FINAL
ENGINEERING EVALUATION / COST ANALYSIS (EE/CA)

OAT HILL EXTENSION MERCURY MINE

JAMES CREEK WATERSHED
Napa County, California

Contract Number: NAB030001
Order Number: NAD06EE18
Requisition / Reference Number: R-0609839

October 2007

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List of Acronyms and Abbreviations

ARAR	Applicable or Relevant and Appropriate Requirement
BLM	Bureau of Land Management
°C	degrees Celsius
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Chemical of Concern
cy	cubic yards
E & E	Ecology and Environment, Inc.
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U.S. Environmental Protection Agency
°F	degrees Fahrenheit
GPS	Global Positioning System
Hg_T	total mercury
HI	hazard index
HQ	Hazard Quotient
km	kilometer
L	liter
mg/kg	milligrams per kilogram
mg/l	milligrams per liter
MMHg	methyl (or monomethyl) mercury
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
ng/L	nanograms per liter
OHE	Oat Hill Extension
PEC	probable effects concentration
ppm	parts per million
PRG	Preliminary Remediation Goals
RCRA	Resource Conservation and Recovery Act
RMC	Risk Management Criterion
RS	Robin Scenario
RSI	Removal Site Inspection Report
SCEM	Site conceptual exposure model
Site	Oat Hill Extension Mercury Mine
SRB	sulfate-reducing bacteria
TRV	toxicity reference value
µg/g	micrograms per gram
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
USGS	United States Geologic Survey
WSG	Waste Solutions Group

1 Introduction

Ecology and Environment, Inc. (E & E) has been retained under the Bureau of Land Management (BLM) contract number NAB030001, order number NAD06EE18 to prepare an Engineering Evaluation/Cost Analysis (EE/CA) for the Oat Hill Extension Mercury Mine Site.

This EE/CA has been prepared in accordance with the criteria established under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as well as sections of the National Contingency Plan (NCP) applicable to removal actions (40 Code of Federal Regulations [CFR] § 300.415 [b][4][I]). The EE/CA is also consistent with the U.S. Environmental Protection Agency (EPA) guidance document, *Guidance on Conducting Non-Time Critical Removal Actions Under CERCLA.*

The goals of the EE/CA are to:

- Determine and fill data gaps and document the need for removal actions to address contamination on site;
- Prepare an analysis of available data and verify results of previous Site studies;
- Conduct streamlined human health and ecological risk assessments to determine the potential threats posed by contamination originating at the Site and develop a Site Conceptual Exposure Model (SCEM); and
- Provide a framework for the evaluation and selection of potential response actions and applicable technologies consistent with the NCP.

At the direction of BLM, data gaps have not been filled through additional site investigation activities. For this reason, risk assessments, removal evaluations, and recommendations are limited.

2 Site Description and Background

2.1 Site Location

The site is located in the southwest, southwest of Section 27, Township 10 North, and Range 6 West; in Napa County, California (38°40'43"N , 122°31'4"W) (Figure 2-1).

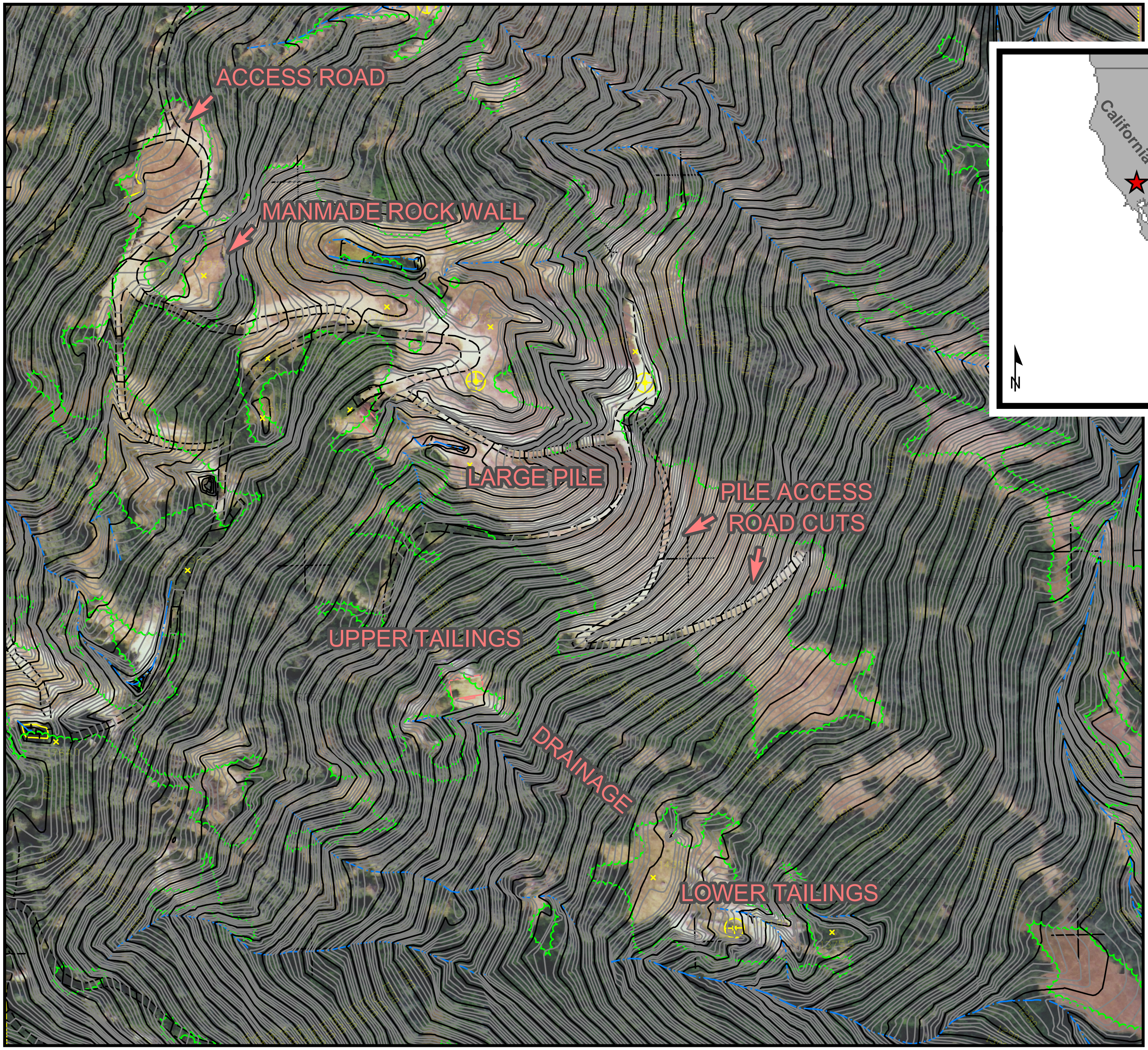
The site consists of approximately 25 acres of BLM-administered public lands. The site contains a mercury mine processing mill, including a retort and several small Scott furnaces, a historic miner’s cabin, and approximately 500,000 tons of mercury mine wastes. Most of these wastes are mercury mill tailings (calcines); however, wastes also include mine waste rock, and other related wastes.

2.2 Facility Description, Operational Status, and Site History

The Oat Hill Extension (OHE) Mine is one of several mercury mines in the East Mayacmas mining district that produced mercury from the 1870s until 1944 when the mines were closed. The OHE mine produced an estimated 1,000 flasks of mercury. For comparison, the neighboring Oat Hill Mine produced 165,000 flasks of mercury over a similar period.

The OHE mine developed veins and mineralized fault zones within Franciscan sandstone that extended eastward from the Oat Hill Mine. Also, waste material from the Oat Hill Mine was reprocessed at the Site using gravity separation methods to obtain cinnabar concentrates that were processed in a retort.

Mercury ores at the OHE mine were mined from the eastern extension of veins and mineralized fault zones of the Oat Hill mine. Thus, the ore grades were likely similar at both mines, although specific information for ore grades at the OHE are not available. Ore grades at the Oat Hill mine ranged from 0.75 to 1.0 per cent, with grades as high as 2 per cent during the early years of mining. Because of poor mercury recovery from the ore, both the waste rock and tailings, containing as much as 0.16 per cent mercury, were



Legend

- Major Contour (10 ft Interval)
- Minor Contour (2 ft Interval)
- Manmade Structure
- Unpaved Road
- Tree Cover Boundary
- Drainage Bottom

0 50 100 200 300 400 Feet

1 inch equals 200 feet

N

NAD 83 State Plane California II
38˚ 40' 43" N, 122˚ 31' 4" W

Oat Hill Extension Mercury Mine
Engineering Evaluation / Cost Analysis (EE/EA)

Figure 2-1: Site Location and Feature Layout

U:\Projects\7469-010 Oat Hill\LAYOUTS\Figure2-1_SiteLocation.mxd - 9/20/2007 @ 10:34:57 AM locally reprocessed at both the Oat Hill and OHE Mines (USGS 2006).

Material from mine waste piles was brought from the Oat Hill mine to the OHE property and reprocessed using a trommel and ore concentrating tables. During this gravity concentration process in the trommel (rotating sieve), oversize fragments were discarded to a waste pile and undersize clasts were sent to a concentrating table where the cinnabar was separated and the waste discarded into tailings piles. Only the cinnabar concentrate was processed in a one-pipe retort. As a result only a minimal amount of calcines generated from the retort was disposed of in the tailings pile (USGS 2006).

The mine has been abandoned for decades and, according to information currently available, it appears that the mine has not operated since the 1950s. Much of the property and former mine workings are relatively inaccessible, and the property is not used other than for occasional camping and hunting.

The Oat Hill and OHE mines potentially contribute to the mercury contamination of James Creek. Erosion has occurred on steep slopes of waste rock, tailings, and other mine waste at the Oat Hill and OHE seasonally replenished placer cinnabar deposits in James Creek (Yates and Hilpert, 1946).

2.3 Structures and Topography

The OHE site consists of approximately 25 acres of BLM land and a significant portion of a private parcel. Except for the private ranch to the north, the Site is surrounded by undeveloped land. The site is accessed by a dirt road. Vehicle access is restricted with a locked gate and boulders. Pedestrian access is not physically prohibited; however, posted signs restrict trespassing on both the BLM parcel and private property. Primitive dirt roads and foot trails traverse the interior of the site. A private property caretaker created road cuts across the large waste pile in order to access various areas.

Site features include several waste rock piles, abandoned mill buildings, separators, furnaces, and other processing equipment. The largest waste pile is situated on the northern portion of the BLM parcel and crosses onto privately owned land to the north of the BLM property line. A smaller waste rock pile is situated toward the southern end of the BLM parcel. The mill features remains vary from deteriorated brick structures, to intact metal buildings. Additional features identified during site visits include cabins, furnaces, foundations, and separators.

The topography information presented here was obtained from available previous investigations. The OHE site is located within the Howell Mountain Range. The Site is situated on southeast facing slopes at an elevation ranging approximately from 1,320 to 1,850 feet above sea level (asl).

Natural drainages convey ephemeral flow at the north portion of the site above the waste rock piles and continue on the southwest boundary of the site. These drainages range in size from small shallow channels to larger steep gullies.

2.4 Geology

The Howell Mountains are composed of Sonoma Volcanics 4,000 feet thick, with rhyolitic flows, including obsidian, near the top (USGS 2006).

The mercury ores in the Mayacmas mining district occur both in greywacke sandstone of the Franciscan Complex at the Oat Hill and OHE mines, and in silica-carbonate altered serpentine at other nearby mines. The sandstone has been hydrothermally altered primarily to kaolinite and quartz in the mineralized area. Cinnabar is the primary ore mineral and usually occurs in association with pyrite (FeS_2) in this district. Calcite and quartz veins are present in the altered sandstone and locally contain cinnabar. Elemental sulfur is present in the upper part of the Oat Hill deposit which, along with kaolinite alteration, indicates that the mercury ore formed in the steam-heated environment above the paleo-groundwater table (USGS 2006).

Mercury ores at the OHE mine were mined from the eastern extension of veins and mineralized fault zones of the Oat Hill mine. Thus, the ore grades were likely similar at both mines, although specific information for ore grades at the OHE are not available.

2.5 Hydrology and Hydrogeology

The OHE site is situated on moderate to steep southeast facing slopes. Surface water flow in this region of the state is ephemeral to intermittent. Natural drainages and tributaries carry runoff from the site approximately 1 mile to James Creek.

Natural drainages run across the southern portion of the site in a northwest to southeast direction. The drainages were identified in previous studies as Drainage A, Drainage B, and the Oat Hill Extension Drainage. Drainage A begins at the upper tailings location of the OHE "extension" piles; and flows southeast to the lower tailings location of the "extension" piles. Drainage B begins at an unnamed spring just north of the lower tailings location and flows southeast and joins the Oat Hill Extension Drainage, which collects drainage from the lowest portion of the lower tailings location (at the southeast corner) and flows southeast into a tributary to James Creek.

In addition to ephemeral flow in natural drainages, surface sheet flow over the mine waste and tailings piles, infiltration, and subsurface flow may also contribute to the flows in the unnamed tributary, and subsequently, James Creek.

During a site visit in June 2007, a wetland with running water was identified on the north side of the smaller waste rock pile.

Previous investigations identified a spring, mentioned previously, that is located in the vicinity of the lower tailings location of the “extension” piles. The spring flows 5 to 10 gallons per minute (gpm) and reportedly exhibits high concentrations of organic and methyl mercury. Water from this spring eventually flows into James Creek by way of the unnamed tributary.

Results from a search of available records obtained from the California Department of Water Resources indicate there are no wells registered within 2 miles of the Site.

Groundwater flow maps are not available for this area and the precise direction of groundwater flow is not known.

While limited documented information regarding groundwater in the vicinity of the site is available, E & E has gathered eye witness accounts of features and conditions at the site that may confirm the presence of groundwater features and demonstrate limited characteristics of the groundwater table in the vicinity of the site. The following information was gathered from interviews and reports from individuals who have visited the site for both recreational and maintenance purposes. Hunters reportedly discovered a hand-dug borehole approximately 1/3 mile west of the site. The hole is approximately 110 feet deep and was reportedly dry at the time of discovery. A drilled well (most likely drilled for experimental, prospecting, or investigative purposes) is located approximately ¾ mile east of the site on a ridge. This well is approximately 120 feet deep and has previously contained water. There are several seeps that normally produce water, but have been observed dry during the late summer and early fall months. A spring, assumed to be separate from the spring referenced in previous investigations and also mentioned earlier in this section, reportedly fed the town of Oat Hill when it was a populated mining town. Additionally, a metal box with dimensions of 24 inches square has been observed to contain water year round. The box may have been used for cooling flasks of mercury as part of the processing. The box is located near the old mining structures and retort at the north portion of the site. It was noted that a grove of maple trees thrives nearby, indicating that groundwater may be near the surface in this location. An onsite caretaker who maintains much of the adjacent private property reported that he obtains his drinking water from an abandoned tunnel located on Table Mountain at an elevation of approximately 2,200 to 2,300 feet. He reported that the tunnel provides “spring-like water” at approximately ½ gpm. He also reported that the water has been tested by the State. Details, including dates and results from this testing, were not provided.

2.6 Surrounding Land Use and Populations

The Site is located approximately 5 miles south-southeast of Middletown, which has a population of 1,020 according to the 2000 U.S. Census. Middletown is at an elevation of 1,105 feet, has a land area of 2.58 square miles, and a low population density of 396 people per square mile. Other nearby towns include Hidden Valley Lake, Cobb, Lower Lake, and Calistoga.

The BLM reports current recreational uses of the site as hiking, camping, hunting, horseback riding, and off-road vehicle activities.

2.7 Ecological Resources

Vegetation information was obtained from The Nature Conservancy webpage. The climate of Napa County ranges from cool coastal areas to hot and dry areas inland. The area has tremendous oak woodland resources and a variety of rare plant species associated with serpentine soils. The vegetation of Napa County includes annual grasslands, chamise, chaparral, mixed conifer, and redwood and Douglas fir (TNC 2007). Site-specific plant communities consist mainly of black oaks in perimeter areas, and annual grassland meadow adjacent to the mine waste piles.

An abundance of animals, including the Pacific giant salamander, the Northwestern pond turtle, and fall-run chinook salmon, are found in Napa County. The county is also home to a wide range of birds, including golden eagles, falcons, hawks, owls, osprey, and gnatcatchers. Species of concern include the spotted owl, red-legged frog, freshwater shrimp, and steelhead trout. Deer tracks and pellets, and jackrabbit pellets were observed in the vicinity of the site. Habitat adjacent to the mine wastes supports a population of blacktail deer. Fish, frogs, and various invertebrates have been observed in local tributaries and creeks.

2.8 Sensitive Species and Environments

A Biological/Botanical Resource Inventory Report was completed in 2006. Surveyors searched for sensitive botanical and wildlife resources. The following is a summary of the findings of the report.

Botanical Resources

A search of the California Natural Diversity Database (CNDDB) plant records found no occurrences of BLM Sensitive plants in the immediate vicinity of the OHE where remediation activities are expected to take place. For inventory purposes in areas adjacent to the proposed remediation area, the CNDDB lists four BLM Sensitive Plants, all California Native Plant Society (CNPS) List 1-B (rare, threatened, or endangered in

California or elsewhere), that have been documented within two miles of the OHE. These plants can be found in Table 2-1 below.

Table 2-1 Rare, Threatened, or Endangered Plant Species documented within two miles of the OHE

Common name	Scientific name	Location found	Documentation
Narrow-anthered California brodiaea	(*Brodiaea californica* var. *leptandra*)	occurring in Kidd Canyon	from a 1999 record
Morrison's jewelflower	(*Streptanthus morrisonii*)	occurring at the upper tunnel #3 at the Corona Mine	from a 1992 record
Cobb Mountain lupine	(*Lupinus sericatus*)	occurring near Bateman Creek	from a 1933 record
Rincon Ridge ceanothus	(*Ceanothus confuses*)	occurring on Oat Hill and also at the Corona Mine	from 1989 and 1988 records, respectively

Additional written information provided by CNPS Napa Valley Chapter and based on inventories of rare plants near the OHE included documented occurrences of Three Peaks Jewelflower ((*streptanthus morrisonii* ssp. *elatus*) located on mining cuts above the Corona Mine furnace, and Rincon Ridge ceanothus (*Ceanothus confuses*) above the Corona Mine. Both of these are BLM Sensitive Plants and CNPS List 1-B plants. They are not known in the immediate area of the OHE where remediation activities are proposed; however, they are located approximately two miles to the west.

Wildlife Resources

The CNDDB has three records of the BLM Sensitive yellow-legged frog (*Rana boylii*) in the area near the site. They are recorded as occurring on James Creek at a location that captures the runoff from the Oat Hill Mine, at the Oat Hill Extension Mine marsh, and the vicinity of James Creek at the Corona Mine. All three records are from 2004. These locations are not within any area where remediation activities are proposed.

2.9 Meteorology

The OHE site climate and ecology are characteristic of the Central Valley area. Average temperatures and precipitation were obtained from the Weather Underground weather station located at Lower Lake, California. Daily high temperatures range from approximately 97 degrees Fahrenheit (°F) in the summer to approximately 53°F in the winter. Daily low temperatures range from approximately 58°F in the summer to approximately 36°F in the winter. The average annual precipitation is approximately 19 inches. The majority of precipitation occurs during the months of December, January, and February. Wind is generally from the north and north-northwest from the months of September through April and generally from the South and East-Southeast from the months of May through August. Wind speed averages fall between a low of 4.6 miles per hour (mph) in July to a high of 7.7 mph in February. Wind gusts up to 65 mph occur. Table 2-2 presents the average air temperature, precipitation, and wind speed at Lower Lake, California, approximately 16 miles north of the Site. The Site is approximately 1,000 feet higher in elevation than the town of Lower Lake.

Table 2-2 Meteorology for the OHE Vicinity				
Month	Average air temperature	Average precipitation	Average wind speeds	Wind direction
Jan	45.0	2.34	6.4	N
Feb	51.3	4.39	7.7	SSE
Mar	53.5	0.52	6.8	NNW
Apr	59.1	0.06	6.7	NNW
May	65.9	0.05	4.9	S
Jun	73.1	0.00	4.8	S
Jul	74.1	0.00	4.6	ESE
Aug	72.7	0.17	4.8	S
Sep	77.8	0.00	5.3	N
Oct	66.7	1.50	6.4	NNW
Nov	56.3	2.50	5.7	N
Dec	48.3	2.60	7.3	N

2.10 Previous Investigations

The following is a list of the site characterization activities reportedly performed at the Site. To date, only a limited number of these investigation reports have been provided for use in this EE/CA report. For this reason, significant data gaps exist regarding the history and background of the OHE.

