Dragon Mine PA/SI Work Plan
CENE 486C

Prepared for:

Eric Zielske

Bureau of Land Management Arizona State Office

One North Central Ave., Ste. 800

Phoenix, Arizona 85004-4427

Prepared by:

Ground Guardians LLC

Bowie Ching, Andres Garcia Rico, Zachary Kauranen, Jorja Whitcher

Northern Arizona University

Flagstaff, AZ 86001

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1.0 Project Description

1.1 Project Purpose

The purpose of this project is to conduct a Preliminary Assessment (PA) and Site Investigation (SI) of the Dragon Mine, located near Wickenburg, Arizona (AZ), to evaluate possible threats to Human Health and the Environment (HHE) and to ensure compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Using information from the PA/SI, a risk assessment will be conducted, and potential remedial actions will be explored.

1.2 Project Scope

A list of tasks was created for the project which include the creation of a Sampling Analysis Plan (SAP), a Health and Safety Plan (HASP), a Site Investigation (SI), X-Ray Florescence (XRF) analysis used to determine and measure the contaminants of concern, a human health risk assessment, and an ecological risk assessment, which will enable the selection of remedial alternatives.

1.3 Project Schedule

The project will take place over a duration of 149 days starting October 17th, 2024, and ending May 2nd, 2025. The site investigation will take place January 17th to the 18th.

Table 1-1 shows milestones for the project deliverables.

Table 1-1. Project Schedule

Deliverable	Date
30% Report	February 13th, 2025
60% Report	March 13th, 2025
90% Report	April 17th, 2025
Final Report & Project Website	May 2nd, 2025

2.0 Project Background

2.1 Site Location

The Dragon Mine is an abandoned mine and milling site located in the south half of Section 23, Township 7 North, Range 4 West, Gila and Salt River Meridian, about 5.7 miles southeast of Wickenburg, in Maricopa County, Arizona. Figure 2-1 shows the location of the site within the state of Arizona and in relation to the City of Wickenburg.

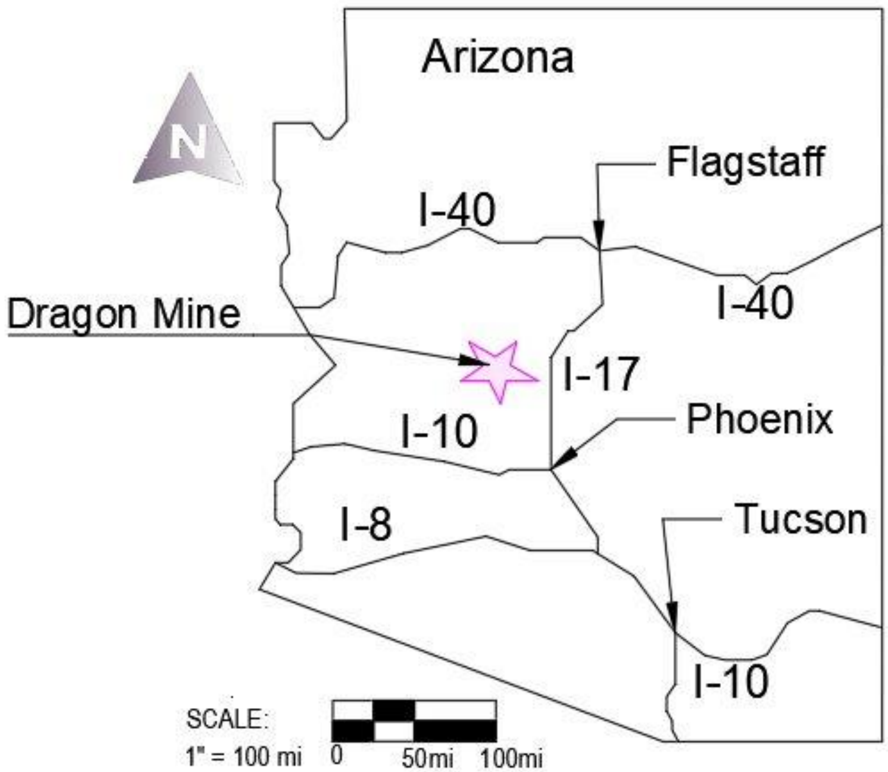

Figure 2-1. Location Map [1]

Figure 2-2 shows the location of the site within Maricopa Country and in relation to the City of Wickenburg.

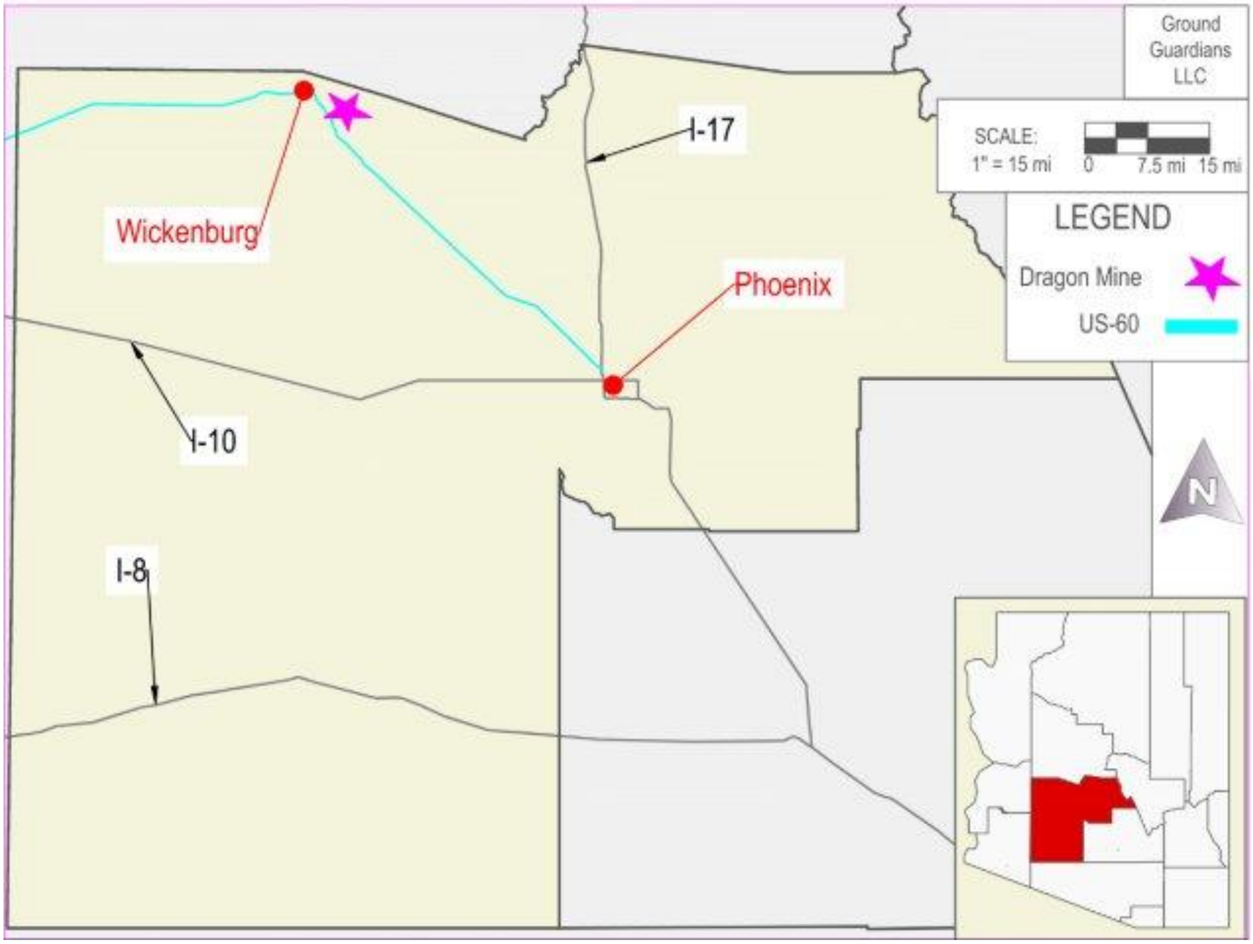

Figure 2-2.Maricopa County Location Map [1]

Figure 2-2 shows the location of the Dragon Mine relative to the city of Wickenburg, AZ and site access roads. Two separate access routes are shown in red. The west access route has a spur where mining occurred. The surrounding land is owned by the Bureau of Land Management (BLM).

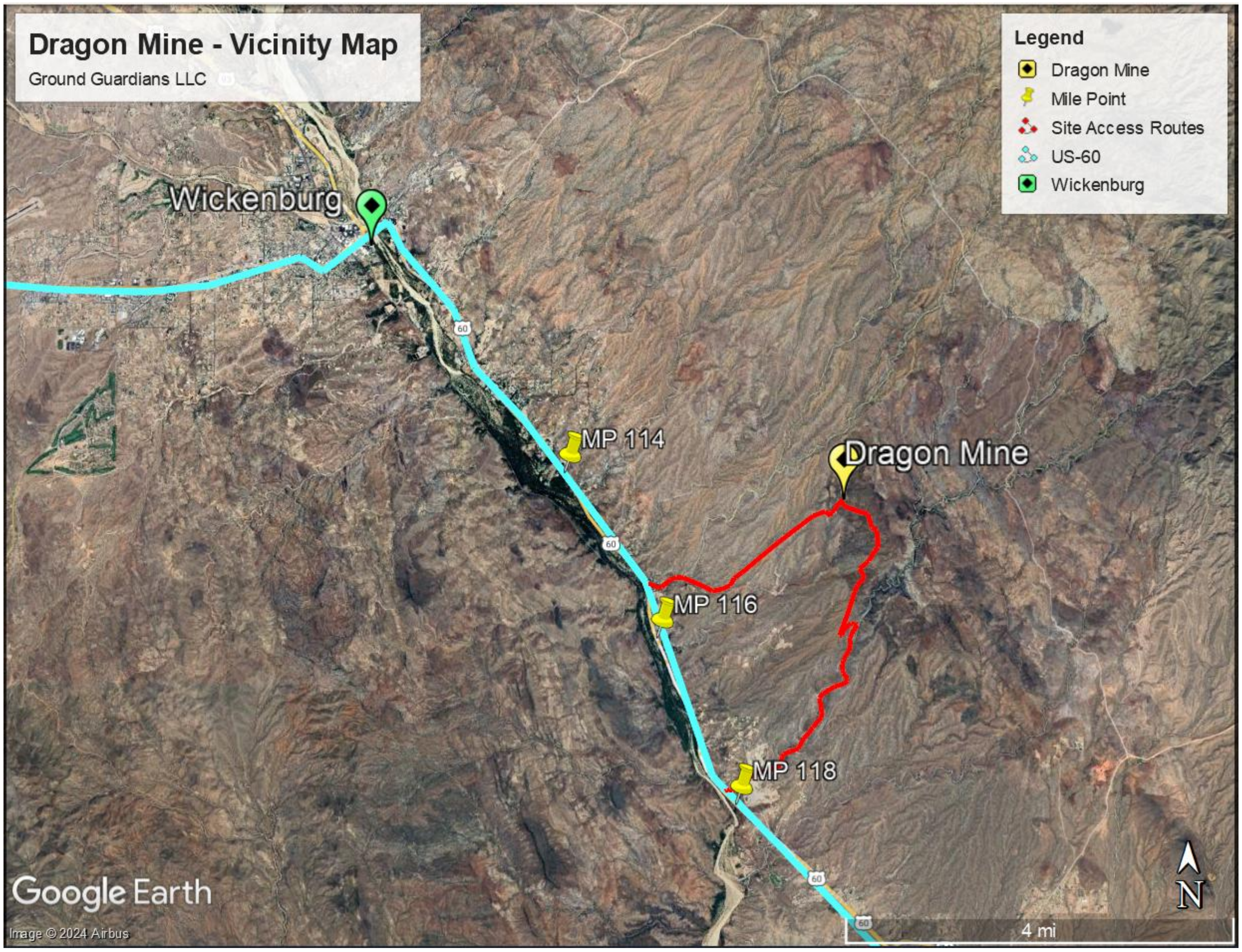

Figure 2-3. Vicinity Map [1]

