Letter of Transmittal

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December 13, 2016

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Dear Mr. Zielske:

Magma Consulting submits herewith a proposal for the preliminary assessment & site inspection of the AZ Magma Mine near Chloride, AZ. This proposal outlines Magma Consulting's project understanding, scope of services, project schedule, staffing plan, and cost of services.

Should you have any comments or concerns, feel free to reach out to me by phone or email.

Thank you,
Jessica Szaro

Bureau of Land Management
AZ Magma Mine Preliminary Assessment & Site Inspection

Magma Consulting

Project Proposal

December 13, 2016

To: Eric Zielske, PE, Environmental Engineer at Bureau of Land Management,

Bridget Bero, Ph.D, PE, Grading Instructor

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CENE 476: Capstone Prep

Fall 2016

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List of Abbreviations

AA	Atomic Absorption
ADMA	Administrative Assistant
ADMMR	Arizona Department of Mines and Mineral Resources
ADWR	Arizona Department of Water Resources
ALM	Adult Lead Model
BLM	Bureau of Land Management
COC	Contaminant of Concern
EHS	Environmental Health and Safety
ENG	Engineer
EPA	Environmental Protection Agency
GIS	Geographic Information System
GPS	Global Positioning Systems
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
IDW	Investigation Derived Wastes
INT	Intern
IEUBK	Integrated Exposure Uptake Biokinetic
LAB	Lab Technician
NAU	Northern Arizona University
PA	Preliminary Assessment
PPE	Personal Protective Equipment
SAP	Sampling and Analysis Plan
SENG	Senior Engineer
SI	Site Inspection
SOP	Standard Operating Procedures
XRF	X-ray Fluorescence

1.0 Project Understanding

1.1 Project Purpose

The purpose of this project is to provide a preliminary assessment (PA) and site inspection (SI) of the Arizona Magma Mine near Chloride, Arizona for hazardous waste. Mine tailings have been identified at the mine's location and there is evidence of contaminant migration. Potential contaminants of concern (COC) include lead and arsenic. After the inspection, it will be determined whether additional, more in-depth analysis of the mine is necessary from the Bureau of Land Management (BLM).

1.2 Project Background

The Arizona Magma Mine (Latitude N 35°25'00" Longitude W114°13'27") is located approximately one mile west of Chloride, Arizona and 28 miles north of Kingman (ADMMR, 1995). Figure 1-1 below shows the mine's location in reference to both towns and Figure 1-2 shows its proximity to Chloride.