- Field investigations / Site reconnaissance (2003-2004)
- Cultural Resource / Site History data review (available data from 1850-2005)
- Environmental sampling (mercury contamination)
- Surface water sampling
- Soil sampling
- Sediment sampling
- Biological Resources - mercury bioassay sampling data (2003-2004) assessment
- Ecological characterization
- Wetland and habitat delineation / function and value assessment
- Wildlife observations
- Benthic reconnaissance / community characterization
- Identification of endangered species and others of special concern
- Biota sampling / population studies -Bioassays
- Bioaccumulation studies
- Sample analysis/ data validation
- Human health and environmental risk evaluation (2006)
- BLM Limited Sampling Program (2007)

This EE/CA incorporates all available data into the site characterization discussion; however, gaps have been identified where either insufficient data exist or data has not been provided. These data gaps restrict the breadth and depth of the site characterization. **At the direction of BLM, these data gaps have not been filled through additional site investigation activities. For this reason, risk assessments, removal evaluations, and recommendations are limited.**

2.10.1 USGS Administrative Report on Mercury in Tailings, Sediments, Water, and Biota 2003-2004

The USGS prepared an administrative report on mercury at the OHE Mine and James Creek (USGS 2006). The report summarized data obtained from tailings and sediment sampling at the Site on October 17, 2003; water sediment and biota sampling from James Creek on May 20, 2004; and biota sampling on October 29, 2004. The USGS team sampled mine waste, tailings, waters, and sediments. The intent of the sampling was to measure and characterize mercury and other biochemical constituents in tailings, sediment, water, and biota at the Site and the tributaries that drain the mine area to James Creek.

2.10.2 Biological/Botanical Resource Inventory Report

The USDOI BLM Ukiah Field Office conducted a site visit on November 2, 2006 with the purpose of establishing an inventory of the biological and botanical resources in the area of the OHE. The specific sensitive species searched for included the Foothill yellow-legged frog (*Rana boylii*), the Three Peaks Jewelflower (*streptanthus morrisonii* ssp. *elatus*), and the Rincon Ridge ceanothus (*ceanothus confuses*). The inventory included both botanical and wildlife literature searches, the results of which are summarized in Section 2.8.

2.10.3 Streamlined Risk Assessment 2006

A streamlined risk assessment for the Site was conducted by the BLM in November 2006. The purpose of the assessment was to identify the primary chemicals of concern, transport mechanisms and pathways, and potential receptors. The assessment also identifies the criteria to be used in evaluating human and ecological risk. The complete streamlined risk assessment is included in Section 4 of this EE/CA.

2.10.4 BLM Limited Sampling Program 2007

On June 5, 2007, the BLM undertook a limited sampling program on the upper part of the OHE large tailings pile. The purpose of the sampling program was to assess the relative

Hg concentration levels in the mine waste. The samples were submitted to a USGS team headed by James Rytuba on June 5, 2007 and shipped to ALS Chemex Lab during the week of June 11, 2007. The USGS team reported to the BLM that the OHE large tailings pile analytical sample results were generally very low level concentrations (1-10 ppm) with a small number of higher Hg concentration samples (+100 ppm). A table including the results from this sampling program and a figure showing sample locations is included in Section 3 of this report.

2.10.5 Removal Site Inspection 2007

A Removal Site Inspection (RSI) was conducted by E & E and was completed in July 2007. A site visit was conducted in the fall of 2006 as part of the investigation. Additional sampling was performed by the BLM in June of 2007. The RSI included a thorough search of all available reports and data in order to compile a comprehensive site characterization. While significant data gaps remain unfilled, E & E did not collect additional samples per the direction of the BLM. This EE/CA utilizes the findings of the RSI to assemble removal action alternatives and recommend the most appropriate action to address contamination at the Site.

3 Source, Nature, and Extent of Contamination

3.1 Location of Contaminated Materials

The contaminated materials at the OHE site are found throughout several waste rock and tailings piles. The largest waste pile is located in the northern portion of the BLM property and extends into private property to the north and northwest. A smaller series of piles is located in the southeast portion of the property. Several auxiliary piles dot the landscape in the southern and western portions of the site.

A boundary/property survey and topographic survey have been performed covering the OHE site. Data from these surveys was used to better examine the location of contaminated materials and determine the extent of the piles within BLM property as well as portions extending into the adjacent private property.

3.2 Definition of Contaminated Material

For the purposes of this study, "contaminated materials" are defined as materials with mercury levels above criteria established in the streamlined risk assessment.

3.3 Volume of Contaminated Materials

The data generated from the property and topographic surveys was used in conjunction with other available horizontal or vertical data for the calculation of volume of contaminated materials on site. Visual interpretation of aerial photographs along with notes from the site visit was used to approximate the horizontal extent of contamination as well. The depth of mercury contamination was approximated using the results of the BLM characterization investigations and site visit observations when available.

Original reports estimate that approximately 500,000 tons of mine waste is deposited at the OHE. The material is located in three primary areas, the large north pile, the upper tailings pile of the extension area, and the lower tailings pile of the extension area. The largest volume of material is piled at the large north pile, while the extension area contains the material with the highest concentrations of mercury. The volumes of contaminated materials used in this report were calculated using horizontal areas interpreted from aerial photographs and depths estimated from site visit observations.

North Pile

The large pile located in the northern portion of the site covers approximately 250,000 square feet of area. The material is situated in a number of large mounds with steep slopes. Wile the orientation of the material varies throughout the pile, E & E noted depths and extents of the material from observations made during the June 2007 site visit. Depths range from approximately 5 feet to more than 40 feet. For purposes of volume calculations, an average depth of the waste material has been estimated at 20 vertical feet. These dimensions result in an approximate volume of 185,200 cy.

Extension Area Upper Tailings

The upper tailings of the extension area cover approximately 13,200 sf of area. Average depths were visually estimated at 10 vertical feet. The resulting volume is approximately 5,000 cy.

Extension Area Lower Tailings

The lower tailings of the extension area cover approximately 31,200 sf of area. Average depths were visually estimated at 10 vertical feet. The resulting volume is approximately 85,600 cy.

3.4 Physical and Chemical Attributes

3.4.1 Waste Piles

Large Pile – North Area

The large pile, which is situated on both BLM and private land, is located on the northwest portion of site. Material in this pile was deposited in large, steep mounds. The mounds are extremely steep in places. Rills and gullies have formed where surface water has etched flow paths. The material is very unstable. Several primitive road cuts have been made in the side slopes of the pile and switch back and forth across the southeast facing slopes.

The material in the large pile is made up of rock of varying size; however, the majority of the material is fine grained. Generally, material making up the steeper slopes is fine material. The solid waste material in the large waste rock pile can also be physically characterized by color. White and red colored material has most likely been processed by heat, i.e. in a furnace.

Extension – Upper and Lower Tailings

Several tailings piles make up the area known as the “extension” area. There are two primary piles, known as the upper and lower tailings areas. The smaller piles in the southern portion of the site are made up of material ranging in size from fines to large gravel. Slopes of this pile range from moderate to shallow. It was noted during the site visit that slopes of lesser degree (less than approximately 30º) were well vegetated with grasses.

Auxiliary Material - Mill Features

A notable amount of waste material is scattered throughout the site, primarily surrounding the remaining mill features. These mill features include: a retort, furnace, and building structures and foundations. Waste rock and other debris were observed in staging and processing areas in the vicinity of these features.

3.4.2 Surface Water

Mercury and associated elements are suspected to be transported in surface waters from the Site into James Creek. Water and sediments have been sampled from a tributary that drains the OHE area. Samples have also been taken from James Creek at reaches above and below the confluence of said tributary and James Creek. Concentrations of mercury below the confluence were 55% higher than above, suggesting that mercury is contributed by the tributary to James Creek. Additionally, drainage from a spring located below the adit of the OHE Mine has been identified as a potential source of mercury to the tributary, since it contains exceptionally high mercury concentrations. The water from the spring deposits calcite and magnesite.

3.4.3 Groundwater

No groundwater samples have been collected from the OHE Site. Limited information is available for this media as the majority of studies performed at the site have focused on waste rock, tailings, sediment, and surface water.

3.4.4 Air

There are no analytical results measuring potential contaminant releases to air at the Site. The cohesive properties of the tailings and waste rock particles minimize the risk of windblown materials. Additionally, at several of the shallow sloped piles, vegetation has been established. Potential releases primarily include mercury in dust emissions caused by disturbances of the uncovered waste rock and tailings materials.

3.5 Sampling and Analysis Activities

3.5.1 Sampling Protocol and Data Quality Objectives

At the direction of BLM, E & E did not perform any sampling procedures at the Site. All sample events and results included in this report were performed by either the U.S. Geological Survey or by the BLM staff. Refer to these specific studies for sampling protocol and data quality objectives utilized.

3.5.2 Analytical Results and Discussion

USGS Administrative Report on Mercury at the Oat Hill Extension Mine and James Creek, Napa County, California

The following is a discussion of findings from the USGS administrative report on Mercury at the OHE Mine and James Creek (USGS 2006).

The intent of the USGS sampling was to measure and characterize mercury and other biochemical constituents in tailings, sediment, water, and biota at the Site and the tributaries that drain the mine area to James Creek. According to the USGS report, mine tailings containing relatively high concentrations of mercury have contributed to contamination of these tributaries primarily by erosion. This contamination is believed to be potentially relevant to ecological impairment of biota, as the Site is located in the James Creek/Pope Creek watershed and is believed to contribute mercury contamination to the area around the mine and the James Creek watershed.

Samples were collected by a USGS field team to assess the concentration of mercury and potentially relevant biogeochemical constituents in tailings at the OHE Mine, and sediments, waters, and biota in James Creek and the unnamed tributary to James Creek that drains the mine area. Table 3-1 lists the latitude and longitude coordinates and a brief description of each sample location.

Table 3-1 Sample Locations and Descriptions – USGS 2006

Sample	Latitude	Longitude	Description
04JC1	38.66965	122.5178	James Creek above confluence with OHE drainage (Tributary 1)
04JC2	38.67013	122.5142	Tributary 1 at confluence with James Creek
04JC3	38.66988	122.5127	James Creek water below confluence with Tributary 1
04OHE1	38.67857	122.5177	OHE drainage (Drainage B) to Tributary 1 (spring water)
23OHE12	38.67910	122.51814	OHE tailings above adit (upper tailings)
23OE13S	Near OE12		Sediments near upper tailings
23OE1 through 5	Near OE12		OHE tailings
23OE11	Near OE12		Sample of retort brick
23OE14	38.67752	122.51819	OHE office site (background soil sample)
CRNU	38.67077	122.5369	James Creek up and down-stream of lower Corona Mine adit

04 indicates samples taken in 2004
JC = James Creek
OHE = Oat Hill Extension Mine site

Ore processing at the OHE resulted in significant residual cinnabar and pyrite in the tailings. The OHE ore, consisting of sandstone and former tailings from the Oat Hill Mine operation, was gravimetrically separated. Waste pile tailings are stratified based on clast size, apparently ranging from coarse sand to coarse gravel. The coarser tailings occur in the northern part of the pile, and reflect accumulation of oversize clasts rejected from the trammel. Tailings in the southern part of the pile consist primarily of undersize clasts rejected from the concentrating tables (USGS 2006).

The geochemical results for samples of mine tailings at the OHE are summarized in the following discussion. The mercury concentrations in the mine tailings ranged from 400 to 1,000 µg/g (ppm). Tailings present above the adit in the northern-most part of the mine area had the highest concentration of mercury (1,175 ppm). Other potentially toxic metal(oid)s were present at lower concentrations, including arsenic (0.2-6 ppm), copper (30-50 ppm), nickel (50-70 ppm), lead (10-20 ppm), and zinc (90-130 ppm).

Background soil sampled at the OHE at a distance of 0.3 miles from the retort site had a mercury concentration of approximately 7 ppm. The high level of mercury in the soil may have been due to mercury mineralization of the sandstone from which the soil developed or atmospheric deposition following emission from retort and furnace stacks at the Oat Hill and adjacent Corona and Twin Peaks mine sites (USGS 2006).

Elevated mercury concentrations exist in sediment sampled from a drainage that transects the upper and lower part of the tailings. The mercury concentration of sediment in the upper part of the drainage was 930 ppm, increasing to 1500 ppm in the lower part of the drainage as it incises the main tailings pile. These limited data suggest that significant amounts of mercury are released from waste located above the OHE Mine area, with additional mercury release from the OHE tailings. The results are consistent with the hypothesis that winter runoff from the Oat Hill and OHE areas replenish cinnabar in the James Creek placer.

Concentrations of mercury, copper, lead and zinc in the lower tailings pile at the OHE site, two sediment samples from an unnamed drainage ditch from the OHE, and tailings above the adit exceed USBLM Robin Scenario (RS) ecotoxicity screening criteria. In addition, five lower tailings samples, two sediment samples from the OHE drainage ditch, and the ‘background’ soil sample taken at the OHE office site contained arsenic concentrations exceeding the USBLM’s RS ecotoxicity screening criteria. Comparisons of all element concentration results with the USBLM’s Human Risk Management Camper Scenario and U.S. Environmental Protection Agency preliminary remediation goals (USEPA-PRG) criteria are contained in the USGS administrative report. One OHE tailings sample contained arsenic and chromium exceeding USEPA-PRG criteria, and all but one sample exceeded the USEPA-PRG thallium criteria. All but two samples (retort brick and background soil) exceeded the USBLM Camper Scenario criterion for mercury, and its arsenic criterion was exceeded in one tailings sample. Brick and mortar from the retort used to process cinnabar concentrates from the OHE Mine had a relatively low mercury concentration (5 ppm), although it exceeded the USBLM's RS ecotoxicity screening criterion. Other metals that exceeded the criteria for this material include arsenic, copper, lead, and zinc.

The USGS team sampled waters and sediments from a tributary that drains the OHE Mine area and in James Creek in order to assess whether mercury and associated elements were being transported from the mine site into James Creek. In the tributary water just above the confluence with James Creek, the total mercury (Hg_T) concentration was 14 ng/l. In James Creek, Hg_T concentrations below this confluence were 55% higher than above, suggesting that mercury is transported through the tributary to James Creek under base flow conditions. Filtered mercury concentrations in the tributary and James Creek waters account for 50 to 60% of Hg_T. Drainage from a spring located below the adit of the OHE Mine is an important source of mercury to the tributary, since it contains an exceptionally high 770 ng/l Hg_T. The water from this spring deposits calcite and magnesite and the sediment associated with water runoff from the spring area, on the basis of visual observation and thermodynamic calculations. This deposition may enhance the accumulation of mercury in OHE drainage sediment.

Analytical results for mercury and methyl mercury in water and sediment sampled in the USGS study are presented in Table 3-2. The geochemistry results for the same samples are presented in Table 3-3. The elemental composition of filtered and unfiltered surface water is presented in Tables 3-4 and 3-5, respectively.

Table 3-2 Mercury and Methyl Mercury in Water and Sediment – USGS 2006

Sample	Mercury in water[1]		Monomethyl mercury in water[2]		Mercury in sediment[3,6]		Monomethyl mercury in sediment[4]	
	Unfiltered ng/l	Filtered (<0.45 µm) ng/l	Unfiltered ng/l	Wt-% solids	µg/g-wet sediment	µg/g-dry sediment[1]	ng/g-wet sediment	ng/g-dry sediment[5]
04JC1	4.8 ± 0.9	2.8 ± 0.5	0.04	79	17	21	0.72	0.92
04JC2	14 ± 3	7.8 ± 1.5	0.08	76	2.5	3.3	0.06	0.08
04JC3	7.3 ± 1.4	3.4 ± 0.6	0.04	72	5.0	6.9	0.05	0.07
04OHE1	780 ± 150	5.8 ± 1.1	0.10	57	64[6]	110	0.43	0.74

Error intervals (2σ of duplicate analyses, or 95% confidence level) are reported where they are on the order of the last significant digit.
Analytical detection limits based on 3σ of reagent blank recoveries were:
(1) 0.2 ng/l, (2) 0.04 ng/l, (3) 0.12 ng/g, and (4) 0.02 ng/g
(5) Concentrations on a dry weight basis were computed by dividing the ng/g-wet sediment by the wt-% solids of the sediment.
(6) Matrix spike recovery was less than unspiked recovery, indicating substantial heterogeneity in the distribution of Hg within the sediment sample. The true bulk concentration of this and the other sediment samples may be substantially different that than these reported values.

For a more reliable assessment of the propensity for inorganic mercury to be methylated in the systems present at the site, further sampling and improvements to sampling procedures would be required. Additionally, to better evaluate the system's true methylation potential, future investigations of James Creek would enumerate zones of anaerobic sediments and analyze the Hg_T and methyl mercury (MMHg) contents at the site. E & E has reviewed the USGS data and conclusions and agrees that additional

Table 3-3 Temperature, pH, Alkalinity, and Select Anions – USGS 2006

Sample	Temperature °C	pH	Alkalinity, mg/l as $CaCO_3$	$HCO_3^{(1,2)}$	Cl^-	F	SO_4^{2-}	Ionic strength (mol/L)(1)
04JC1	14	8.4	114	66	5	0.2	95	0.006
04JC2	16	8.2	168	98	5.1	0.2	68	0.007
04JC3	14	8.2	118	69	5.1	0.2	94	0.006
04OHE1	19	8.3	431		4.5	0.3	130	0.013

All concentration units are mg/l, except ionic strength, which is reported in molar units.
Nitrate was not detected (<0.2 mg/l in any sample.
(1) Calculated from all available aqueous constituents using a thermodynamic model.
(2) Minor fractions of CO32- and H2CO3* are also likely present.

Table 3-4 Elemental Composition of Filtered (<0.45 µm) Water – USGS 2006

Sample	Al	Ba	Ca mg/l	Ce	Co	Cr	Cs	Cu	Eu	Fe	K mg/l	La	Li	Mg mg/l	Mn	Na mg/l	Nd	Ni	P mg/l	Rb	Sc	SiO2 mg/l	SO4 mg/l	Sr	Ti	U	V	Y	Yb	Zn
04JC1-B	15	33	14	nd	7.6	1.5	0.06	nd	nd	82	1.8	nd	3.6	44	66	5.5	nd	440	nd	5.3	2.7	30	95	140	1	0.11	nd	0.04	0.01	1.8
04JC2-B	17	45	36	nd	0.16	1.0	nd	0.56	nd	nd	1.9	0.01	6	35	1.1	7.8	0.02	1.4	0.02	0.59	1.6	17	79	260	0.7	0.71	0.7	0.04	nd	5.2
04JC3-B	20	32	15	0.01	5.0	1.0	0.05	nd	nd	110	1.8	0.01	3.7	43	45	5.6	0.02	350	nd	4.9	2.6	27	99	150	1.2	0.14	0.5	0.03	nd	5.3
04OHE1-B	14	140	47	nd	0.09	1.1	0.11	0.73	0.01	nd	2.5	nd	68	110	2.3	14	nd	1.7	nd	2.8	1.9	17	120	450	1.2	0.48	nd	0.01	nd	3.2

All units are µg/l (microgram per liter) unless otherwise noted.
The following elements were not detected (detection limits in µg/l are in parentheses):
Ag(<3), As (<1), Be (<0.05), Bi (<0.2), Cd (<0.02), Dy (<0.005), Er (<0.005), Ga (<0.05), Gd (<0.005), Ge (<0.05), Ho (<0.005), Lu (<0.1), MO (<2), Nb (<0.2), Pb (<0.05), Pr (<0.01), Sb (<0.3), Se (<3), Sm (<0.01), Ta (<0.02), Tb (<0.005), Th (<0.2), Tl (<0.1), W (<0.5), Zr (<0.2).
nd = not detected

Table 3-5 Elemental Composition of Unfiltered Water – USGS 2006

Sample	Al	Ba	Ca mg/l	Ce	Co	Cr	Cs	Cu	Eu	Fe	K mg/l	La	Li	Mg mg/l	Mn	Na mg/l	Nd	Ni	P mg/l	Rb	Sc	SiO2 mg/l	SO4 mg/l	Sr	Ti	U	V	Y	Yb	Zn
04JC1-B	17	34	15	0.08	8.5	2.0	0.06	0.51	0.01	1650	2.0	0.07	3.8	43	72	5.3	0.06	460	nd	5.1	2.7	31	95	140	1.1	0.12	0.7	0.12	0.01	7.5
04JC2-B	19	44	37	0.02	0.06	1.1	nd	0.60	nd	nd	2.0	0.02	6.3	35	1.3	7.6	0.02	1.4	0.02	0.56	1.7	17	70	250	0.8	0.73	0.7	0.04	nd	4.9
04JC3-B	6.1	34	15	0.05	5.6	1.4	0.05	0.50	0.01	1060	1.9	0.05	4	42	48	5.3	0.05	380	nd	4.7	2.6	28	90	150	1	0.13	0.5	0.1	0.01	6.5
04OHE1-B	35	140	48	0.09	0.17	nd	0.14	0.94	0.01	160	2.5	0.04	67	105	22	13	0.04	1.7	nd	2.8	1.9	16	120	450	1.7	0.48	nd	0.05	nd	16

All units are µg/l (microgram per liter) unless otherwise noted.
nd = not detected

investigations are warranted. However, at the direction of BLM, additional site investigations were not performed as part of this EE/CA.

