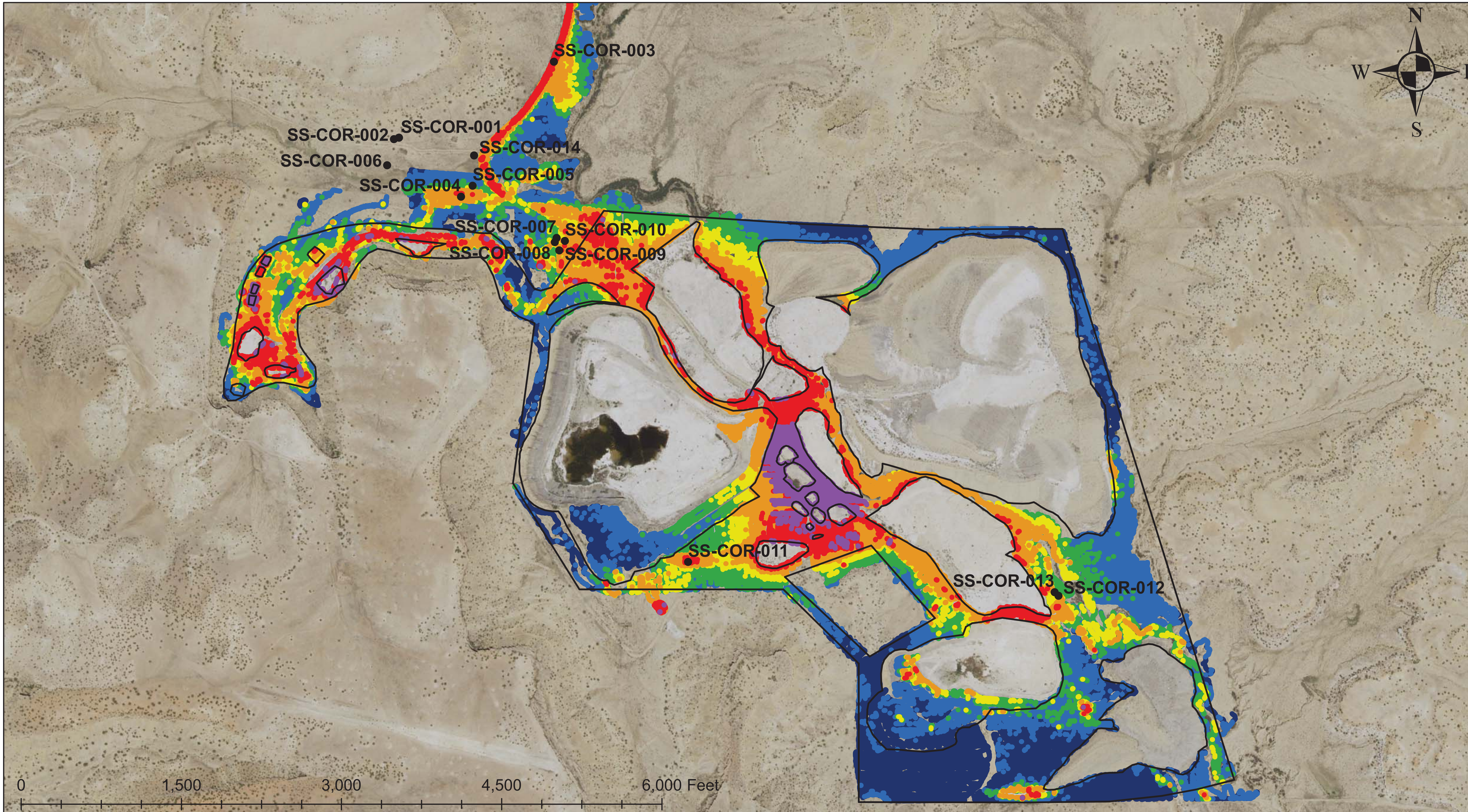


AVM Environmental Services, Inc.

Figure 3
St. Anthony Mine Site Supplemental Radiologic Characterization
Subsurface Investigation Test Pit Locations

Legend

- Test Pit Location - ID(contamination depth)
- <15,000 cpm (bkg) (1.6 pCi/g)
- 15,001 - 20,000 cpm (1.7 - 4.0 pCi/g)
- 20,001 - 25,000 cpm (4.1 - 6.6 pCi/g)
- 25,001 - 32,000 cpm (6.7 - 10.0 pCi/g)
- 32,001 - 62,000 cpm (10.1 - 25.0 pCi/g)
- 62,001 - 212,000 cpm (25.1 - 100.0 pCi/g)
- >212,000 cpm (>100 pCi/g)