2.2 Site Description

The wash at the northern boundary of the site flows from northeast to southwest. There is a range of hills to the east with elevations ranging from 2,400 to 2,600 feet. The site itself is relatively flat with a slope of around 2-3%. Located down gradient are the Hassayampa River and Monarch Wash which are 2.3 miles southwest of the Dragon Mine.

Figure 2-3 below shows a map of the site characteristics and the proposed site boundary.

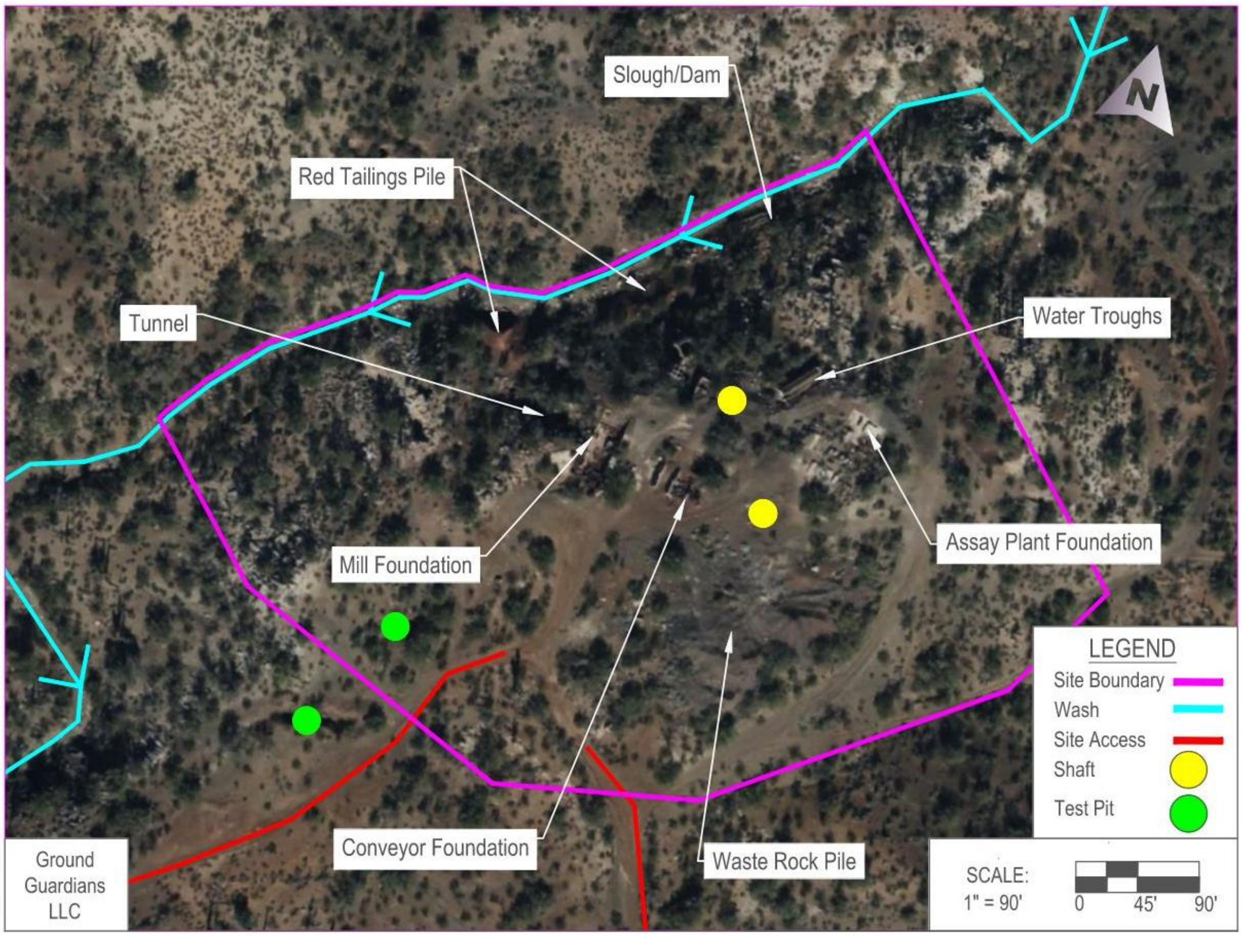

Figure 2-4. Site Characteristics [2]

2.3 Site History

The Dragon Mine was primarily used from the late 1800s to 1942, producing vanadinite, gold, and silver [3]. Two field inspections occurred at the Dragon Mine site in 1989 by the Arizona Department of Mines and Mineral Resources (ADMMR) personnel and by Enterprise Content Management Consultants (ECM) personnel in 2019. The 1989 field inspection discovered that the site had evidence of a heap leaching operation. A heap with 5000 tons of material as well evidence of a small pond of pregnant solution that was neither neutralized nor fenced off remained from the operation. The 2019 field inspection found several adits, shafts, test pits, and concrete foundations. Foundations can be found in the mill, burners, ore bins, and two large water troughs. There is a tunnel from the west side of the ridge that leads to an open stope. The ECM team determined that there was no public recreation going on at the site [3].

2.4 Previous Investigations

ECM consultants conducted an SI on the Dragon mine site to determine concentrations of Contaminants of Concern (COCs).

Figure 2-4 shows the sampling locations from the ECM site investigation [3].

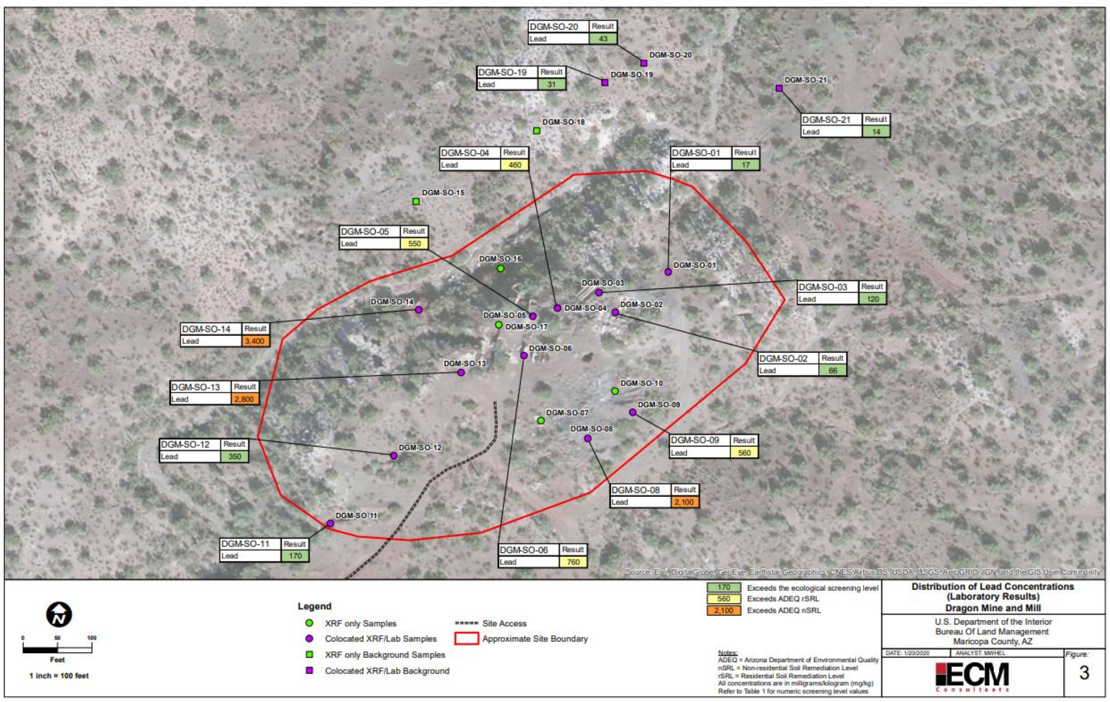

Figure 2-5. ECM Sampling [3]

The COCs determined were antimony, arsenic, cadmium, chromium, copper, lead, manganese, mercury, molybdenum, nickel, selenium, silver, vanadium, and zinc. Table 2-1 shows a summary of the results from the ECM X-Ray Fluorescence (XRF) analysis for the COCs exceeding the Arizona Department of Environmental Quality (ADEQ) residential Soil Remediation Levels (SRL).

