CANYON CITY MILL PA/SI PROJECT PROPOSAL

CENE 476

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List of Abbreviations

ADEQ	Arizona Department of Environmental Quality
ALM	Adult Lead Model
AZSRL	Arizona Soil Remediation Levels
BLM	Bureau of Land Management
COC	Contaminants of Concern
DQI	Data Quality Indicators
DQO	Data Quality Objectives
Eco-SSL	Ecological Soil Screening Levels
ECOTOX	EPA Ecotoxicology Database
EPA	Environmental Protection Agency
EPC	Exposure Point Concentration
FAAS	Flame Atomic Absorption Spectroscopy
HASP	Health and Safety Plan
ICP	Inductively Coupled Plasma
IEUBK	Integrated Exposure Uptake Biokinetic Model
IRIS	Integrated Risk Information System
MSDS	Material Safety Data Sheets
MQO	Measurement Quality Objectives
OSHA	Occupational Safety and Health Administration
PA/SI	Preliminary Assessment/Site Investigation
PLS	Pregnant Leach Solution
PPE	Personal Protective Equipment
SAP	Sampling and Analysis Plan
SLR	Soil Remediation Level
XRF	X-Ray Fluorescence

1.0 Project Understanding

1.1. Project Purpose

Completion of a Preliminary Assessment and Site Investigation (PA/SI) report for the Bureau of Land Management (BLM) for the Canyon City Mill site. The site was utilized for milling activities, including a cyanide heap leaching process, that led to the release of hazardous substances. The hazards substances included lead and arsenic as contaminants of concern (COC). Understanding the extent of the contamination and determining the risk to human and environmental health is imperative in determining if further remedial action is required at the site.

1.2. Project Location and Background

The Canyon City Mill began operation in 1986. The owner of the site, at the time of operation, was Charlie Stoll. Robert Graham, the owner of Canyon City Mill, was subleasing the site from Stoll. The site was used for a cyanide leaching process to extract gold from mined ore from underground gold mines near Oatman, Arizona. One source of the ore was the Minneapolis Mine. No mining was done at the site.

The abandoned Canyon City Mill is located 1.5 miles south of the town of Oatman, Arizona, in the eastern portion of the state within Mohave County. The geographical coordinates are as follows:

- Latitude: 35°0'14.04"N
- Longitude: 114°23'3.57"W

Figure 1.1 below shows the location of the abandoned mine site within the state of Arizona and within Mohave County.

Figure 1.1: Geographical Location of Site [1]

Surrounding cities include Kingman, Arizona (located northeast of the site), Yucca, Arizona (located southeast of the site), Las Vegas, Nevada (located northwest of the site), and Needles, California (located southwest of the site). The site can be accessed from Flagstaff by traveling on I-40 westbound and exiting on State Route 10 (Oatman Highway). The Oatman Highway is followed for approximately 1.5 miles past the town of Oatman until an access road is reached. Figure 1.2 below shows an aerial image of the site in relation to Oatman.

Figure 1.2: Site Location in Relation to Oatman

Figure 1.3 below shows an additional location image of the site. The aerial image shows washes south of the site, which flow from northeast to west/southwest towards the Colorado River. The Colorado River is located approximately 14.5 miles downstream of the site [1]. Highway 10 is indicated by the yellow path in the top left corner of the image.

