REMOVAL SITE INSPECTION
PHASE 1
KELLY MINE
RED MOUNTAIN, CALIFORNIA

Prepared for:
California State Office
U.S. Department of Interior
Bureau of Land Management

National Science & Technology Center
Bureau of Land Management

EXECUTIVE SUMMARY

Under the provisions of 40 CRF 300.415 of the National Contingency Plan, BLM has preformed a Removal Site Inspection at the Kelly Mine near Red Mountain, California. One of the largest silver mines in California, the Kelly Mine and its predecessor operated from 1919 to the 1940s, producing over $10 million in 1924 revenue dollars. The site was first identified by BLM in December 2005. The goals of the RSI were to identify safety hazards such as open shafts, characterize whether there was a release of hazardous substances, characterize the nature and extent of contamination in mine tailings and waste rock dumps, and to determine if a time-critical or non-time critical removal actions is necessary.

Seven areas consisting of over 60 acres were evaluated including the Kelly Mine complex, tailings and nearby rock dumps and the Barkley Mine mill tailings. In February 2006, BLM collected approximately 250 soil and mine waste samples at the site and analyzed them for a suite of metals using an x-ray fluorescence spectrometer (XRF). A suitable fraction of the samples were split and shipped to laboratories for additional chemical analyses and for confirmation of the XRF analyses. Samples were also taken at depth in the waste rock dumps and tailings to help determine the vertical extent and characteristics of the waste. Although there are over 100 nearby residences in the adjacent town of Red Mountain, BLM did not sample private properties during this investigation.

The major chemical of concern causing human health risk is arsenic, with minor risk provided by antimony and possibly tungsten for the Barkley Mine. Arsenic averages 1,525 mg/kg in the Kelly Mine tailings, 846 in surface soil in the Kelly Mine and 2,038 mg/kg in the Kelly Mine waste rock dumps, 1,870 mg/kg in the Red Mountain Wash tailings, and much lower in the Barkley Mine tailings. Background arsenic at the site is 136 mg/kg. Arsenic is a human carcinogen and the concentrations present pose very high risk for recreational visitors and potentially for nearby residents where tailings have migrated into residential area.

Visual evidence shows a release of over 40,000 cubic yards of arsenic tailings has migrated from the Kelly Tailings Pond breach onto several residences in Red Mountain thence across U.S. Highway 395 into Red Mountain Wash. It is likely much of this release dates back to the early mining days. Principal receptors at the site include the 75 - 100 residents of Red Mountain, and an unknown number of recreational visitors, especially off road vehicle users. Soil ingestion is typically the most important exposure pathway for both recreational visitors and residents. In addition, inhalation of dust and ingestion of settled indoor dust may be an exposure pathway especially due to off road vehicle activity during weekends and holidays. Drinking water is supplied from by the Rand Communities Water District water wells in Fremont Valley. There are no surface waters at the site.

The site contains habitat for the endangered desert tortoise and Mojave ground squirrel.

The RSI recommends several time critical actions be taken as soon as possible: fence the tailings, shafts and glory hole at the site to prevent access and arsenic exposure, repair the tailing dam breach and install run-on and run-off controls to prevent further migration. It is also recommended that further studies be performed to study alternatives and select a non-time critical action that would lead to a permanent remedy at the site.

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LIST OF ACRONYMS

ABA	Acid Base Accounting
ARARs	Applicable, Relevant and Appropriate Requirements
AST	Above Ground Storage Tank
ASTM	American Society for Testing Materials
BLM	Bureau of Land Management
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CHSO	Corporate Health and Safety Officer
COC	Chemicals of Concern
CN	Cyanide
CLP	Contract Lab Program
DOT	Department of Transportation
DQO	Data Quality Objective
EPA	U.S. Environmental Protection Agency
EE/CA	Engineering Evaluation/Cost Analysis
gpm	Gallons per minute
HDPE	High Density Polyethylene
HSP	Health and Safety Plan
ICP	Inductively Coupled Plasma
IDW	Investigation Derived Waste
LCS	Laboratory Control Sample
msl	Mean Sea Level
NCP	National Contingency Plan
NIST	National Institute of Standards and Technology
OSHA	Occupational Safety and Health Administration
PPE	Personal Protective Equipment
PRG	Preliminary Remedial Goals
RSI	Removal Site Inspection
RMC	Risk Management Criteria
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RCWD	Rand Community Water District
RCRA	Resource Conservation and Recovery Act
RSI	Removal Site Inspection
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
STLC	Soluble Threshold Limit Concentrations
TPH	Total Petroleum Hydrocarbons
TTLC	Total Threshold Limit Concentrations
USFWS	U.S. Fish and Wildlife Service
WET	California Waste Extraction Test
XRF	X-ray Fluorescence Spectroscopy

1.0 INTRODUCTION

The U.S. Department of Interior, Bureau of Land Management (BLM) prepared a Phase I Removal Site Inspection (RSI) for the Kelly Mine and associated mine waste sources near Red Mountain, California. This RSI has been prepared in accordance with the criteria established under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), sections of the National Contingency Plan (NCP) applicable to removal actions (40 CFR §300.415 (b) (4) (1)).

The purpose of this RSI was to identify the activities that were conducted to: (1) map the mining and site features, (2) characterize the nature of any hazardous process chemicals that remain at the site, (3) characterize the nature and lateral extent of contamination in mine tailings and waste rock dumps, and (4) collect data to determine whether or not a time-critical or non-time critical removal actions was necessary. Because of the size and complexity of the site and because of the potential for offsite migration, BLM refers to the work in the RSI as a Phase I action recognizing that additional work may be necessary to support a long term site remedy.

The RSI included six principal waste source areas in the investigation, which are identified in Figures 2 and 3. All of the identified areas are on BLM lands administered by the BLM Ridgecrest Field Office. Area 4 contains tailings that have been released from Kelly Mine tailings pond onto adjacent private residences and across U.S. Highway 395 into Red Mountain Wash. Area 7 was later defined as several off-site rock dumps near Red Mountain. BLM did not sample on private land. Area 1 is the tailings just west of Red Mountain, and Area 2 is the mill area. Area 3 is a ridgeline southwest of Area 2. Area 4 consists of tailings in Red Mountain Wash that migrated from Kelly Mine Area 1. Area 5 is the lower Barkley Mill tailings, and Area 6 is the upper Barkley Mill tailings. Area 7 is not contiguous, but was added during the field work to include scattered waste rock dumps in the community of Red Mountain and north of Red Mountain Road located on BLM administered land.

The following sections describe the site characterization and sampling activities and results, and include a streamlined risk assessment and recommendations.

2.0 SITE HISTORY AND SITE DESCRIPTION

2.1 Site Location and History

The Kelly Mine site is located near the community of Red Mountain in San Bernadino County, CA at approximately 35°21' 30"N, 117°37' 00"W (WGS84/NAD83) on the USGS Red Mountain Quadrangle, (Figure 1). It was formerly called the California Rand Silver Mine and was the most significant silver mine in California the early to mid 20th century. The site is approximately five miles north of Atolia on U.S. Highway 395. For the purposes of the preliminary investigation, the site was defined to include the area shown in Figure 1, including parts of Sections 6, and 7, T29S, R41E, and Section 1, T29S, R40E.

According to BLM records, initial mining operations were begun at the Kelly Mine in 1919. By 1921, the complex included an assay office, a storehouse, a compressor room, a change room, a hoist house, and approximately 12 cottages for the miners. Construction of the mill was begun in 1921 in order to process the ore on site. Occasional use of the complex continued from 1926-1929; the corporation was dissolved in 1930; mining was carried out by various lessors 1930s. Mining was conducted on a sporadic basis in the 1930-1940s however, recovery levels never reached the levels in the original “find”. In the 1960s, a number of speculative ventures were carried within the complex, with machinery and equipment brought in from other mines to insure investors that the mine was economically viable. The present mine configuration contains 56 features and two isolates.