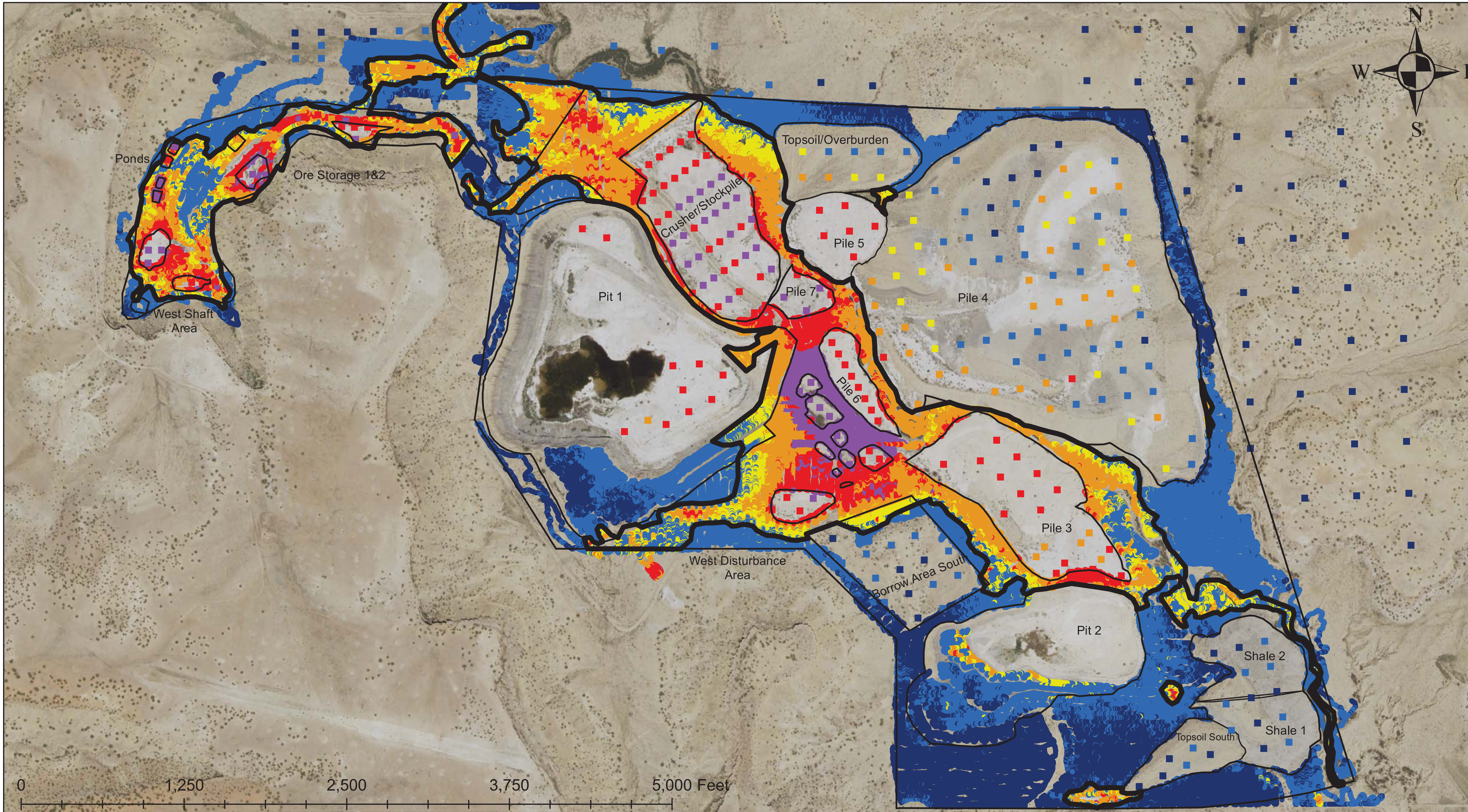


AVM Environmental Services, Inc.

Figure 4
St. Anthony Mine Site Supplemental Radiologic Characterization
Correlation Sampling Locations

Legend

- Correlation Sample Location
- <15,000 cpm
- 15,001 - 20,000 cpm
- 20,001 - 25,000 cpm
- 25,001 - 32,000 cpm
- 32,001 - 62,000 cpm
- 62,001 - 212,000 cpm
- >212,000 cpm