Table 2-1. ECM XRF Analysis Summary [3]

Soil	Antimony	Arsenic	Lead	Molybdenum	Vanadium
Area of Concern	**(mg/kg)**				
Downgradient Debris	<394	5	16	<29	259
Mill Foundation	<437	**10**	**115**	<34	**368**
Water Troughs	<199	**15**	**101**	27	<56
Waste Pile	<368	<28	**667**	<28	**548**
Foundation	<579	**29**	**593**	12	**515**
Foundation for a conveyor	<447	**26**	**373**	<35	**409**
Heap Leach?	<396	<24	**414**	<30	**378**
Heap Leach?	<405	9	**141**	<31	295
Heap Leach?	<385	<36	**1062**	17	**455**
Heap Leach?	43	<33	**827**	5	**538**
Waste Rock Pile	<381	<18	**228**	<29	**1241**
Waste Rock Pile	<390	<14	**127**	<31	**347**
Mill Platform	<334	<60	**3967**	88	**581**
Red Tailings	<324	<65	**4894**	102	**440**
Red Tailings in the vicinity of collapsed structure	<226	<83	**10776**	485	**594**
Tailings near mill	<438	<38	**862**	<35	288
Background	<410	7	**91**	<32	**369**
Background	<380	5	49	<30	**432**
Background	<371	**10**	42	<29	**371**
Background	<426	7	57	<33	**335**
Background	<375	5	21	<29	323

Green shaded cells in Table 1-2 indicate concentrations that exceed the ecological screening levels set by ECM consulting. Yellow and red shaded cells exceed values for human health. Yellow shaded cells indicate concentrations that exceed the residential SRLs, and red shaded cells indicate the concentrations that exceed the non-residential SRLs. The arsenic ecological screening level determined was 18 mg/kg which is why the green cells have larger values than the yellow cells, which is exceeded for human, not ecological health. Bolded cells indicate concentrations three times greater than the background concentrations. The cells containing values with a less than symbol represent concentrations that are lower than the instrument's confidence range. Table 2-2 shows the ADEQ SRLs for the COCs.

Table 2-2. ADEQ SRLs [4]

Contaminant	Residential (mg/kg)		Non-Residential (mg/kg)
	Carcinogenic (10^{-5} Risk)	Non-Carcinogenic	
Antimony		31	410
Arsenic	10	10	10
Lead		400	800
Molybdenum		390	5,100
Vanadium		78	1,000

There are no wells in Section 23 where the Dragon Mine is located. However, there are wells located in Sections 22 and 26, directly west and south of Section 23 respectively. Figure 2-5 shows a map of the existing wells near the site.

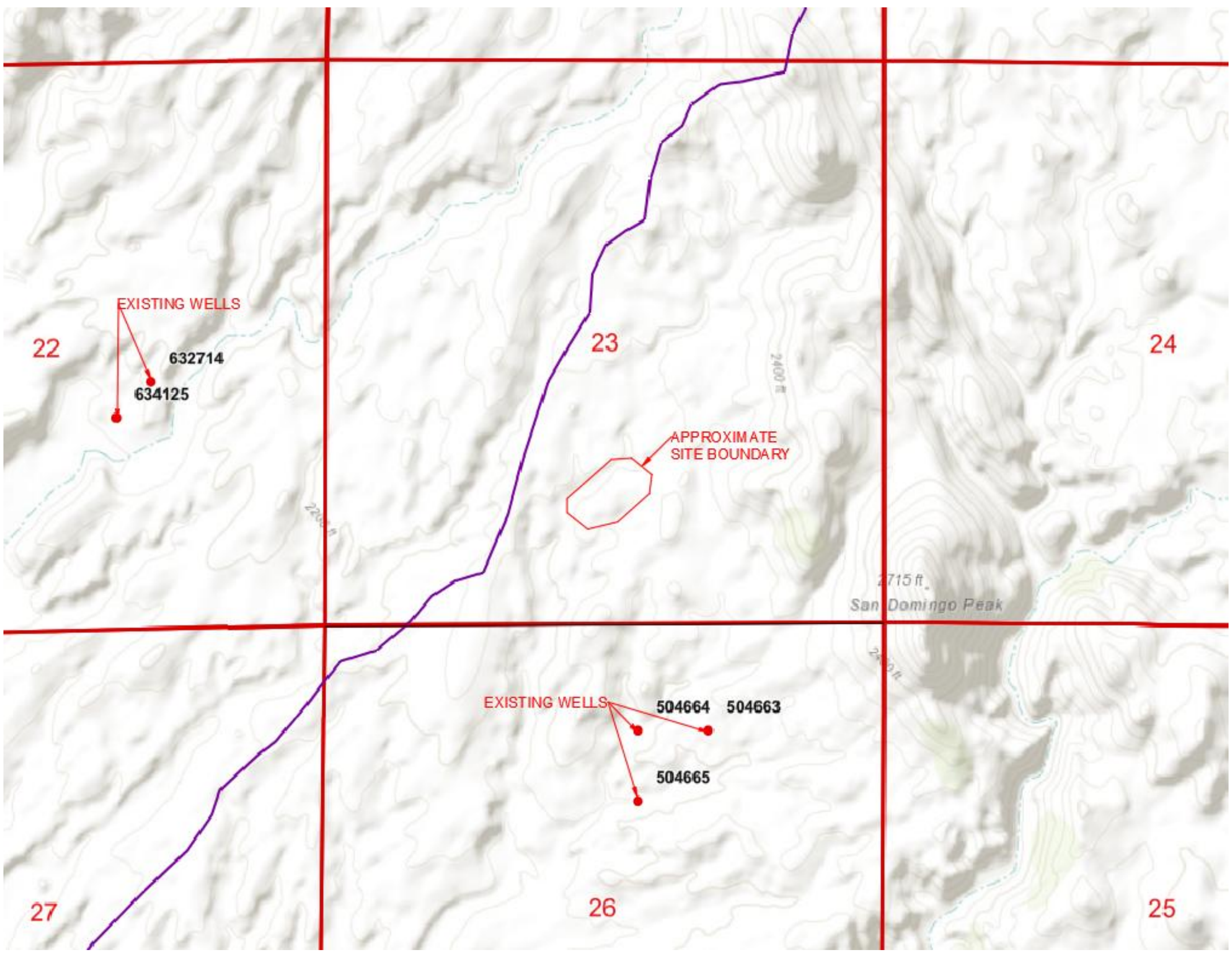

Figure 2-6. Existing Wells [5]

Table 2-3 shows information for the wells shown in Figure 2-7.

Table 2-3. Well Information

Registry Number	Use	Active or Inactive	Depth (feet)
504663	Mineral Exploration	Active	200
504664	Mineral Exploration	Active	200
504665	Mineral Exploration	Active	200
632714	Stockwater	Active	Unknown
634125	Stockwater	Active	Unknown

Dragon Mining and Development Company of Wickenburg Arizona was the claimant of the mine at the time of contamination of the mine; the owner of the Dragon mine is the BLM. The site is potentially under claim for lithium mining from San Domingo LLC.

3.0 Project Management

Table 3-1 shows the management roles for the project.

Table 3-1. Project Management

Position	Name	Role
Client	Eric Zielske, P.E. (BLM State Office)	Primary BLM Contact
Project Manager and Technical Advisor	Dr. Bridget Bero, P.E. (NAU)	Manage quality of project deliverables and answer technical questions
Laboratory Manager	Dr. Adam Bringhurst (NAU)	Oversight of laboratory procedures, safety protocol, and waste disposal
QA/QC Officer	Andres Garcia Rico (NAU)	Maintains all QA/QC protocol throughout SI and laboratory analysis
Health and Safety Officer	Bowie Ching (NAU)	Ensures all safety protocols are followed throughout SI and laboratory analysis

4.0 Field Methods and Procedures

The field methods and procedures will follow the Sampling Analysis Plan (SAP) and Health and Safety Plan (HASP), located in Appendices A and B.

5.0 Deviations from the Work Plan

Any deviations from the work plan will be authorized either by the client, Eric Zielske, or the NAU Technical Advisor for the project, Bridget Bero. Deviations from the laboratory procedures stated in this Work Plan will be authorized by the QA/QC Officer, Bowie Ching with approval from the Technical Advisor. Any deviations from the Work Plan will be documented during the time of the deviation in the field or lab notebook.

6.0 References

[1] A. G. Rico, "Dragon Mine Location Map," Google Earth, 2024.

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[3] ECM Consultants, "Site Summary Report for the Dragon Mine," ECM Consultants, 2020.

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[18] U.S. Department of Labor, "Principal Emergency Response and Preparedness," Occupational Safety and Health Administration, 2004.

[19] Occupational Safety and Health Administration, "Decontamination," U.S. Department of Labor, [Online]. Available: https://www.osha.gov/hazardous-waste/decontamination. [Accessed 27 10 2024].

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Appendix A: Sampling & Analysis Plan

1.0 Introduction

1.1 Responsible Agency

Ground Guardians LLC will conduct this Sampling and Analysis Plan (SAP) under the guidance of the BLM Arizona State Office and the BLM-Hassayampa Field Office.

1.2 Project Organization

All personnel involved in the SAP activities, including roles and responsibilities, are listed in Table A-1-1.

Table A-1-1. Personnel Contact Table

Title/Responsiblity	Name	Phone Number
Technical Advisor	Dr. Bridget Bero, P.E.	(928) 607-2516
Staff Engineer, HS Officer	Bowie Ching	(808) 294-4169
Staff Engineer, QA/QC Officer	Andres Garcia Rico	(623) 326-9139
Staff Engineer	Zachary Kauranen	(224) 938-2903
Staff Engineer	Jorja Whitcher	(605) 877-6660
Client, P.E.	Eric Zielske, P.E.	(602) 653-6283

1.3 Sampling Overview

A combination of sampling methodologies will be performed including transect, grid, and incremental sampling methodology (ISM). A total of 53 samples will be collected including up to 7 hotspot samples and 3 background samples. Core sampling will not be performed.

2.0 Project Data Quality Objectives and QA/QC Methods

2.1 Project Objectives

The Dragon mine site and the immediate surrounding area will have a site investigation completed to identify all the contaminants of concern (COCs). The distribution and migration paths of COCs will be determined through soil sampling. Information gathered from the site investigation and soil sampling will be used to estimate the environmental and human health concerns. Remediation efforts will be determined based on the COCs and extents of contamination.

2.2 Data Quality Objectives

The Data Quality Objectives (DQOs) process is used by the EPA to help users decide what type, quality, and quantity of data will be sufficient for environmental decision making [6]. DQOs for this project are used to define Quality Assurance (QA) procedures for collecting and analyzing contamination data. Examples of these objectives are that background samples need to be taken at undisturbed locations, equipment decontamination must occur after each sample is taken, and duplicates are to be taken a few inches away from the original sample.

The DQO for this project is to obtain data sufficient for screening-level decision making at the site.

2.3 Quality Assurance and Control

The purpose of QA and QC in the field and the laboratory is to ensure that the data collected accurately represents the existing conditions to support the project objectives. Use of the QA/QC protocols will maintain accuracy and precision of the data sets. Field and laboratory QC samples will be used and are described in this section. Chain of Custody documents will be used to keep track of the samples and have physical documentation of sample movements. All samples will have a Chain of Custody document. Details on the Chain of Custody documents are in Section 3.5.3.

2.3.1 Field QA/QC

For each type of sampling (transect, grid, etc.) an initial sample location will be identified using GPS. The remaining sample locations will be determined using a compass and measuring tape. All sampling locations will be flagged including backgrounds, duplicates, and hotspots. After collecting each sample, the GPS location and a picture of the location and sample will be taken and logged in the Field Notebook.