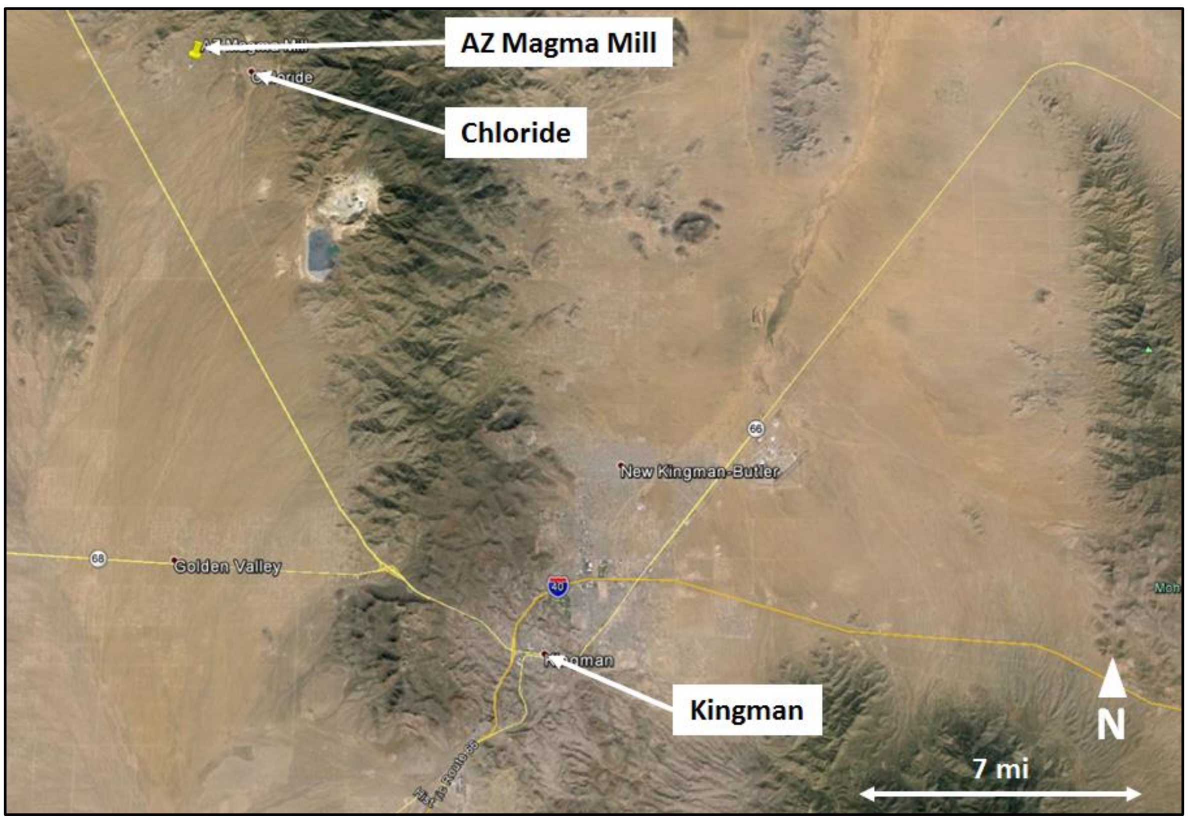

Figure 1-1. Arizona Magma Mine in Reference to Chloride and Kingman (Google Earth, 2016)

Figure 1-2. Arizona Magma Mine's Proximity to Chloride (Google Earth, 2016)

Chloride has a population of approximately 250 residents and is considered one of the oldest mining towns in America because of its proximity to over 70 mines (McNeely, 2016).

Mining began at this site, originally called Arizona Diana Mine, around 1890. It experienced a period of inactivity until the 1920's where its commodities were primarily silver, gold, and lead (ADMMR, 1995). The mine closed again in the 1920's and was reopened and named after its new operating company, Magma Mine, in 1934 (ADMMR, 1995). For the mine's reopening, a new mill was built that was initially reported to provide a steady stream of revenue for years to come. However, after an investigation in 1940, it was found to be run down and in need of repair (ADMMR, 1995). A high-grade ore with ruby silver was mined at the site in its early years, while a low-grade ore with zinc and lead was its primary export in its later years. The mine was reviewed several times from 1940 to 1945 due to lack of funding and difficulty in extracting anything lucrative. As a result of these site investigations, Arizona Magma Mine was advised to close in 1945.

Currently, the site belongs to the BLM and is considered open and accessible to the public. While mine operations shut down in the early 1940's, tailings about 10 feet deep are still present on the site (Zielske, 2016). These tailings may contain lead or arsenic (Zielske, 2016). A photo of the tailings can be seen in Figure 1-3.

Figure 1-3. Current Condition of Tailings (Zielske, 2016)

The tailings have also washed down into the nearby wash (Figure 1-4) and onto the road that connects the mine to Chloride (Figure 1-5).

Figure 1-4. Tailings in the Wash (Zielske, 2016)

Figure 1-5. Tailings on the Road (Zielske, 2016)

The site is also located near several water wells, as seen in Figure 1-6. Wells are signified by red dots on the map.