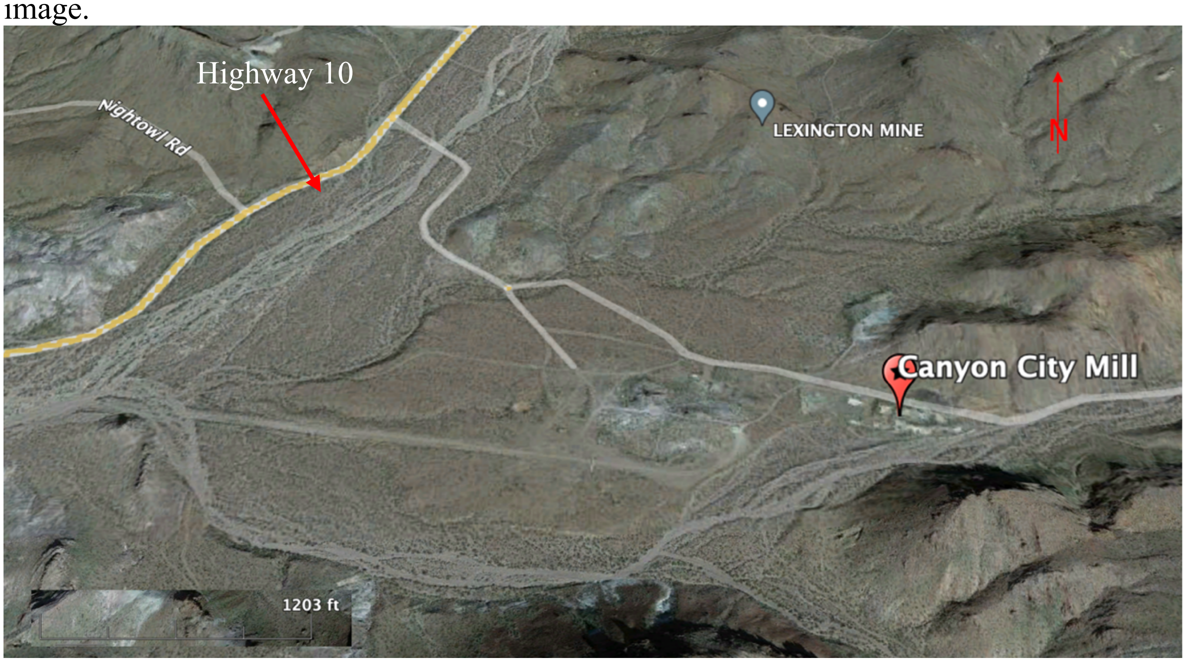

Figure 1.3: Site Location with Surrounding Washes [2]

The cyanide leaching operation used three 30,000-gallon tanks to store sodium cyanide solution (shown in Figure 1.4). The cyanide solution was sprayed or dripped onto piles of crushed ore in the leach field (shown as the leach slab in Figure 1.7). As the cyanide passed through the ore, the gold was leached from the rock, creating what is known as the pregnant leach solution (PLS). The leach solution flowed into the pregnant solution pond, which can be seen behind the chain-link fence to the right of the PLS distributer channel in Figure 1.5. Cinders, which are small pieces of burnt wood or charcoal, were used as a carbon source in the pregnant solution pond to absorb the gold from the cyanide-gold complexes. The gold was recovered by carbon adsorption, and the cyanide was recycled back to the cyanide solution tanks. The spent ore was left at the site in piles south of the leach field [3].

Figure 1.4 : 30,000 Gallon Cyanide Solution Tanks [3]

Figure 1.5: PLS Distributer Channel and Holding Pond [3]

The supernatant from the leach field, the "pregnant" leach solution (PLS), was stored in a pregnant solution pond. The solution then goes through a carbon absorption process where the cyanide is separated from the gold, which can then be recovered. Figure 1.6 below shows a block diagram of the general cyanide leaching process.

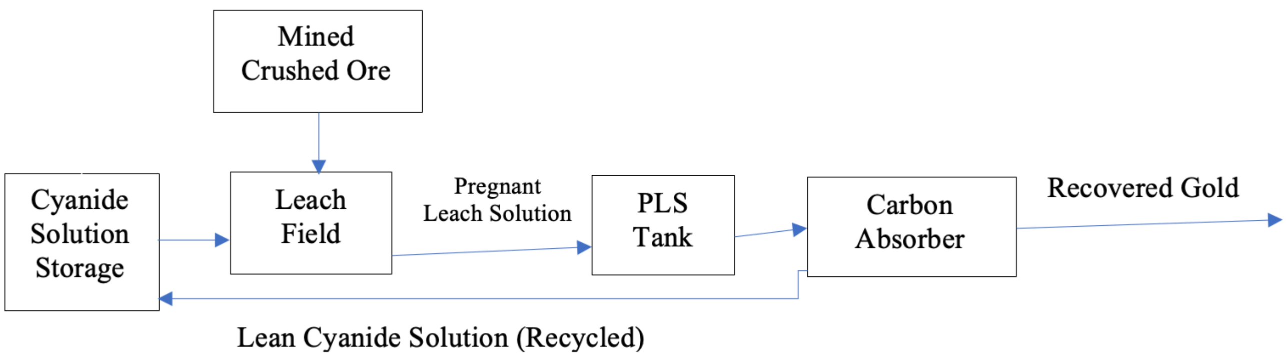

Figure 2.6: Cyanide Leaching Process Block Diagram

In 1991, the three 30,000-gallon tanks holding the cyanide solution were dumped on the site. The Bureau of Land Management and the Arizona Department of Environmental Quality (ADEQ) Emergency Response Unit were contacted and informed of the spill. This prompted a site investigation in 1991, completed by ADEQ's Office of Waste and Water Quality Management [3].

