DRAFT Waste Characterization Study – Phase 2

Section 12 Mine (Mine Permit Application (NM MK046RE)
SW/4, Section 12, Township 14 North, Range 10 West, McKinley County, New Mexico
May 1, 2018

INTRODUCTION

This report describes the results of a waste characterization study at the Section 12 mine as conducted by Permits West personnel on August 22, 2017. The Section 12 mine is located in the southwest quarter of Section 12, Township 14 North, Range 10 West, McKinley County, New Mexico. This second phase of the waste characterization study was designed to utilize the maps developed from the radiological gamma ray survey of the Section 12 mine site as performed by Environmental Restoration Group, Inc. (ERG 2017), and further characterize sub-surface conditions at the Section 12 mine for future site reclamation.

Scope of Work

The Section 12 mine area includes the main access road, an ore loadout area, an equipment yard, a mine shaft with a head frame and hoist, a hoist (mechanical) house, a metal office building, parking areas and driveways around the buildings, piles of non-economical waste rock, and two ventilation shafts.

Gamma radiation levels across the mine range from 13.6 to 211.0 μR/h (micro-Roentgens/hour) and are primarily associated with uranium (U) and its radium-226 and radon daughter decay products. Most of the elevated radiation levels documented at the mine are associated with piles of mineralized waste rock, drill cuttings, and spoils which were brought to the surface as the mine shaft was developed. An ore load-out area located east of the mine's head frame (Figure 1) also evidenced elevated exposure rates. Based on previous visual inspections and walkover surveys of the Section 12 mine by Permits West personnel and others, it is likely that materials in many of these areas have been mixed and/or redistributed by repeated grading and other earthwork at the mine site.

Purpose of Waste Characterization Study

The upper bounds of the exposure rates to be achieved in cleaning up the core area around the mine is 22.112 μR/h (ERG 2017). Thus the purpose of the waste characterization study was to collect additional information about the characteristics of the waste materials at the Section 12 mine, their depths, their likely sub-surface distributions, and their extent across the impacted area. This information was used to: 1) develop a more detailed gridded cleanup map of the mine site; 2) estimate -- as a first approximation -- the volumes of materials to be removed and disposed of; and 3) make additional project scope decisions as they relate to planning and advancement of the mine's reclamation at closure.

METHODS

Prior to conducting the excavation of the trenches, and using the exposure rate (Figure 1) and the Ra-226 concentration (Figure 2) isocontour maps generated from the ERG radiological report (ERG 2017), Permits West personnel conducted a preliminary field investigation and identified 10 potential areas for excavation of soil trenches (Figure 3) at the Section 12 mine. Excavation of the soil trenches was conducted on August 22, 2017 with Michael Coleman, Senior Reclamation Specialist, New Mexico Mining and Minerals Division, and Permits West field personnel Mike Deutsch, Robyn Tierney, and Dan

Gibson-Reinemer, jointly evaluating each trench, recording observations, photographing the soil profiles in each trench, and directing the equipment operator.
The excavation work was carried out by Coyote Drilling and used a 3 cu yd. bucket backhoe. Work began at approximately 10:30 and ended at 4:00 PM. Temperatures during the day ranged from 70°F in the morning to 90°F in the afternoon with clear skies and light breezes. The Ambrosia Lake lakebed was dry and has not contained water since June of 2017.