The relative contribution to the ecological impairment of James Creek of the OHE mine waste, in addition to other sources of mercury, is not clear from invertebrate Hg_T or organic mercury measurements. Hg_T and MMHg were detected in all composite samples of invertebrates. However, sample quantity may be insufficient to compare mercury concentrations in invertebrates residing nearer to point sources of mercury with those farther downstream. The low proportions of MMHg measured in invertebrates in James Creek and the presence of cinnabar in the creek suggest that some invertebrates may have anomolously high mercury concentrations as a result of cinnabar 'contamination'. MMHg concentrations in invertebrates from the wetland area near OHE suggest that the sediments there produce methyl mercury that is taken up by lower trophic level organisms. The most contaminated invertebrates were found in this location.

As is the case for invertebrate data, the ecological impact of the OHE mine waste in addition to other sources of mercury to James Creek is not clear from frog Hg_T measurements. Average concentrations of Hg_T in frogs from James Creek were similar upstream and downstream of the OHE drainage. The highest concentration of Hg_T in frogs was observed at the wetland area of the OHE in autumn season. While the results from this study suggest that mercury is accumulated in biota above the lowest trophic level in James Creek, further study would be required to rule out their misinterpretation due to cinnabar 'contamination'. At the direction of BLM, additional studies in this area have not been performed as part of this EE/CA.

Like invertebrates and frogs, fish mercury results do not clearly indicate whether the OHE site is ecologically impairing biota in addition to other sources of mercury to James Creek, nor do they provide any indication of the relative importance of the OHE to ecological impairment. Compared with the same species from other sites in Northern California, fish from James Creek were moderately contaminated with mercury.

While there is evidence from limited measurements of water, sediment, and biota that mercury from the OHE and other mines may be impairing the ecology of James Creek biota, the measurements do not indicate that the degree of impairment is commensurate with the extraordinary degree of mercury contamination present. Methyl mercury concentrations in flowing water and sediment from James Creek and the tributary that drains the OHE are relatively low. The results of the USGS investigation suggest that the OHE contributes inorganic mercury to James Creek; however, they do not indicate whether the OHE site is ecologically impairing biota in addition to other sources of mercury that are contaminating James Creek, nor do they provide an indication of the relative importance of the OHE to the ecological impairment.

Additional discussion and explanation of transport biogeochemistry of mercury can be found in the USGS Open-File report.

BLM Limited Sampling Program 2007

The following is a discussion of findings from the sampling event performed by BLM staff in June 2007.

The BLM collected samples of waste rock and tailings from the large pile in the north portion of the Site. Table 3-6 presents the results of the sample analyses. Refer to Figure 3-1 for a map of the sample locations.

Table 3-6 BLM Limited Sampling Program 2007

Sample ID	Mercury (ppm)
07OHE-1	>100
07OHE-2	17.4
07OHE-3	33.9
07OHE-4	79.8
07OHE-5	12.5
07OHE-6	6.52
07OHE-7	3.48
07OHE-8	35.9
07OHE-9	13
07OHE-10	42.9
07OHE-11	3.59
07OHE-12	1.46
07OHE-13	60.8
07OHE-14	10.2

NOTE: Detection limits on samples requiring dilutions for Hg-CV41, due to interferences or high concentration levels, have been increased according to the dilution factor.

The results from the BLM Limited Sampling Program show that the majority of samples exceed background levels of mercury, and several exceed these levels by 10-fold. While material sampled in this larger pile exhibits concentrations of mercury significantly lower than those measured in the extension area piles, the levels found here are in exceedance of the established regulatory criteria.

3.6 Targets Potentially Affected by the Site

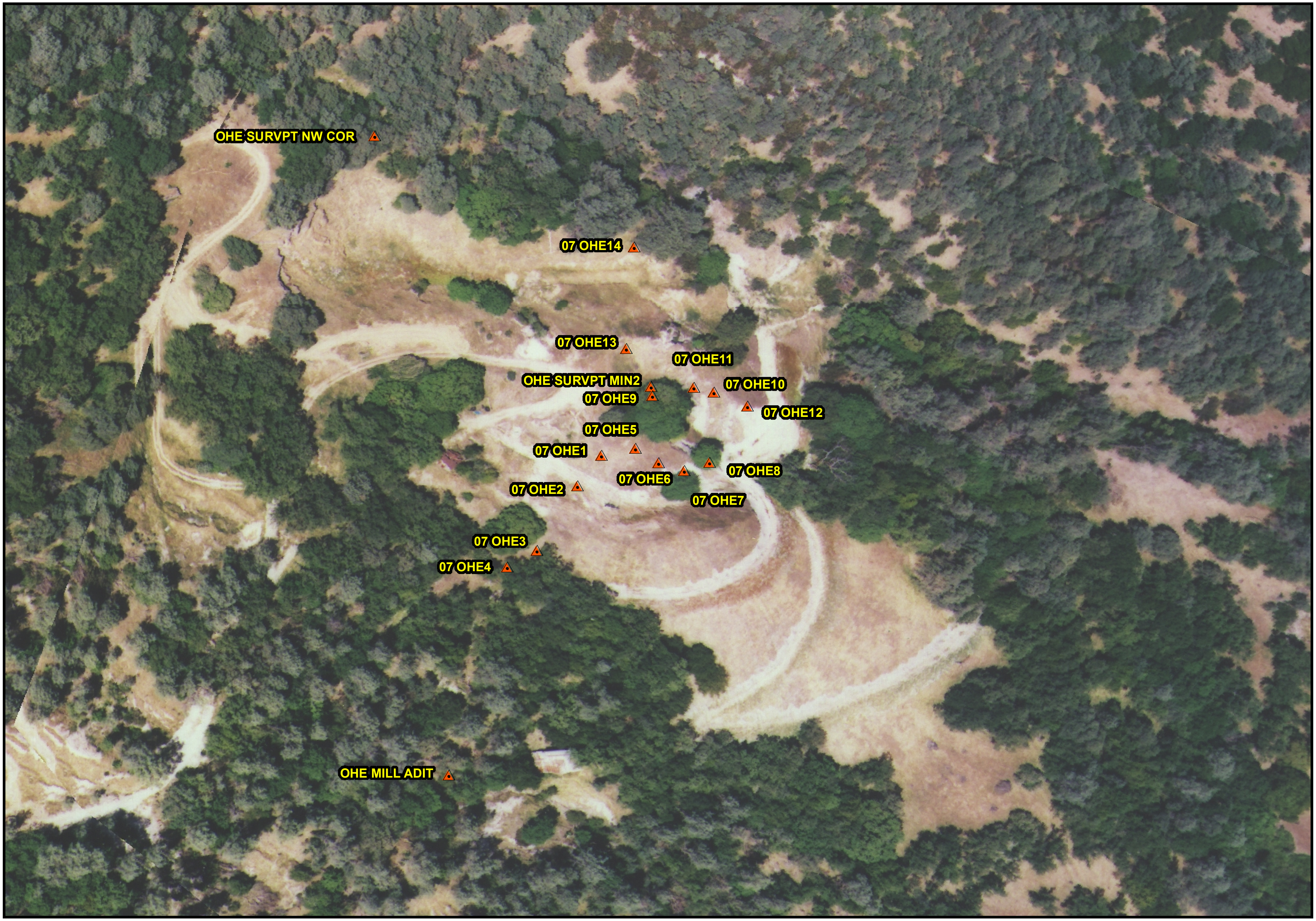
3.6.1 Groundwater

Municipal Wells

There are no municipal wells located near the Site.

Private Wells

There are no private drinking water wells currently in the immediate vicinity of the Site. The nearest domestic well documented in the California Department of Water Resources map interface database is located at latitude and longitude coordinates N 38.6123° W 122.5857°; however, this well is more than 5 miles from the site. Depth to water below ground surface in this well varies between 10 and 20 feet.



Oat Hill Extension Mercury Mine
Engineering Evaluation / Cost Analysis (EE/EA)

Figure 3-1: Sample Locations

3.6.2 Surface Water

Municipal and Private Users

No known population centers near the Site derive potable water from surface water sources. Surface water flow on the Site is ephemeral and there is no record of use of this surface water, the tributaries it flows into, or James Creek for private or municipal potable water.

Ecological Targets

Releases to surface water from the contaminated materials would likely pose the most direct risk to ecological receptors in the drainages and tributaries located on site. Various vertebrates and invertebrates could be receptors of releases. Other mammals and birds could also be incidental consumers of water from the drainages when flowing. These mammals may eat the sediments, invertebrates, and vertebrates that live in the area and thus are also potential receptors.

3.6.3 Soil and Air

Human Targets

The Site may be accessed by visitors on BLM property and by hikers and hunters with reservations or leases to private land. Private rural property surrounds the site. Residents of this land likely obtain their water from nearby springs. One resident reportedly obtains water from an abandoned tunnel on Table Mountain.

Ecological Targets

The Site may provide suitable habitat for several sensitive plant species. The results from a formal survey are included in the discussion in Section 2.8. Windblown dust from the contaminated material could be deposited on the foliar surfaces or other aboveground parts of plants, resulting in direct uptake into plant tissue from aerial deposition. Uptake can also occur through the roots as a result of transport into the soil from deposited windblown dust or by runoff from the ore pile onto the soil. These soil-to-plant pathways can affect the regional fauna as well. Herbivores may be exposed to these contaminants by ingestion.

The Site may provide a suitable habitat for several sensitive species of wildlife. The results from a formal survey are included in the discussion in Section 2.8. During site visits limited wildlife was noted, including various species of birds and small burrowing mammals. In addition to direct exposure by ingestion of plant material or surface water, site contaminants may also enter the food web by other means. For example, burrowing animals (including most small mammal species that provide an important prey base for many predators) may uptake contaminants by incidental ingestion of soil, inhalation of particulate-born or gaseous contaminants, or through the skin (dermal) exposure, as well as ingestion of plants or water.

4 Streamlined Risk Assessment

The streamlined risk assessment was performed by Karl Ford, BLM National Science and Technology Center, in November 2006 and was limited in scope to the 25 acre parcel identified as the Oat Hill Extension Mine. The following is a summary of the assessment as it was prepared in draft form by the BLM.

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). The adjacent Oat Hill Mine and the BLM Oat Hill Extension are so close in proximity that it is difficult to separate the risks from the two sites. For that reason, the site is referred to in this section as the OHE so as to not falsely attribute ecological risk to one or the other site. 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 Oat Hill/Extension have probably made an impact since the mine was discovered in 1870s. Mine and mill tailings generated from area mining activity have contributed mercury into water, stream sediments and soils. The site is in forested mountainous terrain with few residences within three miles. The nearest residence is approximately 1.25 miles due north of the site. Due to restricted site access, the site is infrequently visited by recreational users especially on weekends and holidays, although BLM may consider transferring the land after removal action is completed. The future land use is projected to be similar to the current land use but with more recreational use as access may be made more available, but limited to day-time hiking and equestrian use.

Recreational users generally may come into contact with the tailings by several exposure pathways and types of activities, 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 in RMC Technical Note

390 include camping, boating, swimming, and all types of off road vehicle use. The most pertinent and restrictive of these is the camper scenario which assumes a 14-day exposure duration. Campers may be exposed via soil ingestion and inhalation. Day use visitors would have proportionately lower exposure. 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. Figure 4-1 presents a site conceptual exposure model based on these pathways of exposure.

The COCs and migration pathways were identified from historical information and site evaluation. The camper scenario includes ingestion of groundwater, surface water, soil, sediment and fish, and inhalation of dust. 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.

Recreational demands are expected to increase at the site where exposure to metal concentrations in tailings and waste rock may exist. The COC selection process utilized chemicals documented to have been released to surface water and observed contamination in tailings at the site. The COCs for the site were selected by comparing background concentrations and EPA Preliminary Remedial Goals (PRGs) to the sample results in and around the site. The only COCs in mine wastes are mercury and methyl mercury in surface water, sediment and invertebrates.

The nervous system is very sensitive to all forms of mercury. Methyl mercury and metallic mercury vapors are more harmful than other forms, because more mercury in these forms reaches the brain. Exposure to high levels of metallic, inorganic, or organic mercury can permanently damage the brain, kidneys, and developing fetus. Effects on brain functioning may result in irritability, shyness, tremors, changes in vision or hearing, and memory problems.

Short-term exposure to high levels of metallic mercury vapors may cause effects including lung damage, nausea, vomiting, diarrhea, increases in blood pressure or heart rate, skin rashes, and eye irritation. Very young children are more sensitive to mercury than adults. Mercury in the mother's body passes to the fetus and may accumulate there. It can also pass to a nursing infant through breast milk. However, the benefits of breast feeding may be greater than the possible adverse effects of mercury in breast milk. Mercury's harmful effects that may be passed from the mother to the fetus include brain damage, mental retardation, uncoordination, blindness, seizures, and inability to speak. Children poisoned by mercury may develop problems of their nervous and digestive systems, and kidney damage, (ATSDR, 1999).

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

Mine Waste Site Conceptual Exposure Model (SCEM) for Human and Ecological Receptors

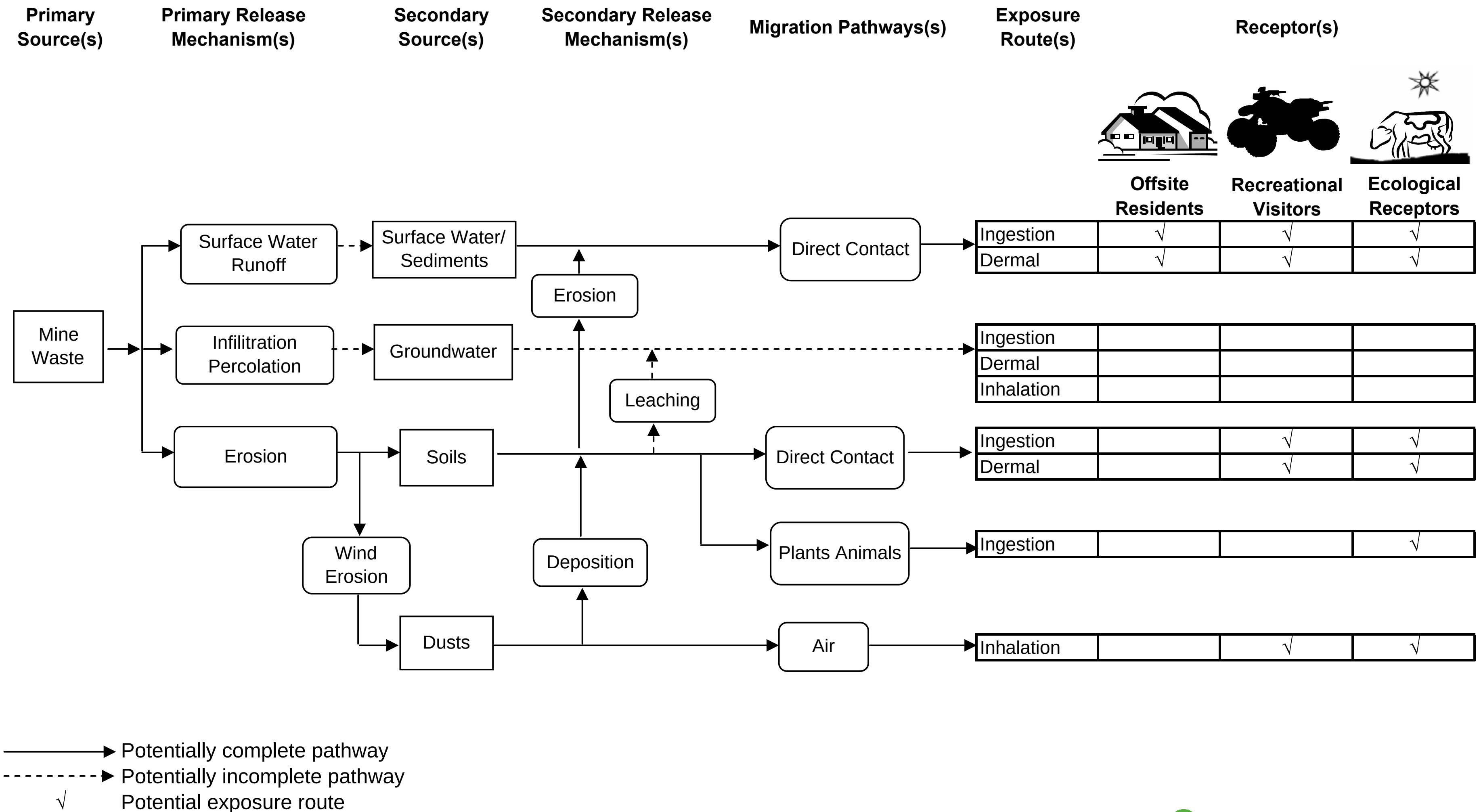


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Figure 4-1 Human and Ecological Site Conceptual Exposure Model

concern were developed using toxicity values and wildlife intake assumptions reported in the current ecotoxicology literature.

4.1 Human Health Risk Assessment

There are two types of risk associated with the Oat Hill/Extension Tailings: off-site risk and on-site risk. Off-site risk is associated with releases of tailings into the James Creek watershed that drains the site. Due to a lack of adequate run-on and run-off controls, precipitation events appear to have sent sufficient flows to erode the tailings and flush mercury-contaminated tailings into the James Creek watershed.

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 hiking, and exploring the mine site.

Sample results were compared to potential ARARs such as EPA PRGs for industrial use and to BLM RMCs for camping. Since the camper is based on 14 days of exposure, for each day of day-use activities, day users would have 1/14th the exposure of the hypothetical camper.

The RMC correspond to either a target excess cancer risk level of 1 x 10-5, or a target noncancer hazard index of 1.0. In the case of metals posing both carcinogenic and noncancer 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 x 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 noncancer 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 noncancer health effects. The RMC is 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.

4.2 Ecological Risk Assessment

Wildlife in the Oat Hill/Extension area and downstream may be exposed to metal contamination via several environmental pathways. Mercury and in particular, methyl mercury are important COCs in the aquatic ecosystem as mercury is normally bioaccumulated as methyl mercury in the aquatic food chain (this site may be an exception). It is well known that inorganic mercury is methylated in anaerobic sediments to the more toxic methyl mercury. Field investigations by the Slowey et al (2006) found evidence of anaerobiosis where plant roots stabilize sediment. While plants enable sedimentation at these locations, plant litter provides organic matter, enhancing microbial activity. In sulfate-rich water such as the Oat Hill/Extension seep/wetlands, mercury methylation has been observed in this type of environment, presumably due to the activity of sulfate-reducing bacteria (SRB). Some species of SRB are known to methylate mercury in freshwater sediments (Slowey et al, 2006).

Methylation of inorganic mercury is important because it greatly increases the bioavailability and toxicity of mercury and increases the exposure of wildlife and humans to methyl mercury.

Because mercury and methyl mercury bioaccumulate in the aquatic food chain, the potential exposure pathways include dietary ingestion, and direct exposure via the gill interface. Terrestrial wildlife may also be exposed although to a lesser degree, by ingestion of soil, dietary items and surface water. Ecological RMCs have been established for metals in soil and sediments for terrestrial wildlife. This has been accomplished using the best data available, including: ecotoxicological 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. Among 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.

RMCs 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. These 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 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 median wildlife RMCs for soil and sediment are found in Table 4-2.

4.3 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 RMCs, using a target hazard quotient and target excess lifetime carcinogenic risk, has inherent uncertainty. One source of uncertainty is the bioavailability of the metals, particularly inorganic mercury at this site seems higher than expected. 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, 2004). 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.

Uncertainty is also associated with the ratio of total mercury to methyl mercury in the invertebrate results which may reduce to the bioavailability and toxicity of mercury to aquatic receptors.

4.4 Risk Assessment Results

4.4.1 Tailings, Sediment, and Water

EPA Region 9 has published 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, typically with greater exposure than for recreational use (e.g. 250-365 days per year). Therefore, BLM uses RMCs for recreational use. 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 RMCs 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. Tables 4-1, 4-2, and 4-3 compare 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 red and scarlet, respectively. In Table 4-1, PRG HQs are flagged in similar manner.