Duplicate samples will be taken as field quality control samples to evaluate precision during sampling every 9 samples, and decision units with less than 9 samples will have 1 duplicate. Decision units with ISM sampling will not have any duplicates taken. All field QC samples will be noted in the Field Notebook. Duplicate samples will be obtained within one foot of the original sample.

The QA/QC officer will keep a sample checklist for sample control to assure that all required samples are collected and stored. Samples will be properly labeled according to the sample naming scheme in Section 3.2.5.

The samples will be stored according to Section 3.3 and 3.5. Equipment decontamination will follow the procedure defined in Section 3.4.

In-situ XRF testing will be done using the hand-held XRF device. Readings will be taken for 90 seconds within 2” of the surface soil sample location. The XRF device has an internal calibration that occurs every time the device is turned on. This internal calibration will be logged in the Field Notebook.

2.3.2 Lab QA/QC

Samples will be tracked and documented in a lab notebook during drying and sieving. When in the drying ovens, each sample will go into its own sample dish with its corresponding label written in China pencil. After drying, the sample will remain in their labeled drying dish until put into the sieve tower. Sieve towers with sample in them will be labeled with a piece of tape that has the corresponding sample label on it. After sieving, material passing the smallest sieve will be placed in a new Ziploc bag and labeled with the original sample number plus an “S” (for “sieved”) Table A.2.1 shows an example of the information in lab notebook to keep track of the dried/sieved samples.

Table A-2-1. Lab Notebook Table Example

Sample	Date Dried	Date Sieved
DU1-1		
DU1-2		

XRF analysis in the lab will be performed on the sieved samples using an XRF device. The device will be maintained and used in accordance with the manufacturer's instructions, EPA Method 6200, and the LSASD Operating Procedure for Equipment Inventory and Management (LSASDPROC-1009) [7]. When powered on, the XRF machine performs an internal calibration. Additional calibration will be performed using the National Institute of Standards and Technology (NIST) standards and blanks, found in the XRF kit.

XRF calibration using the standards will be performed prior to the site visit and upon return; results will be documented in the Field Notebook. For the laboratory work, these checks will be performed each day upon startup, after 4 hours of analysis, and when the XRF machine batteries are changed.

Calibration check values must be within 20% of known values of standards and blanks [8]. Calibration checks conducted in the lab will be documented in the Laboratory Notebooks.

Nine sub samples from each sample will be tested with the XRF device [8]. For each element, the highest and lowest values found will be disregarded and the rest of the readings will be averaged. All XRF tested soil will be returned to their sample bag and retained throughout the length of the project.

2.3.3 Cross Contamination

2.3.3.1 Field Prevention

The following precautions will be taken while collecting samples:

- Sampling equipment will be decontaminated between each sample by washing with soap and rinsing.
- New gloves will be put on before collecting a sample and gloves will be discarded after decontaminating sampling equipment.
- No sampling staff will touch the inside of the sampling bag.
- Sample bags are only open while the sample is being put inside the bag.
- Sample bags that are damaged are to be double bagged.

2.3.3.2 Laboratory Prevention

The following precautions will be taken while analyzing samples:

- Drying containers, sieves, and XRF cups will be decontaminated between uses by washing with soap and rinsing. Sieves will be dried with compressed air.
- All analysis equipment and surfaces will be cleaned between uses.
- New gloves will be used when handling any new samples, gloves are to be removed after decontamination.
- Sieving will be done outdoors to prevent further contamination of surfaces.

2.4 Data Quality Indicators

Data Quality Indicators (DQIs) are used to evaluate the quality of the data and ensure that the values of the data determined are what they are. These indicators are defined in terms of PARCCS (precision, accuracy, representativeness, completeness, comparability, and sensitivity). Specific indicators to ensure data validity for each of the DQIs can be found below.

2.4.1 Precision

Precision is the degree of agreement between similar samples and their measurements found [9]. Field duplicates will be collected every 9 samples. To evaluate the precision of a sample and its duplicate, the relative percent difference will be calculated. See equation A-2-1 below for the relative percent difference.

Equation A-2-1. Relative Percent Difference

$$RPD = \frac{|S_i - S_d|}{((S_i + S_d)/2)} * 100\%$$

Where:

RPD = Relative Percent Difference

S_i = Original Sample Concentration

S_d = Duplicate Sample Concentration

The allowable RPD per the DQI is 85%.

2.4.2 Accuracy

Accuracy is how closely an experimental measurement matches the actual value. Previous experience with XRF testing indicates that lead (Pb) data are reliable. Arsenic (As) levels may be inaccurate, particularly when Pb levels are high, due to an overlap of As and Pb frequencies. To ensure accurate data is analyzed, 10 samples will be sent to a subcontracted laboratory for ICP/FAA testing. Results will be correlated and the XRF As reading will be adjusted as necessary to ensure accuracy.

2.4.3 Representativeness

The accuracy and precision of a data set is referred to as representativeness [9]. It will be up to the QA/QC officer to ensure that every sample collected at the site represents the area's current conditions. The sampling plan outlined in Section 3.1 is subject to change based on unforeseen changes that may come up at the site visit. Any changes to the sampling plan will be approved by the technical advisor, Dr. Bero, or the client, Eric Zielske, while on site.

2.4.4 Completeness

Completeness refers to the proportion of valid data collected compared to the amount originally expected [9]. Factors that reduce completeness include not collecting intended samples, sample loss, equipment malfunctions or technical errors. To assure completeness is achieved, QA/QC procedures will be followed.

The typical target for completeness is between 75% and 90% [9], with a DQI of 85% for this project.

2.4.5 Comparability

Comparability refers to how well one data set can be related to another identical set of data [9]. Comparability does not apply to this project because data sets will not be identical.

2.4.6 Sensitivity

Sensitivity is represented as the method detection limits (MDL) or the lowest concentration that can be reliably detected. XRF, ICP, and FAA data will receive an MDL. When a sample receives a non-detect measurement, then the sample will be recorded as half of the MDL.

2.5 Data Review, Validation, and Management

The data collected will be analyzed by the QA/QC officer to determine if the DQIs are satisfied. Data found to be inappropriate will be flagged and removed from the dataset. All remaining data will adhere to the EPA "National Functional Guidelines for Inorganic Superfund Methods Data Review" [10]. Unaccepted data will be noted in the project report along with a summary of the quality review.

Microsoft Teams will be used to store and backup all data files as excel spreadsheets. The XRF data will be exported as an excel spreadsheet from the XRF machine to a computer. One team member along with the QA/QC Officer will obtain all data.

3.0 Field Sampling Protocols

3.1 Soil Sampling

Between 50 to 57 soil samples will be collected at the Dragon Mine site (18 transect samples, 25 grid samples, 4 ISM samples, 3 background samples, and up to 7 hotspots).

The site will be split into 5 decision units (DU) shown in Table A-3-1.

Table A-3-1. Sampling Plan Breakup

Decision Unit	Area	Sampling Type	Number of Samples (Duplicates)	Color
1	Wash	Transect	18(2)	Cyan
2	Red Tailings Pile	Grid	4(1)	Red
3	Production Area	Grid	9(1)	Purple
4	Waste Rock Pile	Grid	9(1)	Yellow
5	Roads	ISM	4	Green

A map showing the decision units is shown in Figure A-3-1 below.

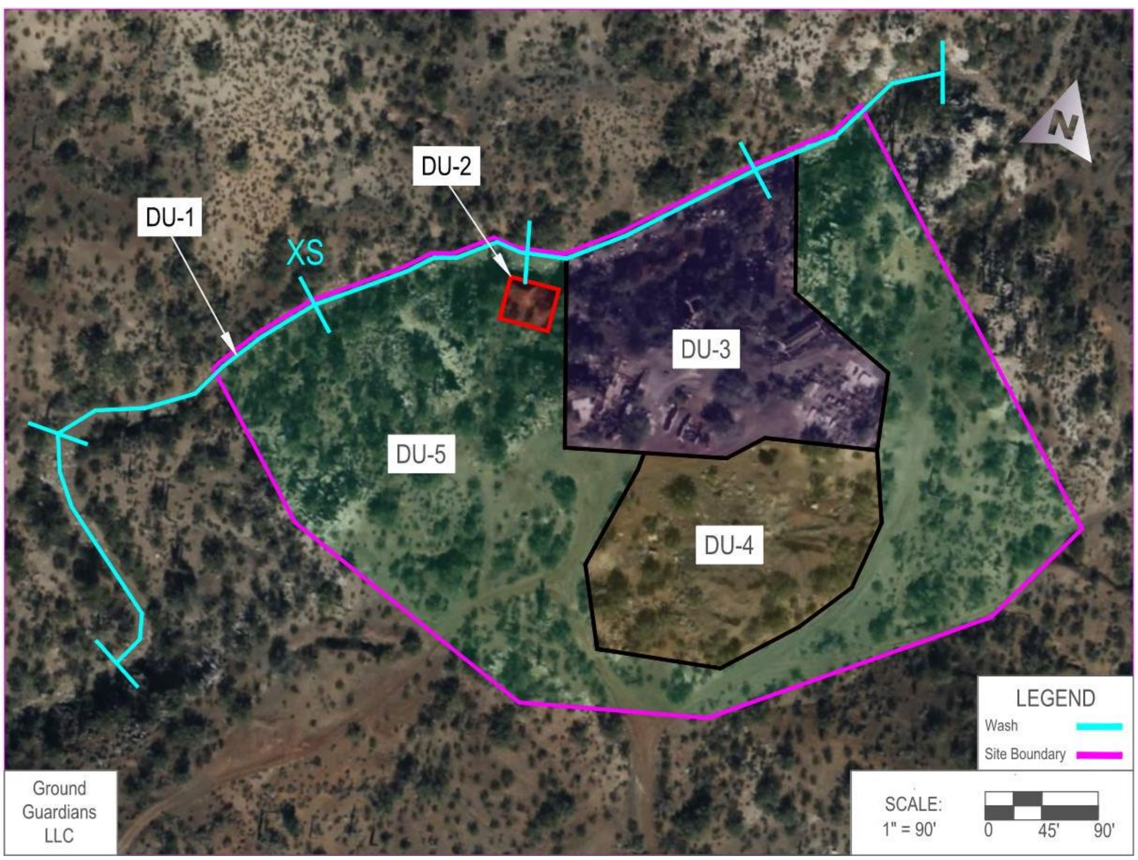

Figure A-3-1. Decision Units

Decision unit 1 will have 18 transect samples taken at both overbanks and the thalweg. DU 2 will be grid sampling with 4 samples and 1 duplicate. DU 3 will have 9 grid samples with 1 duplicate. DU4 will have 9 grid samples and 1 duplicate. DU 5 will be ISM sampling with 4 homogenized samples.