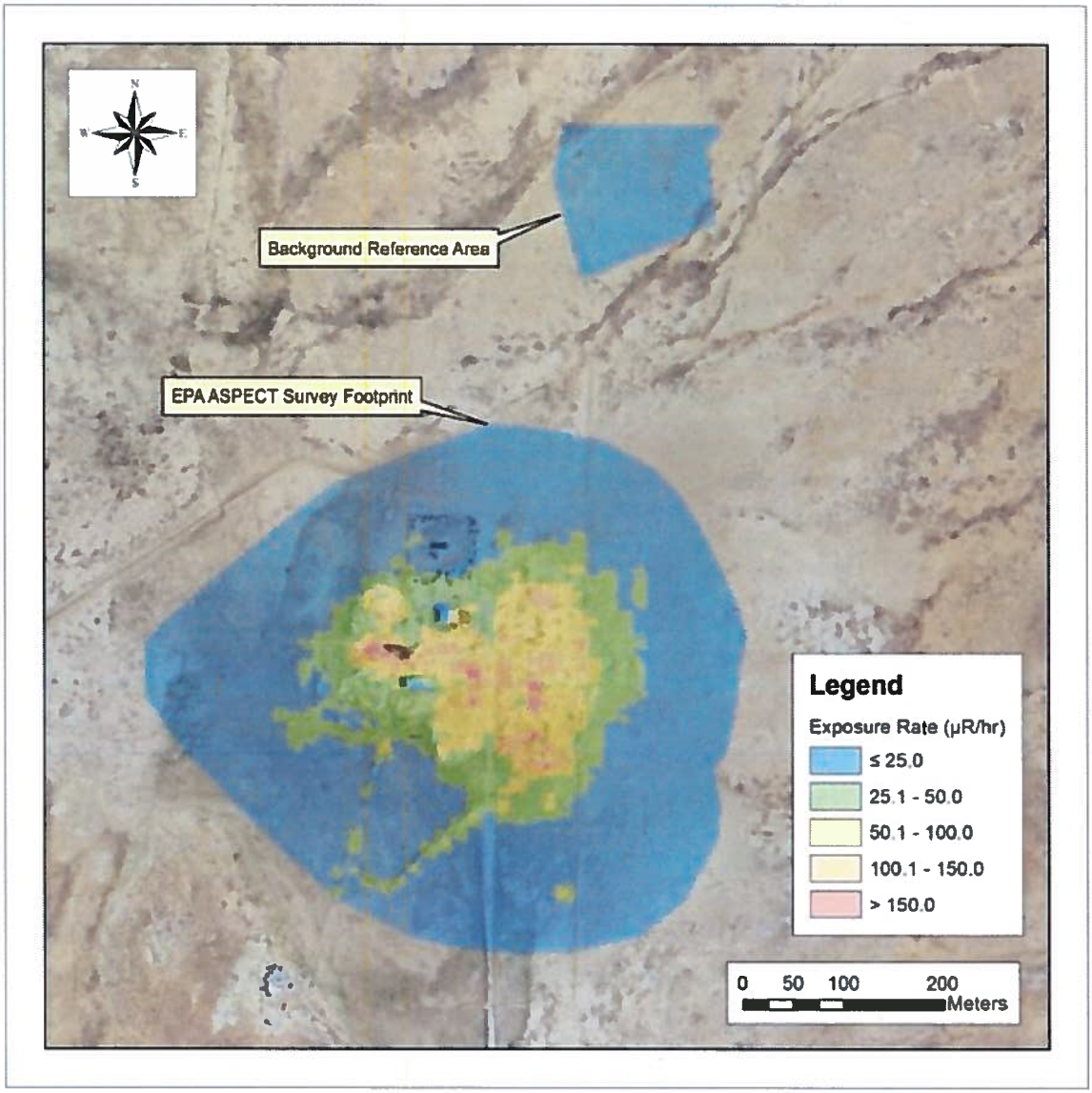

Figure 1. Isocontours of expected exposure rates (µR/hr), Figure 3.3 from ERG 2017 radiological survey report. ERG figure is superimposed on EPA ASPECT survey footprint.

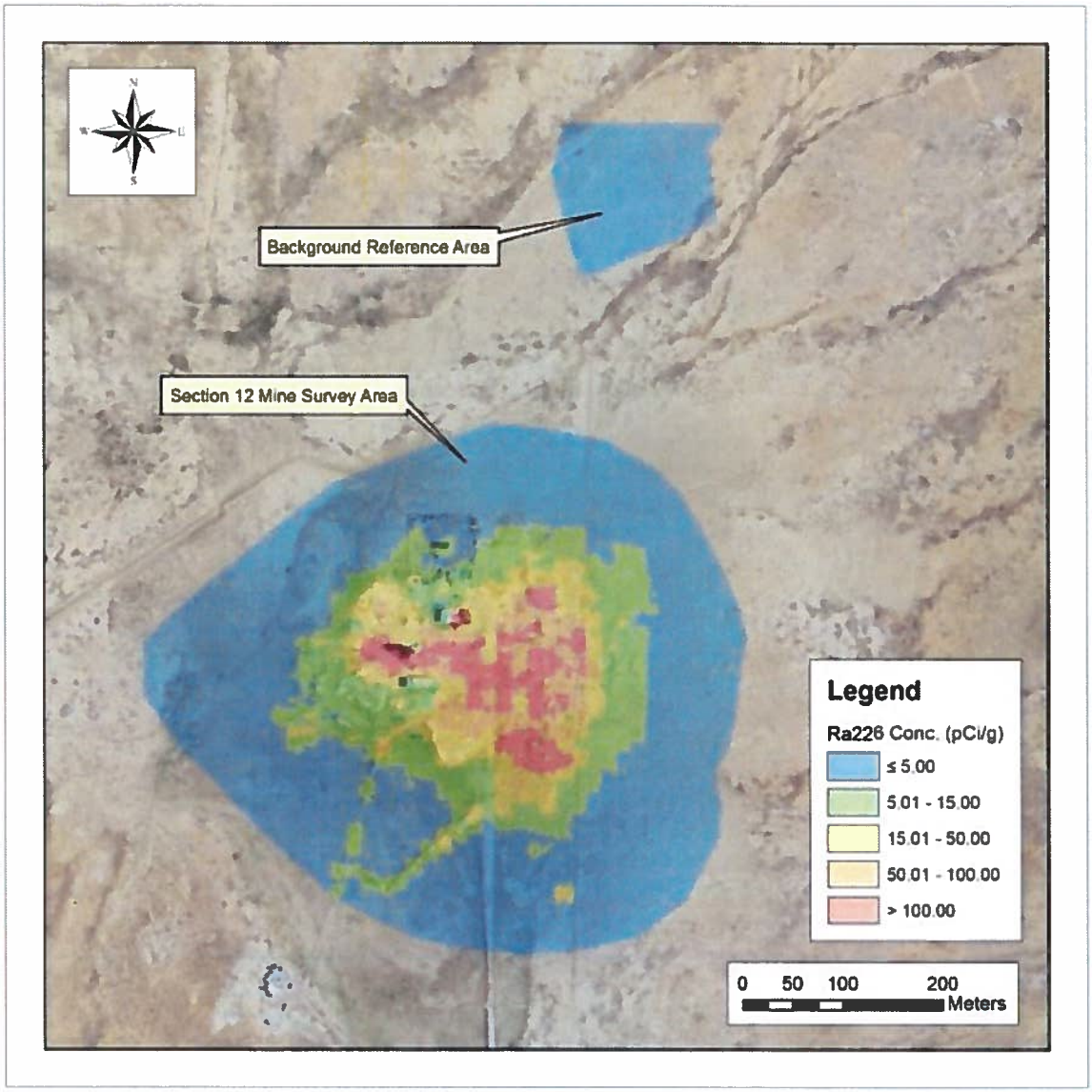

Figure 2. Isocontours of predicted concentrations of Ra-226 (pCi/g), Figure 4-2 from ERG 2017 radiological survey report. ERG figure is superimposed on EPA ASPECT survey footprint.