Comparisons of all element concentration results with the BLM's camper RMC and PRG criteria are provided in Tables 4-1, 4-2, and 4-3.

Of the metals detected in tailings, mercury is the principal chemical of concern for human health with a risk management criterion (RMC) of 40 mg/kg for a 14-day camper, and 310 mg/kg for the industrial PRG. The 14-day camper scenario is the longest period a person may camp on BLM land at a given site. Using the mean metals results, mercury mine waste exceedances of camper RMCs are in the high risk range for campers and low risk range for the one day/year-user.

Concerning ecological risk, MMHg concentrations in sediments were relatively low in comparison to sediments from mine impacted watersheds, which average 1.9 ug/kg. Even in the sediment at the OHE with the highest total mercury concentration, the MMHg concentration was only 0.7 ug/kg. For ecological risk, Table 4-2 compares mean mercury concentrations to a Probable Effects Concentration (PEC) (EPA, 2000) for mercury. The PEC is based on toxicity to sediment dwelling organisms. The risks are in the high to very high risk range (10-100x). Background mercury at the site is 6 mg/kg. Tailings are migrating off-site into the James Creek watershed. The tailings are situated adjacent to a tributary of James Creek and appear to have been mobilized in flood events (Slowey et al, 2006) with impacts to the downstream watershed.

The mercury concentrations in the tailings (approximately 1,000 mg/kg) and mine waste exceed published phytotoxicity benchmarks of 5 mg/kg (Kabata-Pendias and Pendias, 1992) by more than 100-fold, however, grasses appear to flourish on the uneroded tailings.

A critical value for piscivorous wildlife is 0.05 ng/L methylmercury in water (Yeardley et al 1998, EPA, 1997). Surface water at the seep 04OHE-1 slightly exceeded this by 2 fold (low to moderate risk). The California water quality standard for total mercury was not exceeded at OHE.

4.4.2 Biota

In the following three subsections, two different types of data are discussed: total mercury (Hg_T) in invertebrates, frogs, and fish, and organic mercury in invertebrates, which is presumed to be and hereafter referred to as monomethyl mercury (MMHg). MMHg was not measured in frogs and fish by Slowey et al, but interpretation of Hg_T in frogs and fish is thought to be particles of cinnabar instead of MMHg and hence may be less toxic to aquatic life at this site.

Hg_T and MMHg were detected in all composite samples of invertebrates. The geometric means for MMHg in invertebrates collected from James Creek upstream and downstream of the OHE were not appreciably different (0.057 vs. 0.060 µg/g,). Average (geometric mean) MMHg concentrations in several invertebrate taxa collected from the James Creek watershed locations were generally higher than those measured at the reference Bear River watershed 'baseline' station where there are no known point sources of mercury (Slowey et al, 2006).

Unlike most ecosystems where most of the mercury in biological tissues is assumed to be methyl mercury (Slowey et al, 2006), only 40% of predatory insect samples had greater than 50% mercury as organic mercury. Compared to a gold mine-impacted ecosystem, the mean MMHg/Hg_T proportion in predatory insects collected from the OHE area was approximately half that of Greenhorn Creek, Nevada County, CA (Alpers et al., 2005).

The low proportions of MMHg measured in invertebrates in James Creek and the presence of cinnabar in the creek suggest that some invertebrates may have anomolously high mercury concentrations as a result of cinnabar 'contamination.' For example, one dragonfly larva contained 30 µg/g (ww) Hg_T, but only 0.06 µg/g (ww) MMHg, or 0.20%. Unlike this and other benthic invertebrates collected, water striders, whose exoskeletons should have been more thoroughly cleaned of particles and which do not feed in sediments, yielded the highest measured MMHg/Hg_T ratios since they likely were least contaminated by cinnabar. Because inorganic mercury is more quickly excreted from some aquatic organisms than MMHg and organic mercury is more toxic than inorganic mercury, assessment of ecological impairment using MMHg measurements in addition to Hg_T is necessary in mercury mine-impacted ecosystems. MMHg concentrations in invertebrates from the wetland area near OHE (OHE1) suggest that the sediments there produce methyl mercury that is taken up by lower trophic level organisms. The most contaminated invertebrates were from the OHE1 location, where MMHg concentrations in seven samples of invertebrates ranged from 0.06 to 0.22 µg/g MMHg, five of which exceeded 0.14 µg/g MMHg. Of the taxa available at OHE1, dragonflies, water striders, and diving beetles were found to have the highest concentrations of MMHg (all approximately 0.2 µg/g ww, on average) of all the samples collected from the study area.

Slowey et al (2006) conclude the relative contribution to the ecological impairment of James Creek of the OHE in addition to other sources of mercury is not clear from invertebrate Hg_T or organic mercury measurements because of this unusual MMHg/Hg_T ratio, and because upstream James Creek and downstream James Creek are not appreciable different in mercury concentrations.

As is the case for invertebrate data, the ecological impact of the OHE in addition to other sources of mercury to James Creek is not clear from frog HgT measurements. Average concentrations of Hg_T in frogs from James Creek were similar upstream (0.18 µg/g) and downstream (0.15 µg/g) of OHE drainage and at the lower Corona Mine adit drainage (0.14 µg/g). Hg_T in foothill yellow-legged frogs collected from the James Creek study area ranged from 0.1 to 0.6 µg/g Hg) was on average twice that of an extensive database compiled from studies throughout Northern California (0.2 vs. 0.1 µg/g Hg_T), with the highest concentration observed at the wetland area of the OHE in Autumn (Holthem, 2006).

Frogs may be susceptible to bioaccumulation of MMHg from invertebrates at this location, on the basis of relatively high HgT in one frog (0.6 µg/g) and MMHg in invertebrates at that location. The concentration of HgT in this frog from the wetland area of the OHE was only exceeded by only 16 of the 190 frogs analyzed by the USGS to-date in Northern California (Holthem, 2006). While these results suggest that Hg is accumulated in biota above the lowest trophic level in James Creek, further study is required to rule out their misinterpretation due to cinnabar 'contamination.'

Like invertebrates and frogs, fish mercury results do not clearly indicate whether the OHE site is ecologically impairing biota in addition to other sources of mercury to James Creek, nor do they provide any indication of the relative importance of the OHE to ecological impairment. A number of factors could have limited the use of fish data for this assessment, including the close proximity of the sampling locations. The fish, unlike invertebrates, likely resided at both sites. Hg_T concentrations in rainbow trout collected from James Creek up- and downstream of Tributary 1 averaged 0.1 µg/g and 0.13 µg/g, respectively. Similar concentrations were measured in the watershed by Slotton et al, (1999). It is uncertain whether rainbow trout collected from James Creek exceeded the U.S. Environmental Protection Agency 2001 advisory level of 0.3 µg/g methyl mercury of edible tissue (www.epa.gov/mercury), but whole body Hg_T did not exceed 0.3 µg/g. California roach upstream and downstream of OHE drainage averaged 0.16 µg/g. California roach had significantly higher Hg_T on average than trout. Compared with the same species from other sites in Northern California, fish from James Creek were moderately contaminated with Hg (Holthem, 2006). Similar fish Hg_T was measured in Spring 1998 in small and juvenile fish above the confluence of Tributary 1 with James Creek (Slotton and Ayers, 1999).

Some critical values for piscivorous wildlife range from (0.1 µg/g methyl mercury in fish tissue (Yeardley et al 1998, EPA, 1997). Most of the fish tissue samples would exceed this value by 2-3 fold assuming mercury is present as methyl mercury, however this assumption may not hold for this site.

4.5 Risk Assessment Conclusions

Mercury in the tailings may present a high risk to campers assuming 14 days of exposure; however this risk may be acceptable for day hikers (1 day/year). The sediments pose a risk to sediment dwelling organisms, but bioaccumulation at the site is uncertain and may be lower than at other Northern California sites. The results of the USGS biota investigation suggest that the while OHE contributes inorganic mercury to James Creek, they do not indicate whether the OHE site is ecologically impairing biota compared to other sources of mercury to James Creek, nor do they provide any indication of the relative importance of the OHE to the ecological impairment (Slowey et al, 2006).

Table 4-1 Oat Hill/Extension Comparison of Analytical Results and Risk Management Criteria – Tailings (mg/kg)

ANALYTE	23-OE-5 Lower pile	23 OE-12 Upper Pile	EPA Industry PRG	Camper RMC
Arsenic	**3.3**	**1.9**	1.6	20
Cadmium	0.2	0.1	450	70
Copper	37	28	41,000	5,000
Lead	14	13	750	1,000
Mercury	**998**	**117**	310	40
Methyl Mercury	NA	NA	62	NA
Zinc	108	87	100,000	40,000

Table 4-2 Oat Hill/Extension Comparison of Analytical Results and Risk Management Criteria Sediment and Soil (mg/kg)

ANALYTE	04OHE1 Seep Sediment	23-OE-13 Sediment	Median Wildlife RMC	Sediment PEC[1]
Arsenic	NA	11.6	275	33
Cadmium	NA	0.2	3	4.98
Copper	NA	63	136	149
Lead	NA	27	125	128
Mercury	**110**	**37**	8	1.06
Methyl Mercury	0.74	NA	NA	NA
Zinc	NA	120	307	459

[1] PEC - Probable Effects Concentrations (EPA, 2000)

Table 4-3 Oat Hill/Extension Comparison of Analytical Results and Risk Management Criteria
Surface Water (µg/l unless otherwise noted)

ANALYTE	04OHE1-B	CAWQS*
Arsenic	<1	
Cadmium	<0.02	
Copper	0.73	
Lead	<0.05	
Mercury	5.8 [2]	50[2]
Methyl mercury	***0.1*** [2]	0.05[3]
Zinc	3.2	

@Chronic aquatic life protection or drinking water, whichever is more stringent.
*Calculated based on hardness of 400 mg/L NA - Not available
2 ng/L
3 ng/L (Yeardley 1997)

5 Applicable or Relevant and Appropriate Requirements

The lead Federal agency (BLM) is responsible for the identification of ARARs of all environmental laws that pertain to any CERCLA removal actions. This analysis of ARARs is provided to ensure the proposed removal actions themselves are consistent with existing environmental standards. As defined in the Guidance on Consideration of ARARs During Removal Actions (EPA 1991):

> *"Applicable requirements are cleanup standards, standards of control, and other substantive requirements, criteria or limitations promulgated under Federal environmental or State environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstances found at a CERCLA site.*
>
> *Relevant and appropriate requirements are cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location or other circumstances at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site and are well-suited tot he particular site.*
>
> *Other information To Be Considered (TBC) generally falls within three categories: health effects information with a high degree of credibility; technical information on how to perform or evaluate site investigations or response actions; and policy."*

Table 5-1: Applicable or Relevant and Appropriate Requirements			
Standards, Requirement, Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate
Chemical-Specific			
Clean Air Act National Primary and Secondary Ambient Air Quality Standards National Emission Standards for Hazardous Air Pollutants	42 USC 7409 40 CFR Part 50 40 CFR Part 61, Subparts N, O, P, pursuant to 42 USC 7412	Establish air quality levels that protect public health, sets standards for air emissions Regulates emissions of hazardous chemicals to the atmosphere	Relevant pertaining to disturbance of waste material during consolidation, removal, or treatment.
Resource Conservation and Recovery Act	40 CFR Part 261, Subpart D	Defines wastes which are subject to regulation as hazardous wastes under 40 CFR Parts 262-265 and Parts 124, 270, and 271	Relevant pertaining to the potential disposal of the waste material.
Clean Water Act Water Quality Standards	33 USC 1251-1387, Section 303(c)(2)(B), 40 CFR Section 440.40-440.45 40 CFR Part 131, Quality Criteria for Water 1976, 1980, 1986	Chapter 26, Water Pollution Prevention and Control, sets criteria for water quality based on toxicity to aquatic organisms and human health	Relevant to surface water quality standards at the site
Safe Drinking Water Act National Primary Drinking Water Regulations and Maximum Contamination Goals National Secondary Drinking Water Regulations	40 USC 300 40 CFR Part 141, Subpart B pursuant to 42 USC 300(g)(1) and 300(j)(9) and 40 CFR Part 141, Subpart F, pursuant to 42 USC 300(g)(1) 40 CFR Part 143, Subpart B pursuant to 42 USC 300(g)(1) and 300(j)(9)	Establishes health-based standards for public water systems (maximum contaminant levels) and sets goals for contaminants Establishes welfare-based (non-enforceable) standards for public water systems (secondary maximum contaminant levels)	Relevant to drinking water quality at the site
Surface soil risk-based screening levels, Residential (December 2001)	California Regional Water Control Board	Guidance for the application of risk-based screening levels and decision making to sites with impacted soil and groundwater	To be considered
Surface soil risk-based screening levels, Industrial (December 2001)	California Regional Water Control Board	Guidance for the application of risk-based screening levels and decision making to sites with impacted soil and groundwater	To be considered
Water Supply, Reliability, and Environmental Improvement Act	H.R. 2828 (Updated October 6, 2004) House Report 108-573, Part 1	Improves water supply reliability and water quality while enhancing the environment in the State of California.	Not applicable or relevant and appropriate
Porter-Cologne Water Quality Act	California Water Code, Division 7: Water	Mandates that the quality of all the waters of the state shall be	Relevant

Table 5-1: Applicable or Relevant and Appropriate Requirements			
Standards, Requirement, Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate
	Quality, Water Code Section 13000-13002	protected for use and enjoyment by the people of the state.	
California Water Plan	Water Code §10004(a)	Provides for the orderly and coordinated control, protection, conservation, development, and utilization of the water resources of the state (Water Code §10004(a))	Relevant
State of California Drinking Water Policy	State Water Resources Control Board (SWRCB) No. 88-63	Provides direction indicating that groundwater is considered a potential drinking water source if the TDS levels are below 3,000 mg/L (specific conductance of 5,000 µS/cm) and the yield is more than 200 gallons per day.	Relevant to drinking water quality at the site
Regional Basin Plan for Central Valley	RWQCB Basin Plan water quality objectives	The Basin Plan for the Central Valley was prepared and implemented by the Central Valley RWQCB to protect and enhance the quality of waters in the region. The Basin Plan established location-specific beneficial uses and water quality objectives for surface water and groundwater of the region.	Relevant
State of California Water Resources Control Board	SWRCB Resolution 69-18, Statement of Policy with Respect to Maintaining High Quality Waters in California	Resolution 68-16 establishes the policy that high quality waters of the state "shall be maintained to the maximum extent possible" consistent with the "maximum benefit to the people of the state."	Relevant
State of California Water Resources Control Board	SWRCB Resolution 92-49, Policies and Procedures for Investigation and Cleanup and Abatement of Discharges under California Water Code Section 13304	Resolution 92-49 contains policies and procedures that the regional boards apply to all investigations and cleanup and abatement activities for all types of discharges subject to California Water Code Section 13304. Section III.G of the Resolution requires attainment of background water quality, or if background cannot be restored, the best water quality that is reasonable.	Relevant
California Safe Drinking Water Act	Title 22 California Code of Regulations (CCR) Sections 64431 and 64449(a)	Primary and secondary MCLs for public drinking water under the California SDWA of 1976.	Relevant
California Hazardous waste management statutes and regulations	California Hazardous Waste Control Act, California Health & Safety Code (CH & SC) 25100 to 25250.25, and 22 California Code of Regulations (CCR) 66001 to 68400.2	California's hazardous waste management rules include the federal Resource Conservation and Recovery Act (RCRA) rules and numerous more stringent state requirements. The state's rules apply to hazardous waste generators and transporters; owners and operators of hazardous waste treatment, storage, and disposal facilities (TSDF); and handlers of used oil and universal waste.	Not applicable
California Air Quality Control Act	California Air Resources Board	www.arb.ca.gov	Relevant
EPA Region III Risk-Based Concentration, Industrial	EPA Region III RBC Table (10/15/2003)	Concentrations pertaining to industrial exposure levels.	Not applicable
EPA Region III Risk-Based Concentration, Residential	EPA Region III RBC Table (10/15/2003)	Concentrations pertaining to residential exposure levels.	Not applicable

Table 5-1: Applicable or Relevant and Appropriate Requirements			
Standards, Requirement, Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate
Interim Guidance on Establishing Soil lead Cleanup levels at Superfund Sites	EPA Directive #9355.4-02, September 1989	Suggests levels for lead in soil – this factor is considered whenever lead is found at elevated concentrations in soils.	Not applicable or relevant and appropriate
Risk management Criteria for Metals at BLM Mining Sites	Ford, K.L., 1996, *Risk Management Criteria for metals at BLM Mining Sites* (Technical note 390) and BLM, 1998, *Interim Revision of Wildlife Management Criteria.*	BLM risk management criteria for metals at mining sites used to evaluate the potential risk posed by these metals; criteria have been developed for human, livestock, and wildlife receptors.	Applicable
EPA Region IX Preliminary Remedial Goals, Residential Soils	EPA Region IX PRG Table (10/01/2002)	Combine current EPA toxicity values with "standard" exposure factors to estimate acceptable contaminant concentrations in different environmental media (soil, air, and water) that are protective of human health.	To be considered
EPA Region IX Preliminary Remedial Goals, Industrial Soils	EPA Region IX PRG Table (10/01/2002)	Combine current EPA toxicity values with "standard" exposure factors to estimate acceptable contaminant concentrations in different environmental media (soil, air, and water) that are protective of human health.	To be considered
Location-Specific			
National Environmental Policy Act	7 CFR 799 (1969)	http://ceq.eh.doe.gov/nepa/regs/nepa/nepaeqia.htm	Substantive requirements are applicable.
The Historic and Archeological Data Preservation Act of 1974	16 USC 469 40 CFR 6.301	Establishes procedures to provide for preservation of historical and archeological data that might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program	Not applicable or relevant and appropriate.
Historic Sites, Buildings, and Antiques Act and Executive Order 11593	16 USC 461 et seq. 40 CFR Part 6.301(a)	Requires federal agencies to consider the existence and location of landmarks on the National Registry of Natural Landmarks to avoid undesirable impacts on such landmarks.	Relevant.
Protection of Wetlands Order, Executive Order 11990	40 CFR Part 6	Requires minimizing and avoiding adverse impacts to wetlands	Relevant.
Flood Plain Management, Executive Order 11988	40 CFR 6.302	Regulates construction in flood plains	Not applicable or relevant and appropriate.
Fish and Wildlife Coordination Act	16 USC 1251 661 et seq.; 40 CFR 6.302(g)	Requires coordination of Federal and State agencies to protect fish and wildlife	Substantive requirements are applicable
California Fish and Game Code	Section 2080	California natural resource law for threatened or endangered species.	Substantive

Table 5-1: Applicable or Relevant and Appropriate Requirements			
Standards, Requirement, Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate
	Section 3005 Section 5650		requirements are applicable
Migratory Bird Treaty Act	16 USC 703	Establishes federal responsibility for the protection of international migratory bird resources	Not applicable or relevant and appropriate.
California Preservation Laws	Administrative Code, Title 14, Section 4307	No person shall remove, injure, deface or destroy any object of paleontological, archaeological, or historical interest or value	Relevant.
California Solid Waste Management Regulations	TITLE 27. Environmental Protection, Division 2. Solid Waste, Subdivision 1. Consolidated Regulations for Treatment, Storage, Processing or Disposal of Solid Waste	Applies to all disposal sites meaning active, inactive closed or abandoned, as defined in §40122 of the Public Resources Code including facilities or equipment used at the disposal sites	Potentially applicable if solid waste is transported away from site or relevant and appropriate if a disposal facility is constructed as part of final action
Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act Standards Applicable to Generation of Hazardous Wastes Standards Applicable to Transporters of Hazardous Waste Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	42 USC 6901, et seq. 40 CFR Part 262 40 CFR Part 263, pursuant to 42 USC 6923 40 CFR Part 264, pursuant to 42 USC 6924, 6925	Establishes standards for the generation of hazardous wastes Establishes standards for persons transporting hazardous waste within the US if the transportation requires a manifest under 40 CFR Part 262 Defines acceptable management standards for owners and operators of facilities that treat, store, or dispose of hazardous waste	Not applicable or relevant and appropriate Applicable if hazardous wastes are transported off-site Substantive requirements possibly applicable
California Cultural and Paleontological Resources	Document 33.4	State-level cultural resource protection is regulated through the provisions of Appendix K of the California Environmental Quality Act (CEQA). Paleontological resource protection is regulated through the 1906 Antiquities Act.	Relevant.
California Wildlife Conservation Act	Fish and Game Code Section 2050-2068, Section 2080, Section 3005, and	California Department of Fish and Game Habitat Conservation Planning Branch	Substantive requirements are