Red Mountain was a booming mining district in the early 1920's. There are currently about 300 residents between the three mining towns, including about 100 in Red Mountain. The original name of Red Mountain was Osdick, named after one of the original miners. The town was an active and social center for the mining district in the 30's. Red Mountain is part of the Randsburg Mining District which includes Randsburg and Johannesburg. Highlights of the Randsburg mining history (Jack H. McGinnis, http://www.ghosttowns.com/states/ca/redmountain.html:

1895 April 25th, gold was discovered by three men, C.A. Burcham,F.M. Mooers And John Singleton. The place was Called "Rand Camp" Later Called "Yellow Aster Mine".
1896 Population 1500; first official post office on April 16,1896.
1897 First Bank was in Randsburg, first grammar school
1898 Yellow Aster Mine built a 30 stamp mill; Randsburg Railroad from Kramer junction
1899 Orpheum theatre was built.
1900 Newspaper reports $3,000,000.00 in gold taken out.
1901 New grammar school, new 100 stamp mill.
1903 Labor strike at Yellow Aster Mine.
1904 Present Santa Barbara Church built in Randsburg; old one burned.
1905 Tungsten discovered in Atolia 5 miles south on Hwy 395.
1911 Yellow Aster Mine took out $6,000,000 in gold.
1912 Mine has been in continuous operation for 17 yrs.
1913 Charles A. Burcham Dies.
1914 John Singleton died in May leaving only Dr. Rose Burcham as the sole surviving member of the Yellow Aster Mine.
1915 Dave Bowman found a gold nugget in Red Rock Cajon that sold for $1,979.

Al Wiser and Charles Koehn found nugget at their mine near Red Rock Cajon and Las Chance Canyon Rd. Tungsten boom in Atolia again: 2,000 people in Atolia.
1917 WWI took many people away from the mines and the flu epidemic also took its toll.
1918 Silver in large amounts found in what is now Red Mountain. A boom was on, the Kelly mine (stamp mill still visible) was the biggest producer. Mining creates another boom.
1922 The Post Office was established as Osdick (later called Red Mountain).
1933 The Randsburg Railroad, bought by the Santa Fe in 1903, discontinues operation.
1935 Randsburg and Red Mountain are doing very well.
1930's Red Mountain was an active liquor area during Prohibition and had many brothels.
1942 All gold mining is stopped in the US.
1984 With gold prices high, miners are trying again in the area.
1998 Rand's Mine is operating. The Silver Dollar and the Owl are still inhabited.

2.2 Structures/Topography

A 360 degree video clip of the site is found at: http://virtualguidebooks.com/SouthCalif/SouthernDeserts/RandMiningDistrict/AboveRedMountain.html. The average elevation of the site is 3,600 feet above mean sea level. BLM is performing aerial mapping of the site to better characterize site features and extent of contamination.

The site is located between the Rand Mountains to the west and Red Mountain to the east. Red Mountain consists of Tertiary sediments of continental origin which are capped by later flows of andesitic lavas. The major structures associated with this Red Mountain Mining District are shown in Figures 2 and 3 and include numerous shafts, head-frames, tanks, access roads, mill and auxiliary buildings, numerous waste rock dumps, and tailings ponds. Major shafts are the Highway 395 shaft, and the Kelly shaft, but there are at least five additional shafts in Area 2. Area 2 also contains the mill building, the hoist building and several other structures. Area 2 has two large waste rock dumps. Tailings in Areas 1 and 4 are from the Kelly Mine. Tailings in Areas 5 and 6 are from the Barkley Mine which is reported to have been a tungsten mine. Area 6 also contains an old mill foundation and five mostly empty tanks.

Except for mine pits, there are no permanent surface water features on the site. However, there are many ephemeral drainages within the project boundaries. As many as 100 residences are shown on the Red Mountain Mining District USGS 7.5' Quadrangle and the 2002 aerial photograph. Most of the residences are on private property, but up to seven are located on BLM-administered land. Water is supplied to the community of Red Mountain Rand Communities Water District. There are two non-used water wells in Red Mountain.

2.3 Geology, Ore Deposits and Hydrology

The Rand Mountains are composed of flat-lying schists, which have been intruded by a later batholith of quartz monzonite and by later series of shallow dikes of diabase and rhyolite-latite. The poorly consolidated Rosamond series, continental in origin and consisting of stratified conglomerates, feldspathic sandstones and clays, either outcrops or underlies deposits near Red Mountain. Beds of the lake derived Rosamond series underlie area covered by the lavas of Red Mountain. Geological structure is complex near Red Mountain. Near Johannesburg, strata dip northeast at ten to 20 degrees, but one mile south near Red Mountain, they lie flat. There is a closed synclinal basin two miles southeast of Johannesburg near the location of the Big Four shaft which had penetrated 1,100 feet in 1925. The shaft penetrates beds of the Rosamond series and at 1,100 feet, strata dipped west at 55 degrees. Silver mineralization occurred during deposition of the Rosamond. Overlying the Rosamond series with angular unconformity is a thick series of igneous rocks consisting of igneous rocks with lava flows but with prominent amount of agglomerates and tuffs, called andesite (Hulin, 1925).

According to Hulin (1925), the California Rand Silver Mine (Kelly Mine) opened in 1919 exploiting an outcrop of cerargyrite. In 1925, it was owned by California Rand Silver Company of Bakersfield. Work focused on the Shaft Vein that was 17 feet by 22 feet by 75 feet deep. Subsequently, 40-50 shafts were sunk within a one mile radius to exploit this deposit. A 100 ton flotation nill was constructed in 1921; later improvements increased capacity to 400 tons per day. The mine had seven miles of drifts and crosscuts. Principal shafts were the No. 1, No. 2 and the No. 6. The No. 1 shaft is 2-compartmented and inclined at 73 degrees following the dip of the Shaft vein. In 1925, it extended through vein material and schist 11 levels down to 660 feet below ground and was dry at the bottom. The No. 2 shaft is also 2-compartmented and in schist, but is vertical extending to 14 levels and 1003 feet in 1925. The No. 1 and No. 2 shafts are shown on Figure 2. Water was struck at 715 feet below ground. The No. 6 shaft on the northern part of the property was single compartmented and extends 785 feet with a “little” amount of water. Hulin’s mine maps show this in the area of the Claire Mine rock dumps. The No. 6 entered schist at 560 feet below the collar with the material above being Rosamond sandstones. In the five years through March 30, 1924, over 10 million ounces of silver and 30,000 ounces of gold were produced, worth over $10 million in 1924 dollars. Mining gradually slowed, then stopped during the 1940s.

The site is located in a small drainage area of about 200 acres above the site. Drainage is to the east and southeast into the normally dry Red Mountain Wash. Red Mountain Wash flows south or southeast eventually into Cuddeback Dry Lake, approximately ten miles distant. Tailings may have been transported down these drainages, but the Phase 1 investigation only included BLM administered land within 1 mile of Red Mountain.