Figure A-3-2 shows the specific locations of the samples taken in decision unit 1.

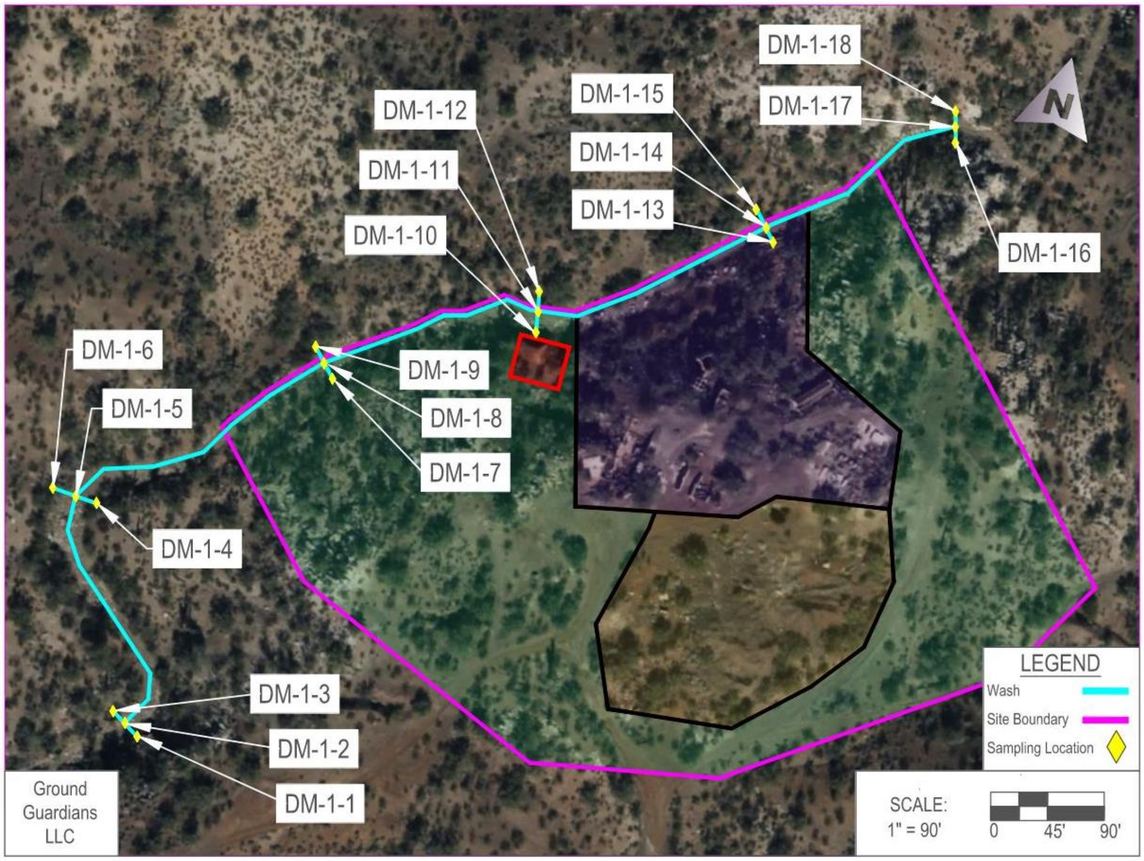

Figure A-3-2. Decision Unit 1 Sampling Plan

Figure A-3-3 shows the 4 sampling locations that will be taken in decision unit 2. Samples will be taken in the center of each grid.

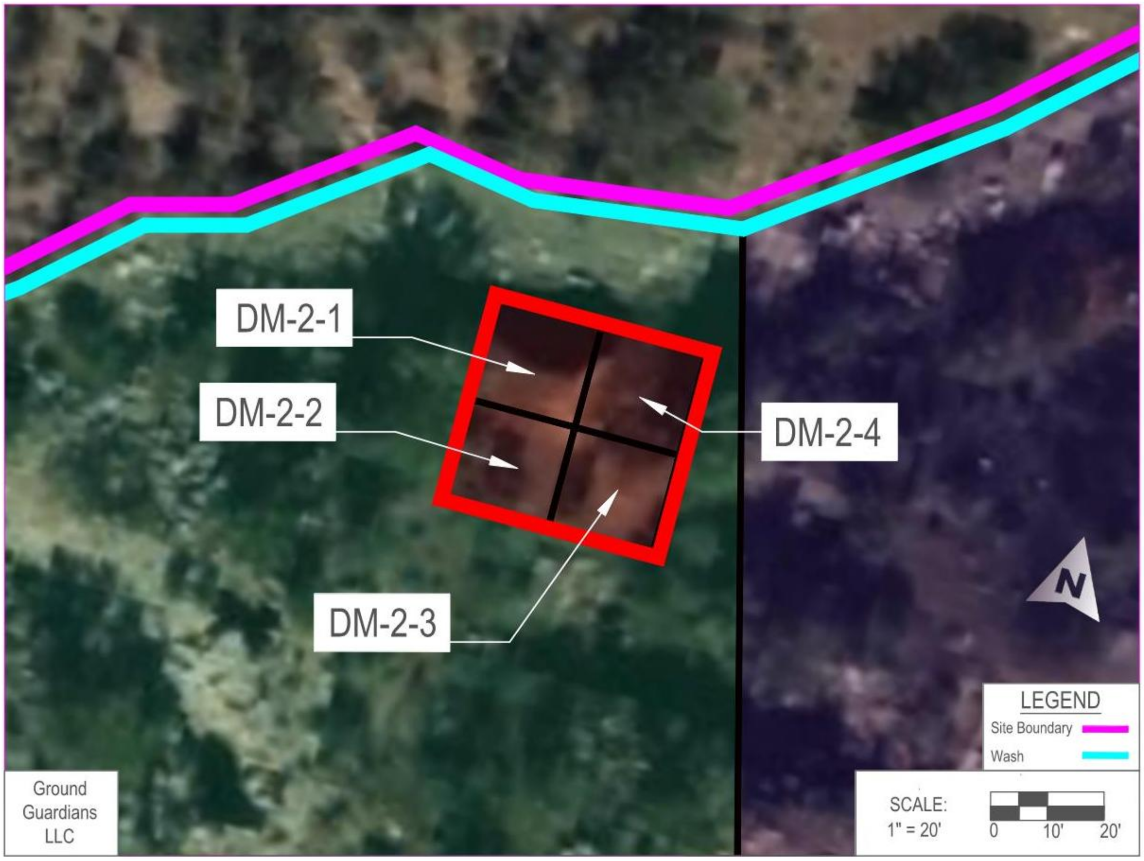

Figure A-3-3. Decision Unit 2 Sampling Plan

Figure A-3-4 shows the 9 sampling locations from decision unit 3. Samples will be taken in the center of each grid.

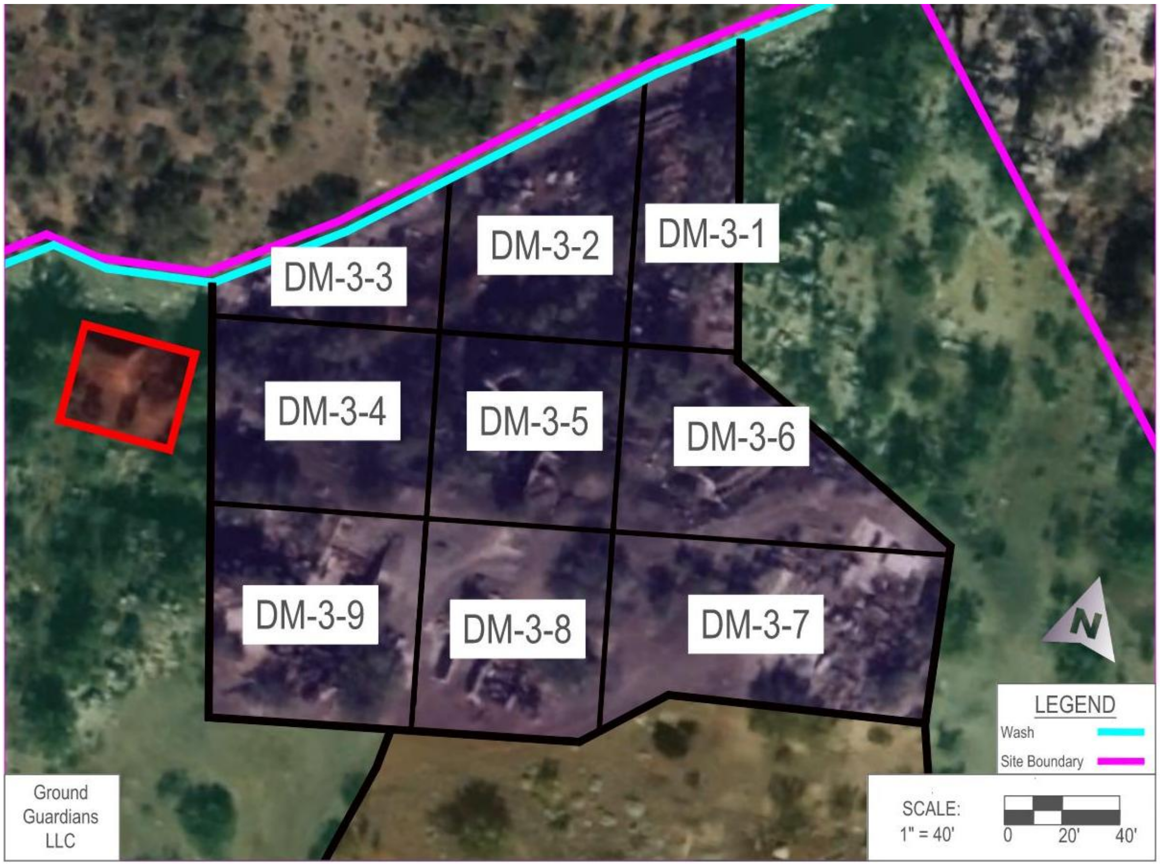

Figure A-3-4. Decision Unit 3 Sampling Plan

Figure A-3-5 shows the 9 sampling locations from decision unit 4. Samples will be taken in the center of each grid.