Table 5-1: Applicable or Relevant and Appropriate Requirements			
Standards, Requirement, Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate
	Section 5650.		applicable.
Endangered Species Act	316 USC § 1531 (h) through 1543 40 CFR Part 6.302 50 CFR Part 402	Requires action to conserve endangered species and critical habitat.	Substantive requirements are applicable.
Action-Specific			
Clean Water Act National Pollutant Discharge Elimination System Effluent Limitations	33 USC 1342 Section 404 40 CFR Parts 122, 125 33 USC 131140 CFR Part 440	Requires permits for the discharge of pollutants from any point source into waters of the United States Sets standards for discharge of treated effluent to waters of the United States	Not applicable or relevant and appropriate.
Section 10 of the Rivers and Harbors Act	Section 10 of the Rivers and Harbors Act, 33 USC Section 403	Prohibits unauthorized obstruction or alteration of any navigable water of the United States.	Not applicable or relevant and appropriate.
California Air Resources Board Regulations	Chapter 5 Toxic Air Contaminant Emissions, Air Quality, and Health Risk (updated December 23, 2003)	Cal/EPA - Air Resources Board The 2003 California Almanac of Emissions and Air Quality	Relevant
Bevill Amendment	RCRA Section 3001 (a)(3)(A)(ii) 42 USC 6921 (a)(3)(A)(ii) 40 CFR Section 261.4(b)(7)	Exempts most mining wastes from regulation as hazardous waste. Exempted waste includes waste from the extraction and beneficiation of minerals, and some mineral processing waste.	Applicable
California Health and Safety Code and California Water Code	Section 13172 27CCR Section 22470 et seq Health and Safety Code Section 25143.1(b)(1&2)	Recognizes the Bevill exclusion	Applicable
California Integrated Waste Management Board Regulations	CCR Title 14	http://www.ciwmb.ca.gov/Regulations/	Applicable
California Mining Waste Regulations	27 CCR 22470-22510	Establish three groups of mining waste	Applicable
Design and Siting under California Water Code	Section 13172	State regulations governing the design of mining waste disposal units	Applicable
Department of Toxic Substances Control Regulations	CCR Title 26	http://www.dtsc.ca.gov/	Applicable
Federal Surface Mining Control and	Surface Mining Control and Reclamation	Establishes a program for the protection of human health and the	Not Applicable

Table 5-1: Applicable or Relevant and Appropriate Requirements			
Standards, Requirement, Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate
Reclamation Act	Act (SMCRA) 30 USC Section 1201 et seq	environment from the adverse effect of surface coal mining operations.	
California Surface Mining and Reclamation Act of 1975	Office of Mine Reclamation Article 9 Title 14 14CCR 3703 14CCR 3704 14CCR 3705 14CCR 3706 14CCR 3710 14CCR 3713	Protection standards for wildlife habitat Performance standard for backfilling, re-grading, slope stability, and recontouring Performance standards for revegetation Performance standards for drainage, diversion structures, waterways, and erosion control Performance standards for stream protection Performance standards for closure of surface openings	Potentially Applicable
Hazardous Materials Transportation Act: Standards Applicable to Transport of Hazardous Materials	49 USC § 1801-1813 49 CFR Parts 10, 171-173 and 177	Requires placing, packaging, documentation for the movement of hazardous materials on public roadways.	Potentially applicable
Closure Criteria for Municipal Solid Waste landfills	40 CFR Part 258.60 (a)(1-3)	Establishes design for caps.	Applicable to potential capping alternative

6 Identification of Removal Action Objectives

Removal action objectives (RAOs) have been developed based on analysis of the sources of contamination, the nature and extent of contamination, results of the human health and ecological risk assessments, and the ARARs that have been identified. The RAOs have been developed to control the contamination sources, and eliminate the potential for exposure of human and ecological receptors to Site contamination.

6.1 Removal Scope

The general evaluation criteria for the analysis of potential removal actions, as defined in the EPA document *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (1993), are effectiveness, implementability, and cost. These criteria are discussed in detail in Section 7.0. To define the RAOs for the OHE site, results of the site characterization activities and streamlined risk assessment were evaluated in an effort to develop removal goals that comply with the ARARs and are protective of human health and the environment. The RAOs are to:

- Prevent or reduce human exposure (through inhalation, ingestion, and dermal contact) to mercury in waste materials at the Site;

- Prevent or reduce ecological exposure (through inhalation, ingestion, and dermal contact) to mercury in waste materials at the Site;

- Prevent or reduce potential migration of mercury in waste materials at the Site via surface runoff, erosion, and wind dispersion; and

- Prevent or reduce potential migration of mercury in waste materials at the Site to groundwater and eventual potential recharge to surface water.

For the Site, not only must the proposed removal action address the RAOs, but it must also address any planned future use of the property to ensure consistency with these objectives. As a result, both the proposed removal action alternative and any potential further land use will be evaluated in subsequent sections to determine the extent to which they meet these RAOs. Although immediate and 100 percent attainment of the RAOs is not required for a removal action, it is considered to be a goal that is desirable pending availability of effective technologies and funding.

6.2 Removal Schedule

The BLM has determined that a non-time-critical removal action is appropriate at the Site. The removal could commence within 6 to 12 months following approval of this EE/CA. Based on past experience with the implementation of removal action technologies similar to those proposed in this EE/CA, it is estimated that any removal action undertaken can be completed within one year, assuming funding is available.

7 Identification and Analysis of Management and Treatment Technologies and Removal Action Alternatives

According to 40 Code of Federal Regulations (CFR) 300.415, the purpose of an EE/CA is to analyze potential removal action alternatives based on current site conditions to address contamination present at a site. The alternatives are evaluated and developed through the criteria suggested in the EPA document, *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (1993). Specifically, the removal action alternatives have been developed and analyzed against the RAOs and evaluation criteria separately.

The development and analysis of removal action alternatives involves four steps. In Section 7.2, the general categories of potential response actions are identified and described. The broad array of technologies that may apply to each category are then identified and screened in Section 7.3. This preliminary screening procedure has been conducted to identify those technologies considered applicable to the Site, and which may be potentially effective in meeting the RAOs. Although many of the technologies discussed in Section 7.3 are not applicable to the OHE site, they are presented to document that they were identified and considered. In Section 7.4, the potential response actions and technologies retained from the screening process in Section 7.3 have been assembled into removal action alternatives. Finally, the alternatives were analyzed against the criteria of effectiveness, implementability, and cost. A detailed description of this analysis is presented in Section 8.0.

7.1 Overview of Evaluation Criteria

The criteria used to evaluate removal action alternatives in an EE/CA are defined by EPA (1993). The three general criteria are effectiveness, implementability, and cost. The specific components of each criterion are defined as follows:

Effectiveness
- Overall protectiveness of human health and the environment
- Ability to achieve RAOs/ARARs
- Short- and long-term effectiveness

Implementability
- Technical feasibility
- Administrative feasibility
- Availability of materials and sources
- Community applicability

Cost
- Capital cost
- Post-removal control cost
- Present worth cost
- Maintenance and monitoring costs

7.2 Description of Broad Categories of Potential Removal Actions

The broad categories of potential removal response actions include:
- No action;
- Administrative controls;
- Surface water controls;
- Management and/or treatment of ore and tailings materials; and
- Site reclamation.

7.2.1 No Action

The No Action Alternative leaves contaminated materials at the Site in their current condition and assumes no further intervention will occur. Although the No Action Alternative will not actively meet the RAOs for the Site (they may be eventually achieved through natural attenuation), its consideration and evaluation is required. Other potential response actions will be compared to the baseline provided by the No Action Alternative. Under the No Action Alternative, no response activities or monitoring would occur at the Site.

7.2.2 Administrative Controls

Administrative controls include administrative land use restrictions, site access restrictions (such as fencing), and/or relocation of potential receptors in an attempt to minimize the potential for exposure to site contamination. In general, administrative controls do not actively address site contamination, but attempt to meet the RAOs by reducing the potential for human and ecological exposure to the contaminants. However, these controls do not address the mobility of the contamination, the direct exposure of contaminants to human or ecological targets, or the off-site transport of contaminated materials via other exposure pathways. Used in conjunction with a removal action, administrative controls can be an effective deterrent to deterioration of a remedy such as an engineered cap, by providing controls for natural processes such as erosion, as well as human intrusion such as trespassing or vandalism. Administrative controls may also include long-term maintenance activities such as monitoring.

7.2.3 Surface Water Controls

Surface water run-on controls or stormwater management structures include drainage channels, ditches, trenches, or other structures designed to prevent surface water from coming into contact with contaminated materials. By doing so, erosion of contaminated surfaces and subsequent off-site transport of contaminants via the surface water pathway are reduced. However, these controls do not address direct exposure of contaminants to human or ecological targets, or the off-site transport via other exposure pathways, particularly the air pathways. Surface water controls may be used in conjunction with other technologies to help the technologies perform optimally.

7.2.4 Management and/or Treatment of Waste Rock and Tailings Materials

Management or treatment of ore and tailings materials includes options that can be conducted in-situ or ex-situ. While it is typical to include treatment methods that do not require movement or handling of mining waste material (such as capping) in EE/CA reports, all in-situ treatment methods for the Site will require moderate handling of the mining waste. Stabilization of the contamination in place, restricting potential exposure by capping, or using innovative technologies to remove the contaminants without physically removing the ore or tailings piles have been identified and potential options are presented in Section 7.3. In addition, treatment methods that involve removal of the material to either on-site or off-site locations have been reviewed and are also presented in Section 7.3. In general, options that involve excavation of contaminated materials will meet the RAOs by removing the contaminants from the property; however, a higher initial cost is typically associated with these actions. Removal actions that involve leaving material in place are likely less expensive in the short term but may not always be effective in meeting the RAOs.

7.2.5 Site Reclamation

Site reclamation measures typically follow removal in order to stabilize the Site and bring natural processes such as erosion and deposition back into equilibrium. Site reclamation includes measures for amending and improving the soil to support vegetation, and revegetating the Site to stabilize the soil and support wildlife.

7.3 Identification and Screening of Management and Treatment Technologies

7.3.1 No Action

The No Action Alternative does not require the use of any management or treatment technologies.

Site-Specific Evaluation: Although the No Action Alternative will not meet the RAOs, it is used as a baseline against which other alternatives are measured. For this reason, and because a No Action Alternative is required according to EPA guidance, it is retained for further evaluation.

7.3.2 Institutional Controls

Institutional controls are used to restrict access or control use of a site. They include construction of barriers, installation of fences and gates, moats, warning signs, hostile vegetation, and designating the Site on lands records as a repository with ground water use restrictions. Site patrols and enforcement actions may be practical depending upon the remoteness of a site.

Site-Specific Evaluation: Institutional controls at the Site would not be expected to be effective in meeting the RAOs. Currently access is limited by a locked gate. While additional fencing may offer added human trespass prevention, it will likely not limit ecological exposure, nor does it address the potential for off-site migration of the contamination. Because of these issues, institutional controls by themselves, although retained for further analysis as a component of other identified alternatives in Section 7.4, are not expected to sufficiently address the RAOs.

Options such as installation of fences, gates, and warning sings are most appropriate for the Site because they are less expensive and easier to implement and maintain than barriers consisting of moats or earthen structures. Currently a locked gate controls access to the Site. Because Site access is through a locked gate, closure of additional public or private roads is not necessary. Site patrols were deemed impractical due to the remoteness of the Site location and were therefore screened out.

7.3.3 Surface Water Controls

Surface water diversion measures are implemented to reduce contaminant mobility by limiting water erosion processes. Drainage channel improvements are utilized for many purposes, including relocation or diversion of a stream around potentially contaminated areas. One approach is to use surface water management systems that divert stormwater away from contaminated areas, and possibly use vegetation or riprap to limit the potential for erosion. This option can be effective in reducing the potential for migration of contaminants; however, it will not reduce the potential for direct human and/or ecological exposures on site.

Site-Specific Evaluation: Surface water controls at the Site would be expected to contribute to remedial actions effective in meeting the RAOs. Surface water controls may prevent potential off-site migration from erosion of contaminated surfaces into the drainage channels present on Site. While surface water at the Site is very minimal if present at all, runoff from the site features flows into tributaries, and subsequently into James Creek. Therefore, controlling surface water flow through and over the contaminated materials on site may limit a significant exposure pathway. It is noted that surface water controls by themselves, are not expected to sufficiently address the RAOs. However, they are retained for further analysis as a component of other identified alternatives in Section 7.4.

7.3.4 Management and/or Treatment of Waste Rock and Tailings/ Materials

This section provides a brief description of the management and treatment alternatives for waste rock and tailings materials at the Site. The management and treatment alternatives are:

- Stabilization/containment;
- Solidification/fixing technologies;
- Excavation and removal to an on-site consolidation location; and
- Excavation and removal to an off-site commercial landfill facility.

Stabilization/Containment

Stabilization/containment technologies for application at contaminated sites include landfill covers (caps), vertical barriers, and horizontal barriers. Stabilization/containment is most likely applicable for (1) wastes that are low-hazard or immobile, (2) wastes that have been treated to produce low-hazard to low-mobility waste for on-site disposal, and (3) wastes whose mobility must be reduced as a temporary measure to mitigate risk until a permanent remedy can be tested and implemented (EPA 1997). Stabilization/containment is considered an established technology at sites where moderate volumes of metal contaminants (which are largely immobile) are the primary concern.

Capping systems reduce surface water infiltration, control fugitive dust emissions, improve aesthetics, and provide a stable surface over the waste. Capping prevents or reduces direct contact exposure from ingestion and inhalation. Consolidation and capping-in-place is an appropriate alternative when contaminated materials are left on site. This type of containment is an option where excavation and disposal or treatment actions are cost prohibitive. Consolidation and capping-in-place is a standard construction practice for addressing mine and mill waste; it uses standard equipment and employs demonstrated design methods. Cap construction costs depend on the number of components in the final cap system. In-situ vertical barriers, such as slurry walls, constitute an impermeable barrier situated perpendicular to the ground surface and groundwater flow to minimize the movement of contaminated groundwater off site and/or limit the flow of uncontaminated groundwater on site (EPA 1997).

The most important advantages of stabilization/containment are (1) surface caps and vertical barriers are relatively simple and rapid to implement at low cost and can be more economical than excavation and removal of waste, (2) caps and vertical barriers can be applied to large areas or volumes of waste, (3) engineering control is achieved and may be a final action if metals are well immobilized and potential receptors are distant, and (4) in some cases it may be possible to create a land surface that can support vegetation and/or be applicable for other purposes (EPA 1997).

Disadvantages of stabilization/containment include (1) design life is uncertain, (2) contamination remains on site and is available to migrate should containment fail, (3) long-term inspection, maintenance, and monitoring is required, and (4) the site must be amenable to effective monitoring (EPA 1997).

Site-Specific Evaluation: Consolidation and capping-in-place would be an appropriate action for the Site if excavation and disposal or treatment actions are cost prohibitive, for lower levels of contamination where environmental impacts outweigh the benefit, or if alternative actions are deemed too difficult to implement. Consolidation and capping-in-place is a standard construction practice for addressing mine and mill waste; it uses standard equipment and employs demonstrated design methods. Slope stabilization activities could include the partial excavation and re-compaction of the existing waste piles and re-contouring of the existing pile slopes.

Capping would involve placing covers over the waste material piles to limit the potential for human and ecological exposure to the contaminants, and limit the potential for off-site migration. The capping configuration would be graded so that drainage would follow the natural contours of the area. Surface water and erosion controls would limit the potential for degradation of the cover. Although capping would not reduce the toxicity or volume of contamination, it would reduce direct exposure, risk, and mobility by making the contamination inaccessible to human receptors. Capping would also limit stormwater flow and infiltration and promote runoff away from the contaminated areas, thereby reducing the potential for leaching of contaminants to groundwater. For these reasons, this technology is retained for evaluation.

Solidification/Fixing Technologies

Solidification or fixing technologies are treatment processes that change the physical characteristics of the contaminated material to reduce the mobility of the contaminants by creating a physical barrier to leaching. Specifically, these technologies improve the physical characteristics of the waste by producing a solid from liquid (or semi-liquid) wastes, reduce the contaminant solubility by formation of sorbed species or insoluble precipitates, decrease the exposed surface area across which mass transfer loss of contaminants may occur, and limit the contact between transport fluids and contaminants by reducing the material's permeability (EPA 1997).

Physical treatment methods involve the separation of particles based on differences in physical properties. Studies have shown that typical mobility of contaminants is an inverse function of particle size: the most mobile contaminants are usually found to be the smaller particle size classes (EPA 1997). Therefore, by physically separating the fines, or smaller particles, from the larger materials in the waste matrix, it may be possible to limit the volume of waste materials requiring treatment or storage. On the whole, this provides project cost savings by volume reduction; however, most physical separation techniques decrease in efficiency as particle sizes decrease. Physical treatment methods include particle size classification, gravity separation, and froth floatation, which utilizes a material's hydrophobic properties for separation. Other physical treatment methods include electrokinetic treatment and deep tilling.

Solidification technology is usually applied by mixing contaminated soil or treatment residuals with a physical binding agent to form a crystalline, glassy, or polymeric framework surrounding the waste particle. The applicability of this technology depends on the chemistry of the site-specific contaminants and the binders being used (EPA 1997). The soil-contaminant-binder equilibrium and kinetics are influenced by several factors and the cost of implementation can be relatively high.

Chemical treatment methods focus on using chemical reactions such as coagulation, ion exchange, and adsorption to either remove metals or neutralize the acid forming potential. These treatment processes include metals flocculation, precipitation, co-precipitation processes, soil washing, leaching processes, hydrometallurgical processing, fixation/stabilization processes, and various forms of in-situ treatment. Soil washing is a chemical process that extracts contaminants, such as metals, from sludge or soil using a liquid medium such as water as the washing solution. Acid extraction processes involve applying an acidic solution to the contaminated materials causing metals to be dissolved. Alkaline leaching is similar to acid extraction in that leaching solutions, such as ammonia, lime, or caustic soda, are applied to the contaminated media. Soil flushing is another innovative process that injects acidic or basic reagents or chelating agents into the contaminated media to solubilize metals (EPA 1997). Hydrometallurgical reprocessing involves excavating the waste materials and transporting the waste to an existing operating mill or smelter facility for processing, metals recovery, and subsequent disposal of the processed materials.

In-situ geotechnical fixation is a cost-effective method of remediating metals-contaminated soil and groundwater. In-situ fixation involves mixing chemical reagents with a small volume of pumped groundwater, and subsequent reinjection of the treated water around the upgradient perimeter of the contaminated plume. Fixation is a process of chemically altering the wastes to reduce the mobility and/or toxicity of the constituents. In-situ treatment involves direct mixing of precipitating and neutralizing chemicals or stabilization agents with the contaminated media in place. Chemical bond processes use in-situ mixing of proprietary powder or liquid reagents with soil to effect a chemical reaction forming an insoluble bond. For inorganic- and organic-based encapsulation methods, the contaminants are bound or enclosed within a stabilized mass, or a chemical reaction is induced between the stabilizing agent and the contaminant to reduce its mobility. Thermal desorption and distillation, a thermal rather than chemical method, can be used to remove mercury from waste material using a rotary kiln, or by distillation processes; however, these processes do not address the other metals in the waste material and are fairly costly**.**

Site-Specific Evaluation: While physical and chemical treatment of contaminated waste and soils has been effective on most metals; effectiveness in reducing the leaching potential of mercury in the waste materials in not well established. No known treatment technologies applied directly to the solid mine waste materials are expected to sufficiently address the RAOs. For these reasons, physical and chemical treatment technologies are not retained for further analysis.

Excavation and Removal to an On-Site Consolidation Cell

This alternative involves excavation, relocation, and placement of the waste rock and tailings materials in an on-site consolidation cell. Under this alternative, the on-site consolidation cell would be selected based on available surface area, natural lithology, groundwater table elevation, surface drainage area, and other relevant factors. The area of consolidation would be specifically designed and constructed to contain the waste and mining materials.

Excavated waste rock and tailings materials would be transferred to the on-site consolidation cell and placed in the densest volume practicable (by compaction). The consolidation cell design could include appropriate controls such as a barrier layer, leachate collection system, surface water controls, and site security and/or fencing as needed. In addition, programs could be developed for the consolidation cell to address waste characterization, operating protocols, daily cover, groundwater monitoring, and explosive gas monitoring, as applicable. Notification and closure plans would be prepared for the location.

Upon completion of waste rock and tailings placement, final grading would be completed and final cover layers would be placed, leaving the consolidation location in a condition of orderliness and good aesthetic appearance. Final grading would promote surface water runoff and protect against excessive erosion. Final cover layers would likely include a low-permeability layer, as well as rooting and seed bed layers to support native plant growth. Establishment of a vegetative cover over the consolidation cell would further reduce infiltration and erosion due to transpiration and interception processes. Removal and placement of the waste materials into the on-site consolidation cell would substantially reduce the potential exposure to human and ecological receptors.