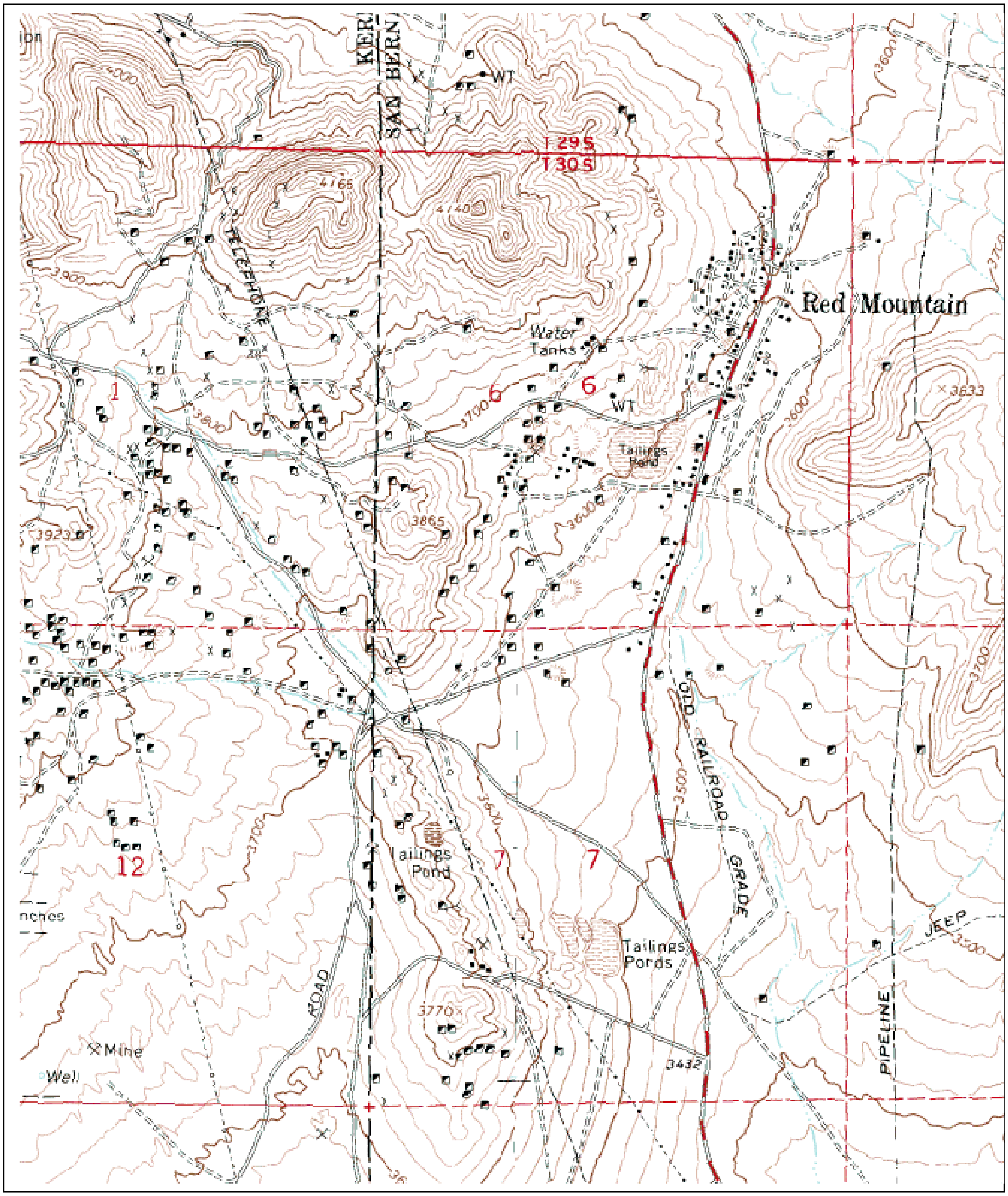

Figure 1. Red Mountain Site Location Map

2.4 Surrounding Land Use, Populations and Water Supply

Areas 1 and 2 are bounded by Kelly Road on the south and Red Mountain Road on the north, the town of Red Mountain on the east and a detached residential area on the west. Areas 3, 4, 5 and 6 are bounded by BLM administered land or private patented land. The small community of Red Mountain with approximately 100-200 persons is located adjacent to the site on the east and west. At least 10 town lots abut the site on the east of Area 1 and seven residences abut the site on the west. There are large rock dumps in these areas that are not in the study area. A major highway, U.S Highway 395 bisects the site. The Rand Mine, a modern closed cyanide leach mine is located about one mile west of the Kelly Mine on the other side of a divide.

The Rand Community Water District (RCWD) provides water to Red Mountain for drinking water purposes. RCWD never used any water in the Red Mountain/Randsburg area. According to Chris Kelly, Manager of the Rand Community Water District, they had “nothing to do with the water since they took over the wells in the late 1960’s early 1970’s” (Kelly, 2006). He stated that their previous water company also did not use the water in the Red Mountain Area. According to Mr. Kelly, everyone in the communities of Red Mountain, Randsburg and Johannesburg, are on the Rand Community Water District’s system and no one uses a private well. The only known private well is the abandoned Airport Well located about 1 mile northeast of Red Mountain. This well was last tested in late 1980’s and the arsenic concentration was 0.11 ppm (according to Jay Friel occupant on the site). Arsenic has been detected above EPA maximum contaminant levels in one RCWD well #2 at 9.2 mg/L in 2002 (Kelly, 2006).

The valley west of Red Mountain contains poor quality groundwater at depths of several hundred feet in gravels and that mining and milling groundwater was supplied from an area north of Red Mountain in Red Mountain andesite. Groundwater in Red Mountain area was greater than 700 feet (Hulin, 1925). Groundwater depth at the Rand Mine fluctuates at around 350 feet below ground surface, according to reports from Hargis Associates in 1997-1998 (Hargis Associates, 1998).

2.5 Sensitive Ecosystems

The site is situated in the Mojave desert and there are no streams in the area. According local reports, the endangered desert tortoise and Mojave ground squirrel occur in this area. The U.S. Fish and Wildlife Service visited the site during the February field work to search for tortoise sign, but none was found. However, the tortoise is in hibernation during this time of year.

2.6 Meteorology

The climate in the area is typified by low annual precipitation, hot summers, and cool winters. Climatological data for Randsburg shows the yearly average maximum temperature to range to 98.3° Fahrenheit in July, and yearly minimum temperatures at 35.7°F in January. Average annual precipitation is listed as 6.26 inches per year with 3.3 inches of snow, (http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?carand+sca). Winds blew from the northeast during the field work. However, the normal wind direction is out of the southwest to west.

2.7 Site Waste Characteristics

Previous reconnaissance tailings sampling at the site was conducted by BLM in December, 2005. These results showed high arsenic concentrations ranging to 4700 mg/kg. Although only limited previous site characterization work has been conducted prior to the RSI, it was expected that the tailings dumps contains high concentrations of metals (arsenic, and lesser concentrations of antimony, copper, and zinc), waste rock piles may also have similar contaminants.

2.8 Previous Investigations

During the December 2005 site reconnaissance, BLM personnel collected seven waste rock and tailings samples for metals analysis. Arsenic averaged 2780 ppm (Attachment 1).

2.9 Cultural Investigations

In 1996, a cultural study was performed for the Kelly Mine and is considered eligible for the National Register of Historic Places under criteria A, C, and D. Attachment A contains a cultural report. However, because of the illegal removal of most of the mining artifacts of historical value, the eligibility for the registry is in question.

3.0 SITE CHARACTERIZATION

The RSI field investigation was conducted to obtain the data necessary to: complete a removal site inspection and characterize any waste chemicals for removal, if required; determine the impact, if any, to surface water from mining activities; and characterize the nature of the wastes to evaluate human and ecological risks.

Field work was conducted during February 13-19 (2006) time period and included collection and analyses of tailings and waste rock samples from the site, and mapping site features. These sampling activities are described in detail in the sections to follow. The sample locations are provided in Figures 5 and 6.

All environmental and waste source samples were collected in accordance with the criteria specified in the following documents: *Compendium of ERT Soil Sampling Procedures (EPA/540/P-91/006)*; *Compendium of ERT Surface Water and Sediment Sampling Procedures (EPA/540/P-91/005)*; *Compendium of ERT Waste Sampling Procedures (EPA/540/P-91/008)*. In general, surface soil samples were collected using stainless steel trowels or disposable/single-use sampling equipment, while subsurface soil samples were collected via a hydraulic push Geoprobe of Soilprobe Inc. of Tulare, CA.

3.1 Data Quality Objectives

The data quality objective (DQO) process is a series of planning steps based on the scientific method that is designed to ensure that the type, quantity, and quality of environmental data used in the decision making are appropriate for the intended purpose. DQOs specify the quality of the data necessary to support evaluation of risk in the human health and ecological risk assessments (RAs) and the decision making process (EPA, 1987). DQOs in general reflect the uncertainty in the data that is acceptable for each specific activity during the investigation. This uncertainty includes both sampling error and analytical instrument error. The ideal level of uncertainty is zero; however, the variables associated with the sampling and analytical processes inherently contribute to some overall uncertainty in the data. The objective of quality assurance and quality control (QA/QC) is to assure that the uncertainty of the generated data is within an acceptable range that will allow proper evaluation of the Site through the collected data.