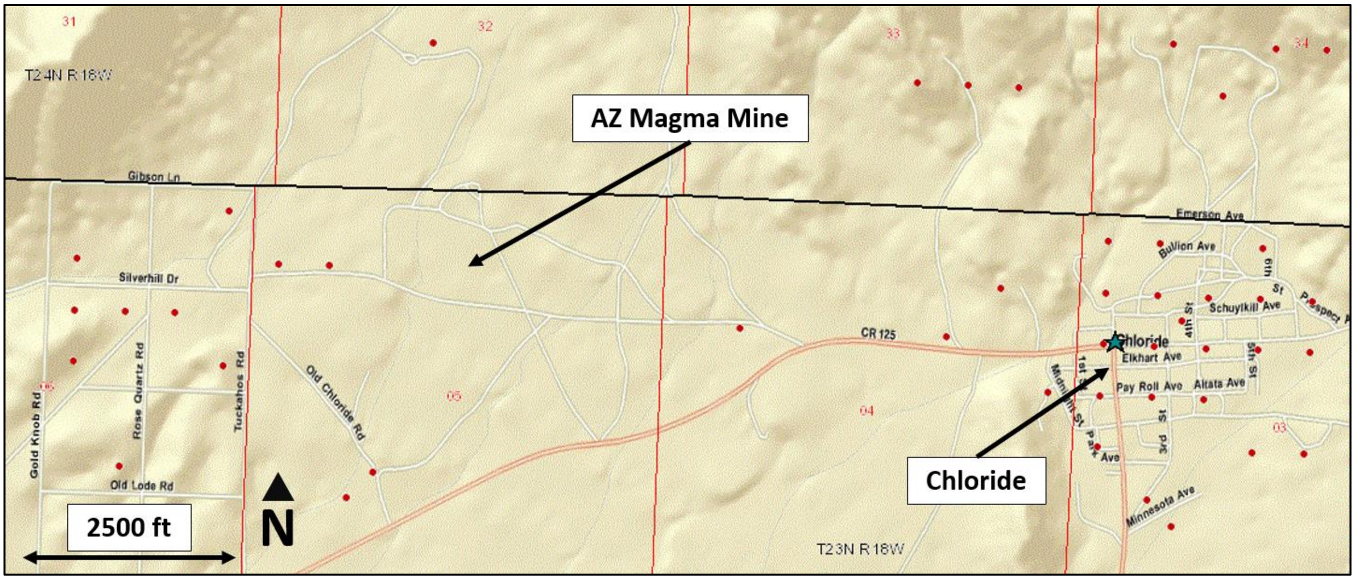

Figure 1-6. Wells near Arizona Magma Mine (ADWR, 2016)

The depth to groundwater for these wells varies from 100 to 150 feet and may be at risk for contamination from the mine (ADWR, 2016).

1.3 Technical Considerations

Characterizing the mine waste at the Arizona Magma Mine will involve developing/executing a sampling plan, conducting a laboratory analysis of the collected soil, identifying whether or not the soil contamination violates environmental regulations, and performing a human health/ecological risk assessment in accordance with the Environmental Protection Agency's (EPA) risk assessment guidelines.

Grid sampling will likely be the choice for the sampling approach (Zielske, 2016). Options for grid sampling include centrally aligned and unaligned grids. Figure 1-7 and Figure 1-8 illustrate the differences between centrally aligned and unaligned grids, respectively.

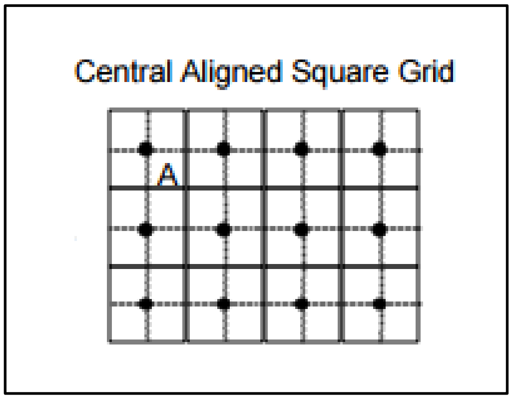

Figure 1-7. Centrally Aligned Grid (EPA A, 2002)

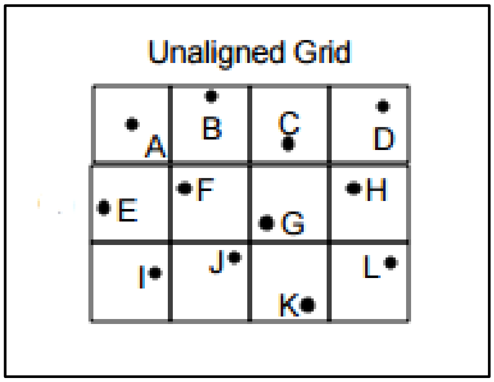

Figure 1-8. Unaligned Grid (EPA A, 2002)

The drawback of a centrally aligned grid is that all points are separated at equal lengths from each other. This is an issue if the contamination of concern occurs in a fixed pattern (EPA A, 2002). The benefits to an unaligned grid sampling approach is randomness combined with good coverage (EPA A, 2002). A global positioning system (GPS) will be used to establish the sampling grid. Grab sampling, background sampling and hotspot sampling will also be utilized in support of the site inspection.

Lead and arsenic are two expected COCs (Zielske, 2016). Because of this, it will be necessary to utilize appropriate personal protective equipment (PPE) while sampling the soil. This will fall under the site health and safety plan, intended to minimize exposure to contaminants.