The mill site has been abandoned since 1991 when extraction operations stopped after the cyanide solution spill. The operational equipment was subsequently removed from the site after operations ceased, leaving behind a concrete holding pond, multiple concrete slabs used for holding cyanide solutions and cyanide leaching, a building foundation, and debris. Figure 1.7 below shows the current site conditions as found from Google Earth aerial imagery. The access road runs to the north of the site, and a wash is present to the south of the site that runs in the southwest direction towards Oatman Highway.

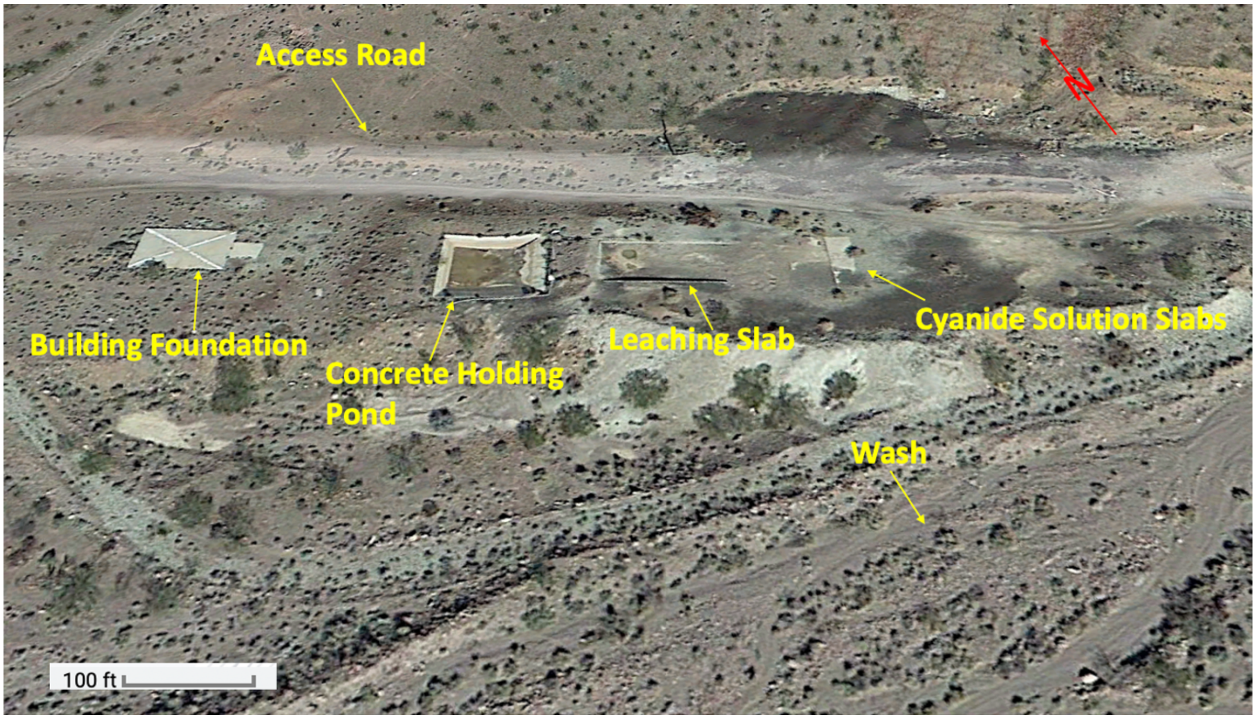

Figure 1.7: Current Site Condition [3]

According to a soil sampling effort conducted for a 2016 PA/SI by ECM Consultants [3], the presence of cyanide was not detected above background levels in the soil and sediment samples collected. However, lead and arsenic concentrations were detected above Arizona Department of Environmental Quality (ADEQ) Soil Remediation Levels (SLRs) [1]. The non-resident, ADEQ soil remediation level for arsenic is 10 mg/kg, and arsenic levels on the site ranged from 2.06 mg/kg to 214 mg/kg [1]. The non-resident, ADEQ soil remediation level for lead is 800 mg/kg, and lead levels on the site ranged from 13.7 mg/kg to 1480 mg/kg [1].