Site-Specific Evaluation: Relocation of the waste rock and tailings materials to a controlled environment would eliminate the unchecked migration of contaminants. The on-site consolidation cell's final cover system would reduce the potential for contaminant transportation via surface water and air pathways. By reducing the potential for water to contact the waste, transport by groundwater would also be reduced. Removal and placement of the waste rock and tailings materials into an on-site consolidation cell would substantially reduce the potential exposure to human and ecological receptors. This alternative provides a high potential for RAO and ARAR achievement and is retained for further evaluation.

Excavation and Removal to an Off-Site Commercial Landfill Facility

This alternative involves excavation, relocation, and placement of the waste materials in an off-site commercial landfill facility. Under this alternative, the location of the off-site facility would be selected based on availability of landfill space, haul distance, and cost. The facility would be permitted for solid waste and would be able to accept the waste rock and tailings materials without substantial facility modifications.

Excavated waste rock and tailings materials would be transferred to the off-site landfill and placed in open cells in a manner determined by the facility operator. The facility would be responsible for being in compliance with all applicable regulations governing solid waste disposal which may include site security, fencing, daily cover, groundwater monitoring, explosive gas generation, leachate collection, and hazardous waste characterization.

Site-Specific Evaluation: Relocation of the waste rock and tailings materials to a controlled environment would eliminate the unchecked migration of contaminants. The off-site commercial facility would be responsible for installation of a cover system to reduce the potential for contaminant transportation via the surface water, groundwater, and air pathways. Material from the Site with analytical results exceeding the EPA TCLP levels would require additional treatment prior to delivery to a solid waste landfill, or would require placement in a regulated hazardous waste landfill. Additional samples may need to be collected to further characterize the contamination areas to determine final disposal locations (hazardous or nonhazardous). Removal and placement of the waste rock and tailings materials into an off-site commercial facility would substantially reduce the potential exposure to human and ecological receptors. This alternative provides a high potential for RAO and ARAR achievement and is retained for further evaluation.

7.3.5 Site Reclamation

Site reclamation measures typically follow removal in order to stabilize a site and bring natural processes such as erosion and deposition back into equilibrium. In addition to the surface water control measures and treatment measures included in this discussion, site reclamation includes measures for amending and improving the soils to support vegetation, and revegetating the Site to stabilize the soil and support wildlife.

Soils

Amending the soils in the disturbed areas of the Site can be accomplished by augmenting them with new soils from other areas, by soil replacement and re-building the soil horizons. Organic matter, water polymers, micronutrients, macronutrients, and nitrogen fixers can be added and tilled in as necessary to help the soils sustain vegetation (Claussen 1998; Munshower 1994; Groff 1994). These activities can stimulate plant growth, and enhance microbial processes, nitrogen utilization, and nutrient cycling rates. Organic matter can be introduced by adding composted plant litter or composts, or by planting fast-growing grasses that distribute a large amount of root biomass through the upper horizons of the soil (Munshower 1994; Claussen 1998). Bacterial and mycorrhizael (fungal) inoculants are often used to enhance the soil matrix to promote recovery (Claussen 1998). Use of these inoculants is determined through a survey of the mycorrhizae and ectorrhizae present in the native vegetation on site (Claussen 1998; Groff 1994).

Mulching provides moisture retention, limits the impacts from erosion, and helps prevent seed loss from wind dispersion. An extensive mulching effort using native hay with litter detritus, seed, and root materials can also provide organic material and propagules (Munshower 1994). Other traditional mulch materials include straw, wood fiber (cellulose), netting, mats, paper, gravel, jute, bark chips, rice hills, and coconut fiber (Goldman et al. 1986). For most areas, pea-sized gravel mulch at 25 percent by volume in the growth media is used with surface roughening to prevent rill erosion from forming (Munshower 1994).

Revegetation

The reintroduction of native species to an area should be utilized to achieve a desired ecosystem mix and provide a more self-sustaining population. Revegetation can be accomplished through various seeding and planting methods. Seeding should be accomplished in the fall, and could be performed by traditional methods such as broadcast seeding, seed drills, and hydromulch, or by innovative methods such as seed balls, which mimic cattle’s role in seed distribution (SER 1999).

Site-Specific Evaluation: Site reclamation will be used in combination with other alternatives and is retained for evaluation. All revegetation alternatives incorporate the highest quality classes of specified materials and amendments. These include Class I commercial compost (Biocomp), agricultural grade lime, Biosol™, Humate™, weed-free straw mulch, double-net erosion control fabric, and exclusively native species in the seed mix. Previous experience has shown that the somewhat higher cost of these products is greatly outweighed by the benefit they contribute to enhanced revegetation success. Soil amendments are recommended based upon soils analysis results and site conditions.

7.4 Assembly of Removal Action Alternatives

The general potential response actions and technologies described in the preceding sections have been assembled into five removal action alternatives that have been analyzed with respect to the evaluation criteria. These alternatives have been developed based on the known nature and extent of soil contamination and results of the human and ecological risk assessments. A "No Action" alternative has been included for comparison purposes. In addition, Alternatives 2 and 3 are "limited actions" that do not fully address the RAOs. These alternatives have been included to address the contact of surface water to waste materials at the Site and to stabilize physical hazards. They are not intended to address all areas of elevated risk at the Site. The five alternatives are as follows:

- Alternative 1: No Action
- Alternative 2: Run-on/off Controls
- Alternative 3: Stabilization by Terracing Slopes
- Alternative 4: On-Site Consolidation and Capping
- Alternative 5: Removal to Off-Site Commercial Landfill Facility

7.4.1 Alternative 1: No Action

The No Action Alternative leaves contaminated materials at the Site in their current condition and assumes no further intervention will occur. Under the No Action Alternative, no response activities or monitoring would occur at the Site.

Effectiveness

The No Action Alternative would not be effective in protecting human health or the environment, would not attain ARARs, and would not meet RAOs. Laboratory results indicate concentrations of mercury at the large pile in the north area and the upper and lower tailings in the extension areas exceed the BLM Camper, BLM Ecological Risk, and EPA PRG screening criteria. The material sampled was taken from the surface of the piles, therefore creating a high possibility of off-site migration and contact pathways. The highest mercury concentration that would remain is 1495 mg/kg (ppm). Short- and long-term risks to important environmental resources, as well as potential human health risks, would continue to exist. The No Action Alternative does not reduce the risk to human health through ingestion, inhalation, or dermal contact pathways. The toxicity, mobility, and volume of contaminants would not be reduced under this alternative.

Implementability

The No Action Alternative is technically implementable; however, this alternative would likely not be acceptable to regulatory agencies or BLM personnel given that the risk assessment concluded that several waste rock and tailings material piles pose an unacceptable risk to human health and the environment based on the elevated concentrations of mercury. Technical and administrative feasibility criteria do not apply to the No Action Alternative.

Cost
There is no direct capital or operating costs associated with this alternative.

7.4.2 Alternative 2: Run-on/off Controls

This alternative aims to minimize contact of run-on with the waste materials on site. This alternative is a limited action alternative in that is does not directly satisfy the RAOs; however, it acts as a preventative measure to limit the potential for transport of contamination off-site. This alternative includes construction of permanent surface water diversion structures above the mine waste piles. Figure 7-1 presents a graphical depiction of this alternative.

The primary elements of this alternative include:

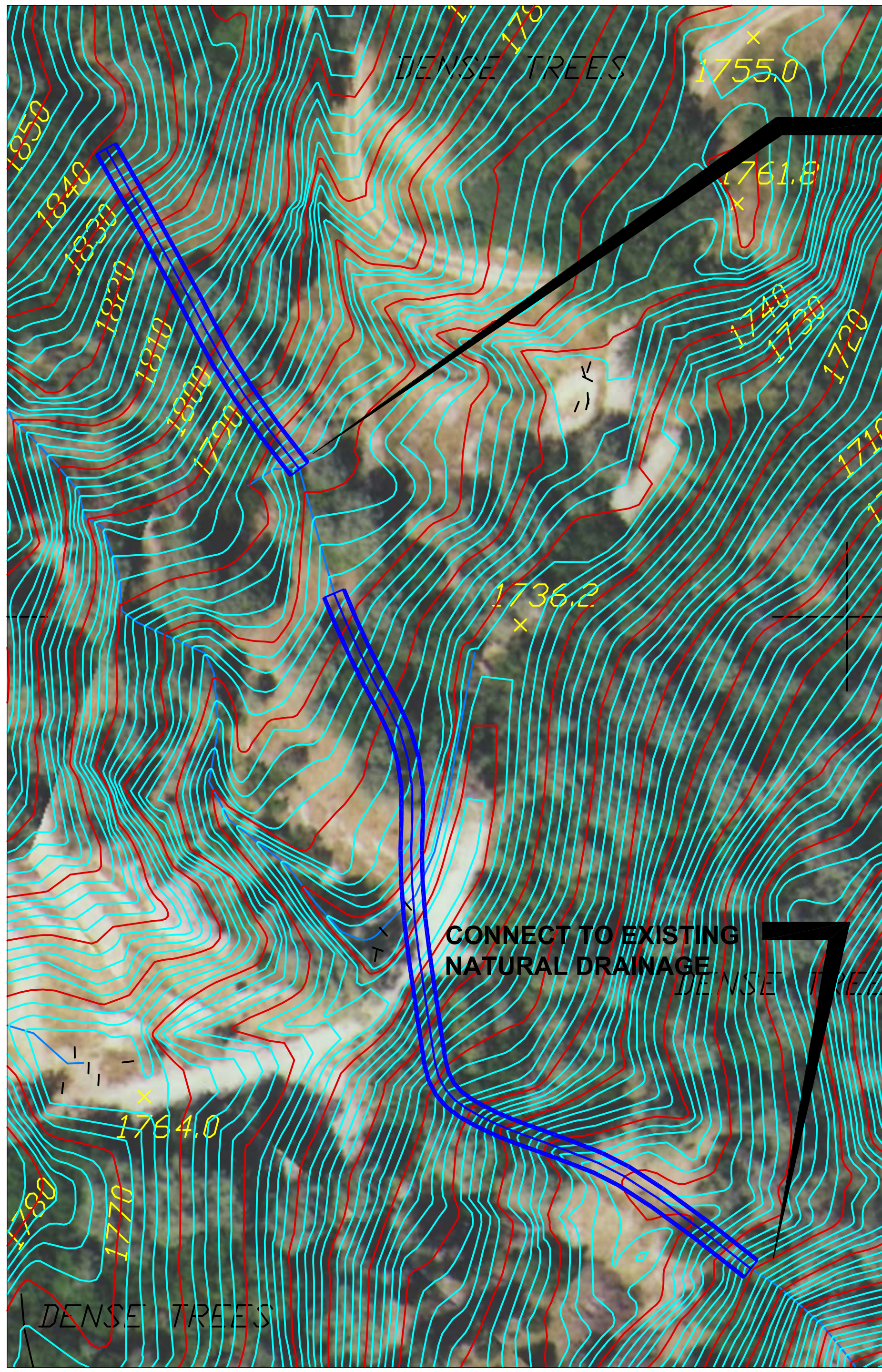
- Construction of permanent surface water diversion structures above (north of) the large waste rock pile and above (northwest of) the extension areas

- Tying the constructed surface water diversion structures into natural drainage features

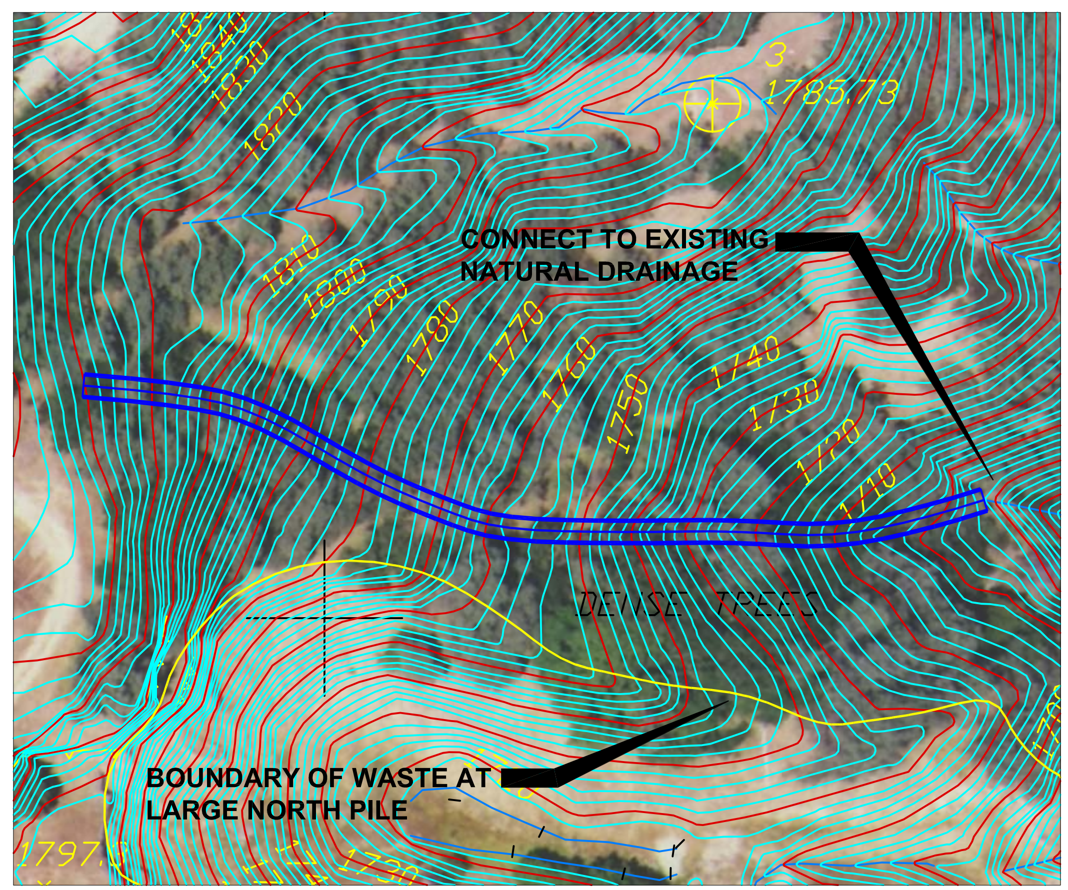
This alternative will include construction of two primary surface water control structures. One structure at the north side of the site will run generally west to east for a length of approximately 400 linear feet. The second structure will be located at the southwest portion of the site, running generally northwest to southeast for a length of approximately 500 linear feet.

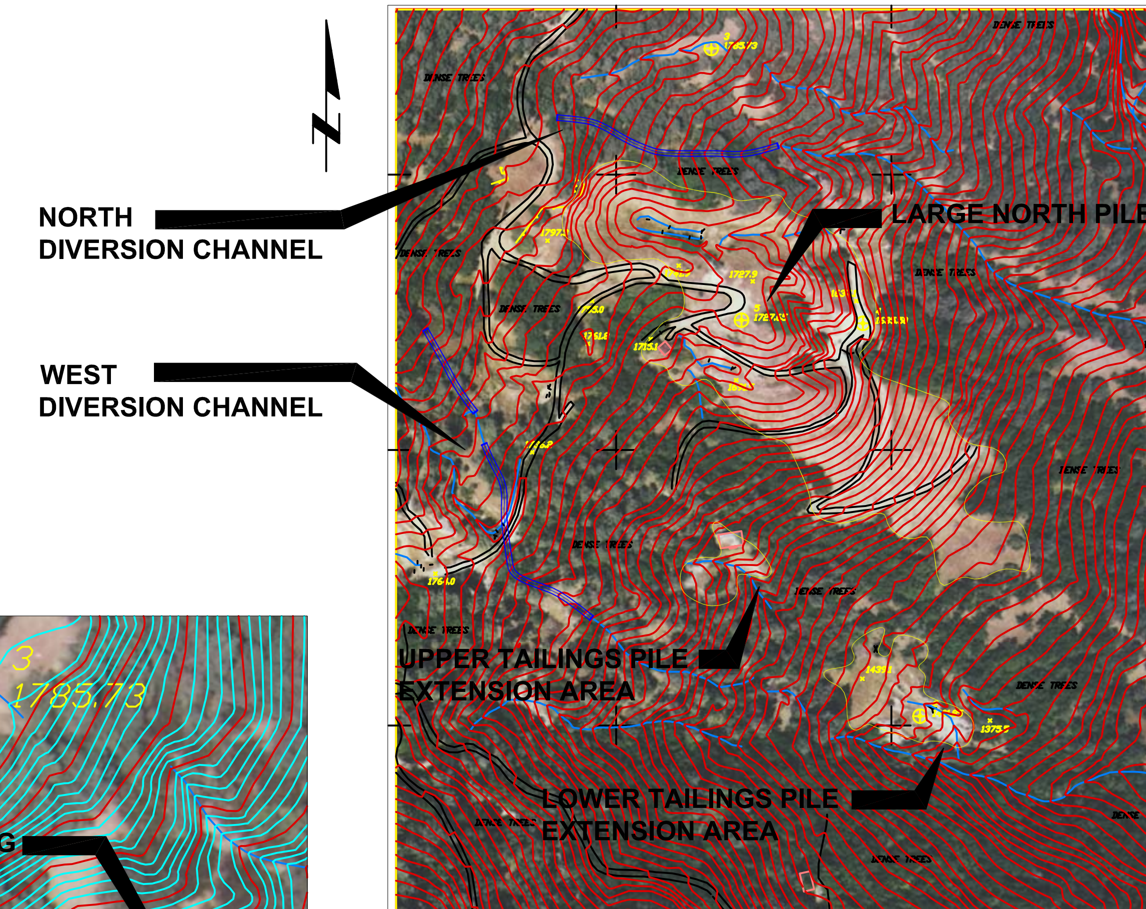
Effectiveness
The design concepts comprising this alternative provide a limited level of environmental protection considering the chemical and physical characteristics of the contamination. This alternative would be effective in removing the potential for off-site migration via

WEST DIVERSION CHANNEL

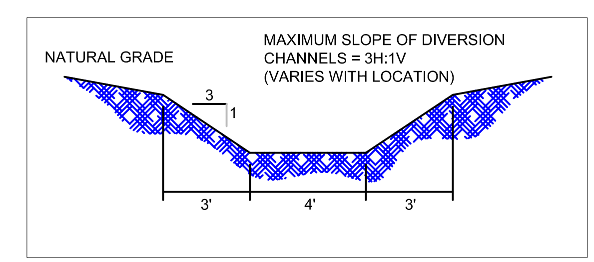


NORTH DIVERSION CHANNEL





OVERALL SITE LAYOUT



DIVERSION CHANNEL DETAIL

ALTERNATIVE 2:
RUN-ON/OFF CONTROLS

No.	Revisions	Date
#1		
#2		
#3		
#4		

Walsh Environmental Scientists and Engineers, LLC

Oat Hill Extension Mercury Mine
Engineering Evaluation / Cost Analysis (EE/EA)
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Scale: 1" = 100'
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Date: SEPTEMBER 21, 2007	Drawn By: A. HAINES
Project No. 7469-010	Checked By: C. G. LABERGE, PE
Figure: 7-1	Sheet: 1 OF 1

surface water flow. Although it would not prevent all off-site migration of contaminants, the alternative would control the amount of water coming in contact with the waste material at the surface of the piles. It would not be effective in reducing direct ecological and human contact with the piles. However, direct human contact to contamination is currently limited by the existing locked site access gate, as well as vegetation that has been established on the surface of the piles. Because all operations would be conducted on site, potential risks to the public related to the transport of hazardous waste would be limited.

Although not suggested as part of this alternative, RAOs and ARARs could be better obtained if additional administrative controls were implemented, such as fencing, signage, and additional monitoring. Fencing and signage could reduce ecological and human contact with contamination that remains exposed at the Site. Monitoring in the form of sampling of surface water and sediments in the tributaries to which the constructed diversion structures would connect would aid in identifying migration to downstream waterways such as James Creek and better determine the occurrence of contaminant migration. These administrative controls, however, would still not address the potential for off-site migration.

It is anticipated that there may be several short-term mitigable impacts to the environment during implementation of this alternative. Impacts could include wildlife disturbance through noise and human activity during construction.

Alternative 2 does not meet RAOs regarding contact with ecological and human receptors. However, it could be used as a short-term measure until a more comprehensive removal action is taken.