X-ray fluorescence (XRF) will be used for screening the site's soil for contaminant levels. Acid digestion and atomic absorption (AA) will be used to verify the results of the XRF analysis. Quality assurance and quality control will be done by using duplicate and blank samples. Blanks are useful for determining field sampling contamination. Duplicate samples are extracted from the main sample and used to verify analytical precision.

A human health/ecological risk assessment following EPA methods will be used for analysis. The Adult Lead Model (ALM) and the Integrated Exposure Uptake Biokinetic (IEUBK) model will be used to characterize human health risk. EPA uses the ALM for long term adult lead exposure scenarios. The IEUBK model will be used to characterize lead exposure and risk for children. The EPA's human health risk assessment method consists of the following steps: planning, hazard identification, dose-response assessment, exposure assessment, and risk characterization (EPA B, 2016). The ecological risk assessment consists of the following steps: planning and scoping, problem formulation, analysis, and risk characterization (EPA C, 2015).

The Arizona Soil Remediation Standards will also be used to determine if further site analysis is necessary. Non-residential contaminant trigger levels will be used in comparison with sampling results.

1.4 Potential Challenges

Challenges may arise in the sampling portions of this project. Sampling challenges include grid establishment, sample consistency, and foul weather. Because GPS units can only pinpoint locations within a few meters, a grid system cannot be fully developed using GPS. To address this issue, a single point will be verified with GPS and the rest of the grid will be laid out using measuring tape, a compass, and stake flags. Sample consistency may vary in this project, sometimes due to natural, geological differences. Foul weather, such as precipitation or wind, may hinder the team's ability to fully and adequately sample the site.

1.5 Stakeholders

Stakeholders for this project include the BLM, residents of Chloride, well-users near the mine, and the public. The BLM is a stakeholder for this project because it owns the land and is responsible for managing it. Residents of Chloride and well-users in the area are stakeholders because they live near the mine and use resources that may be impacted by the potential COCs. Additionally, if COCs have migrated by vehicles (due to the tailings extending to the nearby road), those same COCs may be spread across the town of Chloride. The public is a stakeholder because it can be exposed to the COCs through various recreational activities. This is important to understand when developing exposure scenarios.

2.0 Scope of Services

The scope of services includes all activities necessary to fulfill the project purpose. Major tasks include the development of a Work Plan, team member training, site sampling, laboratory analysis, risk assessment, and the development of a PA/SI document.

2.1 Task 1.0 Work Plan

The Work Plan outlines various procedures and safety considerations for all field and laboratory activities. The Work Plan includes the Sampling and Analysis Plan (SAP) and the Health and Safety Plan (HASP).

2.1.1 Subtask 1.1 Sampling and Analysis Plan

The SAP will outline the team's field activities and standard operating procedures (SOP). Grid sampling, hotspot sampling, background sampling, and sample preservation techniques will be described in the SAP.

The SAP will also outline the team's analysis activities. SOPs for laboratory activities such as sample preparation, XRF analysis, acid digestion, and AA analysis will be described in the SAP. Statistical analyses used to determine sample relevance and reliability will also be described in the SAP.

2.1.2 Subtask 1.2 Health and Safety Plan

The HASP will include health and safety considerations for sampling and analysis procedures. Task-specific risks will be described in the HASP. Necessary PPE and other procedures will be clearly defined in the HASP in order to mitigate on-site chemical risks during sampling. The minimization of investigation derived wastes (IDW) will be described in the HASP.

2.2 Task 2.0 Training

All team members will complete training for field safety, chemical hygiene, Hazardous Waste Operations and Emergency Response (HAZWOPER) certification, and XRF analyzer use.

2.2.1 Subtask 2.1 Field Safety

Online training for field safety will be completed in order to comply with Northern Arizona University's (NAU) environmental health and safety (EHS) requirements.

2.2.2 Subtask 2.2 Chemical Hygiene

Online training for chemical hygiene will be completed in order to comply with NAU's EHS requirements.

2.2.3 Subtask 2.3 HAZWOPER

A 40-hour online HAZWOPER training will certify team members for sampling potentially toxic substances.

2.2.4 Subtask 2.4 XRF Training

XRF training will be completed to teach team members how to use an XRF analyzer with soil samples.

2.3 Task 3.0 Sampling

Approximately 100 grab samples will be collected from the mine site using a grid sampling technique described in the SAP. Background samples and hotspot samples will also be taken.

2.4 Task 4.0 Lab Analysis

Various analyses will be done to determine the concentration of COCs in the soil samples collected.