The extent of the lead and arsenic soil contamination at the site and surrounding area is unknown. Representative background levels for COCs in the soil in the area are also unknown.

1.3. Technical Considerations

In order to successfully assess the human health and ecological risk associated with past cyanide leaching operations, extensive sampling and analysis will be conducted. Prior to the site investigation and sample collection, a Work Plan will be prepared. To identify contaminants of concern, soil samples will be collected and analyzed using X-Ray Fluorescence (XRF). Due to XRF errors caused by interferences when arsenic and lead are present, a Flame Atomic Absorption Spectroscopy (FAAS) analysis will be conducted to confirm arsenic concentrations in the soil.

1.4. Potential Challenges

Potential challenges for collecting the required data include inclement weather and problematic soil conditions. Inclement weather could result in needing to change the date for collecting soil samples resulting in a possible schedule change. Problematic soil conditions such as hard, compacted caliche may eliminate the possibility of core sampling, should that be included in the Work Plan.

1.5. Stakeholders

Stakeholders for this project include the BLM (Eric Zielske, project client) as well as the general public. Residents, recreational users, and visitors near Oatman, Arizona may encounter the site and be exposed to any hazardous materials present.

2.0 Scope of Services

2.1. Task 1.0: Work Plan and Lab Binder

A Work Plan will be developed before investigating the site. The Work Plan will include, a project description, the site background, the project management, and the methods/procedures will be followed. The Work Plan will contain Sampling and Analysis Plan (SAP) and the Health and Safety Plan (HASP).

2.1.1. Task 1.1: Sampling and Analysis Plan (SAP)

The SAP will focus on procedures and analytical requirements of this project. The document will include an introduction, background, project data quality objectives, sampling rationale, field methods and procedures, lab methods and procedures, sample labeling and packaging, disposal of materials, sample documentations, quality control procedures, and field decontamination procedures [4].

2.1.2. Task 1.2: Health and Safety Plan (HASP)

The HASP will meet requirements of OSHA dealing with hazardous waste. This document will include site information, site roles and responsibilities, field and lab hazard/risk, evaluations and mitigation measures to be taken, personal protective equipment (PPE), site control methods, operating procedures, material safety data sheets (MSDS) for any chemicals used, emergency response plans, decontamination procedures, and training required [5].

2.1.3. Task 1.3: NAU Binder

To access the NAU soils and environmental labs, a Lab Binder detailing laboratory procedures, safety and cleanup procedures is required. Approval of this binder by the CECECME Lab Manager is required prior to accessing the lab.

2.2. Task 2.0: Site Investigation

A Site Investigation (SI) is to determine whether there are COCs on site or to confirm COCs previously identified. The SI will be performed in accordance with the Work Plan and will include an inventory of plants and animals in the vicinity of the site. The SI will take place in January 2023 depending on the weather conditions.

2.3. Task 3.0: Analysis of Samples

Samples collected during the Site Investigation will be analyzed to determine all COCs. Samples will be handled in accordance with the procedures defined in the Work Plan.

2.3.1. Task 3.1: Sample Preparation

Each soil sample will be properly prepared before conducting the XRF analysis.

2.3.1.1. Task 3.1.1: Drying of Soil

The soil samples will be dried according to ASTM Method D2216 [7].

2.3.1.2. Task 3.1.2: Soil Sieving

Before conducting the XRF analysis, the soil samples will be sieved to achieve size homogeneity and remove large particles. The samples will be sieved according to a modified ASTM Method D6913 [8].

2.3.2. Task 3.2: XRF Analysis

The XRF Analysis will be performed with accordance to the EPA Method 6200 [9].

2.3.3. Task 3.3: Identify Contaminants of Concern

Results obtained from the XRF will be compared to AZSRL to identify human health COCs and Ecological Soil Screening Levels (Eco-SSL) to identify ecological COCs. The Eco-SSLs can be found on the EPA website, and the AZSRLs can be found in the Arizona Administrative Code [10] [11].