Different intended uses of data require different levels of analytical and sampling certainty. In order to achieve the objectives of the PA/SI, specific data quality requirements are specified, where appropriate, throughout the QAPP. Section 3 of the QAPP provides the specific quality assurance objectives for the field and laboratory measurement data (BLM, 2004).

Appropriate quality levels have been specified for the PA/SI analytical data to be collected. The following definitions of analytical levels were used for this project:

- Level I - This analytical level applies to field screening or analysis using portable instruments. Results often are not compound-specific; however, they can be quantitative or qualitative. The results are available in real time. This level is the least costly of the analytical options. Field measured pH, specific conductance (SC), and dissolved oxygen, and air borne particulates all represent analytical Level I for the R1/FS activities.

- Level II – This analytical level is characterized by the use of portable analytical instruments (e.g. portable x-ray fluorescence spectrometers) that can be used on-site or in mobile laboratories stationed near the Site (close-support laboratories). Depending upon the types of contaminants, sample matrix, and personnel skills, qualitative and quantitative data can be obtained.

- Level III - Under this analytical level, all analyses are performed in an off-Site analytical laboratory using standard EPA methods (e.g., SW-846 Test Methods for Evaluating Solid Waste (Third Edition), referred to hereinafter as SW-846, EPA methods for chemical analysis of water, and ASTM methods for geotechnical laboratories). One laboratory, ALS Chemex does not use EPA methods and samples were split with ACZ Laboratory using EPA Methods for comparative evaluation.

To meet the PA/SI investigation goals and to obtain sufficient quality data for the evaluation of the Site in its present condition, soils and mill residue samples were also collected. Each media was analyzed to obtain Level II or III data. Level I field screening of various media and physical data will also be used to help define the nature and extent of wastes and potential migration pathways. Data types, analytical levels, and data uses for the PA/SI are summarized on Table 1-1 of the QAPP. Analyses were used to determine concentrations of chemicals of potential concern (COPC).

Levels II and III reflect the need for high quality data that can be documented as being representative of Site conditions. This level is necessary to evaluate the Site for the quantitative analysis in risk assessment and to be able to evaluate Site conditions in terms of certain potential Applicable and Relevant or Appropriate Requirements (ARARs). For soils, the DQO was to attain 25 ppm arsenic detection limit for XRF and >0.9 R^2 with laboratory confirmation splits. The DQO process is further discussed in the Quality Assurance Project Plan (BLM, 2004). Based on the objectives of this investigation, data collected during the course of this project will satisfy Level III requirements. The specific USEPA analytical methods for chemical analyses that have been selected are as follows:

Process Wastes (if any):
- EPA SW-846 Method 1010 - Flash Point
- EPA SW-846 8015 - Total Petroleum Hydrocarbons (TPH)
- EPA SW-846 Method 9040B - pH

Tailings and Waste Rock:
- EPA Method 335.1 - Total Cyanide – Soil or water
- EPA Method 200.7 - Total Metals, Dissolved Water
- EPA Method 245.1 – Mercury Dissolved Water
- EPA Method 6010 – Total Metals in soil
- ALS Chemex ICP/MS – Total Metals in soil
- EPA Method 6200 - Field Portable X-ray Fluorescence Spectrometry
- Acid Base Accounting, pH and Lime Requirement – EPA Sobek
- California WET Test with deionized water extraction
- Bio-accessibility per method of Ruby (1994).

The California WET test was performed to measure leaching. Since the tailings and waste rock >500 m/kg was California hazardous anyway, it was recommended by Greg Roller (2006) not to do the aggressive extractant specified in the WET and replace it with an extractant similar to precipitation.

Upon collection, samples were immediately placed in an appropriate container. The sample containers were then labeled and prepared for shipment to the appropriate analytical laboratory or stored for later XRF analysis. The information provided on the sample labels included: time and date the sample was collected; sampling location; preservative used; initials of person who collected the sample; and a unique sample number. Finally, all sampling activities and locations were recorded in the field notebook. Samples were shipped to ALC Chemex in Sparks, Nevada and ACZ Laboratories in Steamboat Springs, CO.

Because of the large area of the site, the site was categorized according as waste rock dumps or tailings and depth samples were obtained as follows:

1. Waste rock dumps – each major dump area was sampled using the test pit composite. The sample was collected from near vertical test pits at the toe of the waste rock dump. A vertical channel was sampled every six inches to make a 1 kg composite. This deviation from the Sampling and Analysis Plan was decided in the field because of the large size of the waste rock dumps would not have generated enough samples. Approximately 61 representative samples from the dumps were collected and sieved to <2 mm.
2. Tailings – each tailing pond was gridded on 200 foot centers, depending on size of the pond. Samples were collected from 0-2 inches. Depth samples were collected every two feet from an east-west transect in Area 1 using a Geoprobe, and in Areas 4, 5 and 6. In addition to the discrete samples, one composite sample was prepared for each Area based on the method of Smith, 2000.

3.2 Opportunity Waste Sampling

No organic process waste was found. No surface water was observed. Twelve opportunity samples were collected from wastes associated with the mill buildings. 2-Sump-1 was collected from wet sumps in the mill building and 2-OP-3 consisted of tailings residue near a former vat adjacent and just east of the mill building where bluish streaks indicated the potential for cyanide. Opportunity samples were collected in Areas 2 and 6 as follows:

- 2-Sump-1
- 2-OP-1 white pile SW of mill
- 2-OP-2 S of mill pile
- 2-OP-3 E of mill at vat leach depression with bluish cyanide streaks
- 2-OP-4 pile N of mill
- 2-OP-5 coarse, acidic yellowish pile adjacent to N side of mill building
- 2-OP-6 from smelter or retort W of mill building
- 6-OP-1 tank bottom
- 6-OP-2 upper pile
- 6-OP-3 barrel
- 6-OP-4 lower small pond

3.3 Mine Waste and Soil Sampling

Samples were collected from the tailings and waste rock for metal analysis using a calibrated portable Niton 702 X-ray Fluorescence (XRF) bulk analyzer. The 6 waste units that are on BLM land are visible on the 2002 aerial photos. Area 3 was not systematically sampled because of its distance from town and inaccessibility. This area consists is a steep ridge (Lion's Head Ridge) with numerous shafts and waste rock dumps and has an indefinite boundary with private land. Table 3 describes the units, grid size and number of samples. Transects were established across the tailings on 200' centers using a laser rangefinder or measuring wheel.

The XRF sample preparation was performed according to EPA Method 6200 except a #10 sieve was used instead of a #60 sieve. Care was taken to ensure that all biotic matter (i.e., roots, plant material, etc.), was removed prior to analysis, that the sample is dried and that the sample is representative of actual waste. If the sample was moist, it was dried prior to sample preparation and analysis. For the 5 units, 27 laboratory confirmation split samples, including two background samples for each of the 5 waste units, were collected and sent to ALS Chemex and/or ACZ Laboratory, Table 3. These steps was taken to ensure that the most accurate and precise results are generated by XRF analyses.

In addition, at least one composite sample for each waste unit was submitted to ACZ Laboratory for the following additional analyses:

- Deionized water WET analysis to estimate leaching concentrations and to determine leaching characteristics and if waste were to be shipped offsite, if it is California hazardous, and
- Total Metals (split with Chemex)
- pH
- Total cyanide
- Bioaccessibility via Dr. John Drexler, University of Colorado.

Composite tailings samples were sampled via the USGS method of Smith, 2004. This involved collecting 30 representative grab samples within the unit, compositing and sieving them through a 2 mm sieve to attain 1 kg. The sample is analyzed for parameters in Table 4. The same procedure was performed for the WET with a deionized leach (Reller, 2006) and pH tests using one composite from each site. Analyzing split samples in Table 3 via Chemex and ACZ added internal consistency and confirmation among methods.