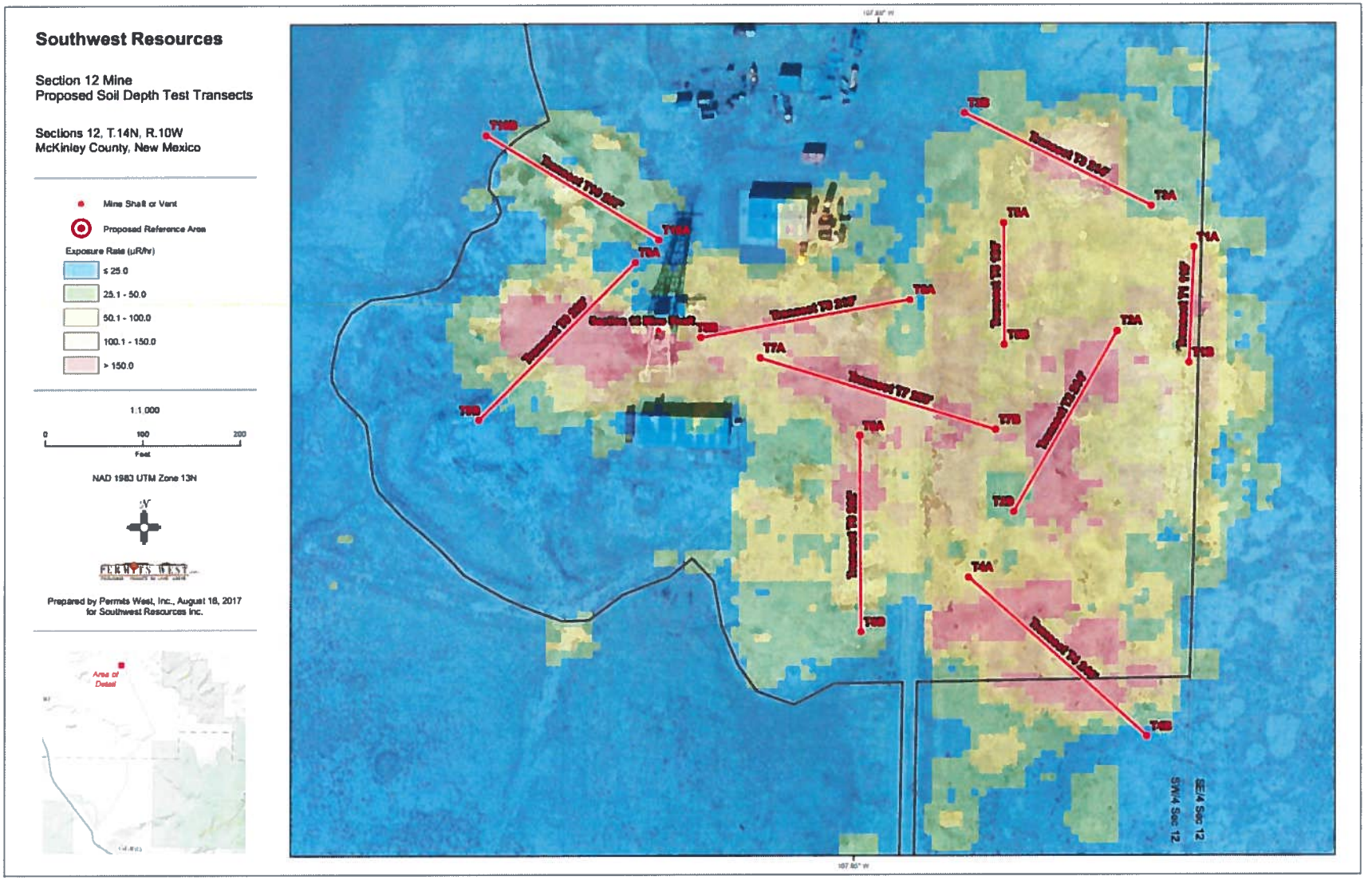

Figure 3. Preliminary layout of 12 soil trenches as selected by Permits West.

Baseline readings were taken using a hand-held gamma detector in an undisturbed area east of the Section 12 mine, and a relative baseline reading of 300 cps (counts per second[1]) was set by Mr. Coleman as the natural un-impacted background level or reference level for this phase of the study.

A total of 13 soil trenches were excavated and visually evaluated by Permits West personnel for changes in color, texture, and soil structure, and by Mr. Coleman, who used the hand-held gamma detector to determine where materials with elevated readings were located in the trenches (Figure 4). The detector was held at approximately 18 inches above the ground surface (ags) as Mr. Coleman walked in or along each trench (Figure 5). Readings and observations were recorded by Robyn Tierney, Permits West Natural Resources Specialist, as they were called out by Mr. Coleman. Additional visual observations about the soil and waste rock's physical characteristics were also made and recorded by Ms. Tierney and photographs were tagged with positional information (i.e. GPS coordinates) for later review. Once the excavation and evaluation of each trench had been completed, the trenches were backfilled and lightly compacted.

Figure 4. Beginning (A) and ending (B) locations of waste characterization trenches

[1] Counts per second (cps) is a measure of the rate that detection events are registered by the measuring instrument on a per second basis, and not the rate of disintegrations or emissiosn from the source of radiation. Readers are reminded that count rates do not universally equate to dose rates, and there is no simple universal conversion factor since conversions are instrument-specific. Rather, the measure of counts per second, is the number of events detected on a per second basis. Dose rate relates to the amount of ionizing energy deposited in the sensor of the radiation detector. The conversion calculation is dependent on the radiation energy levels, the type of radiation being detected and the radiometric characteristics of the detector.

Figure 5. Photo: UQXW5676. Michael Coleman samples the sidewalls of waste characterization trench T-1.

RESULTS

The following descriptions and photographs were compiled from the direct observations and field notes as made by Robyn Tierney during the August 22, 2017 field study. Readers are referred to Figure 4 above for the locations of the waste characterization trenches at the Section 12 Mine.

Trench T-1

Figure 6. Photo: AMNI18284. Trench 1-B (south end of trench)