2.4.1 Subtask 4.1 Sample Preparation

Homogeneous soil samples will be prepared for XRF analysis through sieving. Samples will be prepared using SOPs outlined in the SAP.

2.4.2 Subtask 4.2 XRF Analysis

XRF analysis of the samples will be completed to determine contaminant concentration in the samples. A subset representing 20% of total samples will be further analyzed by AA to determine the accuracy of XRF results.

2.4.3 Subtask 4.3 Acid Digestion

Following EPA Method 3050B, soil samples will be dissolved by acid digestion into solution until the soil matrix is completely dissolved. This will create a complete solution of the analyte, allowing for AA analysis.

2.4.4 Subtask 4.4 Atomic Absorption Analysis

AA analysis will be used to determine contaminant concentrations in the subset of soil samples. The analysis will be subcontracted and performed by professional lab technicians at NAU.

2.4.5 Subtask 4.5 XRF and AA Correlation

Statistical analyses described in the SAP will be used to compare XRF and AA results. The goal of this comparison is to obtain a regression equation showing actual concentrations versus XRF results. This will indicate to the team the validity of all XRF data obtained.

2.4.6 Subtask 4.6 GIS Mapping

A geographic information system (GIS) will be used to geographically present the data collected from the XRF analysis.

2.5 Task 5.0 Screening Risk Assessment

Human health and ecological risk assessments will be completed to determine potential risk of the site.

2.5.1 Subtask 5.1 Human Health

An assessment of human health risk will be done following the EPA's five-step process. These steps include 1) planning, 2) hazard identification, 3) dose-response assessment, 4) exposure assessment, and 5) risk characterization. The ALM and IEUBK model will be used in this assessment. Exposure scenarios relevant to the site will be used in this assessment.

2.5.2 Subtask 5.2 Ecological

An assessment of ecological risk will be done following the EPA's four-step process. These steps include 1) planning and scoping, 2) problem formation, 3) analysis, and 4) risk characterization. This assessment will determine the possible risk for plant and animal life near the site.

2.6 Task 6.0 Preliminary Assessment and Site Inspection (PA/SI)

The PA/SI document will describe the extent of contamination found at the site and its risk to human and ecological health. Social, economic, and environmental impacts resulting from the PA/SI will also be discussed.

2.7 Task 7.0 Project Management

Project management includes all tasks necessary to complete both this project and the team's capstone course.

2.7.1 Subtask 7.1 Team Meetings

The team will meet at least once per week to ensure that the team stays on task and understands what is expected.

2.7.2 Subtask 7.2 Client Communication

Communication will be maintained with the client on a consistent basis to ensure that progress is being made.

2.7.3 Subtask 7.3 Project Tracking

The project schedule will be used to monitor deadlines and understand task dependencies as the project moves forward.

2.7.4 Subtask 7.4 Deliverables

Major deliverables include the 50% design report, the final PA/SI report, final presentation, and project website. The 50% design report will signify that 50% of the project has been completed. The final PA/SI report will signify that the project has been completed. The final presentation will be given once the project is completed to ensure that the client understands what work was completed. A project website will be prepared to present documents and information relevant to the project.

2.8 Exclusions

The team will not be sampling to depth at the site; only surface samples will be taken. The team will not be taking water samples at the site. The team will be focusing on the location of COCs currently at the site; no investigation will be made on the past and future migration of the COCs. Any activities not included in the Work Plan or SAP will not be included in the team's analysis. The team will not be providing recommendations for remedial actions following the PA/SI.

3.0 Project Schedule

The project will start on October 10, 2016 and be completed by May 11, 2017. Figure 3-1 presents the project schedule in a Gantt Chart. A list of the schedule's tasks, their start and end dates, and their dependencies is presented in Appendix A-1.