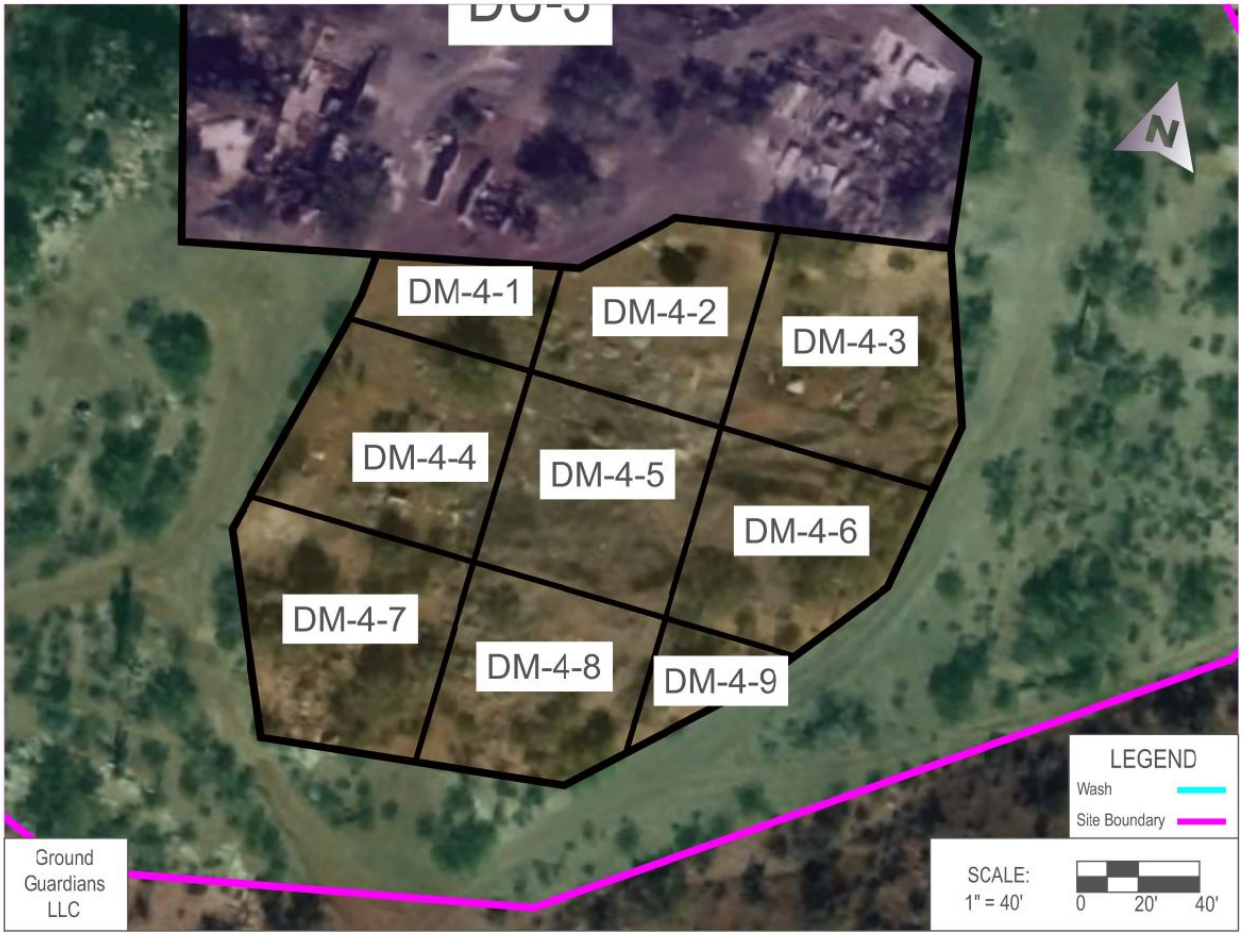

Figure A-3-5. Decision Unit 4 Sampling Plan

Figure A-3-6 shows the incremental sampling plan for DU5. The area will be divided into 34 units of similar size; four small surface soil samples will be taken from each grid and homogenized, creating four duplicates of the DU.

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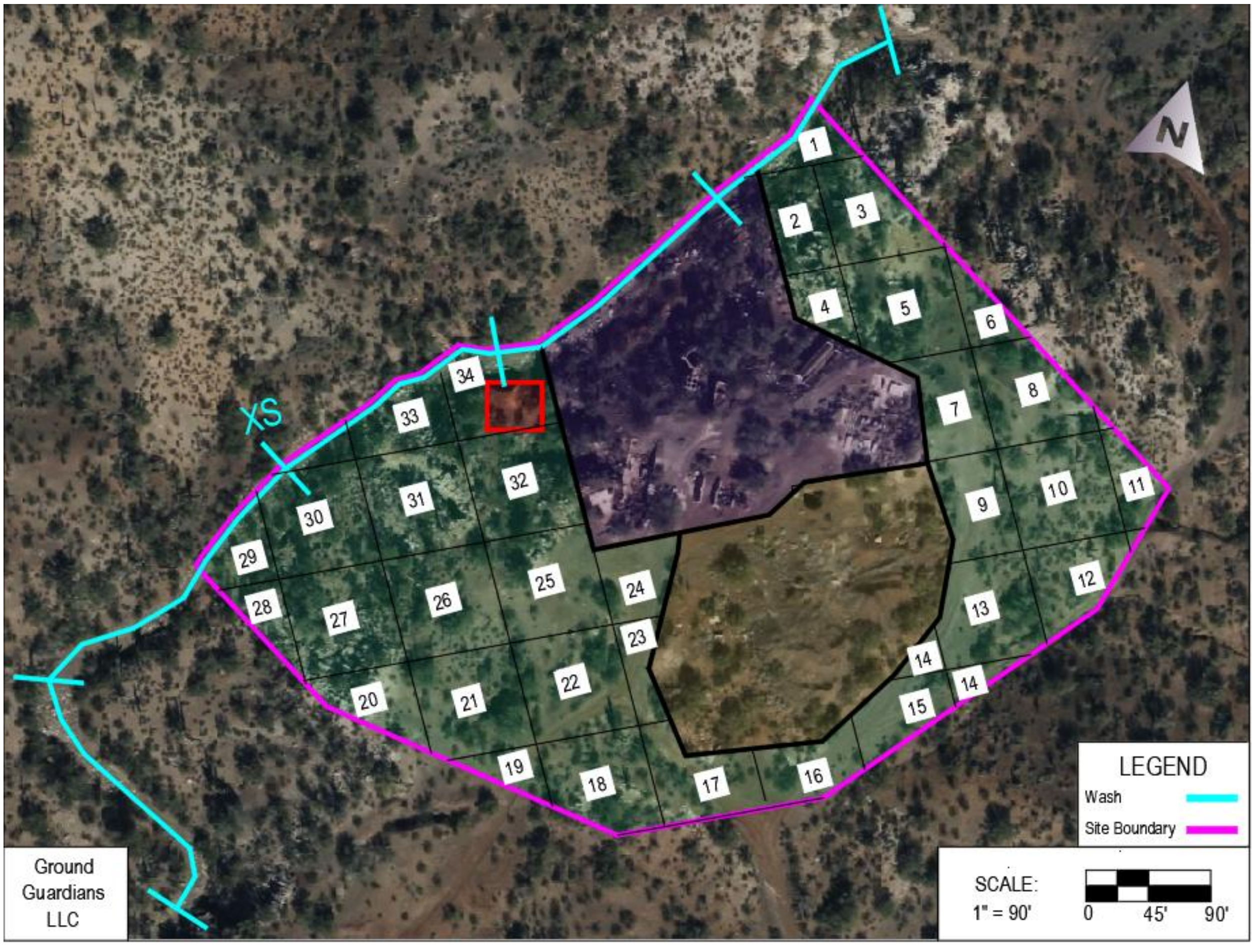

Figure A-3-6. Decision Unit 5 Sampling Plan

Decision units in the maps will be updated after the site investigation to show the actual sampling areas.

3.2 Soil Collection

Surface soil samples will be collected after vegetation, rocks, gravel or other surface litter has been removed using a trowel. A clean stainless-steel trowel will be used to collect the surface sample 0-3 inches below the existing soil surface. The sample will be placed into a gallon sized heavy-duty Ziploc bag and labeled as outlined in Section 3.4. An in-situ XRF reading will be taken at the sample locations after surface litter is removed if there is no precipitation.

3.2.1 Background Samples

Three background samples will be collected as surface samples as described in section 3.2. The location of the background samples will be determined on site, choosing areas without disturbances. The samples are meant to show the true characteristics of the native soil without effects from the site. Wind migration of contaminants will be considered in selecting background sample locations.

3.2.2 Hot Spot Samples

Up to 7 hot-spot samples are allotted to be collected in areas where visual determination indicates the likelihood of high contamination. These samples will be collected as surface samples as described in Section 3.2.

3.2.3 Field Equipment and Calibration

Equipment needed for soil samples includes an XRF device, stainless-steel trowel, heavy-duty gallon sized Ziploc bags, 5-gallon buckets, marking flags, measuring tapes, and a handheld GPS. Field notebooks with writing utensils, and cell-phone cameras in Ziplock bags will be used for documentation. Sampling equipment will be cleaned after each sample is taken using wash water, dish soap, and a scrub brush, see Section 3.6.

The X-Ray Fluorescence (XRF) device will be used to take in-situ measurements at each surface sample location. The device performs an internal calibration each time it is turned on.

3.2.4 Sample Containers

Containers used for the samples will be new heavy-duty gallon sized freezer Ziplock Bags. Once each sample is collected the bags will be transported to the vehicle, logged by the QA Officer into the Field Notebook and the Chain of Custody forms, and placed into large plastic bins for storage and transport. Completed Chain of Custody forms will be placed in each full bin, and the bin will be sealed with the Custody Seal (see Section 3.5.3.1).

3.2.5 Sample Labeling

The samples will be labeled according to the protocol shown in Table A-3-2 below.

Table A-3-2. Sample Labeling Convention

Locator	Sample ID #	Duplicate Sample ID
DU1 (wash)	DU1-1,2,3…18	DU1-(orig#)-D
DU2 (tailings)	DU2-1…9	DU2-(orig#)-D
DU3 (production area)	DU3-1…9	DU3-(orig#)-D
DU4 (waste rock)	DU4-1…9	DU4-(orig#)-D
DU5 (roads)	DU5-1…4	(none)
Background	B-1...3	B-(orig#)-D
Hot Spots	HS-1…7	HS-(orig#)-D

See Section 2.3.2 above for additional sample labeling once laboratory testing begins.

3.3 Sample Preservation, Packaging, and Shipping

Sample preservation is not required for soil samples being tested by XRF. The samples will be transported from the site to NAU in sealed bins.

If samples are tested at subcontracted laboratories, two team members will deliver the samples. Five grams of each sample will be placed into glass vials placed in Styrofoam shipping containers for transport. The samples will be kept at standard conditions when transported. Chain of Custody documents will accompany all sample transfer.

3.4 Equipment Decontamination Procedures

Trowels will be decontaminated after each sample is taken in the field as described in Section 3.2.3. Decontamination is necessary to ensure that each sample is representative of its sampling location. Decontaminated trowels will be stored in a clean 5-gallon bucket.