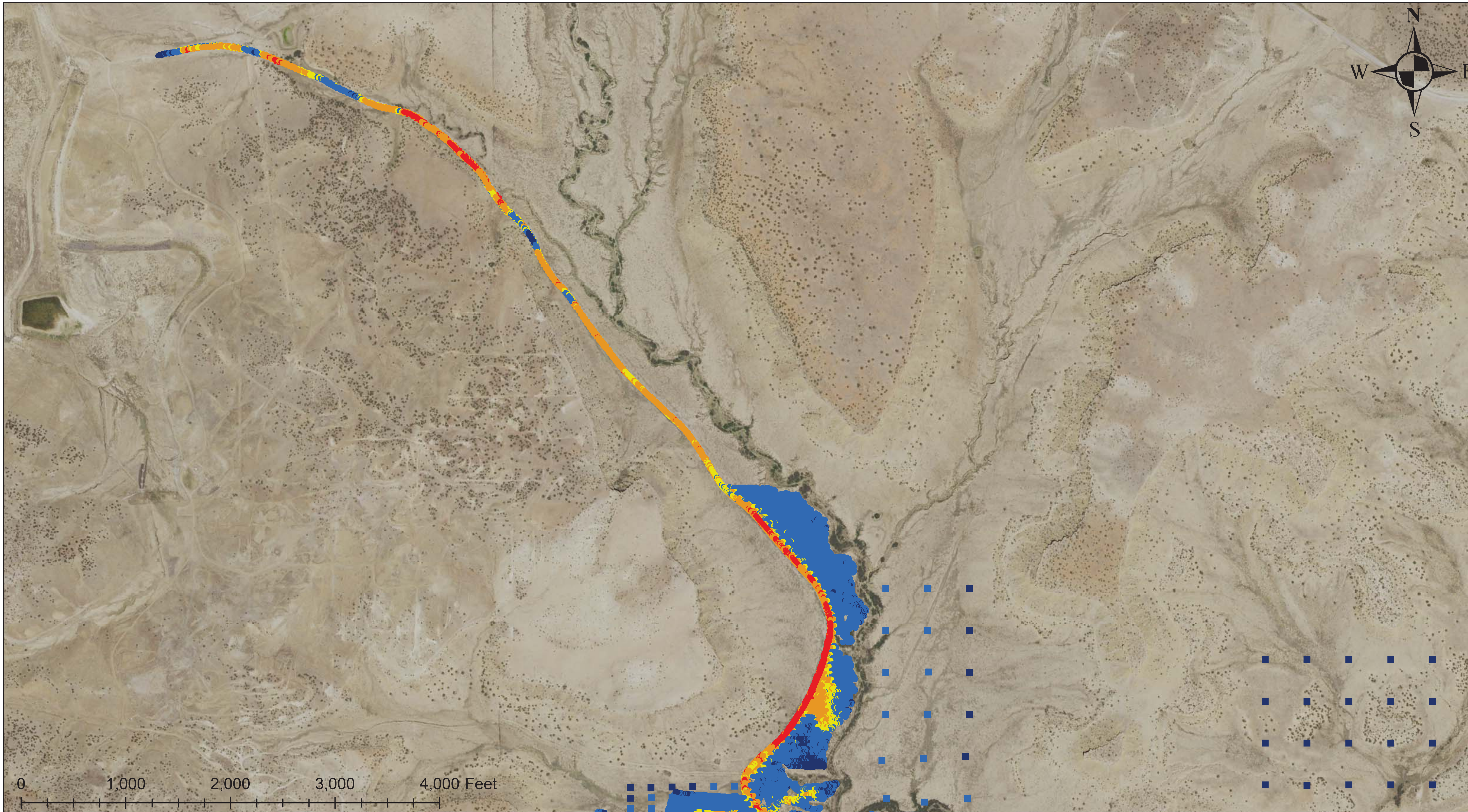
AVM Environmental Services, Inc.

Figure 5
St. Anthony Mine Site Supplemental Radiologic Characterization
Lateral Extent of Ra-226 Contamination

Legend

Ra-226 pCi/g

- <1.6 pCi/g
- 1.61 - 6.6 pCi/g
- 6.61 - 10.0 pCi/g
- 10.1 - 25.0 pCi/g
- 25.1 - 100.0 pCi/g
- >100 pCi/g
- 2007 MC Survey Point
- Boundary above the 6.6 pCi/g Ra-226 Investigation Level



AVM Environmental Services, Inc.

Figure 6
St. Anthony Mine Site Access Road Supplemental Radiologic Characterization
Lateral Extent of Ra-226 Contamination

Legend
Ra-226 pCi/g
- <1.6 pCi/g
- 1.61 - 6.6 pCi/g
- 6.61 - 10.0 pCi/g
- 10.1 - 25.0 pCi/g
- 25.1 - 100.0 pCi/g
- >100 pCi/g
- 2007 MC Survey Point

Appendices