Table 1: Sample Summary

Unit	Description	Approximate Area (acres)	Surface grid or depth	XRF Samples	Splits (Chemex)	Splits (ACZ)
1	Surface tailings near town	13	4x5	22	3	1
1	Tailings near town		Depth	15		
2	Surface mine complex W of Unit 1	25	5x6	30	3	1
2	Waste rock dumps		Depth	36		
3	Waste rock dumps		Depth	7		

4	Red Mtn. Wash tailings	6	13x3	39	3	1
4	Red Mtn. Wash tailings		Depth	8		
5	Tailings 2 mi. S of town	9	5x5	24	3	1
5	Tailings 2 mi. S of town		Depth	4		
6	Tailings W of Area 6	4	3x5	15	3	1
6	Tailings W of Area 6		Depth	6		
7	Waste rock dumps	3	Depth	12	1	
2,6	Opportunity		Surface	12	1	1
Bkgd	2 per area		Surface	10	10	
Total				249	27	6

[1]Surface samples unless otherwise indicated

Table 2: Laboratory Sampling Summary

Sample	Total Metals	Total CN	CA-WET	pH	Bioaccess
Mine Waste	27*	6^	6^	6^	5

*Analyzed by Chemex; ^6 were split and analyzed by ACZ.

All laboratory samples were sent via Federal Express under proper chain of custody. 27 samples were sent to ALS Chemex in Sparks, Nevada and six samples were sent to ACZ Laboratory in Steamboat Springs, Colorado on February 18, 2006.

3.5 Supplemental Activities

In addition to the proposed sampling activities, data was collected for the following:

- size and volume of each waste area
- reconnaissance inspection of any mill buildings for lead paint, asbestos and transformers. None was observed. A transformer cage was observed near the mill, but all transformers had been removed. No soil staining was present.
- particulate air monitoring. On February 15, data was conducted continuously onsite using a MIE DataRam with detection limits to 0.001 mg/m3. The time-weighted average for the afternoon was 0.05 mg/m^3.

In addition, all grid perimeter sampling locations was recorded with a global positioning unit and sketch maps noted in the field notebook. A topographic survey of the site is underway. Site participants during the field work included representatives from the San Bernadino HazMat team, Kern County HazMat Team, Department of Toxic Substances Control, Mine Exploration Inc., TetraTech, USGS, Soilprobe Inc, equipment operators backhoe contractor, and BLM personnel.

3.6 Quality Assurance/Quality Control

Quality assurance and quality control samples were collected to ensure the integrity of the XRF sampling data. The QA/QC samples will consist of confirmation replicate samples collected at mine waste. Confirmation or replicate samples were collected to provide a check on the accuracy of the XRF analyses using linear regression per Method 6200. Blanks, certified standards and precision samples were analyzed to check for sampling and analytical reproducibility per Method 6200.

4.0 DISCUSSION OF RESULTS

Figures 3 and 4 identify the approximate sample locations. The GPS locations will be accurately plotted when the site has been surveyed. Table 3 shows the XRF analytical results and Table 4 shows quality assurance sample results. Arsenic and antimony are the chemicals of potential concern. For arsenic, the range of the concentrations were less than the limit of detection (<LOD) to 8134 mg/kg. Table 3 also shows California Total Threshold Limit Concentrations (TTLC) which are by definition California hazardous waste. Arsenic consistently exceeded the TTLC in Areas 1, 2 and 4.

Sulfur is elevated in Area 1 and 2 samples, and the waste rock sample from Claire Mine CM-NW-1, averaging 0.83 percent, suggesting acid generating conditions. Samples from Area 5 and 6 are high in tungsten, averaging 920 mg/kg. The following sections summarize the XRF and laboratory results for the background samples and each area. Refer to Attachment 2 for photographs of the areas.

4.1 Background

Table 5 shows laboratory results for the ten background samples averaged 136 mg/kg arsenic, 8 mg/kg for antimony and 9.3 mg/kg for tungsten. As shown in Table 3, These levels are considerably higher than for soils of the western United States (Shacklette and Boerngen, 1984), confirming the area is mineralogically enriched. Arsenic and antimony are elevated above local background at Areas 1, 2 and 4, and tungsten is elevated at Area 5 and 6 based on laboratory results.

4.2 Area 1

Area 1 consists of a tailings pond with a dam on the east side made of tailings. The tailings are light tan and support little vegetation. The dam has breached, carrying tailings to the east across private property near the 395 Shaft, see photographs. The area of the Area 1 tailings is approximately 13 acres. The tailings were 0 to 20 feet in depth based on the sampling, with an average depth of approximately 12 feet. Three Geoprobe borings were taken in Area 1 to represent an east-west cross section through the middle of the tailings. The locations were 1BB, 1-2B, and 1-3B. Tailings depth at these locations was: 3 feet, 15 feet, and 12 feet respectively; depth at the eastern face of the dam is about 20 feet. The samplers stopped collecting soil cores when lithology refusal was encountered, suggested native soils.

Some samples at the Area 1 perimeter did not capture the horizontal extent of contamination in all directions. Fence-line samples adjacent to the residential areas are 4A, 4B, 4C, 4D, and 4Z and these ranged from 481 to 1350 mg/kg arsenic. Table 3 shows the arsenic results over the grid and at depth. Using the grid discrete samples, the mean XRF arsenic concentration for this area is 852 mg/kg. The composite arsenic result for this area is 1709 mg/kg, while the laboratory result is 1425 mg/kg. Theoretically, these values should be similar and the difference must be due to the method of compositing or possible laboratory error, although the other area four composites are similar to the mean of the discrete samples (see below). The mean arsenic concentration of the ten background samples was 136 mg/kg (ppm), hence Area 1 exceeds background by 7-12 fold.

Using 136 mg/kg arsenic as a background concentration threshold and the XRF data and an average depth of ten feet, it is estimated that approximately 215,000 cubic yards +/- 20% are present. Further sampling may be needed to refine this estimate.

4.3 Area 2

Area 2 is the mine complex for Kelly Mine containing as many as eight shafts, mill buildings and waste rock dumps. Attachment A contains a detailed sketch map of this area. The area of the Area 2 mine waste is approximately 23 acres. Area 2 contains shrubby vegetation and sparse grasses. Three types of samples were collected: surficial grid and opportunity samples, and waste rock samples. Table 3 shows the arsenic results over the grid and at depth. Using the surficial grid and opportunity discrete samples, the mean XRF arsenic concentration for this area is 926 mg/kg. About 40% of this area appears to be native soils that are contaminated at the surface; the rest is covered by rock dumps. The composite arsenic result for this area is 975 mg/kg. The mean arsenic concentration of the ten background samples is 136 mg/kg, hence Area 2 exceeded arsenic background by about 7 fold. Nearly all of the grid surficial samples at the perimeter captured the horizontal extent of contamination in all directions. The residential area to the west of Area 2 fell below background arsenic concentrations except for 2-3A and 2-4A which had 211 and 290 mg/kg, respectively. The highest surficial concentrations were around the mill and adjacent areas to the north and east, with a maximum arsenic concentration of 5747 mg/kg from 2-OP-5 just north of the mill.

The waste rock is flat-topped ranging from 0 to 30 feet in depth, with an average of 25 feet based on the visual observations. The area of the Area 2 waste rock dumps is approximately 15 acres and areas and volumes of the other dumps will be determined if necessary in a Phase II investigation. For above-ground waste rock, the samplers collected composites from the vertical length of the test pit which ranged from 4-12 feet in depth. Using the grid and opportunity discrete samples, the mean arsenic concentration for this area is 2038 mg/kg or about twice as great as the surficial grid samples, and background is exceeded by about 15-fold. Using 136 ppm arsenic as a threshold and the XRF data and an average depth of 25 feet, it is estimated that at least 595,000 cubic yards +/- 20% are present. Further sampling may be needed to refine this estimate. While the waste rock is less subject than tailings to wind and water erosion because of its coarse texture, there is evidence of leaching based on white efflorescent salts accumulating on the surface.