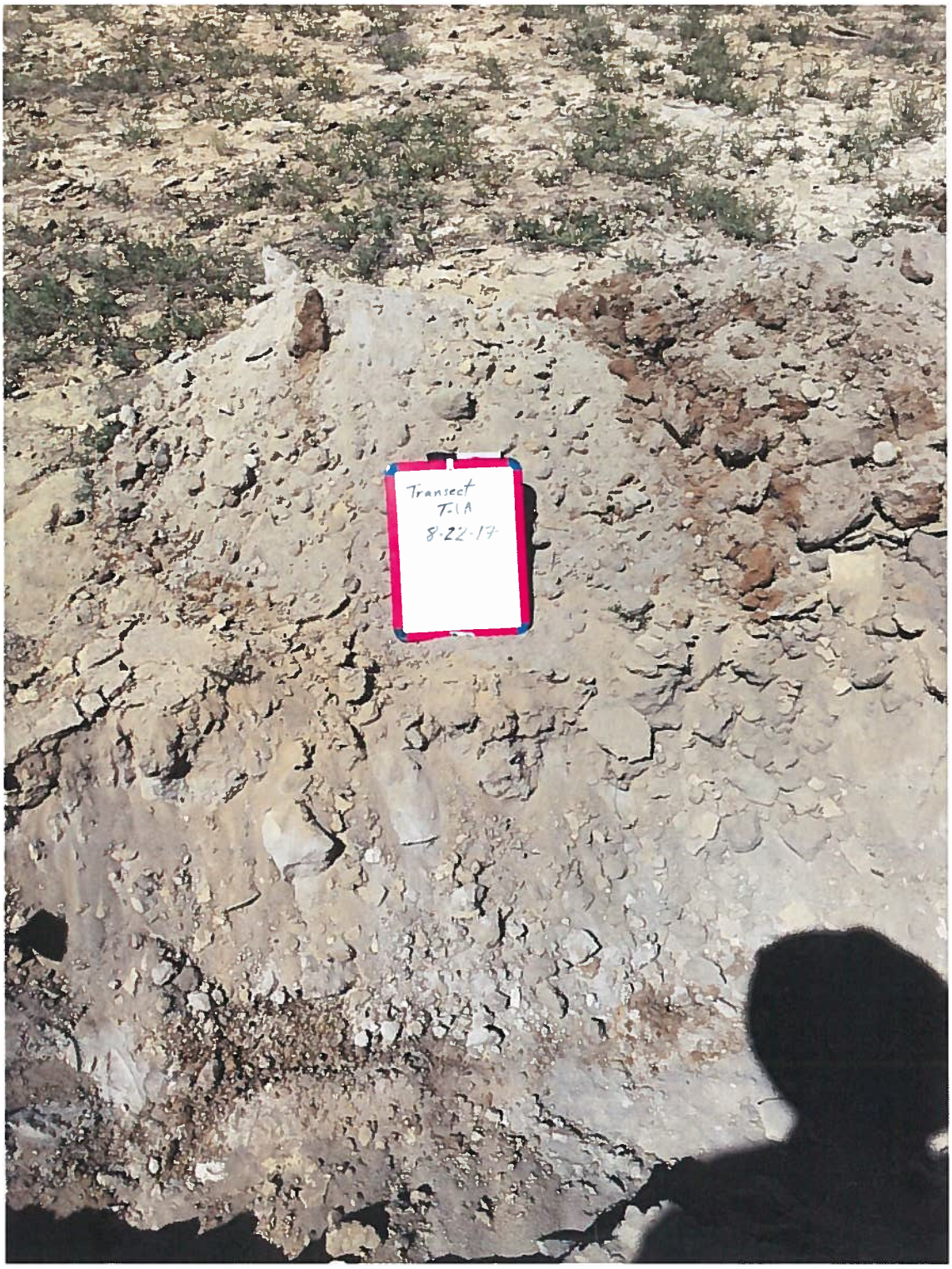

Figure 7. Photo: CRER5389. Trench 1-A (north end of trench at fenceline)

Figure 8. Photo: UEES6706. Trench 1-B (south end of trench)

Trench T-2 (broken into two smaller discontinuous trenches)

Readings at the northeast end of the T-2 trench were elevated (3,400 cps or counts per second) to a depth of 18 inches. The introduced materials were a distinct light grey with darker organic inclusions to a depth of 18 inches and were distinguished from the underlying layer of consolidated brownish lakebed clays below. Readings from these lakebed clays were not elevated and approached the baseline of 300 cps (400 – 600 cps). This suggests these lakebed clays may act as a barrier to downward leaching of materials. Readings of grey materials in the upper 18 inches at the southwest end of trench were also elevated (3,000 – 4,500 cps range).

Figure 9. Photo: AMNI18284. Trench 2-B (southwest end of trench). Note darker grey inclusions or materials in left mid-frame of photograph.

Figure 10. Photo: FWMJ. Note platy and blocky layer of brown-colored lakebed clays.

The southwestern or second part of the Trench T-2 is located adjacent to BLM land. Readings in this trench were also elevated (3,400 cpm) to an 18-inch depth, but not elevated below in the underlying lakebed clay layer. The first 18 inches of the material consists of a sandy, disintegrated waste material, with no clasts. There is a chalky or talc-like quality to the bottom of this 18-inch layer. Wires for blasting caps were identified in this trench.

Figure 11. Photo: OBCG5018. Trench 2-B (southwest end of trench). Note brownish clay layer below 18 inches.

Figure 12. Photo: JZVX5553. Trench 2-B (southwest end of trench)

Figure 13. Photo: VGTB3533. Trench 2-G (also at southwest end of trench)

Figure 14. Photo: SBEE5011. T-2H (also at southwest end of trench). Note ashy layers overlying blocky clay layers.

Third trench at T-3 pile – east facing of side of pile

A trench was excavated from the east-facing side of a large waste rock pile, west to the apex or crest of the pile. The trench began in an eight-inch layer of atypical material overlying brown lakebed clays at the edge of the pile. The excavation on the east-facing side of the pile revealed an ashy grey layer of material with uniformly elevated readings (> 3,000 cps) interspersed with darker humate materials in the pile. The waste rock pile is estimated to be between six and eight feet deep and based on the readings from this trench, the entire pile should be removed.

Figure 15. Photo: ANTE4371. Beginning of trench T-3 on east of waste pile. Note brownish lakebed clays in mid-frame of photograph.

Figure 16. Photo: TXUY7756. Trench T-3 on east of waste pile

Fourth trench at T-3 pile – west side of pile

A separate trench on the west-facing side of the waste rock pile began in a smaller pile of atypical blocky rock fragments located at the base of the larger pile, then proceeded eastward through the pile to the pile's apex or crest. The materials in this trench rapidly changed from the blocky rock fragments at the base of the pile to a fine ash-like layer with elevated readings (>4,000 cps), then into three-and a half to four foot deep layer of altered sandstone and limonite materials (yellow streaky) near the crest of the pile. Again, the waste rock pile is estimated to be between six and eight feet deep and should be removed in its entirety.

Figure 17. Photo: QLUH0714. Trench T-3C on east side of waste pile. Note blocky and angular lakebed clays as well as fragments of sandstone rock with yellowish chroma (limonite).

Fifth trench at T-11

Excavation of this trench revealed a soft, fine black surface layer (4,000 cps) that extended to a one-foot depth. This layer overlies a clay layer with approximately 2,400 cps. The area surrounding the trench may have been missed in the ERG survey, since it was not reflected in that survey's isocontour maps. However, the hand-held radiometer picked this area up and there appears to be a "pinkish ghost" of an area containing "hotter" materials on the survey map. There is insufficient neutral cover material over this area and the readings from the trench T-11 reflect this.