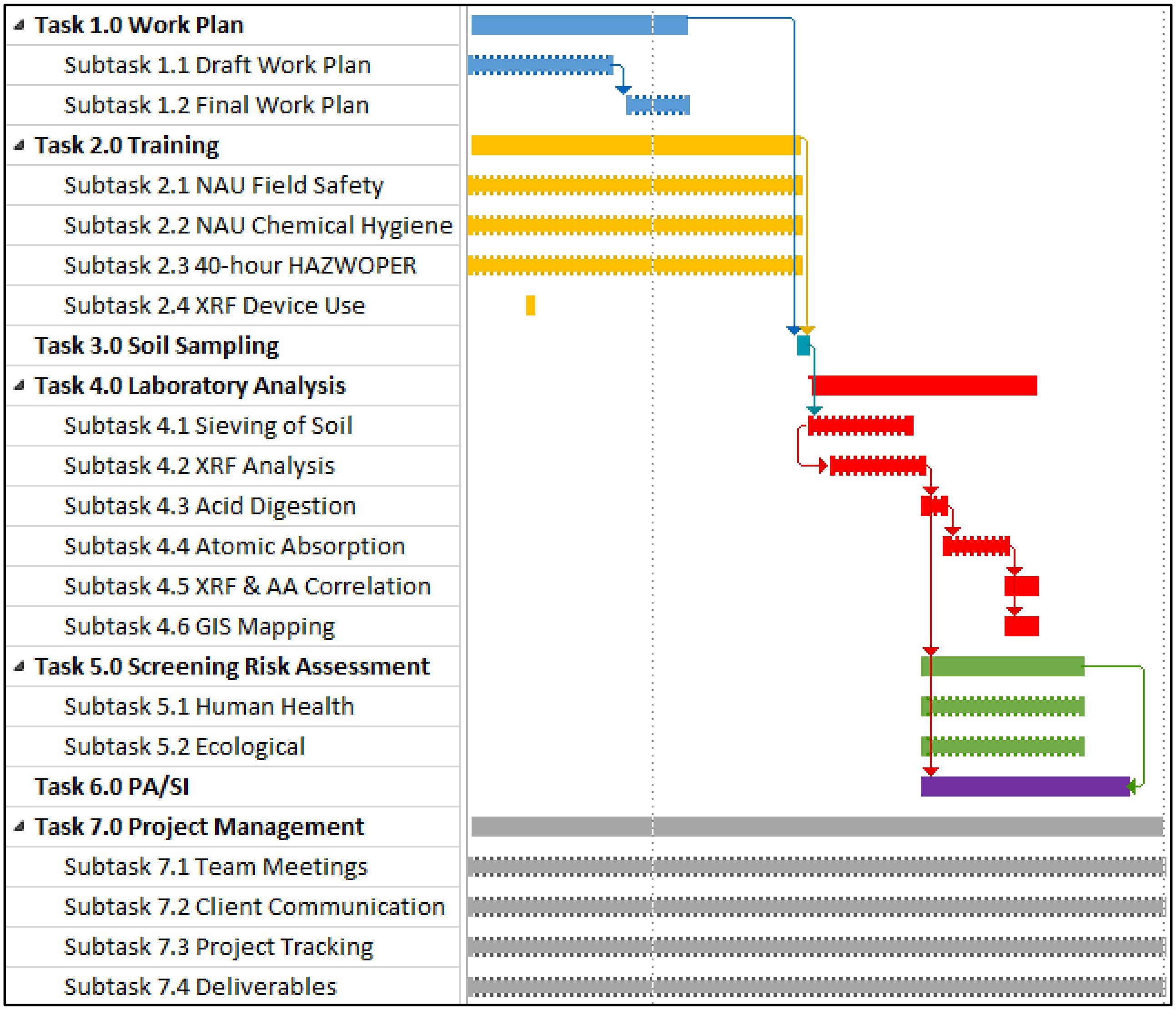

Figure 3-1. Gantt Chart

3.1 Critical Path

The nature of the project necessitates that all tasks are completed in order to finish the project. The critical path is as follows: 1) develop the Work Plan and complete all necessary trainings, 2) collect soil samples (January 20 to January 21, 2017), 3) perform laboratory analyses, 4) perform screening risk assessments, and 5) develop the PA/SI document. The development of the risk assessments and PA/SI will begin following the completion of XRF analysis. However, the completion of the risk assessments depends on the completion of all lab analyses and the completion of the PA/SI depends on the completion of the risk assessments. The earliest projected finish for the project is April 30, 2017, providing the team with 11 days of flexibility.

4.0 Cost of Engineering Services

4.1 Staffing Plan

Personnel for this project include the senior engineer (SENG), engineer (ENG), lab technician (LAB), intern (INT), and administrative assistant (ADMA).

4.1.1 Senior Engineer (SENG)

The senior engineer is responsible for developing the Work Plan, assessing human and ecological risk, writing the PA/SI, as well as creating all project presentations. The senior engineer must be organized, aware of project progression, personable, and have experience in site waste evaluations.

4.1.2 Engineer (ENG)

The engineer is responsible for developing the Work Plan, soil sampling, lab data analysis, and GIS mapping. The engineer must be organized and have experience in both soil sampling and data analysis.