Area 2 was found to have 6 open shafts and the Glory Hole noted in Figure 2. The Glory Hole is approximately 120 feet in diameter and about 70 feet in depth. Several mine openings are apparent in the bottom of the Glory Hole. It is unclear if the area has subsided, but the surface shows piping, tension cracks and evidence of caving. A fence is present, but it is mostly down and ineffective in preventing access.

4.4 Area 4

Area 4 tailings originated from Kelly Mine and migrated into Red Mountain Wash from the Area 1 tailings pond via a breach in the Area 1 dam. The area of the Area 4 tailings is approximately 6 acres, ranging from 100’ to 400’ feet in width and 2600’ in length along Red Mountain Wash.

The tailings are white to light tan, exhibit surface efflorescent salts and support little or no vegetation. BLM believes additional tailings exist downstream in Red Mountain Wash, but they were not a focus in the Phase I investigation. The tailings were 0 to 4 feet in depth based on the sampling and visual observation. In the lower third of Area 4, there are several test pits where it appears persons may have been testing the material. However, the samplers stopped collecting soil cores when lithology refusal was encountered, suggested native soils. Table 3 shows the arsenic results over the grid and at depth. Using the grid and opportunity discrete samples, the mean XRF arsenic concentration for this area is 907 mg/kg. The composite arsenic result for this area is 1240 mg/kg. The mean arsenic concentration of the ten background samples is 136 mg/kg, hence this area exceeds background by 9-10 fold. Nearly all of the grid surficial samples at the perimeter captured the horizontal extent of contamination in all directions. One small area north of the grid was not sampled, because it was hard to find. Using 136 ppm arsenic as a threshold and the XRF data and an average depth of four feet, it is estimated that at least 46,000 cubic yards +/- 20% are present. This is a minimum bound on the amount of tailings released from Kelly Mine. Further sampling may be needed to refine this estimate, especially down gradient of Area 4.

4.5 Area 5

Area 5 consists of tailings from the Barkley Mill (located in Area 6), a tungsten mine according to the mine claimant. Area 5 has an open shaft located near grid sample 5-2E. The area of the Area 5 tailings is approximately 9 acres. There are actually two impoundments, with samples 5-2B, 5-2C, and 5-2D being in the uppermost impoundment and samples 5-3B, 5-3C, 5-3D, 5-4B, 5-4C, and 5-4D in the lower impoundment. The tailings do support greasewood and other shrubby vegetation and some grasses. The tailings dam is 40 feet in height and is made of tailings. The dam has been breached (see photographs) and some tailings appear to have migrated toward Highway 395. The tailings were 0 to 8 feet in depth based on the sampling, but are deeper to the east where Geoprobe could not access. However, the samplers stopped collecting soil cores when lithology refusal was encountered, suggested native soils. Some samples at the perimeter are believed to capture the horizontal extent of contamination in all directions, but this is not ascertainable by arsenic concentrations which are low. Table 3 shows the arsenic results over the grid and at depth. Using the grid and opportunity discrete samples, the mean arsenic concentration for this area is 65 mg/kg. The mean XRF arsenic concentration of the ten background samples is 136 mg/kg. The composite arsenic result for this area is 96 mg/kg, hence this area does not exceed background. Tungsten concentrations from the laboratory sample composite was 350 mg/kg and exceeds tungsten background for Areas 5 and 6 of about 2 mg/kg. Using the XRF data and an average depth of ten feet, it is estimated that at approximately 144,000 cubic yards +/- 20% are present. Further sampling may be needed to refine this estimate.

4.6 Area 6

Area 6 consists of mine workings (five tanks and an old foundation) and tailings from the Barkley Mine, a tungsten mine according to the mine claimant. No shafts were observed. There is no real dam in Area 6, although some small impoundments (dams <2 feet) are located in the northeast quadrant. The area of the Area 6 tailings is approximately 6 acres, including the mill and tank area at the top and west end. The tailings are white to light tan and support little vegetation. The tailings were 0 to 8 feet in depth based on the sampling. However, the samplers stopped collecting soil cores when lithology refusal was encountered, suggested native soils. Samples at the perimeter appear to capture the horizontal extent of contamination in all directions, but this is not ascertainable by arsenic concentrations which are low. Table 3 shows the arsenic results over the grid and at depth. Using the grid and opportunity discrete samples, the mean arsenic concentration for this area is 148 mg/kg. The composite arsenic result for this area is 147.5 mg/kg only slightly exceeding local background of 136 mg/kg. Tungsten concentrations from the laboratory sample composite was 840 mg/kg and far exceed tungsten background for Areas 5 and 6 of about 2 mg/kg. Using 136 ppm arsenic as a threshold and the XRF data and an average depth of six feet, it is estimated that at least 30,000 +/- 20% cubic yards are present. Further sampling may be needed to refine this estimate.

4.7 Area 7

Area 7 is not contiguous, but is a loose category consisting of isolated waste rock dumps in the community of Red Mountain (Claire Mine, 395 shaft), Uranium Claim west of Area 2 and the Big Dipper mine north of Red Mountain Road north of Areas 1 and 2. The 395 Shaft is located within 30 feet of Highway 395 in the center of town and is reported to be 1,600 feet deep. BLM recently placed emergency fencing around the shaft. The waste rock dumps in town had arsenic concentrations much higher and lower than this average. The Claire Mine had a maximum arsenic concentration of 7718 mg/kg on the northwest side, but waste rock associated with the 395 Shaft had an arsenic maximum of 814 mg/kg. The volume of the 395 Shaft dump was estimated at 5,000 +/- 20% cubic yards and the volume of the Claire Mine is approximately 32,000 +/- 20% cubic yards. Arsenic is especially elevated at the Claire Mine averaging 4239 mg/kg.

4.8 Geoprobe Samples

Depth samples from the Geoprobe varied significantly. Refusal depths were as follows: 1-1BB 3 feet, 1-2B 15 feet, 1-3B 12 feet, 4-1B 6 feet, 4-1C 6 feet, 5-2C 8 feet, and 6-2B 4 feet. The only observation that can be made is that the arsenic concentration dropped to background when refusal/native soils were encountered. The tailings at depth were dry and had similar appearance throughout the profile, see photographs.

4.9 Quality Assurance

The XRF data were evaluated for quality assurance per EPA Method 6200. 27 split samples were sent to Chemex Laboratories for confirmation. These results are shown in Table 4. The comparison was made via linear regression per EPA Method 6200. The comparison to the XRF results was very favorable. For waste source samples, the XRF arsenic results were about 1% percent low, and R^2 was 0.983. For background samples, the XRF results were about 20% low, and the R^2 was 0.92. The blanks were acceptable and non-detect for all metals. Based on percent deviation from certified NIST standards, chromium, nickel and mercury detections were rejected, Table 4. The accuracy via the medium concentration certified standard was good for arsenic (%D: -2) and slightly high for the high concentrations standard (%D: 22), but the linear regression of the laboratory split samples was very good and takes precedence.

4.10 Laboratory Analytical Results

For each Area, one composite area-wide surface sample was analyzed via XRF, ALS Chemex, and ACZ Laboratory using EPA Method 6010. ACZ Laboratory results were used to confirm the Chemex results and to provide additional sample analyses on key composite samples (one for each of the five Areas sampled and for sample 2-OP-3. Table 2 shows the comparison of these results using linear regression as specified in EPA Method 6200.

According to speciation work by USGS, the arsenic in Area 1 is arsenopyrite. The hard crust on the surface of the tailings is cemented by gypsum, barite, amorphous silica and magnesium-aluminum silicates. Area 4 arsenic is associated with ferrihydrite. Arsenic in waste rock is associated with pyragyrite (a silver-antimony sulfide). Arsenic bio-accessibility of the area 1, 2, 4, 5 and 6 composites were 24%, 33%, 25%, 8%, and 11% respectively (Drexler, 2006).

5.0 STREAMLINED RISK ASSESSMENT

As lead agency for the site, BLM has conducted a streamlined risk assessment in accordance with EPA's guidance for conducting non-time critical removal actions (EPA, 1993). This risk assessment includes an evaluation of chemicals of concern, exposure pathways and a site conceptual model and comparison to existing standards and criteria.