Sixth trench at T-4

There are two places along this trench with intermittent grayish ash-like materials and elevated readings. The northwest end of the trench contains materials with a 1,400 cps reading to the six-inch depth, but not at deeper depths. The materials in the middle segment of the trench are yellowish with no elevated readings.

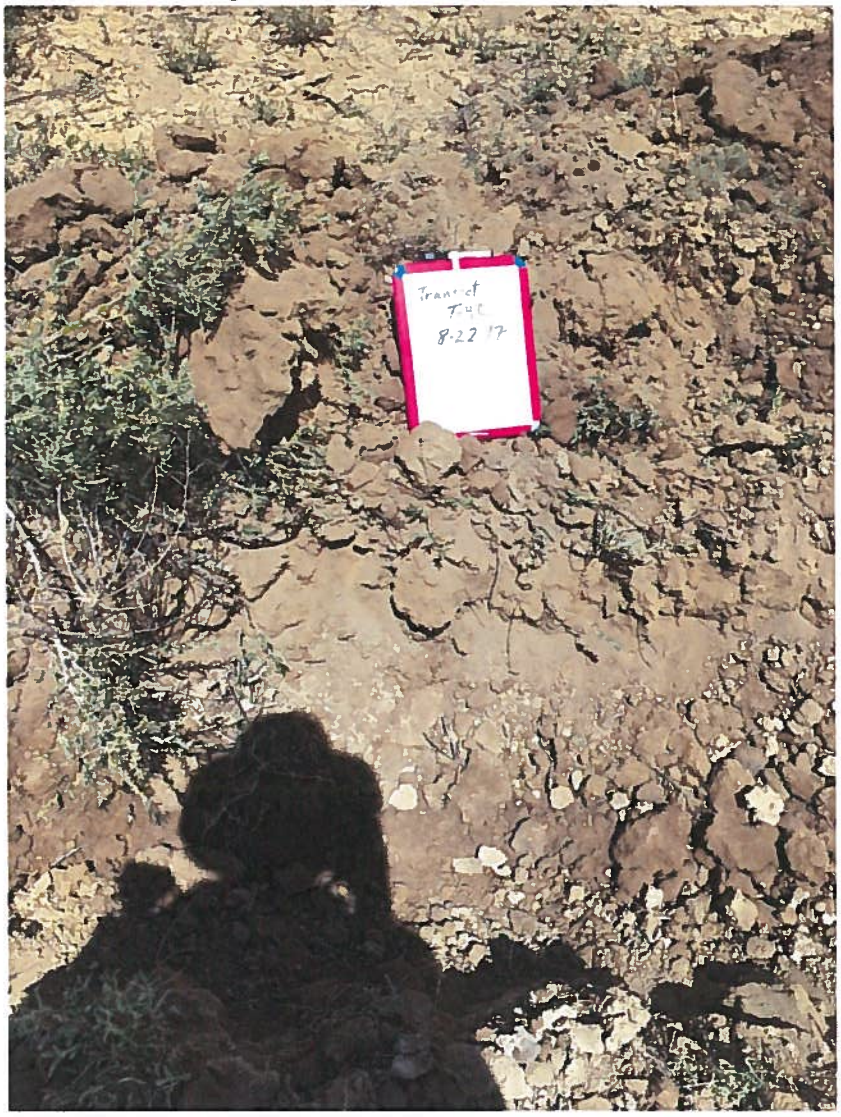

Figure 18. Photo: VIGF0896. Trench T-4C

Figure 19. Photo: RXEW3330. Trench T-4A.

Seventh trench at T-6

Excavation of the T-6 trench began at the south end of trench. Material in trench consists of a sandy white material (700 cps) on top of a darker ashy material with elevated readings (1,400 cps) to an eight-foot depth.

Figure 20. Photo: PXUQ0610. Trench T-6A

Figure 21. Photo: UNRK9162. Trench T-6A (detail).

Eighth trench (West of T6B) at T12

Material in this trench also consists of a layer fine whitish-gray sand (700 cps) which extends to an 18 inch depth (1,300 cps). The material is well weathered and may have come from the initial development of the shaft.

Figure 22. Photo: UGSH8425. Trench T-12A.

Ninth trench at T7

This trench was excavated in a flat area just west of the access road. Material in the trench at the six-inch to one-foot depth is blackish in coloration with elevated readings (3,200 cps) and is layered with or interbedded with a green montmorillonite clay. There are also some yellowish inclusions in the material. The bottom of the trench had a lakebed clay bottom (900 cps) that appears to contain the overlying material and limit its leaching.

Figure 23. Photo: SCN14332. Trench T-7A

Figure 24. Photo: RNC16822. Trench T-7A (detail).

Figure 25. Photo: INBC1023. Trench T7B (detail)

Tenth trench at T9A

This excavation was conducted west of the headframe. Material from the trench consisted of a dominant light gray layer above thinner darker gray layers and blackish inclusions. No elevated readings were observed at the north end of the trench, though readings from the one-foot to 18-inch depth at the south end of the trench were somewhat elevated (1,800 – 2,300 cps).

Figure 26. Photo: UGKT4037. Trench T-9A (beginning of trench)

Figure 27. Photo: YCNB5702. Trench T-9A.

Eleventh trench at T9B

Excavation of the 9B trench was conducted in a graded area located just west of the headframe, west to the edge of the lake bed. The trench material consisted of a dark gray, chalky, homogeneous layer generally eight inches to one-foot deep with 2,500 cps. This layer overlies a greenish clay (montmorillonite) layer that contains some black charcoal-like organic or humate materials. Below this clay layer there were no elevated readings. Again, the clay layer probably represents the original lakebed profile and may act as a barrier to downward leaching of materials.