Implementability

The actions required for construction of this alternative are technically feasible using standard methods and procedures. The necessary equipment, personnel, and services are readily available to support implementation of this alternative. For Alternative 2 it is assumed only small excavation equipment would be necessary. Road improvements under this alternative would not be necessary because vehicle traffic on and off site would be minimal.

Cost

The estimate for implementing this alternative is $146,300 in year 2007 dollars. Annual operating and maintenance costs, as well as estimated indirect capital costs associated with administration, testing, and engineering, have been included. The costs have been included in the total under a present worth analysis over a 30-year design life using a discount rate of 7 percent. A detailed cost estimate is included in Appendix A.

7.4.3 Alternative 3: Stabilization by Terracing Slopes

This alternative aims to minimize offsite migration of contaminated materials by erosion. This alternative is a limited action alternative in that is does not directly satisfy the RAOs; however, it acts as a preventative measure to limit the potential for transport of contamination off-site. This alternative includes the terracing of the steepest slopes where waste materials are piled in such a way that they are currently extremely unstable and pose not only a risk of erosion, but also a physical risk of collapse. This alternative also addresses run-on of surface water by incorporating the construction of permanent surface water diversion structures above the mine waste piles such as those included in Alternative 2. Figure 7-2 presents a graphical depiction of this alternative.

The primary elements of this alternative include:

- Repositioning the material from the areas with the steepest slopes (i.e., the material in the large pile situated directly below the upper bench and man-made rock wall on the north edge of this pile) so that it is stable and contained by the rock walls to the north and by a step down terracing on the down slope side;

- Construct terrace walls in a step down configuration to contain the waste, similar to small retaining walls;

- Grading, contouring, and compacting the terraced waste so that the tops of the terraces are sloped to drain out and away from the center of the pile;

- Construction of permanent surface water diversion structures above (north of) the large waste rock pile and above (northwest of) the extension areas and tying the constructed surface water diversion structures into natural drainage features

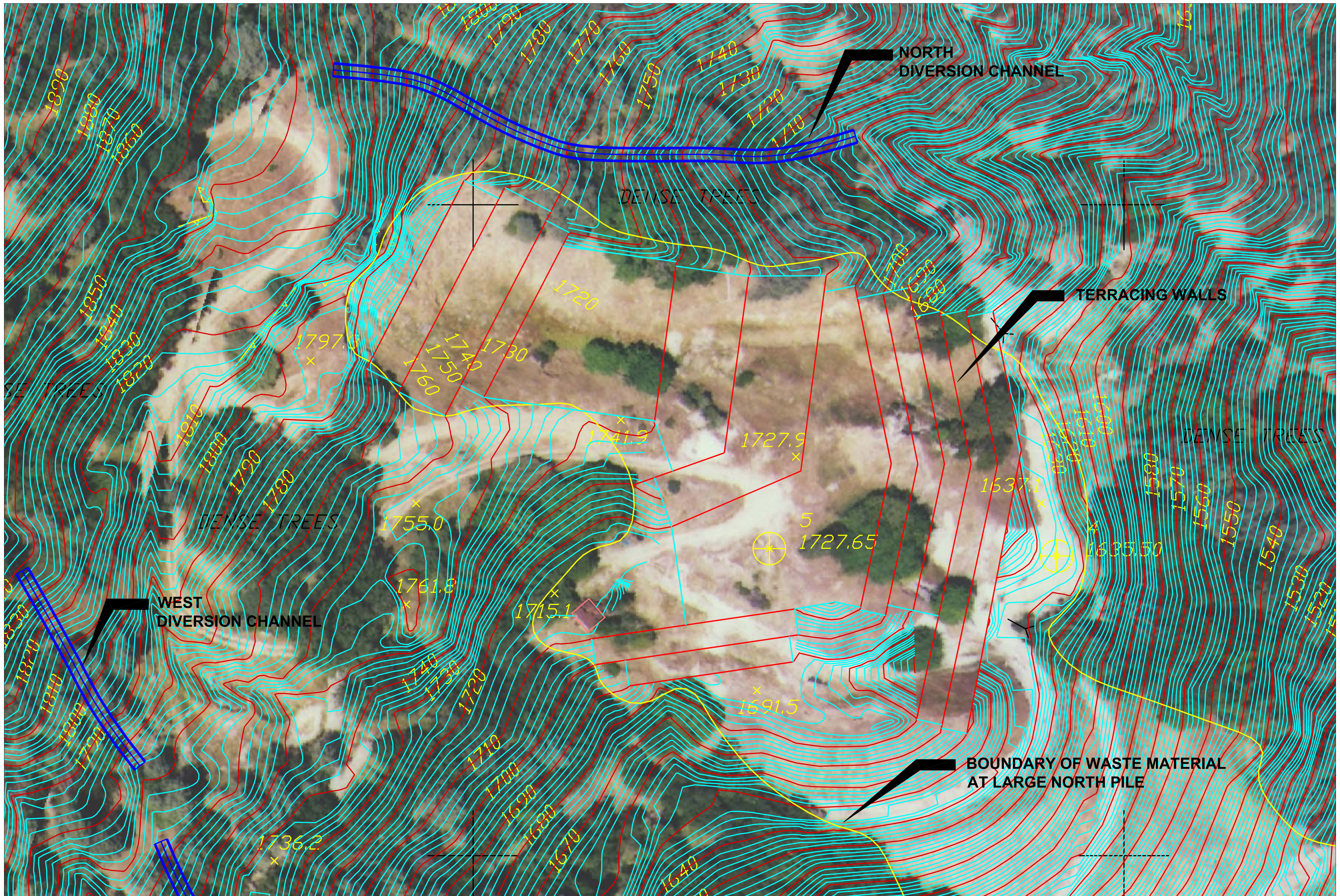
This alternative would utilize the man-made vertical wall at the northern portion of the large waste rock pile as the starting point for a series of step down terraces in order to contain the waste in such a way that it does not pose a means of erosion or a risk of collapse. Each step of the terrace would measure approximately 20 feet wide and 5 feet tall. Slopes between the terraces would be stabilized to a maximum slope of 2H:1V for a horizontal distance between 20 and 40 feet, depending on the volume of material in specific areas of the pile. The vertical wall feature of each step down would be constructed of lumber and would be a total 10 feet in height (5 feet visible at the face of the terrace and 5 feet buried for structural support).

Surface water diversion structures, similar to those included in Alternative 2 will be constructed at the top of the site to convey water around the perimeters of the piles and will connect to existing natural drainages.

Effectiveness

The design concepts comprising this alternative provide a limited level of environmental protection considering the chemical and physical characteristics of the contamination.

TERRACING PLAN VIEW

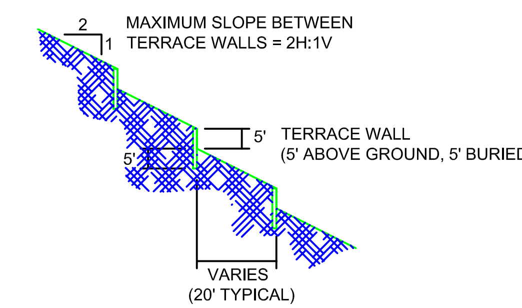


NOTES

STABILIZATION BY TERRACING:

1. MAXIMUM SLOPES BETWEEN TERRACE WALLS IS 2H:1V.
2. WALLS ARE 10 VERTICAL FEET (5 FEET VISIBLE AND 5 FEET BURIED).
3. TYPICAL HORIZONTAL DISTANCE BETWEEN TERRACE WALLS IS 20 FEET; HOWEVER, THIS VARIES BY LOCATION. SEE PLAN VIEW.

TERRACING DETAILS



ALTERNATIVE 3:
STABILIZATION BY TERRACING SLOPES

No.	Revisions	Date
#1		
#2		
#3		
#4		

Walsh
Environmental Scientists and Engineers, LLC

Oat Hill Extension Mercury Mine
Engineering Evaluation / Cost Analysis (EE/EA)
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Scale: 1" = 50'
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Date: SEPTEMBER 21, 2007	Drawn By: A. HAINES
Project No. 7469-010	Checked By: C. G. LABERGE, PE
Figure: 7-2	Sheet: 1 OF 1

This alternative would be effective in removing the potential for off-site migration via erosion and surface water flow. Although it would not prevent all off-site migration of contaminants, the alternative would provide stability for the steep slopes of the large pile and would control the amount of water coming in contact with the waste material at the surface of the piles. It would not be effective in reducing direct ecological and human contact with the piles. However, direct human contact to contamination is currently limited by the existing locked site access gate, as well as vegetation that has been established on the surface of the piles. Because all operations would be conducted on site, potential risks to the public related to the transport of hazardous waste would be limited.

Although not suggested as part of this alternative, RAOs and ARARs could be better obtained if additional administrative controls were implemented, such as fencing and signage. Fencing and signage could reduce ecological and human contact with contamination that remains exposed at the Site.

It is anticipated that there may be several short-term mitigable impacts to the environment during implementation of this alternative. Impacts could include wildlife disturbance through noise and human activity during construction.

Alternative 3 does not meet RAOs regarding contact with ecological and human receptors. However, it could be used as a short-term measure until a more comprehensive removal action is taken.

Implementability

The actions required for construction of this alternative are technically feasible using standard methods and procedures. The necessary equipment, personnel, and services are readily available to support implementation of this alternative. For Alternative 3 it is assumed both excavation equipment and hand work would be necessary. Road improvements under this alternative would not be necessary because vehicle traffic on and off site would be minimal.

Cost

The estimate for implementing this alternative is $1,209,400 in year 2007 dollars. Annual operating and maintenance costs, as well as estimated indirect capital costs associated with administration, testing, and engineering, have been included. The costs have been included in the total under a present worth analysis over a 30-year design life using a discount rate of 7 percent. A detailed cost estimate is included in Appendix A.

7.4.4 Alternative 4: On-Site Consolidation and Capping

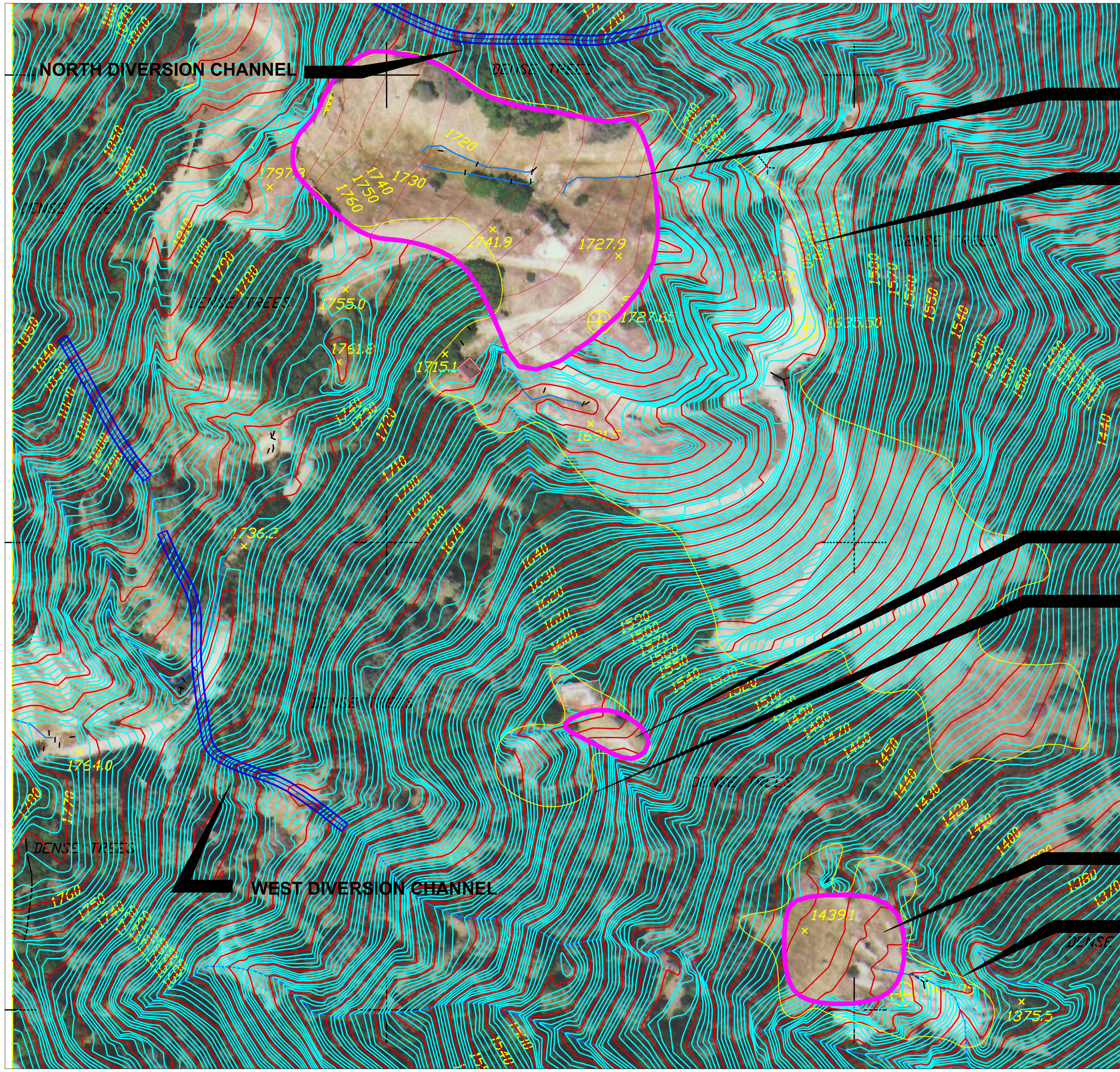
This alternative aims to eliminate the potential for human and ecological contact with contaminated materials and to reduce offsite migration of contaminated materials via gravity, wind, and water erosion. This alternative satisfies the RAOs; as it is protective of human and ecological health and it limits the potential for transport of contamination off-site. This alternative includes the consolidation of waste materials into containment cells and capping of these cells. It includes vegetation of the caps, run-on/off controls, and an administrative closure. A groundwater monitoring plan and investigation is also included in this alternative to provide further characterization of this media for which limited data is currently available. Figure 7-3 presents a graphical depiction of this alternative.

The primary elements of this alternative include:

- Consolidation of approximately 185,200 cy of waste rock and tailings material in the northern portion of the site;
- Grading, contouring, and compacting the newly placed material at the north consolidation location so that it is stable and contained by the man-made walls to the north with a southeast facing slope of 3H:1V;
- Regrading, recontouring, and compacting the material in the south extension areas (approximately 2,500 cy at the upper tailings and approximately 40,000 cy at the lower tailings), so that the piles are stable with southeast facing slopes of 3H:1V;
- Placement and compaction of vegetation cover consisting of 12 inches of select fill and 6 inches of topsoil over the newly placed material at both the north containment cell and the south extension areas;
- Revegetation of the newly placed and regarded material;
- Construction of surface water diversion structures around the containment cells, and connection to the existing drainages;
- Installation of 3 groundwater monitoring wells, long term sampling plan, and compilation of groundwater level and contaminant data into a characterization report;
- Site monitoring including cap and leachate monitoring; and
- Designation of the Site on lands records as a repository with restrictions on future use of the Site.

North Containment Cell

This alternative would utilize the man-made vertical wall at the northern portion of the large waste rock pile as the upper bounds of the north containment cell. The waste



ON-SITE CONSOLIDATION PLAN VIEW

NORTH CONTAINMENT AREA

BOUNDARY OF WASTE MATERIAL AT LARGE NORTH PILE

UPPER TAILINGS CONTAINMENT AREA

BOUNDARY OF WASTE MATERIAL AT UPPER TAILINGS PILE EXTENSION AREA

LOWER TAILINGS CONTAINMENT AREA

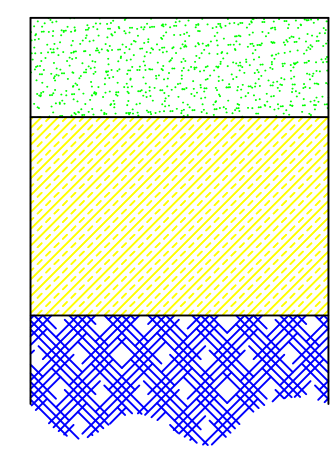
BOUNDARY OF WASTE MATERIAL AT LOWER TAILINGS PILE EXTENSION AREA

NOTES

ON-SITE CONSOLIDATION AND CAPPING:

1. WASTE MATERIAL WILL BE EXCAVATED FROM WITHIN DELINEATED BOUNDARIES.
2. EXCAVATED MATERIAL WILL BE PLACED WITHIN CONSOLIDATION BOUNDARIES.
3. MATERIAL IN CONSOLIDATION AREAS WILL BE GRADED TO SLOPES OF NO GREATER THAN 3H:1V.
4. CAPS WILL CONSIST OF 12 INCHES OF VEGETATIVE COVER AND 6 INCHES OF TOPSOIL.
5. AREAS OF EXCAVATION WILL BE REGRADED TO FILL VOIDS LEFT FROM EXCAVATION AND TO PROMOTE POSITIVE DRAINAGE.

CAP DETAILS



6 INCHES TOPSOIL

12 INCHES VEGETATIVE FILL

WASTE (DEPTH VARIES)

ALTERNATIVE 4:
ON-SITE CONSOLIDATION AND CAPPING

No.	Revisions	Date
#1		
#2		
#3		
#4		

Walsh
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Oat Hill Extension Mercury Mine
Engineering Evaluation / Cost Analysis (EE/EA)
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Scale: 1" = 100'
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Date: SEPTEMBER 21, 2007	Drawn By: A. HAINES
Project No. 7469-010	Checked By: C. G. LABERGE, PE
Figure: 7-3	Sheet: 1 OF 1

material at the large pile in the north portion of the site would be pulled back against the vertical wall and graded to slope down the hillside with southeast facing slopes of 3H:1V and matching natural grade along the west and east sides. The footprint of the north containment cell would be approximately 200 feet north to south and 400 feet east to west; it would have a fill depth of approximately 50 feet at a maximum against the rock wall, tapering down to blend with the surrounding natural topography. It is estimated that approximately 65% (or 122,000 cy) of the total volume of material at this location will require excavation and movement. The material already located within the containment area boundaries would not require excavation, however, this material would be regarded. The surface area would be capped with a vegetative cover and revegetated.

South Extension Containment Cells

The material in the southern extension area, including the upper and lower tailings areas, would be regarded in place creating two smaller consolidation areas, respectively. The footprints of the south extension area containment cells would be as follows. The upper cell would be approximately 80 feet north to south and 40 feet east to west; it would have a fill depth of approximately 5 feet. The lower cell would be approximately 100 feet north to south and 120 feet east to west; it would have a fill depth of approximately 5 feet. Each of the areas would be capped with a vegetative cover and revegetated if necessary. It is important to note that both of the areas currently support minor vegetative growth such as grasses and these surfaces will be preserved where possible.

Revegetation

Vegetation on the cap surface protects it from gullying and scouring by surface water, thereby minimizing erosion. The caps should be sloped from the center of the containment outward with a minimum of two percent slope to allow for good lateral drainage within the cover section, and to limit erosive velocities of local runoff on the cap. In addition, if erosion matting is not used, then the slope should be roughened to prevent rill erosion from forming. Revegetation activities should be implemented on site as soon as practicable after completing construction activities. Site preparation should include necessary soil amendments and/or fertilizer to support vegetation. Based on a successional planting scheme, the recommended initial plantings consist of a mix of plants which include both quick colonizers as well as a few species more adapted to later stages of ecological succession. The operation and maintenance activities for this alternative would likely include watering and other care required for the success of new vegetation, additional placement of seed in areas of unsuccessful revegetation during the initial attempt, and other needed repairs to the surface of the cap.

Surface Water Controls

Surface water diversion structures, similar to those included in Alternative 2 will be constructed at the top of the site to convey water around the perimeters of the piles and will connect to existing natural drainages.

Cap Monitoring and Maintenance

The vegetative caps and the leachate from the containment cells will be inspected and monitored to ensure that the containment remains effective. Monitoring of the caps would involve inspecting the surface for damage or deterioration, observing the edges to check that the cap materials are not receding in locations where the caps meet natural grade, and evaluating the revegetative process to ensure that the planted species are successful. Leachate monitoring would be performed by collecting samples at the downgradient extents of the containment cells. Leachate should be sampled and compared to applicable regulatory criteria and background levels. Results from the monitoring of leachate may indicate that further treatment is required.

Administrative Controls

Administrative controls will be implemented to prevent damage to the constructed containment cells and the associated surface water control features or disturbance to the revegetation process. Access will also be restricted. This will be implemented with the use of fencing and signage. Additionally, the site will be designated as a repository and restrictions will be applied to future uses of the site.