3.5 Documentation

3.5.1 Field Notes and Logbooks

Each team member will keep a logbook documenting work performed in the field. Information will include project name, location, team member name, and any other pertinent information; all information will be written in ink. All observations and deviations from the Work Plan will be documented. In-situ XRF results and information on each sample including sampler name, date/time, sample location, sample ID, sampling method, description of sample, and if it has a duplicate sample. Maps, sketches and notes on weather conditions, terrain, and flora and fauna observed will be included in logbooks. Page numbers will be noted out of total pages in the logbook.

CENE Laboratory Project Activity Log sheets will be used to in addition to laboratory logbooks. The Project Activity Log sheets include team member names, date and start/end times of each activity, description of activity, and project name. The activities taking place in the lab include sample preparation, sample analyses, and equipment checks. When conducting analysis, the laboratory logbooks will include student name, date and time of analysis, test method and specific procedure details, sample IDs. The instrument name and serial number, calibration records, ID of preparation equipment, units, measurement results, and disposal and decontamination procedures used will be recorded once at the beginning of analysis.

3.5.2 Photographs

Cellphones kept in Ziplock bags will be used to photograph and document the site conditions. Each sample, flora and fauna, and any interesting site conditions such as disturbed soil or tailings piles will be photographed. The photos will be compiled into a Photo Log and stored on the shared drive as described in Section 2.5 above.

3.5.3 Chain of Custody

The samples obtained will be tracked from their collection, handling and transport, analysis, and disposal. To track sample movement a Chain of Custody Form will be used. The form includes who is in possession of each sample and its location, and each time the sample changes custody. See Figure A-3-7 for chain of custody form to be used.

<table>
<tr><td colspan="4">Chain of Custody Record
Ground Guardians
Dragon Mine PA/SI</td></tr>
<tr><td>Date of Transfer:

Sample Type:

Name of Person Relinquishing:

Signature of Person Relinquishing:

Name of Person Accepting:

Signature of Person Accepting

Date of Transfer:</td><td></td><td>Sample ID#s:
Add lines based on number of samples.</td><td></td></tr>
</table>

Figure A-3-7. Chain of Custody Form

The Chain of Custody form is to remain with the sample(s) at all times. The forms will be generated each time samples are worked with, and each change of custody will be recorded. Both people relinquishing and accepting the sample must sign the form.

3.5.3.1 Custody Seals

A Chain of Custody Seal will be used on the lid of every container with samples. Each time a container is opened in the laboratory, the date will be recorded, and the broken seal will be stored with the logbook. A new seal will be placed when samples are returned to the bin, with revised Chain of Custody forms as needed. Chain of Custody forms will be revised as needed; any revisions will be dated and initialed by the user. The Custody Seal is shown below in Figure A-3-8.

<table>
<tr><td>Chain of Custody Seal
Ground Guardians

Site Name: ____

Bin #: ______________________ Sample Type: ____

Date Sealed: ________________ Sealed By: ____

Date Opened:________________Opened By:____</td></tr>
</table>

Figure A-3-8. Chain of Custody Seal

4.0 Laboratory Analysis

4.1 Sample Drying

To remove moisture and homogenize the soil, samples will be dried according to ASTM Method D2216 [11]. After drying, the soil will be prepared for sieving. If soils are clumped, they will be broken up with a pestle to ensure an accurate sieving. The entirety of the sample will be dried and placed in a new Ziploc freezer bag. After drying, the sample will retain its original sample ID# with “dried” being written after the sample ID.

4.2 Sample Sieving

Heavy metals such as arsenic and lead tend to adsorb to finer soil particles. Thus, finer and more homogenous soil is desired for XRF analysis. Soil sieving will be performed according to ASTM Method D6913 [12]. Multiple sieve sizes will be used during the test, the smallest being the #60 sieve with a pore size of less than 250 µm. Sieve #60 was chosen acknowledging ASTM Method 6200 which states heavy metals are often found in the finer soil material. A decision to sieve further than Sieve #60 would result in an insufficient amount of remaining sample. Samples will be sieved in their entirety and returned to its Ziploc bag; the bag will then have “S” written on it to show that the sample has been processed and is ready for XRF analysis. Once an entire sample is sieved, the sieves will be washed with soap, rinsed and dried using compressed air to prepare for the next sample. Any material not passing the #60 sieve will be appropriately discarded as solid waste.

4.3 XRF

XRF analysis will be performed in accordance with EPA Method 6200 [13]. Each sample will be further divided into nine different polyethylene XRF sample cups. Each sub-sample will undergo XRF analysis for 90 seconds, resulting in nine unique measurements for each sample. All data will be downloaded into a spreadsheet. The maximum and minimum value for each element within a sample will be excluded and the remaining data will be averaged to provide a reading for each element. Table A-4-1 shows the detection limits for potential COC’s for the NITON XL3t 600 XRF device, as well as AZ SRLs [4]. Any samples that return a non-detect will be assigned a numerical value of half the detection limit for that element.

Table A-4-1. COC Detection Limits and AZ SRLs [14]

<table>
<tr><th rowspan="3">Contaminant</th><th rowspan="3">Detection Limit (mg/kg)</th><th colspan="2">Residential (mg/kg)</th><th rowspan="2">Non-Residential (mg/kg)</th></tr>
<tr><th>Carcinogenic (10^{-5} Risk)</th><th>Non-Carcinogenic</th></tr>
<tr><th colspan="3">Soil Remediation Levels</th></tr>
<tr><td>Antimony</td><td>30</td><td>-</td><td>31</td><td>410</td></tr>
<tr><td>Arsenic</td><td>11</td><td>10</td><td>10</td><td>10</td></tr>
<tr><td>Lead</td><td>13</td><td>-</td><td>400</td><td>800</td></tr>
<tr><td>Molybdenum</td><td>15</td><td>-</td><td>390</td><td>5,100</td></tr>
<tr><td>Vanadium</td><td>70</td><td>-</td><td>78</td><td>1,000</td></tr>
</table>

4.4 Acid Digestion, FAA, and ICP Confirmation Testing

The presence of lead at high concentrations is known to cause inaccurate readings of arsenic concentrations using the XRF device. Acid digestion will be performed in accordance with EPA Method 3050B by an external laboratory to confirm the team's arsenic analysis. Subsequently, Flame Atomic Absorption (FAA) and Inductively Coupled Plasma (ICP) testing will be performed by the external laboratory for additional confirmation of chemical concentration. The FAA and ICP test will follow EPA methods 7000B, and 6010B, respectively [15] [16] [17].

5.0 Disposal of Residual Materials

5.1 Field Disposal

The water used to wash and rinse the sampling equipment will be poured directly onto soil at the site. The water will not pose a threat to human health, and contaminant migration should not be an issue. Gloves, paper towels, and flags used during sampling will be collected into a trash bag and disposed of as solid waste at Northern Arizona University.

5.2 Lab Disposal

Previous TCLP testing of BLM Capstone project soils (Pilgrim Mine, Magma Mine) that had higher levels of lead and arsenic than the Dragon Mine Site indicated that the soils are not considered hazardous waste. Soil waste will either be retained for further use as an educational material or will be disposed of as solid waste.

Appendix B: Health & Safety Plan (HASP)

1.0 Job Name and Location

A Preliminary Assessment and Site Investigation of the Dragon mine will be conducted. The site is located about 5.7 miles southeast of Wickenburg, Arizona in Maricopa County.

2.0 Safety & Health Administration

The project Health and Safety (HS) Officer, Bowie Ching, is responsible for overseeing safety for the team during the field and lab work portions of this project. The HS Officer will provide safety guidelines for fieldwork and ensure members are compliant.

3.0 Hazard Assessment & Required PPE

The soil, air, surface water, groundwater, and foliage at the Dragon mine may contain harmful contaminants. The field sampling team will prepare for potential hazards by following proper procedures and wearing protective clothing.

Personal Protective Equipment (PPE) for field sampling includes long pants and sleeves, closed-toed shoes, a brimmed hat, nitrile gloves, a face mask, and sunglasses. PPE for laboratory work includes a lab coat, closed-toe shoes, long hair tied back, goggles, and nitrile gloves.

3.1 Field Hazards

Table B-3-1 shows the potential hazards that may be encountered doing the field site investigation. The hazard, the level of risk and recommended mitigations are also shown.

Table B-3-1. Field Hazards

Hazard	Level of Risk	Mitigation Strategy
Physical		
Sun exposure	Low	Wear sunscreen and proper attire; drink water frequently; take breaks in shaded areas.
Temperature exposure	Low	Wear clothing based on weather forecasts; wear several layers for different temperatures.
Inclement weather	Moderate	Monitor weather forecasts, bring appropriate and extra clothing, postpone field work if necessary.
Falls/ scrapes	Low	Tread carefully, particular care t aken on inclines; wear sturdy shoes.
Chemical		
Dermal exposure to COC’s	Low	Wear gloves, long sleeve shirts and long pants.

Ingestion exposure to COC's	Low	Wash hands after field work especially before lunch break, wear dust mask if windy.
Inhalation expsure to COC's	Moderate	Wear a dust mask over nose and mouth if windy.
Biological		
Contact with dangerous animals	Low	Be aware of surroundings; do not approach any animal/insect and follow proper first aid if bitten/stung.
Contact with hazardous plants	Low	Be aware of surroundings and watch steps carefully.
Radiological		
X-Ray Exposure	Low	Use XRF machine at arm's length, leaning forward to keep instrument away from torso.

3.2 Laboratory Hazards

Table B-3-2 shows the potential hazards that may be encountered in the laboratory during soil testing. The level of risk and recommended mitigations are provided for each hazard.

Table B-3-2. Laboratory Hazards

Hazard	Level of Risk	Mitigation Strategy
Physical		
Burns	Low	Wear special gloves when using drying ovens.
Cuts	Low	Use caution when handling glassware, dispose of broken glass in proper container.
Fire	Low	Use a fire extinguisher and call 911.
Chemical		
Dermal exposure to COC's	Moderate	Wear gloves, long sleeves and pants, closed toed shoes and a lab coat.
Ingestion exposure to COC's	Moderate	Wear gloves when handling soil and wash hands often.
Inhalation expsure to COC's	Moderate	Work outdoors or under fume hoods when testing and handling toxic chemicals. Wear dusk mask if appropriate.
Biological		

None	N/A	N/A
Radiological		
X-Ray Exposure	Low	Only use XRF machine in proper apparatus.

4.0 Training Requirements

4.1 NAU Lab Safety

All GG LLC personnel are required to complete NAU's Chemical Hygiene Training prior to any lab sample analysis. Training completion certificates will be provided by all GG LLC personnel in the lab binder.