4.1.3 Lab Technician (LAB)

The lab technician is responsible for soil sampling, soil sieving, XRF analysis, and acid digestion. The lab technician must be organized, detail-oriented, and have experience in both soil sampling and laboratory analyses.

4.1.4 Intern (INT)

The intern is responsible for shadowing the senior engineer, engineer, and lab technician in order to gain valuable experience. The intern must be highly motivated and have a general understanding of concepts related to the project.

4.1.5 Administrative Assistant (ADMA)

The administrative assistant is responsible for coordinating meetings and activities related to the project. The administrative assistant must be proficient with Microsoft Office programs, organized, and personable.

4.2 Person-Hour Breakdown

The overall project has been separated into 20 tasks/subtasks. Table 4-1 shows the person-hour breakdown for all project roles and tasks/subtasks.

Table 4-1. Person-Hour Breakdown of Project Tasks

Task	SENG (hrs)	ENG (hrs)	LAB (hrs)	INT (hrs)	ADMA (hrs)
1.0 Work Plan	26	26	-	-	-
2.0 Training	-	-	-	-	-
2.1 Field Safety	-	1	2	1	-
2.2 Chemical Hygiene	-	1	2	1	-
2.3 XRF	-	-	6	6	-
2.4 HAZWOPER	-	40	80	40	-
3.0 Soil Sampling	-	16	32	16	-
4.0 Lab Analysis	-	-	-	-	-
4.1 Sieving of Soil Samples	-	-	60	60	-
4.2 XRF Analysis	-	-	36	36	-
4.3 Acid Digestion	-	-	16	-	-
4.4 AA Analysis	-	-	-	-	-
4.5 XRF vs AA Correlation	-	8	-	-	-
4.6 GIS Mapping	-	8	-	-	-
5.0 Screening Risk Assessment	-	-	-	-	-
5.1 Human Health	20	20	-	-	-
5.2 Ecological Risk	10	10	-	-	-
6.0 PA/SI	22	22	-	-	-
7.0 Project Management	-	-	-	-	-
7.1 Team Meetings	15	15	15	15	15
7.2 Client Meetings	6	-	-	6	6
7.3 Technical Advisor Meetings	7	7	7	7	7
7.4 Website	-	-	-	-	20
7.5 Presentations	6	6	-	6	-
Subtotals	**112**	**180**	**256**	**194**	**48**
TOTAL			**790**		

4.3 Total Project Cost

The total project cost includes personnel, travel, subcontract, material, and laboratory expenditures. The personnel expenses cover the SENG, ENG, LAB, INT, and ADMA billing rates. Billing rates include overhead. Travel expenses cover lodging, food, vehicle rental, and vehicle mileage. Subcontract expenses cover subcontracted AA analysis performed by NAU lab technicians. Material expenses cover all materials necessary for soil sampling. Laboratory expenses cover all lab equipment use for soil sieving, XRF analysis, and acid digestion. The total project cost is $65,448 as seen in Table 4-2.

Table 4-2. Total Project Cost

	Billing Rate	Multiplier	Cost
1.0 Personnel			
SENG	$ 168/hr	x 112 hrs	$ 18,816
ENG	$ 90/hr	x 180 hrs	$ 16,200
LAB	$ 69/hr	x 256 hrs	$ 17,664
INT	$ 27/hr	x 194 hrs	$ 5,238
ADMA	$ 52/hr	x 48 hrs	$ 2,496
			$ 60,414
2.0 Travel			
Lodging	$ 125/room-night	x 3 rooms x 1 night	$ 375
Food	$ 34/person-day	x 5 persons x 2 days	$ 110
Vehicle Rental	$ 55/day	x 2 days	$ 160
Mileage	$ 0.40/mile	x 400 miles	$ 340
			$ 985
3.0 Subcontract			
AA Analysis	$ 9.70/sample	x 20 samples	**$ 194**
4.0 Materials			
Black Sharpies	$ 4.28/marker	x 5 markers	$ 21.40
Rite in the Rain Environmental field logbooks	$ 20.75/logbooks	x 2 logbooks	$ 41.50
Handheld GPS unit	$ 30/day (rent from NAU)	x 2 days	$ 60.00
Trowels	$ 8.37/trowel	x 4 trowels	$ 33.48
Custody seals	$ 16.50/100 seals	x 200 seals	$ 33.00
1-gallon plastic bags	$ 28.56/250 bags	x 250 bags	$ 28.56
200-ft measuring tape	$ 17.85/day (rent from NAU)	x 2 days	$ 35.70
Surveying stakes/flags	$ 7.98/100 stakes	x 100 stakes	$ 7.98
5-gallon decontamination waste bucket	$ 8.91/bucket	x 3 buckets	$ 26.73
Bottles for distilled water, 16 oz	$ 3/bottle-day (rent from NAU)	x 8 bottles x 2 days	$ 48.00
Paper towels	$ 1.98/roll	x 3 rolls	$ 5.94
Dish soap, 16 oz	$ 3.69/bottle	x 1 bottle	$ 3.69