2.3.4. Task 3.4: Acid Digestion

If human health COCs other than Pb and As are found, soil samples will be digested in order to prepare for the FAA or ICP testing for confirmatory analysis. It is known that Pb concentrations in soil by XRF are accurate so no further analysis is required; As digestions will be performed by a subcontracted lab. The EPA Method 3052 will be used [12].

2.3.5. Task 3.5: FAA or ICP Analysis

To confirm the concentrations of As and any other COCs, an FAA or ICP analysis will be conducted by a subcontract lab. FAA analysis will be conducted using EPA Method 7000B and the ICP analysis will be conducted using EPA Method 6010B.

2.3.6. Task 3.6: Correlate Data

Correlation curves will be created between the XRF results and the FAA/ICP results. The XRF data will be corrected based on the correlation.

2.4. Task 4.0: Contaminant Distribution

2.4.1. Task 4.1: Spatial Distribution Maps

The spatial distribution of the identified COC's will be determined throughout the site. Maps will be created to accurately define the locations and concentrations of the identified COC's

2.4.2. Task 4.2: Migration Pathway Analysis

The possible migration pathways of the COC's will be assessed. The pathways will be characterized by creating a site conceptual model that will generate a better understanding of probable migration patterns of the COC's.

2.5. Task 5.0: Human Health Risk Assessment

The team will conduct a human health risk assessment in order to determine the possible health risks associated with the contamination at the Canyon City Mill. By assessing the potential migration pathways determined in Task 5.0, the exposure by potential receptors to the COCs on the site under various use scenarios can be estimated. The team will characterize the risk at the Canyon City Mill site by completing the following tasks.

2.5.1. Task 5.1: Exposure Point Concentrations

Using the soil sample data collected, the 50% and 95% exposure point concentrations (EPCs) will be calculated.

2.5.2. Task 5.2: Exposure Assessment

Various potential exposure scenarios representing realistic use at the site will be identified. Variables such as amount of time spend at the site per year and the use of estimates such as incidental soil consumption, coupled with the EPCs from Task 6.1, will allow computation of intake doses for each exposure scenario.

2.5.3. Task 5.3: Toxicity Assessment

Carcinogenic and non-carcinogenic toxicity data for each COC (other than lead) will be retrieved using the Environmental Protection Agency's (EPA's) Integrated Risk Information System (IRIS) database [13].

2.5.4. Task 5.4: Risk Calculations

For non-Pb COCs, standard risk assessment calculation of both carcinogenic and non-carcinogenic risks will be made for each EPC and exposure scenario to determine if there is elevated risk.

The team will utilize the EPA's Adult Lead Model (ALM) and Integrated Exposure Uptake Biokinetic Model (IEUBK) for lead in children to characterize the risk due to lead contamination. The ALM model will assess lead distribution in adults and provide adult blood lead levels as well as the probability that fetal blood lead concentrations will exceed a target level. The IEUBK model will be used to determine the lead risk in children and will provide child lead blood levels as well as the probability that blood lead levels in children facing a similar exposure will exceed the target level. IEUBK exposure input data will be adjusted to account for non-residential exposures, as the IEUBK model was developed for residential exposures.

2.6. Task 6.0: Ecological Risk Assessment

An ecological risk assessment will be performed to estimate the risk from the site to the surrounding ecosystem. The ecological risk assessment will be based on qualitative data from the site investigation and knowledge of potentially sensitive/endangered/threatened species on site. Site contamination levels from the soil data will be compared to the EPA's Ecological Soil Screening Levels (Eco-SSL) from the ecotoxicology data base (ECOTOX) [14]. The ecological exposure scenarios will be assessed based on the migration pathways determined in Task 5.0.

2.7. Task 7.0: Project Impact Analysis

The environmental, social, and economic impacts of the project will be analyzed and documented in the final report.

2.8. Task 8.0: Project Deliverables

This section outlines all deliverables that will be completed during this project.

2.8.1. Task 8.1: 30% Deliverable

The 30% deliverable includes a report and presentation.

2.8.1.1. Task 8.1.1: 30% Milestone

The 30% milestone will include completed Tasks 1.0, 2.0, and 3.0 through 3.1, and will be completed on February 3, 2023.