4.2 XRF Training

All GG LLC personnel have been trained in use of the XRF device to ensure proficient and correct use of the instrument prior to sample analysis. Additionally, all GG LLC personnel will read the XRF training and operating manual.

5.0 Site Control & Operating Procedures

The site control and operating procedures at Dragon Mine will follow the Occupational Safety and Health Administration (OSHA) 1910 General Industry Subpart H: Guidelines for Hazardous Waste. These guidelines require the inclusion of a site map, site work zones, the use of a buddy system, site communications, emergency response and procedures and safe work practices. These operating procedures are detailed in the following sections. All lab work requires a minimum of two people. Working alone in the lab is prohibited [18].

6.0 Decontamination Procedures

Decontamination for field and laboratory samples will be done following the OSHA standards for hazardous waste decontamination. Procedures will detail the number and layout of decontamination stations, decontamination equipment needed, appropriate decontamination methods, procedures to prevent contamination of clean area, methods and procedures to minimize contamination of workers when taking off PPE, and the methods for disposing of articles that are not completely decontaminated [19]. The details for the procedure have been split into three categories to address field and laboratory decontamination as well as disposal of any contaminated articles.

6.1 Field

Prevention of contamination while in the field shall be done through minimization of contact with waste [19]. The following prevention measures will be taken:

- Do not walk through areas of obvious contamination or touch potentially hazardous substances.

- Protect monitoring and sampling instruments with bags leaving holes for sample ports and sensors.
- Wear disposable outer garments and use disposable equipment where appropriate.
- Cover equipment and tools with coating that can be removed during decontamination.

Articles used as outer wear for both workers and equipment will be removed and consolidated in a disposable plastic bag prior to entering the vehicle used for transport. Care should be taken to prevent contamination of the interior of the vehicle

6.2 Laboratory

A designated space within the laboratory will be used for storage and testing of any potentially hazardous materials. The NAU Chemical Hygiene Plan details the handling and decontamination methods to be followed within the designated space [20]. The following methods will be followed:

- Breakable containers will be stored in a tray.
- When leaving the designated area, all PPE is to be removed and stored in a labeled container. All hands and forearms are to be washed thoroughly.
- Equipment must be decontaminated before leaving the designated area.
- A wet mop will be used to decontaminate surfaces. Do not dry sweep.

6.3 Waste Disposal

NAU Environmental Health & Safety (EHS) will handle the disposal of all hazardous materials. Containers holding any hazardous materials must be triple rinsed and made unusable before discarded. If the container is unable to be made unusable, it must be marked with a completed "EMPTY" label [20]. No hazardous waste is expected in this project.

7.0 Emergency Response Procedures

All personnel at Dragon Mine during the SI will carry a cellphone on their persons if emergency medical services are needed. Phone numbers and physical addresses for emergency response services are listed later in this section. First aid supplies will be provided for all personnel during the SI and during lab analysis. All first aid supplies will be inspected prior to the SI and items will be replaced as needed.

7.1 Closest Medical Facility

The closest medical facility to Dragon Mine is the Wickenburg Community Hospital, less than 10 miles or less than 25 minutes from the site. This facility offers a full-service emergency department that is open 24 hours per day, 7 days a week.

Address: 520 Rose Ln, Wickenburg, AZ 85390

Phone: (928) 684-5421

Figure B-7-1 below shows the path from Dragon Mine to the Wickenburg Community Hospital.

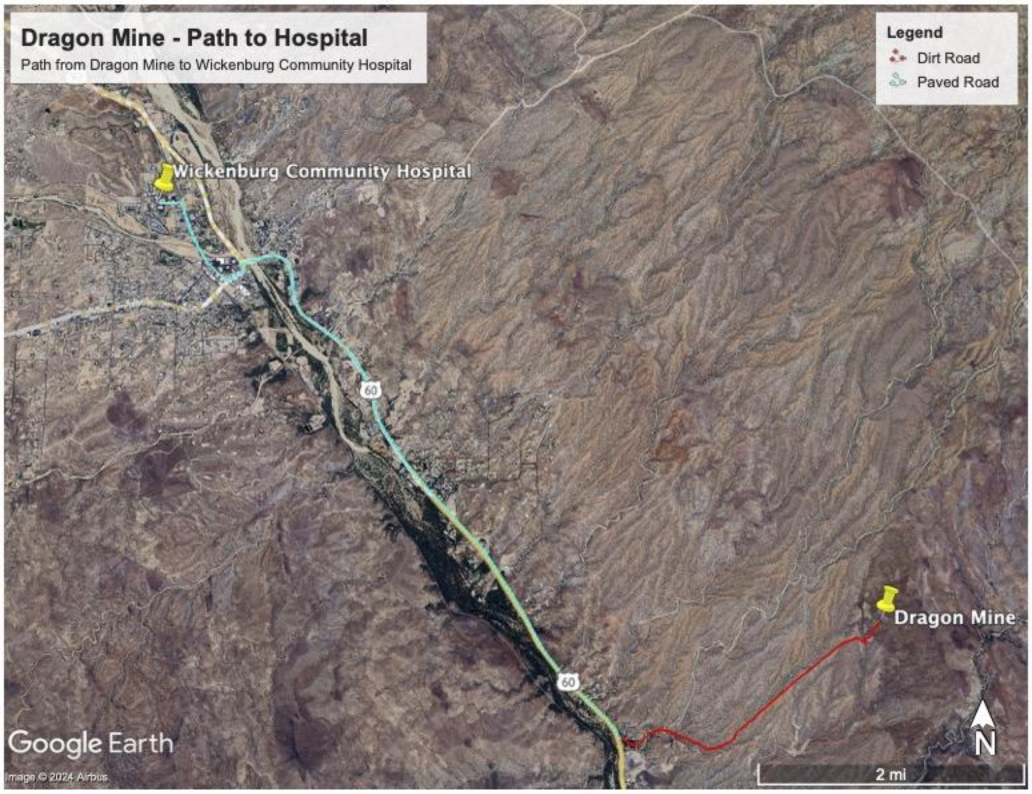

Figure B-7-1. Path from Mine to Nearest Hospital Path from Dragon Mine to Nearest Hospital

The closest medical facility to the lab, where sample analysis will be performed, is the Flagstaff Medical Center, about 3 miles or 10 minutes away from the lab. Flagstaff Medical Center offers a full-service emergency department that is open 24 hours per day, 7 days a week.

Address: 1200 N. Beaver Street, Flagstaff, Arizona

Phone Number: (928) 773-2113

Figure B-7-2 below shows the path from NAU Engineering Building to the Flagstaff Medical Center.

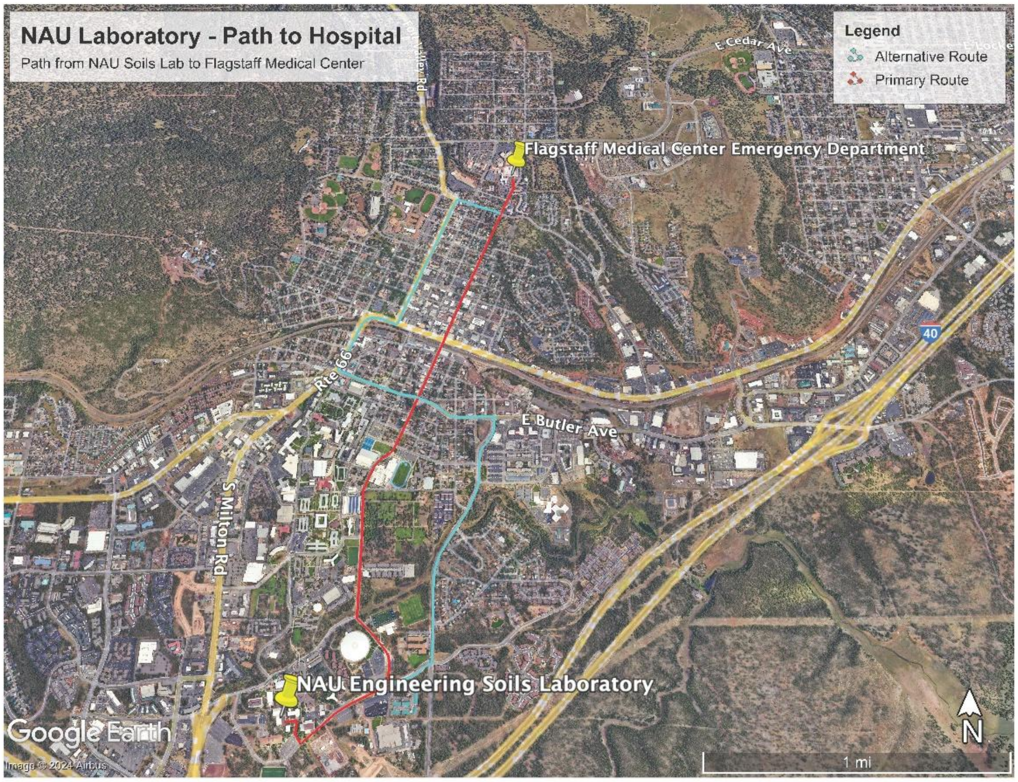

Figure B-7-2. Path from NAU CENE Soils Lab to Nearest Hospital

7.2 Emergency Contact List

In case of an emergency, use the following list to contact the proper authorities and aid services:

Table B-7-1. Emergency Contacts Information. Project Emergency Contact List

Emergency Contact	Phone Number	Address
Wickenburg Community Hospital	(928) 684-5421	520 Rose Ln, Wickenburg, AZ 85390
Wickenburg Police Department	(928) 684-5411	1980 W Wickenburg Way, Wickenburg, AZ 85390
Flagstaff Medical Center	(928) 773-2113	1200 N. Beaver Street, Flagstaff, Arizona
NAU Engineering Department	(928) 523-2704	2112 S Huffer Ln Flagstaff, AZ 86011
BLM Arizona State Office	(602) 417-9223	One North Central Ave, Ste. 800 Phoenix, Arizona 85004
Eric Zielske	(602) 533-6283	-
National Poison Control Center	800-222-1222	-

Personal emergency contacts for all site visit personnel are listed in table B-7-2 below.

Table B-7-2. Personnel Emergency Contact Information List

Name	Phone Number	Emergency Contact	Relationship	Contact's Phone Number
Dr. Bridget Bero	(928) 607-2516	Charles Beadles	Spouse	(928) 607-8688
Bowie Ching	(808) 294-4169	Steven Ashbaugh	Friend	(480) 688-3869
Andres Garcia Rico	(623) 326-9139	Evelyn Garcia Rico	Mother	(623) 396-8866
Zachary Kauranen	(224) 938-2903	Mary Ann Gorge	Mother	(847) 946-1664
Jorja Whitcher	(605) 877-6660	Kristi Erdman	Mother	(605) 390-4722