	Billing Rate	Multiplier	Cost
Scrub brushes	$ 2.97/brush	x 2 brushes	$ 5.94
Tyvek suits (with overboots)	$ 10.09/suits	x 12 suits	$ 121.08
Nitrile gloves	$ 22.25/400 gloves	x 400 gloves	$ 22.25
			$ 495
5.0 Laboratory			
Lab room rental, equipment use, and materials use	$ 80/day (NAU lab manager recommendation)	x 42 days	**$ 3,360**
TOTAL			**$ 65,448**

5.0 References

Arizona Department of Mines and Mineral Resources File Data (ADMMR), “Arizona Magma,” September 1995.

Arizona Department of Water Resources (ADWR), "Well registry web map,". [Online]. Available: https://gisweb.azwater.gov/WellRegistry/Default.aspx. Accessed: Sep. 17, 2016.

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Appendix A-1: Project Schedule

	Task Name	Duration	Start	Finish	Predecessors
1	**Task 1.0 Work Plan**	49 days	Mon 10/10/16	Thu 12/15/16	
2	Subtask 1.1 Draft Work Plan	31 days	Mon 10/10/16	Mon 11/21/16	
3	Subtask 1.2 Final Work Plan	14 days	Mon 11/28/16	Thu 12/15/16	2
4	**Task 2.0 Training**	74 days	Mon 10/10/16	Thu 1/19/17	
5	Subtask 2.1 NAU Field Safety	74 days	Mon 10/10/16	Thu 1/19/17	
6	Subtask 2.2 NAU Chemical Hygiene	74 days	Mon 10/10/16	Thu 1/19/17	
7	Subtask 2.3 40-hour HAZWOPER	74 days	Mon 10/10/16	Thu 1/19/17	
8	Subtask 2.4 XRF Device Use	1 day	Fri 10/28/16	Fri 10/28/16	
9	**Task 3.0 Soil Sampling**	2 days	Fri 1/20/17	Sat 1/21/17	1,4
10	**Task 4.0 Laboratory Analysis**	53 days	Sun 1/22/17	Sun 4/2/17	
11	Subtask 4.1 Sieving of Soil	24 days	Mon 1/23/17	Wed 2/22/17	9
12	Subtask 4.2 XRF Analysis	21 days	Mon 1/30/17	Sun 2/26/17	11SS
13	Subtask 4.3 Acid Digestion	6 days	Mon 2/27/17	Sun 3/5/17	12
14	Subtask 4.4 Atomic Absorption	15 days	Mon 3/6/17	Fri 3/24/17	13
15	Subtask 4.5 XRF & AA Correlation	7 days	Sat 3/25/17	Sun 4/2/17	14
16	Subtask 4.6 GIS Mapping	7 days	Sat 3/25/17	Sun 4/2/17	14
17	**Task 5.0 Screening Risk Assessment**	36 days	Mon 2/27/17	Sun 4/16/17	12
18	Subtask 5.1 Human Health	36 days	Mon 2/27/17	Sun 4/16/17	
19	Subtask 5.2 Ecological	36 days	Mon 2/27/17	Sun 4/16/17	
20	**Task 6.0 PA/SI**	46 days	Mon 2/27/17	Sun 4/30/17	12,17FF
21	**Task 7.0 Project Management**	155 days	Mon 10/10/16	Thu 5/11/17	
22	Subtask 7.1 Team Meetings	155 days	Mon 10/10/16	Thu 5/11/17	
23	Subtask 7.2 Client Communication	155 days	Mon 10/10/16	Thu 5/11/17	
24	Subtask 7.3 Project Tracking	155 days	Mon 10/10/16	Thu 5/11/17	
25	Subtask 7.4 Deliverables	155 days	Mon 10/10/16	Thu 5/11/17	