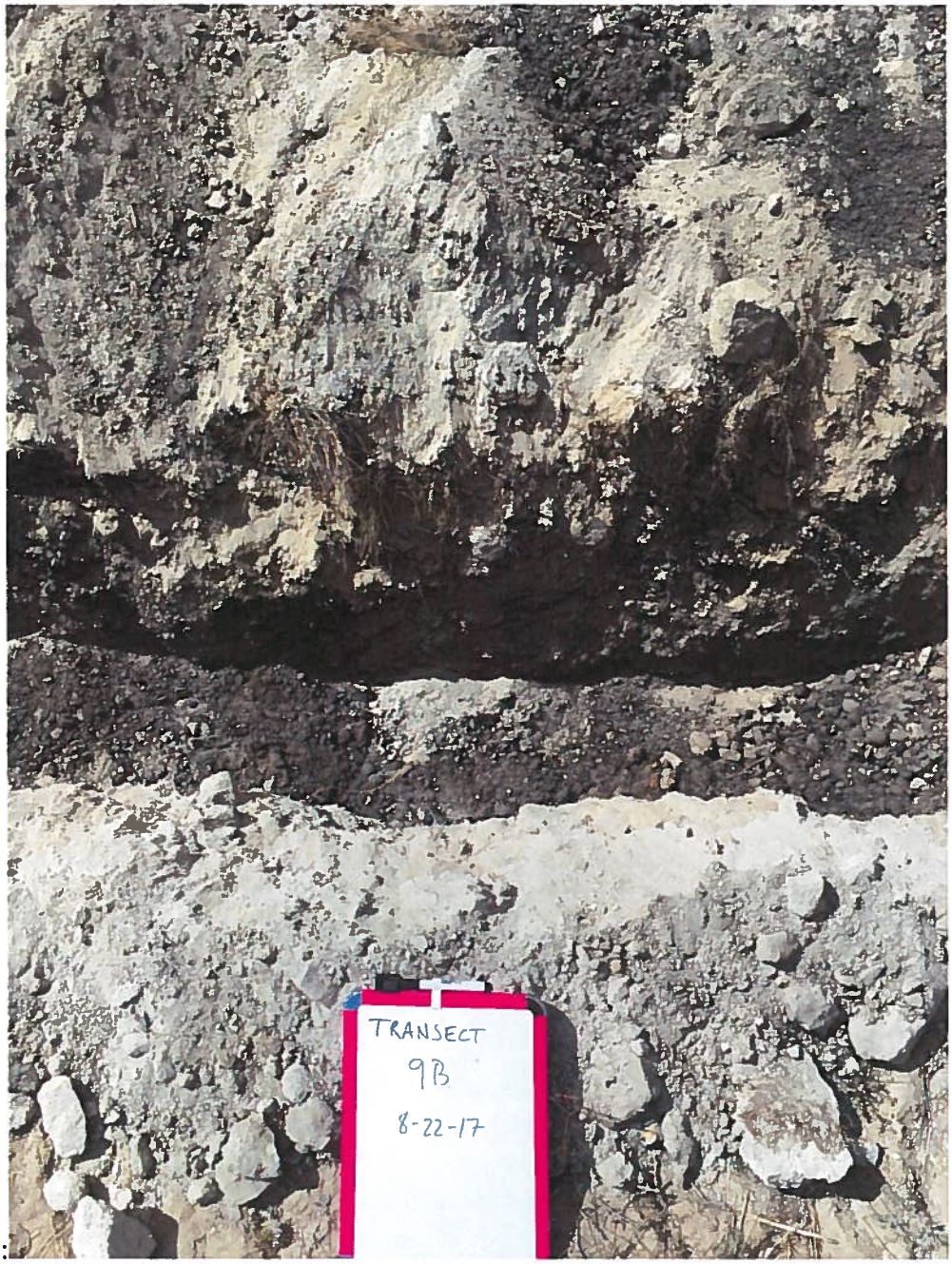

Figure 28. Photo: OSBV1639. Trench T-9B (at edge of lake bed)

Twelfth trench at T10A or east side of waste rock pile in the NW corner of the operations area (above the lakebed)

The excavation indicated that the east side of the waste pile was composed of a pale gray sand with some yellow-orange staining on the sand particles at a three-foot depth. Only moderately elevated readings (1,800 cps) were observed to a three-foot depth in the trench.

Figure 29. Photo: ARAJ5976. Trench 10-A

Thirteenth trench T10B, or west side of waste rock pile in the NW corner of the operations area (above the lakebed)

The excavated material on the west side of this waste rock pile was composed of the same pale gray sand seen on the east side of the pile. Readings ranged from 1,400 cps to 2,400 cps to a two-foot depth.

Figure 30. Photo: RMOS3054. Trench 10B.

DISCUSSION

Based on these results we have identified three areas that likely contain thicker layers of waste rock materials with elevated readings. The first is the graded area containing the T-12 trench (Figure 4). Located approximately 100 feet south of the mechanical building or hoist house, this area appears to contain waste rock materials from the first days of the mine's development that were later re-worked and manipulated through grading. Moreover, the five-foot depth of the T-12 trench and the dispersed

materials with elevated readings observed throughout the trench to the lakebed clays, indicate that most of this 1.25 acre area contains waste rock material that will have to be removed.

The T-6 and T-7 trenches located east and southeast of the mine (Figure 4), also show elevated readings ranging from 1,300 cps in Trench T-6 and 3,200 cps in Trench T-7. Both areas contain a mixture of variously sourced materials to a 4 - 5-foot depth above the lakebed clay. These materials were generated in the early 1980s during the construction of the Section 12 mine shaft and have been spread, graded, and compacted in layers on top of lakebed clays which appear to have slowed and limited the downward movement of water and leachates.

A 10 meter by 10 meter grid (Figure 31) was superimposed onto a map of the predicted exposure rates at the Section 12 Mine (ERG 2017) as the prescribed cleanup interval for an existing mine (See Joint Guidance document of March 2016). Based on this grid, the total acreage of the red zone (>150 uR/hr) is 1.08 acres and the total acreage of the orange zone (100-150 uR/hr) is 1.73 acres.