2.8.2. Task 8.2: 60% Deliverable

The 60% deliverable includes a report and presentation.

2.8.2.1. Task 8.2.1: 60% Milestone

The 60% milestone will include completed Tasks 3.0, 4.0 and 5.0 through 5.3 and will be completed on February 27, 2023.

2.8.3. Task 8.3: 90% Deliverable

The 90% deliverable includes a report and a draft of the final website.

2.8.3.1. Task 8.3.1: 90% Milestone

The 90% milestone will include completed Tasks 5.0 through 7.0, and will be completed on April 14, 2023

2.8.4. Task 8.4: Final Submittal

The Final Submittal will include the final report (PA/SI), final presentation, and final website. Final submittal will be due May 5, 2022.

2.9. Task 9.0: Project Management

This section identifies how the project will be managed. This includes meeting, project schedules, and project resources.

2.9.1. Task 9.1: Meetings

Project meetings will include team meetings, grading instructor or technical advisor meetings, and client meetings. In order to successfully complete the project and meet deadlines, team members will meet on a regular basis. All meetings will be confirmed 24 hours in advance with a meeting agenda shared to all members. Detailed minutes of each meeting will be compiled within 24 hours of the meeting and will list actionable items. Agendas and minutes will be archived for future reference. Meetings will be scheduled with the technical advisor to ensure the project is on track to meet all expectations and deliverables. Client meetings will be scheduled as deemed necessary or as requested by the client to review the progress of the project.

2.9.2. Task 9.2: Schedule Management

The schedule will be tracked on a weekly basis to guarantee that all tasks are done to a high quality and on time.

2.9.3. Task 9.3: Resource Management

Resources will be tracked management is to ensure that the project budget is not exceeded. This area will track staffing hours, expenses, and materials.

2.10. Exclusions

No groundwater or air sampling will be conducted at the Canyon City Mill site by Flag Environmental Solutions. The human health risk assessment will not include risk due to inhalation exposures. No remedial action objectives will be determined for the Canyon City Mill site by Flag Environmental Solutions.

3.0 Schedule

A Gantt Chart showing the project schedule can be found in Appendix A. The duration of the project is a total of 139 days, starting on the 25th of October 2022, and ending on May 5th, 2023. The critical path is indicated in the Gantt chart by the color red and consists of the tasks that must be completed in order for the project to stay on schedule. The schedule follows a linear sequence of major tasks. The major tasks include Task 1: Work Plan and Lab Binder, Task 2: Site Investigation, Task 3: Analysis of Samples, Task 4: Contaminant Distribution, Task 5: Human Health Risk Assessment, Task 6: Ecological Risk Assessment, Task 7: Project Impact Analysis, Task 8: Project Deliverables, and Task 9: Project Management.

4.0 Staffing Plan

4.1. Staffing Positions and Qualifications

The project staff will be comprised of the senior engineer, the engineer, the technician, and the intern. They are described below.

4.1.1. Senior Engineer (SENG)

The senior engineer will serve as the project manager and must have at least a master's degree in environmental engineering, in addition to being a registered Professional Engineer. The SENG must have at least 10 years of professional experience making them knowledgeable of all technical aspects of the project. Their role is to manage to project timeline and oversee the completion of all deliverables.

4.1.2. Engineer (ENG)

The engineer is the primary worker on the project and must have at least a bachelor's degree in environmental engineering and has passed the Fundamentals of Engineering exam in environmental engineering. The engineer must have experience relevant to the project (human health and ecological risk assessment and soil sampling and analysis). All of the work performed by the engineer must be approved by the SENG.

4.1.3. Technician (TECH)

The lab technician will assist with collecting samples and perform relevant analytical techniques. The lab technician will be trained in all required equipment and lab safety procedures.

4.1.4. Intern (INT)

The intern is a current environmental engineering upperclassman student enrolled at an ABET accredited university. The intern must have a minimum GPA of 3.0. Any tasks completed by the intern will be reviewed and performed under supervision by other staff members.

4.2. Project Staffing

The total estimated hours needed to complete this project is 600. The total hours worked by each position are 96, 173, 166, and 165 for the SENG, ENG, TECH, and INT, respectively. The hours are delegated based on the staff position and their role in the project. Table 4.1 shows the staffing matrix that breaks down the hours per task for each staff position.