When evaluating this removal action alternative with respect to future land use, it appears that the consolidation and containment of waste materials would allow for the development of most areas of the Site. The containment area could likely be used for recreation purposes after revegetation efforts have taken hold, so long as cap erosion does not begin to take place. Care must be taken to ensure that the vegetated caps are not disturbed during construction or as a result of activities permitted within any proposed development.

Groundwater Characterization

As limited information is available, it is recommended that a comprehensive investigation be performed to characterize groundwater at the site. This study should investigate both occurrence of contamination and depth of groundwater. It is recommended that three groundwater monitoring wells be installed. In addition, a long term sampling plan should be prepared and implemented. The groundwater level and contaminant data should be compiled into a characterization report used to determine whether contamination exists, the extent of contamination, as well as the depth and direction of groundwater flow. This report should be used to determine if further study is warranted or if remediation of groundwater contamination is required.

Effectiveness

The design concepts comprising this alternative provide a high level of environmental protection considering the chemical and physical characteristics of the contamination. This alternative would be effective in significantly limiting the potential for off-site migration. The alternative would provide stability and containment for all of the waste material on site. It would also prevent surface water from coming in contact with the waste material. It would be effective in eliminating direct ecological and human contact with the piles. Because all operations would be conducted on site, potential risks to the public related to the transport of hazardous waste would be limited.

In this alternative, administrative controls would be implemented, such as fencing and signage. Fencing and signage would reduce ecological and human contact with contamination that remains exposed at the Site.

It is anticipated that there may be several short-term mitigable impacts to the environment during implementation of this alternative. Impacts could include wildlife disturbance through noise and human activity during construction.

Alternative 4 meets the RAOs regarding contact with ecological and human receptors as well as off site migration of contaminants. This alternative is a comprehensive removal action.

Implementability
The actions required for construction of this alternative are technically feasible using standard methods and procedures. The necessary equipment, personnel, and services are readily available to support implementation of this alternative. For Alternative 4 it is assumed moderate to heavy excavation equipment and limited hand work would be necessary. Road improvements under this alternative may be necessary because vehicle traffic on and off site would be required for transport of construction equipment and earthen fill and vegetative materials.

Select fill used in the construction elements of this alternative will be obtained from an offsite source. Potential borrow areas will have to be evaluated during the design phase of this project for adequate volume and appropriate agronomic and geotechnical properties.

Should the leachate from the containment cells exhibit elevated levels of mercury in exceedance of the established regulatory criteria, passive water treatment may be required. It is recommended that a treatability study be performed to find the most suitable technology effective on mercury-contaminated waters. A study might include a pilot treatment system. Research shows that common treatment systems utilized in heavy metals removal, such as sulfate reducing bacteria (SRB) would not be appropriate, as these organisms tend to promote methylation of mercury. One technology that has been recommended for removal of mercury contamination is the use of zero valent iron. A pilot treatment system might include passing the contaminated water through 55-gallon plastic drums containing the zero valent iron component. Samples of the leachate would be taken before and after to determine the reduction of mercury. If implemented, a passive water treatment system would involve long-term monitoring. Passive treatment of leachate has not been included in the evaluation of this alternative, nor in the cost estimate. Further investigation would be required should it be determined that this technology is to be implemented.

Cost

The estimate for implementing this alternative is $3,743,900 in year 2007 dollars. Annual operating and maintenance costs, as well as estimated indirect capital costs associated with administration, testing, and engineering, have been included. The costs have been included in the total under a present worth analysis over a 30-year design life using a discount rate of 7 percent. A detailed cost estimate is included in Appendix A.

7.4.5 Alternative 5: Removal to Off-Site Commercial Landfill Facility

This alternative aims to eliminate the potential for human and ecological contact with contaminated materials and to eliminate offsite migration of contaminated materials via gravity, wind, and water erosion. This alternative satisfies the RAOs; as it is protective of human and ecological health and it eliminates the potential for transport of contamination off-site. This alternative includes the excavation and complete removal of waste materials from the site to a off-site commercial landfill facility. Figure 7-4 presents a graphical depiction of this alternative.

The primary elements of this alternative include:

- Excavation of approximately 185,200 cy of waste material from the large north pile and approximately 90,000 cy of waste material from the extension area upper and lower tailings piles;

- Transport of all excavated material to an off-site commercial landfill or RCRA Class C (Hazardous Waste) landfill;

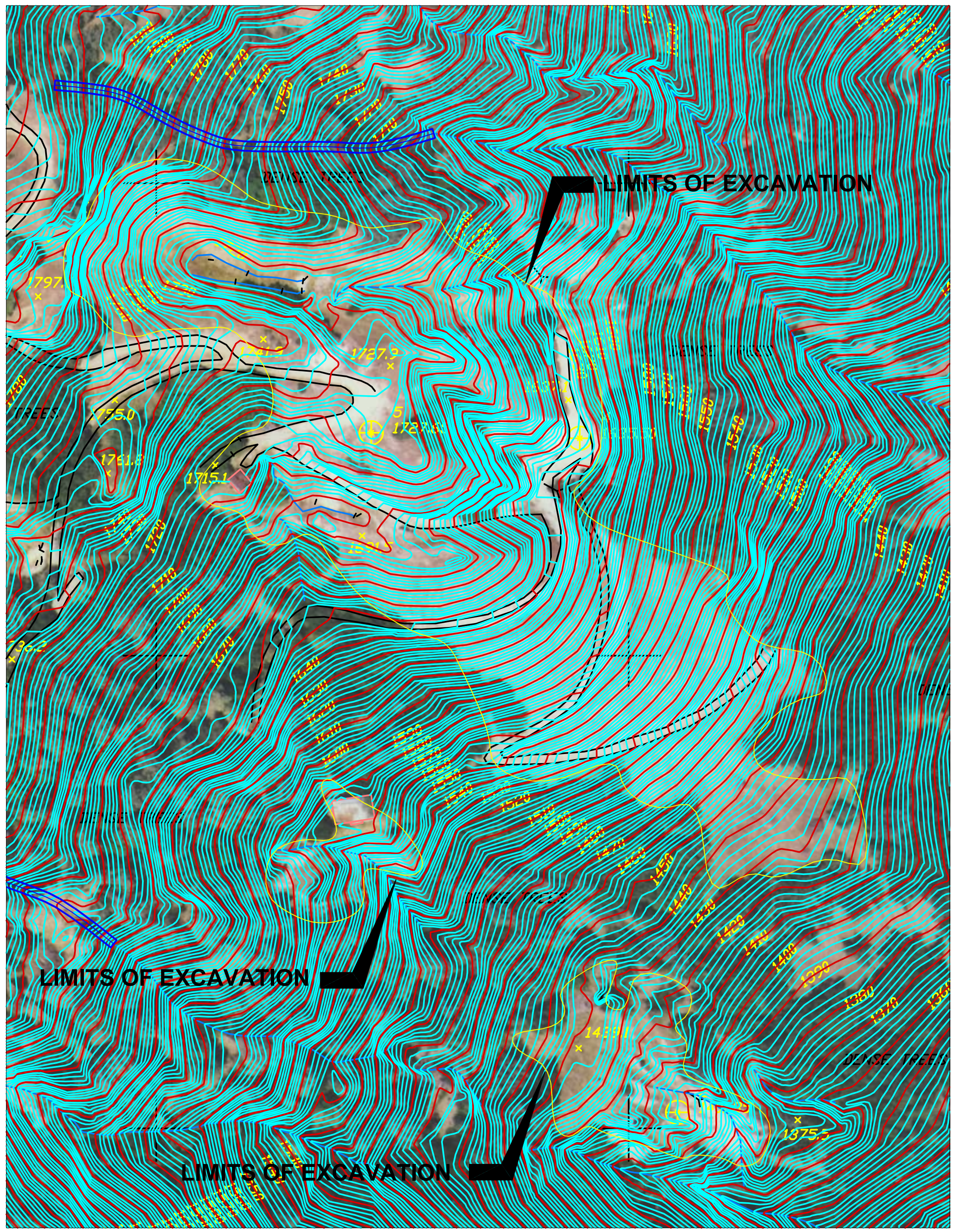
- Site reclamation after excavation, including regrading of surface resulting from excavation and revegetation; and

- Temporary surface water and other site controls during construction.

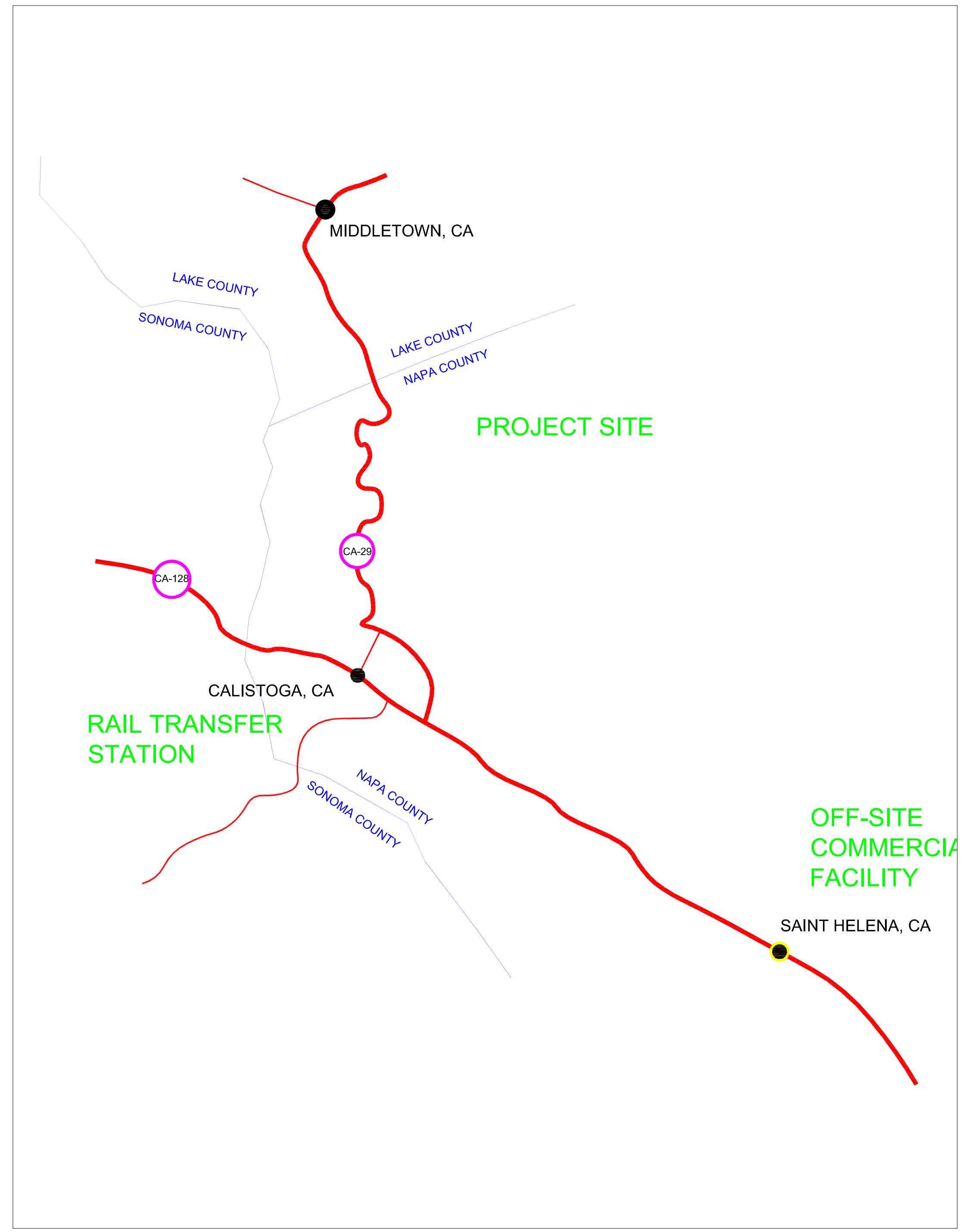
This alternative involves the excavation of all contaminated materials on the site and removal of these materials to an off-site facility. Ancillary work would also include: design and oversight; mobilization, including equipment movement, communications system, per diem, site facilities, contractor's job planning and coordination time, etc.; site grading; drainage system and erosion control; revegetation; and demobilization.

All contaminated material from the site will be excavated, loaded onto trucks, and removed from the site. For this scope component, it is assumed that a contracted trucking

EXCAVATION OF CONTAMINATED MATERIAL



MAP OF HAUL ROUTE



DIRECTIONS TO FACILITY

DIRECTIONS TO OFF-SITE COMMERCIAL LANDFILL FACILITY:

1. FROM SITE, FOLLOW DIRT ACCESS ROAD BACK TO CA-29.
2. FOLLOW CA-29 SOUTH APPROXIMATELY 13.5 MILES.
3. TURN LEFT ONTO FOOTHILL BLVD./CA-128/CA-29. FOLLOW FOR APPROXIMATELY 8.1 MILES.
4. TURN LEFT ONTO ADAMS ST.
5. UPPER VALLEY DISPOSAL SERVICE LANDFILL IS LOCATED IN SAINT HELENA, CA.

ALTERNATIVE 5:
REMOVAL TO OFF-SITE COMMERCIAL LANDFILL FACILITY

No.	Revisions	Date
#1		
#2		
#3		
#4		

Walsh
Environmental Scientists and Engineers, LLC

Oat Hill Extension Mercury Mine
Engineering Evaluation / Cost Analysis (EE/EA)
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Scale: 1" = 100'
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Date: SEPTEMBER 21, 2007	Drawn By: A. HAINES
Project No. 7469-010	Checked By: C. G. LABERGE, PE
Figure: 7-4	Sheet: 1 OF 1

outfit will be required to support the effort of removal to an off-site facility. Coordination of volumes and fees will have to be communicated through the trucking outfits and landfill facility operators.

Because voids or depressions will remain once the contaminated material is removed from the surface of the Site, attention must be paid to the resulting topography. The depressions left by the removed materials must be regraded to direct surface water into natural channels and drainages. All newly exposed surfaces will be revegetated.

Appropriate stormwater pollution prevention measures and best management practices such as diversions, sediment ponds, or silt fencing will be incorporated into the project to minimize the potential for adverse impacts to water quality during construction. All disturbed areas will be regraded for positive drainage, and then vegetated with native species as soon as practicable in order to minimize construction-related sediment transport. Fugitive dust emissions will be limited by the use of dust palliatives, or sprinkling as appropriate.

Post removal site control (operations and maintenance) for this Site would consist of minor erosion repair to the channel systems. When evaluating this removal action alternative with respect to future land use, it appears that the removal of waste will allow for the development of most areas of the Site.

Effectiveness

This alternative potentially provides the highest possible level of environmental protection, as the complete removal of contaminated surface materials from the current exposed, uncontrolled environment to a permitted facility with all required landfill controls and systems potentially meets the RAOs and ARARs. The on-site potential for human and ecological exposure through inhalation, ingestion, and dermal contact is potentially eliminated, and contaminant migration via surface runoff, soil or wind erosion, and groundwater interaction is potentially prevented.

Indirect safety and environmental risks associated with this alternative may be substantial. In order to mitigate these risks, proper plans and practices should be in place. Handling of the waste material needs to be performed in a manner that reduces risks to workers that may be associated with transportation. Engineering controls should be implemented to reduce exposure. Administrative controls and personal protective equipment may also be required. It is anticipated that there may be several short-term mitigable impacts to the environment during implementation of this alternative. Impacts could include wildlife disturbance through noise and human activity during construction. All operations are not confined to BLM property, and the hauling distance to the landfill poses a limited potential exposure to the public. The off-site facility alternative has the highest level of long-term effectiveness as the landfills are expected to be in operation for 50 years or longer and will presumably have site security and other systems that are required of a commercial facility. Moderate amounts of diesel fuel, tires, trucks, equipment and other resources would be utilized and wholly or partially consumed. These are all produced from scarce resources and utilized with direct and indirect environmental and health costs.

This alternative is considered permanent, and is thus effective in both the short and long term.

Implementability

The Site is accessible to construction and transport equipment by way of a 16 to 20 foot wide gravel county road. Travel within the site, however, may prove more difficult. Steep slopes and rough terrain will limit equipment performance. The necessary equipment, personnel, and services for excavating and transporting the waste are readily available to support implementation of this action. Project sequencing will help maintain drainage during the construction period and avoid further contamination or damages to natural or man-made surface water conveyance systems. If funding is available, the project can be completed within one year.

The following is an explanation of the derivation of requirements for excavation, removal, and selection of an appropriate disposal facility.

In determining where the waste may be disposed, the waste will be tested for the RCRA TCLP analysis. The waste that passes the TCLP analyses may be disposed in a non-RCRA regulated commercial facility. The waste that fails the TCLP analyses will be disposed in a hazardous waste accepting facility. See Figure 7-4 for the conceptual approach to this alternative.

The required preparation of acceptance confirmation samples for TCLP Mercury follows EPA Methods 1310 or 1311 and analysis by EPA Method 7470 Cold Vapor. The established acceptance limit is 0.2 mg/L.

An alternative approach to off-site disposal would include retaining an “all inclusive” contractor to perform the loading and transport of removed material as well as taking care of the fees and taxes associated with disposal. Waste Solutions Group (WSG) was contacted for a cost estimate and logistical evaluation. WSG proposes transferring the waste from haul trucks to rail cars for long distance transport. Under this proposal, waste would be excavated and transferred to trucks, hauled to the nearby town of Calistoga where the waste would be transferred to rail cars. The waste would be transported the remainder of the distance to the disposal facility by train. WSG would also be responsible for disposal fees and associated taxes. Should treatment of the waste be required, WSG also has the capability to perform sampling and arrange analyses. WSG can transport waste to either a commercial facility or a RCRA (Hazardous Waste) facility.

Cost

The estimate for implementing this alternative is $31,628,700 in year 2007 dollars. Annual operating and maintenance costs, as well as estimated indirect capital costs associated with administration, testing, and engineering, have been included. The costs have been included in the total under a present worth analysis over a 30-year design life using a discount rate of 7 percent. A detailed cost estimate is included in Appendix A.

8 Comparative Analysis of Removal Action Alternatives

Alternative 1 – No Action
The No Action Alternative would not be effective in reducing or eliminating the threat to human health and the environment through treatment or containment of the contaminated materials.

Alternative 2 – Run-on/off Controls
The alternative would control the amount of water coming in contact with the waste material at the surface of the piles. It would not be effective in reducing direct ecological and human contact with the piles. Alternative 2 does not meet RAOs regarding contact with ecological and human receptors. However, it could be used as a short-term measure until a more comprehensive removal action is taken.

Alternative 3 – Stabilization by Terracing
Although it would not prevent all off-site migration of contaminants, the alternative would provide stability for the steep slopes of the large pile and would control the amount of water coming in contact with the waste material at the surface of the piles. Design life of the terrace features would be a consideration in this alternative. It would not be effective in reducing direct ecological and human contact with the piles. Alternative 3 does not meet RAOs regarding contact with ecological and human receptors. However, it could be used as a short-term measure until a more comprehensive removal action is taken.

Alternative 4 – On-Site Consolidation and Capping
The on-site consolidation and capping of contaminated material would be effective in significantly limiting the potential for off-site migration. The alternative would provide stability and containment for all of the waste material on site. It would also prevent surface water from coming in contact with the waste material. It would be effective in eliminating direct ecological and human contact with the piles. Because all operations would be conducted on site, potential risks to the public related to the transport of hazardous waste would be limited. Alternative 4 meets the RAOs regarding contact with ecological and human receptors as well as off site migration of contaminants.

Alternative 5 – Removal to Off-Site Commercial Landfill

The excavation and placement of the contaminated material in an off-site commercial landfill facility would be an effective and implementable removal action. Landfill and/or hauling fees would be significantly higher than stabilizing in place or building an on-site consolidation cell for the contaminated material. Furthermore, the long-term liability of placing the material in a commercial facility remains to be determined.

9 Recommended Removal Action Alternative

9.1 Description of Evaluation Process Used to Develop Recommended Action

As directed by EPA guidance, the eight removal action alternatives presented in this EE/CA have been evaluated against three general criteria: effectiveness, implementability, and cost. The specific components of each criterion are defined as follows:

Effectiveness

- Overall protectiveness of human health and environment
- Ability to achieve RAOs/ARARs
- Short- and long-term effectiveness

Implementability

- Technical feasibility
- Administrative feasibility
- Availability of materials and sources
- Community applicability

Cost

- Capital cost
- Post-removal control cost
- Present worth cost
- Maintenance and monitoring costs

9.2 Recommended Removal Action

A community meeting will be held on Wednesday, November 14, 2007. A recommended removal action will be determined upon discussion of the EE/CA and decision by BLM.

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