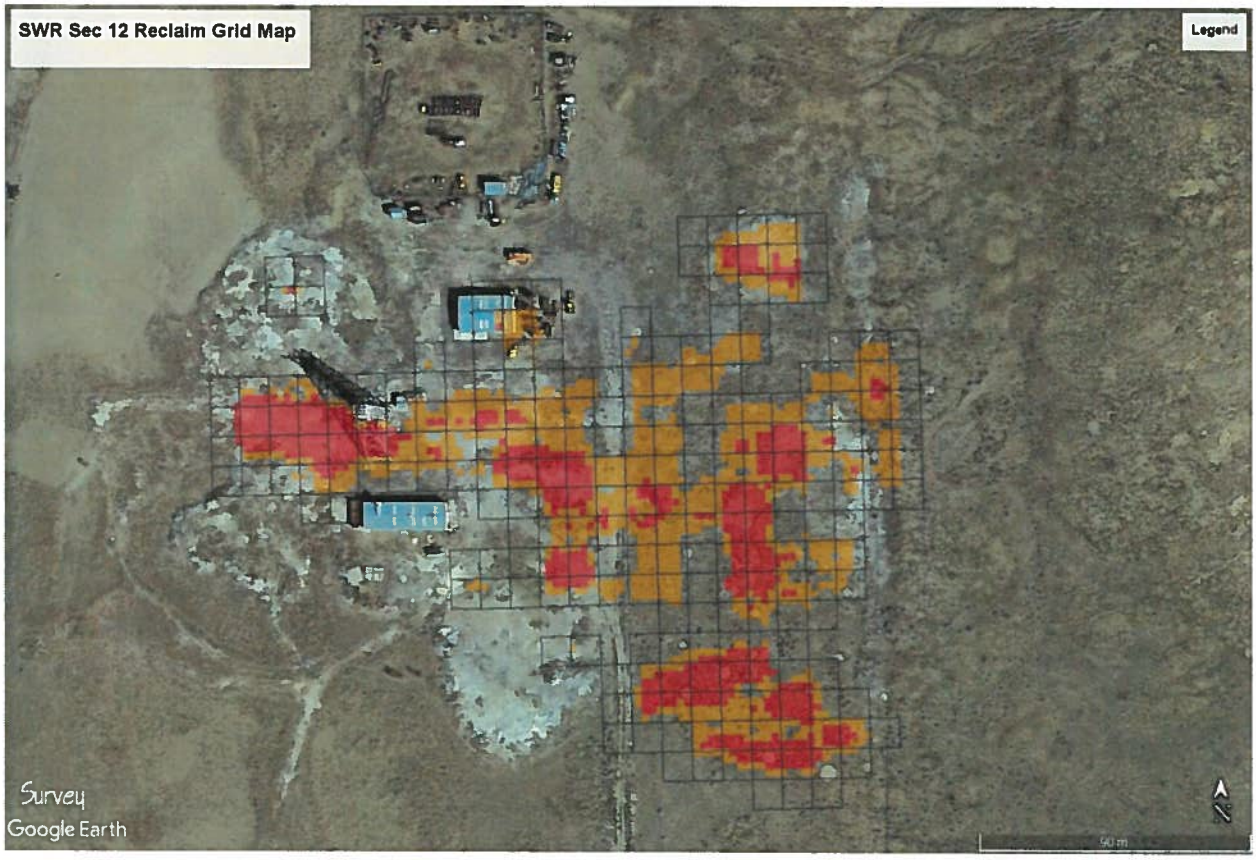

Figure 31. Detail of orange (100-150 uR/hr), and red (>150 uR/hr) exposure rate zones with 10 x 10 meter grid.

Data from the 10 x 10 meter grid were also recombined with the fine-scale (2 m^2 grid) survey data from the ERG study (ERG 2017) and re-analyzed using a "nearest neighbor" sampling process in GIS as shown in Figure 32 below. This nearest neighbor analysis was done to improve our estimates of how much of the Section 12 Mine's sub-surface may contain potentially elevated readings that exceed the standard.

For example, the purple and pink colored grid cells shown in Figure 32 are adjacent to -- or within 2 meters of a red (>150 uR/hr), orange (100-150 uR/hr), or yellow (50 – 100 uR/hr) exposure rate grid cell.

Using this approach we estimated that the total area of purple grid cells representing a combination of the purple, yellow, orange, and red exposure rates is 11 acres, and the total area of the pink colored areas, representing the yellow, orange and red exposure rate zones is 6 acres.

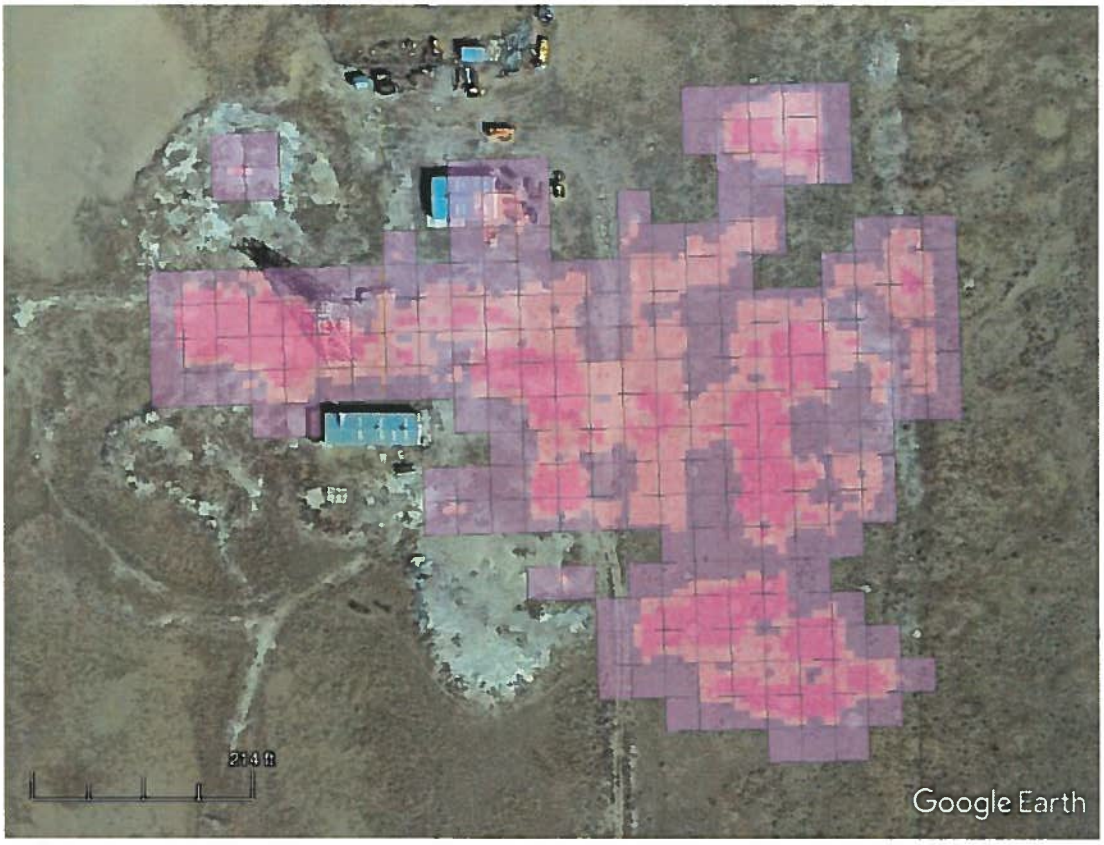

Figure 32. 100 m^2 grid overlay on a 2 x 2 meter nearest neighbor analysis. Purple areas indicate a 2 x 2 meter "sub- cell" with elevated readings.