Table 4.1: Staffing Matrix

Hours				
Task	**SENG**	**ENG**	**TECH**	**INT**
1.0 Work Plan				
1.1 Sampling and Analysis Plan	12	30		
1.2 Health & Safety Plan		16		4
1.3 Lab Binder			6	10
2.0 Site investigation	20	20	20	20
3.0 Analysis of Samples				
3.1 Sample Preparation				
3.1.1 Soil Drying			12	10
3.1.2 Soil Sieving			16	10
3.2 XRF Analysis			60	10
3.4 Acid Digestion			8	
3.5 FAA or ICP Analysis (subcontracted)				
3.6 Correlate Data		6		6
4.0 Contaminant Distribution				
4.1 Spatial Distribution Maps		4		5
4.2 Migration Pathway Analysis		10		14
5.0 Human Health Risk Assessment				
5.1 Exposure Point Concentrations	2	10		14
5.2 Exposure Assessment	2	4		
5.3 Toxicity Assessment	2			
5.4 Risk Calculations	2			
6.0 Ecological Risk Assessment	2	16		14
7.0 Project Impact Analysis	2	5		2
8.0 Project Deliverables				
8.1 30% Milestone	4	8	8	10
8.2 60% Milestone	2	4	4	4
8.3 90% Milestone	4	6	6	6
8.4 Final Submittal	6	6	6	6
9.0 Project Management				
9.1 Meetings	20	20	20	20
9.2 Schedule Management	8	4		
9.3 Resource Management	8	4		
Total	**96**	**173**	**166**	**165**

5.0 Cost of Engineering Services

The total estimated cost of this project is $71,322. The breakdown of this cost is found in Table 5.1 below. The estimated cost is based on personnel travel, supplies, analyses, and subcontractor costs. Personnel costs include benefits, overhead, and profit. Travel costs include mileage, van rental, hotel rooms, and meals for the site investigation; two days are planned for the site investigation. Supply costs include all equipment and tools needed for the site investigation. Cost of analysis includes NAU lab rental rates for 15 days of sample analysis, as well as XRF rental rates for five days of analysis. Subcontractor costs include Western Technology lab rates for approximately ten samples. The number of samples sent to the subcontracted lab may vary depending on results obtained from the XRF analysis.

Table 5.1: Cost of Engineering Services Summary

Personnel	Classification	Hours	Rate ($/hour)	Cost ($)
	SENG	96	205	$19,680
	ENG	173	170	$29,410
	TECH	166	60	$9,960
	INT	165	30	$4,950
	Total			$64,000
Travel	Classification	Quantity	Rate	Cost ($)
	NAU Mileage	395 miles	$0.445/mile	$176
	NAU 12 Passenger Van	2 days	$68/day	$136
	Hotel, 1 night, 4 rooms per night	4 rooms	$94/room/night	$376
	Full Day Rate Meals	2 days, 5 people	$45/day/ person	$450
Supplies	Classification	Quantity	Rate	Cost ($)
	Ziplock bags	2 packs	$15/pack	$30
	Trowel	5	$6/trowel	$28
	Soil Core Sleeves	2	$5/sleeve	$10
	GPS	2 days	$75/day	$150
	Dish Soap	1	$5	$5
	Marking Flags	1 pack (100 per pack)	$2/pack	$2
	Buckets	3	$5/bucket	$15
	Large Bins	3	$16/bin	$48
	Water	25 gallons	$0.35/gallon	$9
	Water Jug	1	$10	$10
	Paper Towels	1 pack	$10/pack	$10
	Pens	1 pack	$6/pack	$6
	Field Logbooks	4	$10/book	$40
	Gloves	3 pack	$4/pack	$12
	Trash Bags	1 pack	$15/pack	$15
	Clip boards	5	$3/board	$15
	Scrub brushes	2	$5/brush	$10

Analysis	Classification	Quantity	Rate	Cost ($)
	NAU Environmental Engineering and Soils Labs	15 days	$100/day	$1,500
	XRF Device	5 days	$654/day	$3,270
Subcontract	Classification	Quantity	Rate	Cost ($)
	Western Tech	10 samples	$100/sample	$1,000
Total				$71,322

6.0 References

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[13] United States Environmental Protection Agency, “Integrated Risk Information System,” 13 August 2021. [Online]. Available: https://www.epa.gov/iris. [Accessed 2-Oct-2022]