Mining activities from the Kelly Mine have probably made an impact since the Gold Rush in the 1850s. Tailing generated from area mining activity has contributed acidity and heavy metals into water, stream sediments and soils. The site is visited by recreational users especially on weekends and holidays. Recreational users generally may come into contact with the tailings by several activities and exposure pathways, particularly soil ingestion and inhalation of dust. To address these issues, BLM has published acceptable multi-media risk management criteria (RMCs) for the chemicals of concern (COCs) as they relate to human use and wildlife habitat on or near BLM lands (Ford, 2004). Activities evaluated include camping, boating, swimming, all terrain vehicle (ATV) drivers. The most inclusive and restrictive of these is the camper scenario which assumes a 14-day exposure duration. Campers and ATV drivers may be exposed via soil ingestion and inhalation. Adults may inhale dust during dry periods; they may accidentally ingest soil by hand-to-mouth activities including eating, drinking and smoking; and small children may ingest larger amounts of soil than adults.

The area is used currently for off-road vehicles and hiking and exploring the old mining mill. Recreational demands are expected to increase at the site where exposure to metal concentrations in tailings and waste rock may exist. Dust reportedly blows from Area 1 toward the residential area when off road vehicles are active on the site e.g. weekends and holidays. Figure 5 is the site conceptual model for exposure to mining waste at the site. The COCs for the site were selected by comparing background concentrations and PRGs to the sample results in and around the site. Area 1, 2 and 4 COCs mine wastes are arsenic and antimony; the only Area 5 and Area 6 potential COC is tungsten, but there is no EPA reference dose or PRG for tungsten, hence it was not evaluated further.

Ingesting very high levels of arsenic can result in death. Exposure to lower levels can cause nausea and vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage to blood vessels, and a sensation of "pins and needles" in hands and feet. Ingesting or breathing low levels of inorganic arsenic for a long time can cause a darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso. Skin contact with inorganic arsenic may cause redness and swelling. Several studies have shown that ingestion of inorganic arsenic can increase the risk of skin cancer and cancer in the lungs, bladder, liver, kidney and prostate. Inhalation of inorganic arsenic can cause increase risk of lung cancer. The Department of Health and Human Services (DHHS) has determined that inorganic arsenic is a known carcinogen. The International Agency for Research on Cancer (IARC), and the EPA have determined that inorganic arsenic is carcinogenic to humans (ATSDR 2006).

RMCs for soil, sediment, fish and water protective of human receptors for the metals of concern were developed using available toxicity data and standard U.S. Environmental Protection Agency (EPA) exposure assumptions. Acceptable soil and sediment concentrations protective of wildlife receptors (ecological RMCs) for the metals of concern were developed using toxicity values and wildlife intake assumptions reported in the current ecotoxicology literature.

The COCs and migration pathways were identified from historical information and site evaluation. The COC selection process utilized chemicals documented to have been released to surface water and observed contamination in tailings at the site. Potential receptors, receptor exposure routes, and exposure scenarios were identified from on-site visits and discussions with BLM personnel. Representative wildlife receptors at risk were chosen using a number of criteria, including likelihood of inhabitation, and availability of data.

5.1 Human Health Risk Assessment

There are two types of risk associated with the Kelly Mine Tailings: off-site risk and on-site risk. Off-site risk is associated with releases of tailings into residential areas and Red Mountain Wash that drains the site. Due to a lack of adequate run-on and run-off controls, major flood events appear to have sent sufficient flows to erode the tailings and flush heavy metals-contaminated tailings into a portion of Red Mountain and across Highway 395, and downstream towards Cuddeback dry lake.

Several on-site human risk scenarios were also developed to provide realistic estimates of the types and extent of exposure which individuals might experience to the metals of concern in the water, soils, and sediments on BLM property. Such exposures might occur to individuals who use BLM lands for off road vehicles, hiking, and exploring the mine site. Contamination appears to have migrated from Area 1 to adjoining property.

Sample results were compared to potential ARARs such as EPA Region IX Preliminary Remedial Goals (PRGs) for residential and industrial use and to BLM RMCs for recreational use.

The RMC correspond to either a target excess cancer risk level of 1×10^{-5}, or a target noncancer hazard index of 1.0. In the case of metals posing both carcinogenic and non-cancer threats to health, the lower (more protective) concentration was selected as the RMC. The concept behind the RMC is that people will not experience adverse health effects from metal contamination on BLM lands in their lifetimes, while exposure is limited to soil, sediments, and waters with concentrations at or below the RMC. A target excess cancer risk of 1×10^{-5} means that for an individual exposed at these RMC, there is only a one in a hundred thousand chance that he would develop any type of cancer in a lifetime as a result of contact with the COCs. A hazard index of <1.0 means that the dose of non-cancer metals assumed to be received at the site by any of the receptors in a medium is lower than the dose that may result in any adverse non-cancer health effects. The RMC are protective for exposures to multiple chemicals and media. Lead RMC for the child receptors were determined from EPA's Integrated Exposure Uptake Biokinetic Model (USEPA, 1993) and other EPA regulations and guidance.

5.2 Ecological Risk Assessment

Wildlife in the Kelly Mine area and downstream may be exposed to metal contamination via several environmental pathways. The potential exposure pathways include soil and sediment ingestion, vegetation ingestion, and ephemeral surface water ingestion. Ecological RMCs have been established for metals in soil and sediments. This has been accomplished using the best data available, including: ectoxicological effects data for the metals of concern, wildlife receptors representative of the Mojave ecosystem, body weights and food intake rates for each receptor, and soil ingestion rates for each receptor. The wildlife receptors evaluated for this area are: deer mouse, mountain cottontail, and bighorn sheep.

The literature was surveyed for toxicity data relevant to either wildlife receptors at the site or to closely related species. In the absence of available toxicity data for any receptor, data were selected on the basis of phylogenetic similarity between ecological receptors and the test species for which toxicity data were reported. Soil ingestion data for each receptor were obtained from a recent study on dietary soil content of wildlife from the U.S. Fish and Wildlife Service (Beyer, et. al., 1994). Where no dietary soil content data were available for a particular receptor, the soil content was assumed to be equal to that of an animal with similar diets and habits. The amount of soil ingested by each receptor was estimated as a proportion of their daily food intake (Beyer, et. al., 1994). The food intake in grams for each receptor was calculated as a function of body weight (Nagy, 1987).

RMC were calculated for each chemical of concern in soil based upon assumed exposure factors for the selected receptors, and species- and chemical-specific toxicity reference values (TRVs). Essentially, the TRVs represent daily doses of the metals for each wildlife receptor that will not result in any adverse toxic effects. TRVs were computed by metal of concern for each wildlife receptor/metal combination for which toxicity data were available. Phylogenetic and intraspecies differences between test species and ecological receptors have been taken into account by the application of uncertainty factors in derivation of critical toxicity values. The uncertainty factors were applied to protect wildlife receptors which might be more sensitive to the toxic effects of a metal than the test species. The uncertainty factors were applied to the test species toxicity data in accordance with a method developed by BLM. In accordance with this system, a divisor of two (USEPA, 1990) was applied to the toxicity reference dose for each level of phylogenetic difference between the test and wildlife species, i.e. individual, species, genus, and family.

The wildlife RMC for soil and sediment are found in Table 7. A Natural Resources Damage and Restoration Scoping Report is contained in Attachment 3.

5.3 Uncertainty Analysis

Toxic doses for each metal were selected from the literature without regard to the chemical speciation that was administered in the toxicity test.