The results of the materials characterization study (Permits West 2018) indicated exposure rates and concentrations of radium-226 (Ra-226) were elevated above background levels near the headframe and ore loadout area, as previously determined in the radiological investigation performed by ERG (2017). Most of the elevated radiation levels measured at the headframe were associated with piles of a mixture of coarse grained, sandy, and chalky mineralized waste rock, drill cuttings, and spoils which had been brought to the surface when the mine shaft was developed in the early 1980s. The average thickness of these materials in the western half of the mine site as observed across eight trenches, was four - five feet above the lakebed clays and soils. The ore load-out area located directly east the mine's head frame (Figure 1) in the eastern half of the mine site, also evidenced elevated exposure rates to an average depth of two-feet across five transects.

It is important to note that the thick layer of lakebed clay observed in the bottoms of many of the trenches, may limit the downward movement of water and leachates from the waste rock materials and spoils, since gamma radiation readings were generally lower in the undisturbed soils beneath the intact undisturbed layers of clay. Thus, removal of soils and materials with elevated radiation levels and the replacement of those materials with clean fill in the western half of the mine may be carried out over as much as five (5) acres. Similarly, the removal of soils and materials with elevated radiation levels and

their replacement with clean fill in the eastern half of the mine may be carried out over as much as six (6) acres (Figure 33).

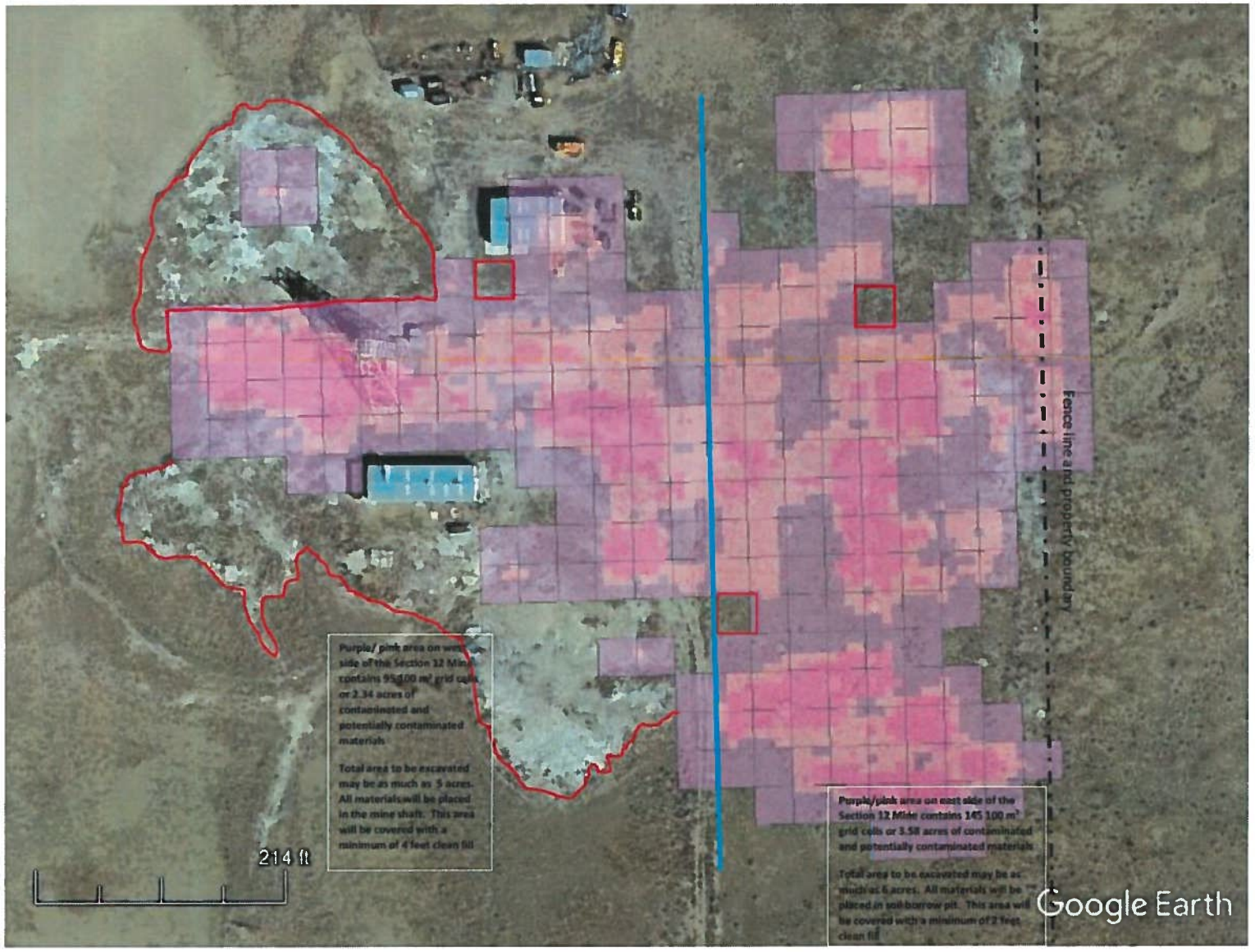

Figure 33. Probable extent of materials with elevated sub-surface radiation readings at the Section 12 Mine.

REFERENCES

Environmental Restoration Group, Inc. 2017. Baseline Radiological Characterization of the Section 11/12 Mine – Phase 1. Report prepared for Southwest Resources and Permits West, Inc. January 2017.

EPA, 2011. Region 6, Airborne Spectral Photometric Environmental Collection Technology (ASPECT) Survey.

Joint Guidance for the Cleanup and Reclamation of Existing Uranium Mining Operations in New Mexico Mining and Minerals Division, Energy, Minerals & Natural Resources Department and Mining March 2016