[14] United States Environmental Protection Agency, “ECOTOX Knowledgebase,” 15 September 2021. [Online]. Available: https://cfpub.epa.gov/ecotox/. [Accessed 2-Oct-2022]

Appendix A: Schedule

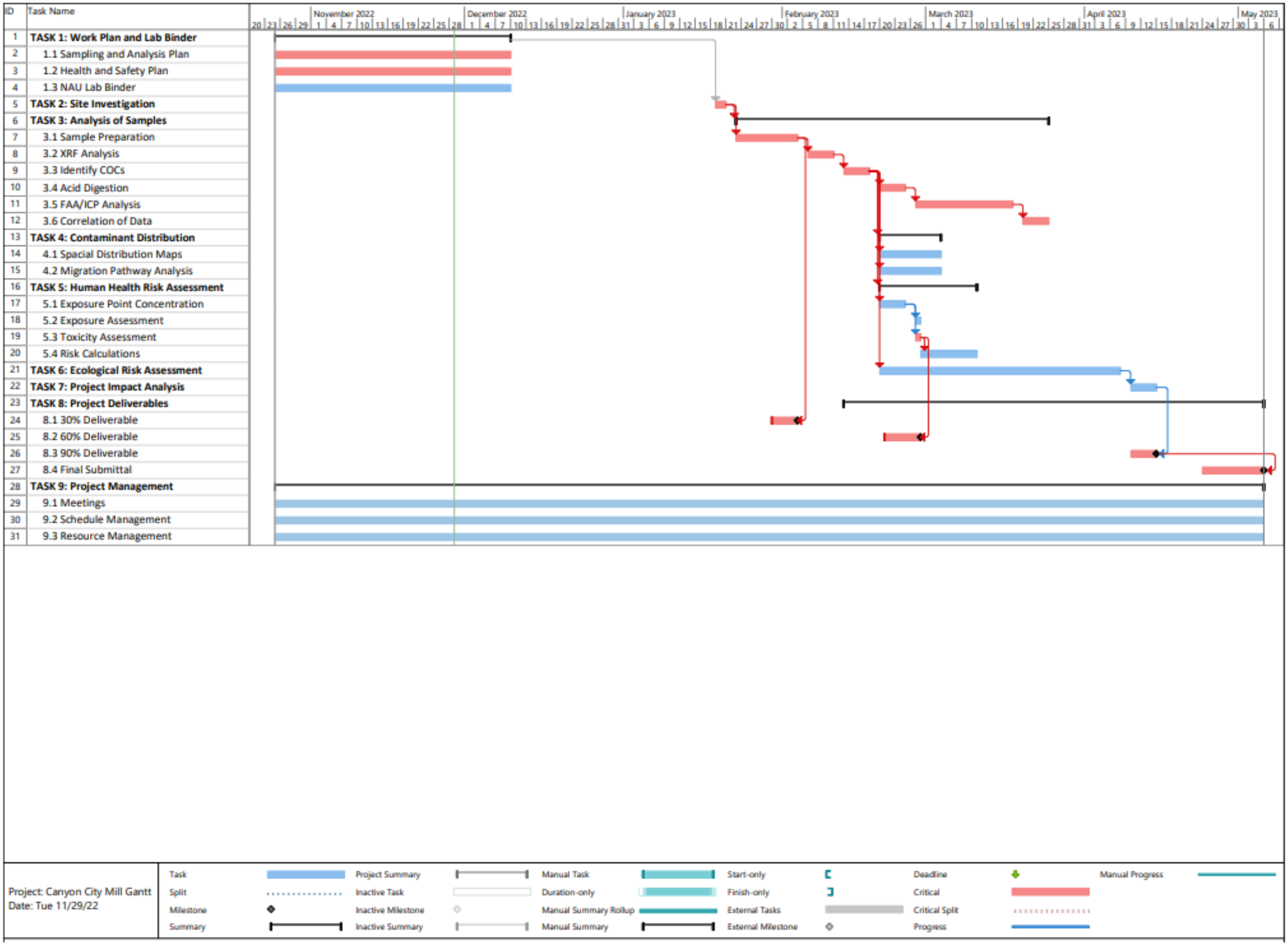

Figure A.1: Gantt Chart Schedule