The process of calculating human health RMC, using a target hazard quotient and target excess lifetime carcinogenic risk, has inherent uncertainty. One major source of uncertainty is the arsenic valence, III or V; it is well known that arsenic III is more toxic than arsenic V. Another source of uncertainty is the bioavailability of the metals, particularly arsenic (Valberg et al 1997). The bioaccessibility test showed less than ten percent bioavailability, thus reducing risk ten-fold. Cumulative effects were quantitatively dealt with for the human assessment, although not all metals are elevated. Additionally, it is improbable that human receptors would be exposed concurrently via all possible exposure pathways, although this has been assumed for conservatism (Ford, 1996). The COCs may also have synergistic (or antagonistic) effects on human or wildlife receptors. There is uncertainty in deriving wildlife RMCs due to the lack of toxicity data for most wildlife species. A standard uncertainty factor approach was used for interspecies extrapolation (Ford, 1996).

5.4 Risk Assessment Results

Tailings and Soil:
EPA Region 9 has published Preliminary Remedial Goals (PRGs) that establish safe soil concentrations that are used for planning site cleanups (EPA, 2002). PRGs are established for residential and industrial types of land use appropriate for offsite areas. For onsite use, BLM uses various RMCs for recreational use, including all terrain vehicle (ATV) drivers and campers. The EPA PRGs are based on single chemical exposures and for carcinogens (arsenic) are established at 10^{-6} (one case per million exposed) cancer risk. The BLM RMC are based on multiple chemicals and pathways and for arsenic, 10^{-5} cancer risk. Both PRGs and RMCs include ingestion and inhalation of soil. Neither of these have regulatory status but are "to be considered" applicable, relevant and appropriate requirements (ARARs).

The RMCs were prepared specifically for recreational use at BLM mining sites. Of these uses, camping for 14 days is considered the worst case. Table 7 compares the maximum media concentrations at the site with potential ARARs without accounting for bioaccessibility. The ratio of the environmental media concentration to the RMC is analogous to a hazard quotient (HQ) of 1.0; that concentration that should present negligible risk. Per the BLM RMC Technical note, media concentrations exceeding RMCs for humans or wildlife by 1-10 times (low to moderate risk) are flagged in yellow; these occurrences may pose a chronic threat. Media concentrations exceeding RMCs by more than 10 (high risk) and 100-fold (extremely high risk) for humans or wildlife are flagged in orange and red, respectively. The BLM reference indicates that if the criterion is exceeded by 1-10 times the criteria, the site is moderate risk and if >100 times the criteria, the site is extremely high risk (Ford, 2004). In Table 7, PRG HQs are flagged in similar manner.

Of the metals detected in tailings, arsenic is by far, the principal chemical of concern for human health with a risk management criterion (RMC) of 20 mg/kg for a 14-day camper, 300 mg/kg for the ATV user and 0.39 mg/kg for the residential PRG. The 14-day camper scenario is the longest period a person may camp on BLM land at a given site. Using the mean XRF metals results, arsenic mine waste exceedances of camper and ATV RMCs are in the high and very high risk ranges for campers and moderate for ATV drivers in Areas 1, 2, 4 and 7. If EPA PRGs are used, risks are very high for residential or industrial uses. Note BLM did not sample residential areas, but did sample adjacent to residential areas and hence it is reasonable to compare to PRGs. For antimony, moderate risk is seen for camper and residential use. The arsenic is 25-33% bioavailable based on bioaccessibility results. Soils with high iron oxide content and lower soil pH have lower bioaccessibility (Zang, 2005). Soil and mine waste at the site show high iron content.

While the on-site soil medium risk to ATV drivers and campers is moderate to high, the tailings are migrating off-site into residential areas. The tailings are situated adjacent to the residential lots in Red Mountain and appear to have been mobilized in flood events with impacts to downstream property owners. Off-site risk must also be considered.

For ecological risk, the results are in the moderate range (HQ 1-10). EPA has published a mammalian SSL for arsenic of 47 mg/kg, however background arsenic at the site is 136 mg/kg. SSLs are very conservative screening values. Had the arsenic SSL been used, the HQ would be in the high range (HQ 10-100). For antimony, since no RMC exists, the EPA SSL 0.27 mg/kg was used and risks are in the high (HQ 10-100) to very high range for wildlife (HQ >100) depending on location. Background antimony is 8.3 mg/kg. For these reasons, SSL HQs are considered possible upper bound risks. Desert tortoise and Mojave ground squirrel are two endangered species that may be present at the site. Although the RMC and SSL are for mammals, there are no soil criteria for reptiles that could represent the tortoise. Tortoise criteria would probably be higher and the HQ lower than mammal criteria because of low metabolic rate and higher proportional skeleton/carapace weight. The 1000-2000 mg/kg arsenic concentrations in the tailings and mine waste exceed published phytotoxicity benchmarks 50 mg/kg (Kabata-Pendias and Pendias, 1992), 200 mg/kg in clay soils (Sheppard, 1992) which explains the lack of vegetation in Areas 1 and 4.

5.5 Justification for the Removal Action

The project was developed by the BLM using its delegated authority under CERCLA to assess impacts to human health and the environment posed by the tailings and mine waste. BLM has elected to use its CERCLA authority for the Kelly Mine site to determine if a potential exists for a release or threat of a release of CERCLA hazardous substances and to addess the need for removal actions. A release of arsenic and antimony has occurred in Areas 1, 2, 4 and 7. A release of tungsten has occurred in Areas 5 and 6. These releases have occurred from migration from rock dumps and tailings. In accordance with Section 300.415(b)(2)(i-viii) of the NCP, a removal action is selected when one of the following criteria is satisfied:

- Actual or potential exposure to nearby populations, animals or the food chain from hazardous substances, pollutants or contaminants: *Analytical results from over 200 samples show high concentrations of arsenic are found in Areas 1, 2 and 4 and visual observations indicate the mine waste has migrated onto residential property in Red Mountain. Arsenic poses high risk to recreational visitors and potentially very high risk to adjacent residents. Access to these areas is unrestricted and off-road vehicles use these areas, especially Area 1 located nearest the residences of Red Mountain. Analytical results from more than 50 samples show Areas 5 and 6 contribute much less risk and are of much lower priority.*

- Actual or potential contamination of drinking water supplies or sensitive ecosystems: *Similar to the above, evidence is found indicating potential habitat contamination of desert tortoise and Mojave ground squirrel in Areas 1, 2 and 4, with lesser contamination in Areas 5 and 6.*

- Hazardous substances in drums, barrels, tanks or other bulk containers that may pose a threat of release: *No containers found. There is a large amount of trash, scrap material and temporary buildings in Area 2 and numerous empty tanks in Area 6.*

- High levels of hazardous substances, pollutants, or contaminants in soils largely at or near the surface that may migrate: *Abundant evidence of high concentrations of arsenic in tailings and mine waste that is migrating off-site into residential areas via erosion and from particulates* *associated with off-road vehicles based on complaints from residents*

- Weather conditions that may promote migration of hazardous substances: *Every precipitation event allows migration of tailings off-site into a residential area.*

- Threat of fire or explosion: *Little or none.*

- Availability of other appropriate Federal or State response mechanisms to respond to the release: *BLM has requested that EPA perform sampling on affected residential properties and to take necessary measures to protect human health.*

- Other situations or factors that may pose threats to public health, welfare or the environment: *None.*

6.0 RECOMMENDATIONS

Due to the urgency of the site, it is recommended the following time-critical actions be performed as soon as possible to reduce exposure to arsenic in the mine waste and to reduce off-site migration:

- Sample residential properties for soil and other media as appropriate,
- Fence Area 1 and the mill with 6-foot chain link fence and 3-strand barbed wire to keep visitors off the site and to prevent dust from off-road vehicle use on the site.
- Fence the glory hole and open shafts in Area 2,
- Repair the breach in the tailings dam,
- Install run-on controls upstream of the tailings and mill area,
- Install run-off controls and a culvert to direct migration away from residences and under Highway 395
- Remove mine waste from the 395 shaft to enable safety closure.

BLM has requested EPA sample private property, especially residential lots to determine if any action is warranted. The remaining measures will prevent the waste from migrating and reduce on-site risk on an interim basis. In order to accomplish a permanent removal action, it is recommended that an Engineering Evaluation/Cost Analysis be performed to study non-time critical removal alternatives.

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Figure 3. Red Mountain Waste Unit Sampling Locations